



# ***PIXIS<sup>®</sup>*** ***System***



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## Introduction

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### PIXIS®

Thank you for purchasing a PIXIS® camera system from Princeton Instruments. For over two decades Princeton Instruments has been the legendary name behind the most revolutionary spectroscopy and imaging products for cutting edge research.



PIXIS represents the most advanced camera design and utilizes years of experience and expertise in low-light detection. Whether your application involves Raman spectroscopy in the near infrared or semiconductor imaging in the ultraviolet, PIXIS has everything you need to tackle the most demanding applications.

Among the many state of the art features are its maintenance-free permanent vacuum, integrated controller, deep thermoelectric air-cooling, and compact design. Currently the platform supports several imaging and spectroscopy CCDs, including eXcelon™ enabled back-illuminated spectroscopy CCDs. Please visit [www.princetoninstruments.com](http://www.princetoninstruments.com) for the current list of supported CCDs.

### eXcelon™

eXcelon is a new CCD/EMCCD sensor technology jointly developed by Princeton Instruments, e2v, and Photometrics. Spectroscopy CCDs using this technology provide three significant benefits:

- **Improved sensitivity** – improved QE over broader wavelength region compared to back-illuminated sensors,
- **Reduced etaloning** – up to 10 times lower etaloning or unwanted fringes in near infrared (NIR) region compared to standard back-illuminated CCDs,
- **Lower dark current** – similar to back-illuminated CCDs or 100 times lower than the deep depletion CCDs.

### Advanced Design

PIXIS is a fully integrated camera system. The camera contains all of the electronics necessary to read out and control the CCD device. For instance, it houses precision analog-to-digital converters (ADCs) positioned close to the CCD for lowest noise and has USB 2.0 electronics to interface with the host computer.

The easy-to-use PIXIS camera system offers all basic CCD camera functions such as region-of-interest (ROI) selection and binning --- all under software control. It also provides advanced triggered operation as well as programmable TTL output.

To utilize the full potential of the PIXIS camera system, please read the manual completely.

## Grounding and Safety

Before turning on the power supply (air-cooled system or liquid-cooled system with a CoolCUBE<sub>II</sub> circulator) or the CoolCUBE circulator (liquid-cooled system), 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:

- The CCD array is very sensitive to static electricity. Touching the CCD 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 camera system, be sure to turn the camera power ON LAST and turn the camera power OFF FIRST.
- Use caution when triggering high-current switching devices (such as an arc lamp) near your system. The CCD can be permanently damaged by transient voltage spikes. If electrically noisy devices are present, an isolated, conditioned power line or dedicated isolation transformer is highly recommended.
- Do not block air vents on the camera. Preventing the free flow of air overheats the camera and may damage it.

## UV Coating

**Caution** If you have a camera with a UV (lumogen or Unichrome) coated CCD, protect it from unnecessary exposure to UV radiation. This radiation slowly bleaches the coating, reducing sensitivity.

## 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.

#### **Camera**

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

#### **Optical Surfaces**

As a good practice, the camera must be closed/capped off with the supplied dust cover or lens cap when not in use. Should a need to clean the optical window arise 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.

## Repairs

Because the PIXIS camera system contains no user-serviceable parts, repairs must be performed by Princeton Instruments. Should your system need repair, contact Princeton Instruments customer support for instructions. For contact information, refer to page 116 of this manual.

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

## About this Manual

#### **Manual Organization**

This manual provides the user with all the information needed to install a PIXIS camera and place it in operation. Topics covered include detailed description of the cameras in the PIXIS family, installation, applications, cleaning, specifications and more.

**Note:** "WinX" is a generic term for WinView/32, WinSpec/32, and WinXTest application software.

**Chapter 1, Introduction** provides an overview of the PIXIS cameras.

**Chapter 2, System Component Descriptions** provides information about the camera, interface card, cables and application software.

**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 camera for imaging or spectroscopic applications and presents over-exposure protection considerations.

**Chapter 5, Operation** includes a step-by-step procedure 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 modes, Logic Level control, and the optional Kinetics mode.

**Chapter 7, Troubleshooting** provides courses of action to take if you should have problems with your system.

**Appendix A, Specifications** includes camera specifications.

**Appendix B, Outline Drawings** includes outline drawings of C-mount and Spectroscopy-mount cameras.

**Appendix C, Adapter Focusing Procedures** discusses focusing of an F-mount adapter and focusing of F-mount and C-mount lenses.

**Appendix D, Spectrometer Adapters** provides mounting instructions for the spectrometer adapters available for PIXIS cameras.

**Appendix E, USB 2.0 Card Installation** provides instructions for installing a USB 2.0 card into the host computer.

**Warranty & Service** contains the 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.

# Chapter 2

## System Component Descriptions

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### System Components

#### **Standard Components**

A typical air-cooled PIXIS<sup>®</sup> system consists of the camera with a Certificate of Performance, a power supply, a USB 2.0 interface cable for your computer system, MCX to BNC adapter cables, and the user manual. A typical liquid-cooled PIXIS system consists of the camera with a Certificate of Performance, a CoolCUBE or a CoolCUBE<sub>II</sub> circulator with hoses, a USB 2.0 interface cable for your computer system, MCX to BNC adapter cables, and the user manual.



Figure 1. Typical System Components

#### **Optional System Components**

Optional items include the WinView/WinSpec application software and manual, Scientific Imaging ToolKit<sup>™</sup> (SITK<sup>™</sup>) for LabVIEW<sup>®</sup>, internal 25 or 45 mm shutter (dependent on CCD array size), and an F-mount adapter.

## PIXIS Camera

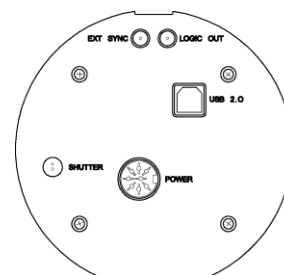


**CCD Array:** The PIXIS camera system offers both front- and back-illuminated CCDs in a variety of array sizes that allow you to precisely match the sensor to your application. Only scientific-grade devices are used in order to ensure the highest image fidelity, resolution, and acquisition flexibility required for scientific imaging. Princeton Instruments has developed exclusive CCDs with unmatched quantum efficiency and low noise to offer the utmost in sensitivity. Large full wells, square pixels, and 100% fill factors provide high dynamic range and excellent spatial resolution. Unichrome (exclusive Princeton Instruments technology) and other UV-enhancement coatings can be used to further improve the quantum efficiency of these CCDs in the ultraviolet. Your choice of CCD is already installed in the camera that you received and has been individually tested.

**Cooling:** Dark current is reduced in PIXIS camera systems through thermoelectric cooling of the CCD arrays. Cooling by this method uses a four-stage Peltier cooler in combination with circulating air or coolant. To prevent condensation and contamination from occurring, cameras cooled this way are evacuated. Due to CCD size/packaging differences, the lowest achievable temperature can vary from one PIXIS model to the next. Please refer to the specific system's data sheet for cooling performance.

### Connectors:

**USB 2.0:** Control signals and data are transmitted between the camera and the host computer via the USB port located on the rear of the camera. As of this printing, you can hot plug the PIXIS camera whenever the WinX application is not running (i.e., connect or disconnect from the camera or the host computer while the camera is powered ON). In the case of cameras built before November 1, 2005, you must exit the WinX application and turn the camera power OFF before connecting the USB cable to or disconnecting it from the camera or host computer.



**Shutter:** LEMO® connector provides the shutter drive pulses for driving a Princeton Instruments-supplied external shutter. Camera power must be OFF before connecting to or disconnecting from this connector.

**Note:** When there is an installed internal shutter, this connector cannot drive an external shutter.

**LOGIC OUT:** 0 to +3.3V logic level output (TTL-compatible). WinView/WinSpec32 (ver. 2.5 and higher) software-selectable NOT SCAN, SHUTTER, or NOT READY signal. The output can also be set to LOGIC 1 or LOGIC 0 through software. Default is SHUTTER.

**EXT SYNC:** 0-+3.3V logic level input (TTL-compatible) that has a 10 k $\Omega$  pullup resistor. Allows data acquisition and readout to be synchronized with external events. Through software, positive or negative (default) edge triggering can be selected.

**Power:** 12 VDC (6.6A max) input from power supply or CoolCUBE circulator.

**Fan:** Air-cooled cameras contain an internal fan. Its purpose is:

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

An internal Peltier device directly cools the cold finger on which the CCD is mounted. The air drawn into the camera by the internal fan through the back slots on the side panels and exhausted through the front slots on the side panels then removes the heat produced by the Peltier device. 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 sides of the camera and the laboratory atmosphere.

**Coolant Ports:** Liquid-cooled cameras have internal hoses that can be connected to the CoolCUBE circulator via the coolant ports on the side of the camera (either port can be the input). As is the case with circulating air (see above), circulating coolant removes the heat produced by the Peltier device. This means of heat removal is designed for vibration-free data acquisition. For the circulating coolant to function properly, free air circulation must be maintained between the sides of the CoolCUBE and the laboratory atmosphere.

**WARNING!**

Use only the hoses and circulator shipped with your system. Attaching any other hoses or circulator voids the warranty.

## Power Supply (Air-cooled and CoolCUBE<sub>II</sub> Liquid-cooled systems)



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

**Maximum Power Output:** 80 W

**Input:** 100-240 VAC, 47-63 Hz, 1.9A

**Output:** 12 VDC at 6.6 A maximum

## CoolCUBE Coolant Circulator (Liquid-cooled systems)



Liquid-cooled PIXIS cameras provide a low vibration system for data acquisition. Instead of using a fan to remove heat, these cameras incorporate a closed loop system of circulating fluid. The CoolCUBE circulator unit provides the power to the camera and continuously pumps the 50:50 mixture of room temperature (23°C) water and ethylene glycol. To prevent voiding the warranty, use only the circulator and hoses shipped with your system.

## CoolCUBE<sub>II</sub> Coolant Circulator (Liquid-cooled systems)



Liquid-cooled PIXIS cameras can cool to a lower temperature (typically -35° C) than air cooling. Instead of using a fan to remove heat, these cameras incorporate a closed loop system of circulating fluid. The CoolCUBE<sub>II</sub> circulator unit continuously pumps the 50:50 mixture of room temperature (23°C) water and ethylene glycol. To prevent voiding the warranty, use only the circulator and hoses shipped with your system.

## Cables



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



**MCX to BNC Adapter Cables:** Two MCX to BNC adapter cables are provided with the PIXIS system. These mount to the EXT SYNC and the LOGIC OUT connectors on the rear of the PIXIS.



**Circulator-Camera Power Cable: (For CoolCUBE Liquid-Cooled Version Only):**

The 10' (3 m) power cable that connects between the circulator to the camera to provide the camera power.

## Certificate of Performance



Each PIXIS camera has a Certificate of Performance. This certificate states that the camera system was assembled and tested according to approved Princeton Instruments procedures. It documents the camera performance data as measured during the testing of your PIXIS and lists the Sales Order, Purchase Order, and Camera Serial numbers (useful if you ever need to contact Princeton Instruments Customer Support).

## User Manuals



**PIXIS System User Manual:** This manual describes how to install and use the PIXIS system components.

**WinView/32 or WinSpec/32 User Manual:** 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.

## Optional Components:

### Application Software



**WinX/32 (WinView or WinSpec):** The PIXIS camera can be operated by using either WinView/32 or WinSpec/32, Princeton Instrument's 32-bit Windows® software packages designed specifically for high-end imaging and spectroscopy, respectively. The Princeton Instruments' software provides comprehensive image/spectral capture and display functions. The package also facilitates snap-ins to permit advanced operation. Using the optional built-in macro record function, you can also create and edit your own macros to automate a variety of operations. WinView and WinSpec take full advantage of the versatility of the PIXIS camera and even enhance it by making integration of the detection system into larger experiments or instruments an easy, straightforward endeavor.

**PVCAM®:** The standard software interface for cooled CCD cameras from Princeton Instruments. It is a library of functions that can be used to control and acquire data from the camera when a custom application is being written. For example, in the case



of Windows, PVCAM is a dynamic link library (DLL). Also, it should be understood that PVCAM is solely for camera control and image acquisition, not for image processing. PVCAM places acquired images into a buffer, where they can then be manipulated using either custom written code or by extensions to other commercially available image processing packages.

**Scientific Imaging ToolKit™:** SITK™ is a collection of LabVIEW® VIs for scientific cameras and spectrographs. This third party software can be purchased from Princeton Instruments.

**Note:** PIXIS may also be operated by several other third-party software packages. Please check with the providers of the packages for compatibility and support information.

### ***Internal Shutter***



Optional 25 or 45 mm internal shutter (dependent on CCD array size). Shutters are mechanical devices with a finite lifetime, typically of the order of a million cycles, although some individual shutters may last a good deal longer. How long a shutter lasts in terms of experimental time will, of course, be strongly dependent on the operating parameters. High repetition rates and short exposure times will rapidly increase the number of shutter cycles and hasten the time when the shutter will have to be replaced.

### ***F-Mount Adapter***



An F-mount adapter (7050-0009) is available for modifying a spectroscopy-mount PIXIS with internal shutter (see Figure 57, page 91).

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# Chapter 3

## Installation Overview

The list and diagrams below briefly describe the sequence of actions required to install 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 23
2. Verify that all system components have been received.	Chapter 4 System Setup, page 24
3. If the components show no signs of damage, verify that the appropriate power cord has been supplied with the power supply.	Chapter 4 System Setup, page 24
4. If the application software is not already installed in the host computer, install it.	Chapter 4 System Setup, page 25 & Software manual
5. If the appropriate interface card is not already installed in the host computer, install it.	Appendix E, USB 2.0 Card Installation, page 109
6. Depending on application, attach lens to the camera or mount the camera to a spectrometer.	Chapter 4 System Setup, page 29
7. With the power supply (or the CoolCUBE) disconnected from the camera, connect the USB cable to the USB port at the rear of the camera and to the USB port at the computer.	
8. <b>Air-Cooled System:</b> Plug the power supply into the rear of the camera and plug the power supply into the power source. Switch the power supply on. <b>CoolCUBE Liquid-Cooled System:</b> Make the hose connections to the camera. Make the circulator/camera power cable connections and plug the circulator into the power source. Add coolant if necessary. Turn on the circulator. <b>CoolCUBE<sub>II</sub> Liquid-Cooled System:</b> Plug the power supply into the rear of the camera and plug the power supply into the power source. Switch the power supply on. Make the hose connections to the camera. Plug the circulator into the power source. Add coolant if necessary. Turn on the circulator.	Chapter 4 System Setup, page 26
9. Turn on the computer and begin running the application software.	Software manual
10. Enter the hardware setup information or load the defaults from the camera.	Software manual

Action	Reference
11. Set the target array temperature.	Chapter 5 Operation, page 42
12. When the system reaches temperature lock, wait an additional 20 minutes and then begin acquiring data in focus mode.	Chapter 5 Operation, page 36 or page 38
13. Adjust the focus for the best image or spectral lines. If you are using WinSpec/32, you may want to use the Focus Helper function for spectroscopy applications.	Chapter 5 Operation, page 38

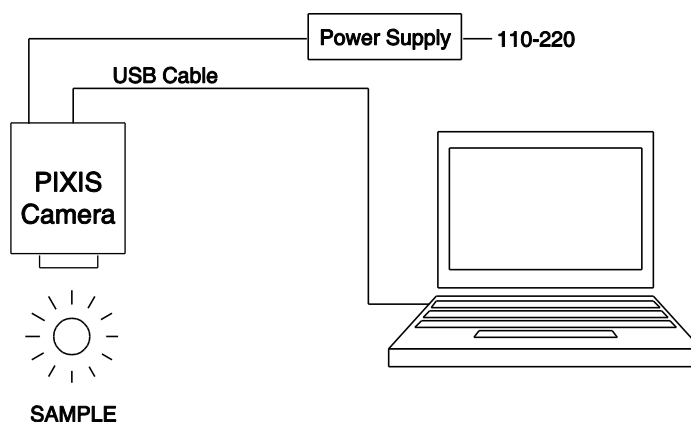


Figure 2. Typical Imaging Experiment Layout (Air-cooled Camera)

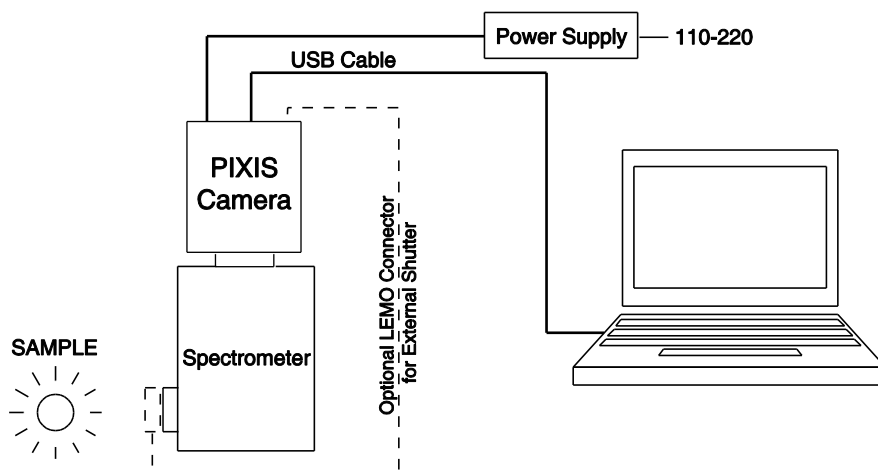


Figure 3. Typical Spectroscopy Experiment Layout (Air-cooled Camera)

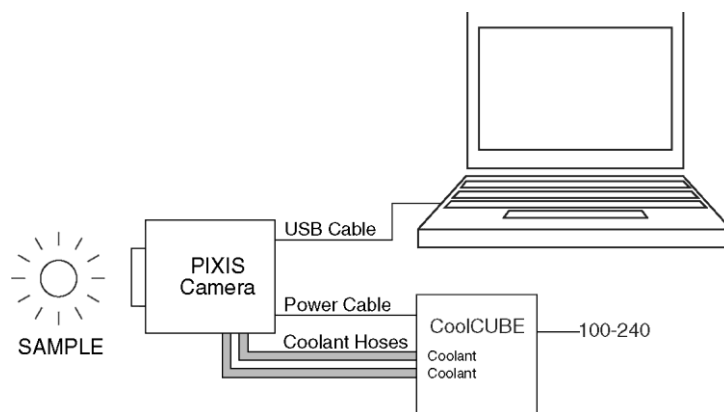


Figure 4. Typical Imaging Experiment Layout (Liquid-cooled Camera with CoolCUBE)

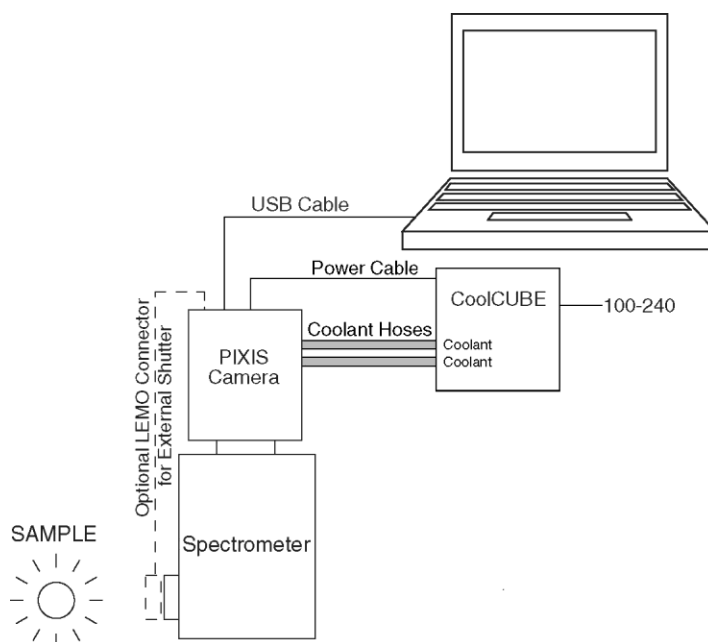


Figure 5. Typical Spectroscopy Experiment Layout (Liquid-cooled Camera with CoolCUBE)

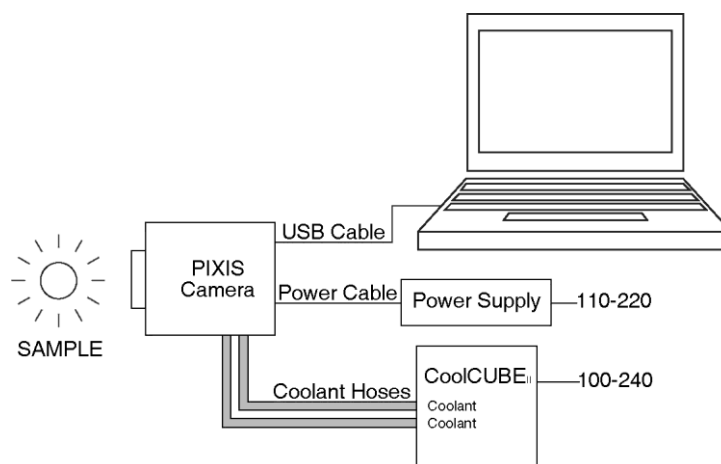


Figure 6. Typical Imaging Experiment Layout (Liquid-cooled Camera with CoolCUBE<sub>II</sub>)

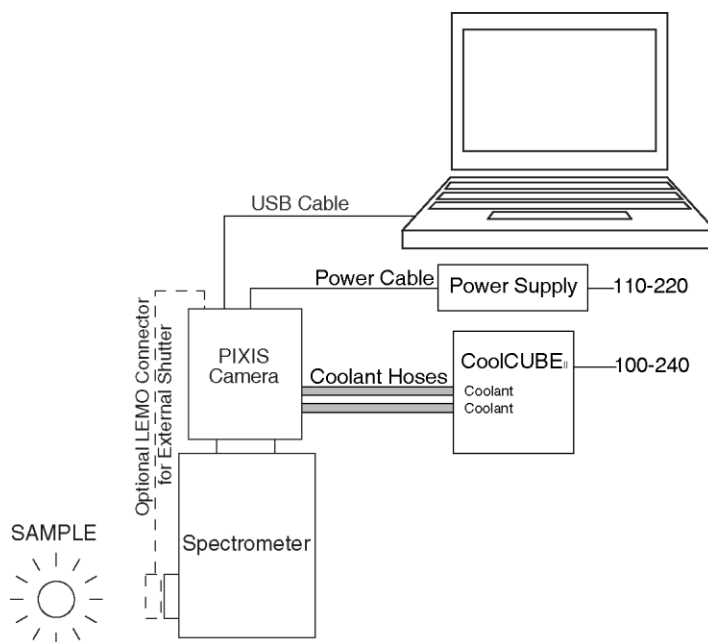


Figure 7. Typical Spectroscopy Experiment Layout (Liquid-cooled Camera with CoolCUBE<sub>II</sub>)

## System Setup

---

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

### Introduction

A PIXIS® camera system consists of three hardware components:

- Camera head
- Power supply
- Cables

All of the components and cables required for your configuration are included with your shipment. Your PIXIS system has been specially configured and calibrated to match the camera options specified at the time of purchase. The CCD and coating you ordered have been installed in the camera head.

Keep all of the original packing materials so you can safely ship the PIXIS system to another location or return it for service if necessary. If you have any difficulty with any step of the instructions, call Princeton Instruments Customer Support. For contact information, refer to page 116.

Hardware installation may consist of:

- Installing an interface card, if the appropriate card is not already resident.
- Attaching a lens to a C-mount on the camera or to an F-mount adapter.
- Connecting the camera to an external shutter, if one is required.
- Mounting the camera to a spectrometer.

