WinSpec

PRINCETON INSTRUMENTS

Princeton Instruments

Spectroscopic Software

ROPER SCIENTIFIC™
BEYOND IMAGING

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Introduction

This manual has been written to give new users a step-by-step guide to collecting, storing, and processing data from your Roper Scientific system. The manual is divided into the following three parts:

- **Part 1**, ***Getting Started****,* is primarily intended for the first time user who is familiar with Windows-based applications or for the experienced user who wants to review. These chapters lead you through hardware setup, experiment setup, data collection, file handling, wavelength calibration, spectrograph setup and calibration and data display procedures.
- **Part 2**, ***Advanced Topics****,* goes on to discuss ancillary topics such as cleaning, ROIs, binning, data correction techniques, printing, gluing spectra, Y:T analysis, processing options, pulser operation and customizing the toolbar. These chapters are more informational and less procedural than those in Part 1.
- **Part 3**, ***Reference****,* contains appendices that provide additional useful information, such as
  - commonly used system, controller type and camera type terminology provided in Appendix A,
  - Hg, Ar, Ne calibration spectrum data and graph provided in Appendix B, and
  - data-structure information provided in Appendix C.

  Also included are appendices that address repair and maintenance of the WinSpec/32 software and installation work-arounds for situations where the CD ROM doesn't support long file names.

A software hardware setup wizard guides you through the critical hardware selections the first time you select Setup – Hardware. To properly respond to the wizard's queries, you may have to refer to your ordering information, such as exact detector model, A/D converters, etc. Keep this information handy.

Even though the wizard will assist you in getting started, it will still be necessary to read through this manual to familiarize yourself with the many data-collection and analysis options available.

Note: Throughout the manual references are made to the PI-MAX camera/detector. This camera/detector was previously called the I-MAX and the ICCD-MAX.

Summary of Chapter Information

Part 1, Getting Started

Introduction describes the contents of this manual as well as other information sources including online Help and other documentation files.

Chapter 1 **Installing and Starting WinSpec/32** lists system requirements and describes how to install the WinSpec/32 software.

Chapter 2 **Basic Hardware Setup** provides detailed instructions on how to configure WinSpec/32 for operation with the hardware (detector, controller, and spectrograph) in your particular system. Pulser configuration is discussed in Chapter 18.

Chapter 3 **Initial Spectroscopic Data Collection** provides a procedure for initial spectroscopic data collection, allowing users to gain some operating familiarity before going on to more complex measurements.

Chapter 4 **Initial Imaging Data Collection** provides a procedure for initial imaging data collection, allowing users to gain some operating familiarity before going on to more complex measurements.

Chapter 5 **Opening, Closing, and Saving Data Files** describes how to open, close and save data files in WinSpec/32.

Chapter 6 **Wavelength Calibration** describes how to calibrate the WinSpec/32 software for one position of the spectrograph grating.

Chapter 7 **Spectrograph Calibration** discusses how to calibrate the WinSpec/32 software for any position of the spectrograph gratings.

Chapter 8 **Displaying the Data** describes the data file display options.

Part 2, Advanced Topics

Chapter 9 **Cleaning** describes the cleaning features that are used, while data acquisition is idle, to prevent the buildup of unwanted charge on the array.

Chapter 10 **ROI Definition & Binning** describes how to set a region of interest (ROI), so that data is only collected from the specified portion of the CCD array. It also describes binning, the summing together of charge from several pixels, on the array or in software during data acquisition. Simple or more advanced binning options can be configured easily with WinSpec/32.

Chapter 11 **Correction Techniques** explains correction options such as background subtraction and flatfield correction.

Chapter 12 **Spectra Math** covers WinSpec/32's mathematical processing features.

Chapter 13 **Y:T Analysis** provides an overview of how to use the Y:T analysis function to track changes in a process with time.

Chapter 14 **Gluing Spectra** discusses gluing existing files or combining the data acquisition and gluing operations under spectrograph control.

Chapter 15 **Post-Acquisition Mask Processes** describes digital mask-operations that can be performed on the acquired data. Discussed are Edge Enhancement, Sharpening, Smoothing, Custom Filter and Morphological functions.

Chapter 16 **Additional Post-Acquisition Processes** describes additional operations that can be performed on an acquired data set. Functions covered include Threshold and Clipping, Cross Section, Binning and Skipping, and Histogram.

Chapter 17 **Printing** describes printing features of WinSpec/32. WinSpec/32 can print directly to almost any Windows® printer driver.

Chapter 18 **Pulser Operation** describes the operation of the Pulsers that can be used with WinSpec/32.

Chapter 19 **Custom Toolbar Settings** describes the Custom Toolbar and explains how to add/remove the available buttons.

Chapter 20 **Software Options** describes WinSpec/32 options that can also be purchased from Roper Scientific.

Part 3, Reference

Appendix A **System and Camera Nomenclature** provides a cross-reference table for systems, controllers, and cameras/CCD arrays. It also provides brief descriptions of systems and system components. CCD array related abbreviations are also included.

Appendix B **Calibration Lines** contains wavelength tables and a detailed spectrum for Mercury-Argon.

Appendix C **Data Structure** contains descriptions of the data structure for both WinView/WinSpec 1.43 and for 1.6. *The data structure for WinView/32 and WinSpec/32 is the same as that for WinView/WinSpec 1.6.*

Appendix D **Auto-Spectro Wavelength Calibration** discusses the WinSpec/32 wavelength calibration algorithm.

Appendix E **CD Failure Work-Arounds** provides advice on how to successfully complete the installation in situations where the CD ROM doesn't support long file names.

Appendix F **WinSpec/32 Repair and Maintenance** provides information on how to repair, reinstall and uninstall WinSpec/32 components.

Appendix G **USB 2.0 Limitations** covers the currently known limitations associated with operating under the USB 2.0 interface.

Appendix H **Troubleshooting USB 2.0** provides solutions to communication problems that may occur when operating under the USB 2.0 interface.

Appendix I **Glossary** includes brief definitions of terms used in relation to WinSpec/32 and the system hardware.

Online Help

The WINSPEC.HLP online documentation contains:

- Information that is in this manual,
- Step-by-step instructions on how to use WinSpec functions,
- Reference information about WinSpec and its functions, and
- Context-sensitive help, which describes a screen or menu item that is being pointed to or that is active when a Help button is clicked on.

Tool Tips and Status Bar Messages

Placing the mouse cursor on a button and resting it there for a few seconds causes a brief tool-tip message to appear that describes the button's function. Tool tips are also provided for the individual panes of the Status Bar (at the bottom of the WinSpec/32 window). Note that tool tips only appear at the desktop level. Tool tips are not provided for the buttons on the individual dialog boxes and tab pages.

More detailed descriptions for each button at the desktop level are provided at the left side of the Status Bar. Status Bar help messages are also provided for the menu selections.

Additional Documentation

Additional documentation can be found in the \WinSpec32\Documentation directory on the hard drive where WinSpec/32 was installed. Among the files that may be in this directory are:

WINHEAD.TXT This file contains documentation on the header structure for WinSpec/32 or WinView/32 Data Files. TXT files can be opened with any ASCII text editor.

WinX_readme.doc This is a read-me file that contains the latest information on new features, fixed problems, and work-arounds for issues not yet solved.

WinX32 Automation 3.X for Visual Basic.pdf This file is stored in the directory when the Visual Basic User Interface component is selected during installation. It describes how to create your own Snap-Ins by using Visual Basic Professional Edition and the WinX32 Automation files. Requires Adobe Acrobat Reader.

WinX32 Programming for Macro Record.pdf This file is stored in the directory when the Macro option is installed. It provides detailed information on how to create and edit macro programs for WinSpec/32. Requires Adobe Acrobat Reader. The Macro option is not supplied with the standard WinSpec/32 program.

Chapter 1
Installing and Starting WinSpec/32

To ensure that the computer you have can operate the Princeton Instruments equipment, please first read the system requirements below carefully. WinSpec/32's requirements differ from those of previous versions of WinSpec.

After confirming that your computer meets all hardware and software requirements, install WinSpec/32 according to the instructions in this chapter. Do not attempt to run the software until you have read Chapters 2, 3 and 4, which discuss important hardware-setup and data acquisition issues. Also, it is recommended that you install the Princeton Instruments interface board in your computer before running the software. Instructions for installing the interface board are provided in your Princeton Instruments hardware manuals.

Note: If your computer and system were purchased together from Roper Scientific, the Interface card will have been installed at the factory.

System Requirements

The following information lists the system hardware and software requirements.

Hardware Requirements

- Roper Scientific camera and, if required by the camera, a Princeton Instruments ST series controller with either a TAXI or USB 2.0 Interface Control module for communication between controller and host computer.
- Host Computer (TAXI Protocol):
  - Minimum is AT-compatible computer with 80486 (or higher) processor (50 MHz or faster): Pentium or better recommended.
  - Princeton Instruments (RS PCI) or Photometrics high speed PCI serial card. *Computers purchased from Roper Scientific are shipped with the card installed.*
  - Minimum of 32 Mbyte total RAM for CCDs up to 1.4 million pixels. Collecting larger images at full frame or at high speed may require 128 Mbytes or more of RAM.
  - Hard disk with a minimum of 80 Mbytes available. A complete installation of the program files takes about 17 Mbytes, and the remainder is required for data storage. Collection of large images may require additional hard disk storage, depending on the number of spectra collected and their size. Disk level compression programs are not recommended.

ATTENTION

> Not all computers are able to satisfy the software and data-transfer performance requirements of Roper Scientific systems. If you purchased a computer through Roper Scientific, it will have already been tested for proper operation with a Princeton Instruments system and will have the Interface card installed.

- Super VGA monitor and graphics card supporting at least 256 colors with at least 1 Mbyte of memory. Memory required will depend on desired display resolution.
- Two-button Microsoft-compatible serial mouse or Logitech three-button serial/bus mouse.

- Host Computer (USB 2.0 Protocol):
  - AT-compatible computer with Pentium 3 or better processor that runs at 1 GHz or better.
  - Native USB 2.0 support on the motherboard or USB Interface Card (Orange Micro 70USB90011 USB2.0 PCI is recommended for desktop computers and the SIIG, Inc. USB 2.0 PC Card, Model US2246 is recommended for laptop computers).
  - Minimum of 256 Mb of RAM.
  - CD-ROM drive.
  - Hard disk with a minimum of 80 Mbytes available. A complete installation of the program files takes about 17 Mbytes and the remainder is required for data storage, depending on the number and size of spectra collected. Disk level compression programs are not recommended.
  - Super VGA monitor and graphics card supporting at least 256 colors with at least 1 Mbyte of memory. Memory requirement is dependent on desired display resolution.
  - Two-button Microsoft compatible serial mouse or Logitech three-button serial/bus mouse.

Operating System Requirements

TAXI Protocol: Windows® 95, Windows® 98SE, Windows® ME, Windows NT® (ver. 4.0 or higher), Windows® 2000, or Windows® XP operating system. WinSpec/32 is ***not*** supported under OS/2. Nor will it run under Windows 3.1 or 3.11.

USB 2 Protocol: Windows 2000 (with Service Pack 3), Windows XP (with Service Pack 1) or later operating system.

Your System Components

Take a few minutes and enter the information in the table below. Various pieces of this information will be required when you install WinSpec/32, when the Setup Wizard (see Hardware Setup Wizard, page 31) runs, and when you begin entering component information on the dialog boxes and tab pages associated with Hardware Setup, Spectrograph Setup, and Pulser Setup. Other information such as software version and hardware serial numbers may be useful if you ever need to contact Technical Support.

System Component	Your System	Notes
Application Software and Version	WinSpec Version 2.5.____	Found on the installation CD or via the WinSpec Help menu.
Software Options		Options (purchased separately from WinSpec) such as Macro Record or Virtual Chip.
PVCAM® Driver	Yes / No	PVCAM driver is used to run Photometrics cameras, Princeton Instruments cameras with USB 2, and the Acton InSpectrum™.
Interface Card	Princeton Instruments PCI, Tucson PCI, USB 2.0	Many systems use the Princeton Instruments PCI. Tucson PCI is required for Photometrics cameras. USB 2 is available for newer Princeton Instruments systems.
System Name		Refer to your order and Appendix A
Controller	ST-121, ST-133, ST-133A, ST-138, ___________________	Refer to your order and Appendix A
Controller Serial Number		Refer to the serial label. Typically, this is located on the bottom of the unit.
Detector/Camera and CCD Array		Refer to your order and Appendix A
Detector/Camera Serial Number		Refer to the serial label. Typically, this is located on the back of the unit.
Shutter Type	Small (≤ 25 mm), Large (≥ 35mm), None	
Spectrograph Type	Acton, Spex, or _____________________	
Pulser Type	DG535, PG200, or PTG	PTG is usually associated with the PI-MAX camera
Pulser Serial Number		Refer to serial label, typically located on the back of the unit and in the lower left corner.

Installing WinSpec/32

Caution Because WinSpec/32 and WinView/32 contain files with the same name but different content, do not install WinSpec/32 and WinView/32 software in the same directory.

Before installing WinSpec/32:

- Verify that your computer meets the requirements listed on pages 19-20.
- Check to see if the interface card has been installed. Note that the interface card is not necessary if the computer will only be used for post-processing data. If you plan to collect data and the card is not installed in your computer, you will need to install it and add the hardware ***after WinSpec/****32 is installed.*
- If installing under Windows NT, 2000, or XP, make sure that you are logged on as administrator of the Workstation. Otherwise, the installation will fail because changes cannot be made to the Windows Registry.
- Check to see if WinView/32 has been installed on your system. If it has, note the directory name so you won't accidentally install WinSpec/32 in the same directory.
- Determine how you will be installing the software. WinSpec/32 is provided on a CD shipped with the system or it can be installed from the Roper Scientific FTP site.

During the installation process, you will be given the choice of **AUTO PCI** or **Custom** installation.

Click on **Custom** if you are using a **SPEX** spectrograph.

AUTO PCI: Installs the WinSpec/32 application and DLLs, the help files, the INF file (if required) and the interface drivers, sample data, diagnostic programs, Acton spectrograph support, pulser support, ASCII and Move Snap-Ins, PI Screen Saver, PI SPE Shell Extension, Visual Basic Interface, and the Imaging option.

Custom: By default, installs the WinSpec/32 application and DLLs, the help files, documentation, Acton spectrograph support, pulser support, selected Snap-Ins, PI Screen Saver, PI SPE Shell Extension, and the Imaging option. However, you can change the components for installation by checking and unchecking the boxes associated with the components. Allows you to install the drivers for SPEX spectrographs.

Installing from the CD

1. Exit any software currently running. This will speed the installation of WinSpec/32.
2. Insert the WinSpec/32 CD into your CD drive. Windows will detect the CD and the installation will begin automatically.

Note: If the auto-start feature has been disabled on your computer, click the desktop **Start** button, select **Run**, key **x:\Setup** (where “x” is the letter designating your CD drive) and press the **Enter** key on your keyboard. The install sequence will begin.

Caution

> If your CD drive doesn't support the Windows long filenames, attempting the installation causes the filenames to be truncated and the installation fails, generating an error message like:
>
> **An error occurred during the move data process: -113**
> **Component: Application\WinXSystem**
> **File Group: WinXSystem**
>
> If this should happen, see Appendix E for workarounds.

3. Click on the program that you want to install. If you have clicked on "Install WinSpec/32 or WinView/32" you will be given additional choices on the next dialog box.
4. After selecting the program, follow the instructions provided on the dialog boxes and continue with the installation process. You can abort the installation at any time by clicking on **Cancel** and following the instructions.

Installing from the FTP Site

> If you aren't sure how to access the FTP site, contact Roper Scientific's Technical Support Department for assistance. Contact information follows.
>
> Roper Scientific
> 3660 Quakerbridge Road
> Trenton, NJ 08619 (USA)
> Tel: 800-874-9789/609-587-9797
> Fax: 609-587-1970
> Tech Support E-mail: techsupport@roperscientific.com
>
> For technical support and service outside the United States, see our web page at www.roperscientific.com. An up-to-date list of addresses, telephone numbers, and e-mail addresses of Roper Scientific's overseas offices and representatives is maintained on the web page.

1. Log onto the FTP site and go to the Software/Official/Current directory.
2. Execute the program WinSpec.exe and follow the instructions on your screen. You can abort the installation at any time by clicking on **Cancel** and following the instructions.

Custom Installation Choices

Application Files: Loads the actual WinSpec/32 files.

Help Files: Loads the Help System, both general and context-sensitive Help.

PCI Interface: Loads the drivers for the PCI Interface card.

Sample SPE Data Files: Creates a directory **Data** containing sample *.SPE files. This directory is located beneath the one containing the WinSpec/32 files.

Diagnostic Program: Loads the diagnostics program pidiag32.exe. It is located in the directory containing the WinSpec/32 application files and can be executed by double-clicking on pidiag32.exe via the Windows Explorer.

Spectrograph Support: Loads drivers for Acton and/or Spex spectrographs.

Pulser Support: Loads the pulser drivers. Currently supported pulsers include the PTG, the PG200, and the DG535 Timing Generator (drives the PI-MAX pulsing circuits).

Snap-Ins: Loads the selected Snap-In files. When a Snap-In is installed, its button will be added to the Snap-In toolbar.

PI Screen Saver: Loads the PI Screen Saver.

PI Shell Extension: Provides additional SPE file properties pages. *Right-click on SPE file name and select Properties. With PI Shell Extension deselected, only the standard Windows'95 file property page will appear. With PI Shell Extension selected, additional property pages will appear.*

Visual Basic User Interface: Allows DLLs programmed using Visual Basic 5 or higher to be executed from WinSpec/32.

Options: Allows you to install or uninstall the Imaging option.

Installing the PCI Card Driver

Administrator privileges are required under Windows NT, 2000, and XP to install software and hardware.

Before installing the PCI card in your computer, turn the computer off. Follow the instructions supplied with your computer for installing an internal card and install the PCI card. After you have secured the card in the computer and replaced the cover, turn the computer on. When Windows boots, it will try to install the new hardware. If it cannot locate the driver, you will be prompted to enter the directory path, either by keyboard entry or by using the browse function.

If you selected AUTO PCI, WinSpec/32 automatically put the required INF file into the Windows/INF directory and put the PCI card driver file in the Windows/System32/ Drivers directory.

Windows Version	PCI INF Filename Located in "Windows"/INF directory*	PCI Device Driver Name Located in "Windows"/System32/Drivers directory
Windows 2000 and XP	rspi.inf (in WINNT/INF, for example)	rspipci.sys (in WINNT/System32/Drivers, for example)
Windows NT	N/A	pi_pci.sys
Windows 95, 98 and Windows ME	pii.inf	pivxdpci.vxd

* The INF directory may be hidden.

Table 1. PCI Driver Files and Locations

Installing the USB 2.0 Card Driver

Administrator privileges are required under Windows NT, 2000, and XP to install software and hardware.

Before installing the Roper Scientific USB2 Interface, we recommend that you defragment the host computer's hard disk. This operation reduces the time the computer spends locating files. Typically, the "defrag" utility "Disk Defragmenter" can be accessed from the Windows® Start menu and can usually accessed from the Programs/Accessories/System Tools subdirectory.

After defragmenting the hard disk, turn off the computer and make the USB cable connections between the host computer and the ST-133A. Then, turn the ST-133A on before turning on the host computer.

At bootup, Windows will detect the Roper Scientific USB2 Interface hardware (i.e., the USB 2.0 Interface Control module). You may be prompted to enter the directory path(s) for the apausbprop.dll and/or the apausb.sys file(s), either by keyboard entry or by using the browse function.

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

Windows Version	USB INF Filename Located in "Windows"/INF directory*	USB Properties DLL Located in "Windows"/System32 directory	USB Device Driver Name Located in "Windows"/System32/Drivers directory
Windows® 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 2. USB Driver Files and Locations

After the drivers have been installed, you will need to create a PVCAM.INI file. This step is required because cameras using the USB 2.0 interface are considered PVCAM® cameras.

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

   Note: If the first camera in the list is not the "Princeton Style (USB2)", you will need to edit the PVCAM.INI file created by RSConfig. See the instructions in *"Demo, High Speed PCI, and PCI(Timer) are Choices on Hardware Wizard:Interface dialog"*, page 237.

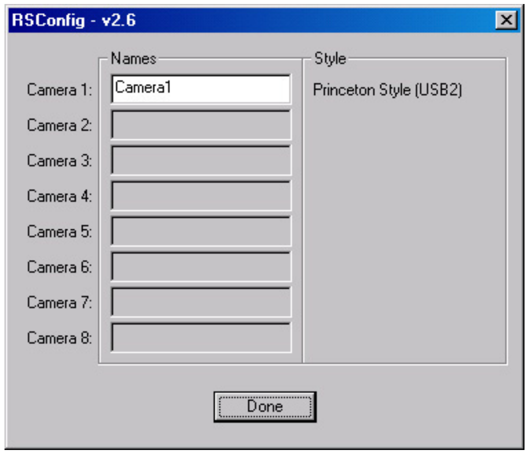


Figure 1. RSConfig dialog box

4. Open WinSpec and, from **Setup|Hardware…,** run the Hardware Wizard.
5. When the PVCAM dialog box (Figure 2) 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.

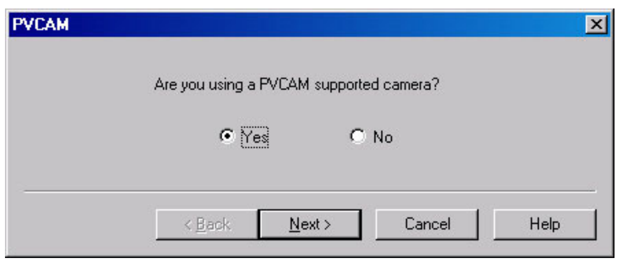


Figure 2. Hardware Wizard: PVCAM dialog box

Changing Installed Components, Repairing, or Uninstalling/Reinstalling WinSpec/32

Refer to Appendix F.

Starting WinSpec/32

Before starting WinSpec/32, follow the hardware interconnection and power up instructions in the hardware manuals supplied with your system. Then, open the Windows Program manager and start WinSpec/32 by clicking on WinSpec32 in the Roper Scientific folder (see Figure 3).

Note: You can start WinSpec/32 even if you have not installed the interface card or if you have not turned on the controller. If there is no interface card, WinSpec/32 will run in "Demo" mode. This mode allows you to look at and post-process previously stored data (such as the sample data installed with the software) and to become familiar with experiment setup and data acquisition. Some features will not be available because the program looks for information from the controller and camera while WinSpec/32 is loading and initializing.

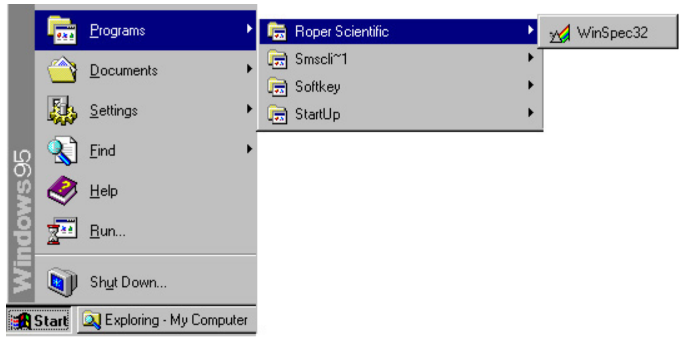


Figure 3. Opening WinSpec/32 from the Program Manager

WinSpec/32 follows the Windows 95 graphical interface conventions. While the software is booting, a splash screen such as the one shown in Figure 4 is displayed until the software has finished loading and initializing. Then, the Main Menu appears as shown in Figure 5. From there, you can access the program's functions through menu selection.

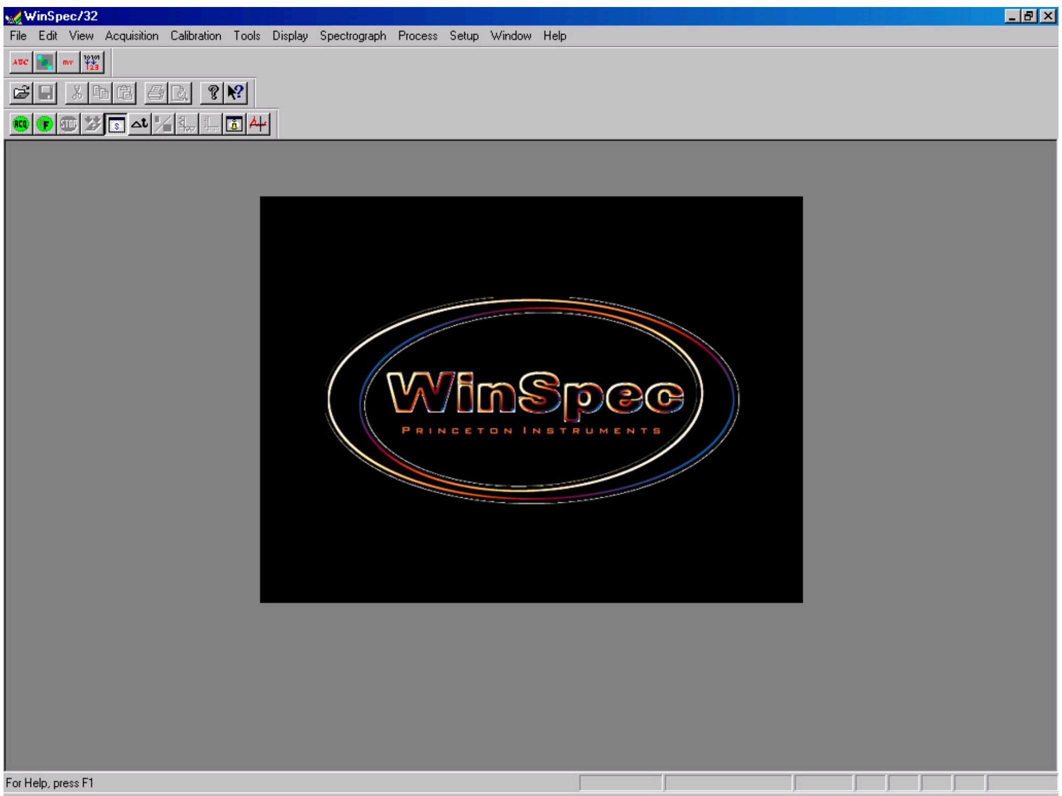


Figure 4. Splash screen

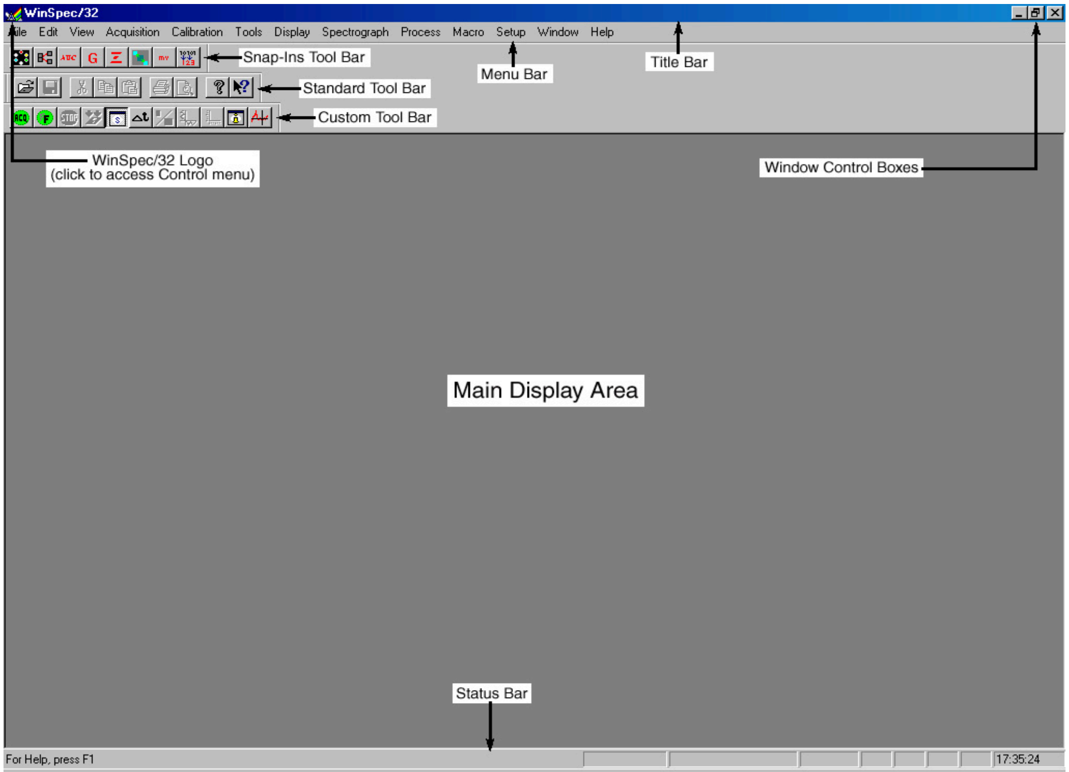


Figure 5. Main WinSpec/32 window

Values, labels, and alphanumeric data are usually entered from the keyboard. Selections and screen control operations are usually done using a mouse or other graphical I/O device, although keyboard selection shortcuts are provided. Mouse selection is typically done by positioning the mouse cursor on the selection item and clicking the left mouse button. In some case, clicking the *right* mouse button will bring up a dialog box with additional information or a special menu that allows additional operations to be performed.

Chapter 2
Basic Hardware Setup

Introduction

This chapter provides an overview of the relationships between the camera, the controller, and the host computer. This overview is followed by a discussion of the Setup Wizard that runs the first time you select Hardware from the Setup menu (Figure 6). The remainder of the chapter presents the Hardware Setup tab pages so you will be able to make the appropriate selections and entries for your system.

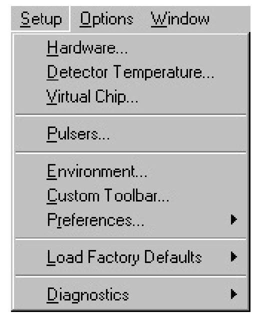


Figure 6. Setup menu

The chapters that follow describe how to configure a spectrograph, set up a pulser, set up experiment parameters, and control array temperature. Initial data acquisition is discussed in Chapters 3 and 4.

Advanced functions such as Post-Processing, User Defined Chip, and User Defined Timing are discussed in Part 2 of this manual.

Basic Hardware Overview

The basic components of a Roper Scientific system are: a camera (or detector), a controller, interconnecting cables, a computer interface card, and the application software (in this case WinSpec/32). Note that other components such as a computer, coolant circulator, and pulser can also be ordered.

The interface card, installed in the host computer, permits communication between the host computer and the controller (often an ST-133).

The controller accepts input from the host computer and WinSpec/32 and converts it to the appropriate control signals for the camera. These signals allow you to specify the readout rate, binning parameters, regions of interest, gain, and array temperature. After data is acquired in the camera, it is transmitted to the controller where it is processed, transmitted to the host computer, displayed in the WinSpec/32 window, and can be stored to disk. Figure 7 illustrates possible system configurations (spectrometers and pulsers are not shown). Figure 8 and Figure 9 show the interconnections for a Roper Scientific system, as well as interconnections to an optional coolant circulator, an optional shutter, and spectrometers.

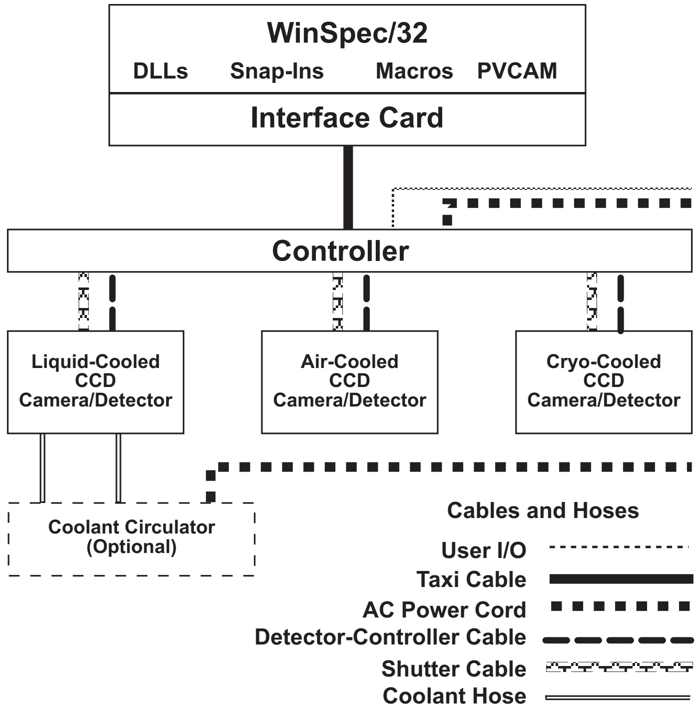


Figure 7. Possible System Configurations

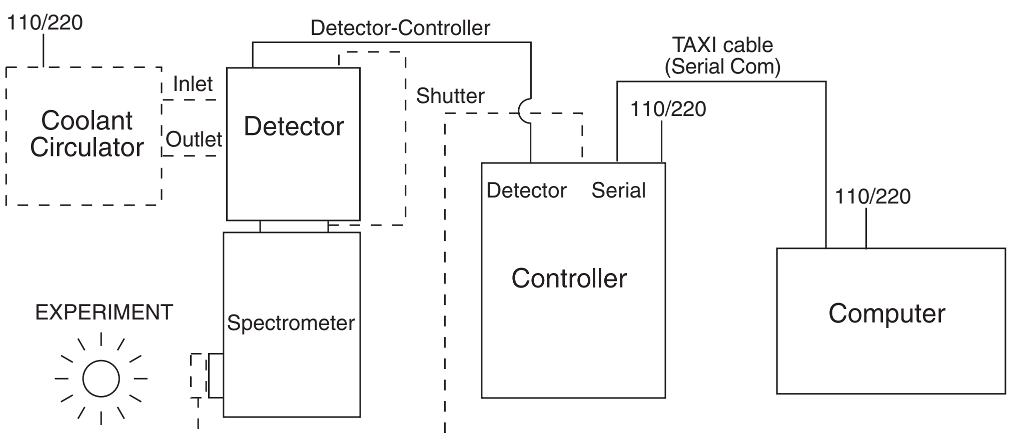


Figure 8. Liquid- or Air-Cooled System Diagram

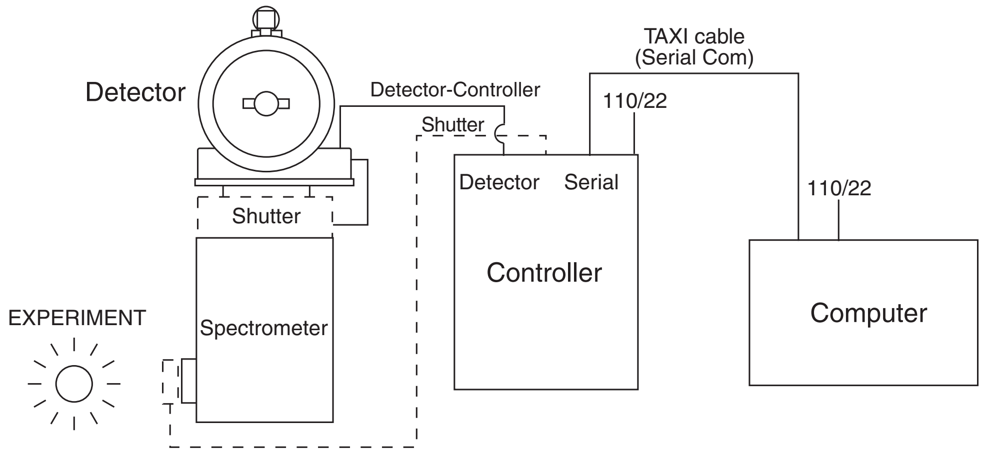


Figure 9. Cryo-Cooled System Diagram

Hardware Setup Wizard

The Setup Wizard runs the first time you select **Setup|Hardware** after WinSpec/32 has been installed on the host computer for the first time or when you are setting up a new controller for running in multi-controller mode. If a PIHWDEF.INI file has been copied to your WinSpec/32 directory, the selections specified in the PIHWDEF.INI will be implemented for the first controller and the Setup Wizard is not necessary.

The wizard leads you through the initial selection of interface, controller type, and Detector/Camera/CCD type. Once you have finished entering information through the wizard, it exits to the Hardware Setup dialog box, where you can make the remaining selections and review those made using the wizard.

The text that follows includes pictures of the dialog boxes you may see and background information about Non-Volatile RAM (NVRAM), interface cards, controllers, and default selections. Wherever possible, the text follows the order in which the dialog boxes will appear.

1. Optional Disk

In most cases you will not be getting a New System Configuration Disk with your system. Therefore, the default selection is "NO". If you do have such a disk, you would select "YES" and follow the directions for loading the information from that disk.

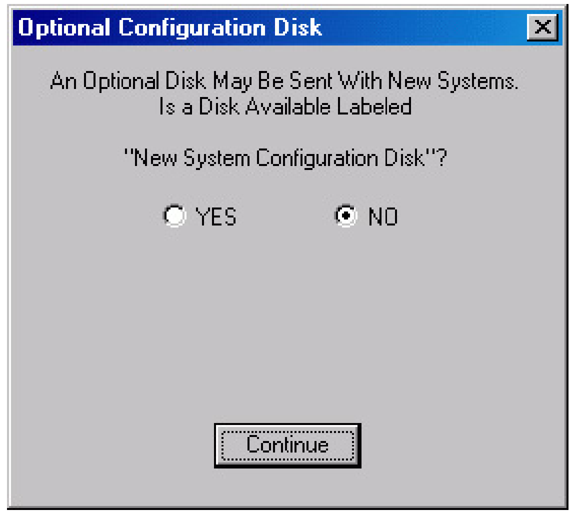


Figure 10. Optional Configuration Disk dialog box

2. PVCAM® Supported Camera Yes/No Selection

WinSpec/32 supports Princeton Instruments and Photometrics brand detectors as well as the Acton InSpectrum™. The choice of "Yes" or "No" determines the sequence of Hardware Wizard dialogs.

