

OMA V™ InGaAs System



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General Information

Introduction

The OMA V:InGaAs uses a 512-element or 1024-element linear InGaAs photodiode array (PDA) for near infrared (NIR) spectroscopy applications and a 320 x 256 InGaAs focal plane array (FPA) for NIR imaging applications. InGaAs provides excellent response in the NIR from 0.8 to 1.7 μm or from 1 to 2.2 μm , depending on the OMA V detector. This 16-bit detector offers outstanding sensitivity for applications such as NIR Raman and emission, plus high dynamic range for NIR transmission, reflectance, and absorbance.

The liquid nitrogen-cooled version of OMA V:InGaAs photodiode array detector is ideal for low light level applications requiring long integration times. The thermoelectrically-cooled version provides similar performance with the added benefit of freedom from the constraints of liquid-nitrogen usage and handling.

The photodiode array (PDA) is a third generation, solid state, image device capable of performing these three essential functions: transducing photons to electrons, integrating and storing, and reading. The array is rugged, compact, and resilient to mechanical shocks, direct exposure to high light levels, and magnetic and RF radiation. PDAs are particularly suited to applications where accuracy, precision, high dynamic range, low noise and high geometric stability are most important. The arrays are, to a great degree, lag and blooming free.

Used in the 2-D OMA V:320 detector, the focal plane array (FPA) is a two-dimensional array of photodiodes that is particularly well suited for near infrared imaging (NIR) applications. The electronics are based on our successful OMA V platform and the detector has a 5MHz readout speed that delivers high frame rate of 53 frames per second. The key specification for the detector is the deep cooling (LN based) to -100C which reduces the dark signal and allows long integration times.

General Features

- Compact and lightweight design allows easy interfacing with various spectrometers and alignment with optical systems.
- Widest range of temperature control:
LN-cooling: -50°C to -100°C.



Figure 1. OMA V:InGaAs Detectors

TE-cooling: ambient to $<-45^{\circ}\text{C}$ with air-assist.

QE vs. Temperature: The red edge (long wavelengths) of the QE curve moves $-0.8\text{ nm}/^{\circ}\text{C}$ as temperature is decreased.

Dark Signal vs. Temperature: Dark signal is reduced as the array temperature is decreased.

- Maximum user safety: Three different valves protect against pressure buildup either in the LN container or in the vacuum vessel.

The OMA V:InGaAs LN-cooled detector has three distinct sections:

- The front enclosure contains the array seated on a cold finger. This finger is in contact with the LN Dewar and has a heater to regulate the array temperature. The front enclosure opens into the vacuum jacket that surrounds the internal LN Dewar.
- The Dewar is filled through a sealable top opening, and has two pressure-relief valves operating at 1 and 10 psi to safely vent N_2 gas.
- The electronics enclosure contains the preamplifier and array driver board. This keeps all signal leads to the preamplifier as short as possible and provides complete RF shielding.

The OMA V:InGaAs TE-cooled detector has three distinct sections:

- The front enclosure contains the array seated on a cold finger, with an attached thermal sensing diode to monitor its temperature. The cold finger is seated on a multi-stage Peltier thermoelectric cooler, driven by closed-loop proportional-control circuitry.
- The electronics enclosure contains the preamplifier and array driver boards. This keeps all signal leads to the preamplifier as short as possible and provides complete RF shielding.
- The back enclosure contains the heat exchanger that is cooled by an internal fan. Air is drawn in from the rear most vents on the side of the detector and is exhausted through the front most side vents. Liquid-assisted cooling is optional.

Detector Window

WARNINGS

Never remove the detector's front window; ice will form immediately, destroying 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. With the exception of the 2-D OMAV:320, the window is made of the highest quality quartz available. A sapphire window is used in the 2-D OMAV:320.

About this Manual

Manual Organization

This manual provides the user with all the information needed to install an OMA V detector and place it in operation. Topics covered include a detailed description of the detector, installation, cleaning, specifications and more.

Notes:

1. The general identifier "ST-133" is used for both the ST-133A Controller and the ST-133B Controller. Where there is a difference, the specific identifier is used.
2. "WinX" is a generic term for WinView/32, WinSpec/32, and WinXTest application software.

Chapter 1, Introduction briefly describes the OMA V family of detectors; details the structure of this manual; and documents environmental, storage, and cleaning requirements.

Chapter 2, System Component Descriptions 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 setting up the computer interface, interconnecting the system components, and mounting the detector to a spectrometer.

Chapter 5, Operation includes simple procedures for verifying system operation and discusses operational considerations associated with exposure, readout, and digitization.

Chapter 6, Advanced Topics discusses standard timing modes (Free Run, External Sync, and Continuous Cleans), Fast and Safe triggering modes, and TTL control.

Chapter 7, 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 OMA V detectors and the ST-133A and ST-133B Controllers.

Appendix C, Mercury-Argon Pen Lamp Spectrum provides a graph of a Mercury-Argon pen lamp spectrum between 750 nm and 1700 nm.

Appendix D, Spectrometer Adapters provides mounting instructions for the spectrometer adapters available for OMA V detectors.

Appendix E, USB 2.0 Limitations covers the currently known limitations associated with operating under the USB 2.0 interface.

Appendix F, Adapter and Lens Focusing Procedures documents how to focus an F-mount adapter and focus an F-mount or C-mount lens.

Declarations of Conformity contains the Declarations of Conformity for OMA V systems (LN- and NTE2-cooled).

Warranty and Service provides warranty and customer support contact information.

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.

Grounding and Safety

The ST-133 is of Class I category as defined in IEC Publication 348 (Safety Requirements for Electronic Measuring Apparatus). It is designed for indoor operation only. Before turning on the controller, the ground prong of the powercord 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 powercord. If it is not compatible with the power socket, replace the cord with one that has suitable connectors on both ends.

WARNING! Replacement powercords or power plugs must have the same polarity as that of the original ones to avoid hazard due to electrical shock.

Precautions

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

- Do not mix and match ST-133 Controllers and detectors. The controller shipped with your detector has been modified to operate with the detector included in the OMA V system you ordered.
- Always switch off and unplug the ST-133 Controller before changing your system configuration in any way.

- 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.

If you are using high-voltage equipment (such as an arc lamp) with your detector system, be sure to turn the controller power ON LAST and turn the controller power OFF FIRST.

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.

Never connect or disconnect any cable while the system is powered on. Reconnecting a charged cable may damage the array.

- Never prevent the free flow of air through the equipment by blocking the air vents.
- Never operate a liquid-assisted or liquid-cooled-only OMA V detector with coolant at a temperature below that specified for it.

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.

Controller and Detector

Although there is no periodic maintenance that *must* be performed on an OMA V detector, 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 also they could damage the finish of the surfaces on which they are used.

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.

Caution!

Since windows may be AR-coated, extreme care should be taken when cleaning the windows. This coating is easily scratched and damage caused by improper cleaning is not covered by the warranty.

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Chapter 2

System Component Descriptions

OMA V:InGaAs Detector



Array:

- **Linear Photodiode Array:** The 512- and 1024-element linear InGaAs photodiode arrays (PDA) with silicon multiplexer readout electronics provide excellent response in the near infrared (NIR) from 0.8 to 1.7 μm or from 1 to 2.2 μm , depending on the detector model. This 16-bit detector offers outstanding sensitivity for applications such as NIR Raman and emission, plus high dynamic range for NIR transmission, reflectance, and absorbance.
- **Focal Plane Array:** The 320 x 256 (30 μm x 30 μm pixel) InGaAs focal plane array (FPA) with silicon multiplexer readout electronics provide excellent response in the near infrared (NIR) from 0.8 to 1.7 μm . This 16-bit detector offers outstanding sensitivity for low light level NIR imaging applications.

Window:

- OMA V:512 and OMA V:1024 window is made of SI-UV fused silica quartz.
- 2-D OMA V:320 window is sapphire.

Connectors:

- **OMA V:512 and OMA V:1024:** Power, control signals, and data are transmitted between the ST-133 and the OMA V detector via the 25-pin D connector located on the rear of the detector. The Detector-Controller cable is secured by a slide-lock mechanism. Controller power must be OFF before connecting to or disconnecting from this connector.
- **2-D OMA V:320:** Power, control signals, and data are transmitted between the ST-133 and the OMA V detector via the 15-pin and 40-pin connectors on the rear of the detector. The cables and connectors are keyed so that they cannot be connected incorrectly. Controller power must be OFF before connecting to or disconnecting from this connector.

Fan: (TE only) There may be a fan located inside the detector's back panel. Its purpose is:

- to remove heat from the Peltier device that cools the PDA and
- to cool the electronics.

An internal Peltier device directly cools the cold finger on which the PDA is mounted. The heat produced by the Peltier device is then removed by the air drawn into the detector by the internal fan and exhausted through the side panels. The fan is always in operation and air cooling of both the Peltier and the internal electronics takes place continuously. The fan is designed for low-vibration and does not adversely affect the

image. For the fan to function properly, free circulation must be maintained between the rear of the detector and the laboratory atmosphere.

Dewar: LN-cooled detectors are available in both the standard side-on and the end-on configuration. The Dewar for the standard side-on holds 1.7 liters of liquid nitrogen (LN).

Adapters: Spectrograph adapters are available from Princeton Instruments. Refer to Appendix D for information about mounting these adapters to your spectrometer and detector.

ST-133 Controller



Electronics: The ST-133 controller is a compact, high performance Detector Controller for operation with Princeton Instruments brand* detectors. Designed for high speed and high performance image acquisition, the ST-133 offers data transfer at speeds up to 5 megapixel per second. A variety of A/D converters are available to meet different speed and resolution requirements.

In addition to containing the power supply, the controller contains the analog and digital electronics, scan control and exposure timing hardware, and controller I/O connectors, all mounted on user-accessible plug-in modules. This highly modularized design gives flexibility and allows for convenient servicing.

Note: The ST-133 Controller supplied with the OMA V:InGaAs detector has been modified for operation with a linear photodiode array or a focal plane array depending on the model. DO NOT use this controller with CCD detectors.

POWER Switch and Indicator: The power switch location and characteristics depend on the version of ST-133 Controller that was shipped with your system. In some versions, the power switch is located on the front panel and has an integral indicator LED that lights whenever the ST-133 is powered. In other versions, the power switch is located on the back of the ST-133 and does not include an indicator LED. Figure 2 shows the two locations

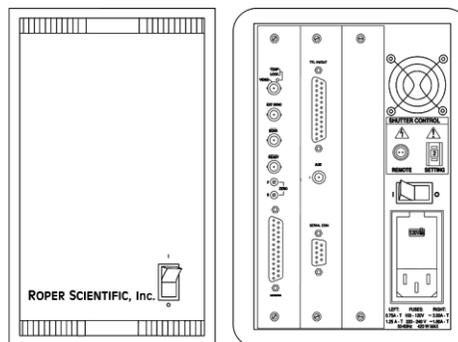


Figure 2. Power Switch Location
(ST-133A and ST-133B)

Rear Panel Connectors: There are three controller board slots. Two are occupied by the plug-in cards that provide various controller functions. The third, covered with a blank panel, is reserved for future development. The left-most plug-in card is the Analog/Control module. Adjacent to it is the Interface Control module. Both modules align with top and bottom tracks and mate with a passive backplane via a 64-pin DIN connector. For proper operation, the location of the modules should not be changed. Each board is secured by two screws that also ground each

* The ST-133 controller must be factory configured for operation with a linear array or for a focal plane array. Additionally, it must be configured for the type of cooling. For this reason, a controller purchased for operation with an LN detector can only be used with an LN detector. Similarly, a controller purchased for operation with a TE detector *cannot* be used with an LN detector.

module's front panel. The connectors and functions located on the rear panel are further described on the following page. Removing and inserting boards is described in Chapter 7, page 84.

WARNING!

To minimize the risk of equipment damage, a module should *never* be removed or installed when the system is powered.

The **Analog/Control Module**, which should always be located in the left-most slot, provides the following functions:

- Pixel A/D conversion
- Scan control
- Exposure control
- Timing and synchronization of readouts
- Temperature control
- Video output control

The **Interface Control Module**, which should always be located in the center slot, provides the following functions:

- TTL In/Out Programmable Interface
- Communications Control (TAXI or USB 2.0 protocol)

WARNING!

Always turn the power off at the Controller before connecting or disconnecting any cable that interconnects the detector and controller or serious damage to the PDA may result. This damage is *NOT* covered by the manufacturer's warranty.

#	Feature	#	Feature
11	AUX Output: Reserved for future use.	15	Remote Shutter Connector: Provides shutter-drive and hold voltages for a Princeton Instruments 25 mm external shutter (typically, an entrance slit shutter). An ST-133 with the 70 V shutter option is required for a detector with the 40 mm shutter. A 70 V OPT label will be next to the Remote connector when this option is installed. Note that this connector may not be present for a 5 MHz system.
12	Serial COM Connector: Provides two-way serial communication between the controller and the host computer. Uses TAXI protocol.	16	Power Module: Contains the powercord socket and two fuses. Depending on the ST-133 version, the power switch may be located directly above the power module.
13	Fan: Cools the controller electronics. Runs continuously when the controller is turned on.	17	Fuse/Voltage Label: Displays the controller's power and fuse requirements. This label may appear below the power module.
14	Shutter Setting Selector: Sets the shutter hold voltage. Dial is correctly set at the factory for the detector's internal shutter if one is present.	18	USB 2.0 Connector: Provides two-way serial communication between the controller and the host computer. Uses USB 2.0 protocol.

Cables



Detector-Controller: 1 MHz or 100kHz/1MHz systems. The standard 10' (3 m) cable (6050-0321) has DB-25 connectors with slide-latch locking hardware. This cable interconnects the Detector connector on the rear of the ST-133 with the Detector connector on the rear of the OMA V detector. The Detector-Controller cable is also available in 6', 15', 20', and 30' lengths.



Camera Power & Signal: 2-D OMA V 1MHz/5 MHz systems only. This cable assembly (6050-0313) consists of two cables that interconnect the Camera Power and Camera Signal connectors on the back of the ST-133 with the mating connectors on the back of the detector. The Camera Power cable has DB-15 Male connectors with locking screws at both ends. The Camera Signal cable has DB-40 Male connectors with slide-latch locking mechanisms at both ends.

Interface Cable: Depending on the system configuration, either a USB or a TAXI cable will be shipped.



TAXI: The standard 25' (7.6 m) cable (6050-0148-CE) has DB-9 Male connectors with screw-down locking hardware. The TAXI (Serial communication) cable interconnects the "Serial Com" connector on the rear of the ST-133 with the Princeton Instruments (RSPI) high speed PCI card installed in the host computer. In addition to the standard length, this cable is available in 10', 50', 100', and 165' lengths. Also available are fiber optic adapters with fiber optic cables in 100, 300, and 1000 meter lengths.

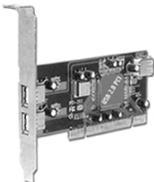


USB 2.0: The standard 16.4' (5 m) cable (6050-0494) has USB connectors that interconnect the "USB 2.0" connector on the rear of the ST-133 with a USB card installed in the host computer.

Interface Card



PCI Card: This interface card is required when the system interface uses the TAXI protocol rather than USB 2.0. The PCI card plugs-into the host computer's motherboard and provides the serial communication interface between the host computer and the ST-133. Through WinSpec/32 or WinView/32, the card can be used in either **High Speed PCI** or **PCI(Timer)** mode. **High Speed PCI** allows data transfer to be interrupt-driven and can give higher performance in some situations. **PCI(Timer)** allows data transfer to be controlled by a polling timer.



USB 2.0 Card: (Optional) This interface card is required when the system interface uses the USB 2.0 protocol rather the TAXI protocol and the computer does not have native USB 2.0 support. The USB 2.0 card plugs-into the host computer's motherboard and provides the communication interface between the host computer and the ST-133. The USB 2.0 PCI card (70USB90011) by Orange Micro is recommended for desktop computers; the SIIG, Inc. USB 2.0 PC Card, Model US2246 is recommended for laptop computers. See www.orangemicro.com or www.siig.com, respectively, for more information.

Application Software



Spectroscopy experiments and imaging applications are easily controlled and monitored via the Princeton Instruments WinSpec and WinView software packages, the SITK™ plug-in for LabVIEW®, and the Roper Scientific® PVCAM® application programming interface.

WinSpec/32: Princeton Instruments' 32-bit Windows® software package for spectroscopy. It provides stand-alone comprehensive spectral acquisition, display, processing, and archiving functions. WinSpec gives you the ability to run automatic spectrometer control and calibration routines, as well as to move to any spectral window or change gratings without having to recalibrate. WinSpec also features snap-ins and macro record capability to permit easy user customization of any function or sequence.

WinView/32: Princeton Instruments' 32-bit Windows® software package for imaging applications. WinView/32 software package provides comprehensive image acquisition, display, processing, and archiving functions so you can perform complete data acquisition and analysis without having to rely upon third-party software. WinView/32 also features snap-ins and macro record functions to permit easy user customization of any function or sequence.

PVCAM: A standard software interface for cooled PDA, FPA, and CCD detectors from Roper Scientific. It is a library of functions that can be used to control and acquire data from the detector when a custom application is being written. For example, in the case of Windows, PVCAM is a dynamic link library (DLL). Also, it should be understood that PVCAM is solely for detector 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.

Scientific Imaging ToolKit™ (SITK™): A collection of LabVIEW® VIs for scientific detectors and spectrographs. This third party software can be purchased from Princeton Instruments.

User Manuals



OMA V:InGaAs System User Manual: This manual describes how to install and use the OMA V:InGaAs system components.

WinSpec/32 User Manual: (Optional) This manual describes how to install and use the application program. A PDF version of this manual is provided on the installation CD. Additional information is available in the program's on-line help.

WinView/32 User Manual: (Optional) This manual describes how to install and use the application program. A PDF version of this manual is provided on the installation CD. Additional information is available in the program's on-line help.

Note: You can download current versions of Princeton Instruments manuals at [ftp://ftp.princetoninstruments.com/Public/Manuals/Princeton Instruments/](ftp://ftp.princetoninstruments.com/Public/Manuals/Princeton%20Instruments/). Versions of Acton manuals are located at <ftp://ftp.princetoninstruments.com/Public/Manuals/Acton/>.

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Chapter 3

Installation Overview

The list and diagrams below briefly describe the sequence of actions required to hookup your system and prepare to gather data. Refer to the indicated references for more detailed information.

Action	Reference
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.	Chapter 4 System Setup, page 25
2. Verify that all system components have been received.	Chapter 4 System Setup, page 25
3. If the components show no signs of damage, verify that the appropriate voltage settings have been selected for the Controller.	Chapter 4 System Setup, page 28
4. If the WinX application software (WinSpec/32 or WinView/32) software is not already installed in the host computer, install it.	WinSpec/32 or WinView/32 manual
5. If the appropriate interface card is not already installed in the host computer, install it.	Chapter 4 System Setup, page 29
6. Mount the Detector for the spectroscopy or imaging application, as appropriate.	Chapter 4 System Setup, page 33
7. With the Controller power turned OFF, connect the Detector-Controller cable to the appropriate connector on the rear of the Controller. Adjust the slide-latch so the cable connection is locked.	Chapter 4 System Setup, page 34 Chapter 7 Troubleshooting, page 86
8. With the Controller power turned OFF, connect the Detector-Controller cable(s) to the appropriate connector(s) on the rear of the Detector. Adjust the slide-latch (and locking screws if this is a 5 MHz controller) to lock the cable connection(s).	Chapter 4 System Setup, page 34 Chapter 7 Troubleshooting, page 86
9. With the Controller and computer power turned OFF, connect the interface cable (TAXI or USB) to the Controller and the interface card in the host computer. Then tighten down the locking hardware.	Chapter 4 System Setup, page 34
10. With the Controller power turned OFF, connect the Controller power cable to the rear of the controller and to the power source.	
11. Turn the Controller ON .	

Action	Reference
12. Turn on the computer and begin running the WinX application software. When the computer boots, you may be asked for the location of the interface drivers.	Chapter 4 System Setup, page 30 (PCI drivers) or page 32 (USB drivers) WinSpec/32 or WinView/32 manual
13. In the WinX application, run the Camera Detection wizard or load the defaults from the controller.	Chapter 4 System Setup, WinSpec/32 or WinView/32 manual
14. Set the target array temperature.	Chapter 5 Operation, page 52
15. If the system is cooled by coolant circulation, make the tubing connections between the coolant circulator and the detector.	Chapter 4 System Setup, page 37
16. If the system is cryogenically cooled, fill the Dewar.	Chapter 4 System Setup, page 38
17. When the system reaches temperature lock, wait an additional 30 minutes and then begin acquiring data in focus mode.	Chapter 5 Operation, page 44
18. Adjust the focus for the best spectral lines. If you are using WinSpec/32, you may want to use the Focus Helper function for this purpose.	Chapter 5 Operation, page 45

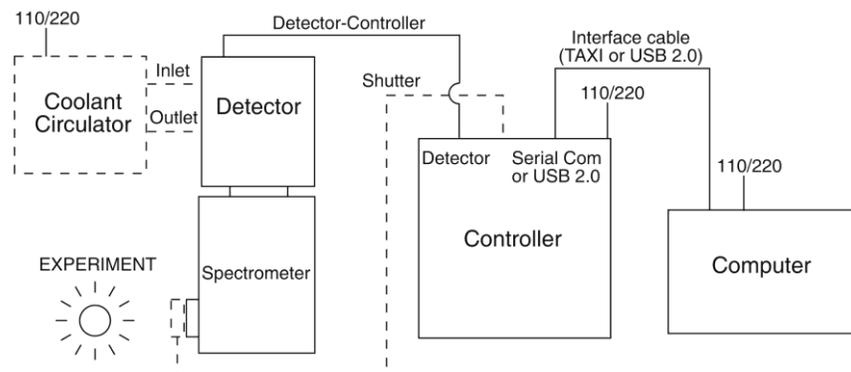


Figure 4. System Diagram: TE-cooled Detector

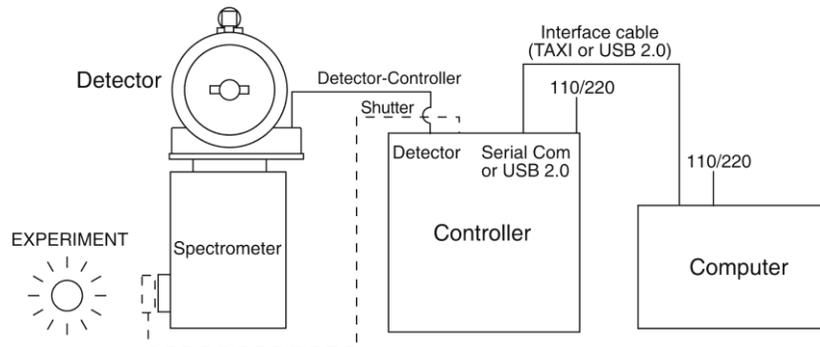


Figure 5. System Diagram: LN-cooled Detector

System Setup

Unpacking the System

During the unpacking, check the system components for possible signs of shipping damage. If there are any, notify 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 ship the detector system to another location or return it to Princeton Instruments for repairs if necessary.

Checking the Equipment and Parts Inventory

Confirm that you have all of the equipment and parts required to set up the OMA V system. A complete system consists of:

- **Detector** (TE- or LN-cooled).
- **ST-133 Controller**
- **Detector-Controller cable:**
 - Standard OMA V:** DB25 to DB25. Standard length is 10 ft (6050-0321). This cable is also available in 6', 15', 20', and 30' lengths.
 - 2-D OMA V:** DB15 to DB15 and high-density DB40 to DB40 (6050-0313).
- **Host Computer:** Can be purchased from Princeton Instruments or provided by user.
- **OMA V User Manual**
- **Interface Dependent Components:**
 - **Controller-Computer Interface cable:**
 - **TAXI cable:** DB9 to DB9 cable (6050-0148-CE is standard) or
 - **USB cable:** Five (5) meter cable (6050-0494) is standard.
 - **Interface Card:**
 - **TAXI:** Princeton Instruments (RSPI) High Speed PCI Interface board or
 - **USB 2.0:** Native on motherboard or user-provided USB 2.0 Interface Card (Orange Micro 70USB90011 USB2.0 PCI is recommended for desktop computers and the SIIG, Inc. USB 2.0 PC Card, Model US2246 is recommended for laptop computers).

- **System Dependent Cooling Components:**
 - Coolant Circulator and Coolant Tubing
- **Optional:** WinX (WinSpec/32 or WinView/32) CD-ROM and Manual

System Requirements

Environmental

Storage temperature $\leq 55^{\circ}\text{C}$;

Operating environment temperature: 5°C to $+30^{\circ}\text{C}$; for TE-cooled detectors, the environment temperature range over which system specifications can be guaranteed is $+18^{\circ}\text{C}$ to $+23^{\circ}\text{C}$

Relative humidity <50% noncondensing. High humidity climates may require continuous flushing of the spectrometer's exit port with nitrogen. If LN-cooled detectors are operated under high humidity conditions, ice-buildup could occur around the vent valves. Operating liquid-assist TE-cooled detectors in high humidity environments can produce condensation inside the detector's electronic enclosure. Damage from humid condensation may not be covered by the product warranty.

Ventilation

Detector: Allow at least one-inch clearance for side and rear air vents. Where an air-assist TE-cooled detector is inside an enclosure, > 30 cfm air circulation and heat dissipation of 100W is required.

ST-133: There is an internal fan located at the right side of the rear panel behind an exhaust opening. Its purpose is simply to cool the controller electronics. This fan runs continuously whenever the controller is powered. Air enters the unit through ventilation openings on the side panels, flows past the warm electronic components as it rises, and is drawn out the rear of the controller by the fan. It is important that there be an adequate airflow for proper functioning. As long as both the controller's intake ventilation openings and the fan exhaust opening aren't obstructed, the controller will remain quite cool.

Coolant

WARNING! COOLANT IS HARMFUL IF SWALLOWED.
KEEP OUT OF REACH OF CHILDREN.

OMA V detectors with liquid-cooling require circulating coolant (distilled water or 50:50 mixture of ethylene glycol and water) for proper operation. The recommended flow rate and fluid pressure are: > 1 liter/minute at 25 psig (maximum).

Power

Detector: The OMA V detector receives its power from the controller, which in turn plugs into a source of AC power.

ST-133: The ST-133 Controller can operate from any one of four different nominal line voltages: 100, 120, 220, or 240 V AC. Refer to the Fuse/Voltage label on the back of the ST-133 for fuse, voltage, and power consumption information.

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 line 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.

Host Computer

Note: Computers and operating systems all undergo frequent revision. The following information is only intended to give an approximate indication of the computer requirements. Please contact the factory to determine your specific needs.

Requirements for the host computer depend on the type of interface, TAXI or USB 2.0, that will be used for communication between the ST-133 and the host computer. Those requirements are listed below according to protocol.