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

### Unpacking the System

During the unpacking, check the system components for possible signs of shipping damage. If there are any, notify Princeton Instruments immediately and file a claim with the carrier. If damage is not apparent but the camera cannot be operated, internal damage may have occurred in shipment. After unpacking the system, save the original packing materials so you can safely ship the camera 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 PIXIS system. A complete system consists of:

### Standard System:

- **Camera**
- **Power Supply** (or a CoolCUBE coolant circulator for liquid-cooled versions)
- **Host Computer:** Can be purchased from Princeton Instruments or provided by user.
- **USB cable:** Five (5) meter cable (6050-0494) is standard.
- **PIXIS System User Manual**

### Options:

- **F-mount adapter**
- **25 mm or 45 mm Internal Shutter** (as appropriate for the CCD size)
- **WinView/32 or WinSpec/32 CD-ROM and User Manual**

## System Requirements

### ***Environmental Requirements***

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

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

Relative humidity  $\leq 50\%$ ; non-condensing

**Note:** The cooling performance may degrade if the room temperature is above  $+23^{\circ}\text{C}$ .

**Ventilation:** Allow at least one inch clearance for the side air vents. Where the camera is inside an enclosure,  $> 30$  cfm air circulation and heat dissipation of 100W is required.

**Power:** The PIXIS camera receives its power from the supplied power supply or a CoolCUBE circulator, which in turn plugs into an AC power source.

### ***Host Computer***

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

- 2 GHz Pentium® 4 (or greater).
- Windows 2000 and later (32-bit only) for WinSpec/32 and WinView/32 versions 2.5.22-2.5.23. Versions 2.5.25 and later operate under Windows XP (32-bit with SP3 or later) and Windows Vista® (32-bit).
- Native USB 2.0 support on the mother board or USB 2.0 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 1 GB RAM (or greater).
- CD-ROM drive.



- Hard disk with a minimum of 1 Gbyte available. A complete installation of the program files takes about 17-50 Mbytes and the remainder is required for data storage, depending on the number and size of images/spectra collected. Disk level compression programs are not recommended. Drive speed of 10,000 RPM recommended.
- Super VGA monitor and graphics card supporting at least 65,535 colors with at least 128 Mbyte of memory. Memory requirement is dependent on desired display resolution.
- Mouse or other pointing device.

## Software Installation

### Notes:

1. Before proceeding, please check to see if your computer supports USB 2.0. If it does not, please refer to Appendix E for instructions for installing a USB 2.0 interface card.
2. If you have multiple cameras from Roper Scientific (PI and PM brands) on the same host computer, it may be necessary to edit the PVCAM.INI file. Refer to Appendix E for instructions.
3. Leave the USB cable disconnected from the camera until you have installed WinView/32 or WinSpec/32.

The following installation is performed via the WinView/32 or WinSpec/32 software installation CD.

1. On the **Select Components** dialog box (see Figure 4), click on the **AUTO PCI** button to install the required drivers (the Princeton Instruments 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 drivers.
2. Make sure the camera is connected to the host computer and that the camera power supply is turned on.
3. Reboot the computer.
4. At bootup, Windows will detect the Princeton Instruments USB2 Interface hardware in the PIXIS. 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.

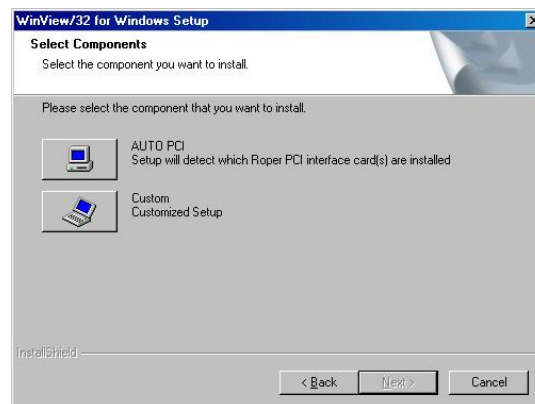


Figure 8. WinView Installation:  
Select Components dialog box

If you selected **AUTO PCI** during the application software installation, WinView/32 or WinSpec/32 automatically put the required INF, DLL, and USB driver files in the "Windows" directories shown in Table 1. If you are prompted for the locations of these files, refer to that table.

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® 2000 and XP	rsusb2k.inf (in WINNT/INF, for example)	apausbprop.dll (in WINNT/System32, for example)	apausb.sys (in WINNT/System32/Drivers, for example)

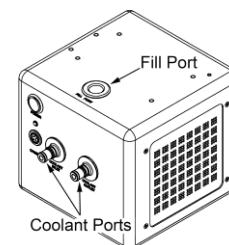
\* The INF directory may be hidden.

Table 1. USB Driver Files and Locations

## Making the Camera-Circulator Connections for a CoolCUBE

The CoolCUBE circulator provides the camera power for liquid-cooled PIXIS cameras and provides a vibration-free method of heat removal.

1. Make sure the CoolCUBE power switch is turned off.
2. Make sure the circulator is 6 inches (150 mm) or more below the camera. The vertical distance should not exceed 10 feet (3 m). Typically, the camera is at table height and the circulator is on the floor.
3. Make the coolant connections between the CoolCUBE and the PIXIS. It does not matter which hose from the CoolCUBE is plugged into a coolant port on the PIXIS.



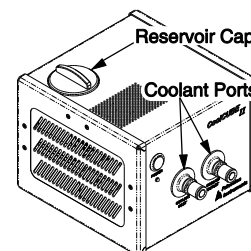
**Note:** Make sure that there are no kinks in the hoses that impede the coolant flow. Lack of sufficient flow can seriously harm the detector and any resulting damage is not covered under warranty

4. Make the circulator/camera power cable connection between the PIXIS and the CoolCUBE.
5. Plug the CoolCUBE into a 100-240 VAC, 47-63 Hz power source.
6. Turn the CoolCUBE on.
7. Start the application software.

## Making the Camera-Circulator Connections for a CoolCUBE<sub>II</sub>

For liquid-cooled cameras, the CoolCUBE<sub>II</sub> circulator provides a vibration-free method of heat removal.

1. Make sure the camera and the circulator power switches are turned off.
2. Make sure the circulator is 6 inches (150 mm) or more below the camera. The vertical distance should not exceed 10 feet (3 m). Typically, the camera is at table height and the circulator is on the floor.
3. Make the coolant connections between the circulator and the



camera. It does not matter which hose from the circulator is plugged into a coolant port on the camera.

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

**Notes:**

1. Make sure that there are no kinks in the hoses that impede the coolant flow. Lack of sufficient flow can seriously harm the detector and any resulting damage is not covered under warranty.
2. Damage caused by water leaking into the PIXIS voids the warranty.

5. Unscrew the reservoir cap (on top of the CoolCUBE II) and make sure that the coolant reservoir contains coolant. If additional coolant is required, fill with a 50:50 mixture of water and ethylene glycol.



6. Screw the reservoir cap back in.
7. Plug the circulator into a 100-240 VAC, 47-63 Hz power source.
8. Turn the circulator on. Make sure there are no leaks or air bubbles in the hoses.
  - If there are no problems, continue to Step 9.
  - If there are leaks or air bubbles, turn the circulator off and correct the problem(s) by securing the hoses or adding more coolant to the reservoir. Turn the circulator back on. Recheck and if there are no problems, continue to Step 9.
9. Turn the camera on.
10. Start the application software.

## Entering the Default Camera System Parameters into WinX (WinView/32, WinSpec/32, or WinXTest/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 PIXIS is connected to the host computer and that it is turned on.
2. Run the WinX application. The **Camera Detection wizard** will automatically run if this is the first time you have installed a Princeton Instruments WinX application (WinView/32, WinSpec/32, or WinXTest/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 page to start the wizard.
3. On the **Welcome** dialog (Figure 9), leave the checkbox unselected and click on **Next**.

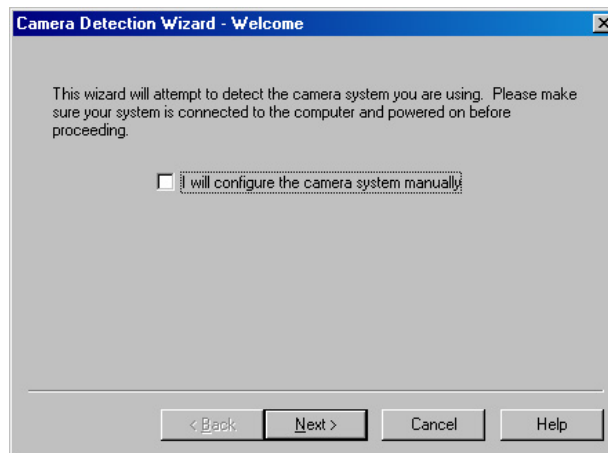


Figure 9. Camera Detection Wizard - Welcome dialog box

4. Follow the instructions on the dialog boxes to perform the initial hardware setup: this wizard enters default parameters on the Hardware Setup dialog box tab pages 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 PIXIS 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 WinView, WinSpec, or WinXTest.
3. When the RSConfig dialog box (Figure 10) 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 "PI Style (USB2:PIXIS)", please refer to Appendix E for instructions on editing the PVCAM.INI file.

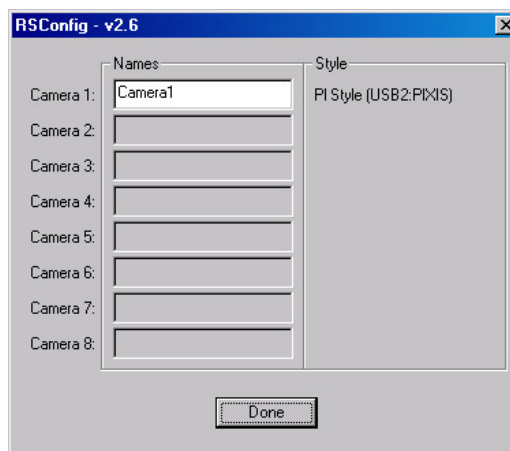


Figure 10. RSConfig dialog box

4. Open the WinX application and, from **Setup|Hardware...**, run the Hardware Setup wizard.
5. When the PVCAM dialog box (Figure 11) 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 11. Hardware Setup wizard: PVCAM dialog box

6. Run the software in focus mode to verify communication between the PIXIS and the host computer.

## Attaching Lenses to C- and F-Mount Adapters

**Caution** **Overexposure protection:** Cameras that are exposed to room light or other continuous light sources will quickly become saturated. Set the lens to the smallest aperture (highest f-number) and cover the lens with a lens cap to prevent overexposure.

PIXIS cameras for imaging applications incorporate an integral C-mount adapter, an adjustable C-mount adapter, or an integral F-mount adapter. *Other mounts may be available. Consult the factory for specific information relating to your needs. See page 116 for Information on accessing the Princeton Instruments Customer Support Dept.*

### Attaching to a C-Mount Adapter

C-mount lenses simply screw into the front of these cameras. Tighten the lens by hand only. An optional C-to-F-mount adapter, which uses the Nikon bayonet format, can be ordered. For information about adjusting the focal distance for an adjustable C-mount adapter, refer to the instructions on page 95.

**Note:** C-mount cameras are shipped with a dust cover lens installed. Although this lens is capable of providing surprisingly good images, its throughput is low and the image quality is not as good as can be obtained with a high-quality camera lens. Users should replace the dust-cover lens with their own high-quality laboratory lens before making measurements.

### Attaching to an F-Mount Adapter

F-mount adapters use the Nikon bayonet format. To mount the lens on the camera:

1. Locate the large indicator dot on the side of the lens.
2. Note the corresponding dot on the front side of the adapter.
3. Line up the dots and slide the lens into the adapter.
4. Turn the lens counterclockwise until a click is heard. The lens is now locked in place.

In addition to the focusing ring of the lens, there is provision for focusing the adapter itself. That adjustment is secured by setscrews on the side of the adapter's adjustment ring. Directions for focusing the adapter *and* the lens are provided on pages 96 and 97.

## Mounting the Camera to a Spectrometer

The camera must be properly mounted to the spectrometer to focus. Additional precautions must also be taken to prevent overexposure of the camera.

The distance to the focal plane from the front of the mechanical assembly depends on the specific configuration. Refer to "**Focal Distance**" on page 80 for more information.

### **Spectrometer Adapter**

Refer to Appendix C, page 99 for instructions for a variety of adapters. *Other adapters may be available. Consult the factory for specific information relating to your needs.*

## Connecting an External Shutter

**WARNING!** Disconnecting or connecting the shutter cable to the camera while the camera is **ON** can destroy the shutter or the shutter driver in the camera!

### **Introduction**

Typically, PIXIS cameras for imaging applications are shipped with an internal shutter. The 25 or 45 mm internal shutter (depending on the CCD array size) is housed in the main body. Typically, cameras for spectroscopy applications do not incorporate internal shutter. However, for cameras without an internal shutter, there is provision for connecting an external 25 or 45 mm shutter (supplied by Princeton Instruments) at the **Shutter** connector on the rear of the PIXIS.

### **Cautions**

1. **DO NOT** connect a Princeton Instruments-supplied external shutter when there is an installed internal shutter. Permanent damage to the shutter driver may occur.
2. Electromechanical shutters typically have a lifetime of about a million cycles. Avoid running the shutter unnecessarily.
3. A shutter can become overheated when short, rapidly repeated exposures are used or if the shutter is held open for an extended period of time. Newer versions of the WinView/WinSpec software and camera hardware monitor the temperature of **45 mm internal shutters** to prevent overheating conditions. ***The temperature of external shutters is NOT monitored!***

### **External Shutter**

A Princeton Instruments-supplied external shutter may be used with a PIXIS camera that does not have an internal shutter. In most cases, the external shutter will be mounted on the entrance slit of a spectrometer. The shutter mount used with all Acton Research spectrographs requires no disassembly. Mount it to the spectrograph as shown in Figure 12.

### **Shutter Cable Connection**

1. Verify that the PIXIS camera is turned OFF (i.e., the power supply is switched OFF).
2. Verify that there is no internal shutter.

### **Caution**

If the camera is equipped with an internal shutter, **DO NOT USE** the **Shutter** connector to drive an external (second) shutter. Such a configuration will result in under-powering both shutters and may cause damage to the system.

3. Connect the shutter cable to the LEMO<sup>®</sup> connector at the rear of the camera.
4. Power the PIXIS camera ON.

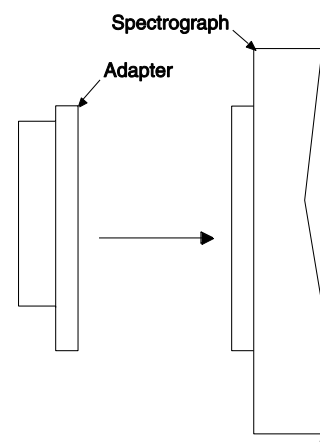


Figure 12. Entrance Slit Mount

### **Overexposure Protection**

Cameras that are exposed to room light or other continuous light sources will quickly become saturated. This most often occurs when operating without a shutter. If the camera is mounted to a spectrograph, close the entrance slit of the spectrograph to reduce the incident light.

**Note:** If the CCD is cooled to low temperatures (below -50°C), exposure to ambient light will over-saturate it. This may increase dark charge significantly. If the camera remains saturated after all light sources are removed, you may have to bring the camera back to room temperature to restore dark charge to its original level.

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## Operation

### Introduction

Once the PIXIS camera has been installed as explained in the preceding chapters, operation of the camera is straightforward. In most applications you simply establish optimum performance using the **Focus** mode (in WinView/32 or WinSpec/32, for example), set the target camera 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.

During data acquisition, the CCD array is exposed to a source and charge accumulates in the pixels. After the defined exposure time, the accumulated signal is readout of the array, digitized, and then transferred to the host computer. Upon data transfer, the data is displayed and/or stored via the application software. This sequence is illustrated by the block diagram shown in Figure 13.

Whether or not the data is displayed and/or stored depends on the data collection operation (**Focus** or **Acquire**) that has been selected in the application software. In WinView and WinSpec, these operations use the Experiment Setup parameters to establish the exposure time (the period when signal of interest is allowed to accumulate on the CCD). As might be inferred from the names, **Focus** is more likely to be used in setting up the system (see the "*First Light*" discussions) and **Acquire** is then used for the collection and storage of data. Briefly:

- In **Focus** mode, the number of frames and accumulations settings are ignored. A single frame is acquired and displayed, another frame is acquired and overwrites the currently displayed data, and so on until Stop is selected. Only the last frame acquired before Stop is selected can be stored. When Stop is selected, the File Save function can be used to save the currently displayed data. This mode is particularly convenient for familiarization and setting up. For ease in focusing, the screen refresh rate should be as rapid as possible, achieved by operating with axes and cross-sections off, and with Zoom 1:1 selected.
- In **Acquire** mode, every frame of data collected can be automatically stored (the completed dataset may include multiple frames with one or more accumulations). This mode would ordinarily be selected during actual data collection. One limitation of Acquire mode operation is that if data acquisition continues at too fast a rate for it

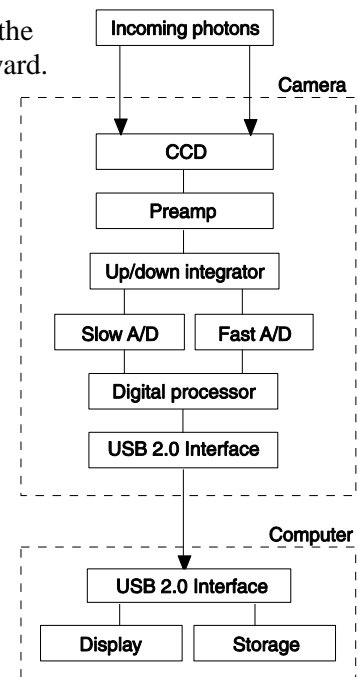


Figure 13. Block Diagram of PIXIS System

to be stored, data overflow will eventually occur. This could only happen in Fast Mode operation.

The remainder of this chapter is organized to first talk about the system on/off sequences. Then "First Light" procedures for imaging and spectroscopy applications follow: these procedures provide step-by-step instruction on how to initially verify system operation. The last three sections discuss factors that affect exposure, readout, and digitization of the incoming signal. By understanding these factors and making adjustments to software settings you can maximize signal-to-noise ratio. For information about synchronizing data acquisition with external devices, please refer to **Chapter 6, Advanced Topics**.

## System On/Off Sequences

The following on/off sequences must be followed to establish and maintain the communication link between the camera and the host computer:

1. The PIXIS camera must be powered ON **before** WinView/32 or WinSpec/32 is opened to ensure communication between the camera and the computer. If WinView or WinSpec is opened and the PIXIS is not powered ON, many of the functions will be disabled and you will only be able to retrieve and examine previously acquired and stored data. You must close WinView or WinSpec, power the camera ON, and reopen WinView or WinSpec before you can set up experiments and acquire new data.
2. WinView/32 or WinSpec/32 must be closed before powering the camera OFF. If you power the camera OFF before closing WinView or WinSpec, the communication link with the camera will be broken. You can operate the program in a playback mode (i.e., examine previously acquired data) but will be unable to acquire new data until you have closed WinView or WinSpec, powered the camera ON, and then re-opened WinView or WinSpec.

## 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 being operated in imaging mode.
5. The target is a sharp image, text, or a drawing that can be used to verify that the camera is "seeing" and can be used to maximize focus.

### Getting Started

1. Mount a test target in front of the camera.
2. Power ON the camera (i.e., switch the power supply ON).

**Note:** The camera must be turned on before WinView/32 or WinSpec/32 is opened, and WinView/32 or WinSpec/32 must be closed before the camera is turned off.

3. Turn on the computer power.
4. Start the application software.
5. 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):** Check the DMA Buffer size.

Large arrays (2048x2048, for example) require a buffer size on the order of 32 Mbytes. 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 page (Setup|Hardware):** These parameters should be set automatically to the proper values for your system.

- **Use PVCAM:** Verify that this box is checked.

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

- **Controller type:** This information is read from the camera.
- **Camera type:** This information is read from the camera.
- **Shutter type:** None or Small (System dependent).
- **Readout mode:** Available modes are read from the camera. Select Full frame.

**Detector Temperature (Setup|Detector Temperature...):** The default temperature setting is read from the camera. When the array temperature reaches the set temperature, the **Detector Temperature** dialog box will report that the temperature is **LOCKED**. Note that some overshoot may occur. This could cause temperature lock to be briefly lost and then quickly re-established. If you are reading the actual temperature reported by the application software, there may be a small difference between the set and reported temperature when lock is established. This is normal and does not indicate a system malfunction. Once lock is established, the temperature will be stable to within  $\pm 0.05^{\circ}\text{C}$ .

**Note:** The Detector Temperature dialog box will not display temperature information while you are acquiring data.

**Cleans and Skips tab page (Setup|Hardware):** Click on **Load Default Values** and click on **Yes**.

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

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

**Experiment Setup ROI tab page (Acquisition|Experiment Setup...):**

Use this function to define the region of interest (ROI).

- **Imaging Mode:** Select this mode if you are running WinSpec.
- Clicking on **Full** loads the full size of the chip into the edit boxes.

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

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

### **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.
  - Adjust the intensity scaling (by clicking the **5%-95%** button at the bottom left corner of the data window) and adjust the lens aperture until a suitable setting is found. Once 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 camera with an F-mount, the camera 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 96.
3. After you have focused the camera, you can stop **Focus** mode, continue **Focus** mode, begin **Acquire** mode, or wait for the CCD to reach the operating temperature before going to **Acquire** mode.

## First Light (Spectroscopy)

The following paragraphs provide step-by-step instructions for operating PIXIS in a spectroscopy setup for 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 camera is to be operated with a spectrograph such as the Acton SpectraPro™ 2356 (SP-2356) 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 being operated in spectroscopy mode.
5. An entrance slit shutter is not being controlled by the PIXIS camera.

### Getting Started

1. Set the spectrometer entrance slit width to minimum (10  $\mu\text{m}$  if possible).
2. Mount the camera to the spectrometer exit port.
3. Power ON the camera (i.e., switch the power supply ON).

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

4. Turn on the computer power.
5. Start the application software.

### 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):** Check the DMA Buffer size. Large arrays (2048x2048, for example) require a buffer size on the order of 32 Mbytes. 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 page (Setup|Hardware):** These parameters should be set automatically to the proper values for your system.

- **Use PVCAM:** Verify that this box is checked.

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

- **Controller type:** This information is read from the camera.
- **Camera type:** This information is read from the camera.
- **Shutter type:** None or Remote (System dependent).
- **Readout mode:** Available modes are read from the camera. Select Full frame.

**Detector Temperature (Setup|Detector Temperature...):** The default temperature setting is read from the camera. When the array temperature reaches the set temperature, the **Detector Temperature** dialog box will report that the temperature is **LOCKED**. Note that some overshoot may occur. This could cause temperature lock to be briefly lost and then quickly re-established. If you are reading the actual temperature reported by the application software, there may be a small difference between the set and reported temperature when lock is established. This is normal and does not indicate a system malfunction. Once lock is established, the temperature will be stable to within  $\pm 0.05^{\circ}\text{C}$ .

**Note:** The Detector Temperature dialog box will not display temperature information while you are acquiring data.

**Cleans and Skips tab page (Setup|Hardware):** Click on **Load Default Values** and click on **Yes**.

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

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

**Experiment Setup ROI tab page (Acquisition|Experiment Setup...):**

Use this function to define the region of interest (ROI).