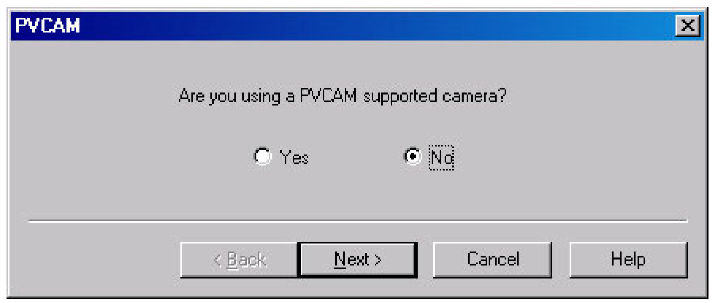


Figure 11. PVCAM dialog box

"No" is the default selection. This is the appropriate choice if you have a Princeton Instruments detector that uses the TAXI protocol (PCI interface). After you click on **Next**, the wizard looks for a Princeton Instruments brand compatible PCI card and opens the **Interface** dialog box.

"Yes" is the appropriate choice if you have a Photometrics camera or an Acton InSpectrum or if the Princeton Instruments detector communication interface is USB 2.0. After you click on **Next**, the wizard will "create the PVCAM controller" and will open the **Controller Type** dialog box.

3. Interface Selection

This dialog is skipped if you have a PVCAM-supported detector.

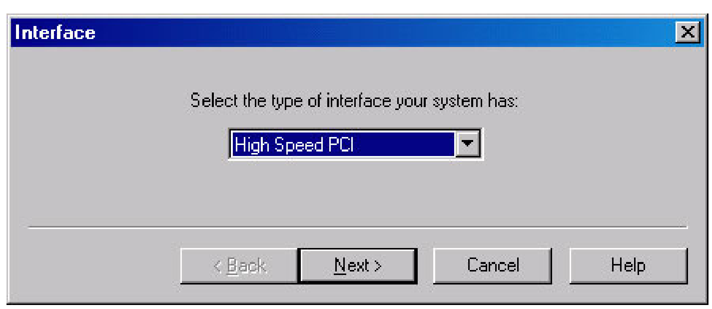


Figure 12. Interface dialog box

If you are using a Princeton Instruments brand detector with the RS PCI interface and a compatible PCI card is found, the choices will be PCI Timer, High Speed PCI, and Demo. The default will be "PCI Timer" data transfer mode in which data transfer is controlled by a polling timer. "High Speed PCI" is a data transfer mode in which data transfer is interrupt driven.

"Demo" provides limited access to WinSpec functions and allows you to display previously acquired data and to use post-processing techniques to analyze it.

After you have selected the interface, click on **Next**, to open the **Controller Type** dialog box.

4. Controller Selection

Note: The **Controller Type** for PVCAM-supported detectors is automatically determined from the entry in the PVCAM.INI file.

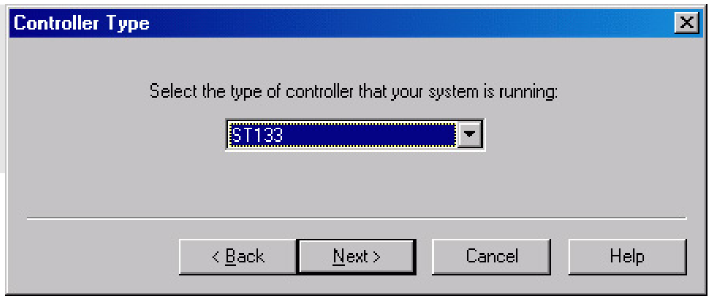


Figure 13. Controller Type dialog box

For Princeton Instruments detectors using the TAXI (PCI) interface, the wizard checks to see if NVRAM is installed in the controller or detector. NVRAM contains detailed information about your system's controller and detector. Note that some controllers and detectors do not contain NVRAM so you will have to select the appropriate entries. See Appendix A for a cross-reference table for systems, controllers, and CCD arrays.

If the wizard finds NVRAM, the wizard reads the controller and detector information and inserts that information into the Controller Type and Detector/Camera/CCD dialog boxes. If it does not find NVRAM, it enters "ST-133" as the default controller. If you have an ST-121, ST-130, or ST-138 controller, you will have to select it from the dropdown list.

The **Controller Type** selection is critical because it determines the nature and type of the other selections that will be available, including the detector type, display orientation options, cleans & skips, and user defined chip parameters. No single controller provides all possible selections, and only the ones applicable to the selected controller are listed on the Hardware Setup dialog box tab pages.

5. Detector/Camera/CCD Selection

Note: The **Detector/ Camera/CCD** for a PVCAM-supported camera is automatically determined from the camera entry in the PVCAM.INI file.

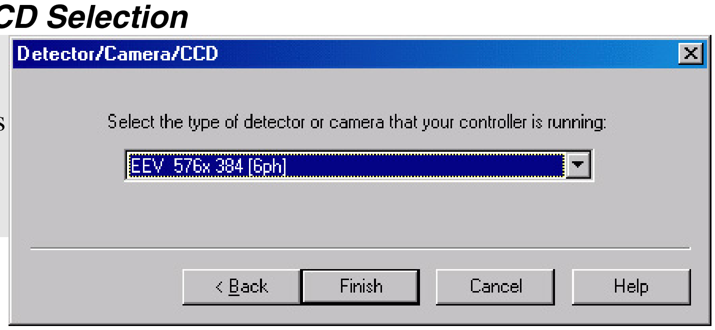


Figure 14. Detector/ Camera/ CCD Setup dialog box

The **Detector/Camera/CCD** dialog is displayed after you select the controller type. Only the detector, camera, or CCD types associated with the selected controller will be available for selection. If your system has NVRAM, the correct selection will be automatically made. Otherwise, you will need to choose from the list. After you click on **Finish**, the **Hardware Setup** dialog box will be displayed so you can begin entering other hardware information.

Entering Controller and Detector Characteristics

The **Controller/Detector** tab page *(may also be named Controller/Camera or Controller/CCD depending on the hardware selections)* is used to enter and update Controller Type, Detector (Camera or CCD, depending on the system) Type and some of the Controller/ Detector type parameters, such as Shutter Type and Readout Mode. The Controller and Detector Type selections are perhaps the most fundamental and important of all hardware selection decisions and directly influence the appearance of many other WinSpec/32 screens and the selections provided on them. As a result, setting up the software for use in any system should always begin with the Controller selection.

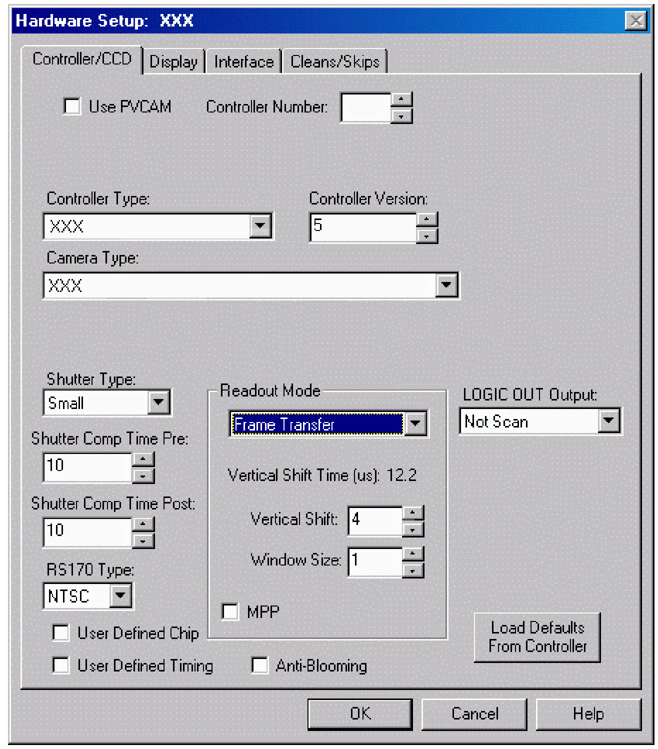


Figure 15. Controller/Camera tab page

Figure 15 shows all of the fields and checkboxes that exist on the **Controller/Detector** tab page. WinSpec/32 will display and hide features based on the controller, detector, and readout mode selected. All of the features are described in the text that follows.

Use PVCAM: This box will only appear if you have an installed Tucson PCI interface card or have an installed USB 2.0 interface for a Princeton Instruments detector or the Acton Research InSpectrum. This box is automatically checked when you indicate during installation that you are using a PVCAM-supported camera.

Note: When you change the check status of this box, a warning message ***"Changing This Value Will Cause All Current Controllers To Be Destroyed! Do You Want To Continue?"*** appears. This message means that the current Hardware settings will be deleted and the Hardware Wizard will be displayed so you can characterize the new controller and detector.

Controller Number: This field will only appear if you have more than one Princeton Instruments brand PCI interface card installed. If you have a controller connected to each PCI card, you would select the number of the controller that you want to use.

Controller Type: The currently selected Controller Type is displayed in this field. If you change the controller that is being used in the system, choose the correct controller name from the selection list (displayed by clicking on the button at the end of the field). Appendix A provides a cross-reference table for systems, controllers, and CCD arrays.

Note: After you have selected the **Controller Type**, you can load the default settings for your controller, camera, and CCD array by clicking on **Load Defaults From Controller**, if this button is present.

Controller Version: In the case of the ST-133, MicroMAX, SpectroMAX, and PentaMAX controllers, different versions have been released having different capabilities. The available software selections will correctly reflect these differences when the proper version number is specified in this box.

Camera Type: The selected Camera (Detector/CCD) Type is displayed in this field. Clicking on the button at the end of the box drops the selection list so that the selected type can be changed if necessary. Note that the listed camera types depend on the controller selection, requiring that the controller type be specified first.

Shutter Type: There are five selections, None, Small, Large, Remote and Electronic.

None: If the camera has no shutter (frame-transfer or interline CCD array) and is not an Intensified camera, select **None**.

Small: A small shutter is one that is typically 25 mm or smaller in diameter. This setting represents a shutter compensation time of approximately 8 msec.

Large: A large shutter is one that is typically 35 mm and larger. In the case of a camera having a very large CCD, such as the Kodak 2k × 2k, a large shutter may have been installed. This setting represents a shutter compensation time of approximately 16 msec.

Remote: **Remote** is primarily intended for spectroscopy applications where an external shutter would be placed ahead of the entrance slit.

Electronic: **Electronic** only applies to operation with an intensified camera, which would normally not be equipped with a mechanical shutter. This selection would apply to both the Gate and Shutter/CW modes of the IIC-100, IIC-200, IIC-300, MCP-100, and PI-MAX

Readout Mode: The readout mode is determined by the characteristics of the CCD array and the controller. The possible choices are:

Full Frame: The entire chip can be read out.

Frame Transfer: Only the unmasked area of the chip can be read out. Frame transfer is only available if the camera has a frame-transfer chip such as the EEV 512 × 1024.

Vertical Shift: Determines the speed of the image transfer from the exposed area of a frame-transfer chip to the masked area. Also sets the speed of image transfer when operating in the Kinetics mode. Setting a lower value increases the shift speed. A higher value gives a slower shift. If the shift is too fast, not all of the charge will be transferred. If too slow, image smearing will be increased due to the exposure that takes place while the transfer is in progress. The default value gives good results in most measurements.

Interline: Provides 100% duty cycle operation. Interline is only available with a camera having an interline chip such as the PI 1300 × 1030.

Kinetics: Kinetics is a special type of operation in which most of the CCD is mechanically or optically masked, leaving a small section open to light. This section is then read out very quickly. See the System or Controller manual for more details on the CCD aspects of this readout mode.

Window Size: Determines the height of the window for **Kinetics** mode. This value must be 1 or greater.

DIF: **(MicroMAX Interline only)** Dual Image Feature (DIF) is a special feature that allows images to be taken in pairs with very short exposure times (as small as 1 µs). This feature is only available for factory modified MicroMAX controller/Interline camera systems. Operating in this readout mode provides three timing modes unique to DIF systems: IEC (Internal Exposure Control), EEC (External Exposure Control) and ESABI (Electronic Shutter Active Between Images). These modes are in addition to Free Run mode.

MPP: This checkbox may appear if the CCD array is designed for MPP (multi-pinned-phase) operation. When this box is checked, the array will be run in MPP mode. Some MPP-capable arrays can also be run in Non-MPP mode (MPP box is unchecked). Running in Non-MPP mode may result in higher dark current in addition to larger full well capacity.

> **Note:** MPP capability reduces the rate of dark-current generation by a factor of 20 or more, and thus relaxes CCD cooling requirements to the level where a thermoelectric cooler is sufficient for most applications.

LOGIC OUT Output: The choices for the signal provided at the controller's **SCAN** Output connector vary based on the selected Controller. If the **LOGIC OUT** field doesn't appear on the tab page, the choice of output may be done via an internal jumper (for information on how to set the jumper,.contact factory Tech Support.). Depending on your system, the following choices may appear in the drop down list:

Cleaning: This signal is high when an array Clean cycle is in progress and otherwise low.

Logic 0: Establishes a TTL logic 0 at the **Logic Out** connector.

Logic 1: Establishes a TTL logic 1 at the **Logic Out** connector.

> **Note:** LOGIC 0 and LOGIC 1 can be used to control an external device using the application software.

Not FT Image Shift: This signal is low when a frame-transfer shift is in progress and otherwise high.

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, then returns high.

Not Scan: Reports when the controller is finished reading out the CCD array. **NOTSCAN** is high when the CCD array is not being scanned, then drops low when readout begins, returning to high when the process is finished.

Shutter: This signal is low when the shutter is closed and goes high when the shutter is activated, dropping low again after the shutter closes. In Gated operation, **SHUTTER** is the correct choice and the signal should be applied to the inhibit input of the pulser to prevent pulsing during readout.

Shutter Comp Time Pre: Delays the acquisition until the shutter (if present) is fully open. The setting range is 0 to 30 ms. For single-strip spectroscopic measurements, a setting of "0" is recommended.

RS170 Type: Selections are NTSC (US video standard) and PAL (European).

User Defined Chip: Advanced feature. See Custom Chip discussion on page 193.

User Defined Timing: Advanced feature. See Custom Timing discussion on page 194.

Anti-Blooming: **(THM 1024x1024FT CCD array)** Checking this box activates this CCD array's anti-blooming feature.

Load Defaults From Controller: Pops up the **Load Factory Defaults From NVRAM** dialog box so you can repopulate the fields and selections with the values stored in the controller's non-volatile RAM.

Entering the Data Orientation

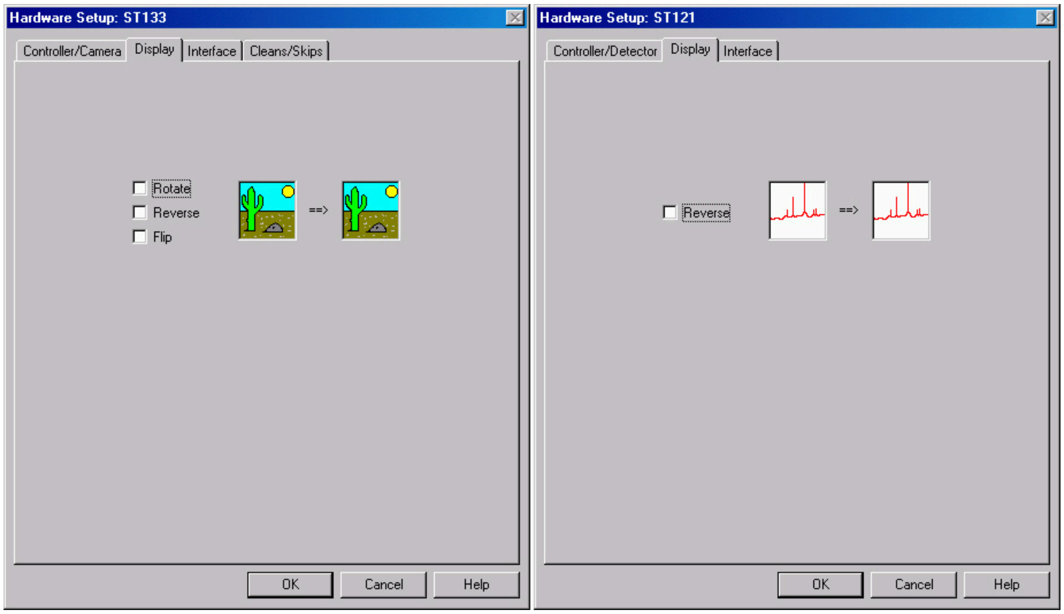


Figure 16. Display tab page; left graphic applies to all controllers except ST-121; right graphic applies to ST-121 only

With the exception of the ST-121, the **Display** tab page is the same for all controllers. Three display options, Rotate, Reverse and Flip, are provided. This feature allows you to compensate for CCD array or camera orientation. Before and after thumbnail illustrations show the effect of each selection. If no option is selected, the thumbnails will be the same. Any orientation can be achieved with the proper combination of Rotate, Reverse, and Flip. In the case of the ST-121, only Reverse is provided.

Rotate: Rotates the image 90° counterclockwise.

Reverse: Reverses the image horizontally.

Flip: Flips the image vertically.

Entering the Interface Communication Parameters

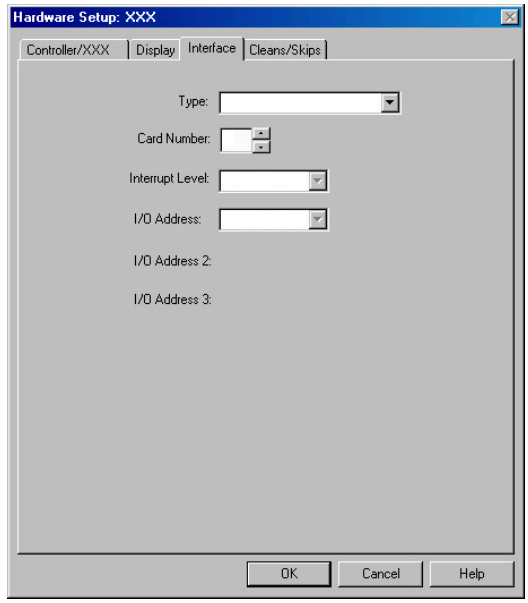


Figure 17. Interface tab page

The **Interface** tab page allows you to specify the interface card installed in your computer and to enter the I/O addresses (if required). This functionality is particularly useful if you have multiple PCI cards installed in the host computer. Figure 15 shows all of the fields and checkboxes that exist on the Interface tab page. WinSpec/32 will display and hide features based on the interface card installed in the host computer. All of the features are described in the text that follows.

Type: Select the communications type that will be used to transmit data from the controller to the computer. All communications types are not available for all controllers and computers. The "Demo" selection, which allows the software to be exercised but which doesn't support data transfer to the computer, would not ordinarily be used in the field.

High Speed PCI: Select if a PI PCI high-speed serial Interface card is installed in your computer and you want data transfer to be interrupt driven. This choice would give the highest performance in most situations.

PCI Timer: Allows data transfer to be controlled by a polling timer if using PCI high-speed serial Interface card. Useful for troubleshooting possible interrupt problems (computer crashes or system fails to return data). Note that data transfer is slower in PCI Timer mode and data overrun more likely. Also PCI Timer cannot be used to continuously acquire small Regions of Interest in asynchronous operation. PCI Timer isn't compatible with **Use Interrupts** operation, a timing mode available when using the ST-138 Controller.

Demo: Allows the software to be exercised without being connected to a controller. This mode is used primarily for demonstration purposes or post-processing of acquired data and cannot be used in an actual measurement.

Interrupt Level: The interrupt level for a PCI card is reported but cannot be changed.

Card Number: This field only appears if more than one PCI card has been detected in your computer. This field allows you to set up the communications parameters so each card is uniquely addressed.

I/O Address: The I/O Address for a PCI card is reported but cannot be changed.

I/O Address 2 and 3: **(High Speed PCI only)** These addresses are reported but cannot be changed; address selection is automatic and under computer control. With other interfaces, these addresses are not displayed.

Entering the Cleans/Skips Characteristics

Caution

For most applications, the default settings will give the best results. We advise contacting the factory for guidance before changing these parameters from their default values. ***Exception:*** With a PI-MAX camera, we suggest settings of Cleans 1 and Strips per Clean 4, Minimum Block Size 16 and Number of Blocks 32.

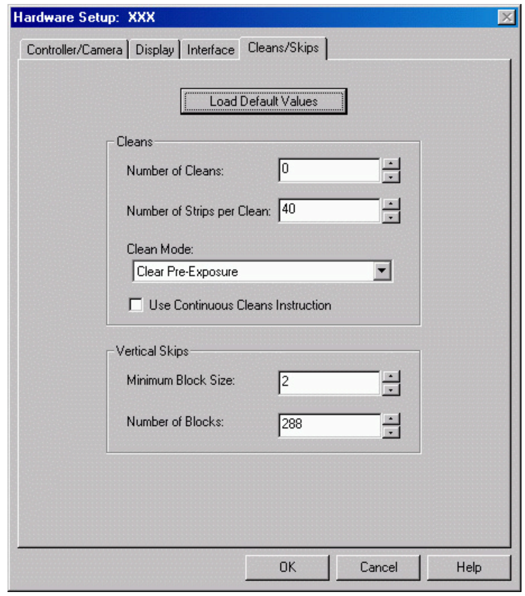


Figure 18. Cleans/Skips tab page

The **Cleans/Skips** tab page allows you to change the clean and skip parameters from their default values or to reload the default values. Figure 18 shows all of the fields and checkboxes that exist on the **Cleans/Skips** tab page. WinSpec/32 will display and hide features based on the controller version. All of the features shown are described in the text that follows. Refer to Chapter 9, "Cleaning" for additional information.

Load Default Values: Reloads the factory defaults from the NVRAM.

Cleans

Cleans are applied to the entire CCD array and remove charge that has accumulated on the array while waiting for data acquisition to begin. The charge on the CCD chip is transferred to the shift register and discarded to prevent charge buildup from occurring. On completion of a setup, successive clean cycles occur normally. The **Number of Cleans** and **Number of Strips per Clean** parameters allow you to program additional clean cycles that will be performed after initiating the run but before any data is taken.

Number of Cleans: For most applications the default value should be used. Clicking on the **Load Default Values** button and then selecting **Yes** will install the default value. Values other than the default can be directly entered in the field or selected via the spin buttons.

Number of Strips per Clean: Sets the number of CCD data strips to be transferred and discarded during each clean. The maximum valid setting is limited by the chip size. The default value will generally give good results.

Clean Mode: (Photometrics brand cameras) Sets when and how charge will be cleared from the array while the camera is waiting to acquire data. Clearing removes charge from the CCD by clocking the charge to the serial register then directly to ground. This process is much faster than a readout, because the charge does not go through the readout node or the amplifier. Note that not all clearing modes are available for all cameras. Be sure to check availability of a mode before attempting to set it.

Clear Never: Don't ever clear the CCD. Useful for performing a readout after an exposure has been aborted.

Clear Pre-Exposure: Before each exposure, clears the CCD the number of times specified by the Number of Cleans entry. This mode can be used in a sequence. It is most useful when there is a considerable amount of time between exposures.

Clear Pre-Sequence: Before each sequence, clears the CCD the number of times specified by the Number of Cleans entry. If no sequence is set up, this mode behaves as if the sequence has one exposure. The result is the same as using Clear Pre-Exposure.

Clear Post-Sequence: Clears continuously after the sequence ends. The camera continues clearing until a new exposure is set up or started, the abort command is sent, the speed entry number is changed, or the camera is reset.

Clear Pre/Post-Sequence: Clears Number of Cleans times before each sequence and clears continuously after the sequence ends. The camera continues clearing until a new exposure is set up or started, the abort command is sent, the speed entry number is changed, or the camera is reset.

Clear Pre-Exposure Post-Sequence: Clears Number of Cleans times before each exposure and clears continuously after the sequence ends. The camera continues clearing until a new exposure is set up or started, the abort command is sent, the speed entry number is changed, or the camera is reset.

Use Continuous Cleans Instruction: This feature is supported by Version 5 (and higher) ST-133 and MicroMAX controllers and will only appear if the detector/camera also supports this feature. Continuous cleans instruction does horizontal shifts while doing vertical shifts for a faster continuous clean. Check this box if you want to apply the continuous cleans instruction to the continuous cleans function available when External Sync timing mode (**Experiment Setup|Timing** tab page) is being used to acquire data. ***With this instruction, the delay between an External Sync trigger and the start of exposure is minimized.*** Refer to Chapter 9, "Cleaning" for more information about continuous cleans and continuous cleans instruction**.**

Note: Older versions of the ST-133 and MicroMAX controllers, as well as other controller types and cameras, do not support this instruction.

Vertical Skips

Vertical skips are associated with regions of interest (ROIs) that are smaller than the full chip. This feature allows you to bin and quickly traverse the rows that precede and follow the ROI. The rows to be processed and discarded are binned into blocks, each containing a number of rows, with the Number of Blocks parameter determining how many blocks there will be before and after the ROI.

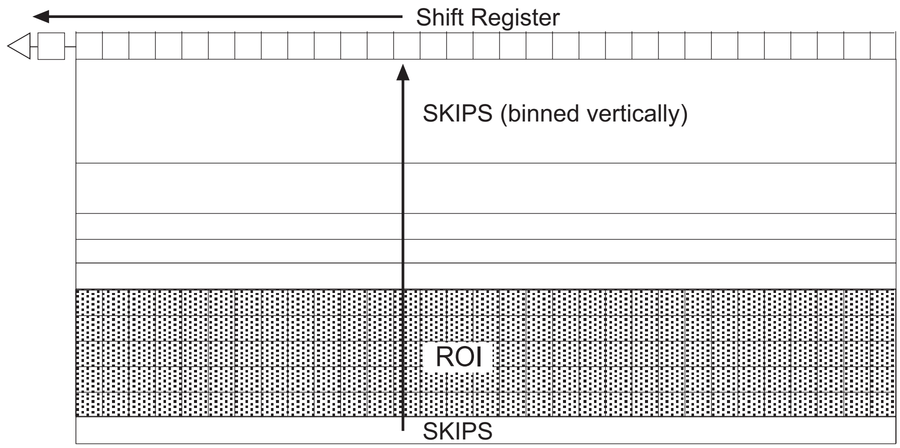


Figure 19. Vertical Skips

The block size determines how quickly the region preceding and following the ROI will be traversed. If the blocks are large, the region will be traversed quickly but there is the possibility of overloading the shift register and causing blooming. With small blocks, the risk of blooming will be minimized but the time to traverse will be large. WinSpec/32 uses an exponential algorithm to simultaneously achieve rapid traversing with minimal risk of blooming. The first block, specified in rows, is as large as possible. Each successive block is a factor of two smaller than the one preceding until the minimum block size is reached. All remaining blocks are the minimum block size. By making the first block as large as possible and subsequent blocks increasingly smaller, the region preceding and following the region of interest is traversed as rapidly as possible while minimizing risk of the shift register saturation.

Minimum Block Size: Sets the size, in rows, of the skip blocks that immediately precede the data. The default value will generally give good results.

Number of Blocks: Sets the number of binned “skip” blocks preceding and following the region of interest. The default value will generally give good results.

Setting up a Spectrograph

WinSpec/32 allows you to control several types of spectrographs. More than one spectrograph can be installed in the system at one time. The total number of spectrographs is limited only by the number of free communication ports.

The following spectrograph operations can be performed after you define your spectrograph:

- Moving a spectrograph grating
- Automatic calibration of acquired data according to the spectrograph position.
- Changing to a different grating for some spectrographs.
- Changing the entrance slit size and/or the selected mirror for some spectrographs.

The following steps explain how to set up a spectrograph. You must correctly install a spectrograph before you can control any of its functions through WinSpec/32.

1. Make sure that the spectrograph is correctly connected to a host computer COM port.
2. Turn on the host computer and the spectrograph.
3. Wait for the spectrograph to finish initializing and then boot WinSpec/32. If this isn't done, although you will be able to install the spectrograph, it will not be possible to establish communications and an error message will result.

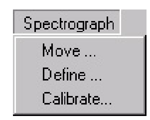


Figure 20. Spectrograph menu

4. Select **Define** on the Spectrograph menu (Figure 20). This will open the Define Spectrograph dialog box (Figure 21).
5. On the **Main** tab page, note the Active Spectrograph text entry box. If spectrographs have previously been installed, the active one will be indicated. If no spectrograph has been previously installed, the box will be blank. Note there is a checkbox that allows you to designate a particular spectrograph as the one that will be used for doing an Auto-Spectro Calibration.

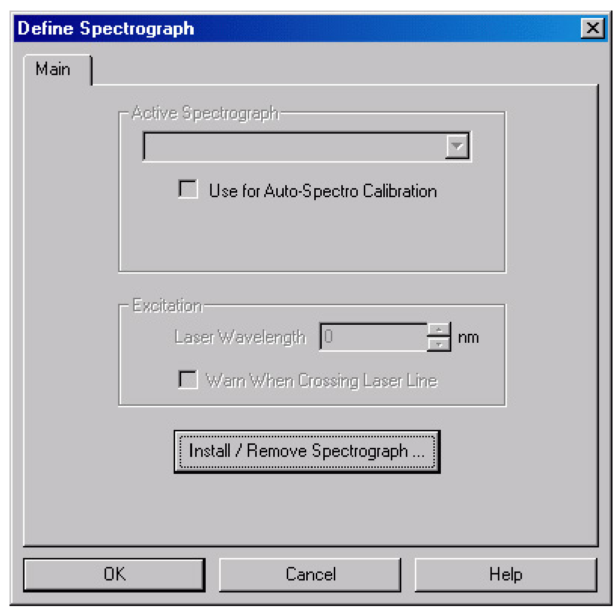


Figure 21. Define Spectrograph dialog box

6. Click on **Install/ Remove Spectrograph**. This will open the Install/Remove Spectrographs dialog box (Figure 22). The lower window lists the supported Spectrographs. The upper window lists those installed. To install a spectrograph, select it from the list in the lower window, select the Communications Port (Auto, COM1-COM8, or DEMO) and click on **Install Selected Spectrograph**. The installed spectrograph will then appear in the upper window. In the case of the example shown in Figure 22, the selected spectrograph is an Acton SP300i.

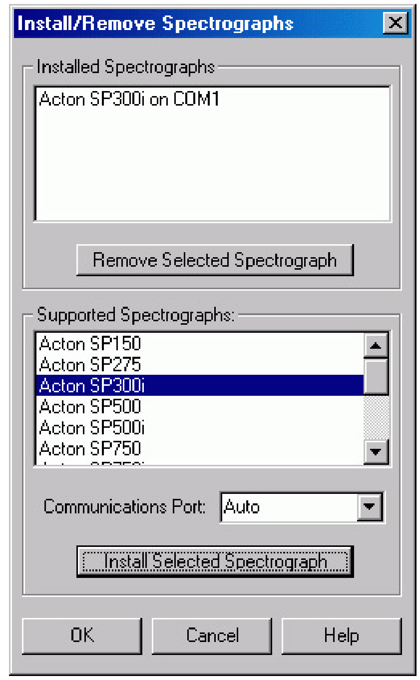


Figure 22. Install/Remove Spectrographs

Notes:

1. When you click on **Install Selected Spectrograph** to install the spectrograph, WinSpec/32 will try to connect the spectrograph to the selected communications port. If you select "Auto" as the port, the system will assign the spectrograph to the first available COM port. If the spectrograph is not found, an error message is displayed. Even if communication is not established, the spectrograph and its assigned port will be added to the list (for example, *Acton SP300i on COM2*).
2. To install another spectrograph, repeat the installation procedure.
3. To remove a spectrograph, select it in the upper box and click on **Remove Selected Spectrograph**. The spectrograph's name will then disappear from the upper window.
4. More than one spectrograph can be assigned to a port. However, only one spectrograph can be active at a time. If you have multiple spectrographs assigned to a port, make sure that the active spectrograph (refer to the Active Spectrograph field on the Main tab page) is the one that is (or will be) physically connected to the port.
5. If you plan to install more than one spectrograph for a COM port, it would be a good idea to make sure that the connection preferences are the same for all of the spectrographs assigned to that port.

7. Click on **OK** to close the **Install/Remove Spectrographs** dialog box.
8. If the newly installed spectrograph is the only installed spectrograph, the **Use for Auto-Spectro Calibration** box will be checked by default. If more than one spectrograph is installed, you need to check in the box for the spectrograph that is attached to the active detector. The checked status indicates which spectrograph can be automatically calibrated using the Spectrograph Calibration function, which requires that the controller take data (see Chapter 7 for more information).

Ports and Comm Parameters

If the spectrograph is not connected to COM2 or if there was an error message during installation, specify the communications parameters and then assign a COM port to the active spectrograph. These steps are done as follows.

1. On the **Main** tab page, select your spectrograph as the "Active Spectrograph".
2. Click on the **Connect** tab.
3. Note the COM port named in the **Communications Port** field. If it is not the one you want to use for the active spectrograph, select the correct port from the drop down list. The choices are COM1 through COM8 and Demo.
4. Click on **Comm Settings** (Figure 23). This will open the Comm Settings dialog box as shown in Figure 24.
5. Set the connection preferences *according to the requirements of your spectrograph. For Acton Spectrographs, use the settings shown in Figure 25.*
6. Click on **OK** to close the Comm Settings dialog box. All parameters will be stored and automatically restored whenever WinSpec/32 is booted.

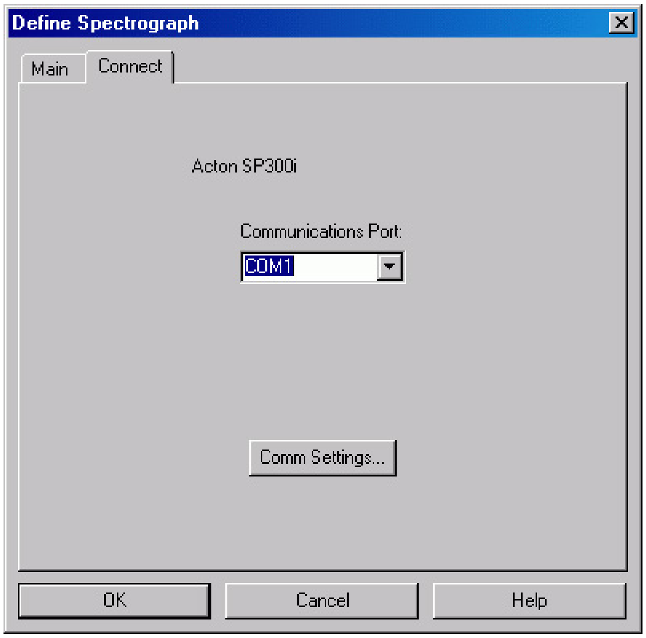


Figure 23. Connect tab page

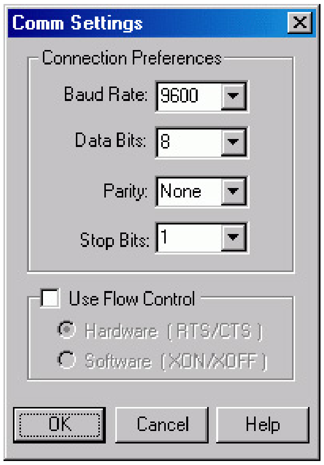


Figure 24. Comm Settings dialog box

Notes:

1. Set the COM parameters separately for each COM port that has an installed spectrograph.
2. Only one spectrograph at a time can be active at each COM port. However, multiple spectrographs can be installed for each COM port. If you plan to install more than one spectrograph for a COM port, it would be a good idea to make sure that the connection preferences are the same for all of the spectrographs assigned to that port.

Specifying the Active Spectrograph

If you have installed more than one spectrograph, you need to define the Active (controlled) Spectrograph. If there is only one spectrograph, that one is the active one. If there is more than one, than you must designate the active one. This can be done via the Define Spectrograph Main tab page, the Move Gratings tab page (to access, click on Move in the Spectrograph menu) and via the Calibrate Spectrograph dialog box (to access click on Calibrate in the Spectrograph menu). On the Define Spectrograph Main page the selection is called **Active Spectrograph**, on the Move Gratings tab page it is called **Spectrograph to Move**, and in the Calibrate dialog box it is called **Spectrograph to Calibrate**. In all three locations the function is simply to specify the active spectrograph, and changing the selection in one location is equivalent to changing it in all three. If only one spectrograph has been installed, the box won't appear in the Move or Calibrate dialog boxes, but the spectrograph model will be reported.