TAXI Protocol:

- AT-compatible computer with 200 MHz Pentium[®] II (or better).
- Windows[®] XP (32-bit, SP3 or later) or Windows Vista[®] (32-bit) operating system.
- Princeton Instruments (RSPI) High speed PCI serial card (or an unused PCI card slot). Computers purchased from Princeton Instruments are shipped with the PCI card installed if High speed PCI was ordered.
- Minimum of 128 Mbytes of RAM for arrays up to 1.4 million pixels. Collecting multiple spectra at full frame or high speed may require 512 Mbytes or more of RAM.
- CD-ROM drive.
- Hard disk with a minimum of 80 Mbytes available. A complete installation of the program files takes about 17 Mbytes and the remainder is required for data storage, depending on the number and size of spectra collected. Disk level compression programs are not recommended.
- Super VGA monitor and graphics card supporting at least 65,535 colors with at least 32 Mbyte of memory. Memory requirement is dependent on desired display resolution.
- Two-button Microsoft[®] compatible serial mouse or Logitech[®] three-button serial/bus mouse.

USB 2.0 Protocol:

- AT-compatible computer with Pentium 3 or better processor and runs at 1 GHz or better.
- Windows XP (32-bit with SP2 or later) or Windows Vista (32-bit) operating system.
- Native USB 2.0 support on the motherboard or USB Interface Card (Orange Micro 70USB90011 USB2.0 PCI is recommended for desktop; SIIG, Inc. USB 2.0 PC Card, Model US2246 for laptop)
- Minimum of 256 Mb of RAM.
- CD-ROM drive.
- Hard disk with a minimum of 80 Mbytes available. A complete installation of the program files takes about 17 Mbytes and the remainder is required for data

storage, depending on the number and size of spectra collected. Disk level compression programs are not recommended.

- Super VGA monitor and graphics card supporting at least 65,535 colors with at least 32 Mbyte of memory. Memory requirement is dependent on desired display resolution.
- Two-button Microsoft compatible serial mouse or Logitech three-button serial/bus mouse.

Verifying Controller Voltage Setting

The Power Module on the rear of the Controller contains the voltage selector drum, fuses and the powercord connector. The appropriate voltage setting is set at the factory and can be seen on the back of the power module.

Each setting actually defines a range and the setting that is closest to the actual line voltage should have been selected. The fuse and power requirements are printed on the panel above the power module. The correct fuses for the country where the ST-133 is to be shipped are installed at the factory.

Note: On ST-133s, the voltage ranges and fuse ratings may be printed above or below the power module (Figure 6).



Figure 6. Controller Power Module

To Check the Controller's Voltage Setting:

1. Look at the lower righthand corner on the rear of the Controller. The current voltage setting (100, 120, 220, or 240 VAC) is displayed on the Power Module.
2. If the setting is correct, continue with the installation. If it is not correct, follow the instructions on page 71 for changing the voltage setting and fuses.

Installing the Application Software

Installation is performed via the WinX (WinSpec/32 or WinView/32) installation process. If you are installing the WinX application for the first time and have a TAXI interface, you should run the installation before the interface card is installed in the host computer. On the **Select Components** dialog (see Figure 7), click on the **AUTO PCI** button to install the interface card drivers (the Princeton Instruments (RSPI) PCI and the USB drivers) and the most commonly installed program files. Select the **Custom** button if you would like to choose among the available program files or do not want to install the PCI driver.

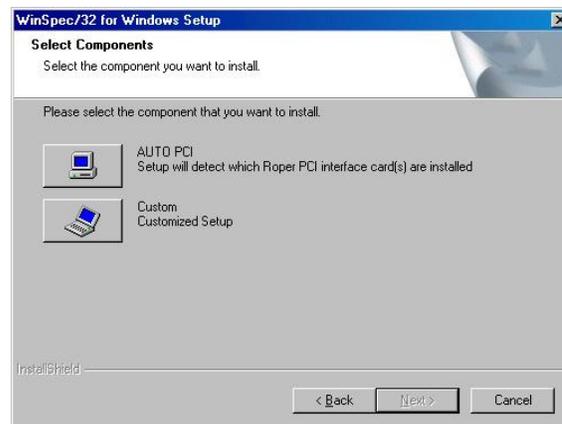


Figure 7. WinSpec Installation: Interface Card Driver Selection

Note: WinX/32 (versions 2.6.0 and higher) do not support the ISA interface.

Setting up the Communication Interface

Setting up a PCI Interface

Administrator privileges are required under Windows® XP and Windows Vista® (32-bit) to install software and hardware.

A Princeton Instruments (RSPI) high speed PCI card must be installed in the host computer if the communication between computer and controller uses the TAXI protocol (i.e., the **Interface Control Module** installed in the ST-133 has a 9-pin **SERIAL COM** connector as shown in the figure at right). With TAXI protocol, the standard cable provided with an ST-133 is 7.6 meters (25 feet) (cable lengths up to 50 meters are available) and the digitization rate may be as high as 5 MHz.

A computer purchased from Princeton Instruments will be shipped with the PCI card already installed. Otherwise, a PCI card will be shipped with the system and you will have to install it in the host computer at your location.

Note: The PCI card can be installed and operated in any Macintosh having a PCI bus, allowing the ST-133 to be controlled from the Macintosh via IPLab™ software and the PI Extension.



Caution

If using the WinX application software (WinSpec/32 or WinView/32), either **High Speed PCI** or **PCI(Timer)** can be the selected Interface type. This selection is accessed on the **Hardware Setup|Interface** tab. **High Speed PCI** allows data transfer to be interrupt-driven and gives the highest performance in some situations. **PCI(Timer)** allows data transfer to be controlled by a polling timer. This selection is recommended when there are multiple devices sharing the same interrupt.

To Install a PCI Serial Buffer Card in the Host Computer:

1. Review the documentation for your computer and PCI card before continuing with this installation.
2. To avoid risk of dangerous electrical shock and damage to the computer, verify that the computer power is OFF.
3. Remove the computer cover and verify that there is an available PCI slot.
4. Install the PCI card in the slot.
5. Make sure that the card is firmly seated and secure it.
6. Replace and secure the computer cover and turn on the computer only. If an error occurs at startup, either the PCI card was not installed properly or there is an address or interrupt conflict. Refer to Chapter 7, "Troubleshooting", page 80 for instructions.

Note: The PCI card has no user-changeable jumpers or switches.

To Install the PCI Card Driver

The following information assumes that you have already installed the WinX application software.

1. After you have secured the PCI card in the computer and replaced the cover, turn the computer on.
2. At bootup, Windows will try to install the new hardware. If it cannot locate the driver, you will be prompted to enter the directory path, either by keyboard entry or by using the browse function.

If you selected **AUTO PCI** during the application software installation, the WinX installation wizard automatically put the required INF file into the Windows/INF directory and put the PCI card driver file in the "Windows"\System32\ Drivers directory. Refer to Table 1 for the appropriate file names and locations.

Windows Version	PCI INF Filename Located in "Windows"\INF directory*	PCI Device Driver Name Located in "Windows"\System32\Drivers directory
Windows [®] XP and Windows Vista [®] (32-bit)	rspi.inf (in Windows\inf, for example)	rspipci.sys (in Windows\System32\drivers, for example)

* The INF directory may be hidden.

Table 1. PCI Driver Files and Locations

Setting up a USB 2.0 Interface

Administrator privileges are required under Windows[®] XP and Windows Vista[®] (32-bit) to install software and hardware.

Your system has been configured to use the USB communication protocol if the **Interface Control Module** installed in the ST-133 has a **USB 2.0** connector as shown in the figure at right). The advantages to the USB 2.0 interface are that it uses a much higher data transfer rate than many common serial data formats (such as the TAXI protocol) and it simplifies the connection to external devices. USB supports "plug and play" -- you do not need to be heavily involved in the setup process.

USB 2.0 Limitations

- Maximum cable length is 5 meters (16.4 feet)
- 1 MHz is currently the upper digitization rate limit for the ST-133 Controller. Large data sets and/or long acquisition times may be subject to data overrun because of host computer interrupts during data acquisition.
- USB 2.0 is not supported by the Princeton Instruments PC Interface Library (EZ-DLLS).
- Some WinX 2.5.X features are not fully supported with USB 2.0. Refer to Appendix E, page 113, for more information.



Note: If you are installing the USB 2.0 interface on a laptop, you will need to perform all of the operations described in this section. In addition, if you are using the recommended USB Interface Card (SIIG, Inc. USB 2.0 PC Card, Model US2246), you must replace the OrangeUSB USB 2.0 Host Controller driver installed for that card with the appropriate Microsoft driver. Instructions for making the replacement are included in "*To Update the OrangeUSB USB 2.0 Driver:*".

To Update the OrangeUSB USB 2.0 Driver:

This procedure is highly recommended when a laptop computer will be used to communicate with the ST-133. As stated before, we recommend the SIIG, Inc. USB 2.0 PC Card, Model US2246 if USB 2.0 is not native to the laptop's motherboard. To reduce the instances of data overruns and serial violations, the OrangeUSB USB 2.0 Host Controller installed for the SIIG card, should be replaced by the appropriate Microsoft driver (Windows XP or Windows Vista (32-bit), depending on the laptop's operating system.)

Note: This procedure may also be performed for desktop computers that use the Orange Micro 70USB90011 USB2.0 PCI.

1. Download and install Microsoft Service Pack 3 (for Windows XP) if the service pack has not been installed.
2. From the Windows **Start** menu, select **Settings|Control Panel**.
3. Select **System** and then **System Properties**.
4. Select the **Hardware** tab and click on **Device Manager** button.
5. Expand **Universal Serial Bus Controllers**.
6. Right-mouse click on **OrangeUSB USB 2.0 Host Controller** and select **Properties**.
7. On the **Driver** tab, click on the **Update Driver...** button. You may have to wait a minute or so before you will be allowed to click on the button.
8. When the **Upgrade Device Driver Wizard** appears, click on **Next**. Select the **Search for a suitable driver ...** radio button.
9. On the next screen select the **Specify a location** checkbox.
10. Browse and select the location. Click on **OK**.
11. In the **Driver Files Search Results** window, check the **Install one of the other drivers** check box.
12. Select the **NEC PCI to USB Enhanced Host Controller B1** driver (Microsoft is the provider). Click on **Next** and the installation will take place. When the **Completing the Upgrade Device Driver Wizard** window appears, click on **Finish**. You will then be given the choice of restarting the computer now or later. According to the window text, the hardware associated with the driver will not work until you restart the computer.

To Install the Princeton Instruments USB2 Interface:

The following information assumes that:

- You have verified that the host computer meets the required specifications for USB 2.0 communication with the OMA V system (see page 27).
- A USB 2.0 board and its driver are installed in the host computer.
- The ST-133 has an installed USB 2.0 Interface Control module.
- You have already installed the WinX software (versions 2.5.15 and higher). Versions 2.5.15 and higher automatically install the driver and INF files required to support the USB 2.0 Interface Control module.

1. Before installing the Princeton Instruments USB2 Interface, we recommend that you defragment the host computer's hard disk. This operation reduces the time the computer spends locating files. Typically, the "defrag" utility "Disk Defragmenter" can be accessed from the Windows[®] Start menu and can usually accessed from the Programs/Accessories/System Tools subdirectory.
2. After defragmenting the hard disk, turn off the computer and make the USB cable connections between the host computer and the ST-133. Then, turn the ST-133 on before turning on the host computer.
3. At bootup, Windows will detect the Princeton Instruments USB2 Interface hardware (i.e., the USB 2.0 Interface Control module). You may be prompted to enter the directory path(s) for the apausbprop.dll and/or the apausb.sys file(s), either by keyboard entry or by using the browse function.

If you selected **AUTO PCI** during the application software installation, the WinX installation wizard automatically put the required INF, DLL, and USB driver file in the "Windows" directories shown below. Refer to Table 2 for the appropriate file names and locations.

Windows Version	USB INF Filename Located in "Windows"\INF directory*	USB Properties DLL Located in "Windows"\System32 directory	USB Device Driver Name Located in "Windows"\System32\Drivers directory
Windows [®] XP and Windows Vista [®] (32-bit)	rsusb2k.inf (in Windows\inf, for example)	apausbprop.dll (in Windows\System32, for example)	apausb.sys (in Windows\System32\Drivers, for example)

* The INF directory may be hidden.

Table 2. USB Driver Files and Locations

Mounting the Detector

Lens Mount

Caution!

For 2-D detectors (C-mount and F-mount), the detector MUST be supported via the tapped holes in the bottom of the detector (refer to the outline drawings on pages 95 and 96 for more information).

For information on installing the F-mount lens adapter and focusing F- and C-mount lenses, refer to Appendix F, "Adapter and Lens Focusing Procedures", starting on 115.

Spectrometer Mount

WARNING!

An OMA V:InGaAs Dewar must never be tilted more than 30° from vertical.

The detector must be properly mounted to the spectrometer to achieve maximum spectral resolution across the array. Depending on the spectrometer and detector type, special adapters may be required to mount the detector to the spectrometer. The appropriate adapters should have been included with your system if the spectrometer type was indicated when the system was ordered.



Because of the many possible OMA V detector and spectrometer combinations, all of the adapter mounting instructions are located in Appendix D. Refer to the table at the beginning of that appendix to find the instruction set appropriate to your system.

Note: For 2-D spectrometer mount detectors, the detector/spectrometer assembly may be unstable without proper support attached to the tapped holes in the detector base. Refer to the outline drawing on page 97 for more information.

Focal Plane Distance

The focal plane distance depends on the detector type and the mounting adapter. Refer to the outline drawings in Appendix B, starting on page 93, for this information.

Connecting the Detector-Controller Cable

Caution The ST-133 Controller supplied with your OMA V:InGaAs detector has been modified for operation with PDAs and for the appropriate cooling method (TE or LN). DO NOT use this controller with any other detector you may have.

Caution Turn the Controller power OFF (OFF = 0, ON = 1) before connecting or disconnecting the Detector-Controller cable.

To Connect the Detector-Controller Cable:

1. Verify that the Controller power is OFF.
2. Connect the Detector-Controller cable to the Controller.
OMA V: Connect the male end of the cable to the "Detector" port on the rear of the Controller. Refer to "*Securing the Detector-Controller Cable Slide Latch*", page 86.
2-D OMA V: Connect the male ends of the cable set the "Camera Signal" and "Camera Pwr" ports on the rear of the Controller.
3. Lock the connector(s) in place. Depending on the detector and the cable used, this operation may require tightening down locking screws or securing a slide-latch.
4. Connect the Detector-Controller cable to the Detector.
OMA V: Connect the female end of the cable to the "Power/Signal" port on the camera.
2-D OMA V: Connect the female ends of the cable set to the "Signal" and "Power" ports on the Detector.
5. Lock the connectors in place.

Connecting the Interface (Controller-Computer) Cable

TAXI[®] Cable

Turn the Controller power OFF (OFF = 0, ON = 1) and the Computer power OFF before connecting or disconnecting the Controller-Computer (TAXI) cable.

To Connect the TAXI Cable:

1. Verify that the Controller power is OFF.
2. Verify that the Computer power is OFF.
3. Connect one end of the TAXI cable to the 9-pin port on the Interface card in the host computer.
4. Tighten down the screws to lock the connector in place.
5. Connect the other end of the cable to the "Serial Com" port on the rear of the Controller.
6. Tighten down the screws to lock the connector in place.

USB 2.0 Cable

Turn the Controller power OFF (OFF = 0, ON = 1) and the Computer power OFF before connecting or disconnecting the Controller-Computer (TAXI) cable.

To Connect the USB 2.0 Cable:

1. Verify that the Controller power is OFF.
2. Verify that the Computer power is OFF.
3. Connect one end of the USB cable to the USB port on the host computer.
4. Connect the other end of the cable to the USB 2.0 port on the rear of the Controller.

Entering the Default Camera System Parameters into WinX (WinSpec/32 or WinView/32)

Software changes implemented in WinX version 2.15.9.6 affected the way in which default parameters were entered for camera systems. Therefore, two sets of instructions are included. Follow the instructions appropriate to the software version that you installed. Note that these instructions assume that you have performed the computer interface installation.

WinX Versions 2.5.19.6 and later

1. Make sure the ST-133 is connected to the host computer and that it is turned on.
2. Run WinSpec. The **Camera Detection wizard** will automatically run if this is the first time you have installed a Princeton Instruments WinX application (WinSpec/32 or WinView/32) and a supported camera. Otherwise, if you installing a new camera type, click on the **Launch Camera Detection Wizard...** button on the **Controller/CCD** tab to start the wizard.
3. On the **Welcome** dialog (Figure 8), leave the checkbox unselected and click on **Next**.

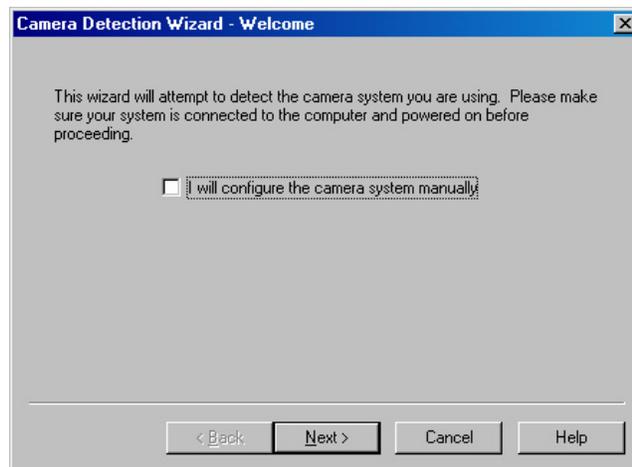


Figure 8. Camera Detection Wizard - Welcome dialog

4. Follow the instructions on the dialogs to perform the initial hardware setup: this wizard enters default parameters on the Hardware Setup dialog tabs and gives you an opportunity to acquire a test image to confirm the system is working.

WinX Versions before 2.5.19.6: Run RSConfig.exe

1. Make sure the ST-133 is connected to the host computer and that it is turned on.
2. Run RSConfig from the **Windows|Start|Programs|PI Acton** menu or from the directory where you installed WinSpec or WinView.
3. When the RSConfig dialog (Figure 9) appears, you can change the camera name to one that is more specific or you can keep the default name "Camera1". When you have finished, click on the **Done** button.

Note: If the first camera in the list is not the "Princeton Style (USB2)", you will need to edit the PVCAM.INI file created by RSConfig. See the instructions in "*Demo, High Speed PCI, and PCI(Timer) are Choices on Hardware Wizard:Interface dialog*", page 76.

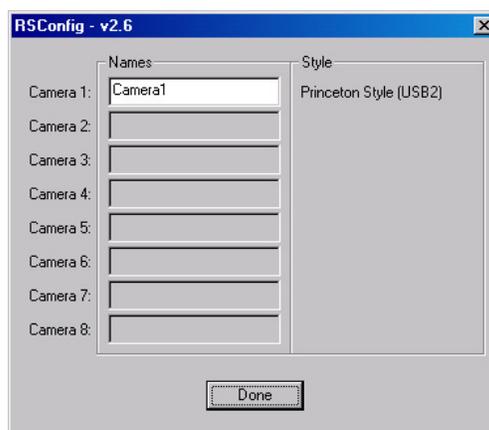


Figure 9. RSConfig dialog

4. Open the WinX application and, from **Setup|Hardware...**, run the Hardware Setup wizard.
5. When the PVCAM dialog (Figure 10) is displayed, click in the **Yes** radio button, click on **Next** and continue through the wizard. After the wizard is finished, the **Controller/Camera** tab card will be displayed with the **Use PVCAM** checkbox selected. You should now be able to set up experiments and acquire data.



Figure 10. Hardware Setup wizard: PVCAM dialog

6. Run the software in focus mode to verify communication between the ST-133 and the host computer.

Making the Optional Coolant Circulator-Detector Connections

Caution

1. Do not use any coolant fittings other than those supplied by Princeton Instruments. Although standard pipe fittings are similar, in most cases they are not the same. Forcing these fittings into the cooling block will permanently damage the threads.
2. OMA V detectors with liquid-only cooling require circulating coolant (distilled water or 50:50 mixture of ethylene glycol and water) for proper operation.
3. Take care that the coolant used is pH neutral. Acidic or alkaline coolant can damage the detector fittings and internal cooling block through corrosion. Such damage could be very expensive to repair.
4. Coolant should be no colder than +15°C to prevent condensation at 50% relative humidity. Operating an OMA V detector with coolant at a colder temperature could cause induced condensation in the electronics enclosure and possible catastrophic damage to the detector. ***Damage resulting from this type of operation may void the warranty.***

1. Set up the coolant circulator according to the directions in the user manual for that equipment. Do not apply power to the circulator until directed to do so.
2. Make the hose connections between the circulator and the detector. The tubing should be no longer than necessary.

Note: The chiller/circulator kit includes hose clamps and two 15' hoses. The hoses are constructed of 3/8" I.D., thick-wall PVC tubing. The hose clamps secure the tubing to male quick-disconnects.

To Secure the Hoses:

- a. Insert the male quick-disconnect (on tubing) into the appropriate female quick-disconnect on the detector (Inlet or Outlet) until you hear a click.
- b. Then insert the fitting at the other end of the tubing into the appropriate port on the coolant circulator. You should hear a click, which indicates that the fitting is latched in place.
- c. Because of the automatic shutoffs, disconnecting the coolant supply is done by simply depressing the release tabs (Figure 11) and removing the fittings. Reconnecting the supply is done by reinserting each fitting into the appropriate valve body until you hear a click.

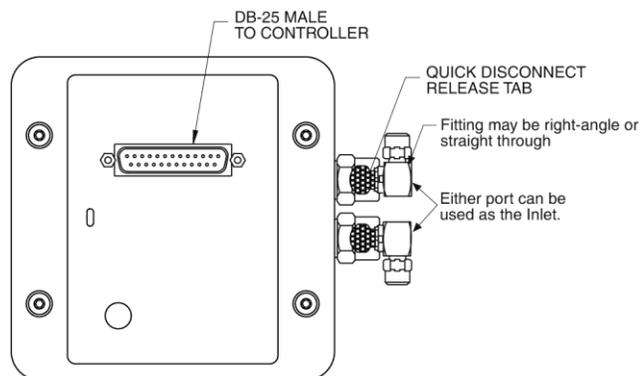


Figure 11. Coolant Ports

Recommended Flow Rate and Fluid Pressure

Flow Rate: 2 liters/minute. Users are advised to install a flow meter to monitor the rate.

Fluid Pressure: 25 psig (maximum).

Filling the Dewar

WARNING!

Even minimal contact with LN can cause damage to eyes and skin. Avoid contact with the splashing that will invariably accompany pouring LN into a room temperature Dewar.

OMA V:InGaAs LN-cooled detectors use liquid nitrogen to reduce the temperature of the PDA. 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. The array temperature can be thermostated from -50°C to -100°C .

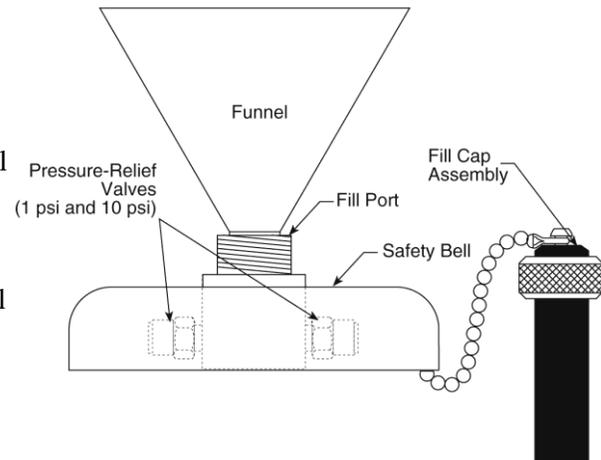


Figure 12. Dewar Fill Port

Fill Procedure

1. Unscrew and remove the brass/nylon fill cap assembly from the fill port.

Caution

Always be careful when removing the fill cap assembly 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.

2. Insert a funnel into the fill port and place a thin vent tube into the Dewar through the funnel to reduce splashing due to boiling LN.
3. If the LN₂ will be carried in a transportable thermos from another location, make sure that both the funnel and the transportable thermos used are clean and dry before filling the thermos with LN₂. While not harmful, crystallized water will make noise in the Dewar.
4. **Slowly** and carefully pour approximately 100 ml of LN₂ into the funnel. Stop for 5-10 minutes until you observe a “geyser-like” vapor burst from the Dewar opening. This burst is normal and has to do with reaching a thermal equilibrium between the LN and the Dewar container surfaces.
5. **Slowly**, top off the Dewar. Be careful to fill the Dewar slowly to avoid spilling and splashing. By following this procedure, you will minimize the amount of nitrogen that boils off as the Dewar is filled. To test the LN level, insert a straight piece of

wire (a cryogenic “dip stick”) into the Dewar briefly, then remove it. The LN level will be indicated by the condensation on the wire.

6. Remove the funnel slowly, taking care to avoid any LN₂ that might boil out.
7. Reinstall the fill cap assembly and hand-tighten the retaining nut. To tighten fully, **HANDTIGHTEN** the retaining nut about 3/4 turn (or more) after the nut feels snug. **NEVER USE A WRENCH** to tighten the nut; hand tight is sufficient to seal the cap.

Note: Some venting may occur at the Dewar pressure-relief valve.

CAUTION

Ice buildup may occur at the valve ports if the detector is being operated under high humidity conditions. If frost appears on the valves, periodically clean the outside of the valves so that ice does not prevent the valves from venting normally.

Note: The pressure relief valves (Figure 12) underneath the safety bell will occasionally emit a plume of N₂ gas and mist. *Continuous* hissing indicates that the vacuum in the Dewar jacket is probably inadequate. Turn off the system and *remove all LN from the Dewar*. Contact Princeton Instruments Customer Support for further instructions.

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Operation

ATTENTION With an LN-cooled detector, it is generally good practice to turn on the controller and leave it on whenever the Dewar contains LN. This will maintain the temperature control of the device and prevent potential damage to the array.

Introduction

Once the OMA V detector has been installed as explained in the preceding chapters, operation of the detector is basically straightforward. In most applications you simply establish optimum performance using the **Focus** mode (WinSpec/32 or WinView/32), set the target detector temperature, wait until the temperature has stabilized, and then do actual data acquisition in the **Acquire** mode. Additional considerations regarding experiment setup and equipment configuration are addressed in the software manual.

Previous chapters have discussed setting up the hardware and the software for basic operation. This chapter discusses topics associated with basic data acquisition:

- *"Data Acquisition Overview"*, the first topic, briefly describes the data acquisition process from controller turn on to controller turn off.
- *"USB 2.0 and System On/Off Sequences"*, the second topic, discusses the on/off sequences that are specific to the USB 2.0 interface. Skip this topic if your system uses the TAXI/RS PCI communication interface (for example, the 2-D OMA V:320 system uses TAXI/RS PCI).
- *"First Light (Spectroscopy)"*, provides step-by-step instructions for placing your spectroscopy system in operation the first time.
- *"First Light (Imaging)"*, provides step-by-step instructions for placing your imaging system in operation the first time.
- *"Exposure and Signal"*, addresses factors that can affect the signal acquired on the array. These factors include array architecture, exposure time, temperature, dark signal, and saturation.
- *"Readout"* discusses region of interest (ROI) and also discusses the two analog gain settings that determine the number of electrons required to generate an Analog-to-Digital Unit.
- *"Digitization"*, discusses the rate of digitization and the purposes/advantages of the dual digitizers used in the 2-D OMA V:320 detector.
- *"Binning"*, the final topic briefly discusses the use of software binning for improving the signal-to-noise ratio. For additional information about software binning, refer to the application software manual.