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

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

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

## **Focusing**

The mounting hardware provides two degrees of freedom, focus and rotation. In this context, focus means to physically move the camera back and forth through the focal

plane of the spectrograph. The approach taken is to slowly move the camera in and out of focus and adjust for optimum while watching a live display on the monitor, followed by rotating the camera and again adjusting for optimum. The following procedure, which describes the focusing operation with an Acton SP-2356 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 camera, turn the power on, wait for the spectrograph to initialize. Then set it to 435.8 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 435.833 as the spectral line.

3. Set the slit to 25  $\mu\text{m}$ . *If necessary, adjust the Exposure Time to maintain optimum (near full-scale) signal intensity.*
4. In WinSpec, select **Focus** (on the **Acquisition** menu or on the **Experiment Setup** dialog box) to begin data accumulation. Data will be continuously acquired and displayed but will not be stored until you stop acquisition and use the **Save** function on the File menu.
5. Slowly move the camera in and out of focus. You should see the spectral line go from broad to narrow and back to broad. Leave the camera set for the narrowest achievable line. You may want to use the **Focus Helper** function (**Process|Focus Helper...**) to determine the narrowest line width: it can automatically locate peaks and generate a report on peak characteristics during live data acquisition (see the WinSpec/32 on-line help for more information).

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

- **Long focal-length spectrographs such as the Acton SP-2356:** The mounting adapter includes a tube that slides inside another tube to move the camera in or out as required to achieve optimum focus.
  - **Short focal-length spectrographs:** There is generally a focusing mechanism on the spectrograph itself which, when adjusted, will move the optics as required to achieve proper focus.
  - **No focusing adjustment:** If there is no focusing adjustment, 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 camera while watching a live display of the line. The line will go from broad to narrow and back to broad. Leave the camera rotation set for the narrowest achievable line.

Alternatively, take an image, display the horizontal and vertical cursor bars, and compare the vertical bar to the line shape on the screen. Rotate the camera until the line shape on the screen is parallel with the vertical bar.

**Note:** When aligning other accessories, such as fibers, lenses, optical fiber adapters, first align the spectrograph to the slit. Then align the accessory without disturbing the camera 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).

## Exposure and Signal

### Introduction

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

### CCD Array Architecture

Charge coupled devices (CCDs) can be roughly thought of as a two-dimensional grid of individual photodiodes (called pixels), each connected to its own charge storage “well.” Each pixel senses the intensity of light falling on its collection area, and stores a proportional amount of charge in its associated “well.” Once charge accumulates for the specified exposure time (set in the software), the pixels are read out serially.

CCD arrays perform three essential functions: photons are transduced to electrons, integrated and stored, and finally read out. CCDs are very compact and rugged and can withstand direct exposure to relatively high light levels, magnetic fields, and RF radiation. They are easily cooled and can be precisely thermostated to within a few tens of millidegrees.

### Exposure with a Mechanical Shutter

For some CCD arrays, the PIXIS uses a mechanical shutter to control exposure of the CCD. The diagram in Figure 14 shows how the exposure period is measured. The NOT SCAN signal at the **LOGIC OUT** connector on the back of the PIXIS can be used to monitor the exposure and readout cycle ( $t_R$ ). This signal is also shown in Figure 14. The value of  $t_c$  is shutter type dependent, and will be configured automatically for PIXIS cameras shipped with an internal shutter.

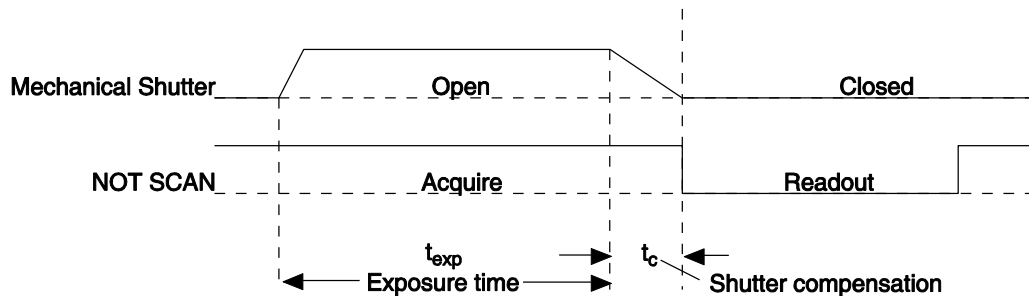


Figure 14. Exposure of the CCD with Shutter Compensation

Note that NOT SCAN is low during readout, high during exposure, and high during shutter compensation time.



Since most shutters behave like an iris, the opening and closing of the shutter will cause the center of the CCD to be exposed slightly longer than the edges. It is important to realize this physical limitation, particularly when using short exposures.

### Caution

A shutter can become overheated when short, rapidly repeated exposures are used or if the shutter is held open for an extended period of time. Newer versions of the WinView/WinSpec software and camera hardware monitor the temperature of **45 mm internal shutters** to prevent overheating conditions. *The temperature of external shutters is NOT monitored!*

### Continuous Exposure (No Shuttering)

For full-frame imaging CCDs, the standard PIXIS camera for imaging is equipped with an integral shutter. However, inasmuch as it is possible to order the camera without a shutter, the following general discussion of unshuttered operation is provided.

Slow scan scientific cameras require a shutter to prevent "smearing" of features during readout. This is because during readout, charge is moved horizontally or vertically across the surface of the CCD. If light is falling on the CCD during readout then charge will continue to accumulate, blurring the image along one direction only.

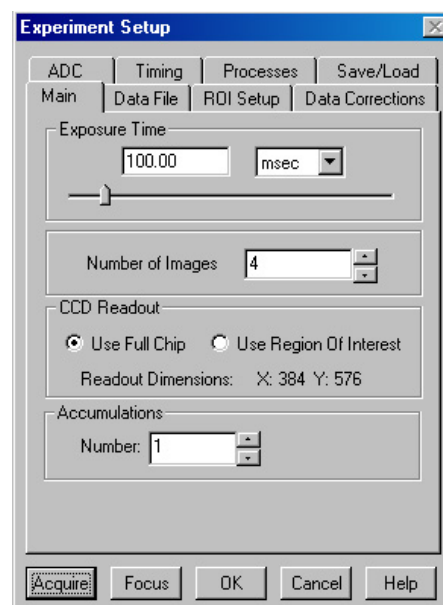
Because spectroscopy CCDs typically have their parallel shifting aligned vertically (perpendicular to the spectrum), smearing does not affect the spectral resolution, only the intensity level of the spectral features. When vertically binned, the readout generally takes a few milliseconds to tens of milliseconds. In experiments where the exposure time is much larger than the readout time, the smearing due to readout is insignificant, and the CCD can be operated without a shutter with very little loss of performance.

If the CCD is set up for imaging mode (the WinSpec Imaging option has been installed and is selected on the **Experiment Setup|ROI Setup** tab page), smearing may be more of a factor. In this case, controlling the light source so no light falls on the CCD during readout would minimize any smearing. If the light source can be controlled electronically via the output of the **LOGIC OUT** connector, the CCD can be read out in darkness.

### Exposure Time

Exposure time (set on the **Experiment Setup|Main** tab page) is the time between start acquisition and stop acquisition commands sent by the application software to the camera. In combination with triggers, these commands control when continuous cleaning of the CCD stops and when the accumulated signal will be readout. The continuous cleaning prevents buildup of dark current and unwanted signal before the start of the exposure time. At the end of the exposure time, the CCD is readout and cleaning starts again.

Because some PIXIS cameras do not incorporate an internal shutter, some signal may accumulate on the array while it is being readout. This continuous exposure of the array during readout may result in some smearing. However, exposures that are significantly longer than the readout time can be performed without a shutter, as the amount of smearing will be low.



If smearing or other factors require a shutter, the **NOT SCAN** or the **SHUTTER** signal at the **LOGIC OUT** connector (on the rear of the PIXIS) can be used to control a customer-supplied external shutter. By using one of the signals to synchronize the shutter operation with exposure, the CCD can be read out in darkness.

### CCD Temperature

As stated before, lowering the temperature of the CCD will generally enhance the quality of the acquired signal. When WinView or WinSpec is the controlling software, temperature control is done via the **Detector Temperature** dialog box (see Figure 15) accessed from the **Setup** menu. Once the target array temperature has been set, the software controls the camera's cooling circuits to reach set array temperature. On reaching that temperature, the control loop locks to that temperature for stable and reproducible performance. When temperature lock has been reached (temperature within 0.05°C of set value) the Detector Temperature dialog box reports that the current temperature is **Locked**. The on-screen indication allows easy verification of temperature lock. There is also provision for reading out the actual temperature at the computer so that the progress of the cooldown can be monitored.

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

The deepest operating temperature for a system depends on the CCD array size and packaging. Refer to Table 5, on page 81, for typical deepest cooling temperatures.

### Dark Charge

Dark charge (or dark current) is the thermally induced buildup of charge in the CCD over time. The statistical noise associated with this charge is known as dark noise. Dark charge values vary widely from one CCD array to another and are exponentially temperature dependent. In the case of cameras with MPP type arrays, the average dark charge is extremely small. However, the dark-charge distribution is such that a significant number of pixels may exhibit a much higher dark charge, limiting the maximum practical exposure. Dark charge effect is more pronounced in the case of cameras having a non-MPP array (such as deep-depletion devices).

With the light into the camera completely blocked, the CCD will collect a dark charge pattern, dependent on the exposure time and camera temperature. The longer the exposure time and the warmer the camera, the larger and less uniform this background will appear. Thus, to minimize dark-charge effects, you should operate with the lowest CCD temperature possible.

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

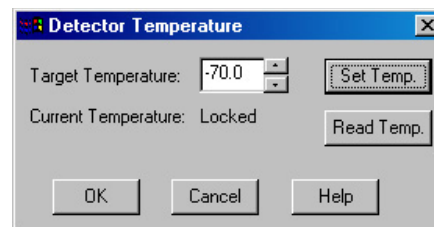


Figure 15. WinView/WinSpec  
Detector Temperature dialog box

**Caution**

If you observe a sudden change in the baseline signal, there may be excessive humidity in the camera vacuum enclosure. Turn off the camera and contact Princeton Instruments Customer Support. See page 116 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 is advisable, with signal averaging to enhance S/N (Signal-to-Noise ratio) accomplished through the software.

For signal levels low enough to be readout-noise limited, longer exposure times, and therefore longer signal accumulation in the CCD, 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 CCD by the signal or the loss of dynamic range due to the buildup of dark charge in the pixels.

**Readout****Introduction**

After the exposure time has elapsed, the charge accumulated in the array pixels needs to be read out of the array, converted from electrons to digital format, and transmitted to the application software where it can be displayed and/or stored. Readout begins by moving charge from the CCD image area to the shift register. The charge in the shift register pixels, which typically have twice the capacity of the image pixels, is then shifted into the output node and then to the output amplifier where the electrons are grouped as electrons/count. This result leaves the CCD and goes to the preamplifier where gain is applied.

WinView and WinSpec allow you to specify the type of readout (full frame or binned), the output amplifier, and the gain (the number of electrons required to generate an ADU).

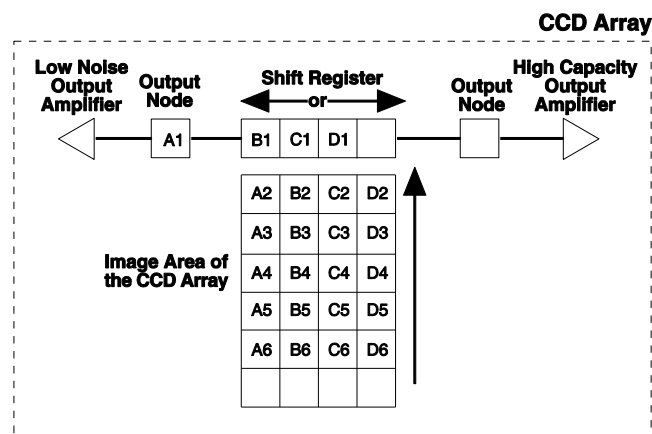


Figure 16. Array Terms for a CCD with a Dual Output Amplifier

### Full Frame Readout

The upper left drawing in Figure 17 represents a CCD after exposure but before the beginning of readout. The capital letters represent different amounts of charge, including both signal and dark charge. This section explains readout at full resolution, where every pixel is digitized separately.

**Note:** With PIXIS cameras you have a choice of amplifier (low noise or high capacity). Depending on the selected amplifier, the shift register may be read out to the right or to the left. For simplicity this drawing shows the readout to the left.

Readout of the CCD begins with the simultaneous shifting of all pixels one row toward the "shift register," in this case the row on the top. The shift register is a single line of pixels along the edge of the CCD, not sensitive to light and used for readout only. Typically the shift register pixels hold twice as much charge as the pixels in the imaging area of the CCD.

After the first row is moved into the shift register, the charge now in the shift register is shifted toward the output node, located at one end of the shift register. As each value is "emptied" into this node it is digitized. Only after all pixels in the first row are digitized is the second row moved into the shift register. The order of shifting in our example is therefore A1, B1, C1, D1, A2, B2, C2, D2, A3....

After charge is shifted out of each pixel the remaining charge is zero, meaning that the array is immediately ready for the next exposure.

Below are the equations that determine the rate at which the CCD is read out.

The time needed to take a full frame at full resolution is:

$$t_R + t_{\text{exp}} + t_c \quad (1)$$

where

$t_R$  is the CCD readout time,

$t_{\text{exp}}$  is the exposure time, and

$t_c$  is the shutter compensation time.

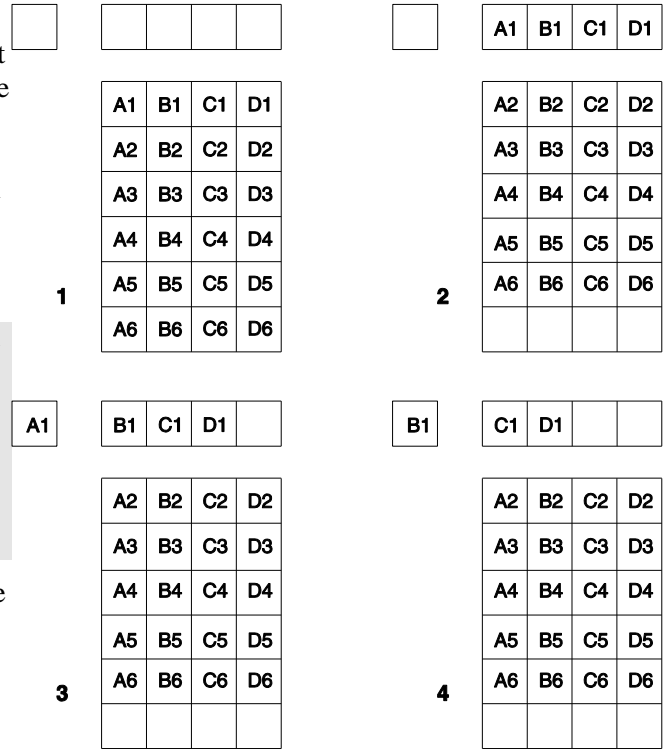


Figure 17. Full Frame at Full Resolution

The readout time is approximately given by:

$$t^R = [N_x \cdot N_y (t_{sr} + t_v)] + (N_x \cdot t_i) \quad (2)$$

where

$N_x$  is the smaller dimension of the CCD

$N_y$  is the larger dimension of the CCD

$t_{sr}$  is the time needed to shift one pixel out of the shift register

$t_v$  is the time needed to digitize a pixel

$t_i$  is the time needed to shift one line into the shift register

A subsection of the CCD can be read out at full resolution, sometimes dramatically increasing the readout rate while retaining the highest resolution in the region of interest (ROI). To approximate the readout rate of an ROI, in Equation 2 substitute the x and y dimensions of the ROI in place of the dimensions of the full CCD. Some overhead time, however, is required to read out and discard the unwanted pixels.

### **Binning**

Binning is the process of adding the data from adjacent pixels together to form a single pixel (sometimes called a super pixel), and it can be accomplished in either hardware or software. Rectangular groups of pixels of any size may be binned together, subject to some hardware and software limitations.

#### **Hardware Binning**

Hardware binning is performed on the CCD array *before* the signal is read out of the output amplifier. For signal levels that are readout noise limited this method improves S/N ratio linearly with the number of pixels grouped together. For signals large enough to render the camera photon shot noise limited, the S/N ratio improvement is roughly proportional to the square-root of the number of pixels binned.

Binning also reduces readout time and the burden on computer memory, but at the expense of resolution. Since shift register pixels typically hold only twice as much charge as image

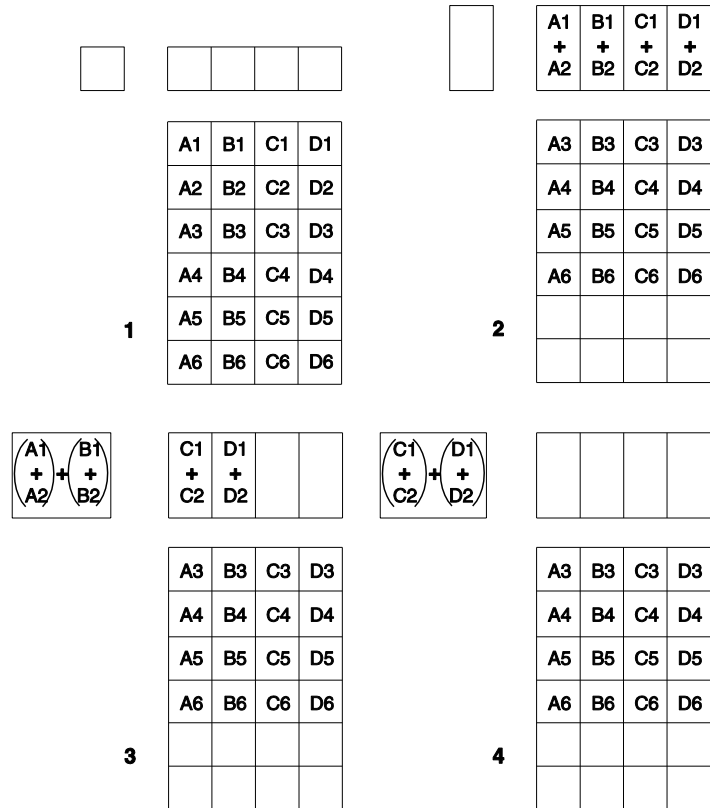


Figure 18.  $2 \times 2$  Binning

pixels, the binning of large sections may result in saturation and “blooming”, or spilling of charge back into the image area.

Figure 18 shows an example of  $2 \times 2$  binning. Each pixel of the image displayed by the software represents 4 pixels of the CCD array. Rectangular bins of any size are possible. Binning also reduces readout time and the burden on computer memory, but at the expense of resolution. Since shift register pixels typically hold only twice as much charge as image pixels, the binning of large sections may result in saturation and “blooming”, or spilling of charge back into the image area.

The readout rate for  $n \times n$  binning is approximated using a more general version of the full resolution equation. The modified equation is:

$$t_R = \left[ N_x \cdot N_y \cdot \left( \frac{t_{sr}}{n} + \frac{t_v}{n^2} \right) \right] + (N_x \cdot t_i) \quad (3)$$

### **Software Binning**

One limitation of hardware binning is that the shift register pixels and the output node are typically only 2-3 times the size of imaging pixels. Consequently, if the total charge binned together exceeds the capacity of the shift register or output node, the data will be corrupted.

This restriction strongly limits the number of pixels that may be binned in cases where there is a small signal superimposed on a large background, such as signals with a large fluorescence. Ideally, one would like to bin many pixels to increase the S/N ratio of the weak peaks but this cannot be done because the fluorescence would quickly saturate the CCD.

The solution is to perform the binning in software. Limited hardware binning may be used when reading out the CCD. Additional binning is accomplished in software, producing a result that represents many more photons than was possible using hardware binning.

Software averaging 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, camera 1/f noise may reduce the actual S/N ratio to slightly below this theoretical value. Also, if the light source used is photon-flicker limited rather than photon shot-noise limited, this theoretical signal improvement cannot be fully realized. Again, background subtraction from the raw data is necessary.

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

### **Array Orientation**

For square format CCDs (for example,  $512 \times 512$ B or  $1024 \times 1024$ F/B) you may orient the CCD to achieve binning along either direction of the CCD.

- Binning along columns provides maximum scan rate.
- Binning along the rows minimizes crosstalk and is therefore better for multi-spectral applications.

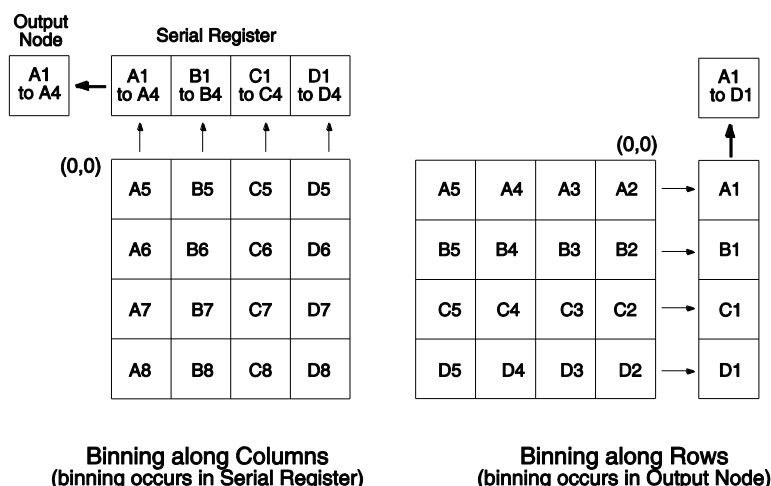


Figure 19. Binning and Array Orientation

**Note:** You can easily switch between these orientations by rotating the camera 90° and changing the binning parameters in the application software.

### Output Amplifier Selection

The output amplifier amplifies the collected charge from the output node and outputs it as electrons/count. Although Figure 16 shows an array with dual output nodes and amplifiers (one set at each end of the shift register), some PIXIS systems are available with a single output node and amplifier. If your system has dual output amplifiers, you can choose the output amplifier to be used (High Capacity or Low Noise) via WinView/32 or WinSpec/32 on the **Acquisition|Experiment Setup...|ADC** tab page:

- **High Capacity amplifier:** Provides a spectrometric well capacity that is approximately 3 times the well capacity for the Low Noise amplifier selection. High Capacity is suitable when you have intense light signals or signals with high dynamic range.
- **Low Noise amplifier:** Provides the highest sensitivity performance and is suitable when you have weak signals.

**Note:** The choice of output amplifier and controller gain setting should be considered together for the best signal capture. Examples of the interaction of output amplifier and controller gain selections are shown in Table 2, page 48.

### Controller Gain

Controller gain (a function of the preamplifier) is software-selectable and is used to change the relationship between the number of electrons acquired on the CCD and the Analog-to-Digital Units (ADUs or counts) generated. In WinView and WinSpec, gain selection is made on the **Acquisition|Experiment Setup...**|ADC tab card (Figure 20). The choices are **1 (Low)**, **2 (Medium)**, and **3 (High)**. Users who measure high-level signals may wish to select **Low** to allow digitization of larger signals. **Medium** is suitable for experiments within the mid-level intensity range. 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.

The "Certificate of Performance" supplied with the camera lists the measured gain values at all settings.