Entering Grating Information

Once you have installed a spectrograph, you may need to enter the grating information for the spectrograph if the spectrograph can't supply them automatically. This is information that WinSpec/32 needs to move and calibrate the spectrograph correctly. *Grating information is supplied automatically for automated Acton spectrographs, as stored in the spectrograph's electronics.*

Grating Parameters

The grating values are required for the dispersion calculation and for the selection of the active grating. Some spectrographs have interchangeable grating turrets, each able to mount up to 3 gratings. Where this is the case, the grating information may have to be separately specified for each turret that may be installed. These parameters are specified on the **Gratings** tab page (Figure 25) of the Define Spectrograph dialog box. *In the case of automated Acton spectrographs, the grating information is automatically supplied.*

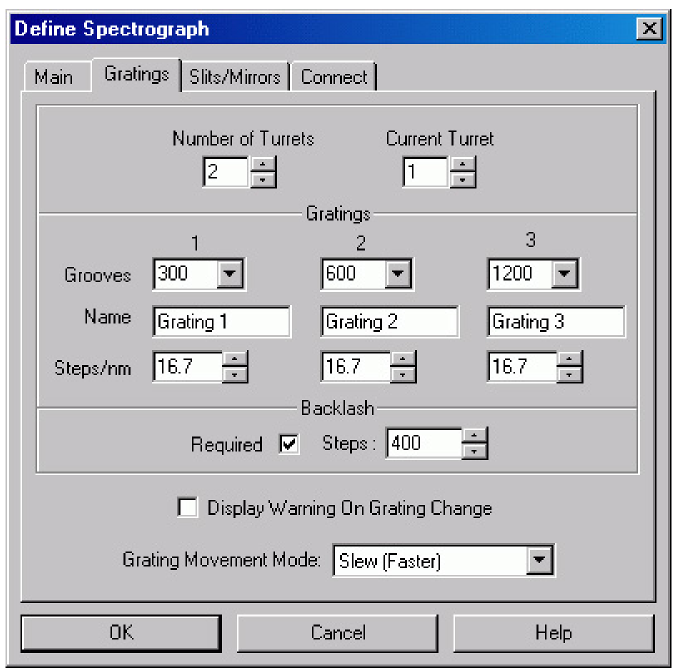


Figure 25. Gratings tab page
Setting the grating parameters

1. If there are two or more turrets, enter the number of the turrets.
2. Then from the **Current Turret** field, select the turret whose grating parameters will be defined.

3. If entries are missing or incorrect, select the correct grooves/mm value for each grating. Make sure that the gratings are listed in the proper order, Grating 1 listed first, etc.

4. You can also enter a Name for each grating. This option is required if you are using two gratings with the same groove density. If, for example, you have two gratings with 300 grooves/mm, one blazed at 300 and one blazed at 500, you could enter BLZ300 and BLZ500 in the Name boxes as identifiers. *These are the Acton default names.* Then, when you subsequently go to the Move Spectrograph dialog box to select the active grating, they would then be listed as 300/BLZ300 and 300/BLZ500 and there would be no possibility of confusing them.

5. If significant backlash occurs when moving the selected grating, check in the **Required** box and then enter the number of steps required to correct for the backlash.

6. If your spectrograph has more than one turret, replace the turret, change the Current Turret value and enter the new grating information. WinSpec/32 will store and recall the different sets of grating information for each turret.

7. Note that there is a checkbox for displaying a warning during a grating change. Since the time to change a grating can vary widely, depending on the spectrograph, this message could be very helpful.

8. If two rates are available for your spectrograph, you can also choose the rate, either faster (slew) or slower (scan). The actual rate will depend on the spectrograph. Depending on the spectrograph manufacturer and model, there may be a difference in wavelength setting accuracy for the two speeds.

Selecting and Moving the Grating

Once the required groove and turret information has been entered on the **Define Spectrograph Gratings** tab page, the next step is to select and move the grating. These operations are performed using the Gratings tab page (Figure 26) of the Move Spectrograph dialog box. The procedure follows.

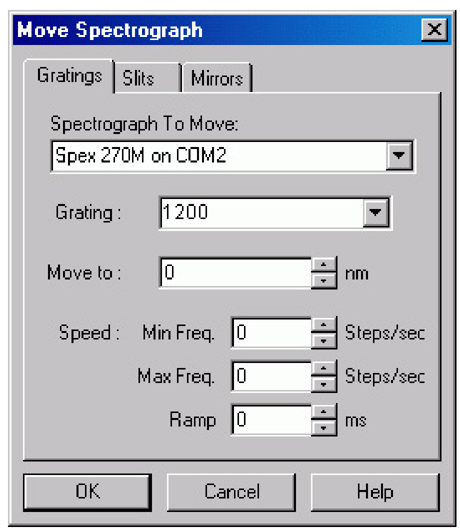


Figure 26. Move Spectrograph Gratings tab page

1. Open the **Move Spectrograph** dialog box by selecting **Move** from the Spectrograph menu.

2. On the **Gratings** tab page, verify that the indicated active spectrograph is the correct one.

3. Select the grating to be moved. The available gratings were previously entered on the Define Spectrograph Gratings tab page.

4. Enter the new position (in nm) in the **Move to** field.

5. Enter any speed settings and click on **OK** to execute the selections. The grating will come to rest with the selected wavelength at the center of the CCD array.

Note: There may well be some finite error in the final position. This error can be measured and compensated for using the Spectrograph Calibrate procedure.

Entering Information for Software-Controlled Slits and/or Mirrors

Some spectrometers allow you to control the slit width and/or do mirror selection under software control. Where this is the case, the Slits/Mirrors tab page (Figure 27) in the Define Spectrograph dialog box is used to specify the controllable slits and selectable mirrors. Actually setting the slit width and specifying which mirror to move is accomplished via additional tab pages provided in the Move Spectrograph dialog box as shown in Figure 28. Once the selections are made, simply press **OK** to execute them.

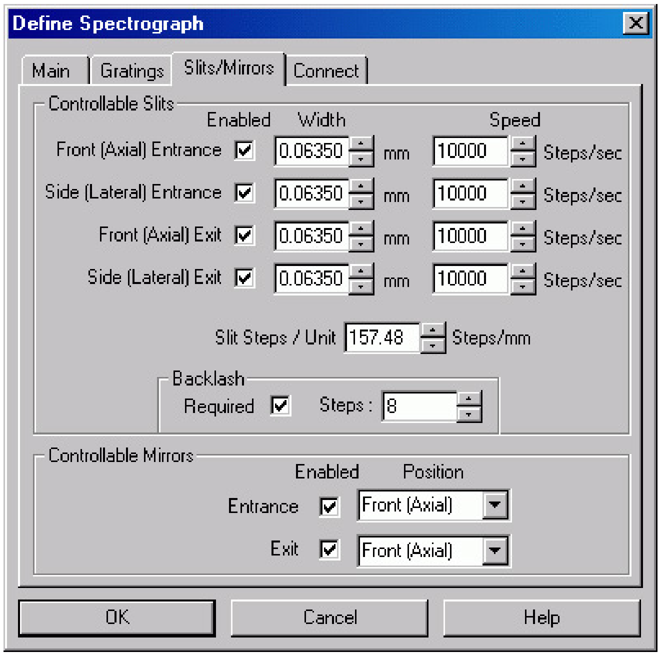
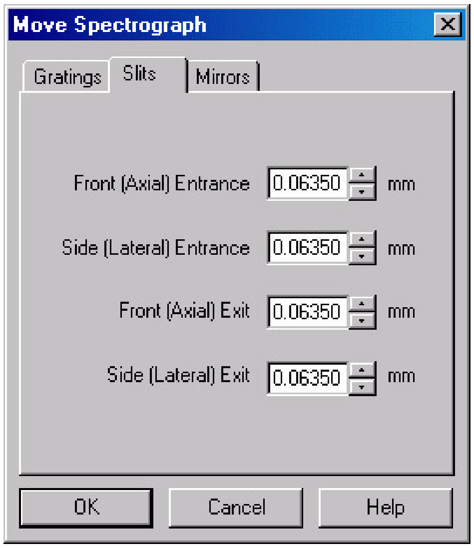


Figure 27. Define Spectrograph Slits/Mirrors tab page



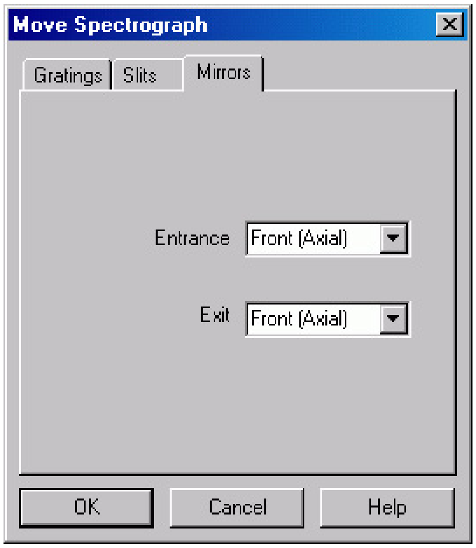


Figure 28. Slit width and Mirror selection tab pages - Move Spectrograph dialog box

Entering Laser Excitation Information

If you want to be warned if the laser will shine directly on the CCD, you need to enter the Laser Wavelength. This is done via the Main tab page in the Define Spectrograph dialog box as shown in Figure 29. The **Warn When Crossing Laser Line** selection tells WinSpec/32 to display a message whenever the grating is moved to where the laser light would be visible to the detector. This is critical for detectors that could be damaged if exposed to high light levels. Also, it will be necessary to enter the laser wavelength if you plan to work with units of relative wavenumbers.

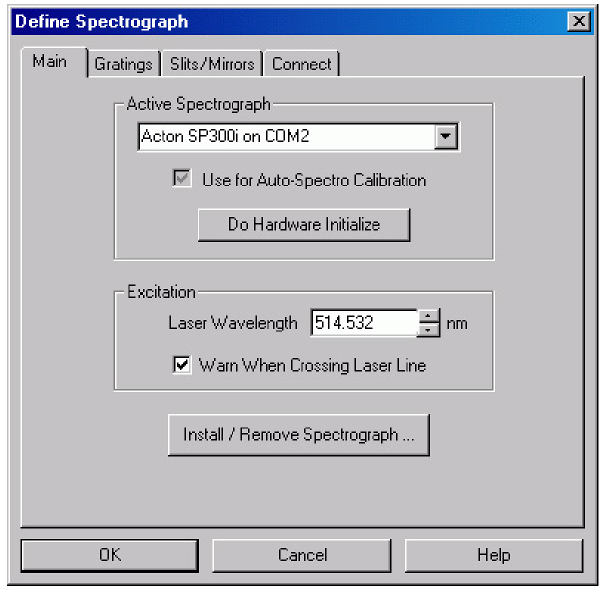


Figure 29. Entering the Laser Line Define Spectrograph Main tab page

- To allow WinSpec/32 to display in units of relative wavenumbers, enter a Laser Wavelength in nanometers, to as many significant digits as desired.
- If you have a bright laser line, check the **Warn when Crossing Laser Line** box and enter the Laser Wavelength in nm. WinSpec/32 will display a warning message whenever the wavelength range viewable by the detector might fall on or pass through the laser line.

WARNING

The **Warn When Crossing Laser Line** is no guarantee that the detector will not be damaged by overexposure. The correct display of the warning depends on all calibration parameters being set correctly. ***Changing or moving gratings*** may cause the laser to shine on the detector. Always block the source when moving or changing the grating to avoid damage.

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Chapter 3

Initial Spectroscopic Data Collection

Introduction

The procedure in this chapter will enable you to begin collecting real data promptly. Minimum requirements are assumed. If your system is more complex, e.g., requiring consideration of complex timing and synchronization issues, you will have to carefully study the other chapters of this manual as well as the manuals provided for the system hardware components before data acquisition that addresses those needs will be possible. Nevertheless, it is a good idea to begin with the simplest possible operating mode. This approach will give you operating experience and familiarity that will prove very valuable when you go to make more complex measurements. For additional information about the various menus and dialog boxes, refer to the online Help topics. Note that controllers and cameras ordinarily used for imaging are not discussed in this chapter, but rather in the next chapter, *Initial Imaging Data Collection.*

Underlying assumptions for the following procedure are that the hardware installation, including mounting the camera to the spectrograph, has been completed. A further assumption is that the hardware and spectrograph setups as discussed in Chapter 2 have been completed. The last assumption is that a suitable spectrographic source is available. The mercury lines produced by ordinary fluorescent lights can be used. However, it will be better to begin with a low-pressure gas-discharge lamp such as neon, mercury, or mercury-argon, if one is available.

There are two data collection modes, ***Focus*** and ***Acquire***:

- In ***Focus*** mode operation, no frames of data are stored until **Start Storage** is selected. 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.
- In ***Acquire*** mode, every frame of data collected is stored. 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 to be stored, data overflow will eventually occur. This could only happen in Synchronous (Full Speed) operation.

The following data collection procedures are done in the **Focus** mode.

WARNING!

> If using an intensified camera, note that data collection in the following procedure will be done in the **Shutter** mode, in which the camera can be damaged if exposed to light overload. Before powering the controller and camera, reduce the room light to reduce the risk of damage. Note that intensifiers are particularly at risk in pulsed laser operation, where overload spot damage can occur without raising the average current to where the overload detection circuits will be activated. It is far better to be careful than sorry. *Before proceeding, take the time to carefully read the manual for your intensified camera.*
>
> Also, take particular care that your intensified camera is connected properly for shutter-mode operation. Cabling and peripheral considerations for intensified cameras are more complex than for unintensified cameras. *Again, read your manual.*

Temperature Control

Before continuing, the array temperature should be set to some easily achieved value in the operating range and Temperature lock should be established. The way this is done depends on the controller.

Temperature Control for a system using an ST-133 or a MicroMAX

1. Open the WinSpec/32 Setup menu and click on **Detector Temperature**. This will cause the Temperature dialog box to appear as shown in Figure 30.
2. Set the Target Temperature to the desired value (0° suggested for initial data acquisition).
3. Click on the **Set Temp.** button. When the **Current Temperature: Unlocked** message changes to **Current Temperature: Locked**, temperature lock will have been established.

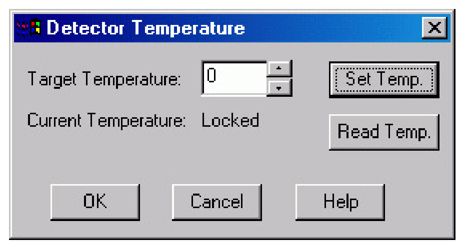

Figure 30. Temperature dialog box

> **Note:** Both the MicroMAX and the ST-133 additionally have a **Temp Lock** LED on the Analog/Control module (at the rear of the controller) that visually indicates when temperature lock occurs.

Temperature Control for Other Systems

ST-121, ST-130 or ST-138 Controller: Change the dial setting on the front panel of the Controller.

PentaMax: Set the temperature on the front panel of the Temperature/Power Supply unit.

MicroView: Not user-settable. Temperature is solely under software control.

Cleans and Skips

With some controllers, specifically the PentaMAX, ST-130, ST-133 and ST-138, there is a Cleans/Skips tab page in the Hardware Setup dialog box. Cleans are used to reduce charge buildup on the CCD array while waiting to begin data acquisition (refer to Chapter 9 for more information). Skips are used when the Region of Interest (ROI) is smaller than the full chip; they allow binning and quick traversing of the rows that precede and follow the ROI. For the procedures that follow, load the default values for these parameters by bringing the **Cleans/Skips** tab page to the front, and then clicking on **Load Defaults** followed by **Yes**.

Exception: With a PI-MAX camera, Cleans should be set to 1 and Strips per Clean to 4.

Spectrograph

Before a spectrum can be acquired, it is necessary that the spectrograph be powered and properly installed as described in Chapter 2. It is not necessary to *calibrate* the spectrograph. The default settings will be close enough for initial familiarization purposes. However, it will be necessary to ***install*** the spectrograph. This is the procedure whereby the WinSpec/32 software is informed of the spectrograph model, communications port, selected gratings, slit-width and mirror selections if applicable. It is also necessary to establish successful communications between the host computer and the spectrograph. These considerations are all discussed in Chapter 2. Additional information for the individual spectrometer setup and dialog boxes is provided in the online Help.

Experiment Setup Procedure

1. Open the Experiment Setup dialog box (Figure 31) from the Acquisition menu.

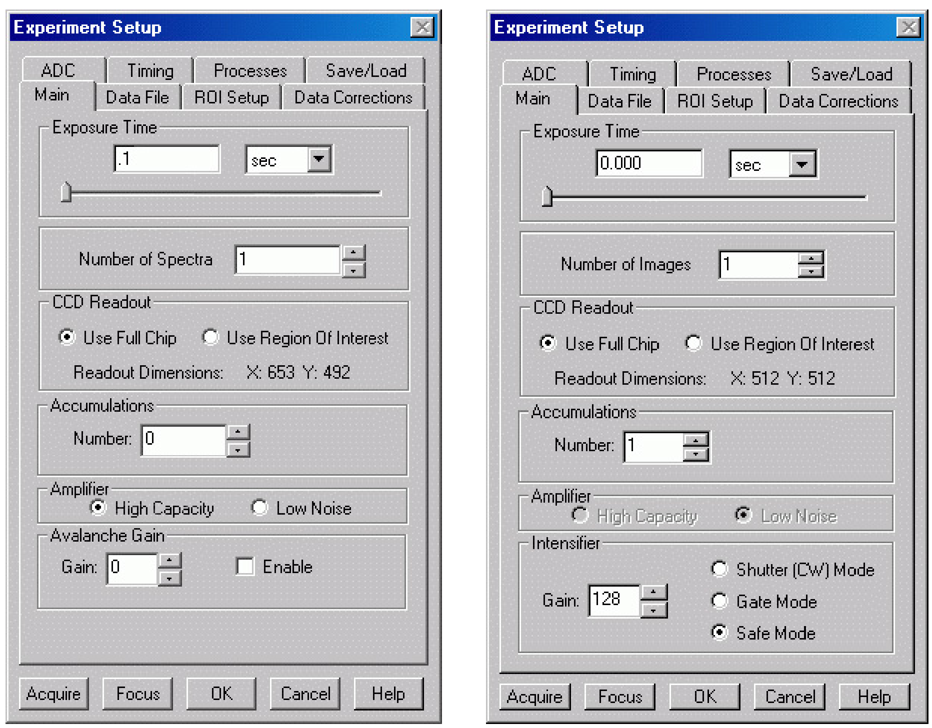

Figure 31. Experiment Setup dialog box Main tab page; left, all but PI-MAX; right, PI-MAX

2. On the **Main** tab page, set the following parameters.

   Exposure time: 0.1 seconds ***(For PI-MAX system using PTG, enter 0 sec)***
   Number of Spectra: 1
   Use Full Chip: selected
   Accumulations: 1
   Gain (PI-MAX only): 128

Amplifier (if available): High Capacity. *If this is a reported-only parameter, set it by selecting FAST on the ADC tab page.*
Camera State (PI-MAX only): Safe (the photocathode is biased OFF)
Avalanche Gain (Cascade™ 512 or Cascade 650™ only): Set to 0 initially and disabled. Enable and increase the gain for low-light level spectra.

WARNING

Intensified Cameras: If working with an intensified camera, the room light should be subdued so as to allow *safe* **Shutter** mode operation of the camera. *Intensified cameras are quite susceptible to damage from light overload in Shutter mode operation and particularly subject to damage from light overload in Gated mode operation with high-intensity pulsed light sources. See your camera or system manual for detailed information.*

Also, take particular care that your intensified camera is connected properly for Shutter mode operation. Cabling and peripheral considerations for intensified cameras are more complex than for unintensified cameras. *Again, read your camera or system manual.*

3. On the **Timing** tab page (Figure 32) set the following parameters.

Note: Not all of these parameters are provided for every controller model. Ignore parameters that don't apply to your system.

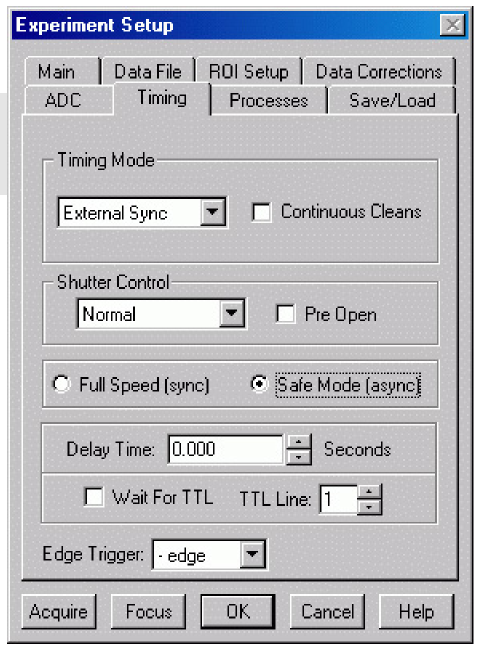

Figure 32. Experiment Setup dialog box Timing tab page

Timing Mode: Free Run ***(For PI-MAX system: Ext.Sync. for DG535; Int.Sync. for PTG)***
Triggered Mode: not checked
Continuous Cleans: not checked. ***(For PI-MAX system: checked for DG535; unchecked for PTG)***
Shutter Control: Normal. ***(for PI-MAX system: Disabled Opened for PTG)***
Pre Open: Not checked. ***(For PI-MAX system: check Pre Open for DG535 or PTG)***
Safe Mode: selected
External Trigger: not checked
Edge Trigger: + edge
Delay time: 0
Use Interrupt: not checked

Note: Not all of these parameters are provided for every controller model. Ignore parameters that don't apply to your system.

4. On the **Data Corrections** tab page (Figure 33) all of the correction functions should be OFF.

5. On the **ADC** tab page (Figure 34), set the parameters as they apply to your particular system. Parameters that might be listed, depending on the controller type, include:

   Rate: ADC rate. Only those rates available for your A/D converter will be displayed, making it necessary to designate the A/D type first. Select the maximum speed allowed by the converter. If the camera is a PI-MAX with a Thomson 512 CCD, select FAST. ST-130 owners must confirm that the internal hardware jumpers of their controller are properly set for the desired speed. *See the ST-130 manual for details.*

   Type: For systems having more than one A/D converter, both FAST and SLOW will be available. Make this selection before selecting the rate or resolution.

   Controller Gain (PentaMAX only): Set to Gain 3

   Resolution: Number of bits. Choices limited by A/D type selection.

   Bit Adjust (ST-138 only): Set to No Clip

   ADC Offset (5MHz MicroMAX only): Use the default setting.

   Analog Gain (ST-133): Medium

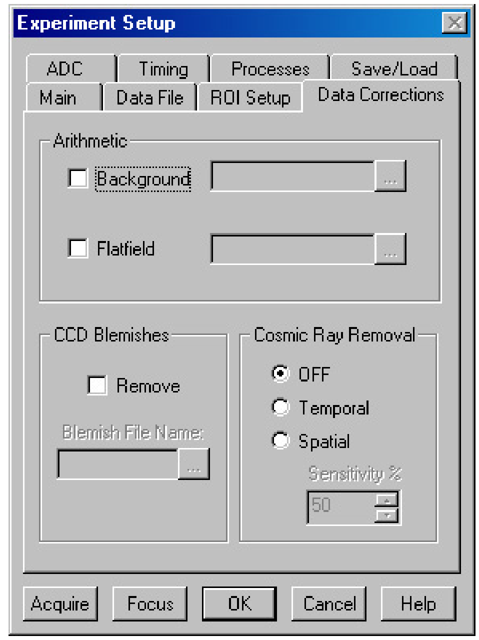

Figure 33. Data Corrections tab page

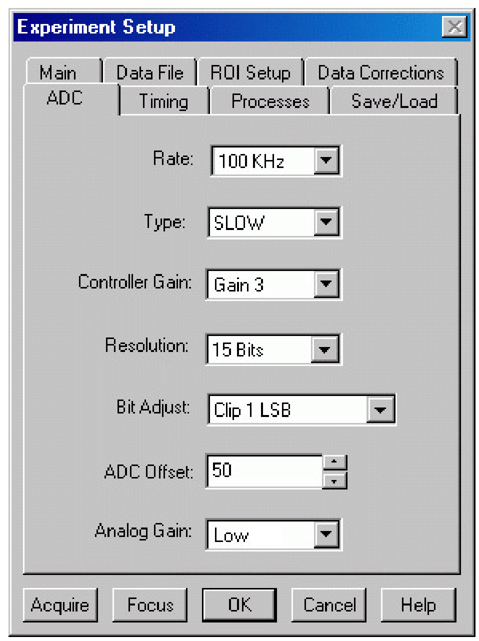

Figure 34. Generic ADC tab page

Note: Not all of these parameters are provided for every controller model. Ignore parameters that don't apply to your system.

6. On the **ROI** tab page select **Spectroscopy Mode** as shown in Figure 35. The **Use Full Chip** selection on the **Main** tab page overrides any ROI settings that may be present.

   Note: The choice of Spectroscopy or Imaging is only provided if the WinSpec/32 Imaging option has been installed. If this choice isn't present, the default state is Spectroscopy.

7. No **Processes** tab page functions should be selected.

8. On the **Data File** tab page, make the following selections.

   Auto Increment File Name Enable: should be OFF.

   Overwrite/Append Existing Files: Select Overwrite (data file will overwrite an existing file having the same name).

   Overwrite Confirmation: Check this box so that you will be warned that the specified file name is already in use. If not checked, the old data file will be overwritten by the new one. No warning is provided.

   Data Type AutoSelect: Should be selected.

   Auto-save and prompts: Select **Don't auto-save or ask to save**. With this selection, you won't receive a prompt when a file is closed as a result of starting a data collection. A prompt will still be issued if you close the file explicitly and it has not been saved since being collected.

   Use a New Window for each run: Leave unchecked.

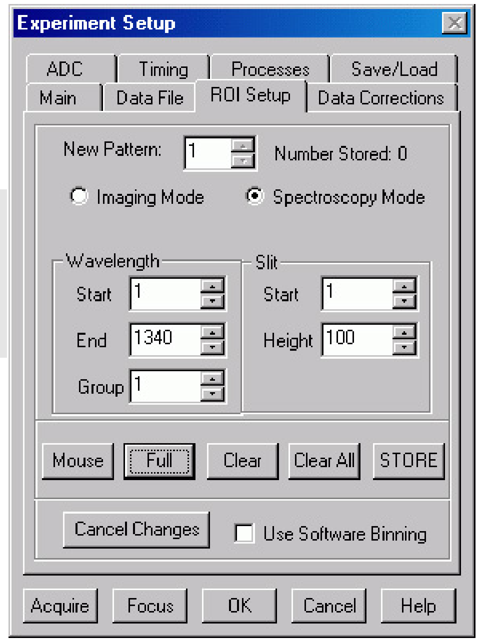

Figure 35. ROI dialog box

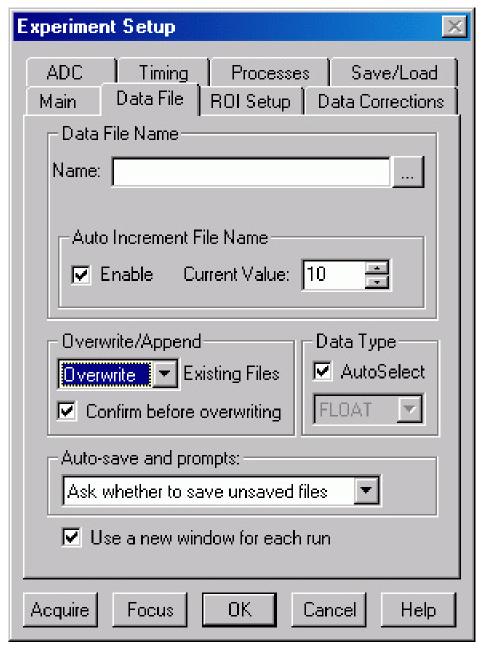

Figure 36. Data File dialog box

9. Click on the button to the right of the **Name** field. This will open a browse box. Select the directory where you want the stored file to go. In the example illustrated, the file name is TESTFILE1 and it will be stored in a directory named Data. *If the filename doesn't automatically appear in the browse box, type it in.* The file type should be WinX Data (*.spe).

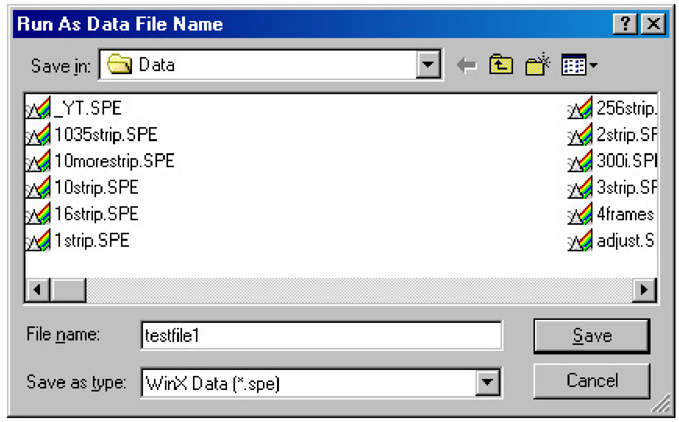

Figure 37. File Browse dialog box

10. Click on the **Save** button to save the entered information and return to the Experiment Setup dialog box.
11. Click on **OK**. This will close the Experiment Setup dialog box.

Data Collection

The following data collection procedure works for all controllers. An underlying assumption is that a suitable light source is available. Although fluorescent room lighting may be adequate, it will probably prove more instructive to use a standard lamp, such as a mercury-argon lamp that provided the spectrum illustrated in Figure 39.

WARNING

Intensified Cameras: If working with an intensified camera, the room light should be subdued. Intensified cameras are quite susceptible to damage from light overload in Shutter mode operation and particularly subject to damage from light overload in gated operation with high-intensity pulsed light sources. See your manual for detailed information.

Figure 38. Acquisition menu

1. If running a PI-MAX system, turn the room light down or off and switch the **Camera State** to **Shutter** mode on the **Acquisition|Experiment Setup|Main** tab page.
2. Select **Focus** from the **Acquisition** menu (Figure 38) to begin collecting data. An acquisition can also be started by clicking on the **Focus** button in the Experiment Setup dialog box or by clicking on the **Focus** button on the **Custom Toolbar**. Data will be continuously acquired and displayed.
3. While observing the displayed data, adjust the system optics for the best possible spectrum (lines as high and narrow as possible). Figure 39 shows a typical mercury-argon spectrum. Your results could appear different depending on the spectrograph grating used.

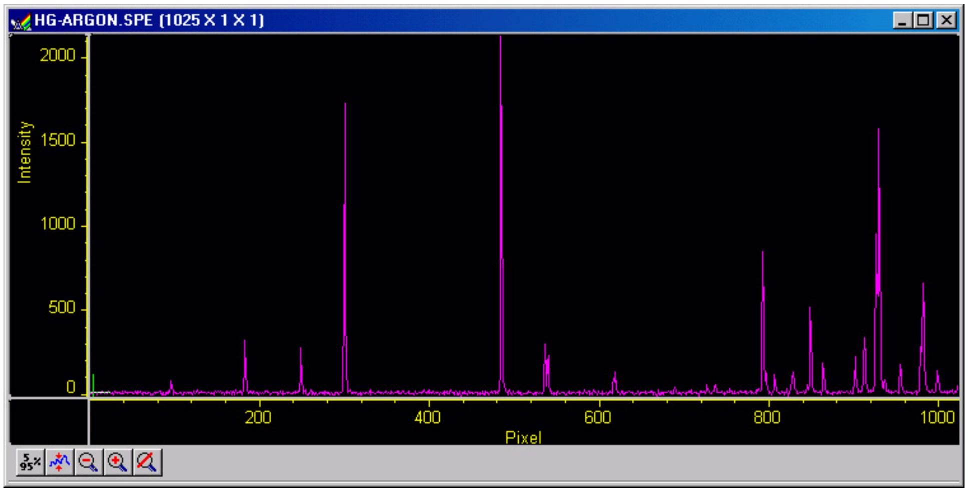

Figure 39. Typical Mercury-Argon Spectrum

4. To store the most recent data set, select **Start Storage** from the Acquisition menu or click on the **Start Store** button on the **Custom Toolbar**. Data acquisition will halt and the most recent image will be stored in a file having the name specified on the Data File tab page.

5. For a PI-MAX system, switch the **Camera State** back to **Safe** mode on the Acquisition|Experiment Setup|Main tab page.

This completes the initial spectroscopy data acquisition routine that should work with any Princeton Instruments brand Controller.

Chapter 4

Initial Imaging Data Collection

Introduction

ATTENTION

Imaging is only possible if the WinSpec/32 software you are using has the Imaging Option installed.

The procedure in this chapter will enable you to begin collecting real image data promptly. Minimum requirements are assumed. If your system is more complex, e.g., requiring consideration of complex timing and synchronization issues, you will have to carefully study the other chapters of this manual as well as the manuals provided for the system hardware components before data acquisition that addresses those needs will be possible. Nevertheless, it is a good idea to begin with the simplest possible operating mode. This approach will give you operating experience and familiarity that will prove very valuable when you go to make more complex measurements. For additional information about the various menus and dialog boxes, refer to the online Help topics.

Underlying assumptions for the following procedure are that the hardware has been installed per the instructions in the hardware manual(s) and that the hardware setup as discussed in Chapter 2 has been completed. A further assumption is that a good imaging subject is available. Often, a picture or optical target mounted on a wall or lab bench will give good results. If initial data collection is to be done using a microscope, be sure to read the chapter on microscopy in your system manual before attempting data collection.

There are two data collection modes, ***Focus*** and ***Acquire***:

- In ***Focus*** mode operation, no frames of data are stored until **Start Storage** is selected. 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 is stored. 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 to be stored, data overflow will eventually occur. This could only happen in Synchronous (Full Speed) operation.

The following data collection procedures are done in the ***Focus*** mode.

WARNING

If using an intensified camera, note that data collection in the following procedure will be done in the **Shutter** mode, in which the camera can be damaged if exposed to light overload. Before powering the controller and camera, reduce the room light to reduce the risk of damage. Note that intensifiers are particularly at risk in pulsed laser operation, where overload spot damage can occur without raising the average current to where the overload detection circuits will be activated. It is far better to be careful than sorry. *Before proceeding, take the time to carefully read the manual for your intensified camera.*

Also, take particular care that your intensified camera is connected properly for shutter-mode operation. Cabling and peripheral considerations for intensified cameras are more complex than for unintensified cameras. *Again, read your manual.*

Temperature Control

Before continuing, the array temperature should be set to some easily achieved value in the operating range and Temperature lock should be established. The way this is done depends on the controller.

Temperature Control for a system using an ST-133 or a MicroMAX

1. Open the WinSpec/32 Setup menu and click on **Detector Temperature**. This will cause the Temperature dialog box to appear as shown in Figure 30.
2. Set the **Target Temperature** to the desired value (0° suggested for initial data acquisition).
3. Click on the **Set Temp.** button. When the **Current Temperature: Unlocked** message changes to **Current Temperature: Locked**, temperature lock will have been established.

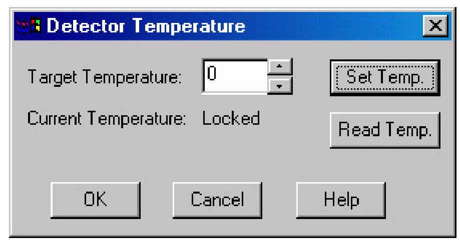

Figure 40. Temperature dialog box

Note: Both the MicroMAX and the ST-133 additionally have a **Temp Lock** LED on the panel of the Analog/Control module that visually indicates when temperature lock occurs.

Temperature Control for Other Systems

ST-121, ST-130 or ST-138 Controller: Change the dial setting on the front panel of the Controller.

PentaMax: Set the temperature on the front panel of the Temperature/Power Supply unit.

MicroView: Not user-settable. Temperature is solely under software control.

Cleans and Skips

With some controllers, specifically the PentaMAX, ST-130, ST-133 and ST-138, there is a Cleans/Skips tab page in the Hardware Setup dialog box. Cleans are used to reduce charge buildup on the CCD array while waiting to begin data acquisition. Skips are used when the Region of Interest (ROI) is smaller than the full chip; they allow binning and quick traversing of the rows that precede and follow the ROI. For the procedures that follow, load the default values for these parameters by bringing the **Cleans/Skips** tab page to the front, and then clicking on **Load Defaults** followed by **Yes**.

Exception: With a PI-MAX camera, Cleans should be set to 1 and Strips per Clean to 4.

Experiment Setup Procedure (all controllers)

1. Open the Experiment Setup dialog box (Figure 41) from the Acquisition menu.

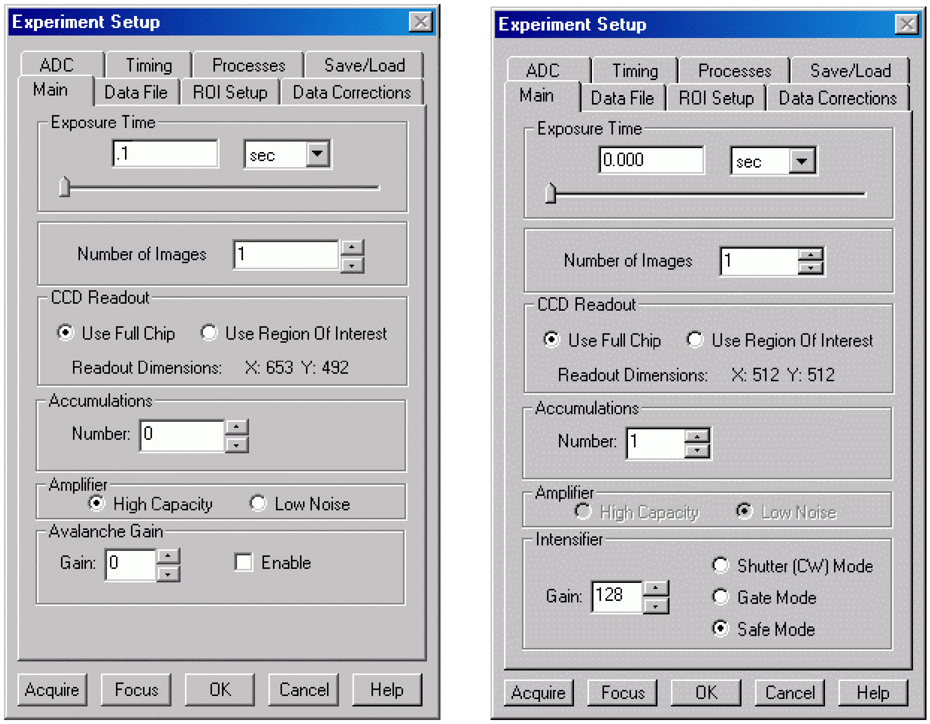

Figure 41. Experiment Setup: Main tab page; left, all but PI-MAX; right, PI-MAX

2. On the **Main** tab page, set the following parameters.

   Exposure time: 0.1 seconds. ***(For PI-MAX system using PTG, enter 0 sec)***

   Number of Spectra/Images: 1

   Use Full Chip: selected

   Accumulations: 1

   Gain (PI-MAX only): 128

   Amplifier (if available): High Capacity. *If this is a reported-only parameter, set it by selecting FAST on the ADC tab page.*

   Camera State (PI-MAX only): Safe (the photocathode is biased OFF)

   Avalanche Gain (Cascade™ 512 or Cascade 650™ only): Set to 0 initially and disabled. Enable and increase the gain for low-light level images.