See Chapter 6 for information on timing modes and experiment synchronization.

Data Acquisition Overview

Before each image from the PDA or the FPA appears on the computer screen, it must first be read, digitized, and transferred to the computer. Figure 13 is a block diagram of the image-signal path.

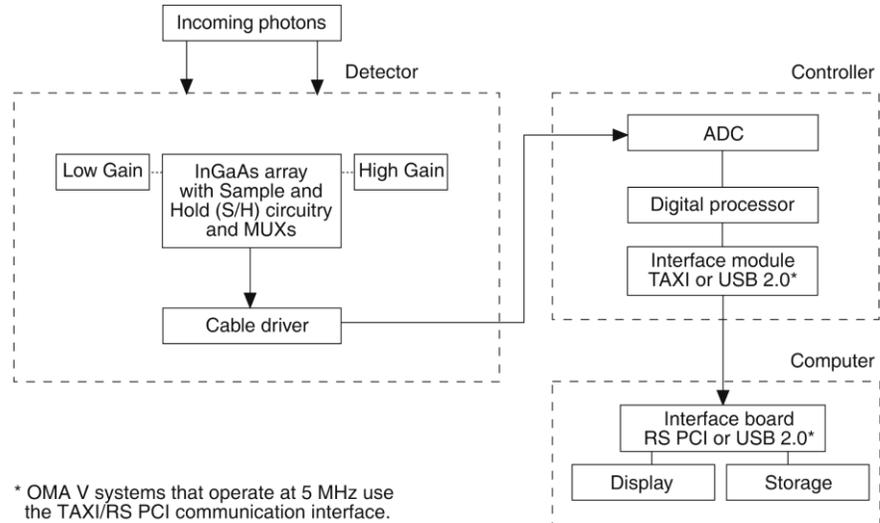


Figure 13. Block Diagram of Signal Path in System

The following sequence briefly explains data acquisition from hardware setup to data display.

1. Controller is turned on and software is booted.
2. Until data acquisition is started, the array is kept in a Reset state (during this time EXP/RST = RST).
3. Experiment setup is defined in software.
 - Temperature is set and locked. Temperature affects dark signal. Lower temperatures reduce dark signal. Temperature also affects the detector's sensitivity to IR noise. Environment and the detector itself are sources of IR signal that will be detected by the array unless the array is kept cold.
 - Exposure time is set (minimum of 20 μ s for PDA, minimum of 1 μ s for FPA). This determines how long signal integrates on the pixels. Exposure is controlled by an electronic shutter.
 - Longer exposure times are used when the signal level is low.
 - Increasing the exposure time may mean that some pixels will saturate, resulting in signal lost at certain wavelengths.
 - Gain (High or Low) is selected. This determines the well capacity of the pixels and the amount of read noise.
 - **High Gain** (high sensitivity): Used for low-light level applications where sensitivity is required.
 - **Low Gain** (high dynamic range): Used for applications requiring high dynamic range such as absorbance and other shot-noise limited applications.

4. Data Acquisition is begun.
 - When Data Acquisition begins, EXP/RST is switched to EXP and the dark signal present while the device was in Reset is transferred to sample/hold devices in the MUXs and signal integration begins on the array.
 - The incoming signal integrates on the pixels for the exposure time. Photons strike the individual pixels and charge is generated in proportion to the number of photons. In addition to the incoming signal, leakage current and ambient noise also integrates on the array. The gain setting determines the pixel well capacity.
5. Data Acquisition is stopped.
 - Integration continues until the set exposure time ends (EXP/RST switches to RST) and the integrated signal is immediately shifted to a second set of sample/hold devices. The signal from the first sample/hold device is subtracted, and the resulting signal is sequentially read out of the MUXs and transferred to the ADC in the ST-133.
 - RST remains active (i.e., "electronic shutter" is closed) until the next Data Acquisition begins.
6. The analog signal is converted to digital.
 - The Analog-to-Digital Converter (ADC) converts the analog signal to digital.
 - The data is processed and then transmitted from the controller to the host computer via the Serial Interface.
7. Data is displayed on the monitor and/or stored.

Note: If required, Background Acquisition is performed before signal acquisition. See "*Background Subtraction*", page 53 for more information.

USB 2.0 and System On/Off Sequences

The following on/off sequences are specific to the USB 2.0 interface:

1. The ST-133 must be turned on before the WinX (WinSpec/32 or WinView/32) application opened to ensure communication between the controller and the computer. If the WinX application is opened and the ST-133 is off, many of the functions will be disabled and you will only be able to retrieve and examine previously acquired and stored data. You must close the WinX application, turn on the ST-133, and reopen the WinX application before you can set up experiments and acquire new data.
2. The WinX application must be closed before turning off the ST-133. If you turn off the ST-133 before closing the WinX application, the communication link with the controller will be broken. You can operate the program in a playback mode (i.e., examine previously acquired data) but will be unable to acquire new data until you have closed the WinX application, turned on the ST-133, and then re-opened the WinX application.

First Light (Spectroscopy)

The following paragraphs provide step-by-step instructions for placing your spectroscopy system in operation the first time. The intent of this simple procedure is to help you gain basic familiarity with the operation of your system and to show that it is functioning properly. Once basic familiarity has been established, then operation with other operating configurations, ones with more complex timing modes, can be performed. An underlying assumption for the procedure is that the detector is to be operated with a spectrograph such as the Acton Series 300i (SP300i) on which it has been properly installed. A suitable light source, such as a mercury pen-ray lamp, should be mounted in front of the entrance slit of the spectrograph. Any light source with line output can be used. *Standard fluorescent overhead lamps have good calibration lines as well.* If there are no “line” sources available, it is possible to use a broadband source such as tungsten for the alignment. If this is the case, use a wavelength setting of 0.0 nm for alignment purposes.

Assumptions

The following procedure assumes that

1. You have already set up your system in accordance with the instructions in Chapter 4.
2. You have read the previous sections of this chapter.
3. You are familiar with the application software.
4. The system is not liquid-cooled.
5. The system is being operated in spectroscopy mode.
6. An entrance slit shutter is not being controlled by the ST-133.

Getting Started

1. Set the spectrometer entrance slit width to 25 μm .
2. Turn on the computer power.
3. Turn on the ST-133.

Note: With USB 2.0, the controller must be turned on before WinSpec/32 is opened and WinSpec/32 must be closed before the controller is turned off.

4. Start the application software.
5. If you have not already done so, start the coolant flow or fill the LN Dewar.

Setting the Parameters

Note: The following procedure is based on WinSpec/32: you will need to modify it if you are using a different application. Basic familiarity with the WinSpec/32 software is assumed. If this is not the case, you may want to review the software manual or have it available while performing this procedure.

Set the software parameters as follows:

Environment dialog (Setup|Environment): Verify that the DMA Buffer size is 8 Mbytes (min.). Large arrays may require a larger buffer size. If you change the buffer size, you will have to *reboot the computer* for this memory allocation to be activated, and then restart WinSpec.

Controller|Camera tab (Setup|Hardware): Controller and Detector parameters should be set automatically to the proper values for your system. However, you can click on the **Load Defaults From Controller** button on this tab to load the default settings.

- **Use PVCAM:** If you are using the USB 2.0 interface, verify that the box is checked.

Note: This check box is not present on software versions 2.5.19.6 and higher.

- **Controller type:** ST-133
- **Controller version:** 5 or higher
- **Camera type:** Select the array installed in your detector.
- **Shutter type:** None.
- **Readout mode:** Full frame.

Cleans/Skips tab (Setup|Hardware): If you are setting up a 2-D OMA V, configure **Vertical Skips** as follows:

- **Minimum Block Size:** 1
- **Number of Blocks:** 256

Detector Temperature (Setup|Detector Temperature...): -40°C for air-cooled; -100°C for LN-cooled.

Note: If you are using the USB 2.0 interface, the Detector Temperature dialog will not display temperature information while you are acquiring data.

Interface tab (Setup|Hardware): High Speed PCI (or PCI(Timer))

Note: This tab is not available if you are using the USB 2.0 interface.

Experiment Setup Main tab (Acquisition|Experiment Setup...):

- **Exposure Time:** 100 ms
- **Accumulations & Number of Images:** 1

Experiment Setup Timing tab (Acquisition|Experiment Setup...):

- **Timing Mode:** Free Run
- **Shutter Control:** Normal
- **Safe Mode vs. Fast Mode:** Fast Mode

Focusing

The mounting hardware provides two degrees of freedom, focus and rotation. In this context, focus means to physically move the detector back and forth through the focal plane of the spectrograph. The approach taken is to slowly move the detector in and out of focus and adjust for optimum while watching a live display on the monitor, followed by rotating the detector and again adjusting for optimum. The following procedure, which describes the focusing operation with an Acton 300I spectrograph, can be easily adapted to other spectrographs.

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

2. With the spectrograph properly connected to the controller, turn the power on, wait for the spectrograph to initialize. Then set it to 1013.975 nm or 1529.582 nm if using a mercury lamp or to 0.0 nm if using a broadband source.

Hint: Overhead fluorescent lights produce a mercury spectrum. Use a white card tilted at 45 degrees in front of the entrance slit to reflect overhead light into the spectrograph. Select 1013.975 nm or 1529.582 nm as the spectral line. Refer to Appendix C for a graph of a Mercury-Argon pen lamp spectrum (750-1700 nm).

3. Set the slit to 25 μm if you have not already done so. *If necessary, adjust the Exposure Time to maintain optimum (near full-scale) signal intensity.*
4. Run the Detector in live mode and watch the display on the monitor.

Hint: If using WinSpec/32, run in **Focus** mode.

5. Slowly move the detector in and out of focus. You should see the spectral line go from broad to narrow and back to broad. If you activate WinSpec's **Focus Helper** feature (accessed from the **Process** menu), it will automatically locate peaks and generate a report on peak characteristics during live data acquisition. After you have gotten the narrowest achievable line, leave the detector set at that focus.

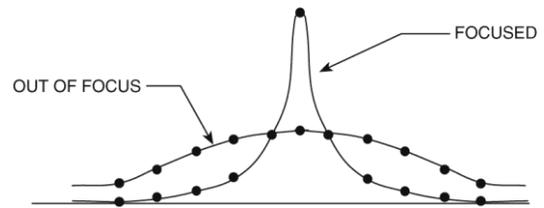


Figure 14. In/Out Focus

Note that the way focusing is accomplished depends on the spectrograph, as follows.

- **Long focal-length spectrographs such as the Acton 300i:** The mounting adapter includes a tube that slides inside another tube to move the detector in or out as required to achieve optimum focus.
 - **Short focal-length spectrographs:** There is generally a focusing mechanism on the spectrograph itself which, when adjusted, will move the optics as required to achieve proper focus.
 - **No focusing adjustment:** If there is no focusing adjustment, either provided by the spectrograph or by the mounting hardware, then the only recourse will be to adjust the spectrograph's focusing mirror.
6. Next, adjust the rotation. You can do this by rotating the detector while watching a live display of the line. The line will go from broad to narrow and back to broad. Leave the detector rotation set for the narrowest achievable line.

Note: When aligning other accessories, such as fibers, lenses, optical fiber adapters, first align the detector to the slit. Then align the accessory without disturbing the detector position. The procedure is identical to that used to focus the spectrograph (i.e., do the focus and alignment operations while watching a live image).

Data Collection

1. After you have achieved focus, you can stop running in **Focus** mode.
2. Make any required changes to your experiment setup and software parameters. Changes might include adjusting the exposure time, setting up an entrance slit shutter, changing the timing mode to External Sync, or lowering the temperature.
3. Begin running **Acquire** mode. Data will be acquired and displayed/stored based on the experiment settings.
4. If you have completed data collection, you can leave the controller on so the array temperature will remain locked or you can go to the shutdown instructions.

Shutdown

1. Before turning off the ST-133:
 - a. Empty the Dewar (if the array is cooled by LN) or stop coolant flow (if a coolant circulator or a chiller/circulator unit is being used to cool the array).
 - b. Close WinSpec/32 if USB 2.0 is being used.
2. Turn off the controller.

First Light (Imaging)

This section provides step-by-step instructions for acquiring an imaging measurement for the first time. The intent of this procedure is to help you gain basic familiarity with the operation of your 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.

Assumptions

The following procedure assumes that

1. You have already set up your system in accordance with the instructions in Chapter 4.
2. You have read the previous sections of this chapter.
3. You are familiar with the application software.
4. The system is LN-cooled.
5. The detector contains a focal plane array (FPA).
6. The system is being operated in imaging mode.
7. The target is a sharp image, text, or a drawing that can be used to verify that the detector is "seeing" and can be used to maximize focus.

Warnings

WARNING

Before You Start, if your system includes a microscope Xenon or Hg arc lamp, it is **CRITICAL** to turn off all electronics adjacent to the arc lamp, especially your digital detector system and your computer hardware (monitors included) before turning on the lamp power.

Powering up a microscope Xenon or Hg arc lamp causes a large EMF spike to be produced that can cause damage to electronics that are running in the vicinity of the lamp. We advise that you place a clear warning sign on the power button of your arc lamp reminding all workers to follow this procedure. While Princeton Instruments has taken great care to isolate its sensitive circuitry from EMF sources, we cannot guarantee that this protection will be sufficient for all EMF bursts. *Therefore, in order to fully guarantee the performance of your system, you must follow this startup procedure.*

Getting Started

1. Mount a test target in front of the detector.
2. Turn on the controller power.
3. Turn on the computer power.
4. Start the application software.
5. Start the coolant flow or fill the LN Dewar.
6. Block light from the lens.

Setting the Parameters

Note: The following procedure is based on WinView/32: you will need to modify it if you are using a different application. Basic familiarity with the WinView/32 software is assumed. If this is not the case, you may want to review the software manual or have it available while performing this procedure.

Set the software parameters as follows:

Environment dialog (Setup|Environment): Verify that the DMA Buffer size is 8 Mbytes (min.). Large arrays may require a larger buffer size. If you change the buffer size, you will have to *reboot the computer* for this memory allocation to be activated, and then restart WinView.

Controller|Camera tab (Setup|Hardware): Controller and Detector parameters should be set automatically to the proper values for your system. However, you can click on the **Load Defaults From Controller** button on this tab to load the default settings.

- **Use PVCAM:** This box should not be checked.

Note: This check box is not present on software versions 2.5.19.6 and higher.

- **Controller type:** ST-133
- **Controller version:** 3 or higher
- **Camera type:** Select the array installed in your detector.
- **Shutter type:** None, Large, or Remote (system dependent).
- **Readout mode:** Full frame.

Detector Temperature (Setup|Detector Temperature...): -40°C for air-cooled, -100°C for LN-cooled. 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** and the **Temp Lock** LED on the back of the ST-133 will light to indicate that the temperature is thermostated to within 0.25°C of the set temperature.

Note: Some overshoot may occur. This could cause temperature lock to be briefly lost and then quickly re-established. If you are reading the actual temperature reported by the application software, there may be a small difference between the set and reported temperature when lock is established. This is normal and does not indicate a system malfunction.

Interface tab (Setup|Hardware): High Speed PCI (or PCI(Timer))

Note: This tab is not available if you are using the USB 2.0 interface.

Cleans/Skips tab (Setup|Hardware): If you are setting up a 2-D OMA V, configure **Vertical Skips** as follows:

- **Minimum Block Size:** 1
- **Number of Blocks:** 256

Experiment Setup Main tab (Acquisition|Experiment Setup...):

- **Exposure Time:** 100 ms
- **Accumulations & Number of Images:** 1

Experiment Setup ROI tab (Acquisition|Experiment Setup...): Use this function to define the region of interest (ROI).

- **Imaging Mode:** Selected
- Clicking on **Full** loads the full size of the chip into the edit boxes.

Experiment Setup Timing tab (Acquisition|Experiment Setup...):

- **Timing Mode:** Free Run
- **Shutter Control:** Normal
- **Safe Mode vs. Fast Mode:** Fast Mode

Acquiring Data

1. If you are using WinView/32 and the computer monitor for focusing, select **Focus** from the **Acquisition** menu. Successive images will be sent to the monitor as quickly as they are acquired.
2. Adjust the lens aperture, intensity scaling, and focus for the best image as viewed on the computer monitor. Some imaging tips follow:
 - Begin with the lens blocked off and then set the lens at the smallest possible aperture (largest f-stop number).
 - Make sure there is a suitable target in front of the lens. An object with text or graphics works best. If working with a microscope, use any easily viewed specimen.
 - Adjust the intensity scaling and lens aperture until a suitable setting is found. The initial intensity scaling setting of 4096 assures that the image won't be missed altogether but could be dim. Once you've determined that the image is present, select a lower setting for better contrast. Check the brightest regions of the image to determine if the A/D converter is at full-scale. *A 16-bit A/D is at full scale when the brightest parts of the image reach an intensity of 65535.* Adjust the aperture to where it is just slightly smaller (higher f-stop) than the setting where maximum brightness on any part of the image occurs.
 - Set the focus adjustment of the lens for maximum sharpness in the viewed image.
 - In the case of a detector with an F-mount, the lens adapter itself also has a focus adjustment. If necessary, this focus can be changed to bring the image into range of the lens focus adjustment. See "*F-Mount Adapter Focusing Procedure*", page 115.
3. After you have focused the detector, you can stop **Focus** mode, continue **Focus** mode, begin **Acquire** mode, or wait for the array to reach the operating temperature before going to **Acquire** mode.

4. If the array is cooled by LN, empty the Dewar before turning off the controller.

Note: Exposing the array to bright light (10× saturation) when cold (<-70°C) may cause the dark signal in the exposed pixels to be 3 to 10 times higher than normal for that operating temperature. The effect can be reversed by allowing the detector to warm up to room temperature.

Exposure and Signal

Introduction

The following topics address factors that can affect the signal acquired on the array. These factors include array architecture, exposure time, temperature, and saturation.

Array Architecture

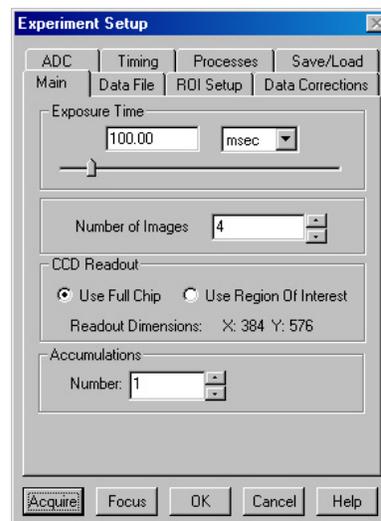
A linear photodiode array (PDA) can be thought of as a one-dimensional array of photodiodes attached to an integrated circuit (IC) chip. For spectroscopy, a PDA is placed at the image plane of a spectrometer to allow a range of wavelengths to be detected simultaneously.

A focal plane array (FPA), such as the one in the 2-D OMA V:320, is a matrix of photodiodes bonded to a readout circuit on an IC chip. The photodiodes are responsive in IR wavelengths, in which they absorb IR radiation, convert it into electrons, and send a voltage signal in response to form an image. IR imaging FPA photodiodes are composed of materials sensitive to IR radiation

Each sensor on a PDA or an FPA is connected to its own charge storage “well.” These sensors respond to the intensity of light or 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 (set in the software), the charge in each well is read out serially.

Exposure Time

Exposure time (set on the **Experiment Setup|Main** tab) is the time between start acquisition 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.



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 MUXs 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.

Array Temperature

When the WinX (WinSpec/32 or WinView/32) application software is the controlling software, temperature control is done via is done via the Detector Temperature dialog (Figure 15) accessed from the **Setup** menu. Once the target array temperature has been set, the software controls the detector's temperature control circuitry to reach the set array temperature. On reaching that temperature, the control loop locks to that temperature for stable and reproducible performance. When temperature lock has been reached (temperature within 0.25°C of the set value), the green **TEMP LOCK** indicator on the Analog/Control module panel lights and the Detector Temperature dialog reports that the current temperature is "**Locked**". The on-screen indication allows easy verification of temperature lock in experiments where the computer and controller are widely separated. There is also provision for reading out the actual temperature at the computer so that the progress of the cool down can be monitored.

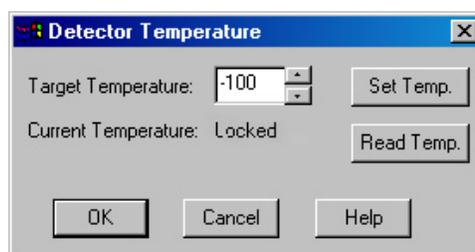


Figure 15. WinSpec/32 Detector Temperature dialog

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

Note: If you are using the USB 2.0 interface, the Detector Temperature dialog will not display temperature information while you are acquiring data.

WARNING!

LN-cooled detectors, because of their low operating temperatures, must *always* be connected to an operating controller whenever there is LN in the Dewar. If the controller power is turned off with liquid nitrogen remaining in the Dewar, the temperature control circuitry is turned off and the array temperature will drop as the LN continues to cool the array. *Damage caused to the array by excessively low temperature (below the specified operating temperature) is not covered by the warranty.*

Background Subtraction

Background subtraction is performed to remove a fixed noise pattern from the integrated signal. In the case of the InGaAs PDA or 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 under zero bias (no dark current), reverse bias (dark current with the same bias as the photo current), or 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 the background to be subtracted, the identical experiment settings are used but the experiment signal source remains OFF. After the background has been saved. Background subtraction can be set up to occur automatically (see Figure 16) 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.

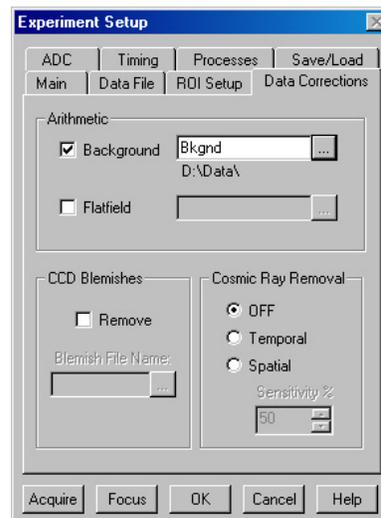


Figure 16. Automatic Background Subtraction

Notes:

1. While the 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 cases where you will need the uncorrected (raw) data, perform background subtraction as a post-process.

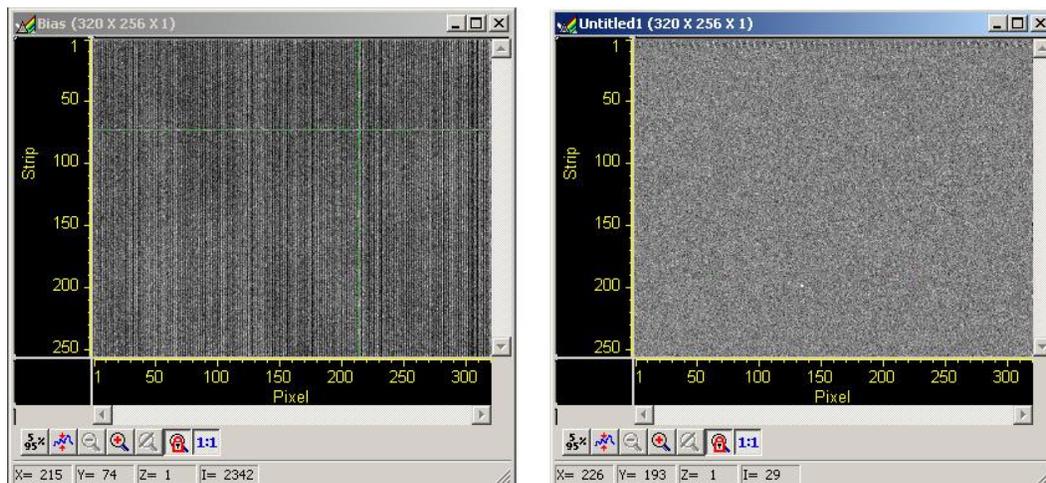


Figure 17. Background Subtraction: Before and After Images

Flat Field Correction

Non-uniformity of illumination sources and/or the non-uniformity of the InGaAs detector can be compensated for by applying Flat Field correction. This procedure is performed by first setting up the experiment parameters, waiting until the detector has reached operating temperature to ensure stability, and taking a Flat Field reference image of the illumination source (without the sample). After the flat field has been acquired, you need to select automatic Flatfield correction and specify the data file to be used (as shown in Figure 18). Then, set up the experiment with the sample in place and acquire data. The flat field data will be automatically applied to the raw data and the resulting data will be displayed and/or stored.

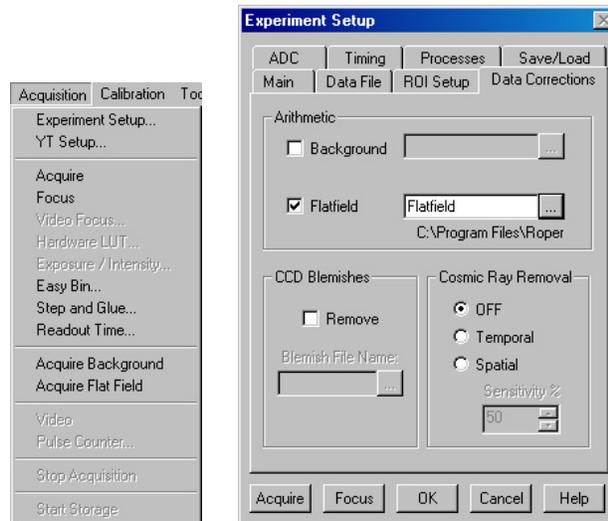


Figure 18. Acquisition menu (on left) and Data Corrections tab (on right)

Dark Signal

Dark signal is a buildup of charge on the array over time. Even with the light into the detector completely blocked, the array will collect a dark signal, 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, you should set the detector temperature at the lowest temperature within the recommended range for your detector (typically -40°C for air-cooled and -100°C for LN-cooled).

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

Note: Dark signal is a fully subtractable readout pattern. See "**Background Subtraction**" on page 53.

Caution

If you observe a sudden change in the baseline signal, you may have excessive humidity in the vacuum enclosure of the detector. Immediately turn off the controller (if LN-cooled, remove the liquid nitrogen also). Then, contact Princeton Instruments Customer Support for further instructions. See page 124 for contact information.

Saturation

When signal levels in some part of the image are very high, charge generated in one pixel may exceed the “well capacity” of the pixel, spilling over into adjacent pixels in a process called “blooming.” In this case, a shorter exposure time is advisable, with signal averaging to enhance 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.