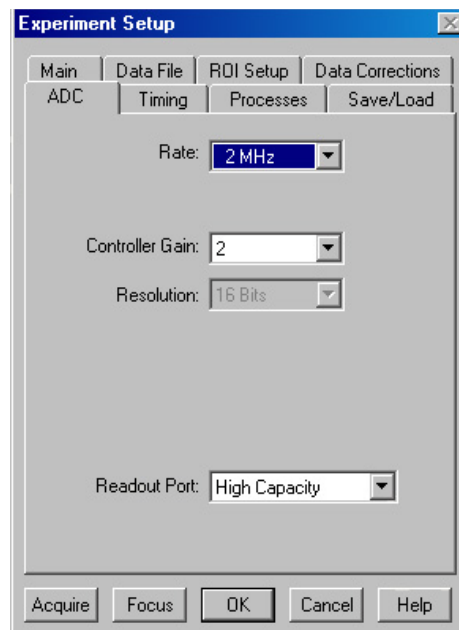


Figure 20. Experiment Setup/ADC tab page

**Example:** The following descriptions assume the **Low Noise** Readout Port has been selected and that the actual incoming light level is identical in all three instances. *The numbers used illustrate the effect of changing a controller gain setting and may not reflect actual performance: gain at the 1, 2, and 3 settings depends on the CCD installed.*

Readout Port	Controller Gain Selection		
	1 (Low)	2 (Medium)	3 (High)
Low Noise	4 e <sup>-</sup> /count	2 e <sup>-</sup> /count	1 e <sup>-</sup> /count
High Capacity	16 e <sup>-</sup> /count	8 e <sup>-</sup> /count	4 e <sup>-</sup> /count

Table 2. Example of Controller Gain vs. Readout Port

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

**2 (Medium)** requires two electrons to generate one ADU. If the gain is set to **Medium** and the images or spectra do not appear to take up the full dynamic range of the CCD array, you may want to change the gain setting to **High**. If the CCD array appears to be flooded with light, you may want to change the setting to **Low**.

**3 (High)** requires one electron 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 CCD array appears to be flooded with light, you may want to change the setting to **Medium** or **Low**.



## Digitization (Rate)

### ***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 camera through the software (see "***Readout***", page 43).

Factors associated with digitization include the digitization rate and baseline offset. The speed at which digitization occurs is software-selectable but baseline offset is factory-set. These factors are discussed in the following paragraphs.

### ***Digitization Rate***

PIXIS cameras incorporate dual digitization (100 kHz/2 MHz), which means that you have a choice of how quickly the data will be digitized. Dual digitization provides optimum signal-to-noise ratios at both readout speeds. Because the readout noise of CCD arrays increases with the readout rate, it is sometimes necessary to trade off readout speed for high dynamic range. The 2 MHz conversion speed is used for the fastest possible data collection and the 100 kHz 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 ADC rate can be changed on the **Experiment Setup|ADC** tab page.

### ***ADC Offset (Bias)***

With the camera completely blocked, the CCD will collect a dark charge pattern, dependent on the exposure time and camera temperature. The longer the exposure time and the warmer the camera, the larger this background will appear. To minimize the amount of this signal that gets digitized, the baseline has been offset by adding a voltage to the signal to bring the A/D output to a non-zero value, typically 500-600 counts. This offset value ensures that all the true variation in the signal can really be seen and not lost below the A/D "0" value. Since the offset is added to the signal, these counts only minimally reduce the range of the signal from 65535 (16-bit A/D) to a value in the range of 500-600 counts lower.

**Note:** It is important to note that the bias level is not noise. It is a fully subtractable readout pattern. Every device has been thoroughly tested to ensure its compliance with Princeton Instruments' demanding specifications.

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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 page in WinView and WinSpec). With the exception of Edge Trigger, the topics are addressed in order of their appearance on the Timing tab page (see Figure 21).

*"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 and Safe Modes"*, the second topic, discusses the Fast and the Safe speed modes. Fast is used for real-time data acquisition and Safe is used when coordinating acquisition with external devices or when the computer speed is not fast enough to keep pace with the acquisition rate.

*"Logic Out Control"* discusses the **LOGIC OUT** output connector on the rear of the PIXIS. The levels at this connector can be used to monitor camera operation or synchronize external equipment.

*"Kinetics Mode (Option)"*, the final topic, describes how to set up and acquire data with the Kinetics option, which allows frame transfer CCDs to take time-resolved images/spectra.

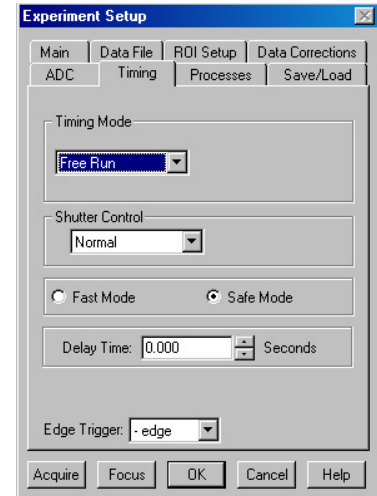


Figure 21. Timing tab page

### Timing Modes

#### Overview

The basic PIXIS timing modes are Free Run, External Sync, and External Sync with Continuous Cleans. These timing modes are combined with the Shutter options to provide the widest variety of timing modes for precision experiment synchronization.

Mode	Shutter Condition
Free Run	Normal
External Sync	Normal
External Sync	PreOpen
External Sync with Continuous Cleans	Normal
External Sync with Continuous Cleans	PreOpen

Table 3. Camera Timing Modes

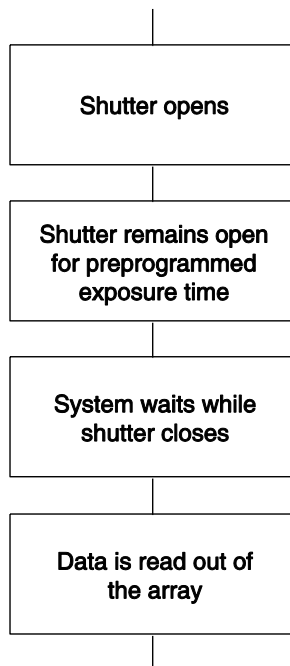
The shutter options available include Normal, PreOpen, Disable Opened or Disable Closed. Disable simply means that the shutter will not operate during the experiment. Disable closed is useful for making dark charge measurements. PreOpen, available in the External Sync and External Sync with Continuous Cleans modes, opens the shutter as soon as the PIXIS 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 ( $t_{\text{exp}}$ ), shutter compensation time ( $t_c$ ), and readout time ( $t_R$ ). These parameters are discussed in more detail in Chapter 5.

### **Free Run**

In the Free Run mode the camera 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,  $t_{\text{exp}}$ . 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 utilize 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.



*Figure 22. Free Run Timing Chart,  
Part of the Chart in Figure 29*

Other experimental equipment can be synchronized to the PIXIS by using the output signal (software-selectable SHUTTER or NOT SCAN) from the **LOGIC OUT** connector. Shutter operation and the NOT SCAN output signal are shown in Figure 23.

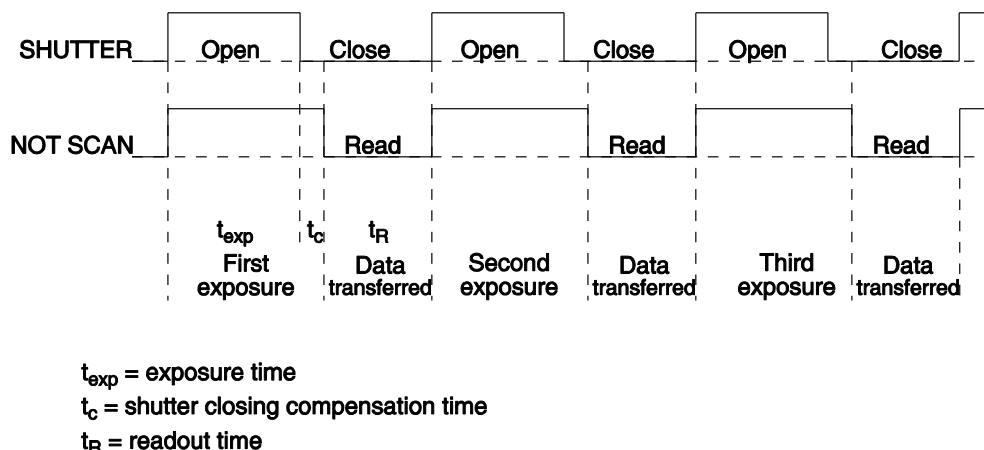


Figure 23. Free Run Timing Diagram

### External Sync

In this mode all exposures are synchronized to an external source. As shown in the flow chart, Figure 24, this mode can be used in combination with Normal or PreOpen Shutter operation. In Normal Shutter mode, the camera 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 CCD array is read out. The shutter requires up to 8 ms or more 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** connector on the back of the camera. The type of edge must be identified in the application software to ensure that the shutter opening is initiated by the correct edge (in WinView/WinSpec, this is done on the **Experiment Setup|Timing** tab page). Since the shutter requires at least 8 ms 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 camera is ready to collect data, the shutter opens. Upon arrival of the first External Sync pulse at the PIXIS, the shutter remains open for the specified exposure period, closes, and the CCD is read out. As soon as readout is complete, the shutter reopens and waits for the next frame.

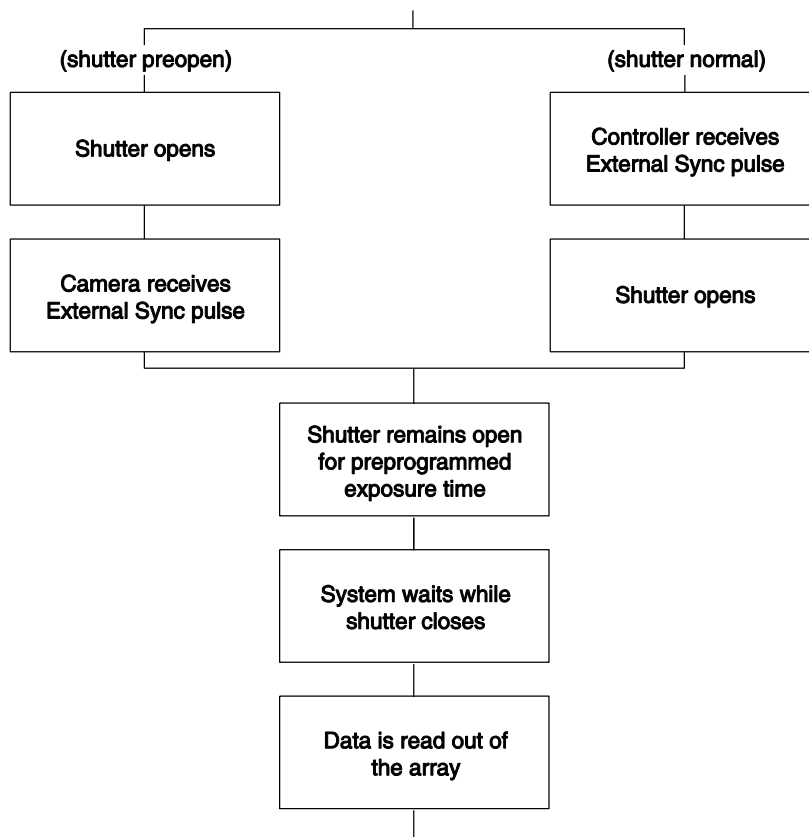


Figure 24. Chart Showing Shutter "Preopen" and "Normal" Modes in External Sync Operation

The PreOpen mode is useful in cases where an External Sync pulse cannot be provided 8 ms or ~ 20 ms (the length of time the 25 mm or 45 mm mechanical shutter takes to open) before the actual signal occurs. Its main drawback is that the CCD 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 CCD. 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 charge accumulates during the "wait" time ( $t_w$ ). Any variation in the external sync frequency also affects the amount of dark charge, even if light is not falling on the CCD during this time.

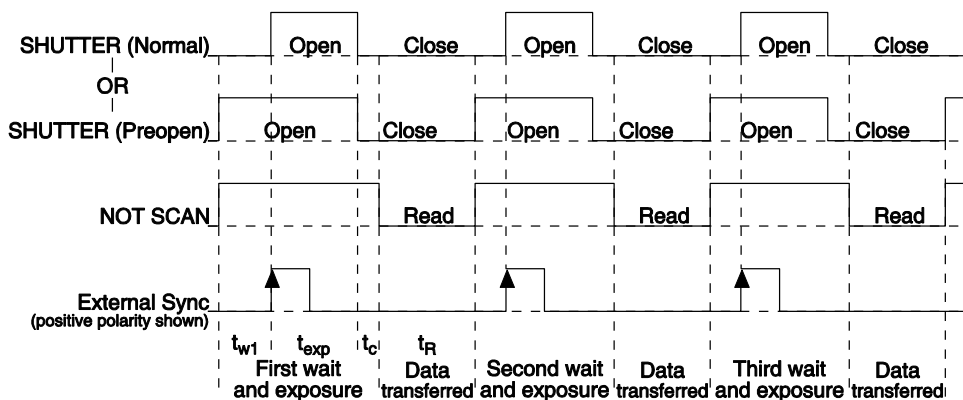
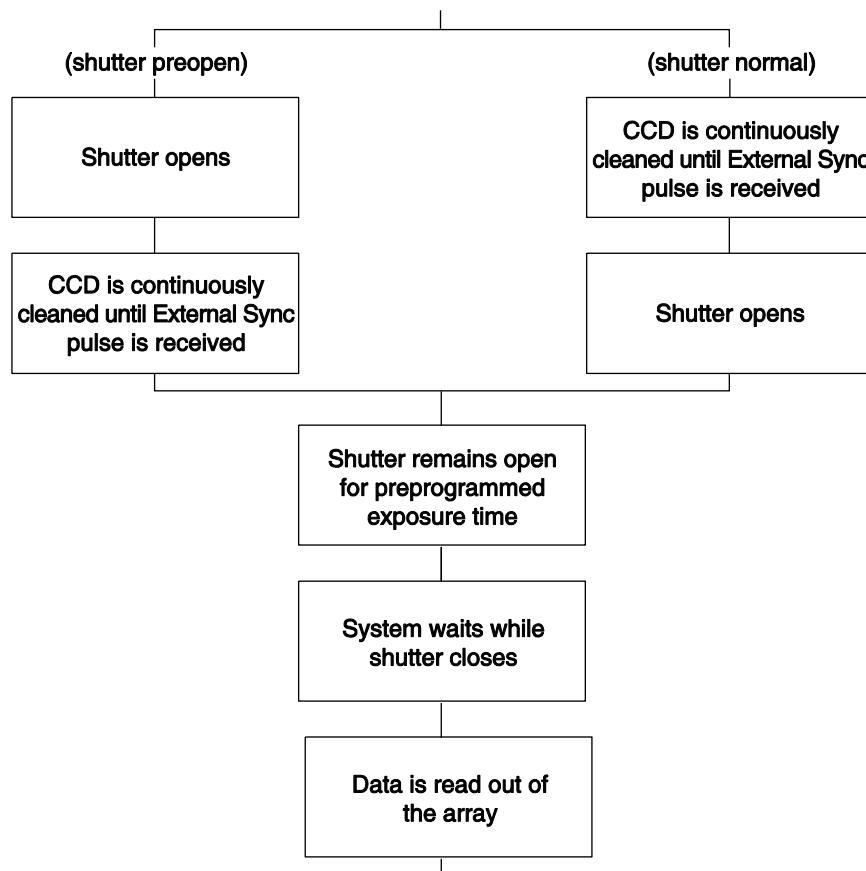


Figure 25. Timing Diagram for External Sync Mode (+ edge trigger)

### ***External Sync with Continuous Cleans Timing***

Another timing mode available with the PIXIS is called Continuous Cleans. In addition to the standard "cleaning" of the array, which occurs after the camera is enabled, Continuous Cleans will remove any charge from the array until the moment the External Sync pulse is received.



*Figure 26. Continuous Cleans Flowchart*

Once the External Sync pulse is received, cleaning of the array stops as soon as the current row is shifted, and frame collection begins. With Normal Shutter operation the shutter is opened for the set exposure time. With PreOpen Shutter operation the shutter is open during the continuous cleaning, and once the External Sync pulse is received the shutter remains open for the set exposure time, then closes. If the vertical rows are shifted midway when the External Sync pulse arrives, the pulse is saved until the row shifting is completed, to prevent the CCD from getting "out of step." As expected, the response latency is on the order of one vertical shift time, from 1-30  $\mu\text{sec}$  depending on the array. This latency does not prevent the incoming signal from being detected, since photo generated electrons are still collected over the entire active area. However, if the signal arrival is coincident with the vertical shifting, image smearing of up to one pixel is possible. The amount of smearing is a function of the signal duration compared to the single vertical shift time.

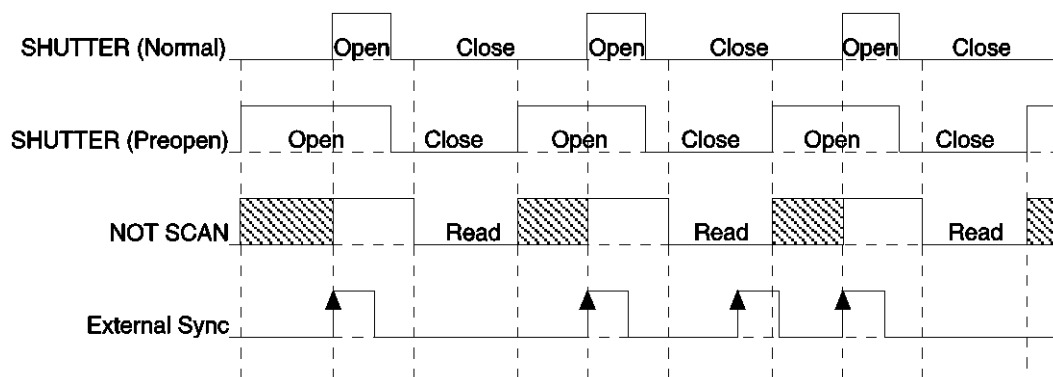


Figure 27. Continuous Cleans Timing Diagram

### EXT SYNC Trigger Input

The selected Timing Mode determines how the camera will respond to an External Sync pulse that is input at the **EXT SYNC** connector on the rear of the camera. Things to keep in mind when setting up the External Sync pulse input are:

**Pulse Height:** 0 to +3.3V logic levels (TTL-compatible).

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

**EXT SYNC Connector Impedance:** 50  $\Omega$

**Trigger Edge:** + (rising) or - (falling) edge must be indicated on the **Experiment Setup|Timing** tab page.

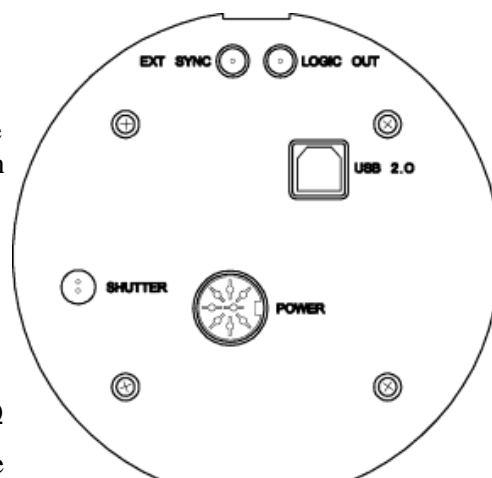


Figure 28. Rear of PIXIS Camera

## Fast and Safe Modes

### Introduction

The PIXIS® has been designed to allow the greatest possible flexibility when synchronizing data collection with an experiment. The **"Fast and Safe Modes"** topic describes the primary data collection modes (chart below) supported by WinView/32.

The fundamental difference between these two modes is how often the start acquisition and stop acquisition commands are sent by the computer for a data collection run. With Safe Mode, the computer sends a start acquisition and a stop acquisition command for **each frame** of a data collection run. With Fast Mode, the computer sends only one start acquisition and one stop acquisition command for **each data collection run**.

Once the start acquisition command is sent, the selected timing mode and the shutter condition determine when charge will be allowed to fall on the CCD array. The chart below lists the timing mode and shutter condition combinations that can be used to synchronize data collection with external events. Use this chart in combination with the detailed descriptions in the **"Timing Modes"** topic to determine the optimal configuration for your application.



The WinView/32 Experiment Setup **Timing** tab page allows you to choose either the **Fast** or the **Safe** data collection mode. Figure 29 is a flow chart comparing the two modes. In Fast operation, the PIXIS runs according to the timing of the experiment, with no interruptions from the computer. In Safe Mode operation, the computer processes each frame as it is received. The PIXIS cannot collect the next frame until the previous frame has been completely processed.

Fast operation is primarily for collecting "real-time" sequences of experimental data, where timing is critical and events cannot be missed. Once the PIXIS is sent the start acquisition command by the computer, all frames are collected without further intervention from the computer. The advantage of this timing mode is that timing is controlled completely through hardware. A drawback to this mode is that the computer 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.

Safe Mode operation is useful when the camera is operated from a slower computer that cannot process the incoming data fast enough. It is also useful when data collection must be coordinated with external devices such as external shutters and filter wheels. As seen in Figure 29, in Safe Mode operation, the computer controls when each frame is taken. After each frame is received, the camera sends the Stop Acquisition command to the camera, instructing it to stop acquisition. Once that frame is completely processed and displayed, another Start Acquisition command is sent from the computer to the camera, allowing it to take the next frame. Display is therefore, at most, only one frame behind the actual data collection.

One disadvantage of the Safe mode is that events may be missed during the experiment, since the PIXIS is disabled for a short time after each frame.

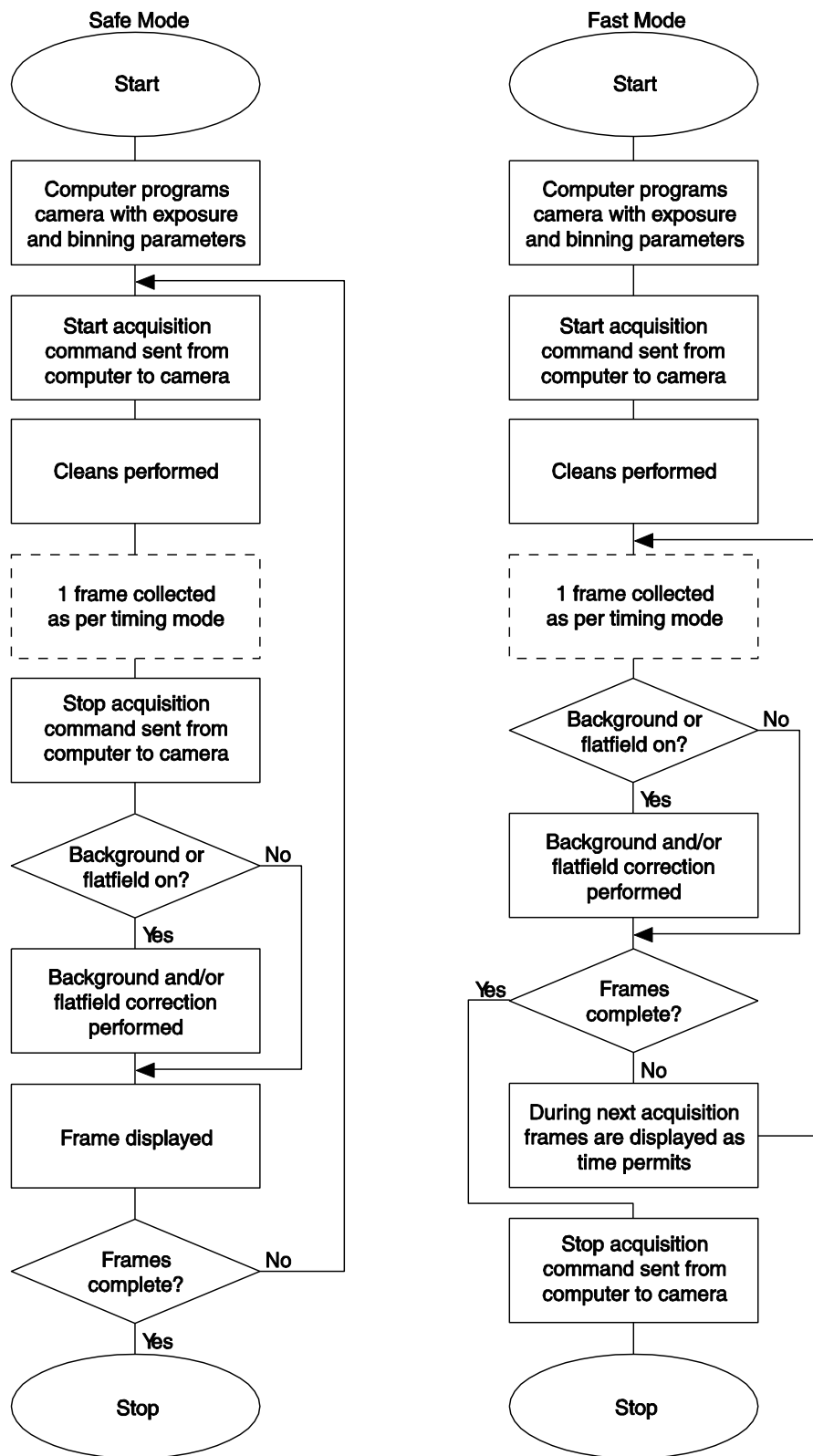


Figure 29. Chart of Safe and Fast Mode Operation

## LOGIC OUT Control

The TTL-compatible logic level output (0 to +3.3 V) from the **LOGIC OUT** connector on the rear panel can be used to monitor camera status and control external devices. The timing of the level changes depends on the output type selected on the **Hardware Setup|Controller/Camera** tab page: *NOT SCAN*, *SHUTTER*, *NOT READY*, *LOGIC 0*, or *LOGIC 1*.