WARNING

Intensified Cameras: If working with an intensified camera, the room light should be subdued so as to allow *safe* **Shutter** mode operation of the camera. *Intensified cameras are quite susceptible to damage from light overload in Shutter mode operation and particularly subject to damage from light overload in Gated mode operation with high-intensity pulsed light sources. See your manual for detailed information.*

Also, take particular care that your intensified camera is connected properly for Shutter mode operation. Cabling and peripheral considerations for intensified cameras are more complex than for unintensified cameras. *Again, read your manual.*

3. On the **Timing** tab page (Figure 42) set the following parameters.

Note: Not all of these parameters are provided for every controller model. Ignore parameters that don't apply to your system.

Timing Mode: Free Run ***(For PI-MAX system: Ext.Sync for DG535; Int.Sync. for PTG)***
Triggered Mode: not checked
Continuous Cleans: not checked ***(For PI-MAX system: checked for DG535; unchecked for PTG)***
Shutter Control: Normal. ***(For PI-MAX system: Disabled Open for PTG)***
Internal Sync (PI-MAX with PTG only): selected
Pre Open: Not checked. ***(For PI-MAX system: checked for DG535 or PTG)***
Safe Mode (async): selected
External Trigger: not checked
Edge Trigger: + edge
Delay time: 0
Use Interrupts: not checked

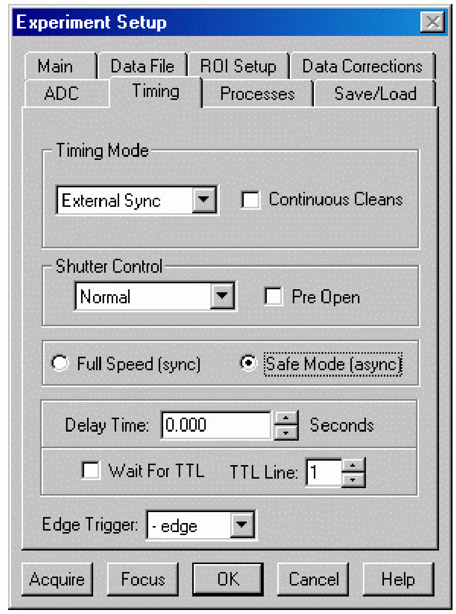

Figure 42. Timing tab page

4. On the **Data Corrections** tab page (Figure 43) all of the correction functions should be OFF.

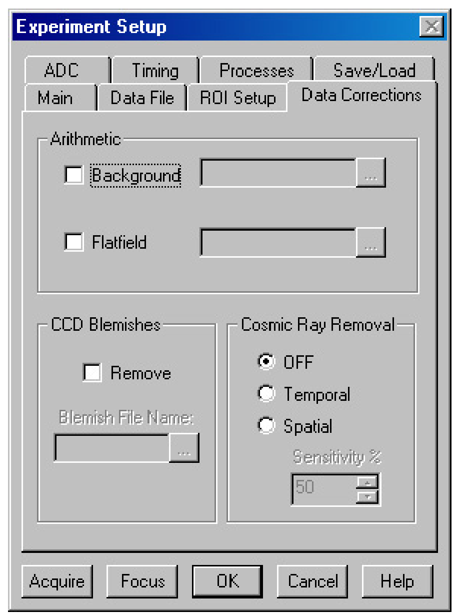

Figure 43. Data Corrections tab page

5. On the **ADC** tab page (Figure 44), set the parameters as they apply to your particular system. Parameters that might be listed follow:

   Rate: ADC rate. Only those rates available for your A/D converter will be displayed, making it necessary to designate the A/D type first. Select the maximum speed allowed by the converter. If the camera is a PI-MAX with a Thomson 512 CCD, select FAST. ST-130 owners must confirm that the internal hardware jumpers of their controller are properly set for the desired speed. *See the ST-130 manual for details.*

   Type: For systems having more than one A/D converter, both FAST and SLOW will be available. Make this selection before selecting the rate or resolution.

   Controller Gain (PentaMAX only): Set to Gain 3

   Resolution: Number of bits. Choices limited by A/D type selection.

   Bit Adjust (ST-138 only): Set to No Clip

   ADC Offset (5MHz MicroMAX only): Use the default setting.

   Analog Gain (ST-133): Medium

   Note: Not all of these parameters are provided for every controller model. Ignore parameters that don't apply to your system.

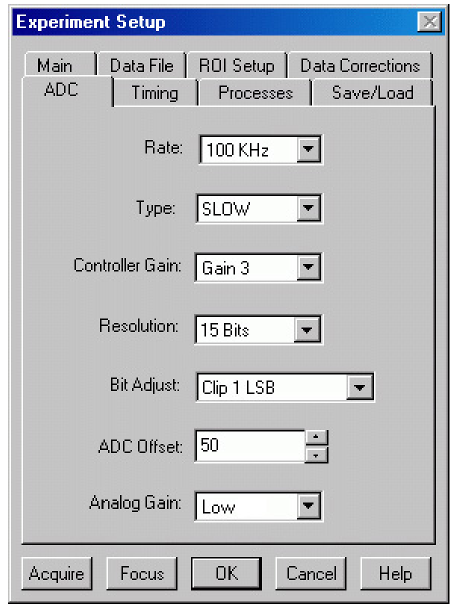

Figure 44. Generic ADC tab page

6. On the **ROI** tab page (Figure 45), select Imaging Mode. WinSpec/32 operated in Imaging Mode always uses the full chip area and ROI considerations do not apply.

7. No **Processes** tab page functions should be selected.

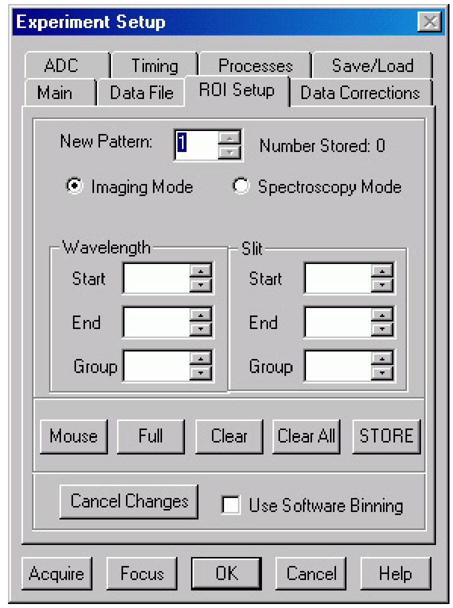

Figure 45. ROI tab page - imaging selected

8. On the **Data File tab page**, make the following selections.

   Auto Increment File Name Enable: should be OFF.

   Overwrite/Append Existing Files: Select Overwrite (data file will overwrite an existing file having the same name).

   Overwrite Confirmation: Check this box so that you will be warned that the specified file name is already in use. If not checked, the old data file will be overwritten by the new one. No warning is provided.

   Data Type AutoSelect: Should be selected.

   Auto-save and prompts: Select **Don't auto-save or ask to save**. With this selection, you won't receive a prompt when a file is closed as a result of starting a data collection. A prompt will still be issued if you close the file explicitly and it has not been saved since being collected.

   Use a New Window for each run: Leave unchecked.

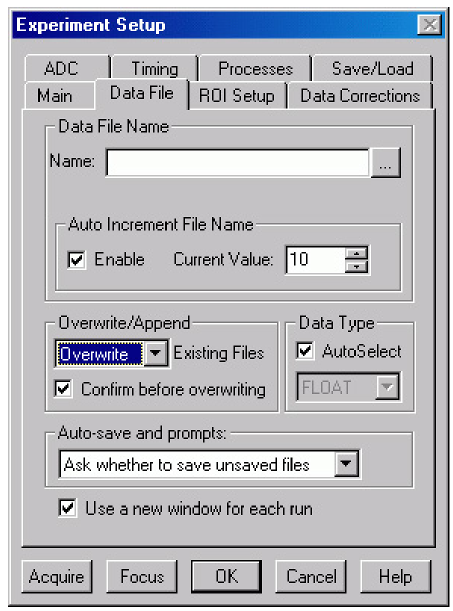

Figure 46. Data File dialog box

9. Click on the button to the right of the **Name** field. This will open a browse box. Select the directory where you want the stored file to go. In the example illustrated, the file name is TESTFILE1 and it will be stored in a directory named Data. *If the file name doesn't automatically appear in the browse box, type it in.* The file type should be WinX Data (*.spe).

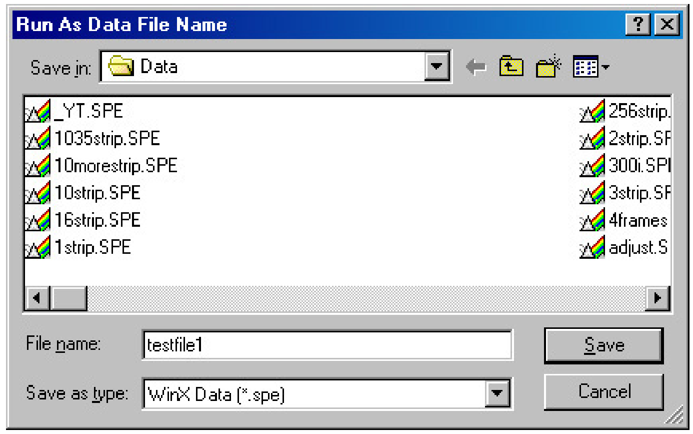

Figure 47. File Browse dialog box

10. Click on the **Save** button to save the entered information and return to the Experiment Setup dialog box.

11. Click on **OK**. This will close the **Experiment Setup dialog box**.

12. Once again, click on **Acquisition** in the Menu bar. Again, the Acquisition menu will appear as shown in Figure 48.

Figure 48. Acquisition menu

Data Collection Procedures (Controller-Specific)

MicroMAX or ST-133

The procedure that follows for these controllers is in two parts, **Video Focusing** and **Data Collection**. In focusing, images are displayed on the video monitor (not the computer monitor) and no data is collected. This allows rapid and easy adjustment of the system optics. Once the settings have been optimized, data collection begun can begin.

Focusing

This procedure applies for a MicroMAX or ST-133 system that includes a video monitor connected to the Video port (BNC connector) on the controller. If your system doesn't include a video monitor, go to the **Data Collection - All Controllers** section, which begins on page 68.

1. Select **Video** from the Acquisition menu. This will allow live data to be displayed on your video monitor.

2. Select **Video Focus** from the Acquisition Menu. The **Interactive Camera** dialog box (Figure 49) will open.

3. Click on the **RUN** button in the Interactive Camera dialog box. The camera will begin acquiring pictures at the fastest possible rate will and the image will be displayed on the video monitor. *Note that the image will not be displayed on the computer monitor while the Interactive Camera dialog box is open.*

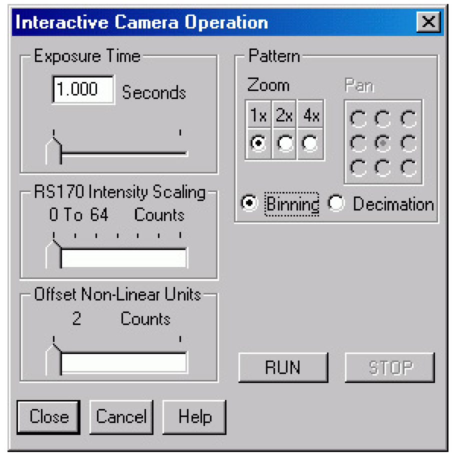

Figure 49. MicroMAX or ST-133 Interactive Camera dialog box

4. Focus the system optics and set the Interactive Camera dialog box **Exposure Time**, **RS170 Scaling** and **Offset** adjustments for the best-viewed image. In addition to the Exposure Time, Intensity Scaling and Offset parameters, the Pattern parameters determine *which* CCD pixels will be displayed on the video monitor. *Note that, in Focus mode, the images will not appear at the computer but only at the video monitor.* If the number of pixels on the CCD is very much larger than the number of video pixels, you can use the Pan function to select any one of nine different subsets to display. The Zoom function gives additional control. One-to-one mapping from the selected region to the screen occurs with 2× selected. You may additionally have the option of selecting Binning, in which a wider view is achieved by combining adjacent pixels, or Decimation, in which pixels are discarded according to an algorithm.

   The exposure time will be the same as that set via the Experiment Setup **Main** tab page. *The two exposure settings track. Changing it at either location should update the other setting automatically.* The Intensity Scaling, together with the Offset, determines how the image data is mapped to the 256 gray-scale levels. Begin with the Intensity Scaling set to “1 to 4096” (slider all the way to the right). Similarly, the Offset setting should initially be set to 2 (slider all the way to left).

5. When no further improvement in the observed image can be obtained, click on **Stop** in the Interactive Camera Operation dialog box to halt focus-mode operation.

6. Click on **Close** to close the Interactive Camera Operation dialog box and return to the Experiment Setup dialog box.

Data Collection

1. Click on **Focus** to begin collecting data. An acquisition can also be started by clicking on **Focus** on the Acquisition Menu or by clicking on the **Focus** button on the **Custom Toolbar**. Images will be continuously acquired and displayed on the computer screen and on the video monitor.

2. To store the most recent image, select **Start Storage** from the Acquisition menu or click on the **Start Store** button on the **Custom Toolbar**. Data acquisition will halt and the most recent image will be stored in a file having the name specified on the **Data File** tab page.

This completes initial data acquisition with a MicroMAX or an ST-133 Controller.

PentaMAX

The procedure that follows for the PentaMAX Controller is in two parts, **Focusing** and **Data Collection**. In focusing, images are displayed on the video monitor and no data is collected. This allows rapid and easy adjustment of the system optics. Once the settings have been optimized, focus mode operation should be ended and data collection performed.

Focusing

This procedure applies for a PentaMAX system that includes a video monitor connected to the Video port (BNC) of the PentaMAX. If your system doesn't include a video monitor, go to the **Data Collection - All Controllers** section, which begins on page 68.

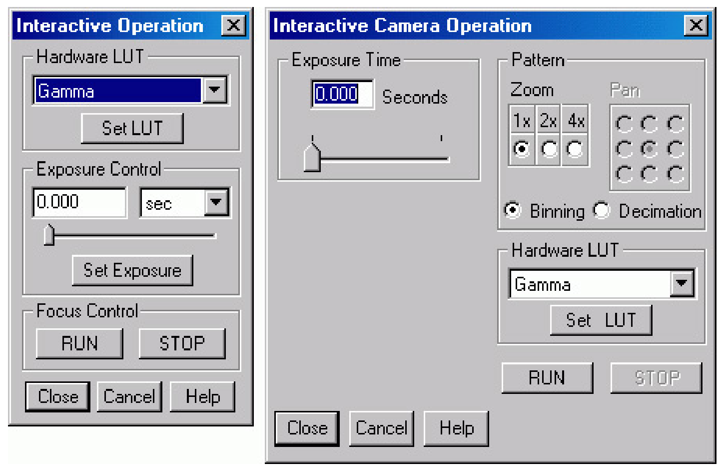

Figure 50. PentaMAX Interactive Operation dialog box

1. Select **Video** from the Acquisition menu. This will allow live data to be displayed on your video monitor.
2. Select **Video Focus** from the Acquisition Menu. The Interactive Operation dialog box that will be displayed depends on the PentaMAX version. Version 5 and higher will display the righthand dialog box shown in Figure 50. Earlier versions, display the lefthand dialog box.
3. Note the **Hardware LUT** field. This selection sets the scaling of the video display only. Unless the signal is very weak, the best LUT choice will be Gamma.
4. Click on the **RUN** button in the Interactive Operation dialog box. Data acquisition at the fastest possible rate will commence immediately and the image will be displayed on the video monitor. *Note that the image will not be displayed on the computer monitor while the Interactive Operation dialog box is open.*
5. Focus the system optics and, if necessary, adjust the **Exposure Time** in the Interactive Camera dialog box for the best-viewed image. The exposure time will be the same as that set via the Experiment Setup **Main** tab page. *The two exposure settings track. Changing it at either location should update the other setting automatically.*
6. When no further improvement in the observed image can be obtained, click on **Stop** in the Interactive Operation dialog box to halt focus mode operation.
7. Click on **Close** to close the Interactive Operation dialog box and return to the Experiment Setup dialog box.

Data Collection

1. Click on **Focus** to begin collecting data. Data collection can be initiated by means of the **Focus** button in the Experiment Setup dialog box, by selecting **Focus** from the Acquisition Menu, or by clicking on the **Focus** button of the **Custom Toolbar**. Images will be continuously acquired and displayed on the computer screen.

2. To store the most recent image, click **Start Storage** on the Acquisition menu or click on the **Start Store** button on the **Custom Toolbar**. Data acquisition will halt and the most recent image will be stored in a file having the name specified on the **Data File** tab page.

3. If you want to initiate data acquisition, select **Focus** again. To store the new data to disk, again click **Start Storage** on the Acquisition menu or click on the **Start Store** button.

This completes initial data acquisition with a PentaMAX Controller.

Data Collection - All Controllers

The following data collection procedure works for all controllers. However, it doesn't exercise some of the special features, such as video monitor support, available on certain controller models.

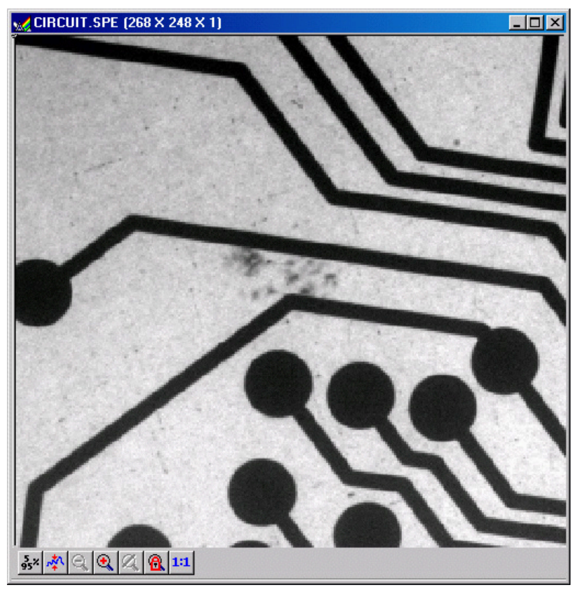

Figure 51. Typical Data Acquisition Image

1. Click on **Focus** to begin collecting data. Data collection can be initiated by means of the **Focus** button in the Experiment Setup dialog box, by clicking on **Focus** on the Acquisition Menu, or by clicking on the **Focus** button of the **Custom Toolbar**. Images will be continuously acquired and displayed.

2. Observe the displayed data and adjust the system optics for the best possible image. *It may be necessary to readjust the Exposure Time (Experiment Setup* ***Main*** *page).*

3. To store the most recent image, click **Start Storage** on the Acquisition menu or click on the **Start Store** button on the **Custom Toolbar**. Data acquisition will halt and the most recent image will be stored in a file having the name specified on the **Data File** tab page.

4. For a PI-MAX system, switch the **Camera State** back to **Safe** mode on the Acquisition|Experiment Setup|Main tab page.

This completes the initial data acquisition routine, which should work with any Princeton Instruments brand Controller.

Chapter 5

Opening, Closing, and Saving Data Files

Introduction

This chapter discusses how to open, close, and save existing data files to disk. Options for saving and deleting files will be explained. Data files created with temporary file names should be saved to disk periodically. Files should be closed completely to conserve RAM for data collection.

Data files can be deleted directly from WinSpec/32, without using the File Manager or any other file utility.

Note: WinSpec/32 can read data files acquired with earlier versions of WinSpec. Versions of WinSpec prior to 1.6 cannot read WinSpec/32 data files. Neither can versions prior to 1.6 read data files that were collected with earlier versions and then opened, modified and saved using WinSpec/32. This should be considered carefully before modifying and ***saving*** old data files with WinSpec/32.

Opening Data Files

In WinSpec/32 files are opened according to Win 95 conventions, as follows.

1. Select Open from the File menu. The File Open dialog box will appear (Figure 52).
2. Open the directory containing the data files. Clicking on the button at the right of the Look In field opens a browser function, allowing you to quickly and easily access the correct folder. As shown in Figure 52, the data files will be listed below.

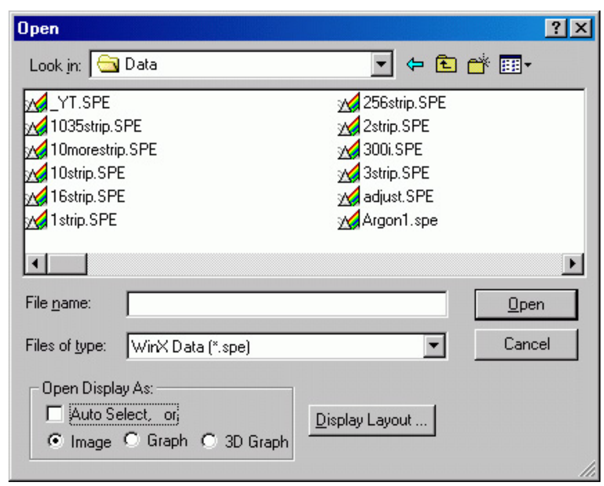

Figure 52. Open dialog box

3. If you want the software to control how the data will be displayed when the file is opened, check **Auto Select**. Leave **Auto Select** unchecked if you want to retain control over whether the data will be displayed as an **Image**, **Graph** or **3D Graph**.

Auto Select is the factory default selection.[*] In addition, one of the three radio buttons, **Image**, **Graph** or **3D Graph**, will be selected but grayed out if Auto Select is checked. If Auto Select is unchecked, the grayed out selection will become active and govern how the file is opened.

- When **Auto Select** is checked, the way the data is displayed depends on the number of data strips it contains.
  - ⇒ If there are eleven or more strips of data, they will be displayed as a normal image, such as that shown in Figure 96 *(page 109)*.
  - ⇒ If there are at least three data strips but less than eleven, the data will be plotted as a 3D Graph as shown in Figure 75 *(page 95)*.
  - ⇒ If there are only two strips of data, they will be displayed as graphs stacked in a two-dimensional plot, the same as for a 3D Graph of two strips. *See (page 94).*
  - ⇒ A single strip ***will always*** be plotted as a simple X vs. Y plot. Note that from two to ten strips, the intensity (Y axis) scale shifts position as required to read true for the selected strip.
- If **Image** is selected, all data points will be plotted as a function of the strip and pixel number.
- If **3D Graph** is selected, multiple data strips will be plotted as a function of intensity versus pixel number, the actual number of data strips plotted depending on the 3D Layout display parameter settings. All of the strips could come from the same frame, or, in the case of a file containing multiple frames, the same numbered strip could come from each frame.
- If **Graph** is selected, the selected data strip only will be plotted as a function of intensity versus pixel number.

4. Note the **Files of Type** field, which allows you to select files for listing according to their type. If **WinXData** (*.spe) is selected, only files of type *.spe will be listed. This is the native WinSpec/32 format. If **TIFF** or **8-bit TIFF File** (*.eps) is selected, only files of the type *.eps will be listed. If **All Files** (*.*) is selected, all files in the folder will be listed. WinSpec/32 can open either *.spe files or *.eps files (8-bit or 16-bit). Select type **8-bit TIFF File** to open an 8-bit TIFF file. Select type **TIFF File** to open a 16-bit TIFF file.

[*] The open/display default selection can be changed and saved from the Display Layout window.

5. Either double-click on the name of the file you want to open or single-click on the name and then click on the **Open** button. For example, with 3D Graph selected, double-clicking on Hid-lamp.spe would open that file, producing the display shown in Figure 53. Note that there are many different ways of controlling how the image will be displayed, as described in Chapter 8.

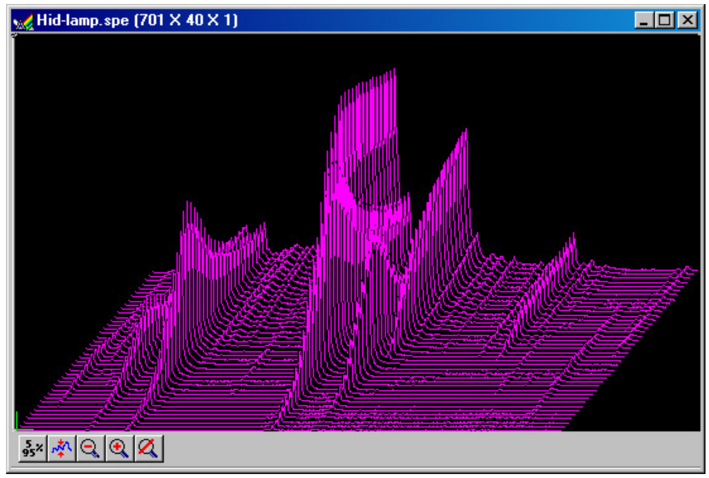

Figure 53. High Intensity Lamp Spectrum

Multiple Files: It is also possible to open multiple files at the same time by using the Win95 **Shift + Click** and **Control + Click** selection features. To select a *range of contiguously listed files* for opening:

- Hold the Shift key down and click on the first file in the range. The file will be selected.
- Then hold the Shift key down again and click on the last file in the range. That file *and all the files between the two designated files* will be selected.

To select multiple files which are *not* listed contiguously:

- hold down the **Ctrl** key and then click on the first file. That file will be selected.
- Then hold down the **Ctrl** key again and click on the second file. That file will also be selected.
- Proceed in similar fashion to select each file to be opened.

Once all files to be opened have been selected, click on **Open** (or double-click on a selected file) and all of the selected files will be opened.

There are a number of additional options and operations that can be performed from the Open dialog box. For example, clicking the Display Layout button will directly open the Display Layout dialog box, described in Chapter 8. In addition, options for the organization of the Open dialog box itself can be selected by means of the icons to the right of the **Look In** field, or by right-clicking the mouse anywhere in the file listing area of the box *(but not on a file name)*.

Right-clicking *on a file name* opens a Windows shortcut menu that provides a number of additional operations, including open, delete, rename, print, properties, and edit operations such as copy and cut.

Saving Data Files

Data files must be saved to disk before exiting the software. It is also recommended that you save periodically when making measurements to minimize the overall risk of data loss. If you exit and there are unsaved data files, you will be prompted to save them. The File menu provides three Save commands, as follows.

1. **Save:** Saves the active data file using the original file name and type and in the original directory (folder).
2. **Save As:** The Save As dialog box is used to save the active data file to a user-specified file name and directory. The file type can be changed.
3. **Save All:** Saves all open data files using the original file names and directories (folders).

Sometimes during data collection or processing, windows will be opened and display data with an <untitled #> title. These are temporary files, and they must be saved to disk if you want to keep them. The Save As dialog box performs this function. The Save As dialog box also allows you to open a file and save it with a different name.

Saving Temporary Data Files

The WinSpec/32 software allows you to work with temporary files, files with names like <untitled 1>. To save these files, or to save any file to a new filename, perform the following steps.

1. Select **Save As** from the File menu. The Data File Save As dialog (Figure 54) appears.
2. Open the directory where you want the file saved. Clicking on the button at the right of the **Save In** field opens a browser function that will allow you to quickly and easily select the target directory.
3. Type in a name for the file. Windows 95 long file-name convention applies. It is not necessary to add the .spe automatically according to the specified file type extension. It will be added.

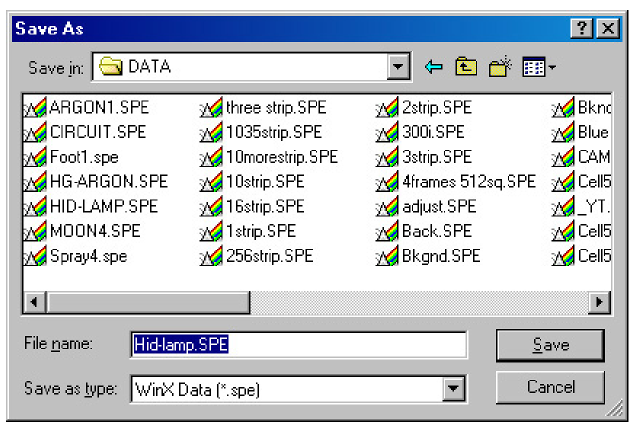

Figure 54. Data File Save As dialog box

Save as type: Indicates the file type. The data types currently supported are listed in Figure 55. If All Files (*.*) is selected, you will be able to save the file with any extension.

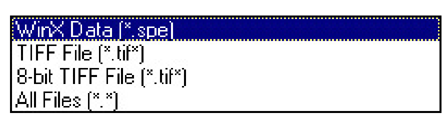

Figure 55. Save As Data Types

The file, however, will be saved in the *.SPE file type format. *Only the data is saved. This could have some unexpected effects. For example, if you save a graph as a *.eps file, and then open the file with an image editor, you will see the data presented as a single strip image, not as a graph.*

4. Click on **OK** to save the file or **Cancel** to close the Data File Save As dialog without saving the file.

Data File tab page

The **Data File** tab page provides you with additional control and flexibility in naming and saving newly collected data. Because the settings on this tab page are applied to data acquisition, not post-processing, make your entries before acquiring data. The auto-save, auto-name, and auto-increment features allow you to acquire data and save it according to the filename template you define. Also, you can take advantage of the multiple open windows functionality and specify that each new data run opens a new window on the display window.

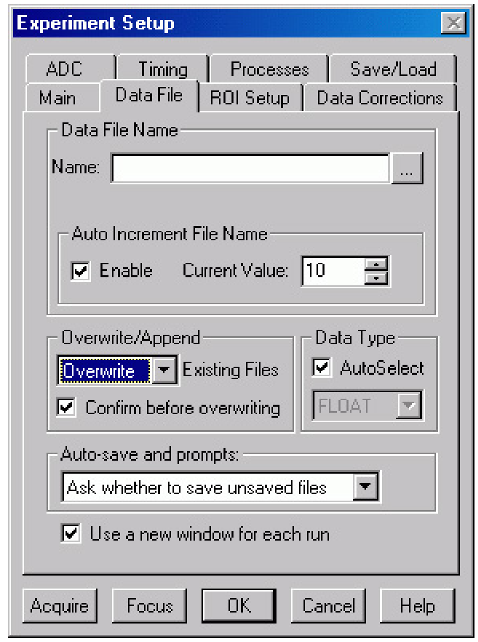

Figure 56. Data File tab page

Closing a Data File

An open data window can be closed by clicking on the box at the upper right of the window or by clicking on **Close** in the File menu. An open data window can be removed from view by clicking on the box at the upper right of the window. The file will be reduced to an icon on the task bar but the data will remain loaded in RAM. There may be situations where you would want to do this to reduce desktop clutter. Unless you intend to expand the file for display again, it is ordinarily better to actually close the file so that the RAM it is using will be freed for other use. If the file hasn't been saved, you will be prompted.

There are several ways of closing an open data window. Each is described below:

- The box at the upper right of the data window will close that window only.
- The box at the upper right of the window will also remove the data window from view by reducing it to an icon on the task bar. There may be situations where you would want to do this to reduce desktop clutter. However, the data will remain loaded in RAM, reducing the memory available for data collection. Unless you intend to expand the file for display again, it is ordinarily better to actually close the file so that the RAM it is using will be freed for other use.
- **Close** in the File menu closes all windows using the data set displayed in the active data window. This may be important if New in the Window menu or in the Data Window Context menu has been used to open additional windows with the same data. Simply clicking on Close in the File menu will close all windows containing the same data, regardless of how it is displayed.
- **Close** in the Control menu, accessed by clicking on the WinSpec/32 icon at the left end of the Title bar, closes WinSpec/32, as does double-clicking on the WinSpec/32 icon. Similarly, the key combination ALT+F4 also closes WinSpec/32.
- **Close All** in the Window menu closes ***all*** open data files.
- The key combination **Ctrl+F4** closes the active window only.

Deleting Data Files

You can delete data files directly from within WinSpec/32, without having to close WinSpec/32, and without having to use the Windows 95 Explorer or another file utility. This is achieved using the File Operations menu, accessed by right-clicking on the file name in the Open dialog box, as explained below.

1. Select **Open** from the File menu. *Only files with the selected data type, *.spe or *.eps, will be listed.*
2. Position the mouse cursor on the name of the file you want to delete and click the *right* mouse button. This will open the “right-click” File operations menu, as shown in Figure 57.
3. Click on **Delete**. Then answer yes to the query asking whether you wish to send the file to the recycling bin. The file will be deleted and the File Operations menu will close.

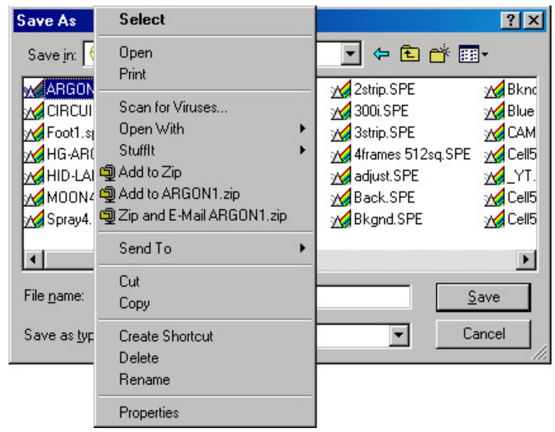

Figure 57. Right-click File Operations menu

Note: Click on the Open dialog box **Cancel** button to exit the dialog box without deleting any files.

Multiple Files: It is also possible to delete multiple files at the same time by using the Win95 **Shift + Click** and **Control + Click** selection features. To select a *range of contiguously listed files* for deleting:

1. Hold the Shift key down and click on the first file in the range. The file will be selected.
2. Then hold the Shift key down again and click on the last file in the range. That file *and all the files between the two designated files* will be selected.
3. To select multiple files which are *not* listed contiguously:
4. Hold down the **Ctrl** key and then click on the first file. That file will be selected.
5. Then hold down the **Ctrl** key again and click on the second file. That file will also be selected.
6. Proceed in similar fashion to select each file to be deleted.

Once all files to be deleted have been selected, *right-click* on a selected file to open the File Operations menu. Then click on **Delete** to delete all of the selected files.

Chapter 6

Wavelength Calibration

Introduction

You can calibrate the WinSpec/32 software either by using the spectrograph stepper motor position (Spectrograph calibration) or by performing a wavelength calibration. Spectrograph calibration, described in Chapter 7, precisely calibrates the movement of the spectrograph gratings. Wavelength Calibration is good for one position of the grating only. Once you move the grating (by hand or by controlling the stepper motor) a different wavelength calibration must be performed for that spectrograph position.

Note: Even after the spectrograph setting is fixed, moving the sample, refocusing, or almost any adjustment of the input optics can have an effect on the wavelength calibration. For the most accurate calibration possible, Roper Scientific recommends recalibrating the system after ***any*** optical adjustment.

Changing the WinSpec/32 Calibration Method

Switching between Wavelength Calibration and Spectrograph Calibration is controlled using the Usage dialog box. This dialog box determines whether calibration is turned on or off, and which type of calibration is used. The display can be calibrated by controlling the stepper motor of the spectrograph, called Spectrograph Calibration (discussed in Chapter 7), or the display can be calibrated for a fixed spectrograph position by entering the position of known peaks from a known source such as a mercury or neon lamp. The calibration of the spectrograph for a fixed position is called Wavelength Calibration and is described in this chapter.

Changing the Calibration Method

1. Select **Usage** from the Calibration menu. The dialog in Figure 58 will be displayed.
2. Select the desired method of calibration.
   - **Auto Spectro** selects Spectrograph Calibration as described in Chapter 7. A spectrograph supported by WinSpec/32 must be installed for this selection to be available.

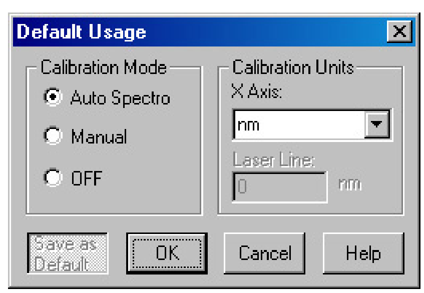

Figure 58. Calibration Usage dialog box

   - **Manual** applies the wavelength calibration to the active data. The calibration is performed using the Default Calibration Setup dialog box, accessed by selecting **Setup** on the Calibration menu.
   - **Off** selects uncalibrated operation.

3. Select the desired X Axis units. *This option is only available if the data set is calibrated.* If **relative wave numbers** are selected, it will additionally be necessary to enter the wavelength of the laser line.

4. Click on **OK**.

See the discussion of the **Calibration Usage** dialog box in the online Help for details concerning the Calibration Usage dialog box selections.

Calibration Menu

The **Calibration** menu, which can be called by clicking on Calibration in the menu bar, is shown in Figure 59. The Calibration menu contains two items, Setup and Usage, which call the Calibration Setup and Calibration Usage dialog boxes. Brief descriptions follow.

Figure 59. Calibration menu

Setup: Once a single spectrum has been acquired or loaded, the menu item **Setup** opens the Calibration Setup dialog box. A calibration session consists of finding the peaks, marking the known peaks to be used for calibration, and saving the calibration data as the default or applying it to the active data set only.