Readout

Introduction

Two factors to be considered with regard to array readout are: region of interest (ROI) and analog gain control. ROI selection (2-D OMA V detector only) allows you specify a section of the array to be read out and saved; the remaining data is read out and discarded. Analog gain control determines how many photons will be required to generate an analog-to-digital unit; the gain choice should be based on the signal intensity.

Region of Interest (ROI)

2-D OMA V:320 supports region of interest (ROI) or area selection. However, there may not be any improvement in frame rate. While there will be no increase in readout speed, there will be a reduction in the size of the data set.

When a detector uses a CCD as the data collection device, an ROI may have rows of data preceding it and following it that are to be read out and discarded without being converted to digital information. This process is called skipping and is controlled by the **Vertical Skips** settings (**Setup|Hardware|Cleans/Skips** tab) which by default are **Minimum Block Size: 2** and **Number of Blocks: 5**. These settings speed up the rate at which the non-ROI areas are read out and discarded and thereby increase the overall readout speed.

The 2-D OMA FPA does not support vertical skips; and all of the rows on the array are read out and converted before the non-ROI information is discarded. The default **Vertical Skips** settings of **Minimum Block Size: 2** and **Number of Blocks: 5**, while appearing to work, will result in invalid data. Instead, you must change these settings to **1** and **256**, respectively, for the 2-D OMA array.

Analog Gain Control

Analog gain control is used to change the number of electrons required to generate an Analog-to-Digital Unit (ADU, also known as a count). In WinSpec/32 and WinView/32, the analog gain choices for OMA V detectors are **Low** and **High**. Users who measure high-level signals may wish to select **Low** to allow digitization of larger signals. Users who consistently measure low-level signals may wish to select **High**, which requires fewer electrons to generate an ADU and reduces some sources of noise. This is a particularly important consideration in absorbance measurements.

Example: The following descriptions assume that the actual incoming light level is identical in both instances. The numbers used are typical values for OMA V linear PDA

detectors and may not reflect actual detector performance; typical values are different for FPAs.

Low requires 1750 electrons to generate one ADU. Strong signals can be acquired without flooding the array. If the gain is set to **Low** and the spectra or images appear weak, you may want to change the gain setting to **High**.

High requires 65 electrons to generate one ADU and some noise sources are reduced. Because fewer electrons are needed to generate an ADU, weaker signals can be more readily detected. Lower noise further enhances the ability to acquire weak signals. If the array appears to be flooded with light, you may want to change the setting to **Low**.

Note: Analog gain is software-selectable in many of the OMA V detectors. In the WinX application software, gain selection is made on the **Acquisition| Experiment Setup...|ADC** tab card.

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

Digitization

Introduction

After gain has been applied to the signal, the Analog-to-Digital Converter (ADC) converts that analog information (continuous amplitudes) into a digital data (quantified, discrete steps) that can be read, displayed, and stored by the application software. The number of bits per pixel is based on both the hardware and the settings programmed into the detector through the software (see "**Readout**", page 55).

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

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. A 1 MHz A/D converter is standard for the OMA V spectroscopy arrays. Dual digitizers (1 MHz/5 MHz) are standard for the OMA V imaging arrays (for example, the array used in the 2-D OMA V:320).

Dual digitizers mean that you have a choice of how quickly the data will be digitized. Because the readout noise of arrays increases with the readout rate, it is sometimes necessary to trade off readout speed for high dynamic range. The 5 MHz conversion speed is used for the fastest possible data collection and the 1 MHz conversion speed is used where noise performance is the paramount concern. Switching between the conversion speeds is completely under software control for total experiment automation.

Note: In WinView and WinSpec, the digitization (ADC) rate can be changed on the **Experiment Setup|ADC** tab.

ADC Offset (*Baseline Offset*)

ADC offset (also known as baseline offset) provides another way of dealing with dark signal (see "*Dark Signal*", page 54). By offsetting the baseline signal, much of the background is ignored during conversion.

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

Caution

If you observe a sudden change in the baseline signal you may have excessive humidity in the detector vacuum enclosure. Turn off the controller, remove the liquid nitrogen, and contact Princeton Instruments Customer Support for further instructions.

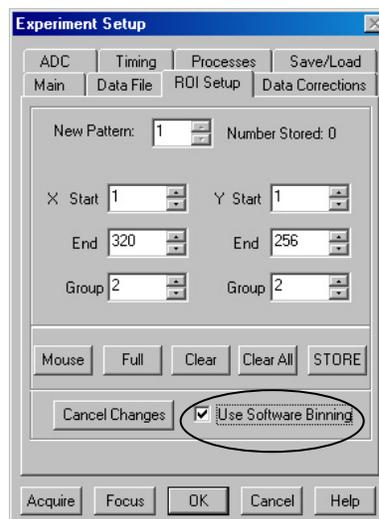
All OMA V:InGaAs arrays have been tested for uniformity and do not exhibit any vignetting (reduction of response) at the extreme ends of the array. If you do measure such reduction in response across the array, it may be the result of one or more of the following conditions:

- Condensation of water on the edges of the Dewar window has occurred. This should not happen unless the cooling/pumping instructions, previously mentioned, were not followed or if the Dewar has sprung a leak (a rare situation).
- Your spectrometer is not illuminating the full photoactive area of the array. Most spectrographs provide at least a 1" wide focal plane that should cover the full array. If the exit port has been masked, the full focal plane may not be available.

Binning

Binning is the process of adding the data from adjacent pixels together to form a single pixel (sometimes called a super pixel). In the case of CCD arrays, binning is often performed on the array as part of the readout process. This is not the case with InGaAs detectors since they do not have a serial register or a summing node. Rather than binning on the array, binning is accomplished in software after the data has been read out and digitized. Software binning can be set up to occur automatically (set up and selected on the **Acquisition| Experiment Setup|ROI Setup** tab).

The advantage to 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 high number of scans, i.e., above 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 realized. Again, background subtraction from the data is necessary.



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Advanced Topics

Introduction

Previous chapters have discussed setting up the hardware and the software for basic operation. This chapter discusses topics associated with experiment synchronization (set up on the **Experiment Setup|Timing** tab in WinView and WinSpec). With the exception of Edge Trigger, the topics are addressed in order of their appearance on the Timing tab (see Figure 19).

- **"Timing Modes"**, the first topic, discusses Timing Modes, Shutter Control, and Edge Trigger. Also included under this topic is a discussion of the **EXT SYNC** connector, the input connector for a trigger pulse.
- **"Fast Mode"**, the second topic, discusses the Fast. Fast is used for real-time data acquisition. Safe Mode is not valid for InGaAs detectors.
- **"TTL Control"**, the final topic, discusses the TTL IN/Out connector on the rear of the ST-133 and how commands can be sent via TTL levels to and from the ST-133.

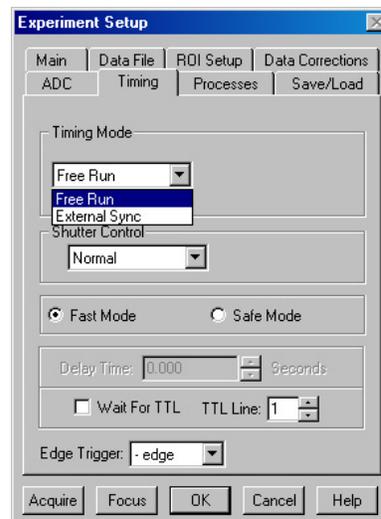


Figure 19. Timing tab

Standard Timing Modes

The basic ST-133 timing modes that are appropriate to OMA V operation are Free Run, and External Sync. These timing modes are combined with the Shutter options to provide the widest variety of timing modes for precision experiment synchronization.

Mode	Shutter
Free Run	Normal
External Sync	Normal
External Sync	PreOpen

Table 3. Timing Modes for OMA V Detectors

If an external entrance slit shutter is being controlled by the ST-133, the shutter options available (Normal, PreOpen, Disable Opened or Disable Closed) may be used to coordinate shutter operation with the experiment. Disable simply means that the shutter will not operate during the experiment. Disable closed is useful for making dark signal measurements of background, or when no shutter is present in the system. PreOpen, available in the External Sync mode, opens the shutter as soon as the ST-133 is ready to receive an External Sync pulse. This is required if the time between the External Sync pulse and the event is less than a few milliseconds, the time it takes the shutter to open.

The shutter timing is shown in the timing diagrams that follow. Except for Free Run, where the modes of shutter operation are identical, both Normal and PreOpen lines are shown in the timing diagrams and flow chart.

The timing diagrams are labeled indicating the exposure time (t_{exp}), shutter compensation time (t_c), and readout time (t_R).

Free Run

In the Free Run mode the controller does not synchronize with the experiment in any way. The shutter opens as soon as the previous readout is complete, and remains open for the exposure time, t_{exp} . Any External Sync signals are ignored. This mode is useful for experiments with a constant light source, such as a CW laser or a DC lamp. Other experiments that can use this mode are high repetition studies, where the number of shots that occur during a single shutter cycle is so large that it appears to be continuous illumination.

Other experimental equipment can be synchronized to the ST-133 controller by using the output signal (software-selectable SHUTTER or NOT SCAN) from **SCAN** connector. Shutter operation and the NOT SCAN output signal are shown in Figure 21.

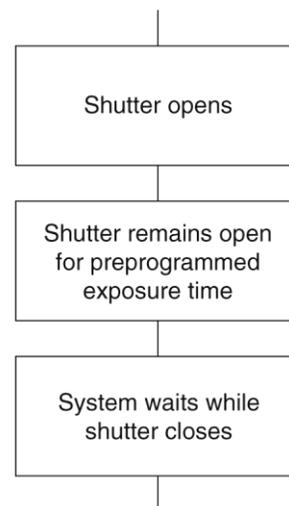


Figure 20. Free Run timing chart, part of the chart in Figure 24

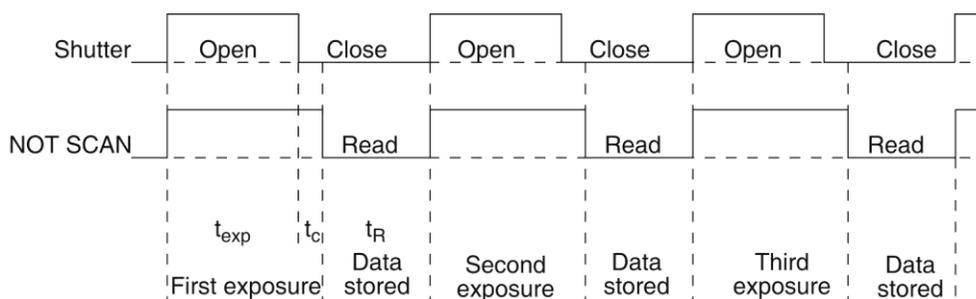


Figure 21. Free Run Timing Diagram

External Sync

In this mode, all exposures are synchronized to an external source. As shown in the flowchart, Figure 22, this mode can be used in combination with Normal or PreOpen Shutter operation. In Normal Shutter mode, the controller waits for an External Sync pulse, then opens the shutter for the programmed exposure period. As soon as the exposure is complete, the shutter closes and the array is read out. The shutter requires up to 26 msec to open completely, depending on the model of shutter.

External synchronization depends on an edge trigger (negative- or positive-going) which must be supplied to the Ext Sync BNC on the back of the ST-133. The type of edge must be identified in the application software to ensure that the shutter opening is initiated by

the correct edge (in the WinX application software, this is done on the Experiment Setup/Timing tab). Since the shutter requires up to 26 msec to fully open, the External Sync pulse provided by the experiment must precede the actual signal by at least that much time. If not, the shutter will not be open for the duration of the entire signal, or the signal may be missed completely.

Also, since the amount of time from initialization of the experiment to the first External Sync pulse is not fixed, an accurate background subtraction may not be possible for the first readout. In multiple-shot experiments this is easily overcome by simply discarding the first frame.

In the PreOpen Shutter mode, on the other hand, shutter operation is only partially synchronized to the experiment. As soon as the controller is ready to collect data, the shutter opens. Upon arrival of the first External Sync pulse at the ST-133, the shutter remains open for the specified exposure period, closes, and the array is read out. As soon as readout is complete, the shutter reopens and waits for the next frame.

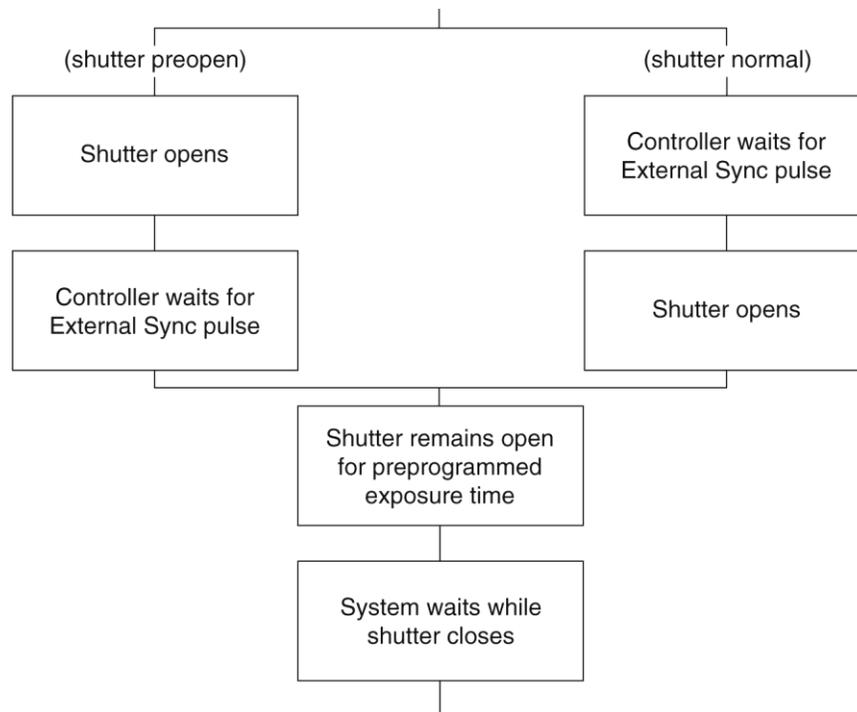


Figure 22. Chart showing two External Sync Timing Options

The PreOpen mode is useful in cases where an External Sync pulse cannot be provided 5-26 msec before the actual signal occurs. Its main drawback is that the array is exposed to any ambient light while the shutter is open between frames. If this ambient light is constant, and the triggers occur at regular intervals, this background can also be subtracted, providing that it does not saturate the array. As with the Normal Shutter mode, accurate background subtraction may not be possible for the first frame.

Also note that, in addition to signal from ambient light, dark signal accumulates during the “wait” time (t_w). Any variation in the external sync frequency also affects the amount of dark signal, even if light is not falling on the array during this time.

Note: If EXT SYNC is still active (in Figure 23, this means that if it is still LOW) at the end of the readout, the hardware will interpret this as a second sync pulse, and so on.

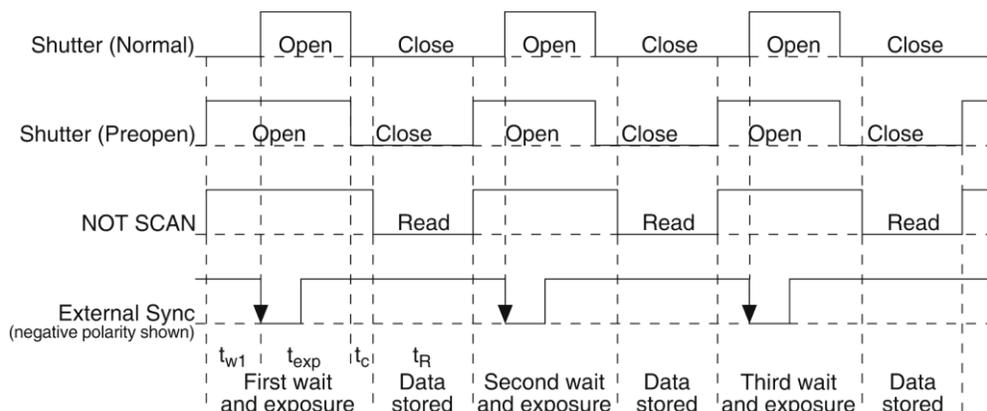
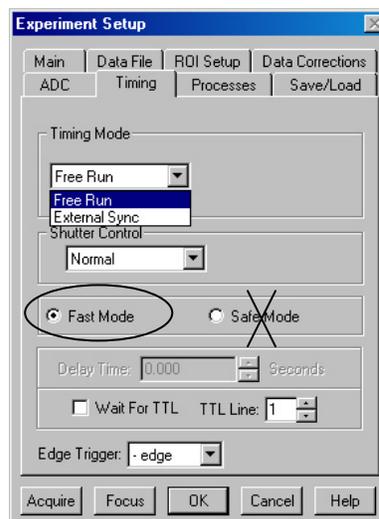


Figure 23. External Sync Timing diagram

Fast Mode

In some versions of the WinX application software, the Experiment Setup **Timing** tab allows the choice of **Fast Mode** or **Safe Mode** operation. Only **Fast Mode** operation is valid for *OMA V detectors*. In this operating mode, the ST-133 runs according to the timing of the experiment, with no interruptions from the computer.

Fast Mode operation is primarily for collecting “real-time” sequences of experimental data, where timing is critical and events cannot be missed. Once the ST-133 is sent the Start Acquisition command by the computer, all frames are collected without further intervention from the computer (Figure 24 shows the acquisition sequence). The advantage of this timing mode is that timing is controlled completely through hardware. A drawback to this mode is that the computer will only display 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.



If an external entrance slit shutter is being controlled by the ST-133, the shutter options available (Normal, PreOpen, Disable Opened or Disable Closed) may be used to coordinate shutter operation with the experiment. Disable simply means that the shutter will not operate during the experiment. Disable closed is useful for making dark signal measurements of background, or when no shutter is present in the system. PreOpen, available in the External Sync mode, opens the shutter as soon as the ST-133 is ready to receive an External Sync pulse. This is required if the time between the External Sync pulse and the event is less than a few milliseconds, the time it takes the shutter to open.

The shutter timing is shown in the timing diagrams that follow. Except for Free Run, where the modes of shutter operation are identical, both Normal and PreOpen lines are shown in the timing diagrams and flow chart.

The timing diagrams are labeled indicating the exposure time (t_{exp}), shutter compensation time (t_c), and readout time (t_R).

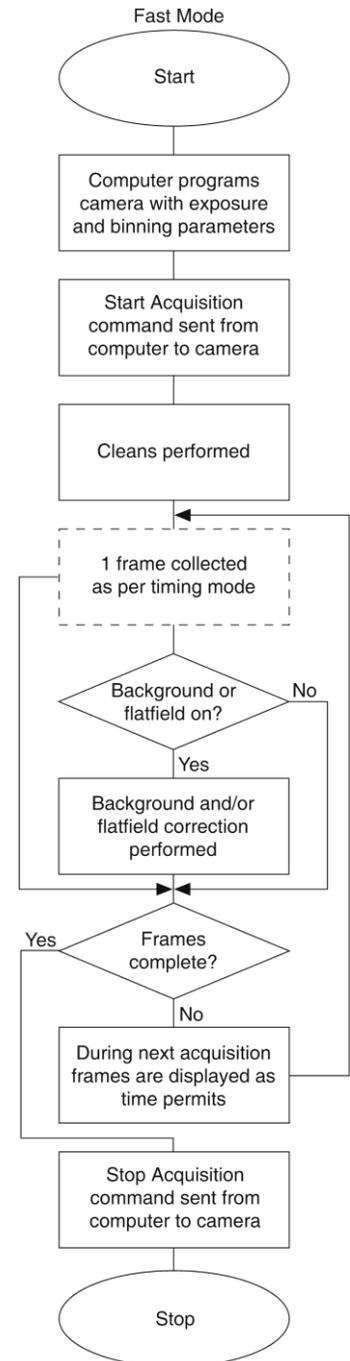


Figure 24. Flowchart of Fast Mode Operation

TTL Control

Fully supported by WinSpec/WinView Version 2.5 when the communication protocol is TAXI (PCI), this feature is not supported when the protocol is USB 2.0.

Introduction

Princeton Instrument's WinSpec/32 and WinView/32 software packages incorporate WinX32 Automation, a programming language that can be used to automate performing a variety of data acquisition and data processing functions, including use of the TTL In/Out functions. WinX32 Automation can be implemented in programs written in Visual Basic. See the WinX32 documentation for more detailed information.

The TTL lines are made available through the TTL In/Out connector on the rear of the ST-133 Controller. This connector provides 8 TTL lines in, 8 TTL lines out and an input control line. Figure 25 illustrates the connector and Table 5 lists the signal/pin assignments.

TTL In

The user controls the 8 TTL Input lines, setting them high (+5 V; TTL 1) or low (0 V; TTL 0).

WARNING!

Voltages above +5V may damage circuitry.

When the lines are read, the combination of highs and lows read defines a decimal number which the computer can use to make a decision and initiate actions as specified in the user's program. If a TTL IN line is low, its numeric value is 0. If a TTL IN line is high, its numeric value is as follows.

TTL IN	Value	TTL IN	Value
1	1	5	16
2	2	6	32
3	4	7	64
4	8	8	128

This coding allows any decimal value from 0 to 255 to be defined. Thus, as many as 256 different sets of conditions can be specified, at the user's discretion, using the TTL IN lines. *Any unused lines will default to TTL high (+5 V).* For example, to define the number three, the user would simply set the lines TTL IN 1 and TTL IN 2 both high (+5 V). It would be necessary to apply TTL low to the remaining six lines because they would otherwise default to TTL high as well.

TTL IN	Value	TTL IN	Value
1	High (1)	5	Low (0)
2	High (2)	6	Low (0)
3	Low (0)	7	Low (0)
4	Low (0)	8	Low (0)

Table 4 illustrates this coding for decimal values 0 through 7. Obviously, this table could easily be extended to show the coding for values all the way to 255.

Decimal Equiv.	TTL IN/OUT 8 1=dec 128	TTL IN/OUT 7 1=dec 64	TTL IN/OUT 6 1=dec 32	TTL IN/OUT 5 1=dec 16	TTL IN/OUT 4 1=dec 8	TTL IN/OUT 3 1=dec 4	TTL IN/OUT 2 1=dec 2	TTL IN/OUT 1 1=dec 1
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	1	0
3	0	0	0	0	0	0	1	1
4	0	0	0	0	0	1	0	0
5	0	0	0	0	0	1	0	1
6	0	0	0	0	0	1	1	0
7	0	0	0	0	0	1	1	1

Table 4. Bit Values with Decimal Equivalents:

1 = High,

0 = Low

Buffered vs. Latched Inputs

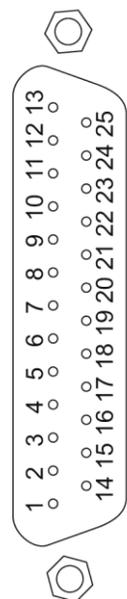
In controlling the TTL IN lines, users also have the choice of two input-line states, *buffered* or *latched*. In the buffered state, the line levels must remain at the intended levels until they are read. With reference to the preceding example, the high level at TTL IN 1 and TTL IN 2 would have to be maintained until the lines are read. In the latched state, the applied levels continue to be available until read, even if they should change at the TTL In/Out connector.

This control is accomplished using the EN/CLK TTL input (pin 6). If EN/CLK is open or high, *buffered* operation is established and the levels reported to the macro will be those in effect when the READ is made. With reference to our example, if pin 6 were left unconnected or a TTL high applied, TTL IN 1 and TTL IN 2 would have to be held high until read. If, on the other hand, EN/CLK were made to go low while TTL IN 1 and TTL IN 2 were high, those values would be *latched* for *as long as EN/CLK remained low*. The levels actually present at TTL IN 1 and TTL IN 2 could then change without changing the value that would be read by software.

TTL Out

The state of the TTL OUT lines is set from the WinX (WinSpec/32 or WinView/32) application software. Typically, a program monitoring the experiment sets one or more of the TTL Outputs. Apparatus external to the ST-133 interrogates the lines and, on detecting the specified logic levels, takes the action appropriate to the detected condition. The coding is the same as for the input lines. There are eight output lines, each of which can be set low (0) or high (1). The combination of states defines a decimal number as previously described for the TTL IN lines.

TTL IN/OUT



Pin #	Assignment	Pin #	Assignment
1	IN 1	14	IN 2
2	IN 3	15	IN 4
3	IN 5	16	IN 6
4	IN 7	17	IN 8
5	GND	18	GND
6	EN/CLK	19	Reserved
7	(future use)	20	GND
8	GND	21	OUT 2
9	OUT 1	22	OUT 4
10	OUT 3	23	OUT 6
11	OUT 5	24	OUT 8
12	OUT 7	25	GND
13	Reserved		

Figure 25. TTL In/Out Connector

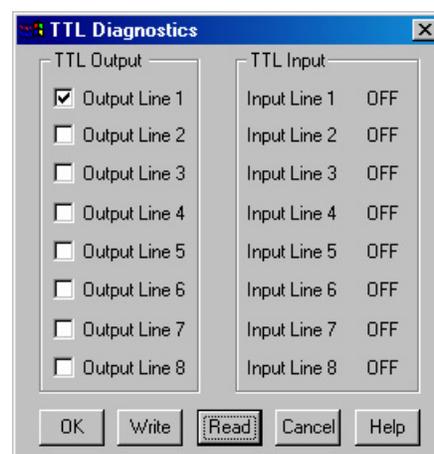
Table 5. TTL In/Out Connector Pinout

TTL Diagnostics Screen

Note that the WinX application software provides a TTL Diagnostics screen (located under **Hardware Setup|Diagnostics**) that can be used to test and analyze the TTL In/Out lines.

Hardware Interface

A cable will be needed to connect the TTL In/Out connector to the experiment. The design will vary widely according to each user's needs, but a standard 25-pin female type D-subminiature connector will be needed to mate with the TTL In/Out connector at the ST-133. The hardware at the other end of the cable will depend entirely on the user's requirements. If the individual connections are made using coaxial cable for maximum noise immunity (recommended), the center conductor of the coax should connect to the proper signal pin and the cable shield should connect to the nearest available ground (grounds are conveniently provided at pins 5, 8, 18 and 20). Connector hardware and cables of many different types are widely available and can often be obtained locally, such as at a nearby



electronics store. A list of possibly useful items follows. Note that, although the items listed may be appropriate in many situations, they might not meet your specific needs.

- 25-pin female type D-subminiature solder type connector (Radio Shack® part no 276-1548B).
- RG/58U coaxial cable.
- Shielded Metalized hood (Radio Shack part no 276-1536A).
- BNC connector(s) type UG-88 Male BNC connector (Radio Shack part no 278-103).

Example

Suppose you needed to build a cable to monitor the line TTL OUT 1. One approach would be to build a cable assembly as described in the following paragraphs. This procedure could easily be adapted to other situations.