- **NOT SCAN:** It is at a logic low when CCD is being read; otherwise high.
- **SHUTTER:** Logic high when the shutter is open. The output precisely brackets shutter-open time (exclusive of shutter compensation,  $t_c$ ) and can be used to control an external shutter or to inhibit a pulser or timing generator.
- **NOT READY:** After a start acquisition command, this output changes state on completion of the array cleaning cycles that precede the first exposure. Initially high, it goes low to mark the beginning of the first exposure. In free run operation it remains low until the system is halted. If a specific number of frames have been programmed, it remains low until all have been taken and then returns high. Figure 31 assumes 3 frames have been programmed.
- **LOGIC 0:** The level at the connector is low.
- **LOGIC 1:** The level at the connector is high.

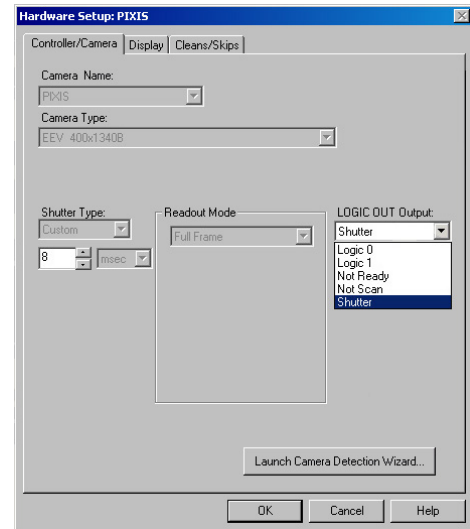


Figure 30. Hardware Setup|Controller/Camera tab page

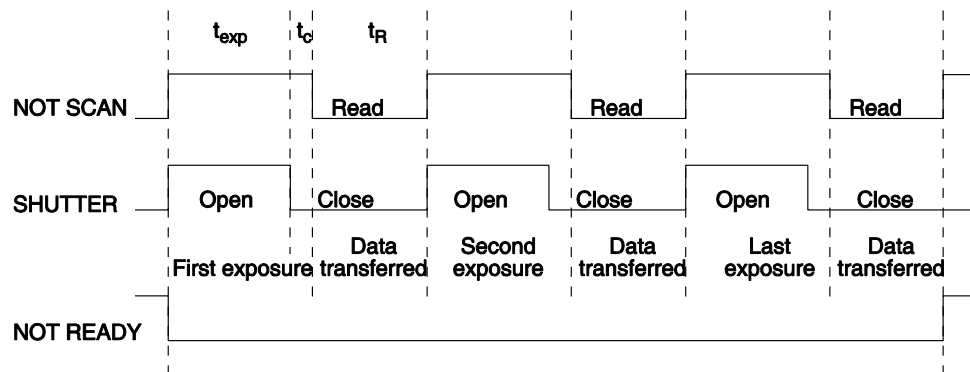


Figure 31. Comparison of *NOT SCAN*, *SHUTTER*, and *NOT READY* Logic Output Levels

## Kinetics Mode (Option)

*Kinetics operation requires that the Kinetics option has been installed in the PIXIS camera.*

### Introduction

Kinetics mode uses the CCD to expose and store a limited number of images in rapid succession. The time it takes to shift each line (or row) on the CCD is as short as a few hundred nanoseconds to few microseconds, depending on the CCD. Therefore the time between images can be as short as a few microseconds. Kinetics mode allows frame transfer CCDs to take time-resolved images/spectra.

**Note:** Kinetics mode is an option, so the controller must be programmed before your order is shipped. If the Kinetics option has been installed in the PIXIS, this readout mode will be made available when you select the appropriate camera type on the **Hardware Setup** dialog box.

Below is a simplified illustration of kinetics mode. Returning to our  $4 \times 6$  CCD example, in this case  $2/3$  of the array is masked, either mechanically or optically. The shutter opens to expose a  $4 \times 2$  region. While the shutter remains open, charge is quickly shifted just under the mask, and the exposure is repeated. After a third image is collected the shutter is closed and the CCD is read out. Since the CCD can be read out slowly, very high dynamic range is achieved. Shifting and readout are shown in Figure 32.

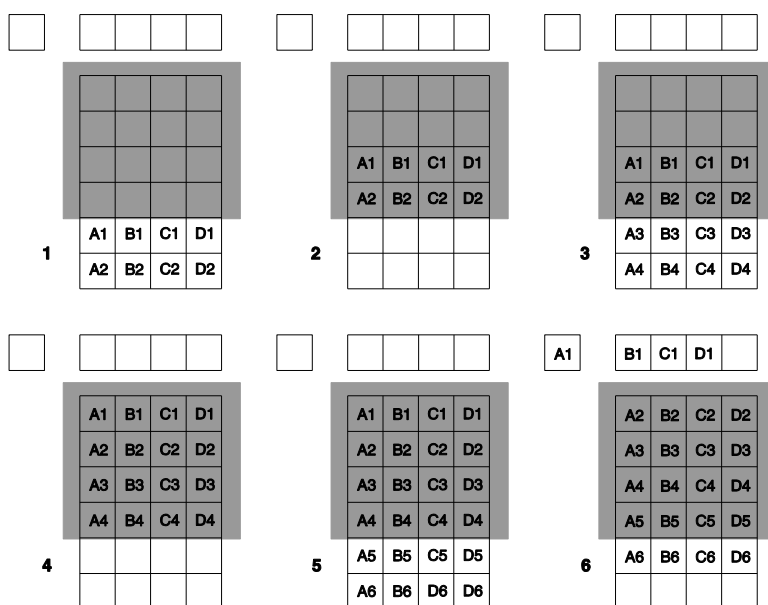


Figure 32. Kinetics Readout

### ***Kinetic Timing Modes***

Kinetics mode operates with three timing modes: Free Run, Single Trigger, and Multiple Trigger.

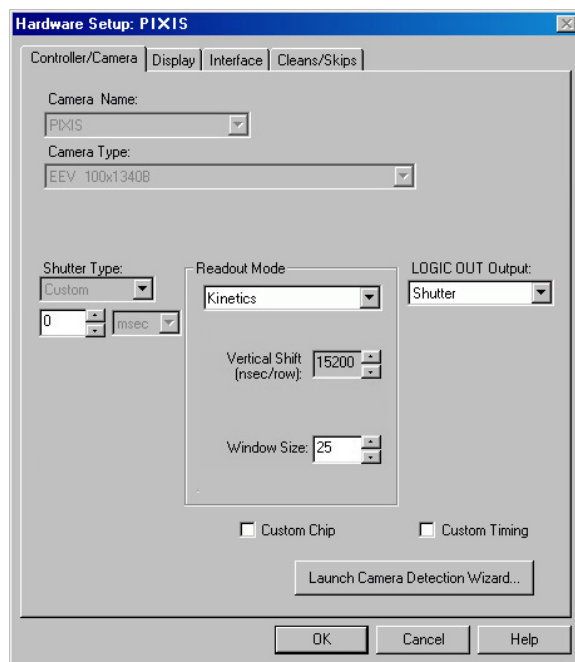


Figure 33. Hardware Setup dialog box

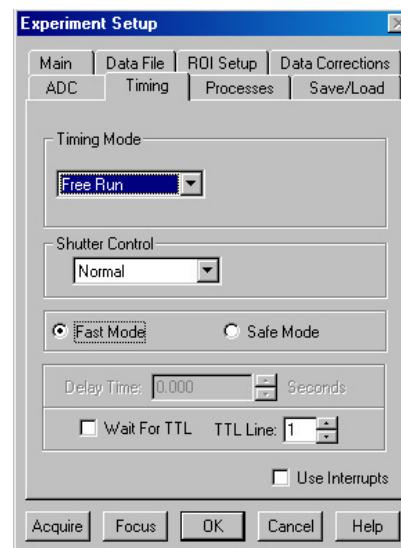


Figure 34. Experiment Setup dialog box

### **Free Run**

In the Free Run Kinetics mode, the PIXIS takes a series of images, each with the Exposure time set through the software (in WinView32 or WinSpec/32, the exposure time is set on the **Experiment Setup|Main** tab page). The time between image frames, which may be as short as a few microseconds, is limited by the time required to shift an image under the mask: this interimage time equals the Vertical Shift rate (specified in ns/row) multiplied by the Window Size (the number of rows allocated for an image frame). The exact number of frames depends on the selected Window Size and is equal to the number of pixels perpendicular to the shift register divided by the Window Size.

**Example:** Referring to the readout shown in Figure 32, there are 6 pixels perpendicular to the shift register and the Window Size is 2 pixels high. The number of frames is 3. If the Vertical Shift rate for the CCD is 1600 ns/row, the Shift time will be 3200 ns per frame.

Integrate signals (SHUTTER) or Readout signals (NOT SCAN) are provided at the **LOGIC OUT** connector for timing measurements

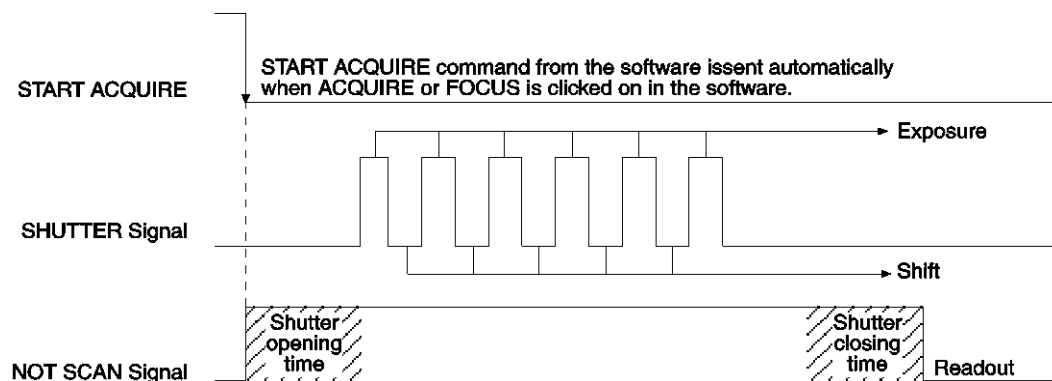


Figure 35. Free Run Timing Diagram

### Single Trigger

Single Trigger Kinetics mode takes an entire series of images with each External Trigger Pulse (applied at the **Ext. Sync** connector on the rear of the PIXIS). After the series is complete the shutter closes and the CCD is read out at normal speeds. Once the readout is complete the camera is ready for the next series of exposures. This timing is shown in Figure 36, where a single External trigger pulse is used to collect a burst of 6 frames.

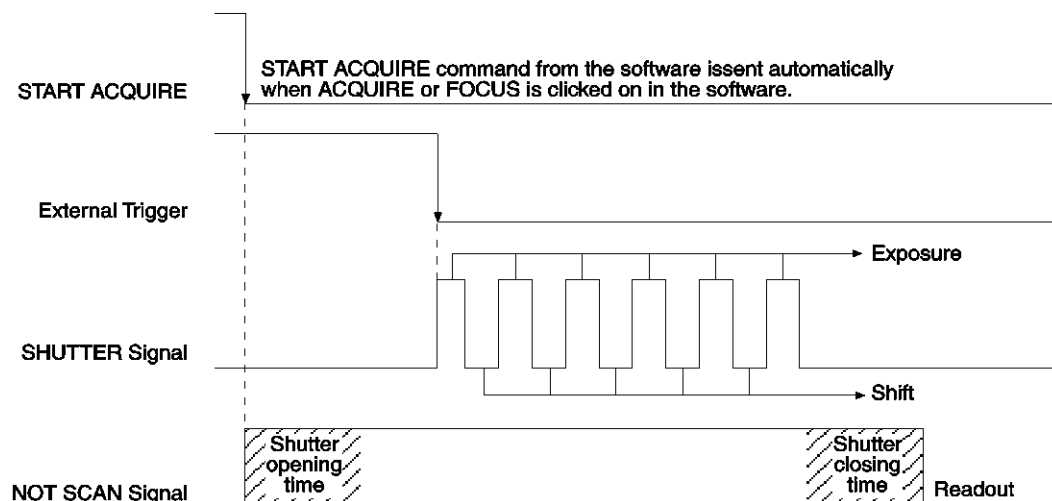


Figure 36. Single Trigger Timing Diagram

### Multiple Trigger

Multiple Trigger Kinetics mode takes a single image in the series for each External Sync pulse received by the PIXIS. Once the series is complete the shutter closes and readout begins. Since the shutter is open during the entire series of images, if the External Sync pulses are irregularly spaced then the exposures will be of different lengths. Once the series has been read out the camera is ready for the next series. This timing is shown in Figure 37, where a series of 6 frames is collected with 6 External Sync pulses.

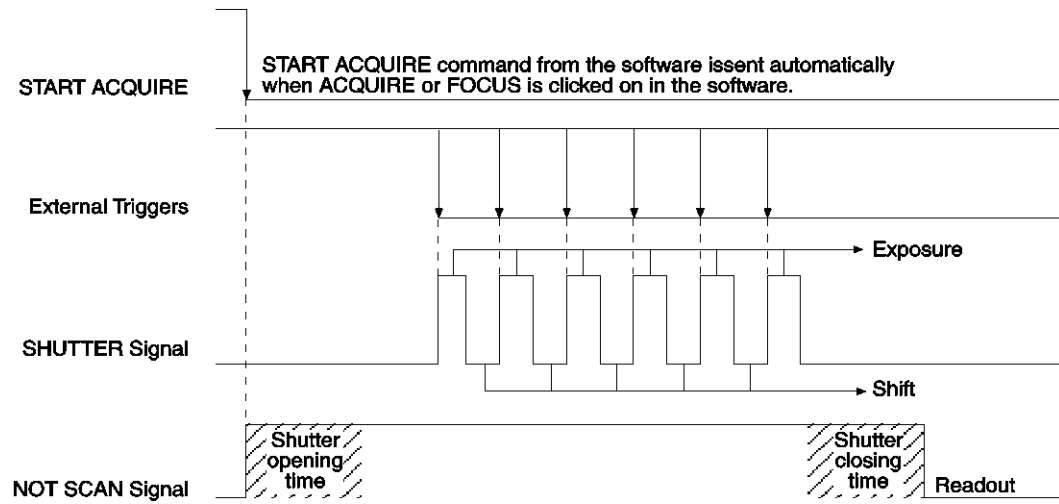


Figure 37. Multiple Trigger Timing Diagram

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# Chapter 7

## Troubleshooting

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

### Introduction

The following issues have corresponding troubleshooting sections in this chapter.

Baseline Signal Suddenly Changes	Page 66
Camera Stops Working	Page 66
Camera1 (or similar name) in Camera Name field	Page 66
Controller Is Not Responding	Page 67
CoolCUBE: Low Coolant (Air in the Hoses)	Page 68
CoolCUBE <sub>II</sub> : Low Coolant (Air in the Hoses)	Page 68
Cooling Troubleshooting	Page 68
Data Loss or Serial Violation	Page 70
Data Overrun Due to Hardware Conflict message	Page 70
Data Overrun Has Occurred Message	Page 70
Demo is only Choice on Hardware Wizard: Interface dialog (Versions 2.5.19.0 and earlier)	Page 71
Demo, High Speed PCI, and PCI(Timer) are Choices on Hardware Wizard: Interface dialog (Versions 2.5.19.0 and earlier)	Page 72
Detector Temperature, Acquire, and Focus are Grayed Out (Versions 2.5.19.0 and earlier)	Page 73
Error Creating Controller message	Page 74
Overexposed or Smeared Images	Page 75
Program Error message	Page 75
Serial violations have occurred. Check interface cable.	Page 76
Shutter Failure	Page 76

## Baseline Signal Suddenly Changes

A change in the baseline signal is normal if the temperature, gain, or speed setting has been changed. If this occurs when none of these settings have been changed, there may be excessive humidity in the camera vacuum enclosure. Turn off the camera and contact Princeton Instruments Customer Support. See page 116 for contact information.

## Camera Stops Working

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

- Turn off all AC power.
- Verify that all cables are securely fastened.
- Turn the system on.
- If you hear 2 clicks separated by 1 second (shutter opening then closing), the shutter is working. Call Princeton Instruments Customer Support for further instructions.

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

## Camera1 (or similar name) in Camera Name field



Figure 38. Camera1 in Camera Name Field

When a PVCAM-based camera is detected/selected during the Camera Detection wizard (formerly the Hardware Setup wizard), a default name such as Camera1 will be shown in the Detected Hardware table and will be entered in the **Camera Name** field on the **Setup|Hardware|Controller/CCD** tab page and in the Hardware Setup title bar. Because this name is not particularly descriptive, you may want to change it. 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 a 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:\WINNT, 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, PIXIS-spec- to indicate that this is a PVCAM-based system using a PIXIS camera for spectroscopy). Then save the edited file.

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

3. The new camera name will now appear in the **Camera Name** field and in the title bar for the Hardware Setup dialog box.

## Controller Is Not Responding

If this message pops up when you click on **OK** after selecting the "Interface Type" during **Hardware Setup** (under the WinView/32 or WinSpec/32 **Setup** menu), the system has not been able to communicate with the camera. Check to see if camera has been turned ON and if the USB 2.0 interface card, its driver, and the USB cable have been installed.

- Verify that the **Use PVCAM** checkbox is checked ☒ **Use PVCAM**. This checkbox is located on the **Controller/Camera** tab page, accessed by selecting **Hardware...** from the **Setup** menu. Data transfer is disabled when this box is left unchecked ☐ **Use PVCAM**.
- If the camera is ON, the problem may be with the USB 2 card, its driver, or the cable connections.
- If the interface card is not installed, close the application program (WinView/32 or WinSpec/32) and turn the camera OFF. Follow the interface card installation instructions in provided with your interface card, and cable the card to the USB 2 port on the rear of the camera. Then do a "Custom" installation of WinView/32 or WinSpec/32 with the appropriate interface component selected. Be sure to deselect the interface component that does not apply to your system.
- If the interface card is installed in the computer and is cabled to the USB 2 port on the rear of the camera, close the application program and turn the camera OFF. Check the cable connections.
- If the interface card was installed after the application program was installed, close the application program and do a "Custom" installation of WinView/32 or WinSpec/32 with the appropriate interface component selected. Be sure to deselect the interface component that does not apply to your system.

## CoolCUBE: Low Coolant (Air in the Hoses)

### WARNING!

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

1. With hoses connected, place the camera and CoolCUBE circulator at the same level.
2. Turn on the circulator.
3. Using the supplied hex tool, open the fill port.
4. Add a 50:50 mix of ethylene glycol and water (only a few cc's are needed).
5. Using the supplied hex tool, close the fill port. **DO NOT OVERTIGHTEN.**

## CoolCUBE<sub>II</sub>: Low Coolant (Air in the Hoses)

### WARNING!

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

1. Unscrew the reservoir cap (on top of the CoolCUBE<sub>II</sub>) and make sure that the coolant reservoir contains coolant. If additional coolant is required, fill with a 50:50 mixture of water and ethylene glycol.
2. Screw the reservoir cap back in.
3. Make sure the power switch is turned off before plugging the circulator in.
4. Plug the circulator into a 100-240 VAC, 47-63 Hz power source.
5. Turn the circulator on. Make sure there are no leaks or air bubbles in the hoses.
  - If there are no problems, continue to Step 6.
  - If there are leaks or air bubbles, turn the circulator off and correct the problem(s) by securing the hoses or adding more coolant to the reservoir. Turn the circulator back on. Recheck and if there are no problems, continue to Step 6.
6. Turn the camera on.
7. Start the application software.

## Cooling Troubleshooting

### ***Temperature Lock Cannot be Achieved or Maintained.***

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

- Ambient temperature greater than +23°C. This condition affects TE-cooled cameras. If ambient is greater than +23°C, you will need to cool the camera environment or raise the set temperature.
- Airflow through the camera and/or circulator is obstructed. The camera needs to have approximately two (2) inches (50 mm) clearance around the vented covers. If there is an enclosure involved, the enclosure needs to have unrestricted flow to an open environment. The camera vents its heat out the vents near the nose. The air intake is near the rear of the camera.

- A hose is kinked. Unkink the hose.
- Coolant level is low. Add coolant. See “*CoolCUBE: Low Coolant (Air in Hoses)*” on page 68 or the “*CoolCUBEII: Low Coolant (Air in Hoses)*” on page 68.
- There may be air in the hoses. Add coolant. See “*CoolCUBE: Low Coolant (Air in Hoses)*” on page 68 or the “*CoolCUBEII: Low Coolant (Air in Hoses)*” on page 68.
- Circulator pump is not working. If you do not hear the pump running when the CoolCUBE is powered on, turn off the circulator and contact Customer Support.
- The circulator is higher than the camera. Reposition the circulator so that it is 6 inches (150 mm) or more below the camera. The vertical distance should not exceed 10 feet (3 m). Typically, the camera is at table height and the circulator is on the floor.
- The camera vacuum has deteriorated and needs to be refreshed. Contact Customer Support.
- The target array temperature is not appropriate for your particular camera and CCD array.
- The camera'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 than the specified limit. TE cameras are equipped with a thermal-protection switch that shuts the cooler circuits down if the internal temperature exceeds a preset limit. Typically, camera operation is restored automatically in about ten minutes. Although the thermo-protection switch will protect the camera, you are nevertheless advised to power down and correct the operating conditions that caused the thermal-overload to occur.

### ***Camera loses Temperature Lock***

The internal temperature of the camera is too high. This might occur if the operating environment is particularly warm or if you are trying 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, camera operation is restored in about ten minutes. Although the thermal overload switch will protect the camera, users are advised to power down and correct the operating conditions that caused the thermal overload to occur.

### ***Gradual Deterioration of Cooling Capability***

While unlikely with the PIXIS camera (guaranteed permanent vacuum for the life of the camera), if you see a gradual deterioration of the cooling capability, there may be a gradual deterioration of the camera's vacuum. This can affect temperature performance such that it may be impossible to achieve temperature lock at the lowest temperatures. In the kind of applications for which cooled CCD cameras are so well suited, it is highly desirable to maintain the system's lowest temperature performance because lower temperatures result in lower thermal noise and better the signal-to-noise ratio. Contact the factory to make arrangements for returning the camera to the support facility.