Usage: Selects the Calibration mode and Units. Once the wavelength calibration has been performed, it can be applied by selecting **Manual** or turned off by selecting **Off**. Selections can either be saved as default power-up parameters or be applied to the active data set only. For more information, see the online Help discussion of the Calibration Usage dialog box.

Wavelength Calibration Procedure

Before a wavelength calibration can be performed, it is necessary to either load a spectrum or acquire one. For good calibration results, the spectrum should have well defined peaks for which you know the wavelength. A calibration requires at least two points defined by pixel and by units. Naturally the more points used, the more accurate the calibration. The ideal calibration spectrum would have one peak at the start of the array (or region of interest), one at the end of the array or region of interest, and one midway between the end peaks. In real life, the ideal spectrum is seldom available, but the closer you can come to this ideal the better the calibration results will be.

Figure 60 shows a mercury-argon spectrum that could serve as the basis for a good calibration in many situations. *Appendix B contains wavelength tables for Argon, Neon and Mercury, together with a detailed spectrum for Hg-Argon.*

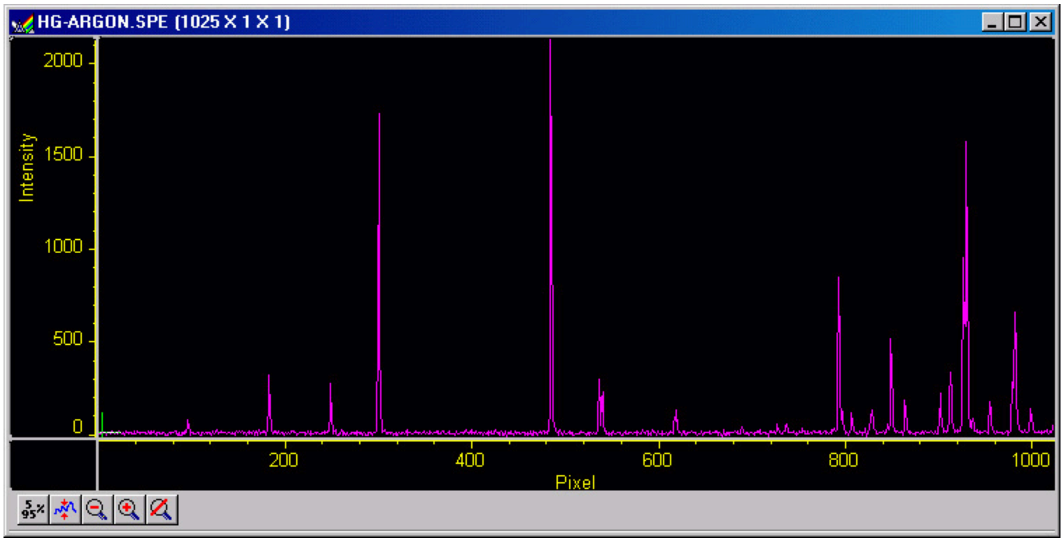

Figure 60. Hg-Argon spectrum

Once you have the calibration spectrum displayed on the screen as the active data set, proceed as follows.

1. Click on **Setup** in the Calibration menu to open the Calibration Setup dialog box. If a previous calibration had been saved, the calibration values would be listed. If no previous calibration had been saved as the default, no values would be listed. *For more information, see the online Help for this dialog box..*

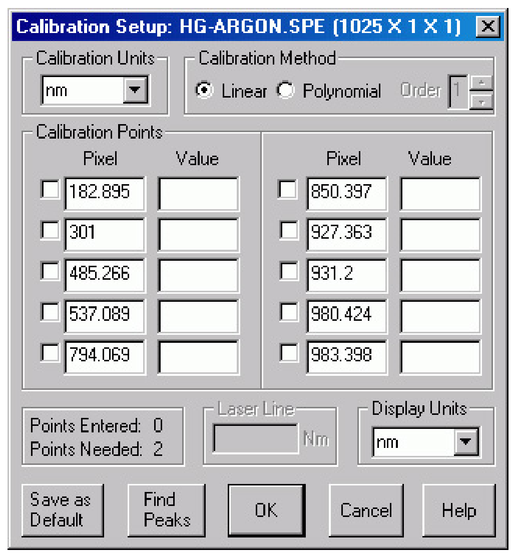

Figure 61. Calibration Setup dialog box after running Find Peaks routine on Hg-Argon spectrum

2. Click on **Find Peaks**. An automatic peak finding routine will be performed. The *maximum* number of peaks is equal to one quarter the number of displayed pixels. The pixel values for the 10 highest peaks will be shown in the Pixel boxes in the Calibration Setup dialog box as shown in Figure 61. Note that the Find Peaks routine causes a small red arrow to be displayed above each peak found in the spectrum together with a notation indicating the peak location in pixels (Figure 62).

Note: Each time the Find Peaks routine is initiated the *displayed* peak heights will decrease. Clicking on the data window Autoscale button will restore their original displayed height.

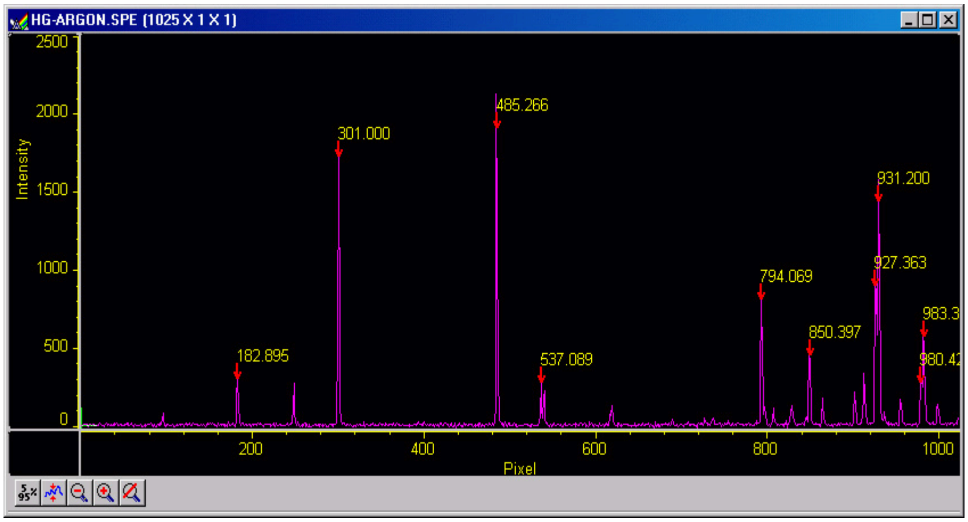

Figure 62. Spectrum after running Find Peaks routine

3. Select the calibration points. For the example being considered, the peaks at 182.90, 301.00, 485.27 and 931.20 would be good choices. *The decimal point locations are based on the calculated center of peak, and not necessarily the largest intensity position.*

4. Select the Calibration Units (if not nanometers) and select the Display Units. Both the Calibration Units and the Display Units are nm (the default) in the example.

5. Manually enter the wavelength of the selected peaks. *Appendix B contains wavelength tables and a detailed spectrum for Hg-Argon.* In our example, the wavelengths for the selected peaks would be:

Peak Location (Pixels)	**Peak Location (Wavelength in nm)**
182.90	365.02
301.00	435.83
485.27	546.07
931.20	811.53

6. Once the wavelengths have been entered for the selected peaks, check the selection box to the left of the Pixel box for each peak selected. (Figure 63). A checkmark in the box indicates that the peak is selected. *Note that wavelength values must be entered for these peaks before the selection box can be checked.*

7. Click on **OK**. This completes the wavelength calibration and the dialog box will close. At the same time, the Calibration Mode selected in the Usage dialog box will automatically change from **Off** to **Manual**.

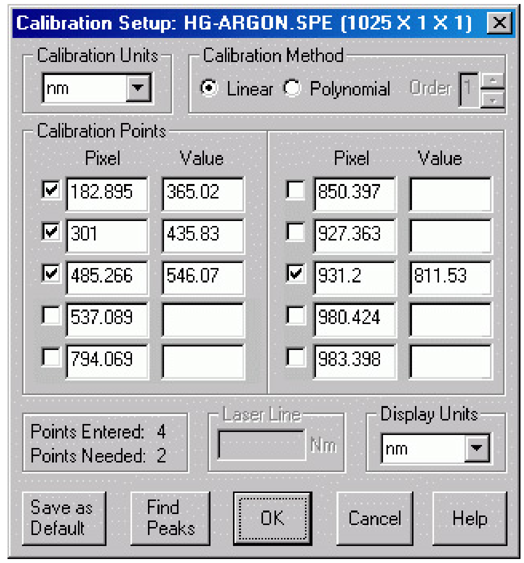

Figure 63. Setup Calibration screen after selecting peaks and entering calibration wavelengths

Note the appearance of the data display. The peak find routine display data (arrows and pixel number of each peak found) does not change. The x-axis units will however change to reflect the display units.

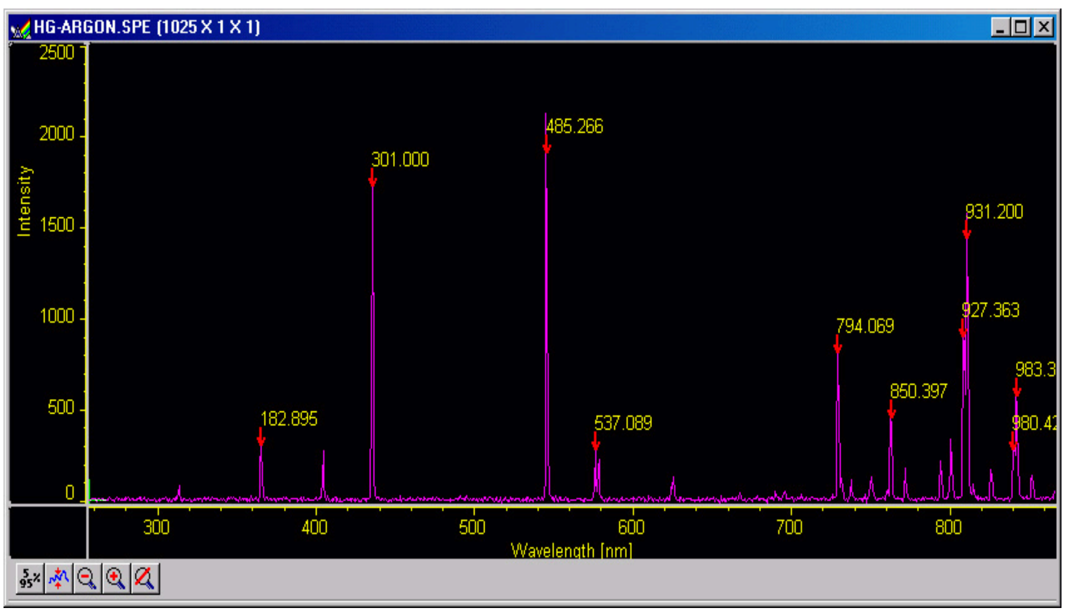

Figure 64. Spectrum after Calibration

Save as Default

The **Save as Default** button in the Calibration Setup dialog box determines whether a calibration is temporary or permanent (until changed). Once a calibration has been saved as the default, it will be automatically applied to subsequently acquired data. ***It will not be applied to data files recalled from disk.***

Note: The default state of the button, not only with respect to the button setting but also with respect to whether it is disabled (grayed out and not user-settable) depends on the situation, as follows.

No Data

If you open the Calibration Setup menu and there is no data, **Save as Default** will be pressed and disabled, that is, it will be locked in the **Save as Default** state. Should you then click on **OK**, no calibration values will be written to the Windows Registry.

Not Live Data

If there is data in the active window when you open the Calibration Setup menu, but the data isn't live, such as would be the case if it were recalled from disk, **Save as Default** is under user control, with "not pressed" as the default state. Note that if the opened data file was saved in a calibrated state, that calibration will be in effect when the file is opened, the calibration values will be loaded in the calibration setup, and the data displayed.

Live Data

If the active window is displaying live data, **Save as Default** will be under user control but in the selected or "pressed" state. If **Save as Default** is selected and you click on **OK**, the calibration will be stored in the Windows Registry and will be automatically applied to all subsequent acquired data, unless a new calibration is performed. If **Save as Default** is unselected and you click on **OK**, the calibration in effect (i.e., in the Calibration Setup dialog box) will apply to the active data file only.

Calibration, Display, and User Units

The default **Calibration Units** are nanometers (nm). These units can be changed, with the change taking effect immediately. Calibration units to choose from are nm (nanometers), cm-1 (wavenumbers), rel. cm-1 (relative wavenumbers), and user units (units other than above). For relative wavenumbers only, the wavelength of the excitation laser must be entered in the Laser Wavelength box in nm. Display unit choices are the same, with the additional selection of pixels.

The **Display Units** selection can be different from the Calibration units, except in the case of **User Units**. Under Display Units, the choices are pixels, nm (nanometers), cm-1 (wavenumbers), and rel. cm-1 (relative Raman shift wavenumbers). Theses units are the ones shown on the X-axis whenever calibrated spectra are displayed. To display files without calibration, even files collected with a specific calibration, select the pixel option under Display Units.

User Units allow the operator to scale the spectra to any arbitrary unit.

Calibration Method

A calibration requires at least two points defined by pixel and by units. Naturally the more points used, the more accurate the calibration. The points must always be defined by pixel number, but nanometers can be changed to another unit if desired.

Two mathematical models can be used to fit the calibration to the data. The first, Least Square, calculates a linear approximation of the fit by minimizing the sum of the squares of the errors between the fit and the calibration points. Linear approximation is generally sufficient. The Polynomial method uses a higher order function of the form $a + bx + cx^2 + \ldots$ where the "order" of the polynomial is the highest power of x used. The general rule is:

(# Cal Peaks - 1) = Order
maximum order = 5

If four peaks are active in the Calibrate dialog, the order of the polynomial can be 2 or 3. Even if ten peaks are used, the maximum order of the Polynomial is 5 (up to x^5). As a general guide, we advise calibrating using the Linear calibration method with widely separated peaks as previous described. If the available peaks are clustered, a Polynomial fit (using the smallest order possible) may give a good fit in the region of the calibration peaks, but have increasing large deviation the further you get from them. In an extreme case, there may even be two values for the same pixel, a clearly impossible condition that will result in an error message.

With the Linear calibration method, at least two peaks are required to calibrate. For a Polynomial calibration, the number of peaks must be at least one higher than the order of the polynomial. This information is displayed at the lower left of the Calibration Setup dialog box. The lower Points value is the number of peaks required. The upper points value is the number available for calibration. A peak is available if it has been found, its known value has been entered, and the adjacent checkbox has been checked.

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Chapter 7
Spectrograph Calibration

Introduction

You can calibrate the WinSpec/32 software by either using the spectrograph stepper motor position (Spectrograph calibration) or by manual wavelength calibration. Spectrograph calibration is achieved using the Calibrate selection on the Spectrograph menu, and is described in detail in this chapter. Wavelength calibration, which is only good for one position of the grating, is explained in Chapter 6.

The spectrograph calibration routine requires you to enter certain default values into a series of dialogs. You are also required to have a known source, such as a mercury lamp, placed near the entrance slit of the spectrograph. Once you have completed the following calibration procedure, any movement of the spectrograph will be accounted for in the display of spectral information.

Notes:

1. The spectrograph ***MUST*** be focused and aligned properly before a good calibration can be achieved. Spectrograph focusing and alignment is an art onto itself and is beyond the scope of this manual. Basically it consists of filling the aperture from a broad light source and adjusting the focusing mirror for the sharpest image (narrowest possible symmetrical peak) on the CCD. Focusing can also be accomplished by moving the detector in and out. Different detectors and/or spectrographs will have different means for doing this. In addition, it may be necessary to rotate the detector so that the spectral line is perfectly vertical on the CCD.
2. The Offset, Adjust and Dispersion parameter values for WinSpec/32 will not be the same as they were with earlier versions of WinSpec. This is true even if the same spectrograph is used. You cannot simply enter values you may have recorded when using the earlier (16-bit) WinSpec versions. If you do, very large calibration errors will be introduced. The calibration must be performed using the following procedure.

Preparation

1. Install the spectrograph, mounting it to the detector per the instructions in the Detector manual, and turn it on. You may have to restart the WinSpec/32 software after turning on the spectrograph.
2. Mount a suitable light source (mercury lamp preferred) near the entrance slit of the spectrograph so that the light passes through the spectrograph onto the detector.
3. Review the **Define Spectrograph** selections and settings to be sure they are correct for the calibration to be performed.

4. The **Experiment Setup** parameters must be set so that a spectrum can be acquired. Using **Easy Bin**, select a single strip of several rows near the center of the CCD and an exposure time between 0.1 and 0.5 seconds.
5. A filename should have been entered for the test acquisitions using the Data File tab page (Experiment Setup dialog box). Also, **Overwrite Confirmation** should be turned off so you won't see warning messages about overwriting data files. Exit the Experiment Setup dialog box by clicking on the **OK** button.
6. Acquire some data and display the data as a graph. Next position and size the data window. We suggest locating it at the upper left and sizing it so that it doesn't extend more than half way across the screen. Then select **Keep Window Placement** on the **Display Layout General** tab page, followed clicking on **OK**. This operation assures that all data windows will fall in precisely the same spot and will be precisely the same size, a configuration that conveys a significant convenience advantage when calibrating.

Notes:

1. You must use the supplied cable to control the spectrograph. Do not use a standard 9-pin serial cable, even if it worked with an earlier version of WinSpec.
2. If the spectrograph does not move or you get an error message such as "Communication Error with Spectrograph", the spectrograph setup is probably incorrect. Check the power on the spectrograph, the cable connections, and the settings in the Spectrograph dialog. Also try turning off and back on the spectrograph, then closing and reopening the WinSpec/32 software.
3. If wavelength direction is reversed, you won't be able to calibrate successfully. However, a warning message will be displayed. If this happens, open the Hardware Setup dialog box and select the Display tab page. If Rotate is selected, toggle the Flip box. If Rotate is not selected, toggle the Reverse box. Click on **OK** and then begin Offset calibration again.

Calibration Parameters

1. Select **Auto Spectro** on the Usage dialog box (to open, select Usage on the Calibration menu). *If the **Use for Auto-Spectro Calibration** checkbox on the Define Spectrograph Main tab page was used to designate a particular spectrograph as the one to be used for calibration purposes, that spectrograph will be automatically selected.*
2. If the **Save as Default** button on the Usage dialog box isn't already selected, select it now.
3. Select **Calibrate** on the Spectrograph menu. This will open the Spectrograph Calibration dialog box (Figure 65).

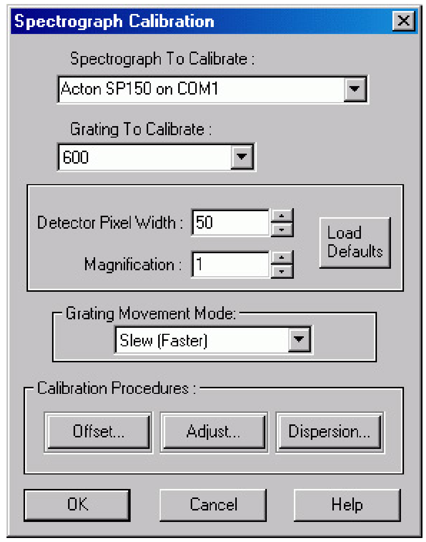


Figure 65. Spectrograph Calibration dialog box

4. Be sure the correct **Spectrograph to Calibrate** is selected. If another spectrograph is indicated, click on the down arrow at the right of the selection box to display all of the installed spectrographs and make the correct selection. *If only one spectrograph has been installed, the selection box won't appear but the spectrograph model will be reported.*

5. Be sure the correct **Grating to Calibrate** is selected. Calibration is grating specific. If the indicated grating is incorrect, click on the arrow at the right of the selection box to display the available gratings and make the correct selection.

6. Be sure the indicated value for the **Detector Pixel Width** in microns is correct. The default value will depend on the type of CCD chip installed. Note that some design factors, such as a tapered fiber optic ahead of the chip, will change *the pixel size seen by the spectrograph* and so will have to be taken into account in determining the value to be entered.

7. Be sure the indicated **Magnification** value is correct for your spectrograph. This parameter is determined by the geometry of the spectrograph. Contact your spectrograph manufacturer if you have any questions about the magnification parameter value.

8. Select the Grating Movement Mode, **Slew** or **Scan**. Operation with Slew selected will be significantly faster than with Scan selected.

Offset

Caution

> You must begin calibration with the **Offset** procedure and end with the **Dispersion** procedure. Performing the steps in this order is absolutely necessary for correct calibration.

Theoretically, if you were to move your spectrograph to the zero order peak or any other known peak, the peak would fall exactly on the center of the array. In the real world, the mechanical tolerances of the mounting will probably result in the peak being a few pixels off. The Offset procedure that follows allows you to correct for this small offset error.

1. Select **Info** on the View menu. The Info dialog box should be visible. This will help indicate the status of spectrograph movement and data collection.
2. In the Spectrograph Calibration dialog box, click on the **Offset** button. This will open the Offset dialog box (Figure 66).
3. The dialog box that appears has a Reference Wavelength entry box. This is the wavelength where the spectrograph is set for the offset measurement. All Acton spectrographs use the zero order, that is, a setting of "0."
4. Click on the **Start Offset Procedure** button. The spectrograph should now move to the reference wavelength and data acquisition will commence. Then a peak-find will be performed and the resulting data will be displayed.

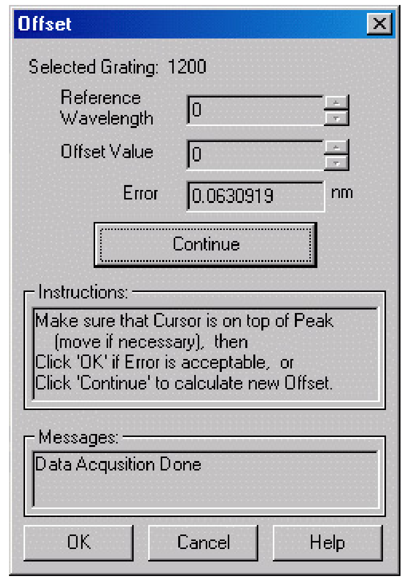


Figure 66. Offset dialog box

5. Figure 68 illustrates a typical Offset data acquisition. The reference peak should appear near the center of the display and the cursor should be near or on the highest point of the peak. If the peak is saturated, cancel, lower the exposure time, and repeat the operation. The display X-axis should be calibrated (any units other than pixels). *If the X-axis is calibrated in pixels, select the desired units as the calibration units on the Usage dialog box (opened by selecting Usage from the Calibration menu).*

Peak Finder

Before going on, you have to make a judgment regarding the location of the cursor on the peak. There may be situations where you will need to readjust the cursor position to get it precisely on the correct location. Although this should be a relatively uncommon event, it could happen, and it is important to take a moment to understand how the peak finder works, how it may appear to be in error when it in fact it is not, and how it could come to be in error and require manual intervention to correct the cursor position.

The peak finder works by taking the second derivative of the spectrum to find the peaks. Each peak found is then divided in two so that the area to the left of the divider equals the area to the right of the divider. The cursor is located at precisely the point where the divider intersects the peak. Note that, depending on the shape of the peak, the cursor may or may not end up precisely on the highest point. Figure 67 shows three possible peaks, and illustrates the action of the peak finder in each case.

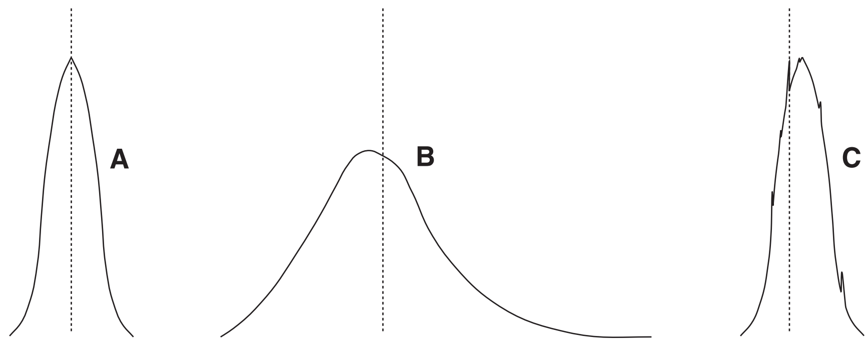


Figure 67. Peak Finder Examples

Peak **A** is perfectly symmetrical. As you would expect, dividing it into two equal areas and locating the cursor at the intersection of the divider with the peak will put the cursor precisely at the highest point. Peak **B**, on the other hand, is not symmetrical but rather extends further to the right than to the left. As a result, the final cursor position is a little to the right of the highest point. *This is the correct peak location. Any attempt to "improve" it by manually moving the cursor to precisely the highest point will degrade the offset computation. Note that moving the cursor immediately changes the reported Error. Do not assume that this means the cursor wasn't optimally located. Rather it indicates a possible optical problem and the spectrograph may need to be realigned.* Peak **C** is like peak A but is accompanied by a number of noise spikes. The peak finder is quite sensitive and might well select one of these spikes as the real peak and incorrectly place the cursor on the noise spike as shown in **C**. If this happens, the correct action would be to manually adjust the cursor position to the right so that it is on the true peak before going on.

Doublets are also a problem. At any stage of the calibration procedure the peak finder might find the wrong peak of a doublet. For example, if using the 579.066 nm mercury line in doing the Dispersion Calibration, you need to take care to check that the peak finder hasn't selected the 576.96 nm line instead. If it does, it is a simple matter to move the manually move the cursor to the correct peak. *Note that the zoom function can also be controlled using the data window icons.*

If it is difficult to see the precise cursor position, simply press the keyboard **Insert** key to expand the display about the cursor position. The key may have to be pressed several times to achieve the desired resolution. *(Use the Delete key to return to the original display.)* If you do decide to move the cursor, note that each time a cursor-positioning arrow key is pressed, the cursor will move one data point. Assuming no horizontal binning is in effect, one data point will correspond to one pixel on the array.

As a final comment, even if you should move the cursor when it wasn't necessary, repeating the Calibration Offset cycle a few times will still achieve an optimum offset adjustment.

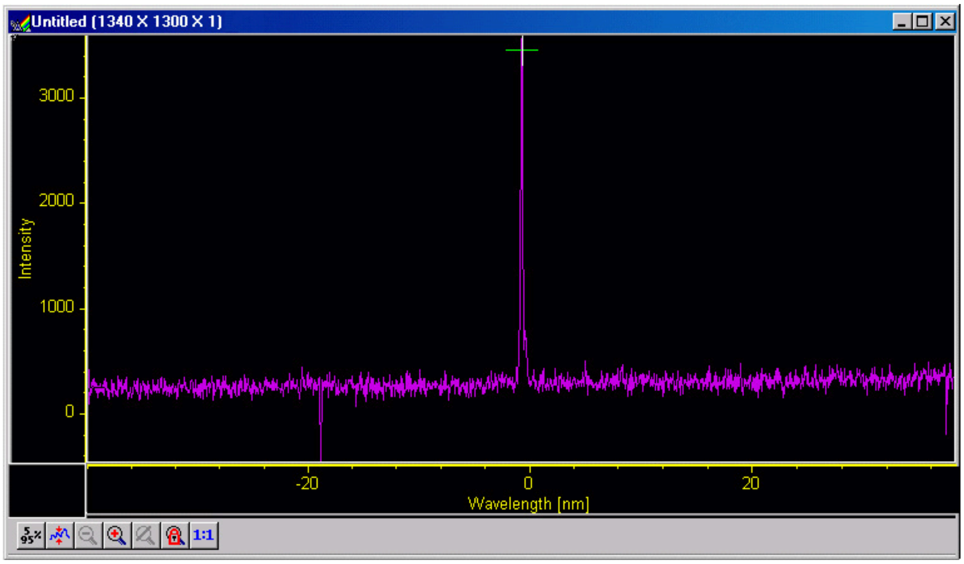


Figure 68. Offset Spectrum for Zero-order Measurement

6. Note the reported **Error** value in the Offset dialog box. The value is reported in nm. Transposed to pixels it should be less than one pixel. *The number of nm represented by one pixel will depend, of course, on the dispersion of the grating.*
7. Press **Continue** to initiate another offset computation cycle. The reported error should decrease. Repeat the cycle two or three times – until no further reduction in the error can be achieved. The final error value achieved may wander a bit with each cycle repetition, reflecting the noise content of the spectrum.
8. Click on **OK** to close the Offset dialog box and return to the Spectrograph Calibrate dialog box.

Adjust

Once you have adjusted the Offset for a reference wavelength (or for the zero order peak) other wavelengths may still be improperly calibrated. To see why this is so, think of the calibration in terms of the linear general equation:

$$y = mx + b$$

Although this is a simplified model, it suffices to show the basic relationships. The “b” term can be thought of as the offset, which is adjusted to place the reference at precisely the center of the array. The location of points away from the offset reference will be determined by the “m” or slope term (as well as “b”) and the Adjust procedure allows “m” to be set so that adjusting the spectrograph to other wavelengths will result in this wavelength falling on the center of the array.

1. Click on the **Adjust** button to open the Adjust dialog box (Figure 69).

2. Enter as the Reference Wavelength a known line in the observed spectrum, such as 579.066 for Mercury. Next click the **Start Adjust Procedure** button.

3. The spectrograph will move to the reference wavelength and collect a spectrum. It will also perform a peak-find operation and display the acquired data. The reference peak should appear somewhere near the center of the display and the cursor should be on the peak at or near the highest point.

4. Figure 70 illustrates a typical Adjust data acquisition. The reference peak should appear near the center of the display and the cursor should be near or on the highest point of the peak.

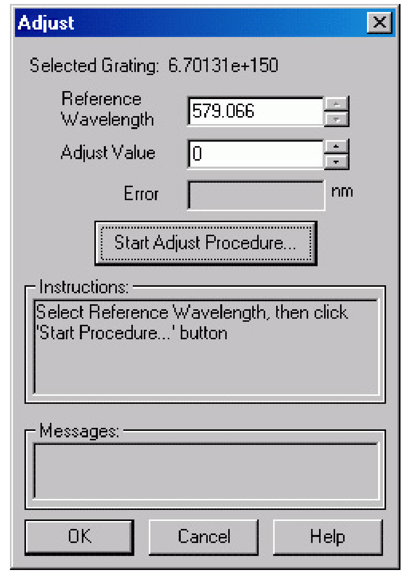


Figure 69. Adjust dialog box

5. As was the case for the Offset adjustment, before going on, you have to make a judgment regarding the location of the cursor on the peak. Take particular care that the proper peak has been found. If, for example, the peak finder places the cursor on the 576 peak, manually move the cursor to the 579 peak. For additional information, refer to the earlier discussion of how the peak finder works in the Calibration Offset procedure.

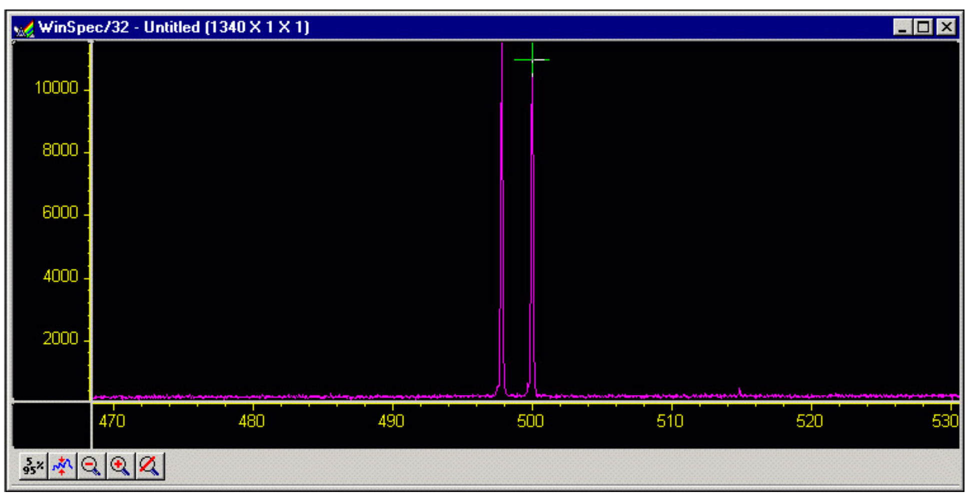


Figure 70. Calibration Adjust Spectrum

6. Note the reported **Error** value in the Adjust dialog box. The value is reported in nm. Transposed to pixels it should be less than one pixel. *The number of nm represented by one pixel will depend, of course, on the dispersion of the grating. The nm/pixel can be approximated by picking the difference in the location of the two peaks while in pixel mode, and dividing the difference reported in calibration units in the calibration mode.*

Note: The absolute value of the peak is reported in the Info box. If it is not already open, open it by selecting Info on the View menu.

7. Press **Continue** to initiate another Adjust computation cycle. The reported error should decrease. Repeat the cycle two or three times – until no further reduction in the error can be achieved. The final error value achieved may wander a bit with each cycle repetition, reflecting the noise content of the spectrum.
8. Click **OK** to close the Adjust dialog box and return you to the Spectrograph Calibrate dialog box.

Dispersion

Now that Offset and Adjust are complete, the spectrograph can move a target peak very close to the center of the display. The final step is to calibrate the wavelength scaling so that peaks on the far left or the far right in the window are also accurately calibrated. This is called the Dispersion calculation, and again it is automated in WinSpec/32.

To adjust the Dispersion calculation you will make two measurements in the lower spectral range (253.652 for Mercury); one measurement with the peak at the left edge of the display and one with the peak at the right edge. Then you will make two measurements in the upper spectral range (579.066 for Mercury). After these steps, WinSpec/32 then tries to find the combination of Focal Length, Inclusion Angle, and Detector Angle that minimizes the error.

Note: Some CCDs have very little response at 253.652. If this is the case for your detector, it will be necessary to use a peak having a longer wavelength as the low value. For mercury, the 435.833 line should prove suitable.

1. Click on the **Dispersion** button to open the Dispersion dialog box. If you have never calculated the Dispersion before, click on the **Default** button. This provides standard values for Focal Length, Inclusion Angle, and Detector Angle based on the manufacturer's data for the active spectrograph. If you have already run the Dispersion calculation before and it provided satisfactory values, they will be displayed and should be used as your starting values.
2. Enter the Lower and Higher Reference Wavelengths. For the mercury spectrum, use 253.652 (low) and 579.066 (high). *Again, if your CCD doesn't have sufficient response to calibrate at 253.652, it will be necessary to use a different peak.* It isn't necessary to enter a Target Wavelength. It will be calculated during the procedure.

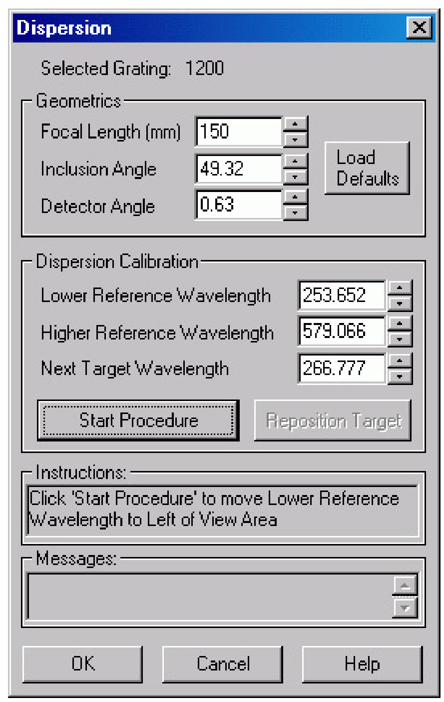


Figure 71. Dispersion dialog box

Note: In the following steps, four data sets will be taken, each initiated by you. The **Start Procedure** button initiates the first, and the same button, named **Continue** once the first data set has been taken, is used to initiate each of the other three. After each data set is taken, you have the option of adjusting the cursor position on the peak. However, as previously explained, this will not be required or advisable in most instances. *See the Peak Finder discussion in the Calibration Offset procedure.* The data sets are taken in the following order:

1. Low peak (253.652) at the left of the display.
2. Low peak (253.652) at the right of the display.
3. High peak (579.066) at the left of the display.
4. High peak (579.066) at the right of the display.

3. Click on the **Start Procedure** button.

- WinSpec/32 will acquire the first data set and display it. It will also calculate the Target Wavelength so that the Lower Reference Wavelength peak appears near the left edge of the display. *The Target Wavelength is the wavelength the spectrograph must move to in order for the reference wavelength to be properly located near the edge of the display.*

- If the peak is outside the display, you should enter a Target Wavelength that might be better and click the **Reposition** button. If the peak is too close to the center of the display you should enter a slightly higher Target Wavelength and click on the **Reposition** button. Once the peak appears near the left edge, check, and if necessary adjust, the cursor position on the peak using the same criteria as for the Offset and Adjust operations. Then click on **Continue to Step 2** to initiate the second data acquisition.

- The spectrograph will acquire the second spectrum. If the peak is close to the right edge of the display as expected, click on **Continue to Step 3** to initiate the third data set acquisition. If the peak is not in the right position, use the **Reposition** button to move the spectrograph as required to position the low peak near the right edge of the display. Then click on **Continue to Step 3** to initiate acquisition of the third data set.

- The spectrograph will acquire the third spectrum, this time positioning the cursor on the high peak at 579.066. If the peak is close to the left edge of the display as expected, click on **Continue to Step 4** to initiate the fourth data set acquisition. If the peak is not in the correct position, use the **Reposition** button to move the spectrograph as required to position the high peak near the left edge of the display. Then click on **Continue to Step 4** to initiate acquisition of the fourth data set.

- After completion of the fourth data set, once again check to be sure the cursor is on the correct peak and manually move it if it is not.