1. Begin with a 25-pin female type D-subminiature solder type connector (Radio Shack part no 276-1548B). This connector has 25 solder points open on the back.
2. Referring to Table 5 on page 66, note that pin 8 = GND and pin 9 = TTL OUT 1.
3. Using coaxial cable type RG/58U (6 feet length), strip out the end and solder the outer sheath to pin 8 (GND) and the inner line to pin 9 (TTL OUT 1). Then apply shielding to the lines to insulate them.
4. Mount the connector in a Shielded Metalized hood (Radio Shack part no 276-1536A).
5. Build up the cable (you can use electrical tape) to where the strain relief clamp holds.
6. Connect a BNC connector (UG-88 Male BNC connector) to the free end of the cable following the instructions supplied by Radio Shack on the box (Radio Shack part no 278-103).
7. To use this cable, connect the DB-25 to the TTL In/Out connector on the back of the ST-133 controller.
8. To check the cable, start the WinX (WinSpec/32 or WinView/32) application software and open the TTL Diagnostics screen (located under *Hardware Setup - Diagnostics*). Click the **Write** radio button. Then click the **Output Line 1** box. Next, click the **OK** button to actually set TTL OUT 1 high. Once you set the voltage, it stays until you send a new command.
9. Measure the voltage at the BNC connector with a standard voltmeter (red on the central pin, black on the surrounding shielding). Before clicking **OK** at the TTL Diagnostics screen you should read 0 V. After clicking **OK** you should read +5 V.

Note that adding a second length of coaxial cable and another BNC connector would be straightforward. However, as you increase the number of lines to be monitored, it becomes more convenient to consider using a multiple conductor shielded cable rather than individual coaxial cables.

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Chapter 7

Troubleshooting

WARNING!

Do not attach or remove any cables while the detector system is powered on.

Introduction

The following issues have corresponding troubleshooting sections in this chapter.

Baseline Signal Suddenly Changes	Page 70
Camera1 (or similar name) on Hardware Setup dialog	Page 70
Changing the ST-133 Line Voltage and Fuses	Page 71
Controller Is Not Responding	Page 72
Cooling Troubleshooting	Page 72
Data Loss or Serial Violation	Page 73
Data Overrun Due to Hardware Conflict message	Page 74
Data Overrun Has Occurred message	Page 74
Demo is only Choice on Hardware Wizard:Interface dialog (Versions 2.5.19.0 and Earlier)	Page 75
Demo, High Speed PCI, and PCI(Timer) are Choices on Hardware Wizard:Interface dialog (Versions 2.5.19.0 and Earlier)	Page 76
Detector Temperature, Acquire, and Focus are Grayed Out (Versions 2.5.19.0 and Earlier)	Page 78
Error Creating Controller message	Page 79
Error occurs at Computer Powerup	Page 80
No CCD Named in the Hardware Wizard CCD Dialog (Versions 2.5.19.0 and Earlier)	Page 82
Program Error message	Page 83
Removing/Installing a Plug-In Module	Page 84
Securing the Detector-Controller Cable Slide Latch	Page 86
Serial violations have occurred. Check interface cable.	Page 87
Vignetting	Page 87

Baseline Signal Suddenly Changes

If you observe a sudden change in the baseline signal, you may have excessive humidity in the vacuum enclosure of the detector. Turn off the controller (if LN-cooled, remove the liquid nitrogen also) system and have the detector repumped before resuming normal operation. *Contact Customer Support for further instructions. See page 124 for contact information.*

Camera1 (or similar name) on Hardware Setup dialog



Figure 26. Camera1 in Controller Type (Camera Name) Field

If you see a default name such as Camera1 on the **Setup|Hardware|Controller/CCD** tab, you may want to change it since this name is not particularly descriptive. Such a change is made by editing the PVCAM.INI file that is generated by Camera Detection wizard (or by the RSConfig.exe if you have software version 2.5.19.0 or earlier).

To change the default Camera Name:

1. Using **Notepad** or a similar text editor, open **PVCAM.INI**, which is located in the Windows directory (C:\Windows, for example). You should see entries like the ones below.

```
[Camera_1]
Type=1
Name=Camera1
Driver=apausb.sys
Port=0
ID=523459
```

2. Change the "Name=" entry to something more meaningful for you (for example, ST133USB - to indicate that this is a PVCAM-based system using an ST-133 with a USB 2.0 interface) and save the edited file.

```
[Camera_1]
Type=1
Name=ST133USB
Driver=apausb.sys
Port=0
ID=523459
```

3. The new camera name will now appear in the **Controller Type (Camera Name)** field.

Changing the ST-133 Line Voltage and Fuses

The appropriate voltage setting for your country is set at the factory and can be seen on the back of the power module. If your voltage source changes, you will need to change the voltage setting and you may need to change the fuse configuration.

WARNING! Use proper fuse values and types for the controller and detector to be properly protected.

To Change Voltage and Fuse Configuration:

WARNING!

Before opening the power module, turn the Controller OFF and unplug the powercord.

1. As shown in Figure 27, place the flat side of a flat bladed screwdriver parallel to the back of the Controller and behind the small tab at the top of the power module, and twist the screwdriver slowly but firmly to pop the module open.
2. To change the voltage setting, roll the selector drum until the setting that is closest to the actual line voltage is facing outwards.
3. Confirm the fuse ratings by removing the two white fuse holders. To do so, simply insert the flat blade of the screwdriver behind the front tab of each fuse holder and gently pry the assembly out.
4. Refer to the Fuse/Voltage label (above or below the Power Module) to see which fuses are required by the selected voltage. If Controller power switch is on the back of the ST-133, the Fuse/Voltage label is located below the Power Module.
5. After inspecting and if necessary, changing the fuses to those required by the selected voltage, reinstall the holders with the arrow facing to the right.
6. Close the power module and verify that the correct voltage setting is displayed.
7. Verify that the Controller power switch is in the OFF position and then plug the powercord back into the power module.

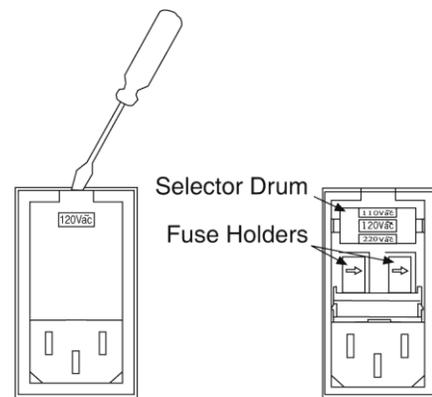


Figure 27. Power Input Module

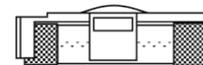


Figure 28. Fuse Holder

Controller Is Not Responding

If this message pops up when you click on **OK** after selecting the Interface Type during **Hardware Setup** (selected from the **Setup** menu), the system has not been able to communicate with the Controller. Check to see if Controller has been turned ON and if the interface card, its driver, and the interface cable have been installed.

- If the Controller is ON, the problem may be with the interface card, its driver, interrupt or address conflicts, or the cable connections.
- If the interface card is not installed, close the WinX (WinSpec/32 or WinView/32) application software and turn the Controller OFF. Follow the interface card installation instructions in Chapter 4 and cable the interface card to the SERIAL COM port on the rear of the Controller. Then do a "Custom" installation of the WinX application software with the appropriate interface component selected: "PCI Interface". Be sure to deselect any interface component that does not apply to your system.
- If the interface card is installed in the computer and is cabled to the SERIAL COM port on the rear of the Controller, close the WinX application software and turn the Controller OFF. Check the cable connections and tighten the locking screws if the connections are loose.
- If the interface card was installed after the WinX application software has been installed, close the WinX application software and do a "Custom" installation of the WinX application software with the appropriate interface component selected: "PCI Interface". Be sure to deselect any interface component that does not apply to your system.

Cooling Troubleshooting

Temperature Lock cannot be Achieved or Maintained.

Possible causes could include:

- The vacuum has deteriorated and needs to be refreshed.
- The connectors of the cable that interconnects the controller and the detector need to be secured.
- The target array temperature is not appropriate for your particular detector and array.
- For a TE-cooled detector, the detector's internal temperature may be too high, such as might occur if the operating environment is particularly warm or if you are attempting to operate at a temperature colder or warmer than the specified limit. TE-cooled detectors are equipped with a thermal-protection switch that shuts the cooler circuits down if the internal temperature exceeds a preset limit. Typically, detector operation is restored automatically in about ten minutes. Although the thermal-protection switch will protect the detector, you are nevertheless advised to power down and correct the operating conditions that caused the thermal-overload to occur.

Detector loses Temperature Lock

The internal temperature of the detector is too high. This might occur if the operating environment is particularly warm or if you are attempting to operate at a temperature colder than the specified limit. If this happens, an internal thermal overload switch will disable the cooler circuits to protect them. Typically, detector operation is restored in about ten minutes. Although the thermal overload switch will protect the detector, users are advised to power down and correct the operating conditions that caused the thermal overload to occur. *With some versions of the software, the **indicated** temperature when the detector is in thermal overload (thermal switch is in the cut-out state) is -100° C.*

Note: If the **Detector Temperature** dialog is open, the following message will be displayed in the box when thermal overload is detected: "**Detector Overheated! Consult operations manual or contact PI Technical Support if problem persists.**"

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 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 Princeton Instruments Customer Support to make arrangements for returning the detector to have the vacuum restored. See page 124 for contact information.*

WARNING! Do not open the vacuum valve under any circumstances. Opening the vacuum valve will void your warranty.

Data Loss or Serial Violation

You may experience either or both of these conditions if the host computer has been set up with Power Saving features enabled. This is particularly true for power saving with regard to the hard drive. Make sure that Power Saving features are disabled while you are running the WinX (WinSpec/32 or WinView/32) application software.

Data Overrun Due to Hardware Conflict message



Figure 29. Data Overrun Due to Hardware Conflict dialog

If this dialog appears when you try to acquire a test image, acquire data, or run in focus mode, check the CCD array size and then check the DMA buffer size. A large array (for example, a 2048x2048 array), requires a larger DMA buffer larger setting than that for a smaller array (for example, a 512x512 array).

To change the DMA buffer setting:

1. Note the array size (on the **Setup|Hardware|Controller/CCD** tab or the **Acquisition|Experiment Setup|Main** tab Full Chip dimensions).
2. Open **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 the WinX application software.
4. Reboot your computer.
5. Restart the WinX application software and begin acquiring data or focusing. If you see the message again, increase the DMA buffer size.

Data Overrun Has Occurred message

Because of memory constraints and the way that USB transfers data, a "Data overrun has occurred" message may be displayed during data acquisition. If this message is displayed, take one or more of the following actions:

1. Minimize the number of programs running in the background while you are acquiring data with the WinX (WinSpec/32 or WinView/32) application software.
2. Add memory.
3. Use binning.
4. Increase the exposure time.
5. Defragment the hard disk.
6. Update the Orange Micro USB2 driver. See *"To Update the OrangeUSB USB 2.0 Driver"*, page 31.

If the problem persists, your application may be USB 2.0 bus limited. Since the host computer controls the USB 2.0 bus, there may be situations where the host computer interrupts the USB 2.0 port. In most cases, the interrupt will go unnoticed by the user. However, there are some instances when the data overrun cannot be overcome because USB 2.0 bus limitations combined with long data acquisition times and/or large data sets increase the possibility of an interrupt while data is being acquired. If your experiment requirements include long data

acquisition times and/or large data sets, your application may not be suitable for the USB 2.0 interface. Therefore, we recommend replacement of the USB 2.0 interface module with our TAXI interface module and Princeton Instruments (RSPI) high speed PCI card. If this is not the case and data overruns continue to occur, contact Customer Support (see page 124 for contact information).

Demo is only Choice on Hardware Wizard:Interface dialog (Versions 2.5.19.0 and Earlier)

If RSConfig.exe has not been run and there is not an installed Princeton Instruments (RSPI) high speed PCI card, the Hardware Wizard will only present the choice "Demo" in the Interface dialog (Figure 30). Clicking on **Next** presents an "Error Creating Controller. Error=129." message, clicking on **OK** presents "The Wizard Can Not Continue Without a Valid Selection!" message, clicking on **OK** presents the Interface dialog again.



Figure 30. Hardware Wizard: Interface dialog

At this point, you will need to exit the WinX (WinSpec/32 or WinView/32) application software and run the RSConfig.exe program, which creates a file called PVCAM.INI. This file contains information required to identify the interface/camera (or detector) and is referenced by the Hardware Wizard when you are setting up WinSpec/32 with USB for the first time:

1. If you have not already done so, close the WinX application software.
2. Make sure the ST-133 is connected to the host computer and that it is turned on.
3. Run RSConfig from the **Windows|Start|Programs|PI Acton** menu or from the directory where you installed the WinX application software.
4. When the RSConfig dialog (Figure 31) appears, you can change the camera name to one that is more specific or you can keep the default name "Camera1". When you have finished, click on the **Done** button.

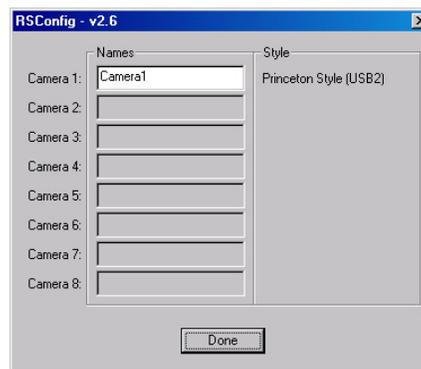


Figure 31. RSConfig dialog

5. You should now be able to open the WinX application software and, from **Setup|Hardware...**, run the Hardware Wizard.
6. When the PVCAM dialog (Figure 32) is displayed, click in the **Yes** radio button, click on **Next** and continue through the Wizard. After the Wizard is finished, the **Controller/Camera** tab card will be displayed with the **Use PVCAM** checkbox selected. You should now be able to set up experiments and acquire data.

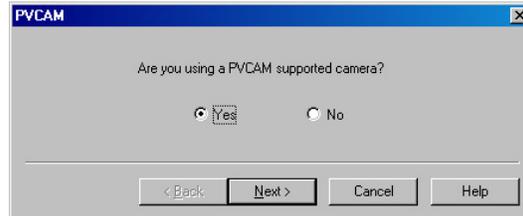


Figure 32. Hardware Wizard: PVCAM dialog

Demo, High Speed PCI, and PCI(Timer) are Choices on Hardware Wizard:Interface dialog (Versions 2.5.19.0 and Earlier)

If there is an installed Princeton Instruments (RSPI) high speed PCI card in the host computer and you want to operate a detector using the USB 2.0 interface, the PVCAM.INI file (created by RSConfig.exe) must exist and the USB 2.0 supported detector/camera must be [Camera_1]. PVCAM.INI, which contains information required to identify the interface/camera (or detector), is referenced by the Hardware Wizard when you are setting up the WinX (WinSpec/32 or WinView/32) application software with USB for the first time. If the Wizard did not find a PVCAM.INI file or if RSConfig.exe was run but the USB 2.0 camera is [Camera_2] in the PVCAM.INI file, "Demo", "High Speed PCI", and "PCI(Timer)" will be selectable from the Wizard's Interface dialog.

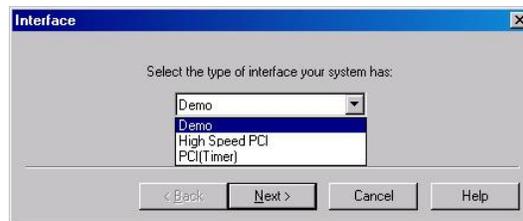


Figure 33. Hardware Wizard: Interface dialog

At this point, you will need to run the RSConfig.exe program:

4. If you have not already done so, close the WinX application software.
5. Make sure the ST-133 is connected to the host computer and that it is turned on.
6. Run RSConfig from the **Windows|Start|Programs|PI Acton** menu or from the directory where you installed the WinX application software.
7. When the RSConfig dialog (Figure 34) appears, you can change the camera name to one that is more specific or you can keep the default name "Camera2". When you have finished, click on the **Done** button. You will next edit the generated PVCAM.INI file.

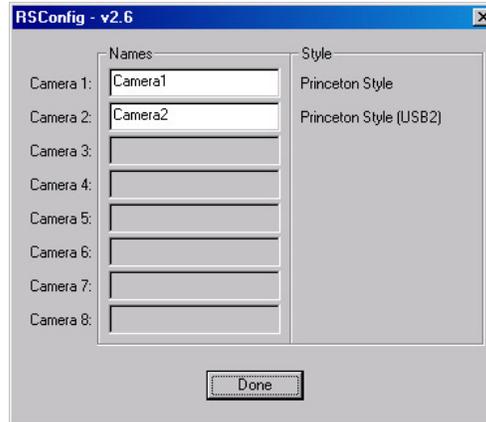


Figure 34. RSConfig dialog: Two Camera Styles

8. Using **Notepad** or a similar text editor, open PVCAM.INI, which is located in the Windows directory (C:\Windows, for example).

If the contents of the file look like: Change the headings so the contents now look like:

<p>[Camera_1] → Type=1 Name=Camera1 Driver=rspipci.sys Port=0</p>	<p>[Camera_2] Type=1 Name=Camera1 Driver=rspipci.sys Port=0</p>
<p>[Camera_2] → Type=1 Name=Camera2 Driver=apausb.sys Port=0</p>	<p>[Camera_1] Type=1 Name=Camera2 Driver=apausb.sys Port=0</p>

Note: The [Camera_#] must be changed so the camera supported by the USB interface will be recognized (the USB driver is "apausb.sys"). For consistency, you may also want to change the camera names.

9. Save the file. With the ST-133 connected and on, open the WinX application software.
10. Run the Hardware Wizard.
11. When the PVCAM dialog (Figure 35) is displayed, click in the **Yes** radio button, click on **Next** and continue through the Wizard. After the Wizard is finished, the **Controller/Camera** tab card will be displayed with the **Use PVCAM** checkbox selected. You should now be able to acquire data.

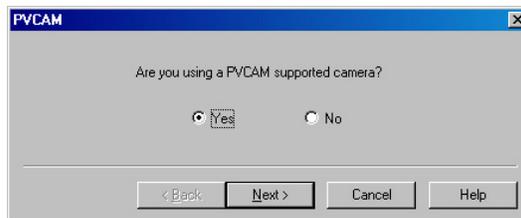


Figure 35. Hardware Wizard: PVCAM dialog

Detector Temperature, Acquire, and Focus are Grayed Out (Versions 2.5.19.0 and Earlier)

These functions and others will be deactivated if you have installed a camera/detector being run under USB 2.0 and have opened the WinX (WinSpec/32 or WinView/32) application software without having first turned on the ST-133. They will also be deactivated if you have installed a camera/detector being run under USB 2.0 and a Princeton Instruments (RSPI) high speed PCI card was also detected when RSConfig.exe was run.

1. Check to see if the ST-133 is connected to the host computer and is turned on. If it is not connected or is connected but not turned on, go to Step 2. If it is connected and on, go to Step 3.
2. Close the WinX application software, verify that the ST-133 is connected to the host computer, turn on the ST-133, and reopen the WinX application software. The formerly grayed out functions should now be available.
3. If the ST-133 is connected and on, the USB 2.0 camera/detector may not be listed as Camera 1 in the PVCAM.INI file.
4. Run RSConfig.exe (accessible from the **Windows|Start|Programs|PI Acton** menu). If the USB 2.0 camera/detector is listed as Camera 2 (Princeton Style (USB2) in Figure 36), you will have to edit the PVCAM.INI file.

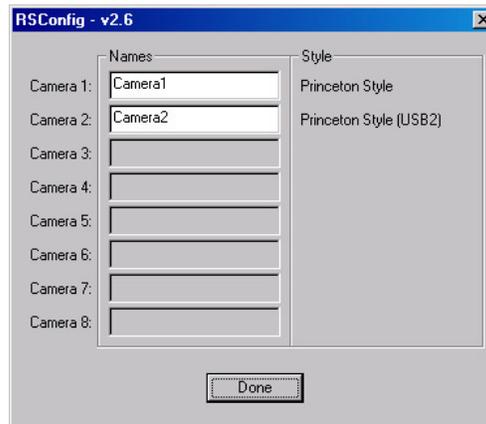


Figure 36. RSConfig dialog: Two Camera Styles

- Using **Notepad** or a similar text editor, open PVCAM.INI, which is located in the Windows directory (C:\Windows, for example).

If the contents of the file look like: Change the headings so the contents now look like:

<pre>[Camera_1] Type=1 Name=Camera1 Driver=rspipci.sys Port=0</pre>	→	<pre>[Camera_2] Type=1 Name=Camera1 Driver=rspipci.sys Port=0</pre>
<pre>[Camera_2] Type=1 Name=Camera2 Driver=apausb.sys Port=0</pre>	→	<pre>[Camera_1] Type=1 Name=Camera2 Driver=apausb.sys Port=0</pre>

Note: The [Camera_#] must be changed so the camera/detector supported by the USB interface will be recognized (the USB driver is "apausb.sys"). For consistency, you may also want to change the camera names.

- Save the file. With the ST-133 connected and on, open the WinX application software. The formerly grayed out functions should now be available.

Error Creating Controller message

This message may be displayed if you are using the USB 2.0 interface and have not run the RSConfig.exe program (see previous topic), if the PVCAM.INI file has been corrupted, or if the ST-133 was not turned on before you started the WinX (WinSpec/32 or WinView/32) application software and began running the Hardware Wizard.

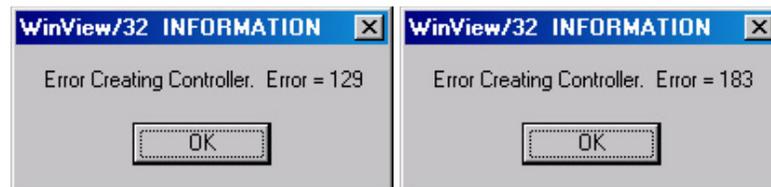


Figure 37. Error Creating Controller dialog

Error 129: Indicates that the problem is with the PVCAM.INI file. Close the WinX application software, run RSConfig, make sure the ST-133 is on, reopen the WinX application software, and begin running the Hardware Wizard.

Error 183: Indicates that the ST-133 is off. If you are running the Hardware Wizard when this message appears, click on **OK**, turn on the ST-133, and, on the PVCAM dialog, make sure **Yes** is selected and then click on **Next**. The Hardware Wizard should continue to the Controller Type dialog.

Error occurs at Computer Powerup

If an error occurs at boot up, either the Interface is not installed properly or there is an address or interrupt conflict. Turn off the computer, try a new address or interrupt and reinstall the card. Be sure the Interface card is firmly mounted in the slot.

Caution

Since interrupts and DMA channels cannot be shared, make sure no other boards in your computer use this interrupt or these DMA channels.

Conflicts

One of the many advantages that PCI offers over ISA is that the whole issue of address and interrupt assignments is user transparent and under BIOS control. As a result, users typically do not have to be concerned about jumpers or switches when installing a PCI card. Nothing more should be required than to plug in the card, make the connections, and operate the system. As it turns out, however, in certain situations conflicts may nevertheless occur and user intervention will be required to resolve them.

Typical PCI motherboards have both ISA and PCI slots and will have both PCI and ISA cards installed. In the case of the ISA cards, the I/O address and Interrupt assignments will have been made by the user and the BIOS will not know which addresses and interrupts have been user assigned. When a PCI card is installed, the BIOS checks for available addresses and interrupt levels and automatically assigns them so that there are no *PCI* address or interrupt conflicts. However, because the BIOS doesn't know about the user-assigned ISA I/O address and interrupt level assignments, it is possible that a PCI card will be assigned an address or interrupt that is already assigned to an ISA card. If this happens, improper operation will result. Specifically, the problems could range from erratic operation under specific conditions to complete system failure. If such a conflict occurs, because the user has no control over the PCI address and interrupt assignments, there will be no recourse but to examine the ISA assignments and change them to values that do not conflict. Most (but by no means all) ISA cards make provision for selecting alternative I/O addresses and interrupt levels so that conflicts can be resolved. Software is available to help identify specific conflicts.

The following example may serve to illustrate the problem. Suppose you had a system with an ISA network card, a PCI video card and an ISA sound card. Further, suppose that you were then going to install a PCI Serial Buffer card. Before installing the PCI Serial card, the I/O address and interrupt assignments for the installed cards might be as follows.

Slot Type	Status	I/O Address	Interrupt
1 (ISA)	ISA Network Card	200-210	11
2 (PCI)	PCI Video Card	FF00-FFFF	15
3 (ISA)	ISA Sound Card	300-304	9
4 (PCI)	Empty	N/A	N/A

*Table 6. I/O Address & Interrupt Assignments
before Installing Serial Card*

As shown, there are no conflicts, allowing the three peripheral cards to operate properly. If the PCI Serial card were then installed, the BIOS would interrogate the PCI cards and may reassign them new address and interrupt values as follows.

Slot Type	Status	I/O Address(s)	Interrupt
1 (ISA)	ISA Network Card	200-210	11
2 (PCI)	PCI Video Card	FE00-FEFF	11
3 (ISA)	ISA Sound Card	300-304	9
4 (PCI)	Princeton Instruments (RSPI) PCI Serial Card	FF80-FFFF	15

Table 7. I/O Address & Interrupt Assignment after Installing Serial Card

As indicated, there is now an interrupt conflict between the ISA Network Card and the PCI Video card (both cards have been assigned Interrupt 11), causing the computer to no longer function normally. This does not mean that the PCI Serial card is defective because the computer stops functioning properly when the Serial card is installed. What it does mean is that there is an interrupt conflict that can be resolved by changing the interrupt level on the conflicting Network card in this example. It is up to the user to consult the documentation for any ISA cards to determine how to make the necessary change.

Note: Changing the order of the PCI cards, that is, plugging them into different slots, could change the address and interrupt assignments and possibly resolve the conflict. However, this would be a trial and error process with no guarantee of success.

Diagnostics Software

Many diagnostics programs, both shareware and commercial, are available to help resolve conflicts. Most often, all that is required is a program that will read and report the address and interrupt assignments for each PCI device in the computer. One such program available from Princeton Instruments' Customer Support department is called PCICHECK. When the program is run, it reports the address and interrupt assignments for the first PCI device it finds. Each time the spacebar is pressed, it moves on to the next one and reports the address and interrupt assignments for that one as well. In a few moments, this information can be obtained for every PCI device in the computer. Note that, although there are generally only three PCI slots, the number of PCI devices reported may be larger because some PCI devices may be built onto the motherboard. A good strategy for using the program would be to run it before installing the PCI Serial card. Then run it again after installing the card and note any address or interrupt assignments that may have changed. This will allow you to easily focus on the ones that may be in conflict with address or interrupt assignments on ISA cards. It might be noted that there are many programs, such as the MSD program supplied by Microsoft, that are designed to read and report address and interrupt assignments, including those on ISA cards. Many users have had mixed results at best using these programs.

Operation

There are no operating considerations that are unique to the PCI Serial card. The card can easily accept data as fast as any Princeton Instruments System now available can send it. The incoming data is temporarily stored in the card's memory, and then transferred to the main computer memory when the card gains access to the bus. The PCI bus arbitration scheme assures that, as long as every PCI card conforms to the PCI guidelines, the on-board memory will never overflow.