## 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 WinView/32 or WinSpec/32.

## Data Overrun Due to Hardware Conflict message

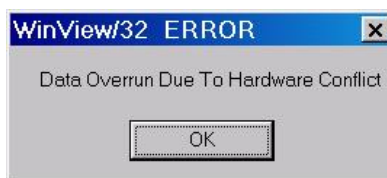


Figure 39. Data Overrun Due to Hardware Conflict dialog box

If this dialog box 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 page or the **Acquisition|Experiment Setup|Main** tab page Full Chip dimensions).
2. Open **Setup|Environment|Environment** dialog box.
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 (WinView or WinSpec).
4. Reboot your computer.
5. Restart the WinX application 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 WinView/32 or WinSpec/32.
2. Run data acquisition in Safe Mode.
3. Add memory.
4. Use binning.
5. Increase the exposure time.
6. Defragment the hard disk.
7. Update the Orange Micro USB2 driver. See *"To Update the OrangeUSB USB 2.0 Driver"*, page 109.

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. If this is not the case and data overruns continue to occur, contact Customer Support (see page 116 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, the Hardware Wizard will only present the choice "Demo" in the Interface dialog box (Figure 40). 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 box again.

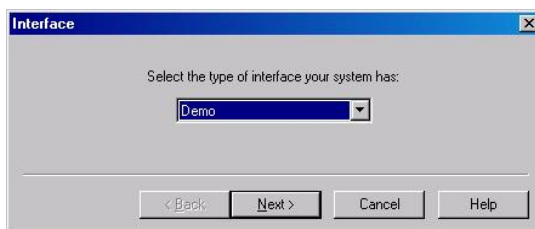


Figure 40. Hardware Wizard: Interface dialog box

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

1. If you have not already done so, close WinView/32 or WinSpec/32.
2. Make sure the PIXIS is connected to the host computer and that it is powered on.
3. Run RSConfig from the **Windows|Start|Programs|PI Acton** menu or from the directory where you installed WinView.
4. When the RSConfig dialog box (Figure 41) 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.

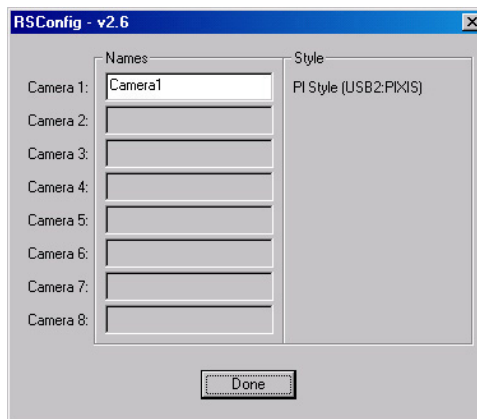


Figure 41. RSConfig dialog box

5. You should now be able to open WinView and, from **Setup|Hardware...**, run the Hardware Wizard.
6. When the PVCAM dialog box (Figure 42) 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 42. Hardware Wizard: PVCAM dialog box

## 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 card in the host computer and you want to operate a camera using the USB 2.0 interface, the PVCAM.INI file (created by RSConfig.exe) must exist and the USB 2.0 supported camera must be [Camera\_1]. PVCAM.INI, which contains information required to identify the interface/camera, is referenced by the Hardware Wizard when you are setting up WinView/32 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 box.



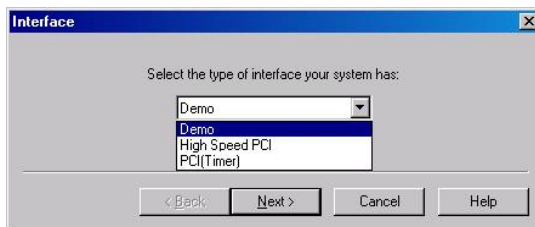


Figure 43. Hardware Wizard: Interface dialog box

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

1. If you have not already done so, close WinView/32 or WinSpec/32.
2. Make sure the PIXIS is connected to the host computer and that it is powered on.
3. Run RSConfig from the **Windows|Start|Programs|PI Acton** menu or from the directory where you installed WinView.
4. When the RSConfig dialog box (Figure 44) 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.

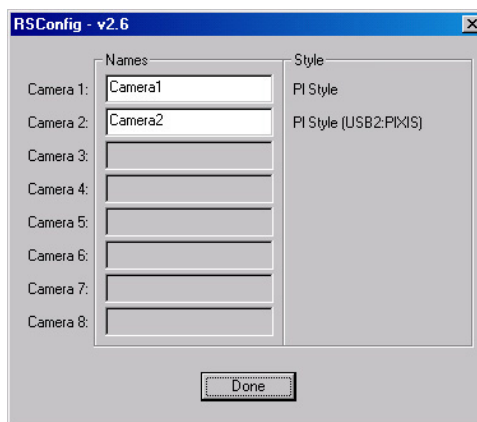


Figure 44. RSConfig dialog box: Two Camera Styles

5. Because the PIXIS camera is second in the list (PI Style (USB2:PIXIS)), you will now have to edit the PVCAM.INI file created by RSConfig.exe. Refer to *"Editing the PVCAM.INI File"*, page 111, for instructions.

## 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 being run under USB 2.0 and have opened WinView/32 or WinSpec/32 without having first turned on the PIXIS. They will also be deactivated if you have installed a camera 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 PIXIS is connected to the host computer and is powered on. If it is not connected or is connected but not powered on, go to Step 2. If it is connected and on, go to Step 3.

2. Close WinView, verify that the PIXIS is connected to the host computer, power the PIXIS on, and reopen WinView. The formerly grayed out functions should now be available.
3. If the PIXIS is connected and powered on, the USB 2.0 camera 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 is listed as Camera 2 (Princeton Style (USB2:PIXIS) in Figure 45), you will have to edit the PVCAM.INI file. Refer to *"Editing the PVCAM.INI File"*, page 111, for instructions.

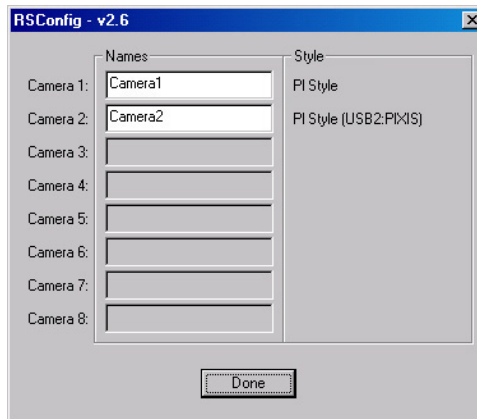


Figure 45. RSConfig dialog box: Two Camera Styles

## 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 PIXIS was not powered on before you started the WinX application (WinView/32 or WinSpec/32) and began running the Hardware Wizard.

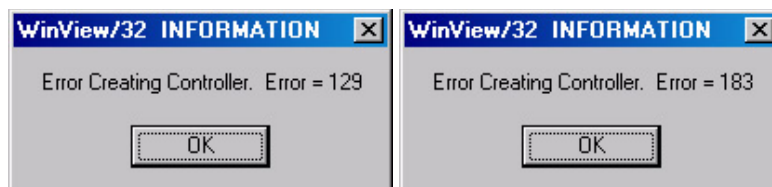


Figure 46. Error Creating Controller dialog box

**Error 129:** Indicates that the problem is with the PVCAM.INI file. Close the WinX application, run RSConfig, verify that the PIXIS is the first camera, make sure the PIXIS is powered on, reopen the WinX application, and begin running the Hardware Wizard.

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

## Overexposed or Smeared Images

If the camera has an internal shutter, check to see that the shutter is opening and closing correctly. Possible shutter problems include complete failure, in which the shutter no longer operates at all: the shutter may stick or open (causing overexposed or smeared images) or stick closed (resulting in no images). It may even happen that one leaf of the shutter will break and no longer actuate. High repetition rates and short exposure times will rapidly increase the number of shutter cycles and hasten the time when the shutter will have to be replaced.

Shutter replacement is usually done at the factory. If you find that the shutter on your camera is malfunctioning, contact the factory to arrange for a shutter-replacement repair. *Shutters are not covered by the warranty.*

## Program Error message



Figure 47. Program Error dialog box

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 WinView.
3. Note the array size (on the **Setup|Hardware|Controller/CCD** tab page or the **Acquisition|Experiment Setup|Main** tab page 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 box.
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 WinView.
6. Reboot your computer.
7. Restart WinView and begin acquiring data or focusing. If you see the message again, increase the DMA buffer size.

## Serial violations have occurred. Check interface cable.

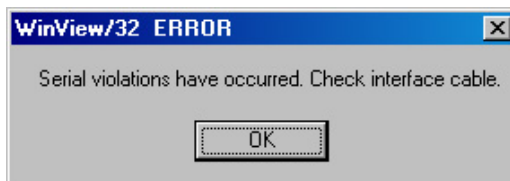


Figure 48. Serial Violations Have Occurred dialog box

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 computer interface cable is secured at both ends.
3. After making sure that the cable is 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.

## Shutter Failure

See "*Overexposed or Smeared Images*", page 75.

# Declaration of Conformity

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This section of the PIXIS system manual contains the declaration(s) of conformity for PIXIS systems.

# DECLARATION OF CONFORMITY

We,

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

Declare under our sole responsibility, that the product,

**PIXIS CAMERA,**

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: December 1, 2004

TRENTON, NJ



**(PAUL HEAVENER)  
Engineering Manager**

# Appendix A

## Basic Specifications

---

**Note:** This appendix provides some of the basic specifications of a PIXIS® system. If the information you are looking for is not here, it may be available in Appendix B, "*Outline Drawings*" or on the appropriate data sheet. Data sheets can be downloaded from the Princeton Instruments website ([www.princetoninstruments.com](http://www.princetoninstruments.com)).

### Window

SI-UV fused-silica quartz (.125"/3.17 mm thick)

### CCD Arrays

e2v (Marconi) CCD77-00: 512x512B/F, AIMO, 24 x 24 µm pixels

e2v CCD47-10: 1024x1024BUV/F, AIMO, 13 x 13 µm pixels

e2v CCD47-10: 1024x1024BR, NIMO, 13 x 13 µm pixels

e2v CCD42-40: 2048x2048B/BUV/F, AIMO, 13.5 x 13.5µm pixels

e2v CCD42-40: 2048x2048BR, NIMO, 13.5 x 13.5µm pixels

Princeton Instruments Proprietary: 512x512B eXcelon, AIMO, 24 x 24 µm pixels

Princeton Instruments Proprietary: 1340x1300B/F, AIMO, 20 x 20µm pixels

Princeton Instruments Proprietary: 1340x1300BR, NIMO, 20 x 20µm pixels

Princeton Instruments Proprietary: 1340x1300B eXcelon, AIMO, 20 x 20 µm pixels

Princeton Instruments Proprietary: 1024x1024B eXcelon, AIMO, 13 x 13 µm pixels

Princeton Instruments Proprietary: 2048x2048B, eXcelon AIMO, 13.5 x 13.5µm pixels

**Note:** The arrays listed are those that were available at the time that the manual was written. Contact Princeton Instruments or visit [www.princetoninstruments.com](http://www.princetoninstruments.com) for an updated list of arrays supported by the PIXIS.

### Mounts

C-mount: Standard threaded video mount.

F-mount: Standard Nikon® bayonet mount.

Spectroscopy mount: 3.60" (91.44 mm) or 3.88" (98.55 mm) bolt circle. Optional Spectroscopy-to-F mount adapter

## Focal Distance (Optical)

The distance to the focal plane from the front of the mechanical assembly depends on the specific configuration as follows. Note that neither set of reference points includes an adapter.

Application Type	Adapter Type	Reference Points	Distance
Imaging	C-Mount	Face of Camera to Focal Plane	0.690" /17.53 mm (optical)
	F-Mount	Face of Camera to Focal Plane	1.83"/46.48 mm (optical)
Spectroscopy	Spec-Mount (3.60" bolt circle, flange)	Mounting Flange to Focal Plane	0.600"/15.24 mm (optical)
	Spec-Mount (3.60"/3.88" bolt circle)	Mounting Flange to Focal Plane	0.886"/22.50 mm (optical)

Table 4. Focal Plane Distances

## Shutter

Typically, PIXIS cameras for imaging applications are shipped with an internal shutter.

- **PIXIS:512/1024:** Internal, windowless, 1 in (25 mm) aperture, 8 ms open time, 8 ms close time
- **PIXIS:2048:** Internal, windowless, 1.8 in (45 mm) aperture, ~ 20 ms open time, ~48 ms close time

Typically, PIXIS cameras for spectroscopy applications do not have an installed internal shutter. An optional Princeton Instruments-supplied 25 or 45 mm external shutter can be ordered if the camera has no internal shutter.

## Camera

**Cooling:** Thermoelectric (air)

**Gain:** Software-selectable (high, medium, low)

**Dimensions:** See Appendix B.

**Connectors:**

**EXT SYNC (MCX):** 0 to +3.3 V logic level input to allow data acquisition to be synchronized with external events. Trigger edge can be positive- or negative-going as set in software. Synchronization and Timing Modes are discussed in Chapter 6. MCX-to-BNC adapter cable supplied with system.

**LOGIC OUT (MCX):** 0 to +3.3 V logic level output for monitoring camera status. Logic output is software-selectable as *NOT SCAN*, *SHUTTER*, *NOT READY*, *LOGIC 0*, or *LOGIC 1*. Logic Out Control is discussed in Chapter 6. MCX-to-BNC adapter cable supplied with system.

- **NOT SCAN:** Logic low when CCD is being read; otherwise high.
- **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.

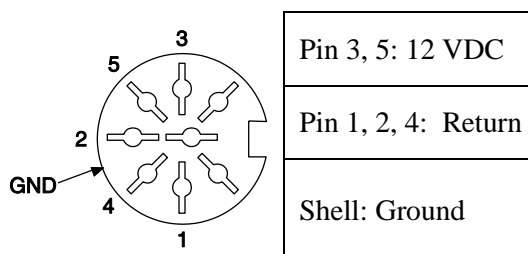


- **NOT READY:** The output changes state on completion of the array cleaning cycles that precede the first exposure. Initially high, it goes low to mark the beginning of the first exposure. In free run operation it remains low until the system is halted. If a specific number of frames have been programmed, it remains low until all have been taken, then returns high.
- **LOGIC 0** and **LOGIC 1:** Logic low and logic high, respectively.

**Shutter (LEMO):** Optional. Used for connecting to a Princeton Instruments-supplied external shutter. Cable not supplied.

**USB 2.0 (USB B Female):** 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 Support for more information. USB A/B cable supplied with system.

**Power (DIN):** 12 VDC (6.6A max) input from power supply.



**Fan:** (Air-cooled systems only) 24 CFM fan capacity at full power.

**Coolant Ports:** (Liquid-cooled systems only) Two interchangeable 1/4" CPC valved quick disconnect fittings for connection to the CoolCUBE circulator hoses.

#### Deepest Operating Temperature:

CCD Size	Typical
512x512	-70°C
1024x1024	-70°C
2048x2048	-65°C
1340x100	-80°C
1340x400	-75°C

Table 5. Typical Deepest Operating Temperature

**Temperature Stability:**  $\pm 0.05^\circ\text{C}$ ; closed-loop stabilized-temperature control

**Power Input:** 100-240 VAC; 47 to 63 Hz, 1.9A. DC power to camera is provided by the self-switching power supply or CoolCUBE circulator.

**Tripod Mount:** 1/4-20 x .25" mounting hole at bottom of camera. M6 threaded adapter supplied with system.

**A/D Converters:** Dual digitizers with 100 kHz/2 MHz readout rates. Software-selectable. Low-speed operation gives better noise performance; high-speed operation allows faster data acquisition.

## CoolCUBE Circulator

### Closed loop system

**Hoses:** 3/8" ID, with no-drip quick disconnects at the circulator ends and CPC quick disconnects at the camera ends

**Coolant:** 50:50 ethylene glycol and water at 25°C

**Dimensions:** Refer to *Appendix B, "Outline Drawings"*, page 92

**Circulator Weight (Filled):** 6.0 lbs (2.7 kg)

**Hose Weight (Filled):** 3.0 lbs (1.4 kg) per hose

## CoolCUBE<sub>II</sub> Circulator

### Closed loop system

**Hoses:** CoolCUBE<sub>II</sub> and **PIXIS-Compatible** 3/8" ID, with no-drip quick disconnects at the circulator ends and 1/4" CPC quick disconnects at the camera ends. Requires PI kit (Part Number 2550-0629).

**Coolant:** 50:50 ethylene glycol and water at 23°C (DI water recommended)

**Dimensions:** Refer to *Appendix B, "Outline Drawings"*, page 93

**Minimum Flow Rate:** 2.5 liters per minute.

**Maximum Pressure:** 22 PSI

**Power Input:** 120 V/220 V, 3 A

**Operating Environment:** +5°C to 30°C, non-condensing

**Circulator Weight (Filled):** 6.0 lbs (2.7 kg)

**Hose Weight (Filled):** 3.0 lbs (1.4 kg) per hose

## Options

A partial listing of options includes: internal 25 mm shutter, internal 45 mm shutter, C-to-F-mount adapter, and Spectroscopic mount adapters. Contact the factory for more information regarding options available for your system.

## Appendix B

**NOTE:** Dimensions are in inches [mm].

## PIXIS Camera: C-mount (Air-Cooled)

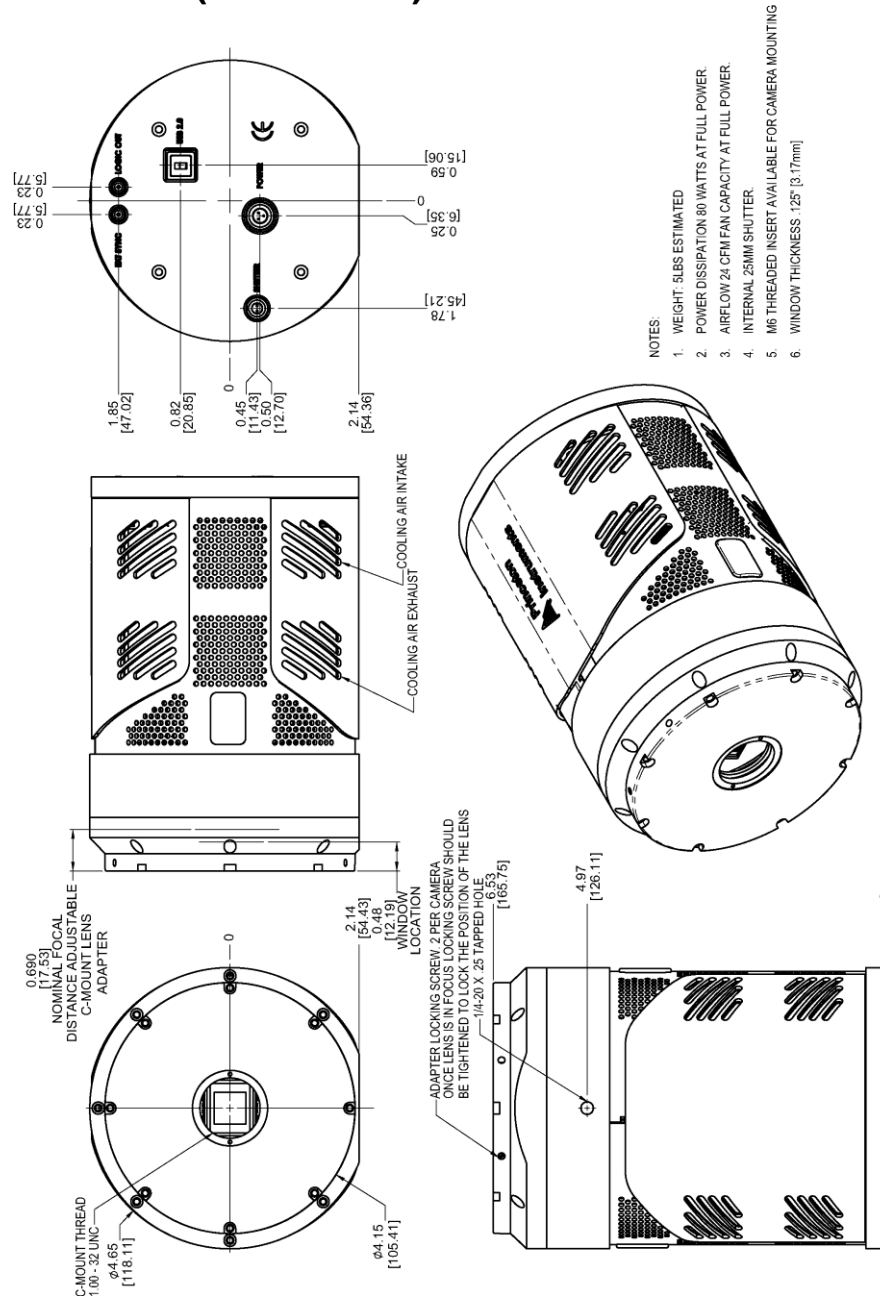


Figure 49. Adjustable C-Mount: Internal Shutter (Air-cooled)



# PIXIS Camera: C-mount (Liquid-Cooled)

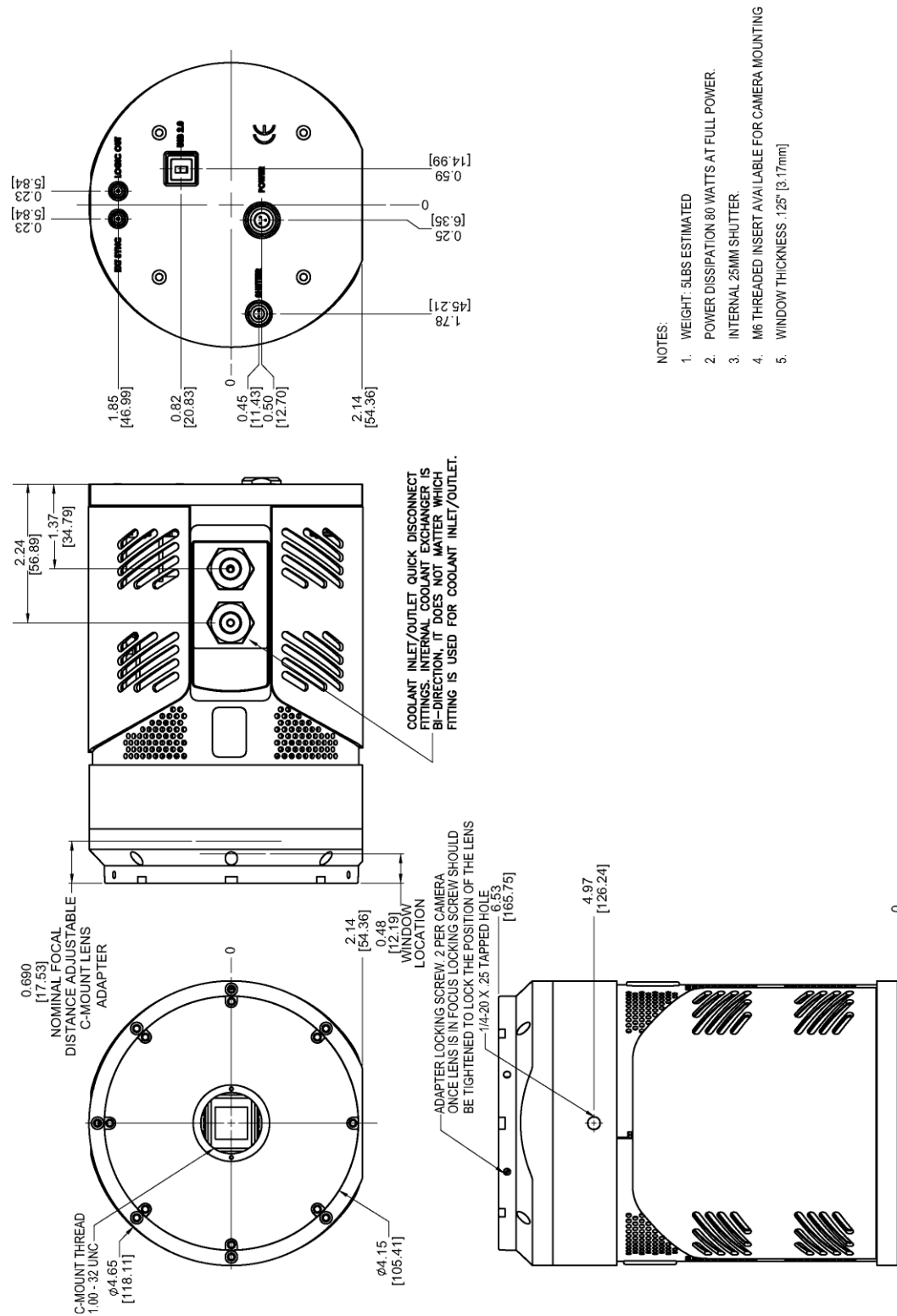


Figure 51. Adjustable C-Mount: Internal Shutter (Liquid-cooled)