After all four reference points are taken, WinSpec/32 begins an iterative process to find the best values. This process is initiated by clicking on the **Calculate Results** button. You will see the parameters change as WinSpec/32 performs the calculations. The program stops when the best parameters are displayed in the Dispersion dialog box. If satisfied with the calibration, simply click on **OK** to make the save the final dispersion parameters as part of the calibration data for the grating. Click on **Cancel** to revert back to previously saved parameters. Note that you can also change the parameters manually and click on **OK** to save them.

Having completed the calibration for one grating, select the next grating and repeat the procedure. Continue until all available gratings have been calibrated.

Chapter 8

Displaying the Data

Introduction

WinSpec/32 can display data as an image, as a two dimensional graph, or as a 3D Graph (multiple strips from the same graph or the same strip from multiple frames). You can choose to allow the software control how the data will be displayed or make the selection yourself. To have WinSpec/32 control the data-display mode, simply select the **Auto Select** checkbox provided on the File Open dialog box and also on the Display Layout dialog box. The Auto Select algorithm makes the selection depending on the number of data strips as follows.

- If there are eleven or more strips of data, they will be displayed as a normal image, such as that shown in Figure 72.

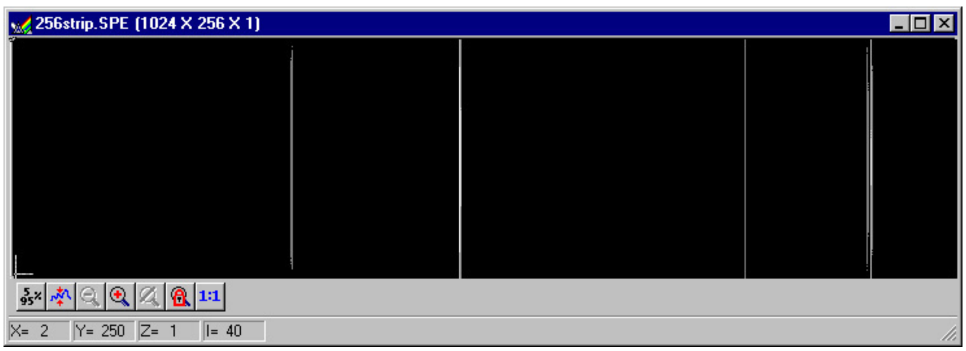


Figure 72. Image display of 256 data strips

- If there are at least three data strips but less than eleven, the data will be plotted as a 3D Graph as shown in Figure 73.

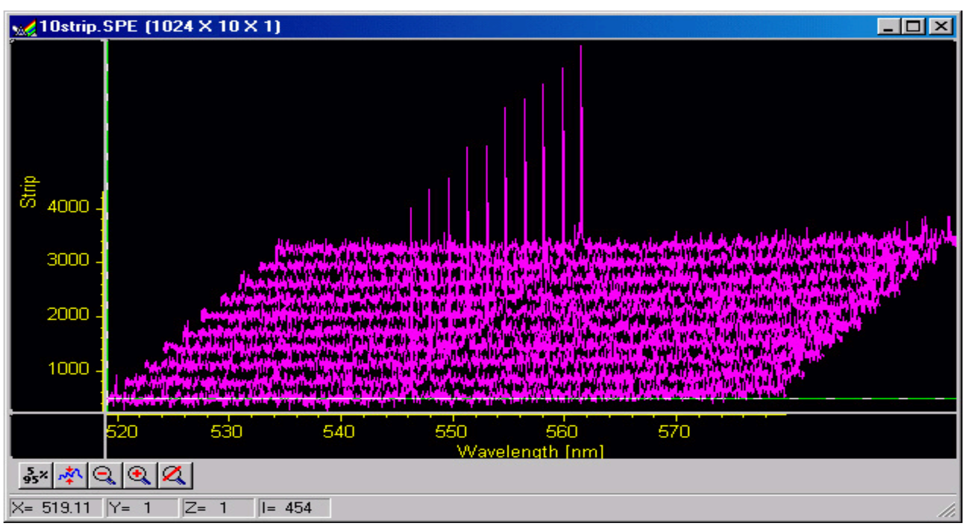


Figure 73. 3D Image display of 10 data strips

- If there are only two strips of data, they will be displayed as graphs stacked in a two-dimensional plot, the same as for a 3D Graph of two strips.

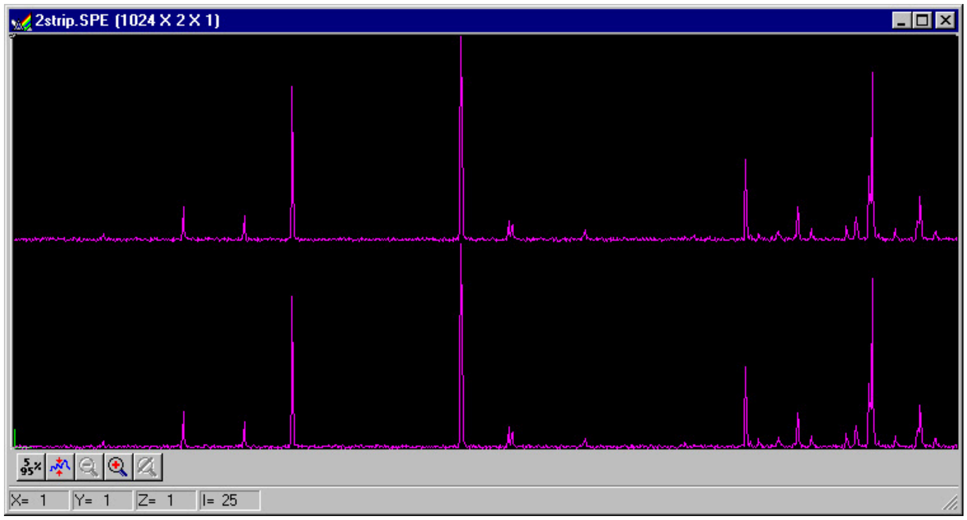


Figure 74. 3D graph with two data strips

A single strip ***will always*** be plotted as a simple graph. Note that from two to ten strips, the intensity (Y axis) scale shifts position as required to read true for the selected strip.

The file Open dialog box and Display Layout dialog box both contain the three display-mode select radio buttons, **Image**, **Graph** and **3D Graph**. If you want to control the data-display mode yourself, simply leave Auto Select unchecked and the display mode will correspond to whichever of the three radio buttons is selected.

Screen Refresh Rate

The Screen Refresh Rate is an important but often overlooked display performance parameter. At times, such as when focusing, by making the screen refresh rate as rapid as possible, the focusing operation may be much easier to perform than it would be with a slow refresh rate. To obtain the fastest possible refresh rate, simply operate with the axes and cross-sections both switched off (View menu) and with the Zoom factor set to 1:1. *Note that the Zoom 1:1 button on the Data Window toolbar is only present when viewing an image.* To check the refresh rate, click on the Status bar (bottom of screen) **Collection Status** pane, which is immediately to the left of the Timer pane (right end of Status bar). The refresh rate will be displayed in the Collection Status pane. Do not confuse the screen refresh rate with the data collection rate.

Data Displayed as a 3D Graph

Data files can be opened as 3D graphs from the Open dialog box. Figure 75 shows a 3D graph with five data strips. Figure 74 (on the previous page) shows a 3D graph with two data strips. Both examples illustrate the behavior of the **Auto Select** algorithm as discussed on page 93. The following paragraphs contain procedures for opening and displaying data in graphical format.

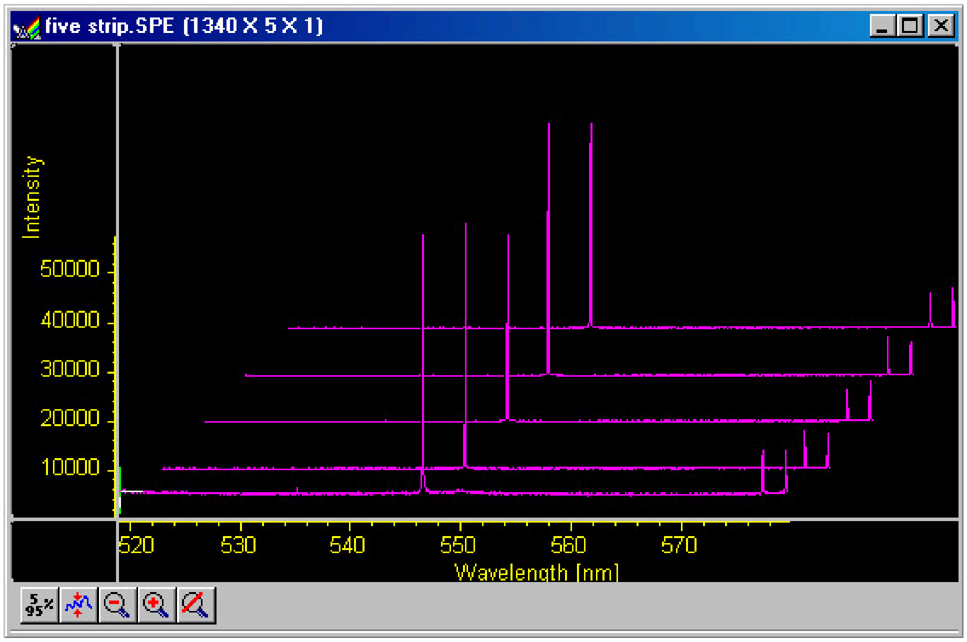


Figure 75. 3D graph with five data strips

Displaying Hid-lamp.spe

The data file used in this exercise is Hid-lamp.spe, one of the data files supplied with your WinSpec/32 software.

1. From the File menu select **Open**. The Open dialog box (Figure 76) will appear, allowing you to select the image to be opened. The Look-In box provides a browser function so that the directory where the images are located can be easily accessed. By default the data directory is a subdirectory of the WinSpec program directory. Files of the specified type (the WinSpec/32 data type is *.spe) in the current directory and any subdirectories are listed in the box below the directory name.

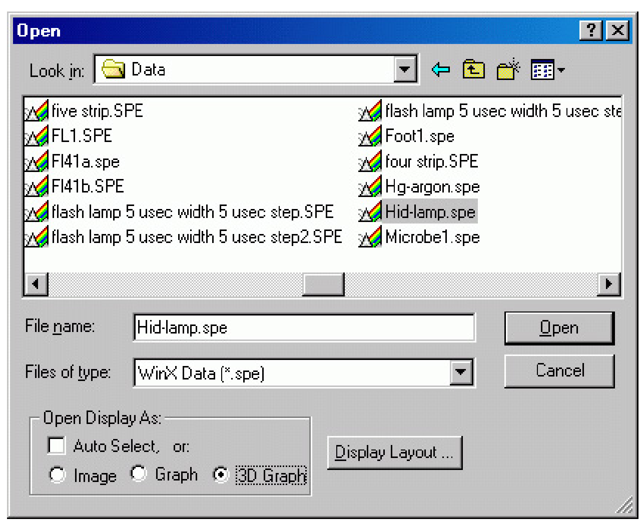


Figure 76. Open dialog box

2. The Image, Graph and 3D Graph radio buttons at the bottom of the box allow you to select whether the file will be opened and displayed as an image, two-dimensional graph or as a 3D graph. Select **3D Graph**. (Auto Select should not be checked.)

3. From the data directory select the image file called Hid-lamp.spe. Click on the **OK** button. A window of the appropriate dimensions should appear immediately. The graph display may take a few seconds, depending on the speed of the computer. The initial appearance of the display may vary depending on the initial Display Layout parameter settings.

4. Select Layout on the Display menu. The Display Layout dialog box will open as shown in Figure 77.

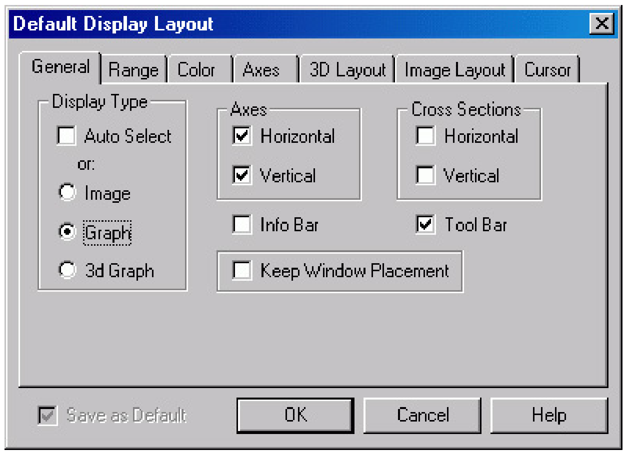


Figure 77. Display Layout dialog box

5. Check and, if necessary, set the following parameter selections on each tab page.

   General tab page
   Display As: 3d Graph
   Auto Select: unchecked
   Axes: both boxes checked
   Cross Sections: both boxes checked
   Keep Window Placement: unchecked

   Range tab page
   - **Initial Autoscale:** checked
   - **Set to Full Range:** checked
   - **Frame:** 1

   Color tab page: no changes

   Axes tab page
   - **Horizontal axis:** checked
   - **Horizontal label:** checked
   - **Horizontal label string:** Pixel
   - **Vertical axis:** checked
   - **Vertical label:** checked
   - **Vertical label string:** Intensity

   3D Layout
   - **3D Mode:** Multi-strip; same frame selected
   - **3D Properties:** Remove Hidden Line checked; other two boxes unchecked.
   - **Z Axis Endpoint:** %X set to 20; %Y set to 40
   - **3D Marker curves:** Marker Curves unchecked; Curve set to 5

6. Click on **OK**. The Display Layout dialog box will close and the data display, exclusive of the intensity profiles, should appear as shown in Figure 78. Each strip is displayed as a plot of intensity vs. pixel number. The first strip is at the front and the last strip is at the back. Initially the cursor will be at the lower left. Use the up arrow key to move to a higher numbered strip and the right arrow key to move to a higher numbered pixel on the strip. Then click the Intensity Autoscale key to scale the

intensity profiles. *Note that clicking the mouse button at different points on the display will change the pixel selection but not the strip.*

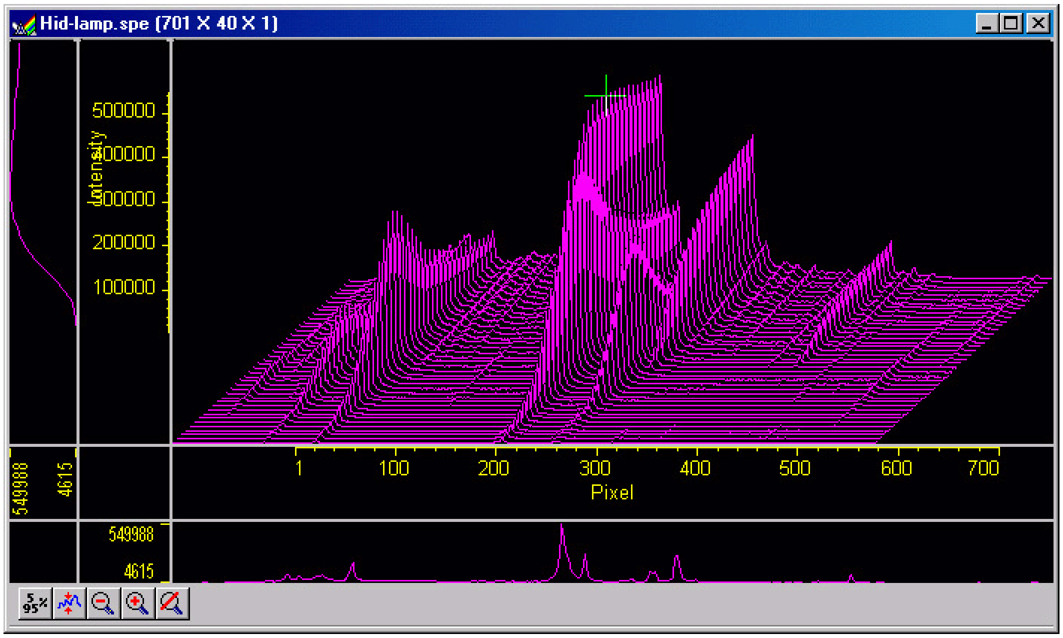


Figure 78. Hid-lamp.spe 3-D Graph

7. Press the **Insert** key repeatedly. Each time it is pressed the display expands about the cursor position. Then press the **Delete** key repeatedly to contract the display, restoring the appearance of the data display.

8. Note the cross sectional displays in Figure 78. The vertical cross-section profiles the intensity at the same point on each successive strip. The horizontal cross-section profiles the intensity at each point on the same strip. If the large cursor is selected, cursor projections will intersect the cross section to show indicate the cursor position. These projections may not be visually aligned with the cursor position on the main plot. This effect will be particularly noticeable with a long Z axis. Because of perspective effects, the higher numbered strips will be further away and visually smaller. The axes automatically adjust so that they read true for the strip on which the cursor is located. However, because the cross-section profiles expand to use all of the available space, they will not be in alignment visually with the cursor. The profile shapes will be correct, and the point on the profiles intersected by the large cross-hair extensions will accurately indicate the cursor position. Also, the information box will accurately report the pixel number and intensity at the cursor position.

5%-95% Display Range

1. Click on . The data display will shift so that it only fills the 5% to 95% region of the window range. Had the data initially extended all the way to the window boundary, the data display would have been slightly compressed to fit within the 5%-95% range.

2. Click on , restoring the image to its initial appearance.

3. Before advancing to the next topic, open the **View** menu. Then select the Small cursor and deselect Cross-Sections.

Selecting a Region of Interest

1. Using the mouse, drag a rectangular region on the image as shown in Figure 79.

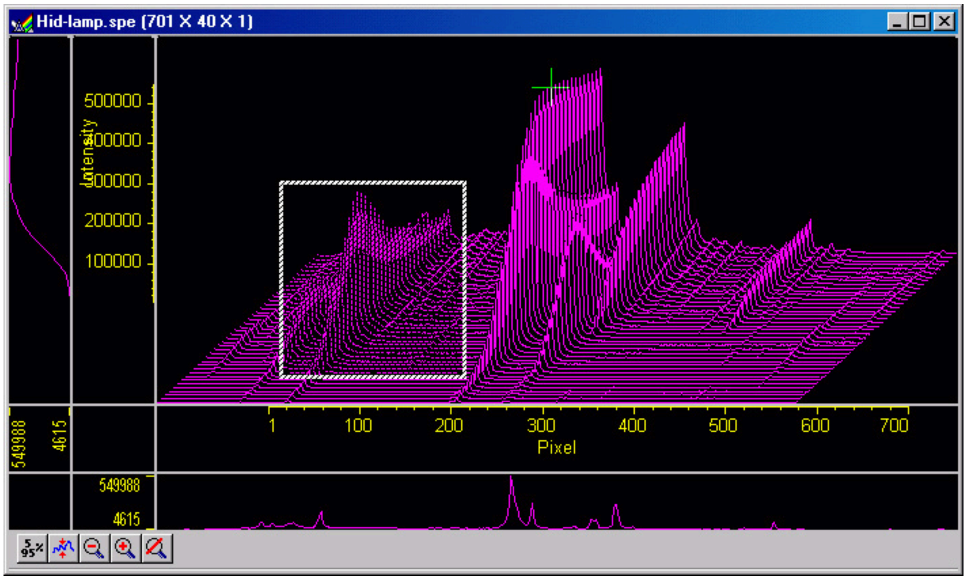


Figure 79. Hid-lamp.spe 3D graph with region selected for viewing

2. Click on  (Zoom In). The view will change so that only the selected region is displayed as shown in Figure 80.

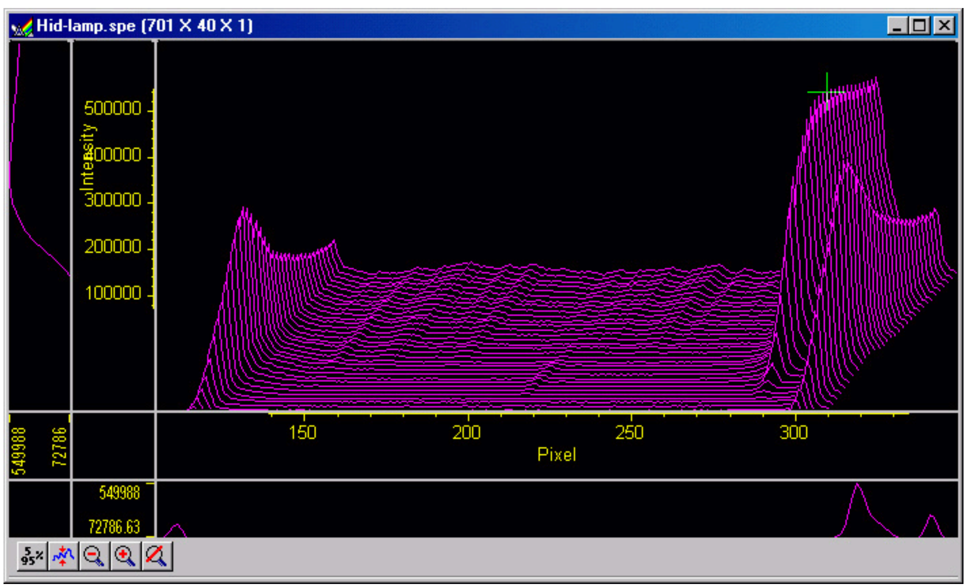


Figure 80. Hide-lamp.spe 3D graph expanded to show defined region

3. Click on  (Undo All Zoom-In). The original view will be restored.

Information box

On the View menu, select Info. The information box should appear as shown in Figure 81. The first line reports the intensity and pixel number at the cursor position. The second line reports the frame number, strip number, and the pixel number. The intensity in A/D counts is reported at the X and Y position corresponding to the cursor position. If a region is defined by dragging the mouse cursor, the region coordinates, length and height will also be reported. *You may have to lengthen the Information box for all this information to appear.*

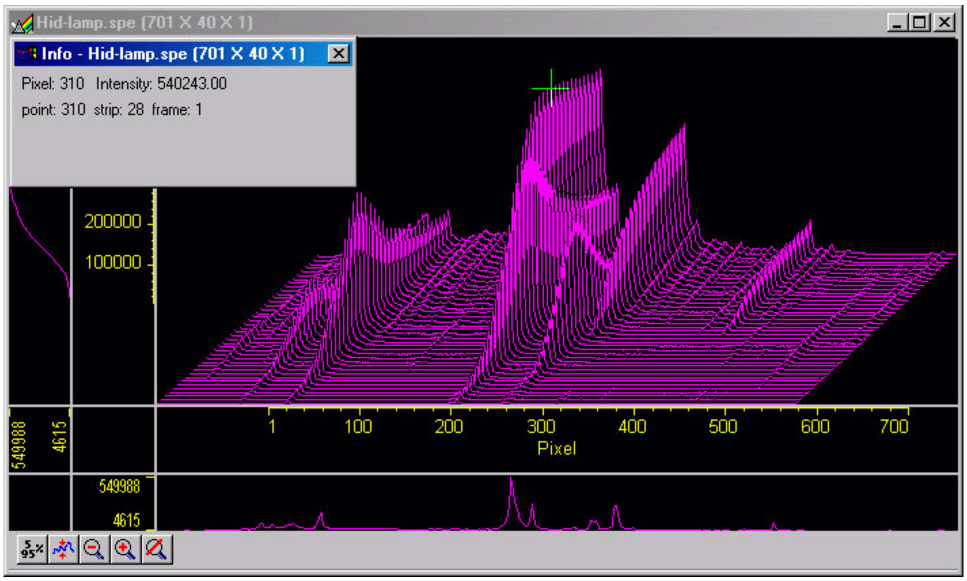


Figure 81. Graphical Display with Information box

Note: When you open the information box, it becomes the active window. To perform operations in the data display window, such as changing the selected strip, you must again make the data display window active by clicking the mouse cursor anywhere in the data box. The data-window title bar will become highlighted, indicating that it is the active window, and the cursor positioning functions will become operative again. The data displayed in the information box will continue to be updated automatically.

Displaying a Single Strip

1. Open the **Display Layout** dialog box by selecting **Layout** on the Display menu.
2. On the **General** tab page, with Auto Select unselected, click on the Display Type **Graph** radio button and then on **OK**. The single data curve for the strip on which the cursor is positioned will be displayed.

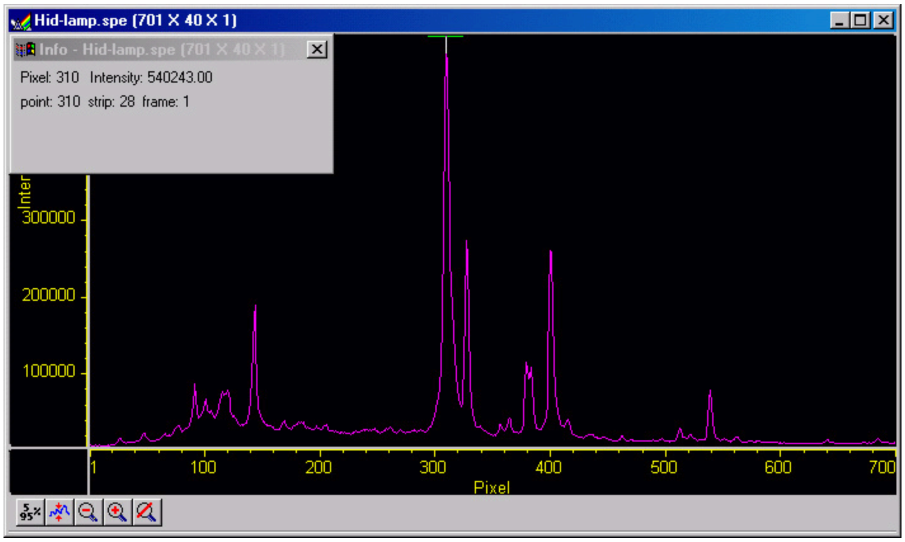


Figure 82. Single Strip displayed graphically

3. Try operating the cursor positioning keys to demonstrate their effect. The left/right arrow keys move the cursor along the strip, and the up/down keys move it from strip to strip. The **Home** and **End** keys move the cursor to the strip ends, and **Shift + Home** and **Shift + End** move it the first strip and last strip, respectively. The **Insert** and **Delete** keys expand or contract the data about the cursor position.
4. Restore the 3D display by selecting **3D Graph** on the **Display Layout|General** tab page.

Cursor

The cursor's appearance and behavior are a bit different with graphical plots than with image plots, as detailed in the following table.

Table 3. Cursor Appearance and Behavior for Images and Graphs

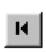
Selection	Image Plot	Graph	3D Graph
None	No Cursor	No Cursor	No Cursor
Small	Small cross; both mouse and arrow keys can place cursor at any pixel on image. **Home** and **End** keys move cursor to end points on strip. **Shift + Home** moves cursor to first strip. **Shift + End** moves it to the last.	Small cross; left/right arrow keys select pixel on strip; up/down arrow keys select strip to be displayed. **Home** key moves to first pixel, **End** key to last pixel.	Small cross; left/right arrow keys change selected pixel on strip; **Home** key moves to first pixel, **End** key to last pixel. Up/down arrow keys move cursor from strip to strip. **Shift + Home** moves to first strip,

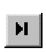
Selection	Image Plot	Graph	3D Graph
			Shift + End to last. Strips may all be from same frame or each may be from a different frame.
Large	Large cross; rays extend to edges of data set; with projections through the cross-section profiles if displayed. Both mouse and arrow keys can place cursor at any pixel on image. **Home** and **End** keys move cursor to end points on strip. **Shift + Home** moves cursor to first strip. **Shift + End** moves it to the last strip.	Same as Small Cursor and Graph combination.	Same as Small Cursor and 3D Graph except that cursor ray projections through the cross-section profiles are provided. These will not necessarily be visually aligned with the cursor.

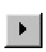
Strip Selection

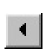
As described above, when displaying data as a graph, the up/down arrow keys can be used to select a higher or lower numbered strip. This is true if displaying multiple strips or a single strip. For additional utility where a large change is required, **Shift + Home** can be used to move the selection to the first strip and **Shift + End** to move it to the last one.

Four of the Custom Toolbar buttons similarly allow the selected strip to be changed when data is displayed as a graph.

 Selects the first strip.

 Selects the last strip.

 Selects the next strip.

 Selects the previous strip.

These buttons have no effect on the strip selection when viewing data as an image. Instead they select the first, last, next and previous frame respectively if the data set contains multiple frames.

Note: When displaying the data as a graph, to view data from multiple frames, it is necessary to select **Same Strip - Multi Frame** on the 3D Layout tab page of the Display Layout dialog box.

It might further be noted that these buttons do not appear on the default Custom Toolbar. Instead they must be added using the Customize Toolbar dialog box, accessed by selecting **Custom Toolbar** on the **Setup** menu.

Cursor Curve and Marker Curves

In analyzing a data display, it is often desirable to highlight the cursor curve and to have every *n*th curve displayed in a different color as a convenient marker. WinSpec/32 provides these functions as demonstrated in the following procedure.

1. On the 3D Layout tab page, select **Highlight Cursor Curve** and **Marker Curves On**. Then press **OK**. The cursor curve and marker curves should be clearly delineated. Note that on a color monitor they would be in contrasting colors and much easier to see than in a black and white print as shown in Figure 83.

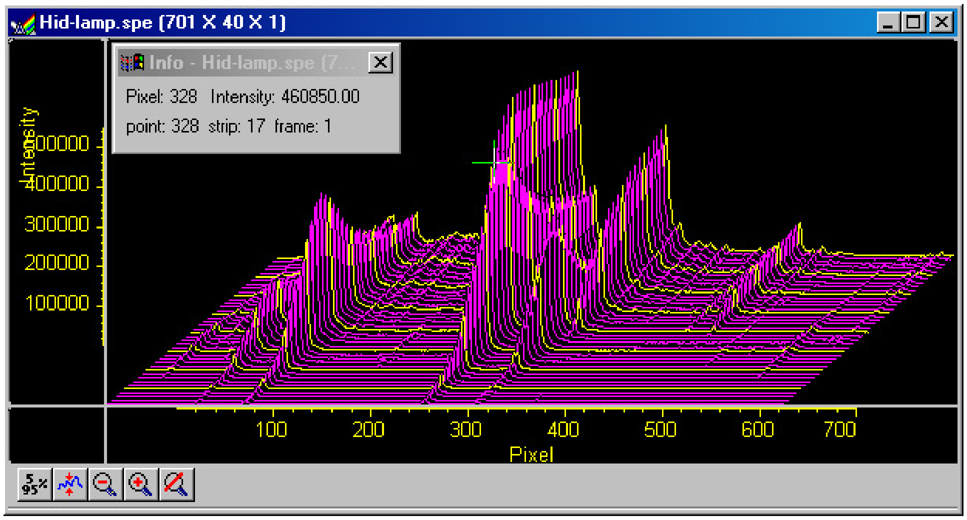


Figure 83. 3D Display with Cursor curve and Marker Curves

   Note that displaying the data with Highlight Cursor Curve displayed affects the time required to step the cursor from curve to curve. If Highlight Cursor Curve is OFF, the cursor can step without updating the entire display. If Highlight Cursor Curve is ON, the entire display updates with each step, a considerably slower operation.

2. If the Cursor Curve and Marker Curves don't appear, the problem may be with the assigned colors, which should be different from the normal graph color and different from the background color. On the Display Layout Color tab page, it the **Active 3D Graphs** button that allows the cursor-curve color to be set. The **Marker Graphs** button is used to set the marker-curves color.

Hidden Surfaces

The following procedure shows you how to shift the view to see the hidden or underside of the data.

1. Open the Display Layout dialog box and make the following changes.

   Range: Change Y so that the range is "from 40 to 1" (not "from 1 to 40").

   3D Layout: Select **Show Hidden Surface** and deselect **Highlight Cursor Curve** and **Marker Curves On**. **Remove Hidden Lines** should be selected. Change the Z Axis Endpoint to X% 25 and Y% 0.

> The Z Axis Endpoint can be set by entering values up to 80% X (either polarity) and 80% Y (positive only) or graphically by using the mouse. If you click on **Adjust Z Graphically** and then on **OK**, the Z Axis Adjust window will appear. With the cursor in that window, depress the left mouse button, and drag the cursor around the WinSpec/32 desktop until you see the desired axis orientation. Then release the mouse button.
>
> Because the data is displayed the moment you depress the mouse button and then updated as you drag the cursor, you can see the effects of dragging the axis while moving it. When working with a high-density data set, every *n*th line will be suppressed during the adjustment so the process remains fast. When the data is displayed as desired, releasing the mouse button will cause the entire data set to be displayed with the new orientation.
>
> ***TIP:*** Since you can move the cursor outside the data window, reducing the data window size before adjusting the Z axis will give you greater range of motion while dragging the axis.

2. Click on **OK**. The data should be redisplayed as shown in Figure 84, with the hidden surface clearly visible.

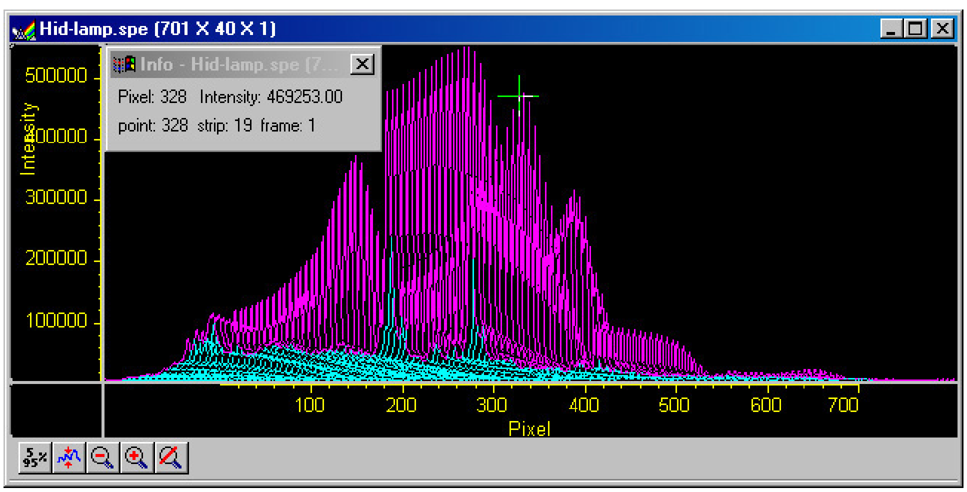


Figure 84. 3D Plot with Hidden Surfaces

3. If the hidden surfaces aren't clearly delineated, you may need to change their color. Use the **Normal Hidden Surface** button on the Display Layout Color tab page to choose a different hidden-surface color. *Note that the* ***Marker Hidden Surface*** *button allows you to set the color of the marker curves in hidden surface regions.*

Data Window Context menu

For your convenience, the essential data window functions have been gathered into a single menu, illustrated in Figure 85. This menu, which is available whether the data is displayed as an image, graph, or 3D graph, can be accessed by right-clicking anywhere in the data display area. Brief descriptions of the provided functions follow.

Note: Right-clicking inside an ROI will open the ROI context menu.

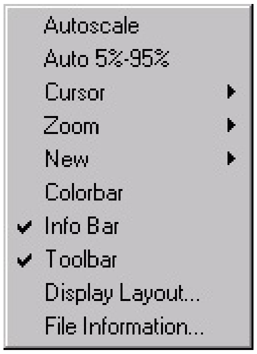


Figure 85. Data Window Context menu

Labeling Graphs and Images

For graphs and images, the normal context menu (right-click) is as shown in Figure 86.

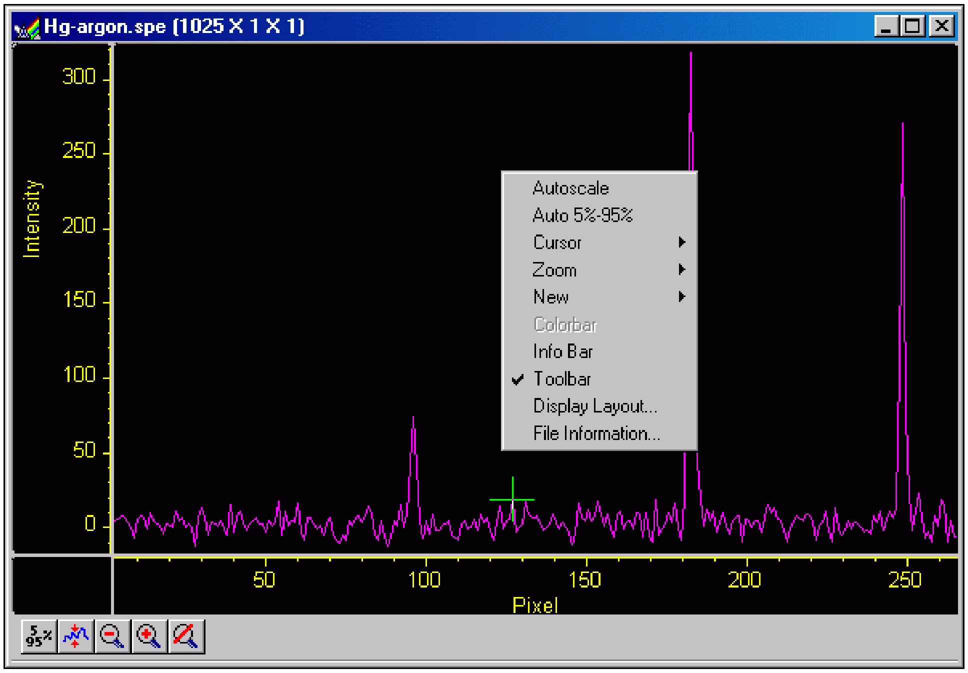


Figure 86. Normal Context menu

This menu was changed for ROIs. If there is an ROI, and if the mouse is right-clicked in the ROI, the context menu changes to that shown in Figure 87.