Unfortunately, there are some PCI peripheral cards that do *not* fully conform to the PCI guidelines and that take control of the bus for longer periods than the PCI specification allows. Certain video cards (particularly those that use the S3 video chip) are notorious in this respect. Usually you will be able to recognize when memory overflow occurs because the displayed video will assume a split-screen appearance and/or the message **Hardware Conflict** will be displayed (WinSpec/32 or WinView/32). At the same time, the LED on the upper edge of the PCI Serial card will light.

Users are thus advised not to take any actions that would worsen the possibility of memory overflow occurring when taking data. In that regard, avoid multitasking while taking data. Specific operations to avoid include multitasking (pressing ALT TAB or ALT ESC to start another program), or running a screensaver program.

No CCD Named in the Hardware Wizard: CCD dialog (Versions 2.5.19.0 and Earlier)

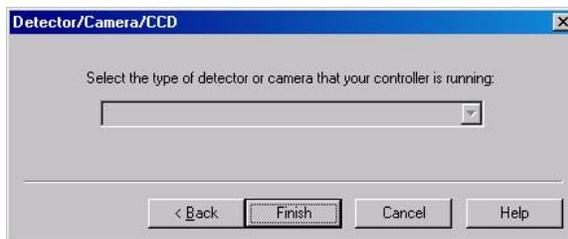


Figure 38. Hardware Wizard: Detector/Camera/CCD dialog

If you have installed a USB 2.0 Interface Module in your ST-133, a blank field may be displayed in the Detector/Camera/CCD dialog (Figure 38) if the ST-133 controller was made before January 2001. Earlier versions of the ST-133 did not contain non-volatile RAM (NVRAM), which is programmed with information about the controller and the camera/detector. PVCAM, the program under which the Princeton Instruments USB works, retrieves the information stored in NVRAM so it can enter specific camera/detector characteristics into the WinX (WinSpec/32 or WinView/32) application software.

Check the serial label on underside of your controller. If the first five characters are D1200 (December 2000) or earlier (J0797 or July 1997, for example), contact Customer Support to find out about an NVRAM controller upgrade.

Program Error message



Figure 39. Program Error dialog

This dialog may appear if you have tried to acquire a test image, acquire data, or run in focusing mode and the DMA buffer size is too small. A large array (for example, a 2048x2048 array), requires a larger setting than that for a smaller array (for example, a 512x512 array).

To correct the problem:

1. Click on **OK**.
2. Reboot the WinX application software.
3. Note the array size (on the **Setup|Hardware|Controller/CCD** tab or the **Acquisition|Experiment Setup|Main** tab Full Chip dimensions). If your camera contains a large array (such as a 2048x2048 array), and the DMA buffer size is too small, there will not be enough space in memory for the data set.
4. Open **Setup|Environment|Environment** dialog.
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 the WinX application software.
6. Reboot your computer.
7. Restart the WinX application software and begin acquiring data or focusing. If you see the message again, increase the DMA buffer size.

Removing/Installing a Plug-In Module

The ST-133 Controller has three plug-in slots. The Analog/Control module (leftmost slot when the controller is viewed from the rear) and the Interface Control module (either a TAXI or a USB 2.0 compatible module in the middle slot) are always provided. The third slot, however, is covered with a blank panel unless a PTG module has been installed in the ST-133.

If a module is ever removed for any reason, internal settings should **not** be disturbed. Changing a setting could radically alter the controller's performance. Restoring normal operation again without proper equipment and guidance would be very difficult, and it might be necessary to return the unit to the factory for recalibration.

WARNINGS!

1. Always turn the Controller OFF before removing or installing a module. If a module is removed or installed when the controller is powered, permanent equipment damage could occur which would not be covered by the warranty.
2. Before handling any boards, take precautions to prevent electrostatic discharge (ESD). The modules are susceptible to ESD damage. Damage caused by improper handling is not covered by the Warranty.

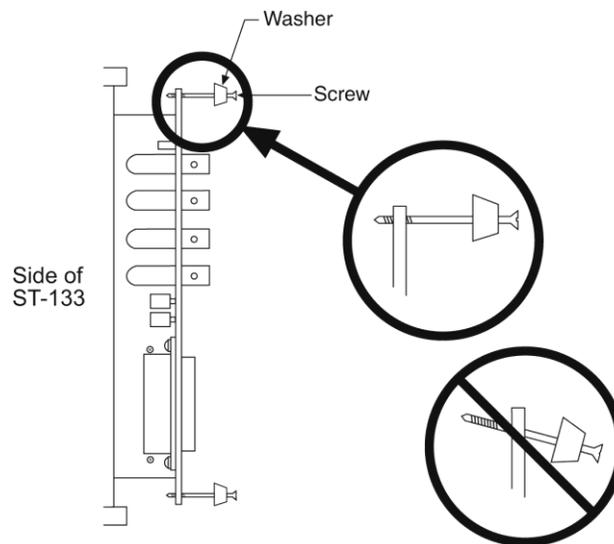


Figure 40. Module Installation

To Remove a Module:

1. Verify that the Controller has been turned OFF.
2. Rotate the two locking screws (one at the top of the module and one at the bottom) counterclockwise until they release from the chassis.
3. Then, grasp the module and pull it straight out.
4. Set the module aside in a safe place. If you are replacing it with another module, as in the case of exchanging a TAXI module with a USB 2.0 module, you may be able to use the packaging from the new module to store the module being replaced. This packaging is usually an antistatic bag that will protect the module components from electrostatic discharge.

To Install a Module:

Installing a module is a bit more complex because you first have to be sure the locking screws are aligned correctly. The following procedure is suggested.

1. Verify that the Controller has been turned OFF.
2. Remove the replacement module from its antistatic packaging. This packaging is designed to protect the module components from electrostatic discharge.
3. Rotate the two locking screws counterclockwise until the threads on the screws engage those of the module panel. *See Figure 40.* By doing this, the screws will be perfectly perpendicular to the module panel and will align perfectly when the module is inserted.
4. Insert the module so that the top and bottom edges of the board are riding in the proper guides.
5. Gently but firmly push the module in until the 64-pin DIN connector at the back of the module mates with the corresponding connector on the backplane, leaving the module panel resting against the controller back panel.
6. Rotate the two locking screws clockwise. As the screws are rotated, they will first disengage from the module panel threads, and then begin to engage those of the bracket behind the controller panel.

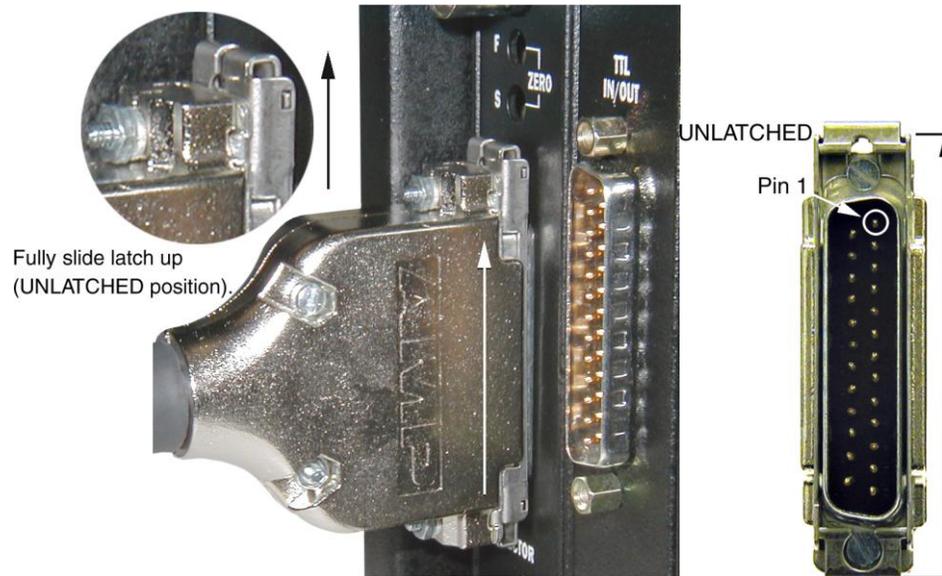
WARNING!

Tighten the screws to where they are just snug. Do *not* tighten them any further because you could easily bend the mating bracket.

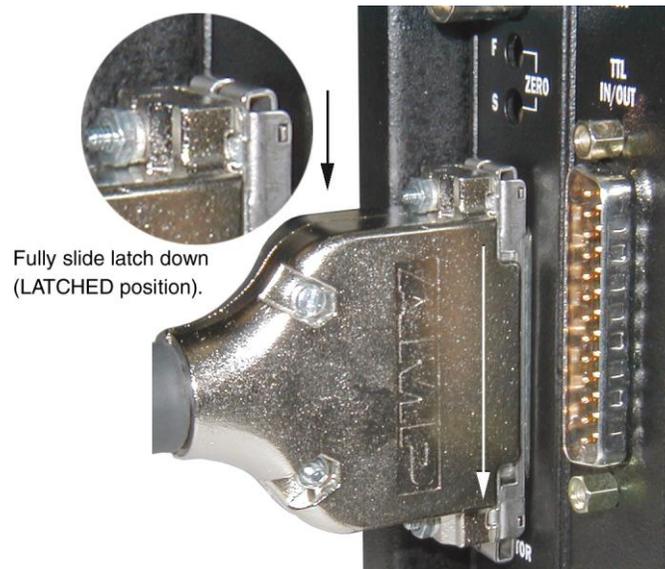
Securing the Detector-Controller Cable Slide Latch

Some Princeton Instruments Detector-Controller cables use a slide latch to secure the Detector-Controller cable to the DETECTOR connector on the back of the ST-133. Incorrectly plugging this cable into the connector and improperly securing the slide latch may prevent communication with the Spec-10 (the detector may appear to stop working).

1. Before trying to plug in the cable, slide the latch up (toward Pin 1). Then, plug the cable into the DETECTOR connector on the ST-133.



2. Slide the latch down. You may hear a click when the latch locks.



3. Verify that the connector is fully secured.

If you are having trouble sliding the latch, slightly pull the connector out and then slide the latch into its locked position.

Serial violations have occurred. Check interface cable.



Figure 41. Serial Violations Have Occurred dialog

This error message dialog will appear if you try to acquire an image or focus the camera and either (or both) of the following conditions exists:

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

To correct the problem:

1. Turn **OFF** the camera system (if it is not already OFF).
2. Make sure the Detector-Controller cable is secured at both ends and that the computer interface cable is secured at both ends.
3. After making sure that the cables are connected, turn the camera 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 you turn the camera system OFF or a cable comes loose while the application software is running in Focus mode.

Vignetting

All arrays have been tested for uniformity and do not exhibit any vignetting (reduction of response) at the extreme ends of the array. If you do measure such reduction in response across the array, 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 sprung a leak (a rare situation).
- The arrays are held with a special mask that has been designed to minimize reflection and stray light. These masks were designed to allow light rays to enter through the Dewar window even at very wide angles ($\geq f/1.5$). If vignetting is observed, it is possible that your experiment exceeds these angular constraints. 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

The specifications supplied in this manual are subject to change without notification. For up-to-date information about OMA-V detectors, refer to the data sheets available from Princeton Instruments at www.princetoninstruments.com or contact a Princeton Instruments Customer Representative. See page 124 for contact information.

Photodiode Array

OMA V:512-1.7 LN

PDA Format: Linear InGaAs photodiode array, 512 x 1 (50 x 500 μm pixels) with 25 mm spectral coverage

Cryogenic Cooling: Cools array from -50 to -100°C

Sensitivity: Response from 0.8 μm to 1.7 μm , peak QE >80%

Software-selectable Amplifiers: Select for high sensitivity or high dynamic range

Spectral Data Rate: 1800 spectra/second with 1 MHz digitization

Spectrometric Well Capacity (Typical): 120 Me⁻ (low gain), 4.5 Me⁻ (high gain)

Integration Time: 20 μs to many minutes

Dark Signal (Typical): 15 ke⁻/pixel/sec (low gain); 26 ke⁻/pixel/sec (high gain). Dark signal includes the array's dark current at -100°C and ambient background at +25°C.

OMA V:512-1.7 TE

PDA Format: Linear InGaAs photodiode array, 512 x 1 (50 x 500 μm pixels) with 25 mm spectral coverage

Thermoelectric Cooling: Cools array from +20 to -50°C

Sensitivity: Response from 0.8 μm to 1.7 μm , peak QE >80%

Software-selectable Amplifiers: Select for high sensitivity or high dynamic range

Spectral Data Rate: 1800 spectra/second with 1 MHz digitization

Spectrometric Well Capacity (Typical): 120 Me⁻ (low gain), 4.5 Me⁻ (high gain)

Integration Time: 20 μs to many minutes

Dark Signal (Typical): 20 ke⁻/pixel/sec (low gain); 35 ke⁻/pixel/sec (high gain). Dark signal includes the array's dark current at -50°C and ambient background at +25°C.

OMA V:1024-1.7 LN

PDA Format: Linear InGaAs photodiode array, 1024 x 1 (25 x 500 μm pixels) with 25 mm spectral coverage

Cryogenic Cooling: Cools array from -50 to -100°C

Sensitivity: Response from 0.8 μm to 1.7 μm , peak QE >80%

Software-selectable Amplifiers: Select for high sensitivity or high dynamic range

Spectral Data Rate: 900 spectra/second with 1 MHz digitization

Spectrometric Well Capacity (Typical): 120 Me⁻ (low gain), 4.5 Me⁻ (high gain)

Integration Time: 20 μs to many minutes

Dark Signal (Typical): 15 ke⁻/pixel/sec (low gain); 20 ke⁻/pixel/sec (high gain). Dark signal includes the array's dark current at -100°C and ambient background at +25°C.

OMA V:1024-2.2 LN

PDA Format: Linear InGaAs photodiode array, 1024 x 1 (25 x 250 μm pixels) with 25 mm spectral coverage

Cryogenic Cooling: Cools array from -50 to -100°C

Sensitivity: Response from 1.0 μm to 2.2 μm , peak QE >65%

Software-selectable Amplifiers: Select for high sensitivity or high dynamic range

Spectral Data Rate: 900 spectra/second with 1 MHz digitization

Spectrometric Well Capacity (Typical): 120 Me⁻ (low gain), 4.5 Me⁻ (high gain)

Integration Time: 20 μs to ~ 1 minute

Dark Signal (Typical): 4.2 Me⁻/pixel/sec (low gain); 3.7 Me⁻/pixel/sec (high gain). Dark signal includes the array's dark current at -100°C and ambient background at +25°C.

2-D OMA V:320-1.7 LN

PDA Format: two-dimensional InGaAs photodiode array, 320 x 256 (30 x 30 μm pixels) with .8-1.7 μm spectral coverage

Window Material: Sapphire

Cryogenic Cooling: Cools array from -50 to -100°C

Sensitivity: Response from .8 μm to 1.7 μm , peak QE >80%

Software-selectable Amplifiers: Select for high sensitivity or high dynamic range

Spectral Data Rate: 53 frames/second with 5 MHz digitization

Spectrometric Well Capacity (Typical): 2.5 Me⁻ (low gain), 65 ke⁻ (high gain)

Integration Time: 1 μs to minutes

Dark Signal (Typical): 5000 e⁻/pixel/sec

Detector

Cooling: Cryogenic or Thermoelectric cooling with full software control

-50 to -100°C (cryogenic)

ambient to <-45°C (thermoelectric)

Dewar Capacity (LN): 1.7 liters

Coolant Circulation (TE): 50:50 mixture of ethylene glycol and water for proper operation. Recommended flow rate and fluid pressure are: > 1 liter/minute at 25 psig (maximum).

Spectroscopy Mount: Standard mount integrates with Acton SpectraPro spectrographs or third party spectrographs. Other mounts are available from Princeton Instruments.

Focal Distance: Refer to the outline drawings in Appendix B.

Read Noise (Typical):

OMA V:512-1.7 LN: 520 e- rms (high gain); 5000 e- rms (low gain)

OMA V:1024-1.7 LN: 520 e- rms (high gain); 5000 e- rms (low gain)

OMA V:1024-2.2 LN: 520 e- rms (high gain); 5000 e- rms (low gain)

OMA V:512-1.7 TE: 650 e- rms (high gain); 7000 e- rms (low gain)

2-D OMA V:320-1.7 LN: 50 e- rms (high gain); 1500 e- rms (low gain)

Detector Control: ST-133 with high-speed serial interface via Princeton Instruments (RSPI) PCI card

Nominal Gain (Typical): Varies by detector

Dynamic Range: 16 bits

Thermostating Precision: $\pm 0.05^\circ\text{C}$ over entire temperature range

Scan Rate: 1 MHz for OMA V:512 and OMA V:1024 detectors; 5 MHz/1MHz for 2-D OMA V detectors

Controller

Controller Type: ST-133

Dimensions: See Appendix B

Controller Weight:

ST-133A: 13 lb (5.9 kg)

ST-133B: 12.5 lb (5.7 kg)

Inputs:

EXT SYNC: TTL input (BNC) to allow data acquisition to be synchronized with external events. Sense can be positive or negative going as set in software. Synchronization and Trigger Modes are discussed in Chapter 6.

Outputs:

AUX : Reserved for future use.

SCAN: TTL output (BNC) for monitoring detector status. *Logic output is software-selectable as either NOT SCAN or SHUTTER.* When the logic output is NOT

SCAN, it is at a TTL low when the array is being read; otherwise high. When the logic output is SHUTTER, the output precisely brackets shutter-open time (exclusive of shutter compensation) and can be used to control an external shutter or to inhibit a pulser or timing generator. Default selection is SHUTTER.

READY: TTL output (BNC); marks start of *first* exposure. When run is initiated, remains high until completion of cleaning cycles preceding *first* exposure, then goes low and remains low for duration of run.

SERIAL COM: TAXI protocol. Data link to computer via proprietary cable connected to this 9-pin “D” connector. Cable lengths to 165 feet (50 m) available. An optional fiber optic link is available to extend the distance to ~3300 feet (1 km).

USB 2.0: USB 2.0 protocol. Data link to computer via USB cable inserted at this connector. Cable length of 5 meters is standard. Other lengths may be available. Contact Customer Service for more information.

TTL In/Out: male, D-subminiature 25-pin connector; 8 TTL inputs; 8 TTL outputs

TTL Input: external sync

TTL Output: (ready) frame start; (scan) shutter/readout status

TTL Requirements: Rise time ≤ 40 nsec, Duration ≥ 100 nsec.

AUX BNC connector: Not currently activated. Reserved for future use

Power Input: Nominally 100, 120, 220 or 240 VAC. Refer to the Fuse/Voltage label on the back of the controller for details. Required DC voltages are generated in the controller. Power to detector is supplied via controller cable.

Power Consumption: Refer to the back of the controller.

Appendix B

Outline Drawings

Note: Dimensions are in inches unless otherwise indicated.

Liquid Nitrogen-Cooled Detector (Linear PDA)

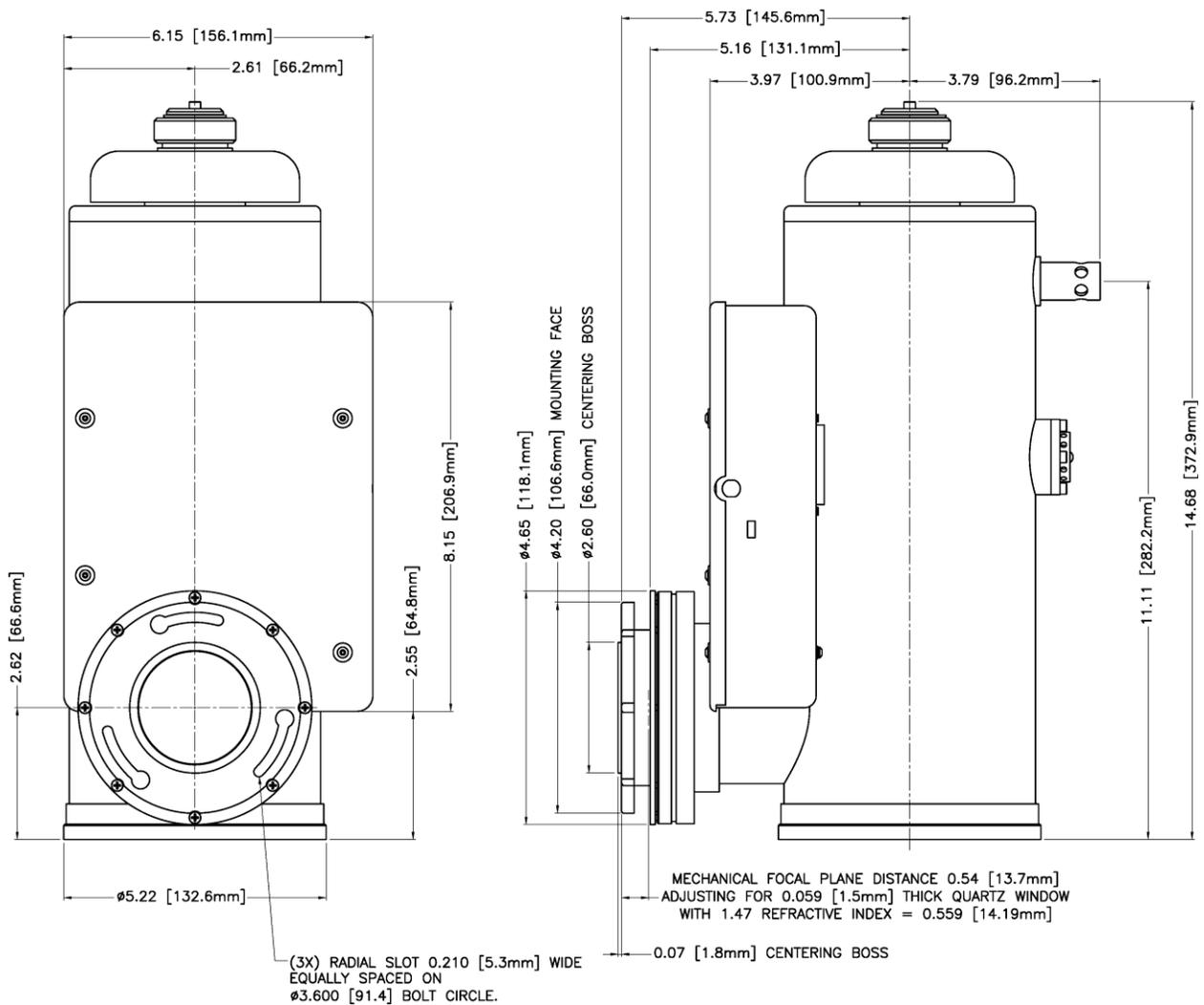


Figure 42. OMA V:InGaAs, LN-Cooled Detector (Design phased in on or about June 2006)

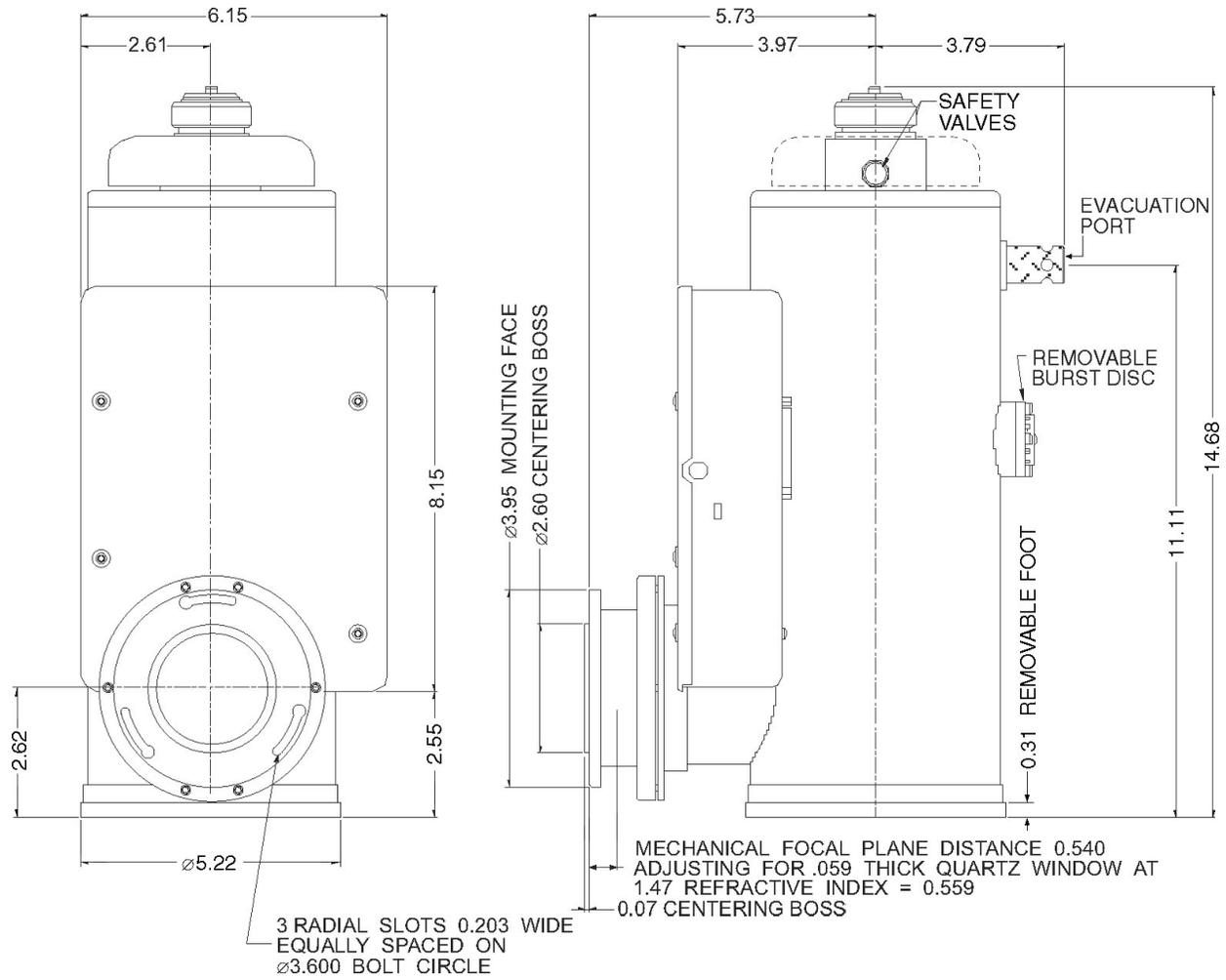


Figure 43. OMA V:InGaAs, LN-Cooled Detector (Design phased out on or about June 2006)

Liquid Nitrogen-Cooled Detector (2-D OMA FPA)