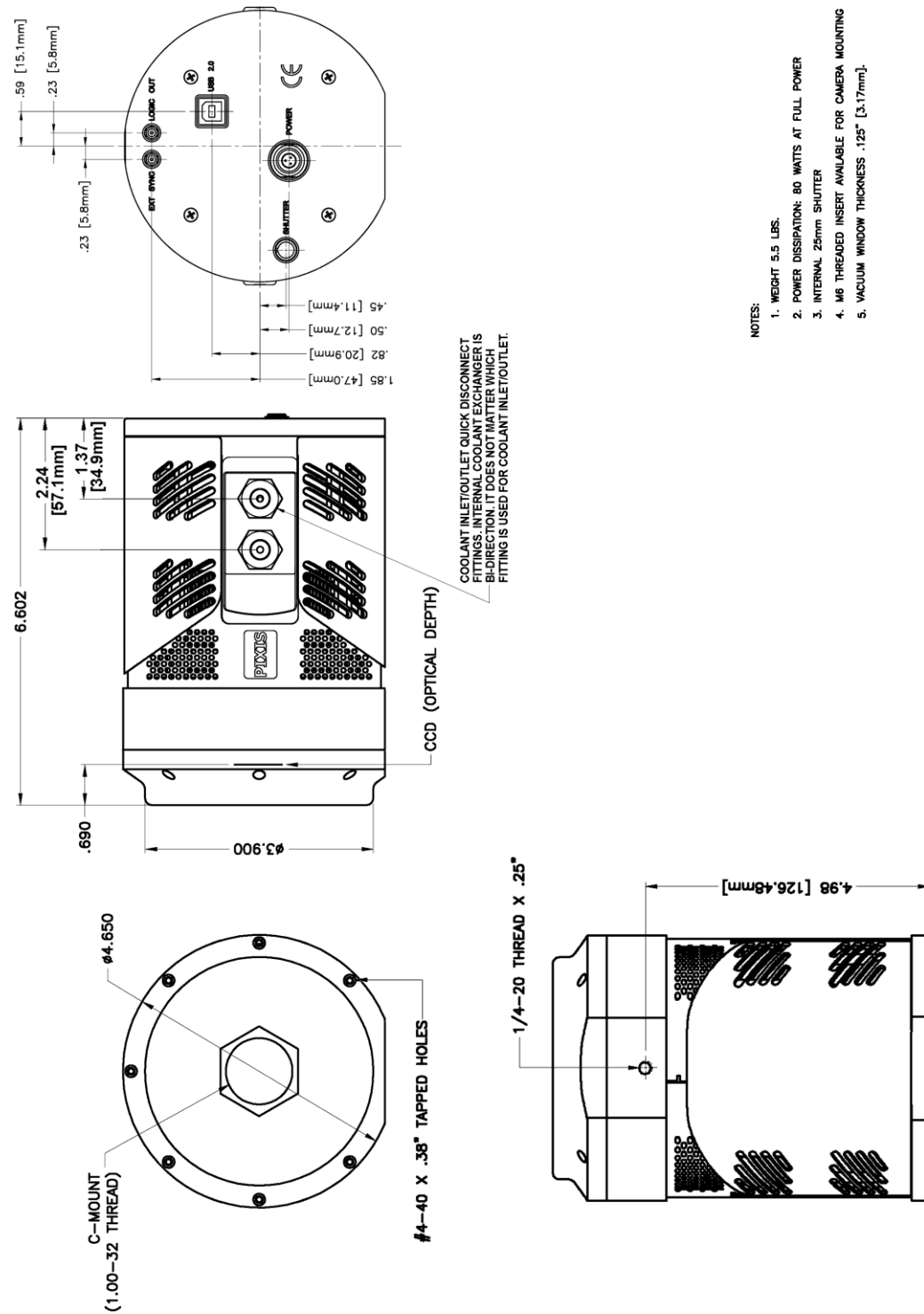


Figure 52. Fixed C-Mount: Internal Shutter (Liquid-cooled)

## PIXIS Camera: F-mount (Air-Cooled)

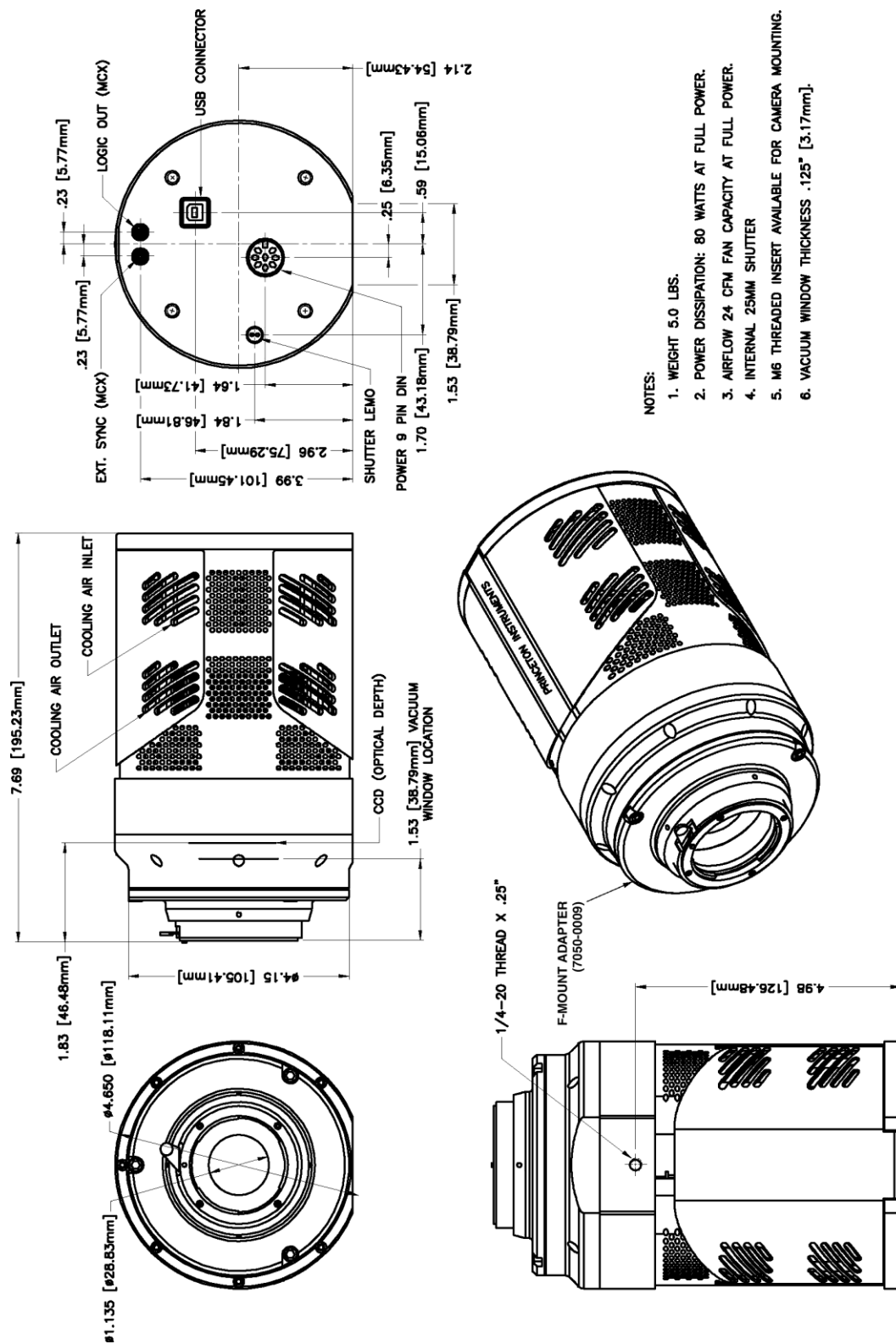


Figure 53. F-Mount: Internal Shutter (Air-cooled)

## PIXIS Camera: 2048 F-mount (Air-Cooled)

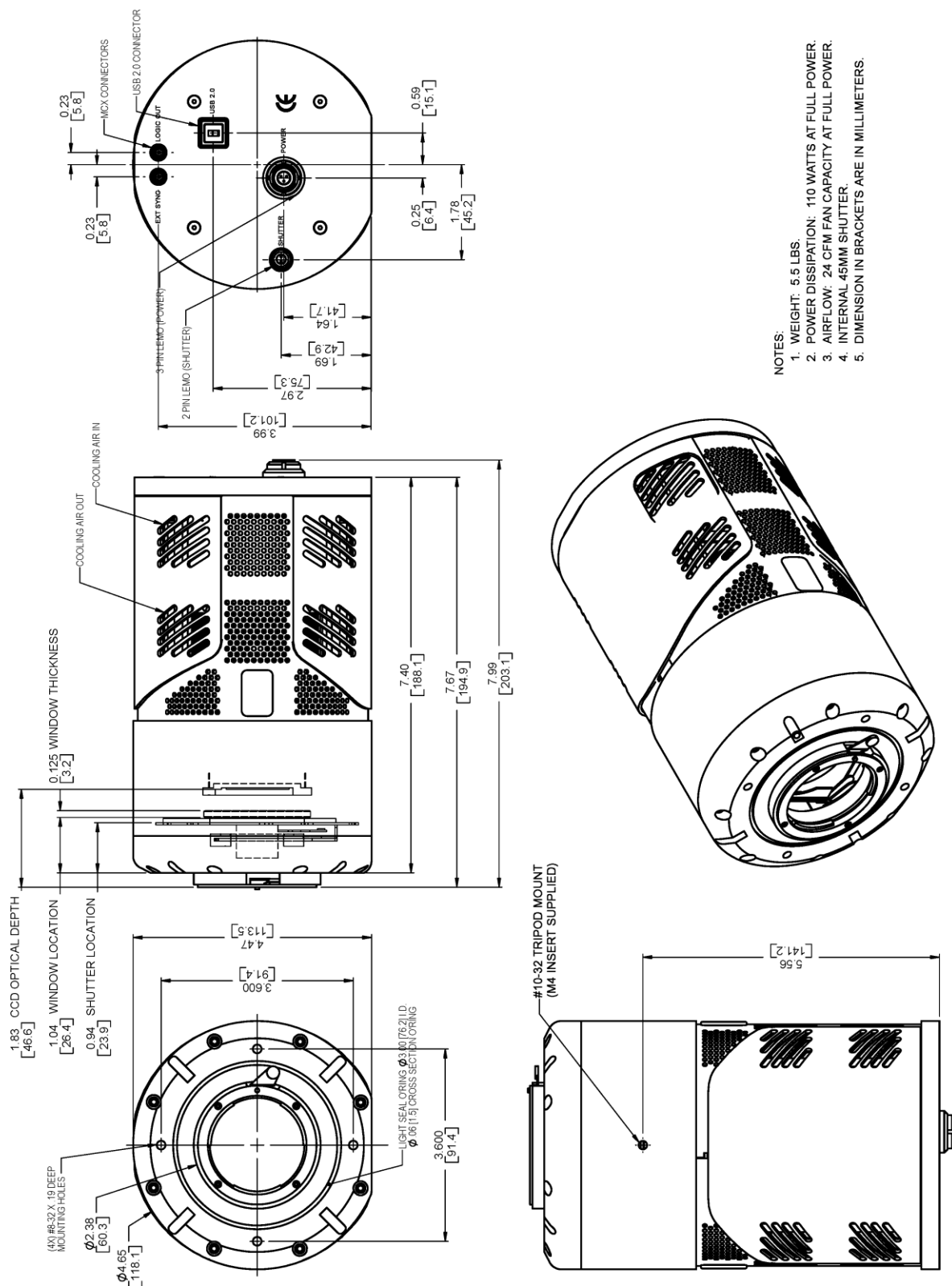


Figure 54. F-Mount: 2048x2048, Internal Shutter (Air-cooled)



## PIXIS Camera: F-mount (Liquid-Cooled)

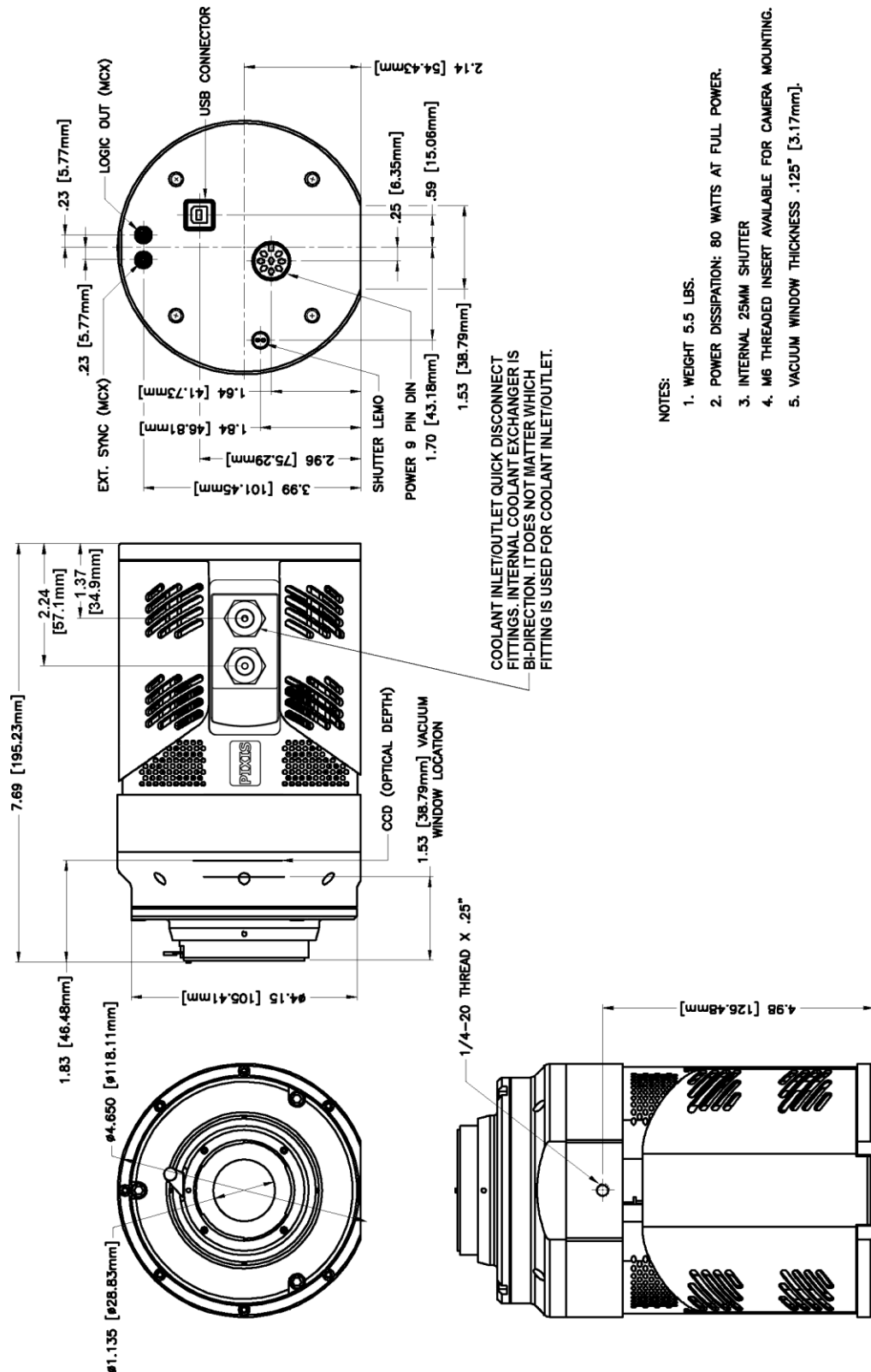


Figure 55. F-Mount: Internal Shutter (Liquid-cooled)





## CoolCUBE Circulator

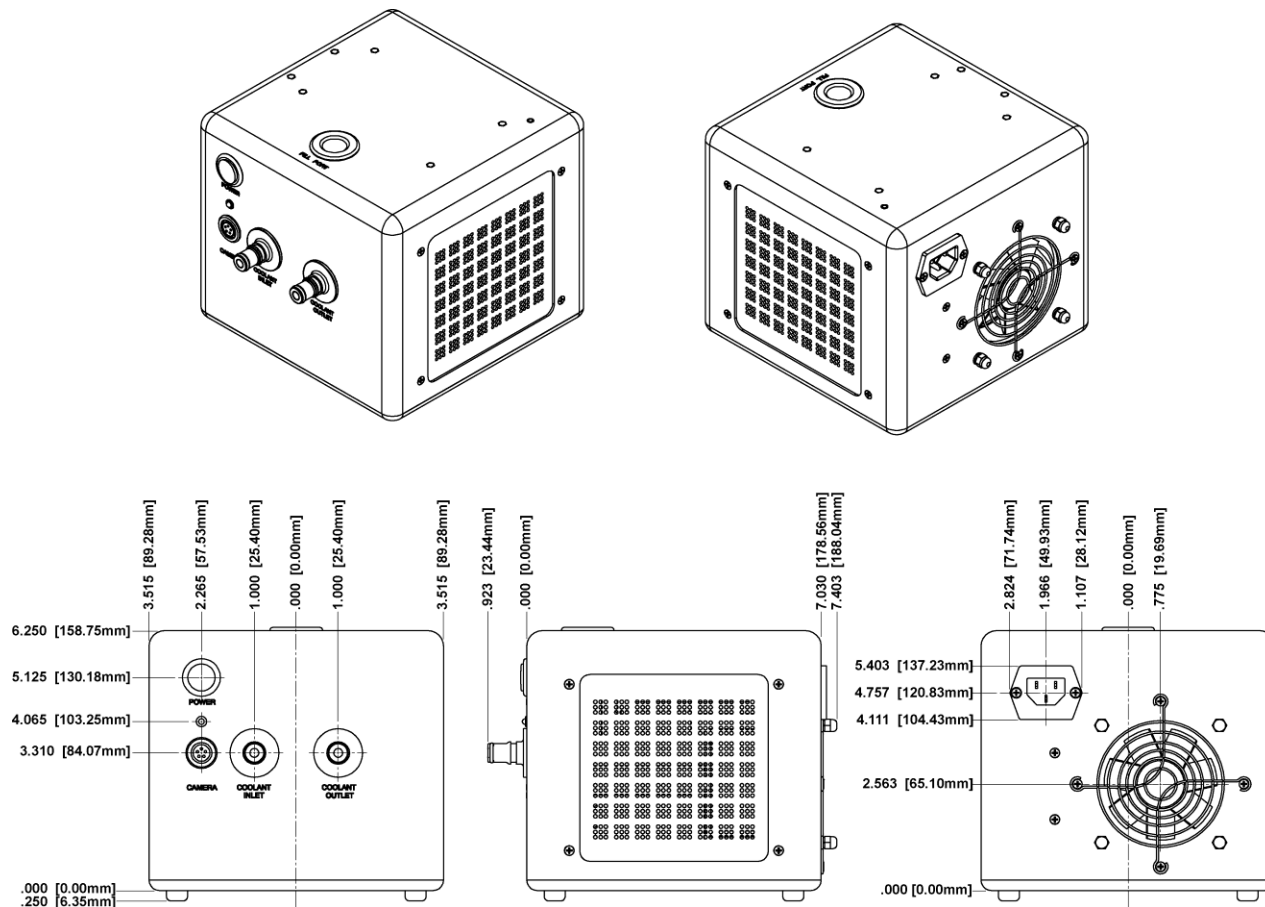
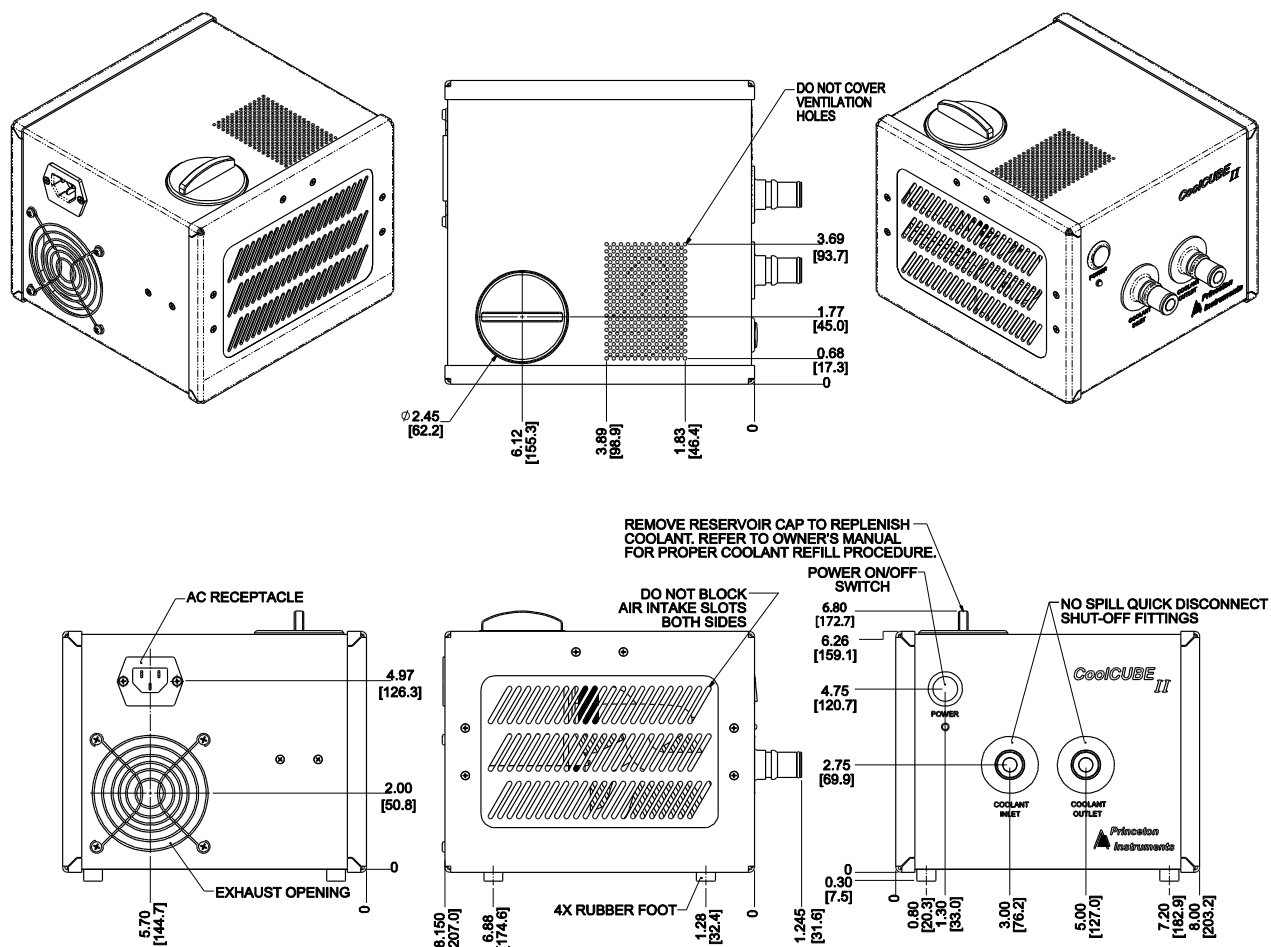


Figure 58. CoolCUBE Circulator

CoolCUBE<sub>II</sub> CirculatorFigure 59. CoolCUBE<sub>II</sub> Circulator

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# Appendix C

## Adapter Adjustment and Focusing Procedures

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### Adjustable C-Mount Adapter

PIXIS cameras are now available with an adjustable C-mount adapter. The camera is adjusted at the factory for standard C-mount focusing distance. However, you may want to adjust the focusing distance for your application.