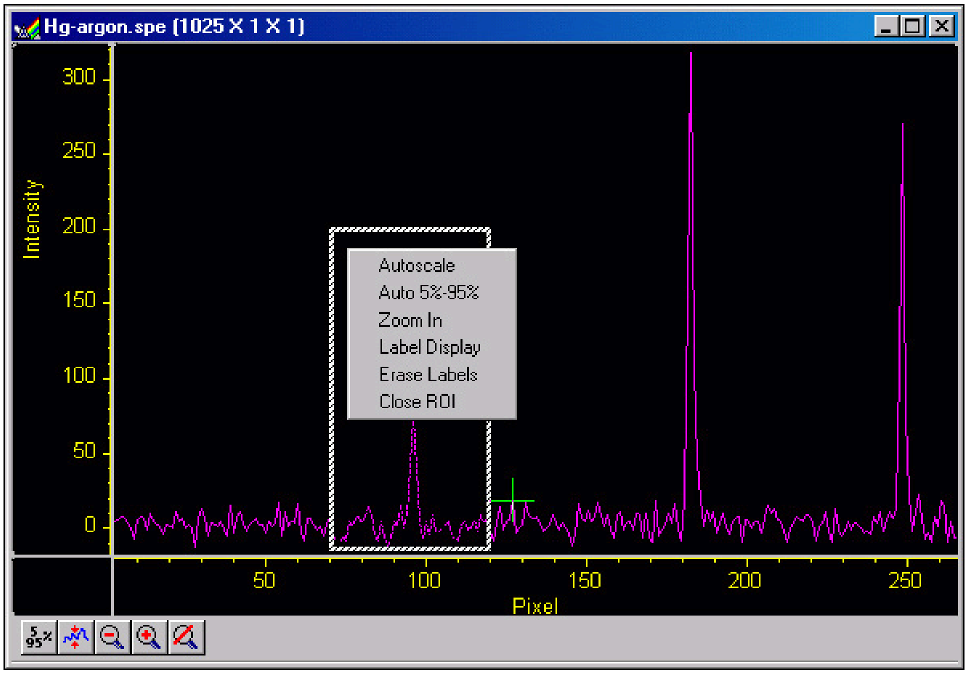


Figure 87. ROI Context menu

If the mouse is right-clicked outside the ROI, the normal menu (Figure 86) appears. The ROI context menu (Figure 87) contains the usual actions pertaining to the ROI (autoscaling on the region inside the ROI, and zooming in to the ROI region) plus three new actions:

Label Display: which allows user labels to be placed on the display,

Erase Labels: which removes ALL user labels from the display, and

Close ROI: which erases the ROI with no other action (it doesn't move the cursor!).

The **Label Display** action brings up a dialog box and opens an Edit box - ***Inside the ROI!*** as shown in Figure 88.

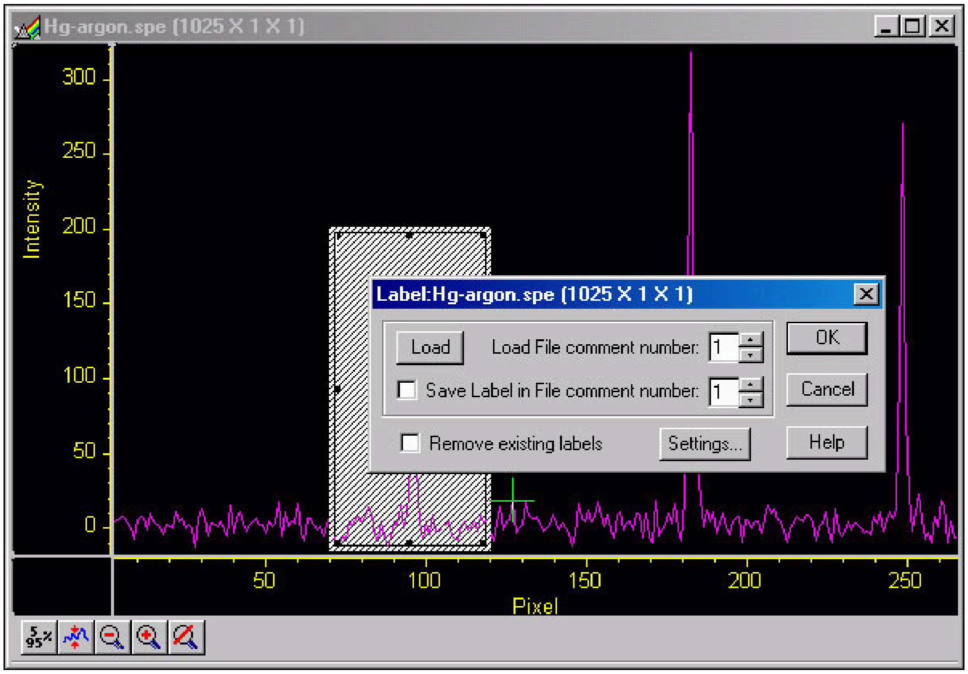


Figure 88. Label Display action

The dialog box allows loading a previously saved label (from one on the SPE file's 5 comment fields); alternatively you can type the label into the edit box. The label can be saved into a file's comment field (when **OK** is clicked). The source comment field and the destination comment field can be different.

Clicking **Remove existing labels** will erase all previous labels from the display before adding the current label.

The **Settings** button brings up a dialog box with options for the label itself (Figure 89). The Display Label Settings dialog box allows you to change the color of the label text, to choose between an opaque (white) background and a transparent background, and choose whether the labels are to run vertically or horizontally. The opaque background works well with images, where the label can get lost inside the image.

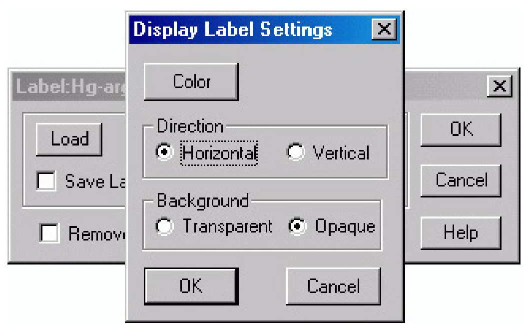


Figure 89. Label Options subdialog box

The simplest way to label a display would be to place the ROI where the label should appear (the origin starts at the top left corner of the ROI box), right-click inside the ROI box, type the label text, and click **OK**.

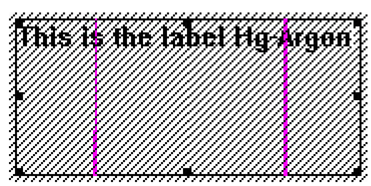


Figure 90. Label text entry box

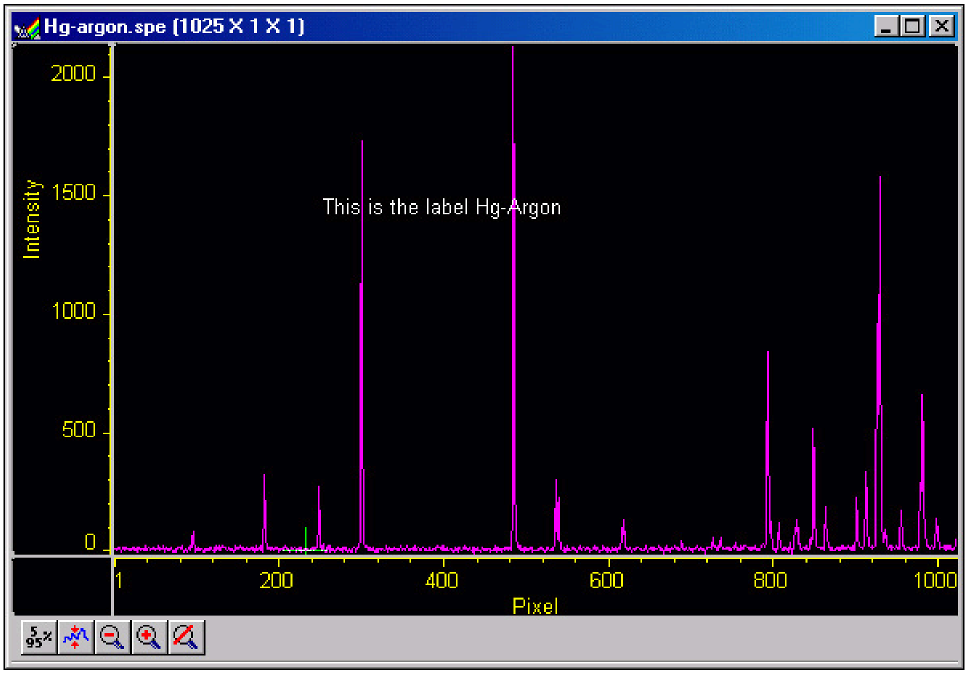


Figure 91. Data with Finished Label

Figure 90 shows a label as entered in the label text entry box. Figure 91 shows the same label as it will appear with the data after clicking on **OK**. Generally it is advisable to save the label in a comment field; otherwise, once the label is printed and the display is closed, the label will be lost. In fact, once the label is on the display, it cannot be edited. However, if it has been saved, it can be edited, as follows.

1. Erase labels.
2. Call up the display label menu.
3. Load the label.
4. Edit the label in the edit box.
5. Check the **Save Label** box to save the changes.
6. Click **OK** to print the corrected label.

Labels are printed with the same font as is used for the axes. To change fonts, use the Display Layout, Axes dialog, and select Fonts… (this works even if axes are not displayed).

To reposition the label, move or resize the ROI (and Edit) box before you click on **OK**. Moving the box, however, requires that you position the mouse very near the edge of the box, because further in, the Edit box will capture the mouse. Resizing is done in the usual way with the ROI box handles. If the ROI box is accidentally erased, just redraw a new one in the desired location, and the Edit box will reappear. The Edit box wraps lines at the end of the box, and the Label function will display the label as it appears in the box (Figure 92).

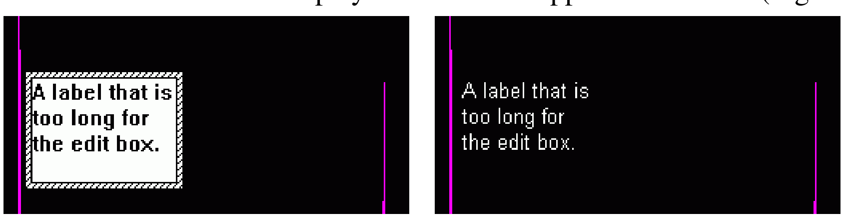


Figure 92. Edit box with line-wrapped label and finished label with same line wraps

To correct the line-wrapping, simply resize the ROI as shown in Figure 93.

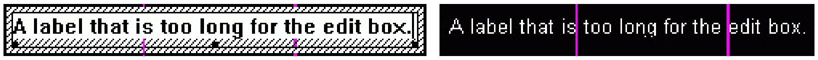


Figure 93. ROI resized to correct Line-wrapping

The font can be changed after the label is printed on the display:

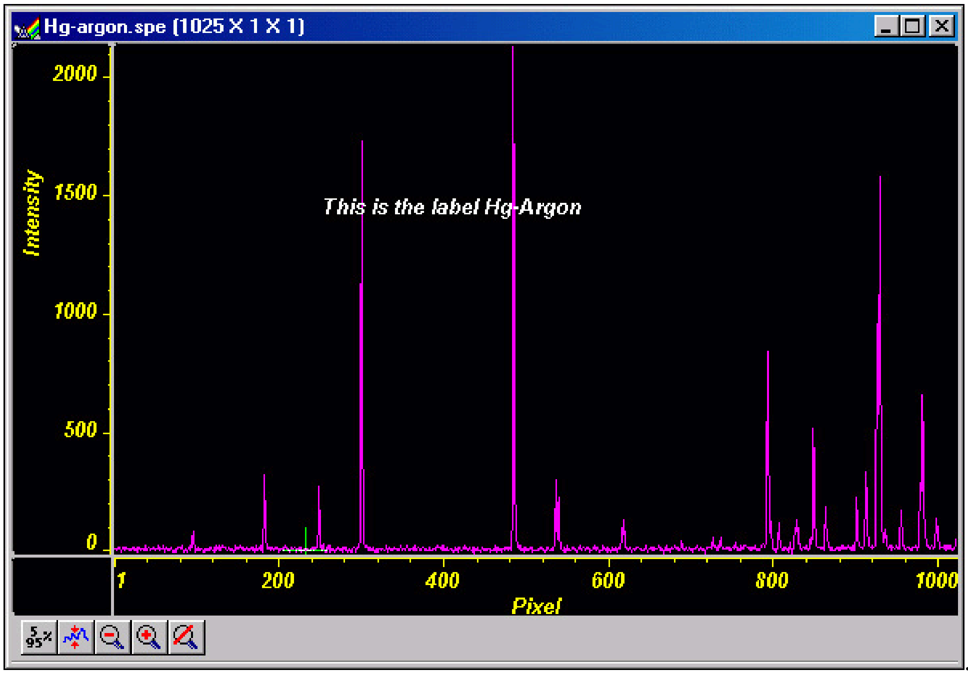


Figure 94. Display after changing Font Selection

To change the background or color, the label must be erased and reprinted; it can only be altered inside the edit box.

Data Displayed as an Image

WinSpec/32 can display data as an image, as a two dimensional graph, or as a 3 D Graph (multiple strips from the same graph or the same strip from multiple frames). You can choose to allow the software control how the data will be displayed or make the selection yourself. To have WinSpec/32 control the data-display mode, simply check the **Auto Select** checkbox provided in the **File Open** dialog box and also in the **Display Layout** dialog box. The Auto Select algorithm makes the selection depending on the number of data strips as described on page 93.

Displaying circuit.spe

The image used in this exercise is circuit.spe, one of the images supplied with your WinSpec/32 software. Once you become comfortable working with this image, you should have little difficulty in working with images from actual measurement data.

1. From the File menu, select **Open**. The **Open** dialog box (Figure 95) allows you to select the image to be opened. The **Look-In** field provides a browser function so you can easily find the directory where the images. By default, the data directory is a subdirectory of the directory where WinSpec/32 was installed. Subdirectory names and the filenames of all files of the specified type (the WinSpec/32 data type is *.spe) in the current directory are listed in the box below the directory name. The WinSpec/32 data type is WinXData (*.spe).

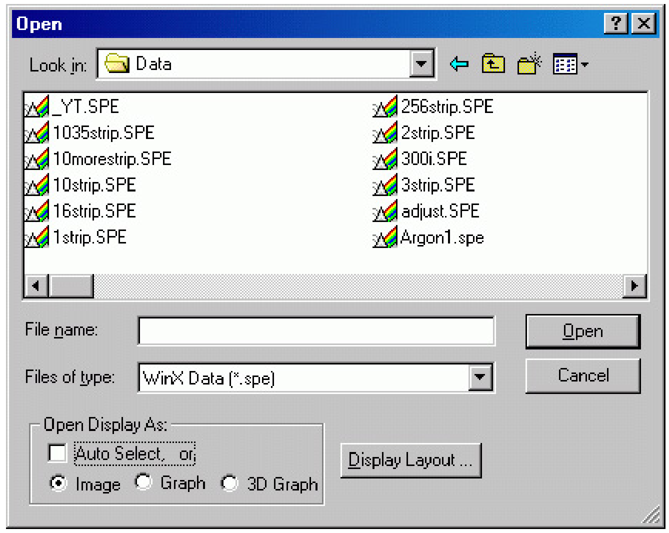


Figure 95. Open dialog box

Note: The directory can be changed by changing the selection in the Look-In box. The next time the Open dialog box is opened, the new folder name will appear in the box and its contents will be shown.

2. If the **Auto Select** checkbox is checked, deselect it. Then select **Image**.

3. From the data directory select the image file called CIRCUIT.SPE. Click on the **OK** button. A window of the appropriate dimensions should appear immediately. The image display (Figure 96) may take a few seconds, depending on the speed of the computer.

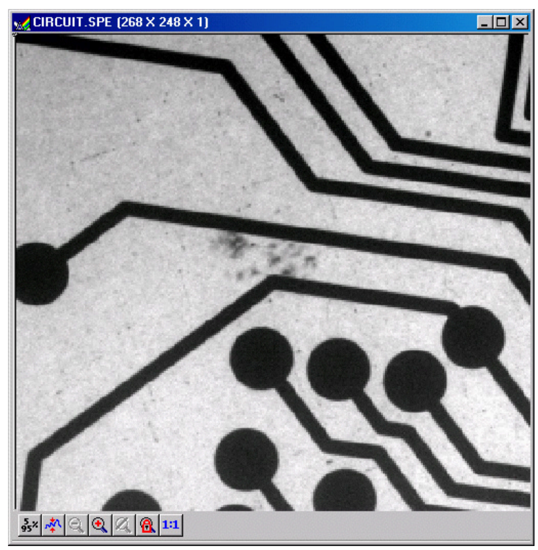
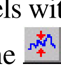


Figure 96. Circuit.spe Image

Changing the Brightness Range

1. Click on  (5%-95%) (located beneath the displayed image as shown in Figure 96). You will observe a moderate brightening of the image as it autoscales on the central 90% of the image histogram. The brightest (pixels with high dark charge) and the darkest pixels (pixels with low response) are ignored.
2. Click on the  (Autoscale) button, restoring the image to its initial appearance.

Brightness/Contrast Control

Select Palette on the Display menu. This will open the Brightness/Contrast dialog box (Figure 97). Note that the window includes a plot of display brightness (Y axis) versus data value (X axis). As settings are changed, the displayed curve change to reflect the change in the transfer function. *(See the online Help for a detailed discussion of the palette and transfer function options.)*

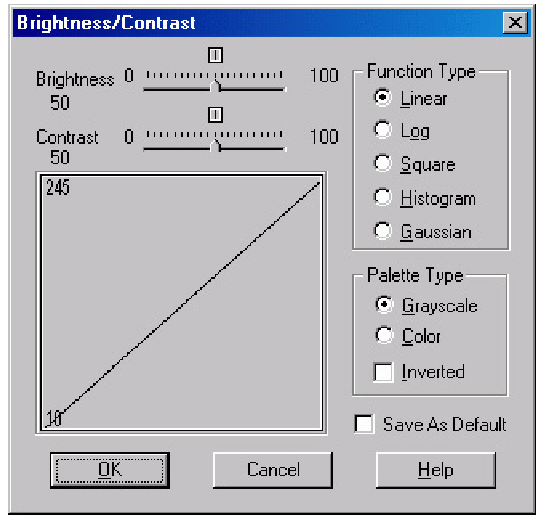


Figure 97. Brightness/Contrast dialog box

1. Change the brightness and contrast settings to obtain the most pleasing image display. Note that clicking on the small square above the Brightness scale and above the Contrast scale will restore the default brightness and contrast values (50).
2. Try different Function and Palette Type selections to see the effect on the displayed image. Note that the displayed curve will also change, reflecting the change in the brightness transfer function. Until you gain more operating experience, we suggest you leave the Function Type set to Linear, the Palette to Grayscale, and the Brightness and Contrast both to 50.
3. Click on **OK** to close the box. Any setting changes will be applied.

Selecting a Region of Interest

1. Using the mouse, position the cursor at one corner of the region to be defined, depress the left mouse button, drag the cursor to the diagonally opposite corner, and release the mouse button. Refer to Figure 98.
2. Click on the . (Zoom In) button. The view will change so that only the selected region is displayed as shown in Figure 99.

> **Note:** The Display Layout Cursor tab page allows you to change how the ROI region is displayed.

3. Click on the  (Undo Zoom-In) Button. The original view will be restored.

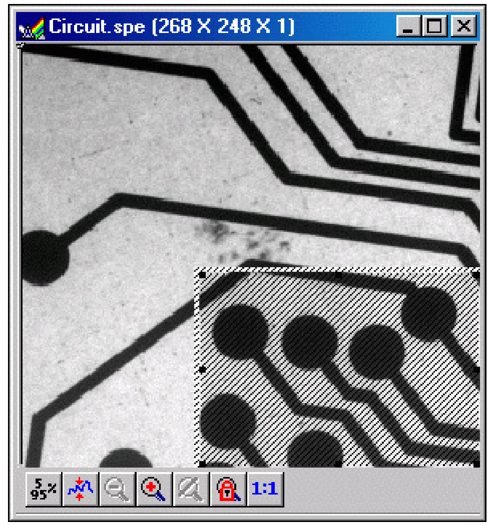


Figure 98. Circuit.spe with Region Selected for Viewing

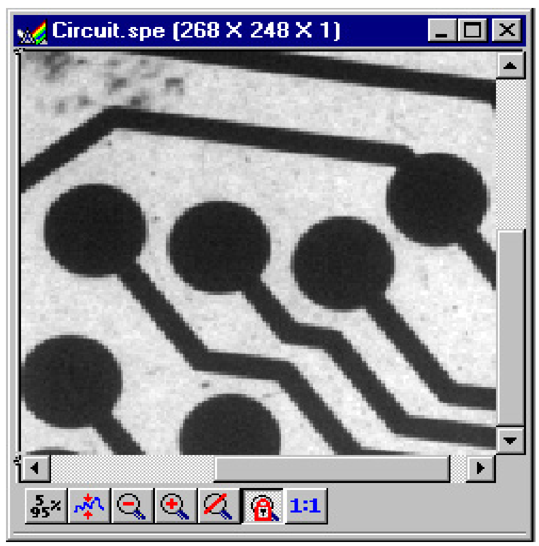


Figure 99. Circuit.spe Expanded to show Defined Region

Opening the Display Layout dialog box

With the image still open, select Layout from the Display menu. The Display Layout dialog box will open (Figure 100). *Note that you can also access the Display Layout dialog box by clicking on the Display Layout button of the Open dialog box.*

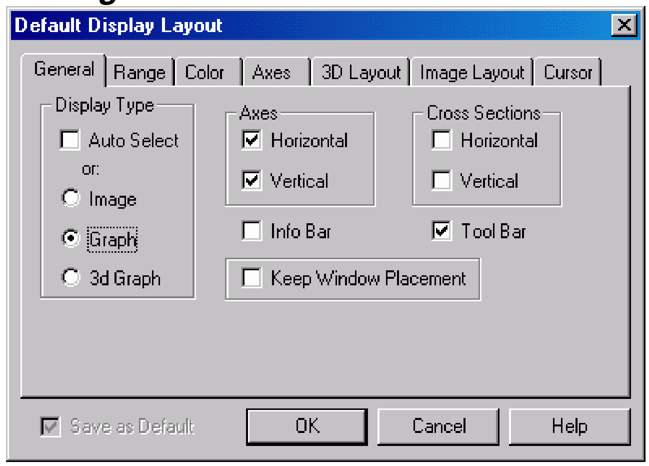


Figure 100. Display Layout dialog box

Viewing Axes and Cross Sections

1. Still in the Display Layout dialog box, select Axes Horizontal, Axes Vertical, Cross Sections Horizontal and Cross Sections Vertical. *Refer to the online Help for additional information on Axes and Cross Sections.*

2. Click on the **Range** tab to move the Range tab page (Figure 101) to the front. **Initial Autoscale** and **Set to Full Range** should be selected. The Frame number should be "1."

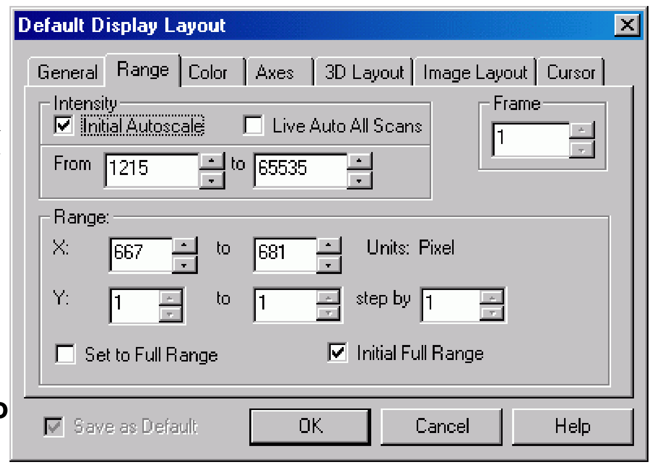
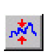


Figure 101. Range tab page

3. Click on the **OK** button. The Display Layout dialog box will close.

4. Click on the  (**Autoscale**) button at the bottom of the image window. Then select the large cursor by clicking on Cursor on the View menu and then on Large as shown in Figure 102.

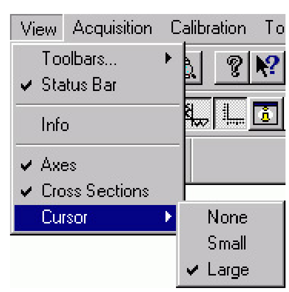


Figure 102. Selecting the Large Cursor

5. The display should now appear as shown in Figure 103. The axes will be labeled in image pixels and strips with respect to the CCD chip used to acquire the image. The vertical image intensity profile at the cursor position will be displayed to the left and the horizontal image intensity profile at the bottom. The minimum and maximum values for each profile are indicated. Note that you can use the mouse and drag the axes and profile boundaries to change the size of the profile display regions. To change the cursor location, simply click the mouse at the new spot. The cross-sectional graphs will change to reflect the profiles at the new location.

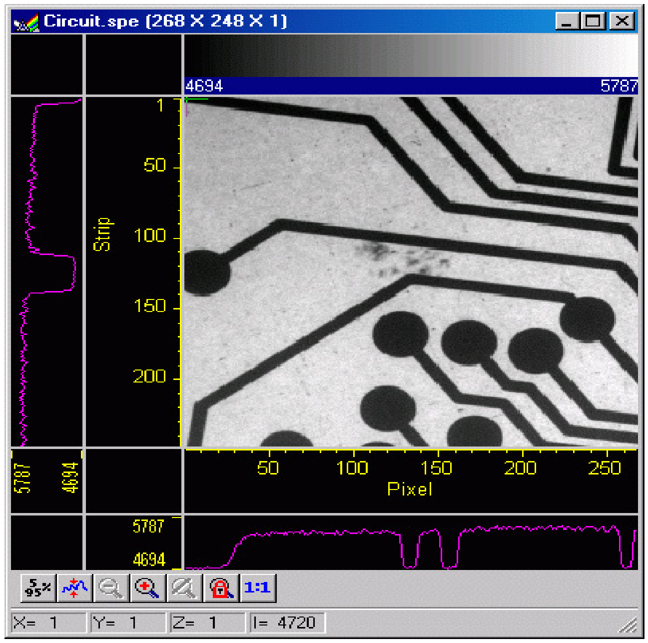


Figure 103. Circuit.spe with Axes and Cross-sections

Information box

On the View menu, select Info. The information box should appear as shown in Figure 104. The intensity in A/D counts is reported at the pixel and strip position corresponding to the cursor position. Also reported are the Frame number, Aspect ratio, and X and Y Zoom in effect. If a region is defined by dragging the mouse cursor, the region coordinates and diagonal length will also be reported.

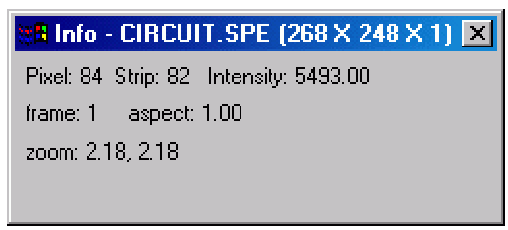
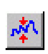
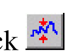


Figure 104. Information box

Autoranging the Intensity in a ROI

1. Drag the mouse cursor to define a rectangular region of interest on the displayed image.
2. Click on  (Autoscale). The display will autorange to the intensity range in the defined region. The effect will be an increase in contrast in the observed image. Throughout the image, pixels darker or lighter than those in the defined region will be displayed as black or white.
3. Click the mouse anywhere in the displayed image and click  again to restore the original image view.

Relabeling the Axes

1. Open the Display Layout dialog box and open the Axes tab page (Figure 105). Note that Horizontal Axis, Vertical Axis, and the Label box for each are all checked (If unchecked, the corresponding axis or label would not be displayed.)
2. Change the axis label for both axes. Then click on **OK**. The displayed axes will no longer be named **Pixel** and **Strip**, but rather the new labels.
3. Try selecting different fonts to see the effect. Only True-type or Type 1 (Postscript) fonts will work correctly. Open the Fonts dialog box, change the various font choices, and click on **OK** twice. To return to the original font choices, select 10 pt Arial Regular.
4. Reopen the Axes tab page and change the axis labels back to their original designations (**Pixel** for horizontal; **Strip** for vertical).

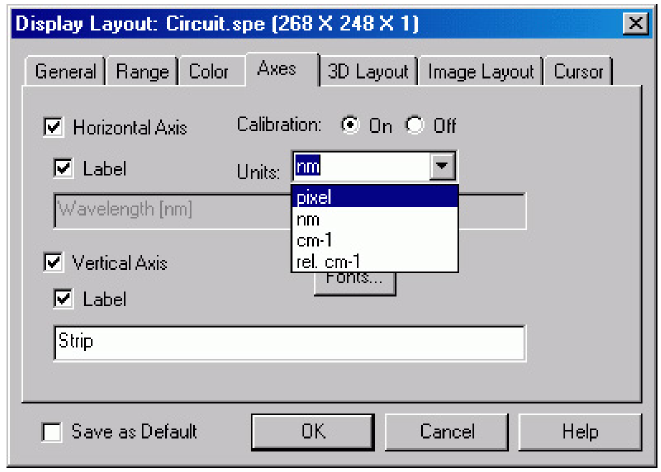


Figure 105. Axes tab page

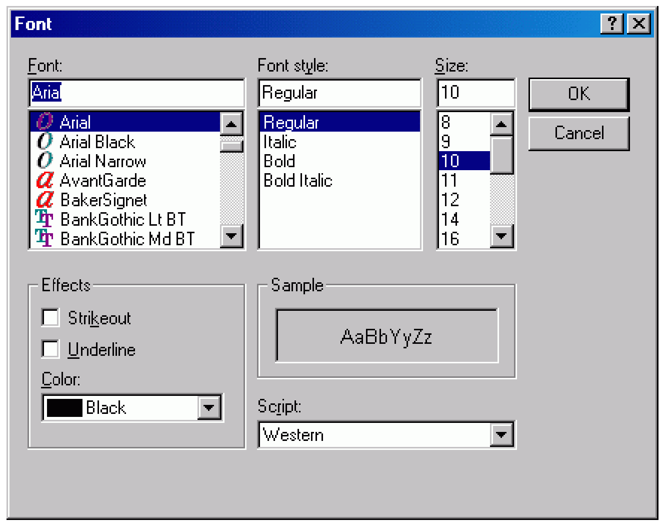


Figure 106. Fonts dialog box

Changing the Color of the Axes and Labels

1. Open the **Color** tab page. Note that there is a button for each item to which a color can be assigned and that the current color for each item is indicated in a color swatch to the right of the button. The default for the Axis is yellow.
2. Click on **Axis**. The color palette will open as shown in Figure 107.

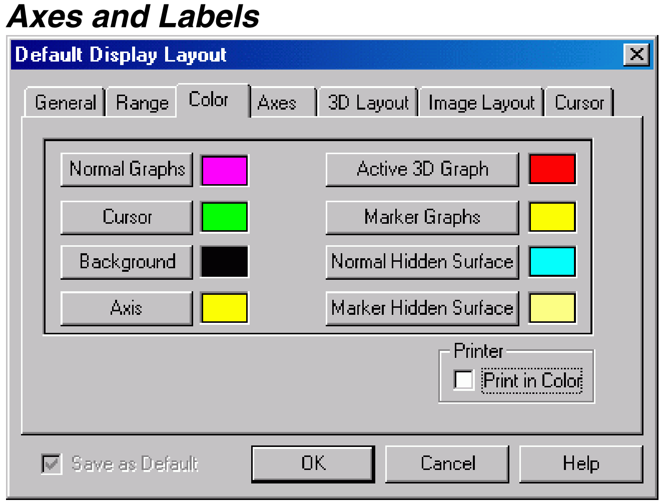


Figure 107. Color tab page

3. Select a different color by clicking on the swatch of the desired color. Then click on **OK** to close the **Color** dialog box and on **OK** again to close the **Display Layout** dialog box. The axes and colors will now appear with the new color.

4. Repeating the process, open the **Color** dialog box again and restore the default color. Again, click on **OK** to close the **Color** dialog box and on **OK** again to close the **Display Layout** dialog box. The axes and labels will now be displayed in the original color.

Figure 108. Display Layout Color Palette

Specifying a New ROI and Intensity Range

1. Open the **Range** tab page. Note that you can change the displayed intensity range as well as the X-Y range.

2. Try entering more restricted ranges and note how the displayed image changes. Changing the X-Y range by entering new values is functionally equivalent to changing the displayed area by dragging the cursor as previously described. Selecting a narrower intensity range results in pixels brighter and darker than the range limits being displayed as white and black respectively. The effect is to increase the contrast of the image. Each time a change is made, click on **OK** to close the Display Layout dialog box and observe the effect of the change.

3. On completing your display experiments, restore the defaults (Autoscale Intensity and Full Range checked). Last, close the data file.

Displaying a Z-Slice

1. Open a data file with multiple frames.

2. Position the cursor in the data window.

3. Click on Z-slice button. It will cut a section across multiple frames.

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Part 2
Advanced Topics

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Chapter 9

Cleaning

Introduction

An acquisition is made up of an exposure period and a readout period. For the rest of the time, the camera is waiting to be told to acquire spectra or images. During this waiting period, charge generated from different sources builds up on the array unless some kind of cleaning process is ongoing. Cleaning minimizes the impact of the unwanted signal (noise) by row shifting the accumulated charge to the output register and then discarding it.

Depending on your system, WinSpec/32 will provide you with up to five cleaning features. The most common cleaning feature is Clean Cycles, which occur until **Acquire** is selected and may continue up to the entered number of cleans before exposure begins. If External Synchronization is being used to control exposure, a feature called continuous cleans may be used in addition to the standard clean cycles. Where the detector and controller support it, a specialized version of continuous cleans Continuous Cleans Instruction can be used with the External Sync timing mode. The readout of ROI information is enhanced by the Vertical Skips feature. With Version 5 of the ST-133 Controller, continuous cleans for Kinetics is also supported. All of these cleaning features and their interrelationships are described in the sections that follow.

Clean Cycles

The basic cleaning function is implemented by clean cycles. These cycles start when you turn the controller on and a clean pattern is programmed into the controller. Their purpose is to remove charge that accumulates on the array while the camera not acquiring data (i.e., exposing and reading out the array). The timing diagram below is for an experiment set up to acquire three (3) spectra in Freerun timing mode with normal shutter operation selected. In this diagram clean cycles occur before the first exposure and after the last readout period.

Note: The start of the exposure is signaled by **NOTSCAN** going high but will not occur until the current clean cycle has finished.

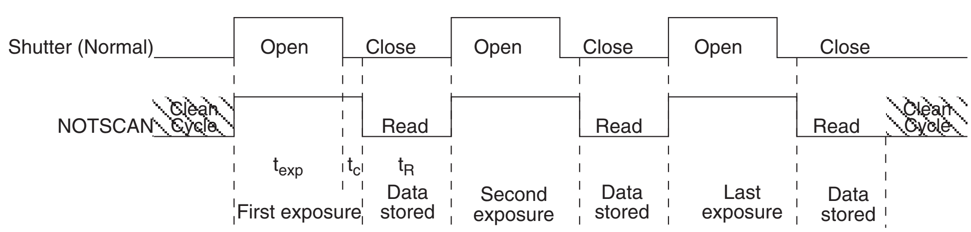

Figure 109. Clean Cycles in Freerun Operation

The configuration of clean cycles is performed on the **Hardware Setup|Cleans/Skips** tab page (Figure 110). When you set up the detector for the first time, default values are automatically inserted into these fields. These will give the best results for most applications. Even so it is a good idea to know what these entries mean with regard to cleaning.

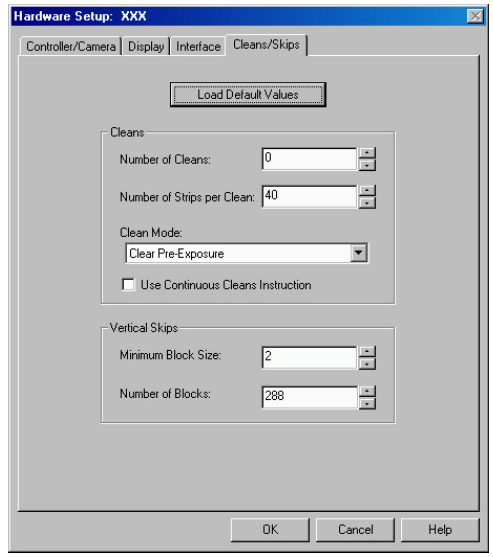

Figure 110. Cleans/Skips tab page

Let's begin with **Number of Strips per Clean**. This parameter sets the number of rows that will be shifted and discarded per clean cycle. While a large number such as the number of rows in the array may result in the best cleaning of the array, the tradeoff is that there may be a significant delay between the receipt of a start exposure signal (**NOTSCAN** signal at the $\overline{\textbf{SCAN}}$ BNC goes high) and the beginning of the actual exposure. This delay occurs because the current clean cycle must be completed before a start exposure signal received during the cycle will be implemented. Typically, the default setting is much smaller and in time critical experiments, the setting should be 1 or 2.

The **Number of Cleans** value is usually set to zero (0). These are additional clean cycles that can be required after a start exposure signal is received and the current clean cycle has finished. The maximum value for this entry depends on the controller. For example, the range of values for an ST-133 is 0-7 and is 0-255 for an ST-138.

Continuous Cleans

Clean cycles will always occur but an additional cleaning function called Continuous Cleans is provided when the start of exposure is tied to an external trigger (i.e., the experiment is being run in **External Sync** timing mode.)