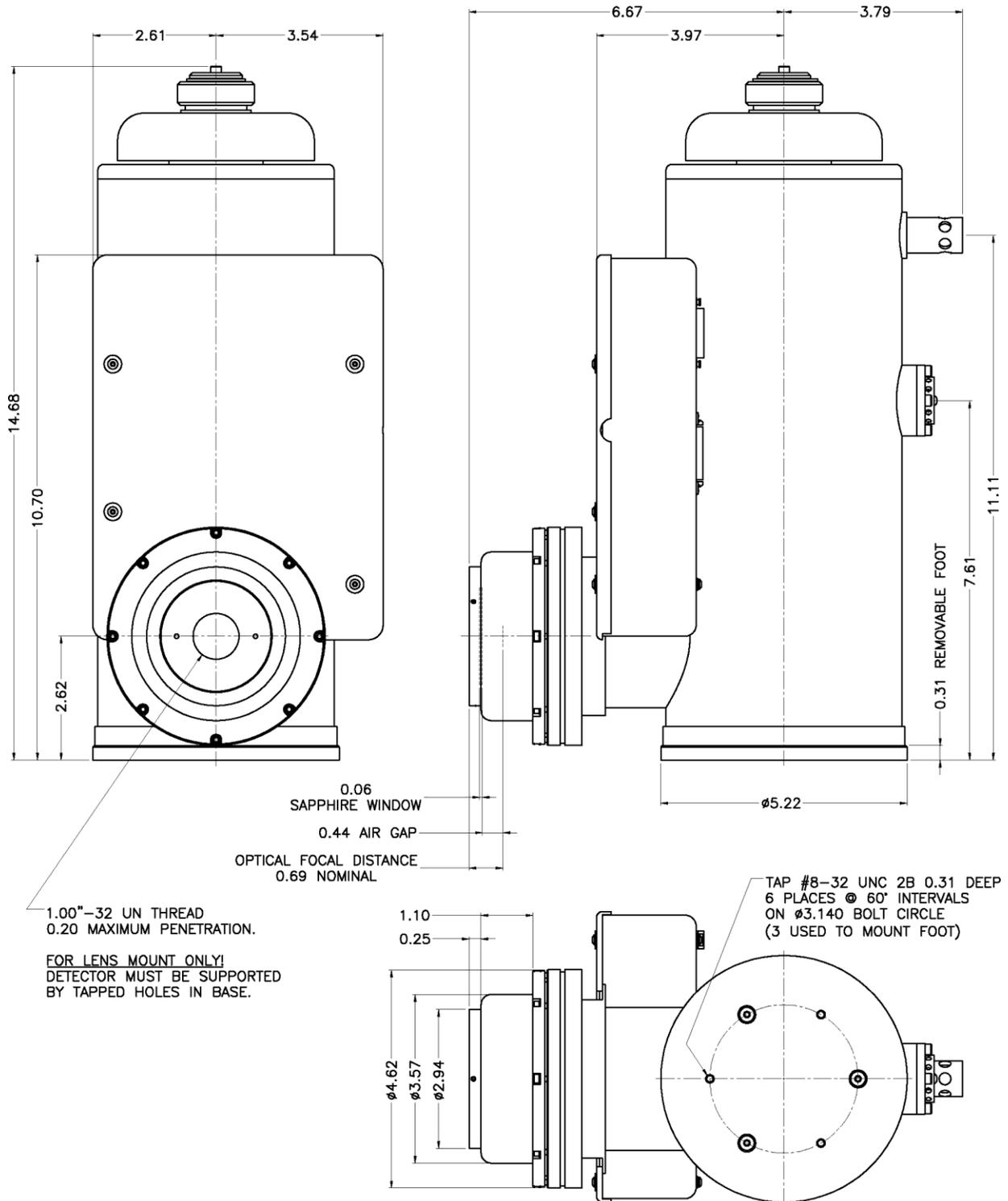


Figure 44. OMA V:InGaAs, 2-D LN-Cooled Detector, C-Mount

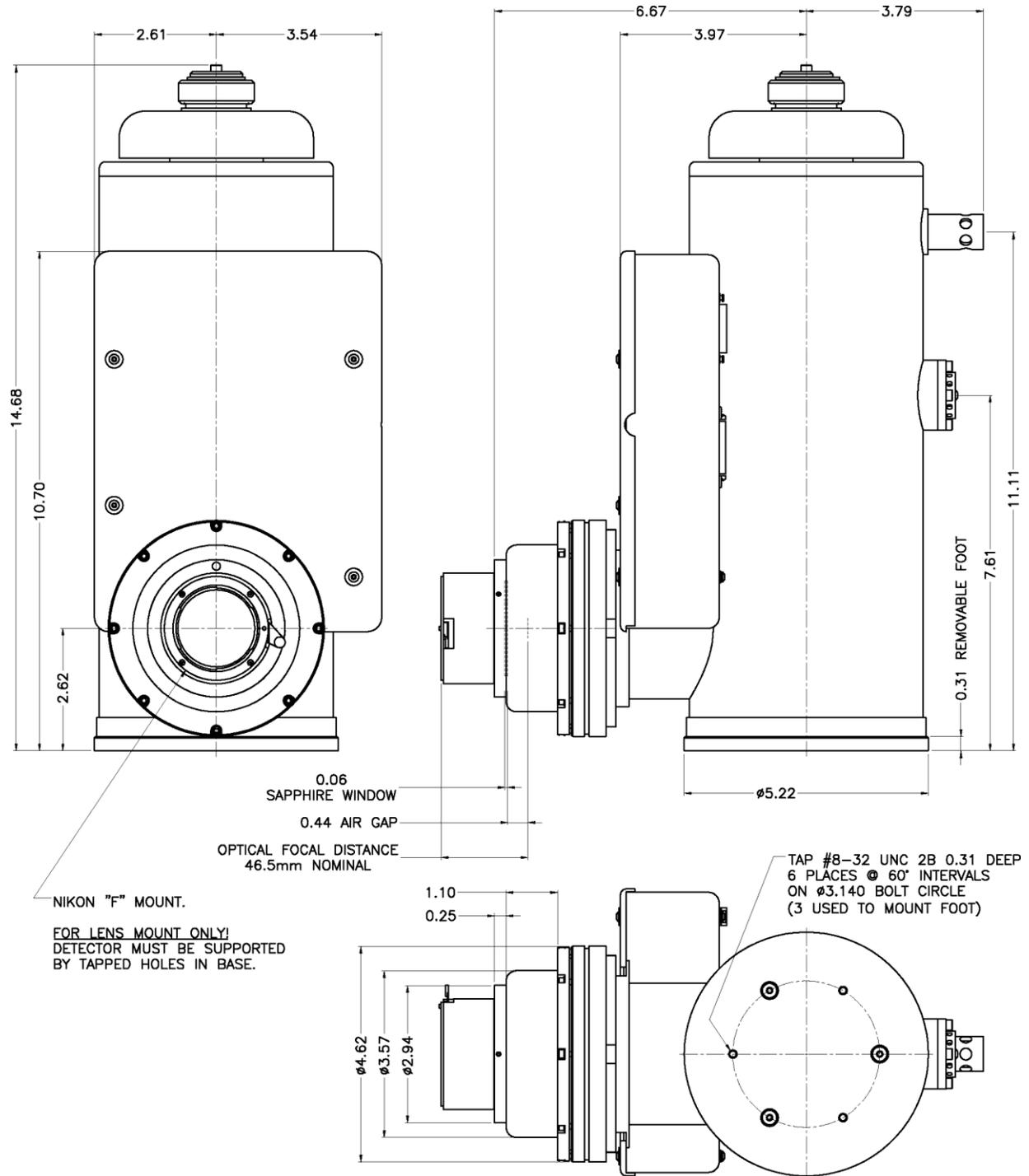


Figure 45. OMA V:InGaAs, 2-D LN-Cooled Detector, F-Mount (Nikon)

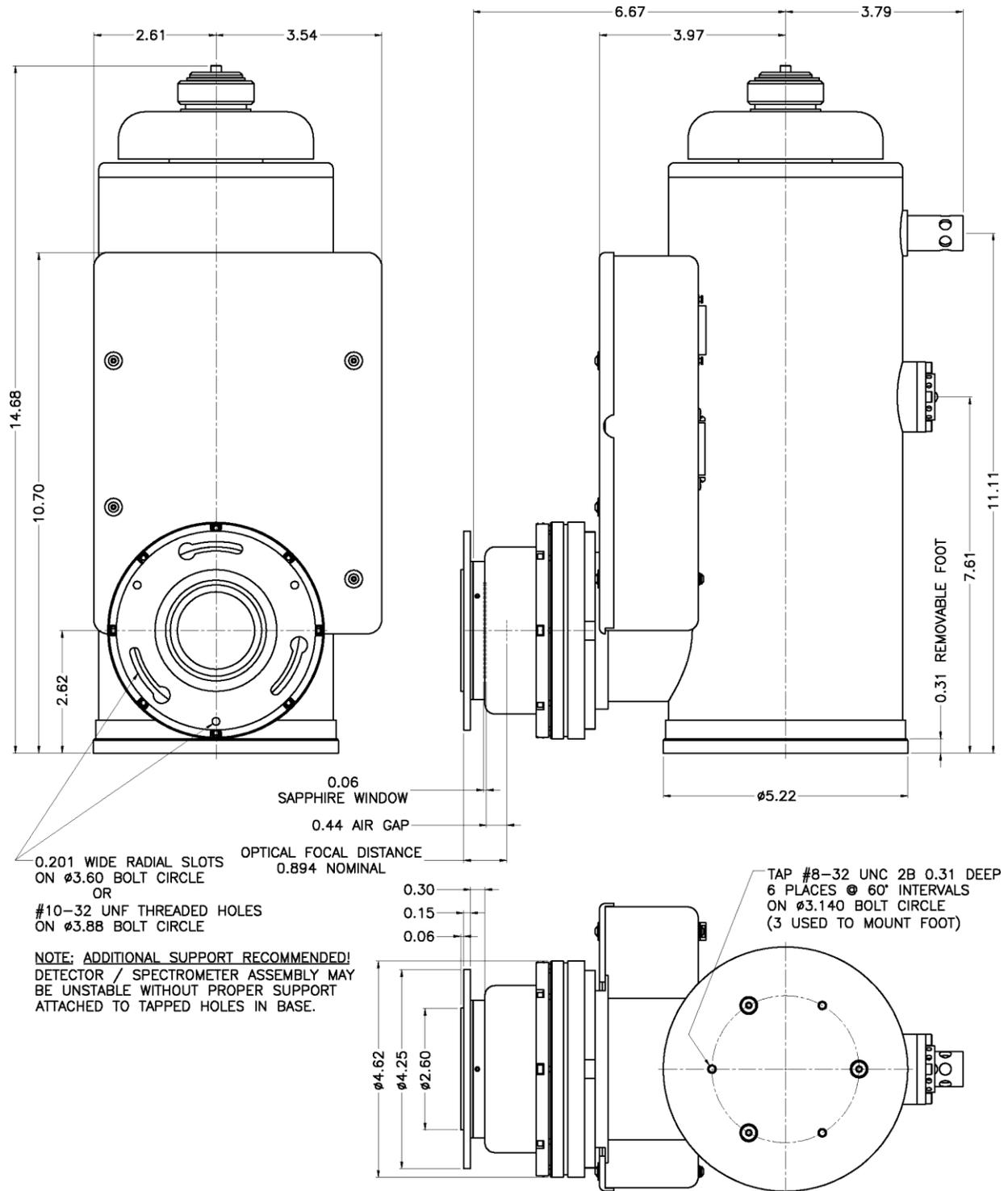


Figure 46. OMA V:InGaAs, 2-D LN-Cooled Detector, Spectroscopy-Mount

Thermoelectrically-Cooled Detector

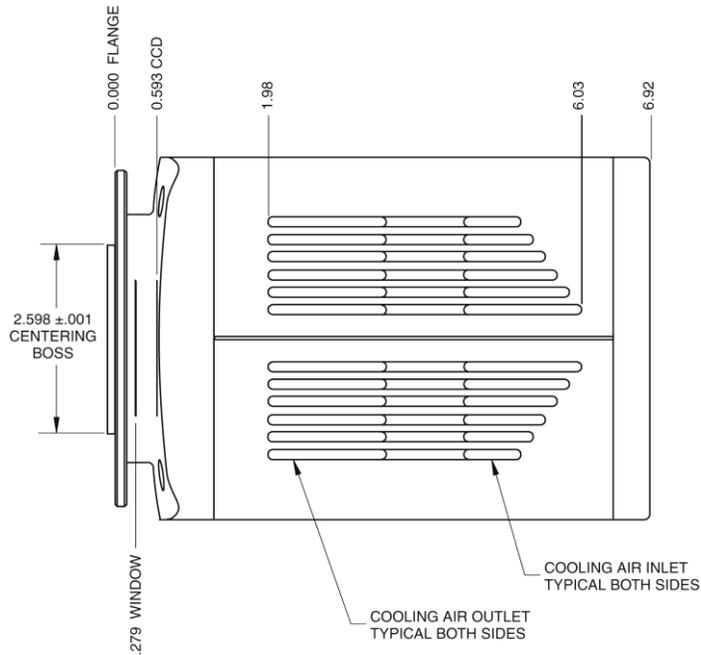


Figure 47. OMA V:InGaAs, NTE Side View

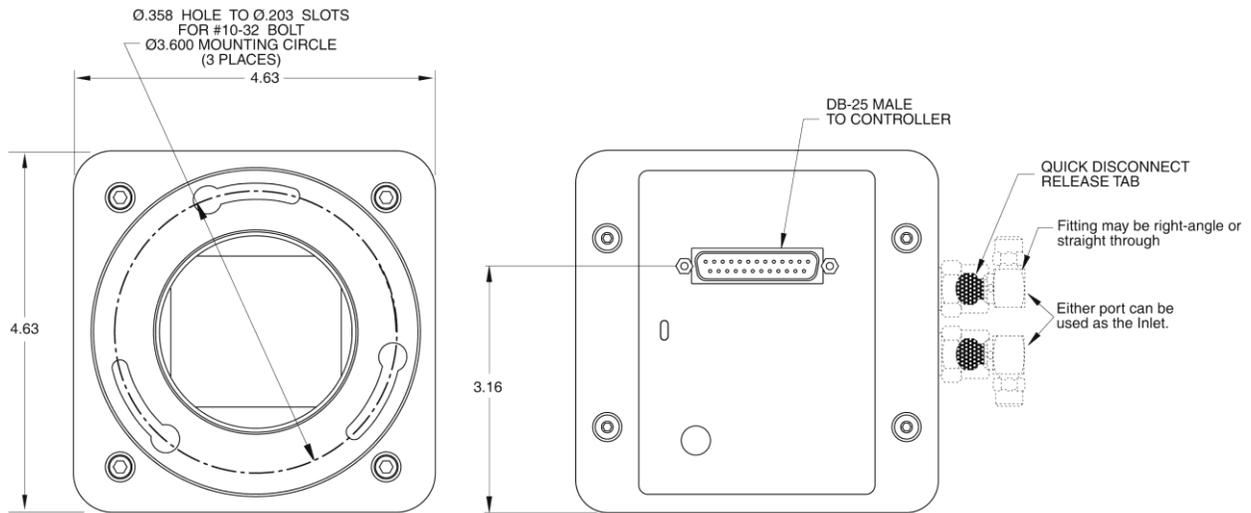


Figure 48. OMA V: InGaAs, NTE Front and Back Views

ST-133A Controller

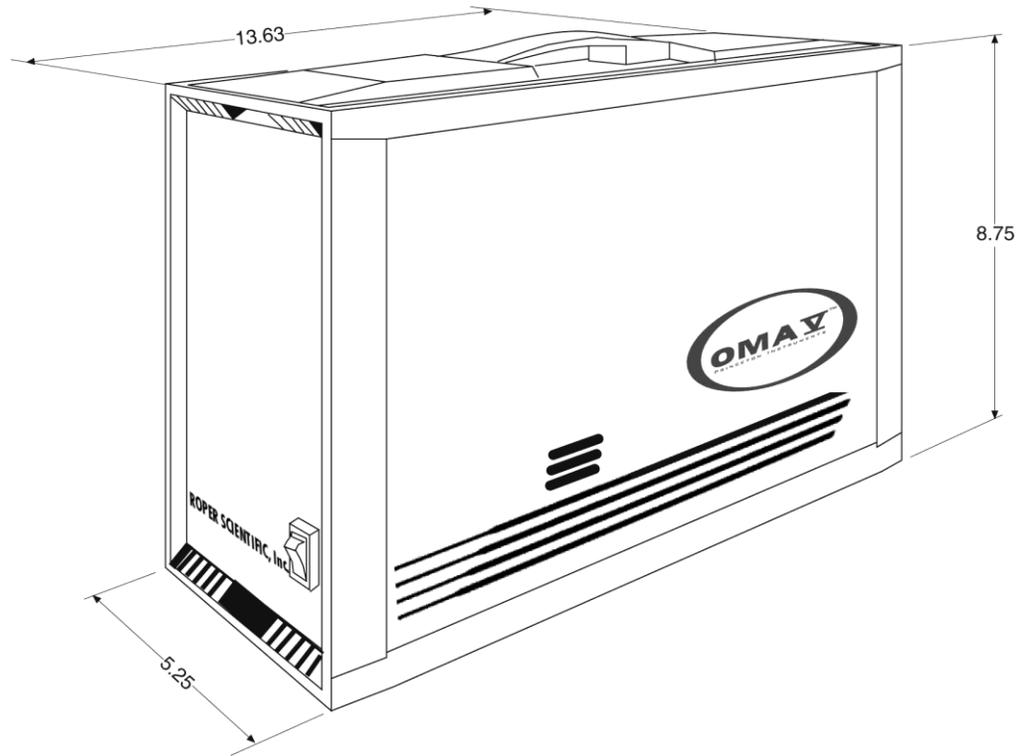


Figure 49. ST-133A Controller Dimensions

ST-133B Controller

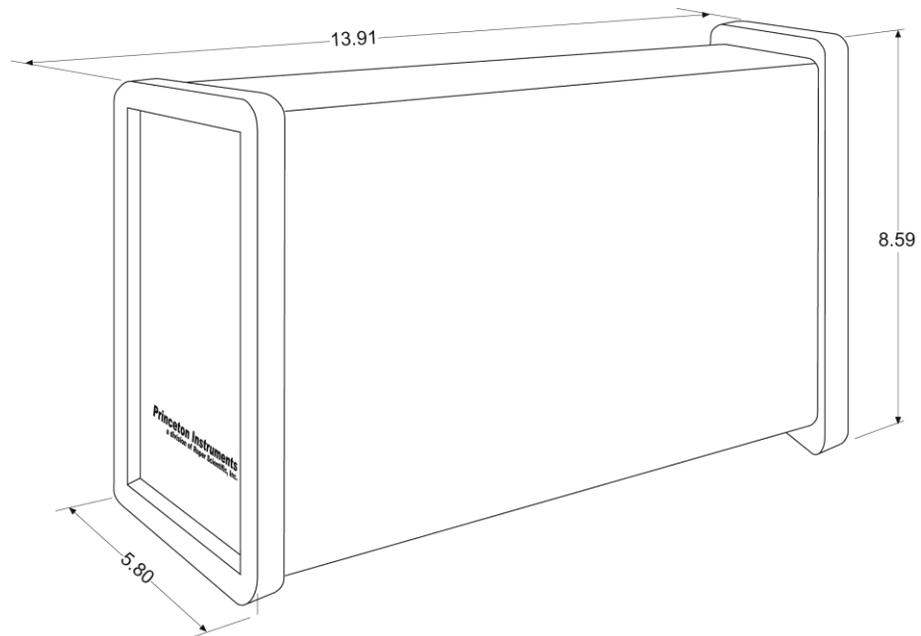
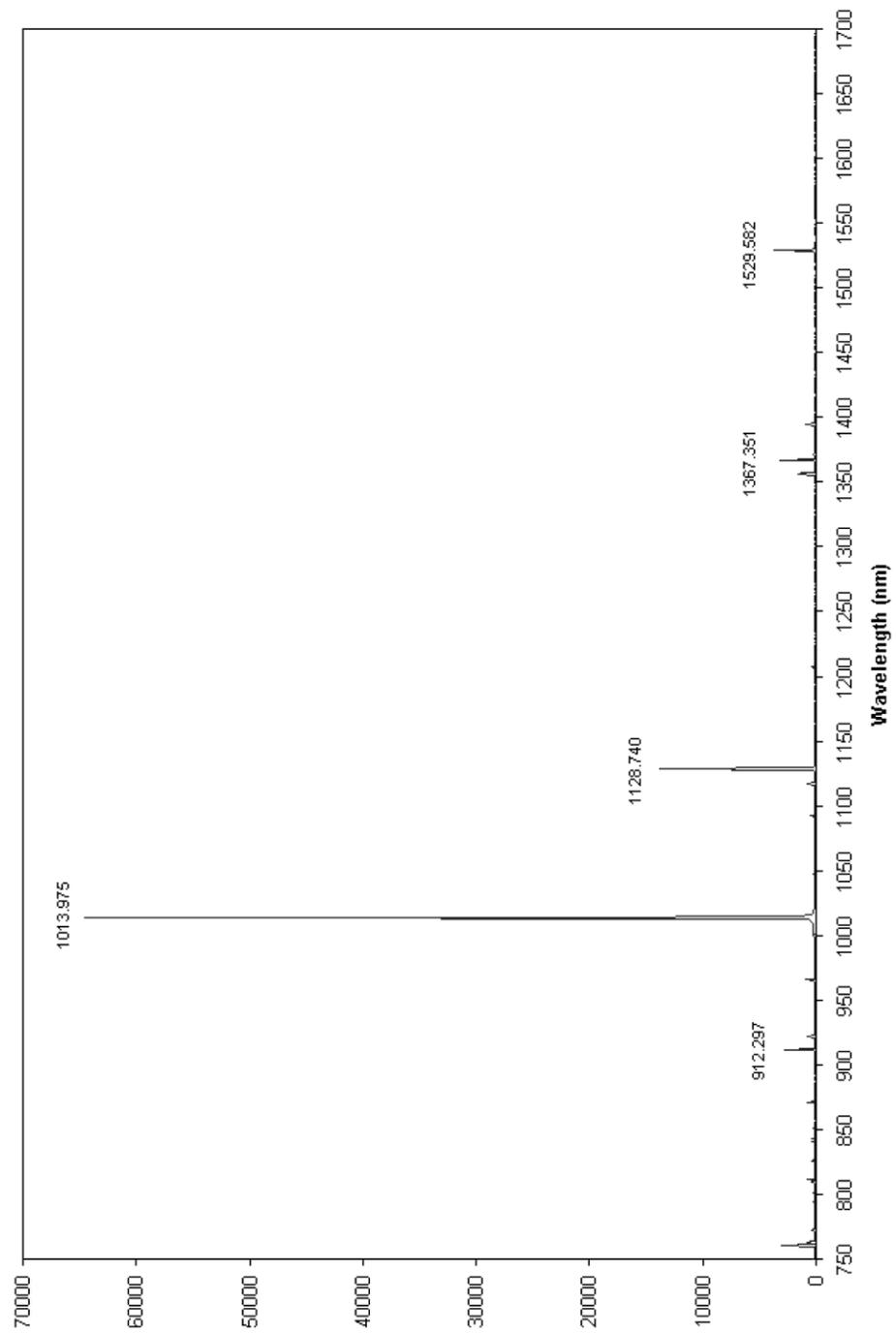


Figure 50. ST-133B Controller Dimensions

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Appendix C

Mercury-Argon Pen Lamp Spectrum



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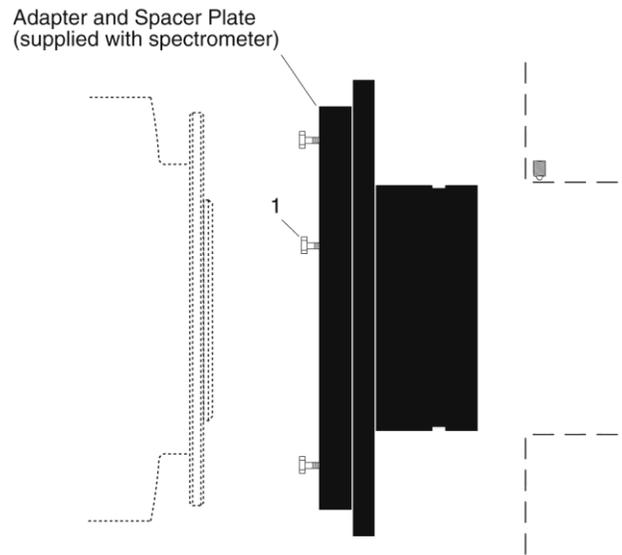
Appendix D

Spectrometer Adapters

Princeton Instruments offers a variety of spectrometer adapters for OMA V: InGaAs systems. The mounting instructions for these adapters are organized by spectrometer model, detector type, and adapter kit number. The table below cross-references these items with the page number for the appropriate instruction set.

Spectrometer	Detector Type	Adapter Kit No.	Page
Acton	LN & TE		104
Chromex 250 IS	LN & TE	7050-0090	105
ISA HR 320	LN & TE	7050-0010	106
ISA HR 640	LN & TE	7050-0034	107
JY TRIAX-OMA	LN	7050-0092	108
JY TRIAX family	TE	7384-0072	109
SPEX 270M	LN & TE	7050-0041	110
SPEX 500M	LN & TE	7050-0038	111
SPEX TripleMate	LN & TE	7050-0007	112

Acton (LN & TE)



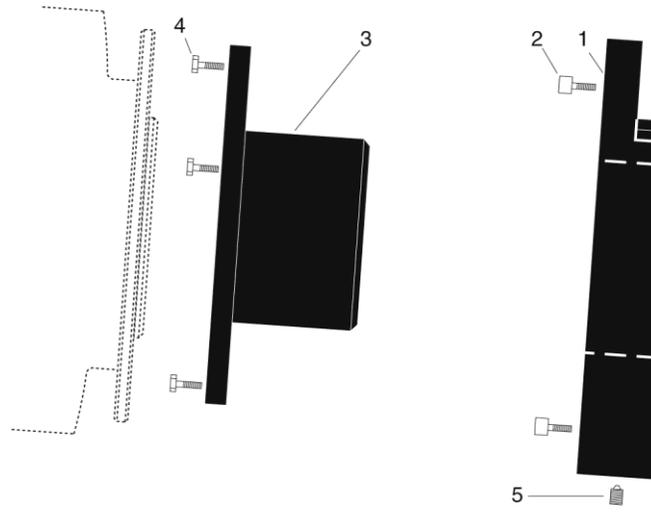
Qty	P/N	Description
1. 3	2826-0120	Screw, 10-32 × 1/2, Hex Head, Stainless Steel

Assembly Instructions

1. Make sure that the shipping cover has been removed from the detector port on the spectrometer.
2. Loosen the setscrews holding the Acton adapter in the spectrometer and remove the adapter. If the spacer plate has been removed, reinstall it on the adapter.
3. Leaving 1/4" of thread exposed, mount the three (3) hex head screws to the adapter.
4. Mount the adapter to the detector flange and rotate the adapter so the screw heads are over the narrow end of the slots.
5. Tighten the screws.
6. Gently insert the adapter into the spectrometer and fasten with the setscrews.

Note: Adapter parts are machined to provide a tight fit. It is necessary to rotate the detector back and forth when inserting into the spectrometer adapter. Do not force the two parts of the adapter together, as they can be permanently damaged by excessive force.