#### **Tools Required**

- Spanner (supplied)
- Small flat blade screwdriver

#### **Procedure**

1. Using a small flat blade screwdriver, loosen the lock screws.
2. Use the spanner to rotate the C-mount adapter the desired distance.
3. Tighten the lock screws to lock the C-mount adapter in place.

**Note:** To tighten down the screws, the face of the adapter should be no further than .06" (1.5 mm) out from the front surface of the camera nose.



#### **Caution**

The C-mount lens thread-depth should be .21" (5.3 mm) or less. Otherwise, depending on the adapter in-out location, the lens could bottom out and damage the shutter, if there is one installed. If you are not certain of the thread depth, remove the adapter from the camera, thread the lens into the adapter until the lens threads are flush with the back surface of the adapter. Note the depth at the front surface, remove the lens, and then re-insert the adapter into the camera nose.

## 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. The lens should be mounted to the camera as described in Chapter 4.
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 camera. 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 **Safe** modes (consult the software manual if you are unfamiliar with these modes). Choose a fast exposure (.1 ms) 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.
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.

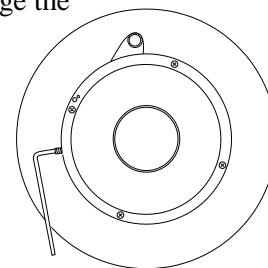


Figure 60. F-mount Adjustment

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*.

---

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



## **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.

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## Appendix D

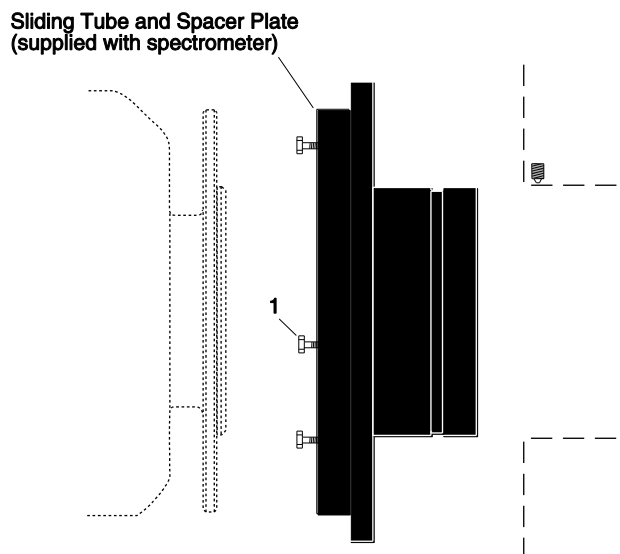
# Spectrometer Adapters

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Princeton Instruments offers a variety of spectrometer adapters for PIXIS systems having a 3.60" bolt circle. 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	Adapter Kit No.	Page
Acton (PIXIS with Flange)		100
Acton (PIXIS with 3.60/3.88" Bolt Circles)		101
Acton (PIXIS with C-Mount)		102
Chromex 250 IS (PIXIS with Flange)	7050-0090	103
ISA HR 320 (PIXIS with Flange)	7050-0010	104
ISA HR 640 (PIXIS with Flange)	7050-0034	105
SPEX 270M (PIXIS with Flange)	7050-0041	106
SPEX 500M (PIXIS with Flange)	7050-0038	107
SPEX TripleMate (PIXIS with Flange)	7050-0007	108

## Acton (PIXIS with Flange)



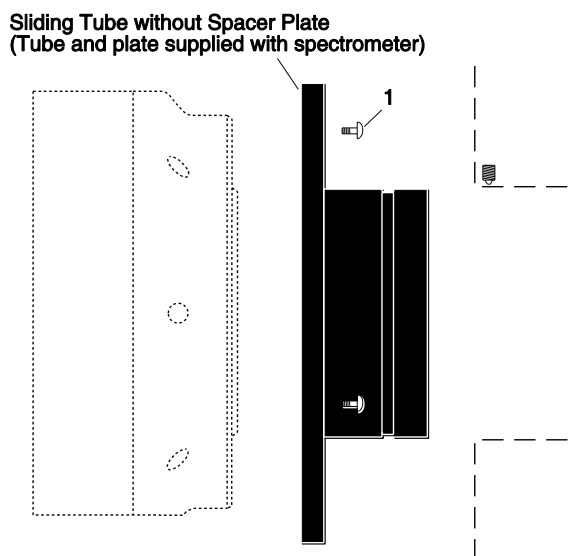
Qty	P/N	Description
1. 3	2826-0120	Screw, 10-32 $\times$ 1/2, Hex Head, Stainless Steel

### 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 sliding tube in the spectrometer and remove the sliding tube. If the spacer plate has been removed, reinstall it on the sliding tube.
3. Leaving 1/4" of thread exposed, mount the three (3) hex head screws to the sliding tube.
4. Mount the sliding tube assembly to the detector flange and rotate the sliding tube so the screw heads are over the narrow end of the slots.
5. Tighten the screws.
6. Gently insert the sliding tube into the spectrometer and secure it with the setscrews.

**Note:** Adapter parts are machined to provide a tight fit. It may be necessary to rotate the detector back and forth when inserting the sliding tube into the spectrograph. Forcing the tube into the spectrometer could permanently damage the tube and the spectrometer opening.

## Acton (PIXIS with 3.60/3.88 Bolt Circles)



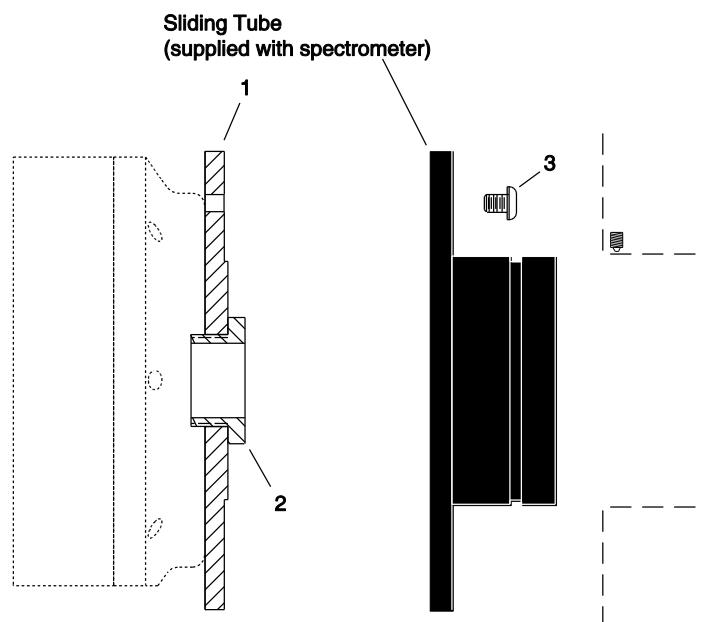
Qty	P/N	Description
1. 3	2826-0127	Screw, 10-32 $\times$ 1/4, Button Head Allen Hex, Stainless Steel

### 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 sliding tube in the spectrometer and remove the sliding tube.
3. Remove the spacer plate from the sliding tube by removing the three (3) socket head screws.
4. Mount the sliding tube to the detector nose with the three (3) 1/4" long button head screws.
5. Gently insert the sliding tube into the spectrometer and secure it with the setscrews.

**Note:** Adapter parts are machined to provide a tight fit. It may be necessary to rotate the detector back and forth when inserting the sliding tube into the spectrograph. Forcing the tube into the spectrometer could permanently damage the tube and the spectrometer opening.

## Acton (PIXIS with C-Mount)

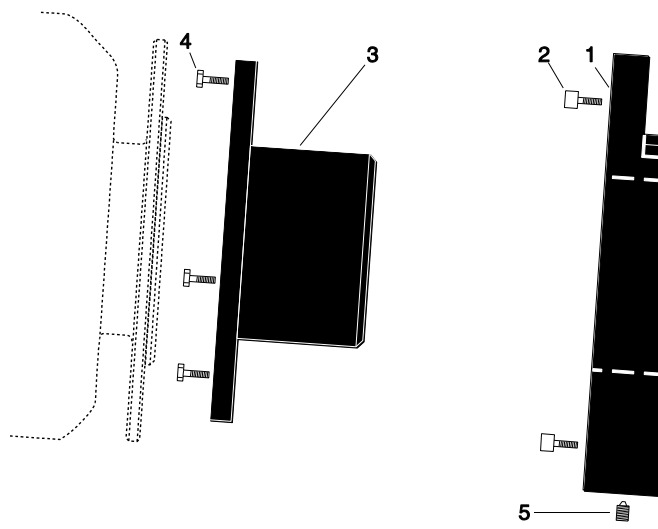


Qty	P/N	Description
1.	1 8401-071-01	Adapter Plate
2.	1 8401-071-02	Threaded C-Mount Adapter
3.	3 2826-0127	Screw, 10-32 $\times$ 1/4, Button Head Allen Hex, Stainless Steel

### Assembly Instructions

1. Make sure that the shipping cover has been removed from the detector port on the spectrograph.
2. Loosen the setscrews holding the sliding tube in the spectrograph and remove the tube. If there is a spacer plate installed on the sliding tube, remove it.
3. Place the flat side of the adapter plate against the face of the detector.
4. Insert the threaded C-mount adapter through the center hole in the plate and screw the adapter into the detector's C-mount.
5. Using three (3) 1/4" long button head screws, secure the sliding tube to the adapter plate.
6. Gently insert the sliding tube into the spectrograph and secure it with the setscrews.

**Note:** Adapter parts are machined to provide a tight fit. It may be necessary to rotate the detector back and forth when inserting the sliding tube into the spectrograph. Forcing the tube into the spectrometer could permanently damage the tube and the spectrometer opening.

**Chromex 250 IS (PIXIS with Flange) -- Adapter Kit 7050-0090**

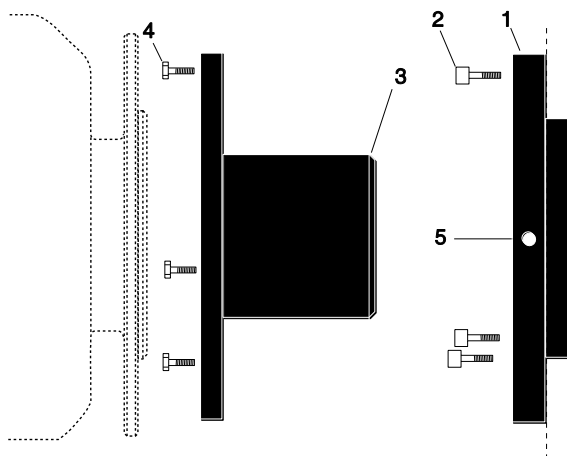
	Qty	P/N	Description
1.	1	2517-0901	Plate, Adapter-Female
2.	4	2826-0283	Screw, 10-32 $\times$ 3/4, Socket Head, Stainless Steel, Hex, Black
3.	1	2518-0227	Adapter-Male, ICCD Diode Array
4.	3	2826-0120	Screw, 10-32 $\times$ 1/2, Hex Head, Stainless Steel
5.	1	2826-0082	Set Screw, 10-32 $\times$ 1/4, Stainless 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 (PIXIS with Flange) -- Adapter Kit 7050-0010



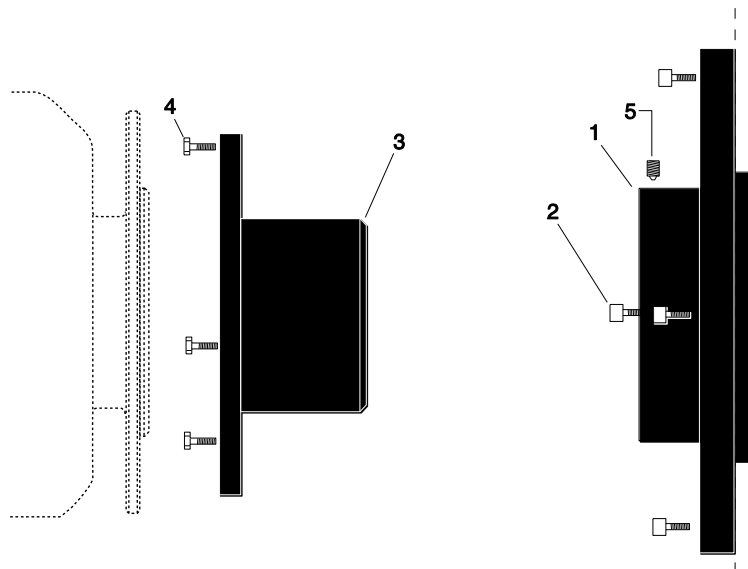
	Qty	P/N	Description
1.	1	2518-0044	Flange-Female, Mechanical, ISA, HR320
2.	3	2826-0053	Screw, 10-32 $\times$ 7/16, Socket Head Cap Hex, Stainless Steel
3.	1	2518-0045	Flange-Male, Detector Mate
4.	3	2826-0120	Screw, 10-32 $\times$ 1/2, Hex Head, Stainless Steel
5.	1	2826-0082	Set Screw, 10-32 $\times$ 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 (PIXIS with Flange) -- Adapter Kit 7050-0034**

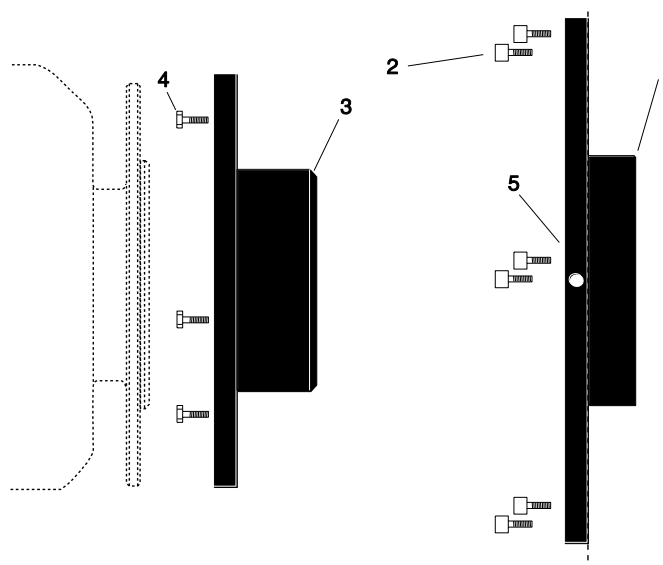
	Qty	P/N	Description
1.	1	2518-0203	Adapter-F, HR-640
2.	4	2826-0144	Screw, M4x.7x14 mm, Socket Head, Hex, Stainless Steel
3.	1	2518-0227	Adapter-Male, ICCD Diode Array
4.	3	2826-0120	Screw, 10-32 $\times$ 1/2, Hex Head, Stainless Steel
5.	2	2826-0082	Set Screw, 10-32 $\times$ 1/4, Stainless Steel, Allen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

## SPEX 270M (PIXIS with Flange) -- Adapter Kit 7050-0041



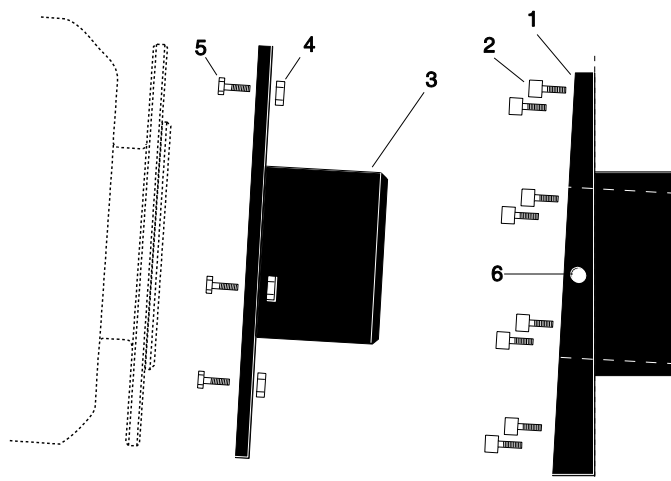
	Qty	P/N	Description
1.	1	2518-0691	Female Adapter Plate, 2.400 ID
2.	6	2826-0068	Screw, 6-32 $\times$ 3/8. Socket Head, Hex, Stainless Steel
3.	1	2518-0690	Adapter Male, Focusing, Male, Spec 270
4.	3	2826-0120	Screw, 10-32 $\times$ 1/2, Hex Head, Stainless Steel
5.	2	2826-0019	Set Screw 8-32 $\times$ 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 (PIXIS with Flange) -- Adapter Kit 7050-0038



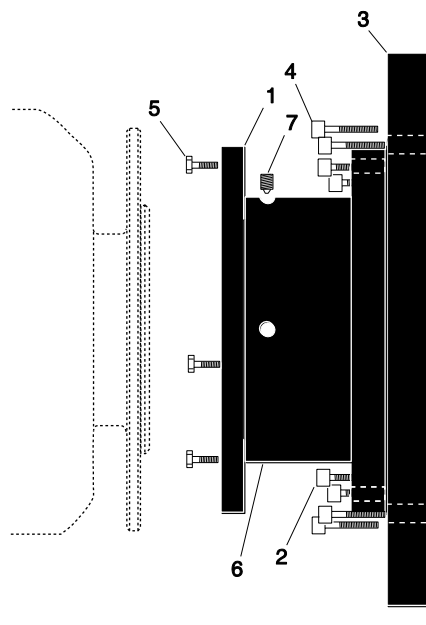
	Qty	P/N	Description
1.	1	2517-0214	Adapter-Female, Spex 500M
2.	8	2826-0170	Screw, 1/4-20 × 0.5L, Low Socket Head Cap
3.	1	2518-0291	Adapter Male, Spex 500M
4.	3	2827-0010	10-32 Nut, Stainless Steel
5.	3	2826-0120	Screw, 10-32 × 1/2, Hex Head, Stainless Steel
6.	2	2826-0055	Set Screw 8-32 × 1/4, Allen 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 (PIXIS with Flange) -- Adapter Kit 7050-0007



	Qty	P/N	Description
1.	1	2518-0183	Adapter-Male, ICCD/For Spex TripleMate
2.	4	2826-0128	Screw, 10-32 $\times$ 5/8, Socket Head Cap, Stainless Steel
3.	1	2517-0163	Slit Mount, Spex
4.	4	2826-0129	Screw, 1/4-20 $\times$ 3/4, Socket Head Cap, Stainless Steel
5.	3	2826-0120	Screw, 10-32 $\times$ 1/2, Hex Head, Stainless Steel
6.	1	2518-0185	Adapter-Female, Flange Spex
7.	2	2826-0070	Set Screw, 6-32 $\times$ 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 Card Installation

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### Introduction

The information in this appendix is provided for those cases when you need to install a USB 2.0 card into computer to be used as part of a PIXIS system. Although these instructions are written primarily for laptop installation, they can also be used when installing a USB 2.0 card into a desktop computer.

### Setting up a USB 2.0 Interface

*Administrator privileges are required under Windows® 2000 and Windows® XP to install software and hardware.*

**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 PIXIS camera. 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 2000 or Windows XP, 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 4 (for Windows 2000) or Service Pack 1 (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. 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 PIXIS system (see page 24).
- A USB 2.0 board and its driver are installed in the host computer.
- You have already installed the WinView/32 or WinSpec/32 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 be 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 camera. Then, turn the camera on before turning on the host computer.
3. At bootup, Windows will detect the Princeton Instruments USB2 Interface hardware in the PIXIS. 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, WinView/32 or WinSpec/32 automatically put the required INF, DLL, and USB driver files in the "Windows" directories shown below. If you are prompted for the file locations, refer to Table 6 below for that information.

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® 2000 and XP	rsusb2k.inf (in WINNT/INF, for example)	apausbprop.dll (in WINNT/System32, for example)	apausb.sys (in WINNT/System32/Drivers, for example)

\* The INF directory may be hidden.

Table 6. USB Driver Files and Locations

## Editing the PVCAM.INI File

If you have multiple cameras from Roper Scientific (PI and PM brands) on the same host computer, the RSConfig.exe program will list all of the cameras that it has found installed on the host computer (in Figure 61 two different cameras were found). Depending on the order in which they are listed, it may be necessary to edit the PVCAM.INI file that RSConfig generates. This is because the PIXIS camera must be Camera 1 in that file in order for the application software to recognize it. In Figure 61, the PI Style camera is first in the list as Camera 1 and the PI Style (USB2:PIXIS) is second. Therefore, the PVCAM.INI must be edited.

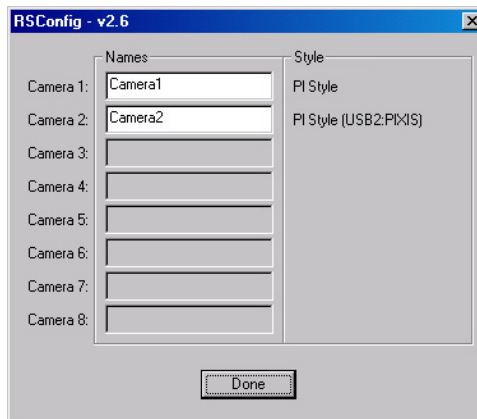


Figure 61. RSConfig dialog box: Two Camera Styles

### To Edit the PVCAM.INI file

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

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

<b>[Camera_1]</b>	→	<b>[Camera_2]</b>
Type=1		Type=1
Name=Camera1		Name=Camera1
Driver=rsipci.sys		Driver=rsipci.sys
Port=0		Port=0
<b>[Camera_2]</b>	→	<b>[Camera_1]</b>
Type=1		Type=1
Name=Camera2		Name=Camera2
Driver=apausb.sys:pixis		Driver=apausb.sys:pixis
Port=0		Port=0

**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.

2. Save the file. With the PIXIS powered and on, launch WinView or WinSpec from **Start|Programs|PI Acton**.
3. When the PVCAM dialog box (Figure 62) 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 62. Hardware Wizard: PVCAM dialog box*



# Warranty & Service

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## 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](http://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](http://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 Support page at [www.princetoninstruments.com](http://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](mailto:techsupport@princetoninstruments.com)

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

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

Otherwise, see our Support web page at [www.princetoninstruments.com](http://www.princetoninstruments.com).

An up-to-date list of addresses and telephone numbers is posted on the [www.princetoninstruments.com/Support](http://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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