Chromex 250 IS (LN & TE)



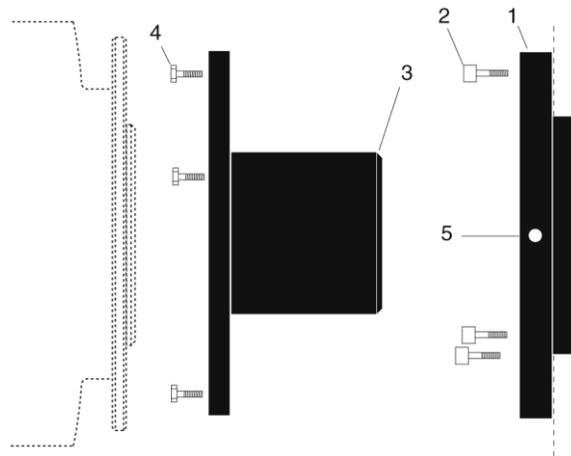
Qty	P/N	Description
1.	1	2517-0901 Plate, Adapter-Female
2.	4	2826-0283 Screw, 10-32 × 3/4, Socket Head, Stainless Steel, Hex, Black
3.	1	2518-0227 Adapter-Male, ICCD Diode Array
4.	3	2826-0120 Screw, 10-32 × 1/2, Hex Head, Stainless Steel
5.	1	2826-0082 Set Screw, 10-32 × 1/4, Stainless Steel, Allen Hex, Nylon Tip

Assembly Instructions

1. Attach part 1 to the spectrometer wall (dashed line in illustration) with the socket head screws provided.
2. Leaving 1/4" of thread exposed, mount the three (3) hex head screws to part 3.
3. Mount the adapter to the detector flange and rotate the adapter so the screw heads are over the narrow end of the slots.
4. Tighten the screws.
5. Gently insert part 3 into part 1 and fasten with the setscrew.

Note: Adapter parts are machined to provide a tight fit. It is necessary to rotate the detector back and forth when inserting into the spectrometer adapter. Do not force the two parts of the adapter together, as they can be permanently damaged by excessive force.

ISA HR 320 (LN & TE)



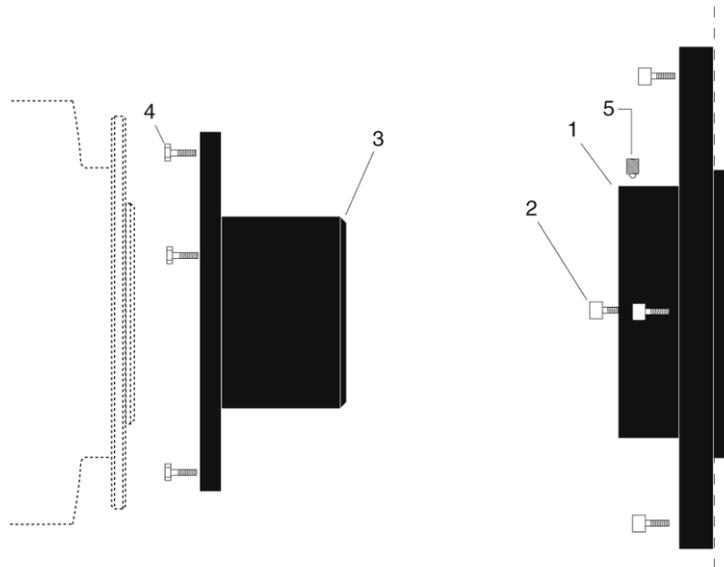
Qty	P/N	Description
1.	1	2518-0044 Flange-Female, Mechanical, ISA, HR320
2.	3	2826-0053 Screw, 10-32 × 7/16, Socket Head Cap Hex, Stainless Steel
3.	1	2518-0045 Flange-Male, Detector Mate
4.	3	2826-0120 Screw, 10-32 × 1/2, Hex Head, Stainless Steel
5.	1	2826-0082 Set Screw, 10-32 × 1/4, Stainless Steel, Allen Hex, Nylon Tip

Assembly Instructions

1. Attach part 1 to the spectrometer wall (dashed line in illustration) with the socket head screws provided.
2. Leaving 1/4" of thread exposed, mount the three (3) hex head screws to part 3.
3. Mount the adapter to the detector flange and rotate the adapter so the screw heads are over the narrow end of the slots.
4. Tighten the screws.
5. Gently insert part 3 into part 1 and fasten with the setscrew.

Note: Adapter parts are machined to provide a tight fit. It is necessary to rotate the detector back and forth when inserting into the spectrometer adapter. Do not force the two parts of the adapter together, as they can be permanently damaged by excessive force.

ISA HR 640 (LN & TE)



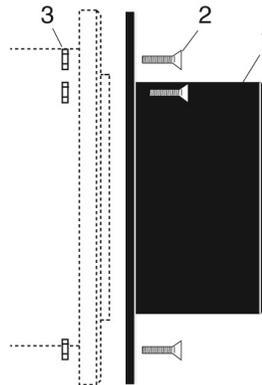
	Qty	P/N	Description
1.	1	2518-0203	Adapter-F, HR-640
2.	4	2826-0144	Screw, M4x.7x14 mm, Socket Head, Hex, Stainless Steel
3.	1	2518-0227	Adapter-Male, ICCD Diode Array
4.	3	2826-0120	Screw, 10-32 × 1/2, Hex Head, Stainless Steel
5.	2	2826-0082	Set Screw, 10-32 × 1/4, Stainless Steel, Allen Hex, Nylon Tip

Assembly Instructions

1. Attach part 1 to the spectrometer wall (dashed line in illustration) with the socket head screws provided.
2. Leaving 1/4" of thread exposed, mount the three (3) hex head screws to part 3.
3. Mount the adapter to the detector flange and rotate the adapter so the screw heads are over the narrow end of the slots.
4. Tighten the screws.
5. Gently insert part 3 into part 1 and fasten with the setscrews.

Note: Adapter parts are machined to provide a tight fit. It is necessary to rotate the detector back and forth when inserting into the spectrometer adapter. Do not force the two parts of the adapter together, as they can be permanently damaged by excessive force.

JY TRIAX-OMA (LN)



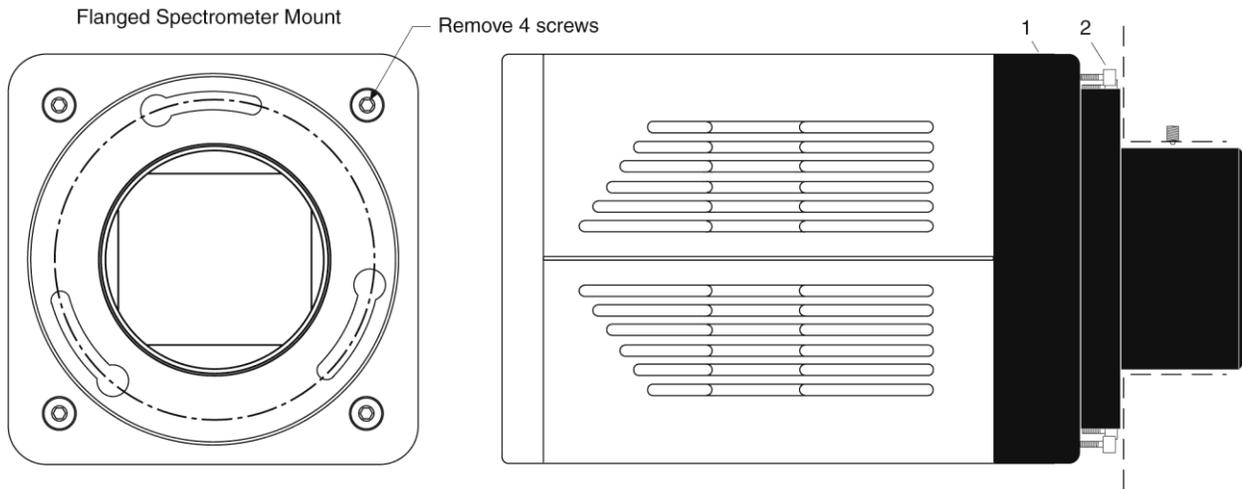
	Qty	P/N	Description
1.	1	2518-0962	Adapter-Male, Triax, TE & LN
2.	3	2826-0249	Screw, 10-32 × 5/8, Flat Head Slot, Stainless Steel
3.	3	2827-0010	Nut, 10-32, Hex, Stainless Steel

Assembly Instructions

1. Mount part 1 to the detector flange using the flat head screws and nuts provided.
2. Leave enough exposed screw thread so you can rotate the adapter until the nuts are over the narrow end of the slots.
3. Tighten the screws.

Note: Adapter parts are machined to provide a tight fit. It may be necessary to rotate the detector back and forth when inserting into the spectrometer adapter.

JY TRIAX family (TE)



Qty	P/N	Description
1.	1	2518-1000 Adapter, TRIAX, TE, 7377, 7376, 7413
2.	4	2826-0191 Screw, 10-32 × 5/8, Socket Head, Stainless Steel, Hex, Black

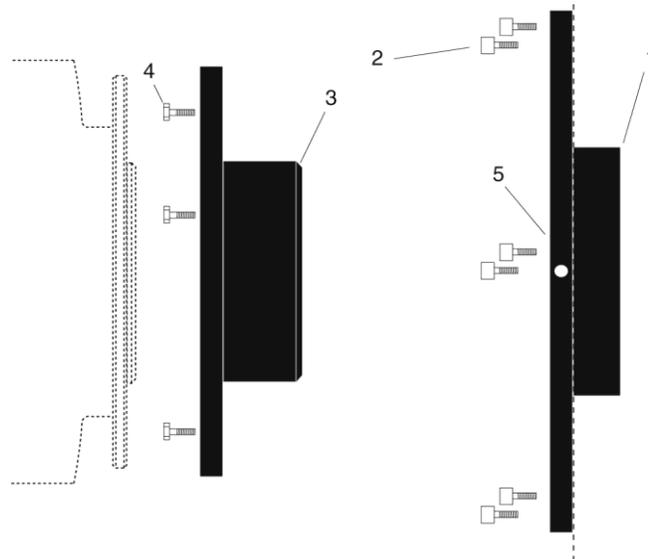
Typically, the adapter is shipped already mounted to the detector. The following procedure is provided in case you have ordered a JY TRIAX adapter for a shutterless OMA V TE detector that you already own.

Assembly Instructions

1. While supporting the flange, remove the four (4) of the socket head screws from the front of the detector (see illustration above) and store these screws.
2. Using the four (4) screws provided with the adapter kit, mount part 1 to the front of the detector.
3. Remove the spectrometer cover.
4. Insert part 1 into the spectrometer and fasten it in place with the spectrometer setscrew.
5. Replace the spectrometer cover.

Note: Adapter parts are machined to provide a tight fit. It may be necessary to rotate the detector back and forth when inserting into the spectrometer adapter.

SPEX 270M (LN & TE)



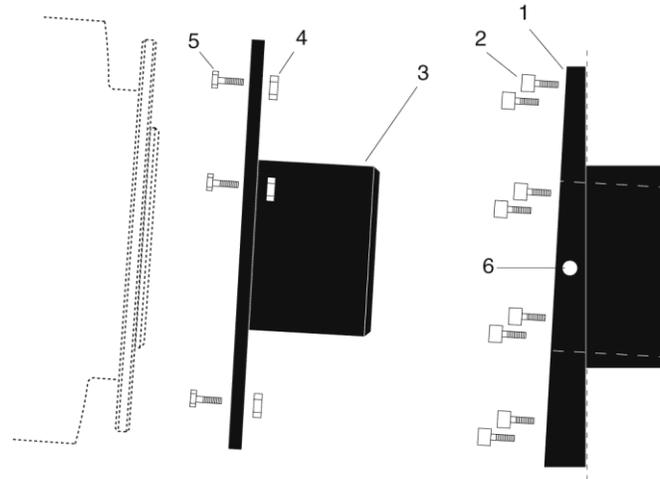
Qty	P/N	Description
1	2518-0691	Female Adapter Plate, 2.400 ID
2	2826-0068	Screw, 6-32 × 3/8. Socket Head, Hex, Stainless Steel
3	2518-0690	Adapter Male, Focusing, Male, Spec 270
4	2826-0120	Screw, 10-32 × 1/2, Hex Head, Stainless Steel
5	2826-0019	Set Screw 8-32 × 3/16, Hex, Nylon Tip

Assembly Instructions

1. Attach part 1 to the spectrometer wall (dashed line in illustration) with the socket head screws provided.
2. Leaving 1/4" of thread exposed, mount the three (3) hex head screws to part 3.
3. Mount the adapter to the detector flange and rotate the adapter so the screw heads are over the narrow end of the slots.
4. Tighten the screws.
5. Gently insert part 3 into part 1 and fasten with the setscrews.

Note: Adapter parts are machined to provide a tight fit. It is necessary to rotate the detector back and forth when inserting into the spectrometer adapter. Do not force the two parts of the adapter together, as they can be permanently damaged by excessive force.

SPEX 500M (LN & TE)



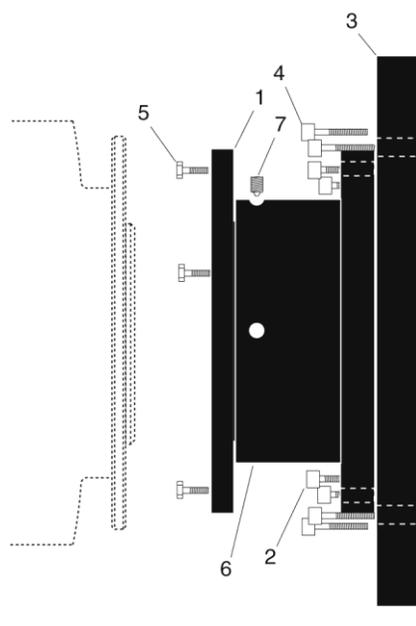
Qty	P/N	Description
1.	1	2517-0214 Adapter-Female, Spex 500M
2.	8	2826-0170 Screw, 1/4-20 × 0.5L, Low Socket Head Cap
3.	1	2518-0291 Adapter Male, Spex 500M
4.	3	2827-0010 10-32 Nut, Stainless Steel
5.	3	2826-0120 Screw, 10-32 × 1/2, Hex Head, Stainless Steel
6.	2	2826-0055 Set Screw 8-32 × 1/4, Allen Hex, Nylon Tip

Assembly Instructions

1. Attach part 1 to the spectrometer wall (dashed line in illustration) with the socket head screws provided.
2. Leaving 1/4" of thread exposed, mount the three (3) hex head screws and nuts to part 3.
3. Mount the adapter to the detector flange and rotate the adapter so the screw heads are over the narrow end of the slots.
4. Tighten the screws.
5. Gently insert part 3 into part 1 and fasten with the setscrews.

Note: Adapter parts are machined to provide a tight fit. It is necessary to rotate the detector back and forth when inserting into the spectrometer adapter. Do not force the two parts of the adapter together, as they can be permanently damaged by excessive force.

SPEX TripleMate (LN & TE)



Qty	P/N	Description
1.	1	2518-0183 Adapter-Male, ICCD/For Spex TripleMate
2.	4	2826-0128 Screw, 10-32 × 5/8, Socket Head Cap, Stainless Steel
3.	1	2517-0163 Slit Mount, Spex
4.	4	2826-0129 Screw, 1/4-20 × 3/4, Socket Head Cap, Stainless Steel
5.	3	2826-0120 Screw, 10-32 × 1/2, Hex Head, Stainless Steel
6.	1	2518-0185 Adapter-Female, Flange Spex
7.	2	2826-0070 Set Screw, 6-32 × 3/16, Stainless Steel, Allen Hex
	1	2500-0025 O-ring, 2.359x.139, Viton (installed)
	1	2500-0026 O-ring, 2.484x.139, Viton (installed)

Assembly Instructions

1. Mount the whole assembly onto the spectrometer (dashed line in illustration).
2. Leaving 1/4" of thread exposed, mount the three (3) hex head screws to part 1.
3. Mount the adapter to the detector flange and rotate the adapter so the screw heads are over the narrow end of the slots.
4. Tighten the setscrews.
5. Tighten the hex head screws.

Note: Adapter parts are machined to provide a tight fit. It is necessary to rotate the detector back and forth when inserting into the spectrometer adapter. Do not force the two parts of the adapter together, as they can be permanently damaged by excessive force.

Appendix E

USB 2.0 Limitations

The following information covers the currently known limitations associated with operating under the USB 2.0 interface.

- Maximum cable length is 5 meters (16.4 feet)
- 1 MHz is currently the upper digitization rate limit for the ST-133 Controller.
- Large data sets and/or long acquisition times may be subject to data overrun because of host computer interrupts during data acquisition.
- USB 2.0 is not supported by the Princeton Instruments PC Interface Library (EZ-DLLS).
- Some WinSpec and WinView 2.5.X features are not fully supported with USB 2.0. See the table below.

Feature	Supported with USB 2.0 in WinX 2.5.X	Supported in WinX 2.7	Remarks
Demo Port Capability	NO	YES	
DIF			
Kinetics	YES	YES	WinX 2.5.18.1
Reset Camera to NVRAM Defaults	NO	YES	
Temperature Lock Status	YES	YES	WinX 2.5.x doesn't utilize hardware lock status
PTG	YES	YES	
Virtual Chip	NO	YES	
Custom Timing	NO	YES	WinX 2.5.18.1
Custom Chip	NO	YES	WinX 2.5.18.1
Frames per Interrupt	NO	NO	
RS170 (Video Output)	NO	YES	
Online Exposure	NO	YES	
File Information	YES	YES	Not all header info is currently available in WinX 2.5.x through PVCAM

Table 8. Feature Support under USB 2.0 (continued on next page)

Feature	Supported with USB 2.0 in WinX 2.5.X	Supported in WinX 2.7	Remarks
Overlapping ROIs	NO	NO	
Macro Record	YES	YES	Macros recorded for non-PVCAM cameras may have to be re-recorded to function
TTL I/O	NO	YES	

Table 8. Feature Support under USB 2.0

Appendix F

Adapter and Lens Focusing Procedures

F-Mount Adapter Focusing Procedure

Note: This procedure sets the focus for the F-mount adapter, not the lens. Once set, it should not need to be disturbed again.

1. Insert the F-mount lens into the F-mount adapter on the front of the detector.
2. The F-mount adapter is in two sections: the adapter body (into which the lens is mounted) and the adapter adjustment ring that is secured to the front of the detector. Try rotating the adapter body. If it doesn't rotate, you will have to loosen the securing setscrew(s) in the side of the adapter adjustment ring. To change the focus setting, proceed as follows.
 - Loosen the setscrew(s) with a 0.050" hex key*. Do not remove the screw(s); loosen just enough to allow the adapter body to be adjusted.
 - Set the *lens focus adjustment* to the target distance.
3. Block off the lens and set it to the smallest possible aperture (largest F-stop number).
4. Mount a suitable target at a known distance in front of the lens. Typically, a photo resolution chart is used. However, even a page of small print will generally serve quite well for this purpose.
5. Verify that all cables and connectors are secured.
6. Turn on the system and start the **WinView/32** software.
7. Set the software to the **FreeRun** and **Fast** modes (consult the software manual if you are unfamiliar with these modes). Choose a fast exposure (.1 msec) and begin data collection by selecting **Focus**.
8. Slowly uncover the lens. If the image becomes washed out, recover the lens, choose a shorter exposure, and uncover the lens again. If it is too dark, choose a longer exposure.
9. Double check to be sure the *lens focus* is set to the *target distance* and readjust if necessary.

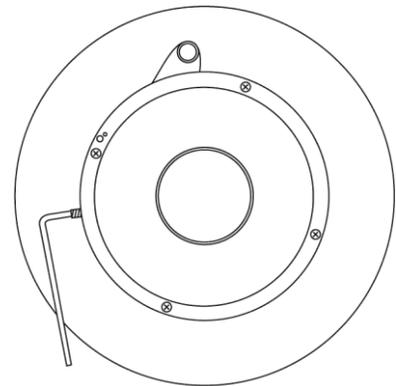


Figure 51. F-mount Adjustment

* The screws are #4-40 setscrews. A 0.050" hex key is required to loosen or tighten them.

10. Taking care not to disturb the *lens focus*, rotate the *adapter body* for maximum sharpness in the observed image and tighten the setscrews to secure the adapter body's position.

This completes the procedure for adjusting the *F-mount adapter*. It should not be necessary to disturb the adjustment again. In actual measurements with real subjects, the focusing will be done entirely with the *lens focus adjustment*. Microscope adapters follow a similar procedure except, in this case, the front part of the lens mount should not need adjustment.

Lens Focusing Procedure

Except for the lens mount focus procedure that applies to F-mount lenses as described above, there is no difference between focusing considerations for an F-mount lens and a C-mount lens. Simply use the focusing ring on the lens to produce the sharpest image at full aperture. Then stop the lens down to its sharpest aperture (probably at a mid-range aperture setting) and adjust the Exposure Time for the best possible image as observed at the monitor.

Declarations of Conformity

This section of the OMA V manual contains the declarations of conformity for OMA V systems. OMA V systems encompass LN-cooled and NTE-cooled detector heads and their associated controllers.

DECLARATION OF CONFORMITY

We,

ROPER SCIENTIFIC
(PRINCETON INSTRUMENTS)
3660 QUAKERBRIDGE ROAD
TRENTON, NJ 08619,

Declare under our sole responsibility that the product

ST-133 CONTROLLER with
InGaAs CAMERA HEAD,

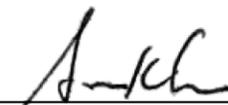
To which this declaration relates, is in conformity with general safety requirement for electrical equipment standards:

IEC 1010-1:1990, EN 61010-1:1993/A2:1995
EN 55011 for Group 1, Class A, 1991,
EN 61326-1, 1997-03 (EN 61000-4-2, EN 61000-4-3, EN 61000-4-4,
EN 61000-4-5, EN 61000-4-6, EN 61000-4-11)

Which follow the provisions of the

CE LOW VOLTAGE DIRECTIVE 73/23/EEC
And
EMC DIRECTIVE 89/336/EEC.

Date: August 6, 1999
TRENTON, NJ



(SAM KHOO)
Vice President, Engineering

DECLARATION OF CONFORMITY

We,

ROPER SCIENTIFIC
(PRINCETON INSTRUMENTS)
3660 QUAKERBRIDGE ROAD
TRENTON, NJ 08619,

Declare under our sole responsibility that the product

ST-133 CONTROLLER with
InGaAs NTE CAMERA HEAD,

To which this declaration relates, is in conformity with general safety requirement for electrical equipment standards:

IEC 1010-1:1990, EN 61010-1:1993/A2:1995
EN 55011 for Group 1, Class A, 1991,
EN50082-1, 1991 (EN 61000-4-2, EN 61000-4-3, EN 61000-4-4),

Which follow the provisions of the

CE LOW VOLTAGE DIRECTIVE 73/23/EEC

And

EMC DIRECTIVE 89/336/EEC.

Date: January 23, 2003
TRENTON, NJ



(PAUL HEAVENER)
Engineering Manager

DECLARATION OF CONFORMITY

We,

ROPER SCIENTIFIC
(PRINCETON INSTRUMENTS)
3660 QUAKERBRIDGE ROAD
TRENTON, NJ 08619,

Declare under our sole responsibility that the product

ST-133 16-bit 5 MHz CONTROLLER with
2-D InGaAs CAMERA HEAD,

To which this declaration relates, is in conformity with general safety requirement for electrical equipment standards:

IEC 1010-1:1990, EN 61010-1:1993/A2:1995,
EN 61326 for Class A, 1997/A1:1998/A2:2000,
(EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5,
EN 61000-4-6, EN 61000-4-11), EN 61000-3-2:2000, and
EN 61000-3-3:1995/A1:2001,

Which follow the provisions of the

CE LOW VOLTAGE DIRECTIVE 73/23/EEC

And

EMC DIRECTIVE 89/336/EEC
(Amending Directive 93/68/EEC, et al (CE Marking)).

Date: June 29, 2005
TRENTON, NJ


(William E. Asher)

Vice President of New Product Development

Warranty & Service

Limited Warranty

Princeton Instruments, a division of Roper Scientific, Inc. ("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

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, 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 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 Princeton Instruments authorized representative/distributor for repair information and assistance, or visit our technical support page at www.princetoninstruments.com.

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

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, 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 Princeton Instruments factory or, at our option, a factory-authorized service center. You are responsible for the shipping costs to return the product to Princeton Instruments. International customers should contact their local Princeton Instruments representative/distributor for repair information and assistance or visit our technical support page at www.princetoninstruments.com.

XP Vacuum Chamber Limited Lifetime Warranty

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 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

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

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. 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. *See 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

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. *See 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

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. 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 CD-ROM from our factory for an incidental shipping and handling

charge. *See Item 12 in the following section of this warranty ("Your Responsibility") 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 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 Princeton Instruments technical support staff or our authorized service representative. *See Item 12 in the following section of this warranty ("Your Responsibility") 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 Princeton Instruments.
2. You must notify the 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 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 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 Princeton Instruments factory or one of our authorized manufacturer's representatives or distributors.
6. Unless specified in the original purchase agreement, 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;
 - been damaged as a result of misuse, improper installation, faulty or inadequate maintenance or failure to follow instructions furnished by us;
 - had serial numbers removed, altered, defaced, or rendered illegible;
 - been subjected to improper or unauthorized repair; or
 - been damaged due to fire, flood, radiation, or other "acts of God" or other contingencies beyond the control of Princeton Instruments.
8. After the warranty period has expired, you may contact the Princeton Instruments factory or a Princeton Instruments-authorized representative for repair information and/or extended warranty plans.
9. Physically damaged units or units that have been modified are not acceptable for repair in or out of warranty and will be returned as received.

10. All warranties implied by state law or non-U.S. laws, including the implied warranties of merchantability and fitness for a particular purpose, are expressly limited to the duration of the limited warranties set forth above. With the exception of any warranties implied by state law or non-U.S. laws, as hereby limited, the forgoing warranty is exclusive and in lieu of all other warranties, guarantees, agreements, and similar obligations of manufacturer or seller with respect to the repair or replacement of any parts. In no event shall 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 Princeton Instruments factory of purchase, contact your authorized Princeton Instruments representative or reseller, or visit our technical support page at www.princetoninstruments.com.

Contact Information

Roper Scientific's manufacturing facility for this product is located at the following address:

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

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

Customer Support E-mail: techsupport@princetoninstruments.com

For immediate support in your area, please call the following locations directly:

America	1.877.4.PIACTON (877.474.2286)
Benelux	+31 (347) 324989
France	+33 (1) 60.86.03.65
Germany	+49 (0) 89.660.7793
Japan	+81 (3) 5639.2741
UK & Ireland	+44 (0) 28.3831.0171

Otherwise, see our Support web page at www.princetoninstruments.com.

An up-to-date list of addresses and telephone numbers is posted on the www.princetoninstruments.com/Support page. In addition, links on this page to support topics allow you to send e-mail based requests to the customer support group.

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