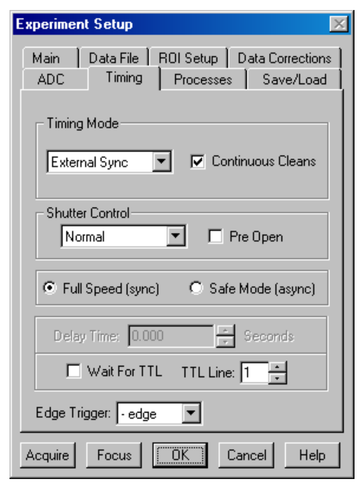

Figure 111. Timing Tab page: External Sync with Continuous Cleans Selected

Figure 112 shows the timing diagram for an experiment with External Sync trigger active on the negative edge. Note that the timing diagram shows two possible setups for the shutter. In the first setup (Normal), the shutter is opened when External Sync goes low. Because it takes time to open a shutter, data may be missed while the shutter is opening. In the second setup (Preopen), the shutter is opened when the **NOTSCAN** signal (at the $\overline{\textbf{SCAN}}$ BNC on the back of the ST-133) goes high. The advantage is that the shutter is fully opened when the exposure (triggered by External Sync) begins. The disadvantage is that ambient light is no longer being blocked from the array during the period between **NOTSCAN** going high and the External Sync going low. Continuous cleans provides a way to get rid of the signal that accumulates on the array during that interval.

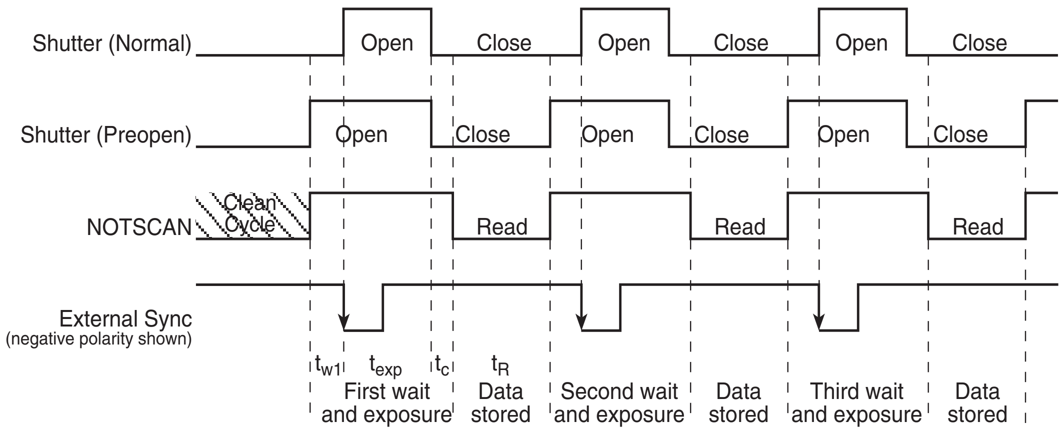

Figure 112. External Sync Timing Diagram

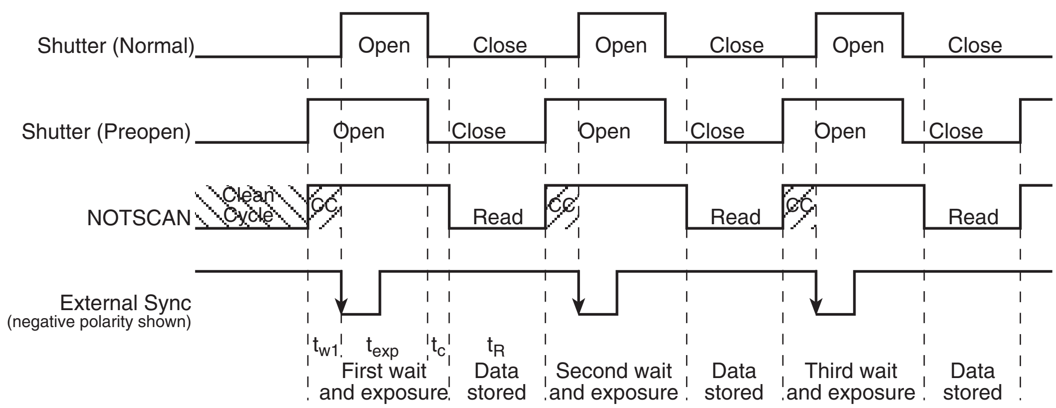

Figure 113. External Sync with Continuous Cleans Timing Diagram

Figure 113 shows the same timing diagram with the addition of continuous cleans (indicated by the shaded areas labeled CC). Continuous cleans are additional clean cycles and defined by the same parameter values as the standard clean cycles. When the External Sync trigger arrives during continuous cleaning, the current clean cycle must be completed before the exposure will begin. In time critical experiments, the number of rows per clean (set on the **Hardware Setup|Controller/Camera** tab page) should be 1 or 2 to minimize the delay.

Continuous Cleans Instruction

If the controller and the detector support it, a specialized cleaning function can be used when continuous cleans is active. This function, "Continuous Cleans Instruction", can only be activated if the checkbox for it is visible on the **Hardware Setup|Cleans/Skips** tab page (see Figure 114).

Continuous cleans instruction does horizontal shifts while doing vertical shifts for a faster continuous clean. ***With this instruction, the delay between an External Sync trigger and the start of exposure is minimized.***

Continuous cleans instruction will be used in place of the standard continuous cleans if both **Use Continuous Cleans Instruction** on the **Cleans/Skips** tab page and **Continuous Cleans** on the **Experiment Setup|Timing** tab page are checked.

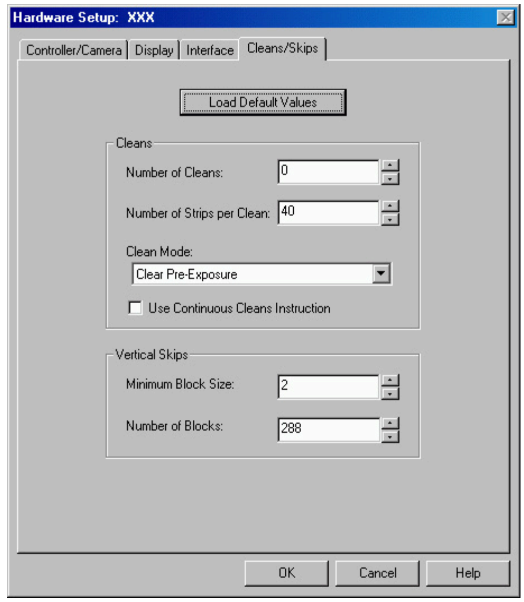

Figure 114. Cleans/Skips tab page: Continuous Cleans Instruction

ROIs and Cleaning

An ROI is a user-defined subsection of the array. As with full frames, the defined clean cycles are used to keep charge from accumulating on the array while it is waiting for a start exposure signal and after the data has been readout of the array. The specialized cleaning function for an ROI – Vertical Skips – is applied when the ROI is read out. **Vertical Skips** parameters are used to shorten the readout/discard time for the rows before and after the ROI. **Minimum Block Size** sets the number of invalid rows (horizontal lines of the CCD) to bin before the valid data. **Number of Blocks** sets the number of these blocks to shift and discard before going to a geometric grouping algorithm. Refer to *"Vertical Skips"* on page 42 for detailed information about vertical skips and the grouping algorithm.

Kinetics and Cleaning

Kinetics is a special type of operation in which most of the CCD is mechanically or optically masked, leaving a small section open to light. This section is then shifted under the mask very quickly. The defined clean cycles are used to keep charge from accumulating on the array while it is waiting for a start exposure signal and after the data has been readout of the array. In addition to clean cycles, continuous cleans for kinetics is supported by Version 5 (or higher) of the ST-133 Controller. For kinetics experiments, continuous cleans are only applied between the first **NOTSCAN** low-to-high transition and the **External Sync** high-to-low transition. Because of the speed at which the array is then shifted, exposed, and shifted no further cleaning occurs until the last frame has been exposed and shifted. At that point, the clean cycles begin again.

Chapter 10
ROI Definition & Binning

Overview

General

A Region of Interest (ROI) may be the entire CCD array or it may be a rectangular subregion of the array. For data acquisition, the definition of such a region is done either from the Easy Bin dialog box (Figure 122) accessed from the Acquisition menu or from the ROI Setup tab page (Figure 123), accessible after selecting Experiment Setup from the Acquisition menu. Easy Bin is a simple way of a defining a single full chip width ROI. ROI Setup allows you to create multiple ROIs with greater flexibility in ROI location and width.

Each ROI is defined in the X and Y direction by a start pixel, an end pixel, and a group/height (binning) factor. After one or more regions have been defined and stored, data acquisition will use these regions to determine which information will be read out and displayed and which information will be discarded.

When ROIs are used to acquire data, the ROI parameter information (for the first 10 ROIs) is stored in the data file when that data is saved to disk. You can review this information for the active data display by using the File Information functionality (accessible from the File menu or from the Display Context menu).

Notes:

1. For Flatfield Correction, Background Subtraction, etc., the images must be ***exactly*** the same size.
2. References to X and Y axes assume that the shift register is parallel to the X-axis and that the data is shifted to the shift register in the Y direction. See Figure 115 below.

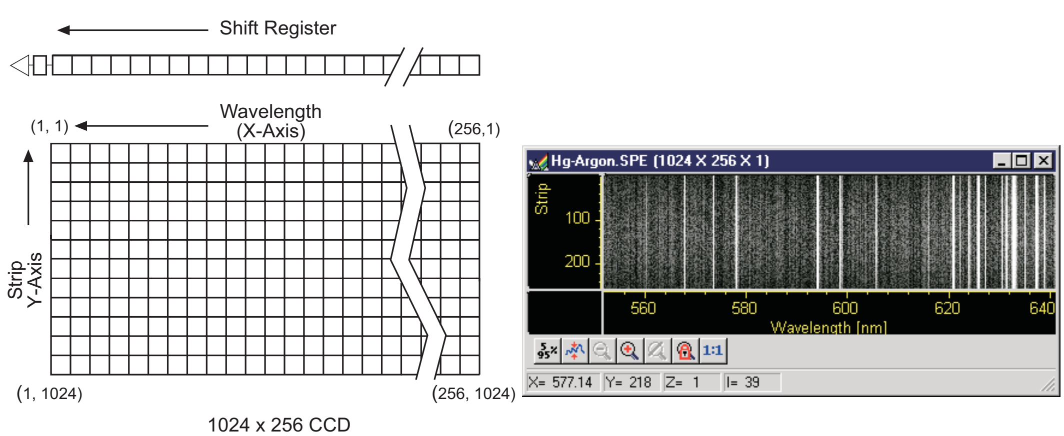

Figure 115. Assumed CCD Array Orientation

Spectroscopy Mode

In Spectroscopy Mode (the default if the Imaging option has not been installed), all pixels in a column are automatically binned. The effect is to produce a single strip of data that is then displayed as a spectrum. If **Use Full Chip** is selected, data acquisition will result in as many data strips as there are pixel strips on the chip, allowing a full frame image to be acquired. If **Use Region of Interest** is selected, data acquisition will result in as many data strips (spectra) as there are defined ROIs.

Imaging Mode

In **Imaging Mode** (available only if the option has been installed) you have the ability to acquire full-frame or ROI-specific images.

If the Imaging option has not been installed, images can only be acquired through the **Use Full Chip** function (on the Experiment Setup|Main tab page). When this is selected, data acquisition will result in as many data strips as there are pixel strips on the chip, allowing a full frame image to be acquired.

Binning (Group and Height parameters)

Overview

Binning is the process of adding the data from adjacent pixels together to form a single pixel (sometimes called a super-pixel). The combination of pixels can be along the X-axis, the Y-axis, or along both axes. The combination can occur while data is being shifted into the shift register (hardware binning) or after the data has been sent to the host computer (software binning). Both of these types of binning occur during data acquisition. Post-acquisition binning can be performed on previously acquired data.

Hardware Binning

Hardware binning is performed *before* the signal is read out by the preamplifier and may be used to improve the signal to noise (S/N) ratio. 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 so that the detector is photon shot noise limited, and for all fiber-coupled ICCD detectors, the S/N ratio improvement is roughly proportional to the square-root of the number of pixels binned.

Because hardware binning is performed while the signal is shifted into the readout register, the readout time and the burden on computer memory are reduced. However, this time and memory savings are at the expense of resolution. Since shift register pixels typically hold only twice as much charge as image pixels, hardware binning of large sections may result in saturation and “blooming,” spilling charge into adjacent pixels.

If you want to use hardware binning, you define the binning parameters on the **Experiment Setup|ROI** tab page. These settings will be used for acquiring data until you change the ROI size or the amount of binning.

Note: If you have a PCI card, and your controller is other than a MicroMAX or PentaMAX, you must ensure that the number of pixels to be read out is always an even number. A warning will appear if this is not the case. If you are doing binning, the number of pixels digitized (after hardware binning is complete) must be an even number.

Software Binning

If blooming is an issue, you can use software binning instead of hardware binning. Software binning is activated by checking **Use Software Binning** on the ROI Setup tab page. While software binning will prevent saturation of the CCD chip shift register pixels, it is not as fast as hardware binning.

Note: The binning that is set up on the ROI Setup tab page occurs while data is being acquired. You can also perform post-acquisition binning on previously acquired data. For more information, see ***"Binning and Skipping"**, page 166.*

Spectroscopy Mode

X-axis binning can be used in spectroscopy mode to improve the signal-to-noise ratio. However, in many instances a longer exposure time, higher light level, or use of an intensified system may prove to be better ways of improving the signal-to-noise ratio in that they don't degrade the resolution.

As stated earlier, Y-axis binning is the key factor that distinguishes spectroscopy readout from imaging readout. In spectroscopy, ***all*** pixels in each column of an ROI (the entire chip or a specified subregion) are ***automatically binned***. The effect is to generate a single strip of data that is then displayed as one spectrum.

In WinSpec, the ROI definition and binning parameters for spectroscopy are grouped under the headings of **Wavelength** and **Slit**. The Wavelength (X-axis) parameters determine the start point and length of a data strip and the amount of X-axis binning. By default, the Group value is 1 (no binning) but can be increased to indicate the number of pixels being binned to increase the sensitivity (at the expense of resolution). The Slit (Y-axis) parameters determine the vertical location and height of the Y-axis columns. When multiple ROIs are defined, all of the ROIs will have the same Wavelength values, multiple data strips will be generated, and multiple spectra will be displayed. The Slit values, however, may vary from ROI to ROI as long as the Slits do not overlap.

Imaging Mode

Imaging mode allows you to define rectangular groups of pixels (of any size) that will be binned together to create an image rather than a spectrum. Separate Group parameter values can be entered in the X and Y directions for every defined parameter to give you the greatest possible flexibility in controlling the readout. Although modest binning may be employed to increase the sensitivity, there is a tradeoff in that it adversely affects the image resolution. As a result, binning when imaging is normally limited to a few pixels vertically and horizontally.

Defining ROIs

TIP: You can acquire a full-chip data set without losing your ROI definitions. To do so, simply click on the **Use Full Chip** radio button on the **Experiment Setup|Main** tab page. As long as **Use Full Chip** is selected, the ROI setup parameters are ignored and data collection will result in full frame data sets. To switch back to a defined ROI pattern, click on the **Use Region of Interest** radio button on the **Experiment Setup|Main** tab page.

Examples of Spectroscopy and Imaging ROIs

Figures 116-120 show possible ROI patterns. Note that the patterns in Figure 120 demonstrate varying size ROIs, a feature of Imaging Mode.

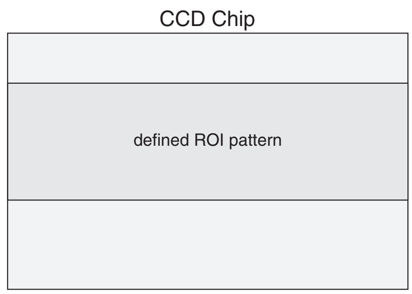

Figure 116. Single Full-width ROI

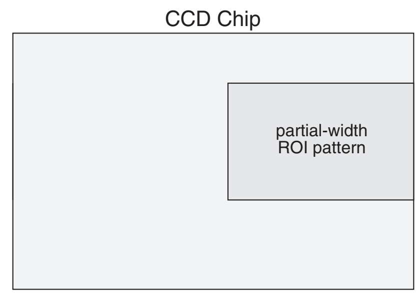

Figure 117. Single Partial-width ROI

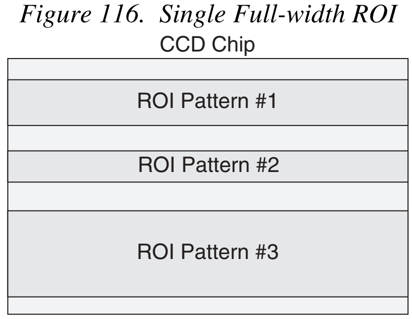

Figure 118. Multiple Full-width ROIs

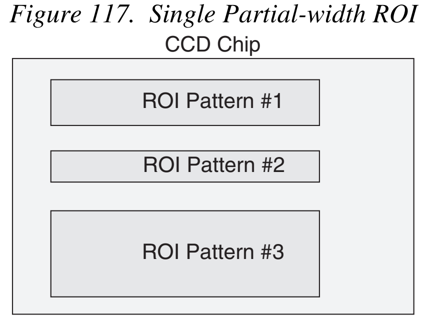

Figure 119. Spectroscopy Mode Multiple Partial-width ROIs

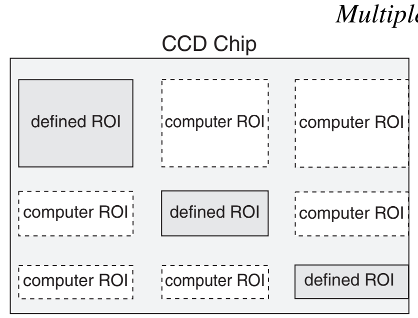

Figure 120. Imaging Mode Multiple ROIs with Different Widths

Constraints on Defining Multiple Regions of Interest (ROIs)

General: You may create more than 10 ROIs but when data is acquired using these ROIs, the parameter information for only the first 10 ROIs will be stored when you save the data.

Spectroscopy Mode:

1. ROIs cannot overlap. This places restrictions on the Slit (Y) values that can be specified. For example, if Pattern 1 has a Slit Start value of 1 and a Slit Height 100, the Start value for the next ROI must be greater than 100. *If a Full pattern is selected and stored, it overlaps all others, causing all data collections to be full-chip*. Figure 118 illustrates multiple full-width ROIs.

2. Once the first pattern is defined, all subsequent patterns are automatically assigned the same X-axis starting, ending, and grouping values. The first pattern need not be full width — any values in the chip range can be entered, but once stored, those values will apply as well to subsequently defined patterns. The figures below illustrate possible ROI patterns. Note the additional functionality available in Imaging Mode (Figure 116).

Imaging Mode:

In this mode, ROIs can have varying sizes and degrees of overlap. However, when you define multiple ROIs like those in Figure 116, the computer automatically generates six "side-effect" ROIs in the regions where *extensions* of the strips and columns of the defined ROIs intersect. Both the defined and computer generated ROIs will be stored and the data for both will be displayed (see Figure 121). The side-effect ROIs are necessary to accommodate hardware limitations.

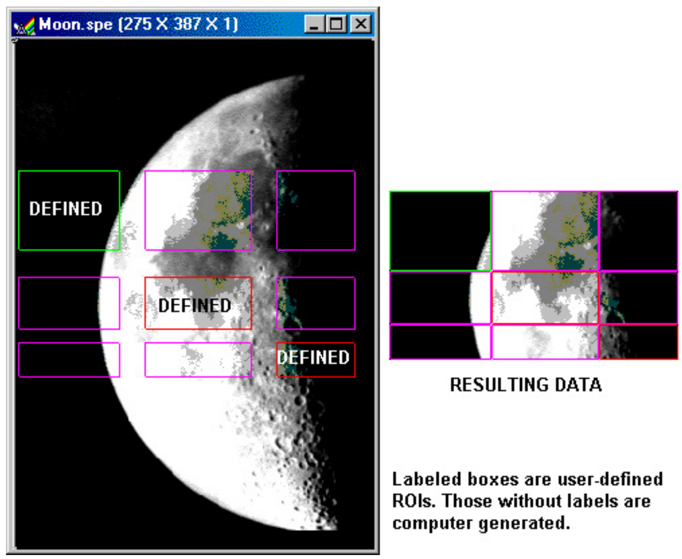

Figure 121. Multiple Imaging ROIs and Resulting Data

Methods of Defining and Storing ROIs

A region of interest (full-width or partial width) can be defined by:

1. Opening the Easy Bin dialog box and entering the values for a single, full chip wide spectroscopy mode ROI.

2. Entering values for the Wavelength (X) and Slit (Y) parameters from the keyboard.

3. Dragging the mouse cursor on a displayed image to define a rectangular region and then clicking the **Mouse** button. Before using this method, you must acquire a Full-Chip image. Otherwise, you will get a "Size of Image in Active Window is Incompatible with Current Chip Size" message when you try to define an ROI.

Note: In Spectroscopy mode, ROIs created via the mouse are limited to full chip width like the ones depicted in Figure 118. This is not the case in Imaging mode.

4. Defining the region with the mouse and then changing parameter values via the keyboard before storing the pattern. This allows you to change a full-width ROI created by mouse selection to a partial-width ROI like the one in Figure 120.

5. After an ROI is defined, its pattern can be stored, edited, or deleted. All defined areas will be indicated on the displayed image after they have been stored. If a pattern is being edited, its outline will be green and all other patterns will have red outlines. In Imaging mode, purple outlines will be drawn if two or more patterns are defined that do not have identical Wavelength Start and End points (these outlines represent additional data that will be included in the image acquired using the ROI Setup). The display of defined regions of interest is automatically updated when patterns are added or cleared. Stored patterns are save to disk when you exit the WinSpec/32 and are automatically loaded the next time you start the program.

Notes:

1. Right-clicking inside an ROI opens the ROI Context menu, which, in addition to providing auto-scale and zoom functions, enables the labeling of image and graphical data.

2. The **Experiment Setup|Save/Load** tab page allows all experiment set parameters, including ROI, to be saved in a user-designated file for later recall. See the discussion of the **Save/Load** tab page in the online Help.

Defining an ROI via Easy Bin

Easy Bin allows you to define of a single, full chip wide ROI.

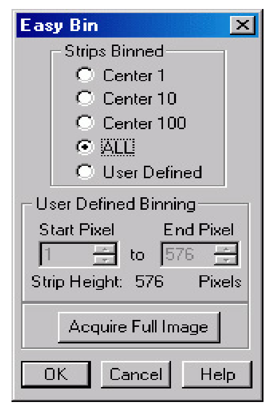

Figure 122. Easy Bin dialog box

1. Select **Easy Bin** from the Acquisition menu.

2. On the **Easy Bin** dialog box (Figure 122), click on the appropriate radio button:

   Center 1: Establishes an ROI one pixel high.

   Center 10: Establishes an ROI 10 pixel high.

   Center 100: Establishes an ROI 100 pixel high.

   All: Selects the full chip height.

   User Defined: Allows you to set the Slit (Y-axis) Start and End pixels. If you have a full chip image displayed, you can use the mouse cursor to create the bounding box for the ROI. Since all Easy Bin ROIs are full chip width, only the box's height parameters will be used.

3. If you have selected **User Defined**, enter the start and end pixels. This allows you to create an ROI that is not centered vertically on the chip.

4. Click on **OK** when you have finished.

To define multiple ROIs, ROIs that are not full chip width, and/or ROIs that are not centered vertically on the chip, use the ROI Setup functions accessible from the Experiment Setup dialog box.

Defining ROIs by Keyboard entry

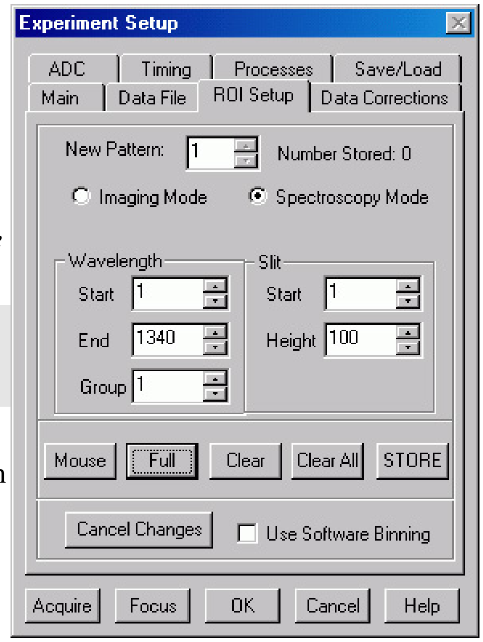

Figure 123. ROI Setup tab page (Spectroscopy Mode)

1. Open the **Experiment Setup** dialog and click on the ROI Setup tab to open the **ROI Setup** tab page (Figure 123).

2. Select the appropriate mode (**Imaging** or **Spectroscopy**). *If you don't have the Imaging option, the Imaging Mode and Spectroscopy Mode radio buttons will not be present.*

   TIP: Acquire a full-chip image before adding or editing ROI patterns. The existing patterns will be superimposed on the image.

3. Note the **Number Stored** value. This will tell you if how many ROIs have already been stored. Depending on what you want to do, you may want click on **Clear** or **Clear All** to remove stored ROI patterns.

4. To add a new pattern, click on the spin buttons (next to the **Number Stored** text) until the text to the far left is **New Pattern**. This will not be necessary if there are no patterns stored.

   a. Enter the Wavelength (X-axis) **Start**, **End**, and **Group** values. The **Group** value controls the X-axis binning: 1 indicates no binning; higher values indicate the number of pixels being binned to increase the sensitivity at the expense of resolution.

      - **Spectroscopy Mode:** When multiple ROIs are defined, the Wavelength values for the first pattern are applied to the subsequent patterns created.

      - **Imaging Mode:** Multiple ROIs can have different Wavelength values.

      TIP: If you're not sure of the chip size, open the **Main** tab page and note the X and Y values there.

   b. Enter the Slit (Y-axis) **Start**, **Height**, and **Group** (if in **Imaging Mode**) values.

      - **Spectroscopy Mode: Height** controls the Y-axis binning: 1 indicates no binning; higher values indicate the number of pixels being binned to generate the strip of data. Do not overlap Slit values.

      - **Imaging Mode: Height** is the height of the image and **Group** determines the Y-axis binning. Image ROIs can overlap.

   c. Click on **Store** to store the newly created ROI. The **Number Stored** will be updated. Repeat this process until you have finished adding ROIs.

5. To edit an existing pattern, click on the spin buttons until the pattern number is displayed in the **Edit Pattern** field.

6. Then make your changes.

   TIP: If you are changing the Wavelength (X-axis) values in **Spectroscopy Mode**, select the first pattern and enter your changes there.

7. Click on **Store** to store the changed ROI pattern.

Note: To scan the full CCD chip at any time, simply select the **Use Full Chip** radio button (on the **Main** tab page) and begin acquisition.

Defining ROIs by Mouse Input

Often you can easily identify a region of interest by visually inspecting the full-chip image. When this can be done, it is very easy to define the ROI graphically as follows.

1. First, click on the **Use Full Chip** radio button (Experimental Setup Main tab page) so that a full-chip image will be acquired. Then click on **Run**. Alternatively, if you already have an image, open this image and display it on screen.
2. Next click on the **Use Region of Interest** radio button (Main tab page). Then click on the ROI Setup tab to display the ROI Setup tab page. If there are already regions stored, you will now see them displayed as rectangles on the displayed image.
3. Click on the spin button to the right of the **New/Edit Pattern** field until the field label says **New Pattern** (instead of **Edit Pattern**).
4. Use the mouse to drag an ROI box over the desired region in the image display.
5. Click on **Mouse** (ROI tab page) to enter the ROI information. Once this information is displayed on the tab page, you edit it.
6. Click on **Store** to save the new pattern.

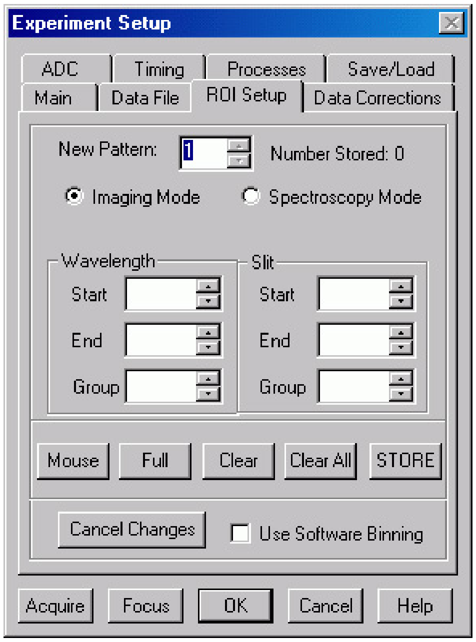

Figure 124. ROI Setup tab page (Imaging Mode)

Chapter 11
Correction Techniques

Introduction

Advanced data collection includes background subtraction, flatfield correction, CCD blemishes removal and Cosmic Ray removal. The skillful use of these techniques can significantly enhance measurement capabilities. *Note that not all of these techniques will be available in early releases of the software.*

Background Subtraction

Princeton Instruments systems are adjusted so that data have a small offset. This offset assures that small signals won't be missed. This offset can be subtracted after the signal is acquired to prevent it from having any influence on the data.

Background subtraction allows you to automatically subtract any constant background in your signal. This includes both constant offsets caused by the amplifier system in the controller as well as time-dependent (but constant for a fixed integration time) buildup of dark charge. Some users collect background spectra with the shutter open, including ambient light in their background data. The background subtract equation is:

(Raw image data – Background) = Corrected image data.

When background and flatfield operations are both performed, background subtraction is always performed first. The equation is the following:

(Raw image data – Background)/Flatfield = Corrected image data.

Below are instructions for collecting and using background data files.

Acquiring Background Files

This operation is similar to normal data acquisition.

1. Use exactly the same temperature setting as will be used in data collection. Wait at least 30 minutes after the detector has reached operating temperature to ensure stability.
2. Set the same binning parameters, ROI and Exposure.
3. Select **Acquire Background** from the Acquisition menu. This will immediately acquire a background file using the Experiment Setup parameters, only the shutter will remain closed for most applications.

To acquire a background with the shutter open, or if the Acquire Background feature is too restrictive in some other way, a background file can be collected as a normal data file. Once the file is collected and stored, enter the filename in the Background Subtract filename box on the Experiment Setup Data Corrections tab page (see Figure 125).

Setting Automatic Background Subtraction

These steps instruct the software to automatically subtract a previously stored background file from each new data acquisition.

1. Select Experiment Setup from the Acquisition menu. This will open the Experiment Setup dialog box.
2. Click on the Data Corrections tab. The Data Corrections tab page will be selected (Figure 125).
3. Click on the Background checkbox to turn on background subtraction. Type in the name of a background file if it is in the current directory. Alternatively, click on the button at the end of the entry window to open the file browser to select the background file if it is in a different directory.
4. Once the Background filename has been entered, click on the **OK** button. This saves the background filename for all future data acquisitions, or until the Background is turned off.

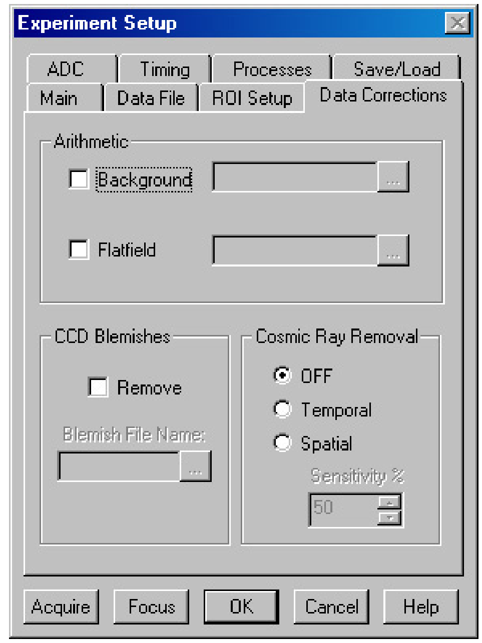

Figure 125. Data Corrections tab page

The filename entered in the Background box will be subtracted from each new file before it is displayed or stored. If both Flatfield and Background are selected, the background will be subtracted first, before the flatfield correction.

Background Subtraction with Intensified Detectors

To properly perform background subtraction with an intensified detector, a new background must be acquired whenever the intensifier gain setting is changed. This is necessary because changing the intensifier gain also affects the dark charge of the intensifier (EBI).

Flatfield Correction

Flatfield correction allows you to divide out small nonuniformities in gain from pixel to pixel. The instructions below set the flatfield correction to be performed before data are saved to RAM or disk.

Acquiring a Flatfield File

This operation is similar to normal data acquisition.

1. Use exactly the same temperature setting as will be used in data collection. Wait at least 30 minutes after the detector has reached operating temperature to ensure stability.
2. Set the same binning parameters and ROI. If you plan to use a background file with data collection, on the Experiment Setup dialog select Background and enter the name of the background file. This background file will be subtracted from the flatfield file before it is saved to disk.
3. Illuminate the detector uniformly. The accuracy of this uniformity will be translated into an accurate flatfield correction.
4. Select **Acquire Flatfield** from the Acquisition menu (Figure 48). This will immediately acquire a flatfield file using the Experiment Setup parameters. Unlike background subtraction, the shutter will open and close normally.
5. If background subtraction was selected, the background file will be subtracted from the flatfield file before it is saved to disk.

If the Acquire Flatfield feature is found to be too limiting in some way, a flatfield file can be collected as a normal data file. Once the file is collected, enter the filename in the Flatfield Correction filename box on the Experiment Setup Data Corrections tab page see (Figure 125).

Automatic Flatfield Correction

These steps instruct the software to automatically divide each new data file, pixel-by-pixel, by the specified flatfield file.

1. Select Experiment Setup from the Acquisition menu. This will open the Experiment Setup dialog box.
2. Click on the Data Corrections tab to select the Data Corrections tab page (Figure 125).
3. Click on the Flatfield checkbox to turn on Flatfield correction. Type in the name of a flatfield correction file in the current directory. Alternatively, click on the button at the end of the field to open the file browser to select the flatfield correction file if it is in a different directory.
4. Once the Flatfield filename has been specified, click on the **OK** button. This saves the flatfield filename for all future data acquisitions, or until the Flatfield correction is turned off.

Each pixel in a new file will be divided by the corresponding pixel in the Flatfield file. If both Flatfield and Background are selected, the background will be subtracted first, before the flatfield correction.

CCD Blemishes

Columns specified as bad in the blemish file will be replaced by interpolated data (based on the column before and the column after the bad column) as data is collected. After you click on the Remove checkbox, you can select the appropriate blemish file. Clicking on the button at the right of the **Blemish File Name** field opens a browse dialog box so you can locate and select a file. If you don't have a blemish file but have determined that there are one or more bad columns, you can create one to be used.

Note: CCD Blemishes removal may not be implemented in early releases of the software.

Creating a Blemish File

1. Open an ASCII text editor.
2. On the first line, key in the number of columns on the CCD. For example, you would key in 1024 if the CCD format was 1024 x256.
3. Press [Enter].
4. For each CCD column, enter either a 0 (no blemish) or a 1 (blemish) and press [Enter]. If there was only one blemish and it was in column 10, you would have 9 lines of 0s, a 1 in the tenth row, and 0s in the remaining 1014 lines.

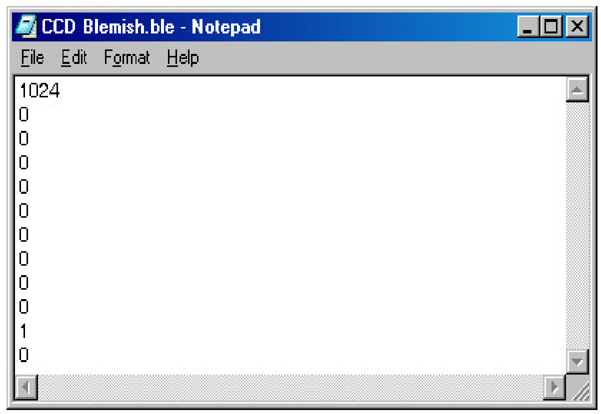

Figure 126. Blemish File

5. When you have finished entering the 0s and 1s, save the file with a .BLE extension. Files with this extension are recognized by WinSpec as blemish files.

TIP: If you have a long array, use a spreadsheet that can save data to .TXT files. The numbered rows will help you keep track of where you are. When you have finished with the data entry, save the data to a text file (.TXT extension) and then change the file extension to .BLE.

Cosmic Ray Removal

Causes highly localized spikes, such as would be caused by cosmic rays interacting with the silicon of the CCD, to be removed from the data after it is acquired but before it is stored. Two different techniques (in addition to OFF) can be selected. The Temporal technique compares a series of spectra and requires no user parameters. The Spatial technique compares the data with the set threshold level. If Spatial is selected, the Sensitivity setting determines how large a data spike must be to be identified as a cosmic ray effect (essentially the Sensitivity is a gain setting on the thresholding algorithm. A value of 0 will find 0 cosmics, while a setting of 100 will be most sensitive.). A setting of 50 will give good results in most situations. Cosmic ray data is replaced by interpolated before-and-after data.

Chapter 12
Spectra Math

Introduction

A variety of mathematical operations can be performed on WinSpec data files. This functionality, called Spectra Math, is selectable from the Process Menu. The four tab pages on the Math dialog box (Figure 127) allow you to select the source file(s), operation, and the destination file for the results of the selected mathematical operation (displayed at the top of the dialog box). Additionally, you can use the mouse to specify an ROI to be processed (available on tab pages A and B).

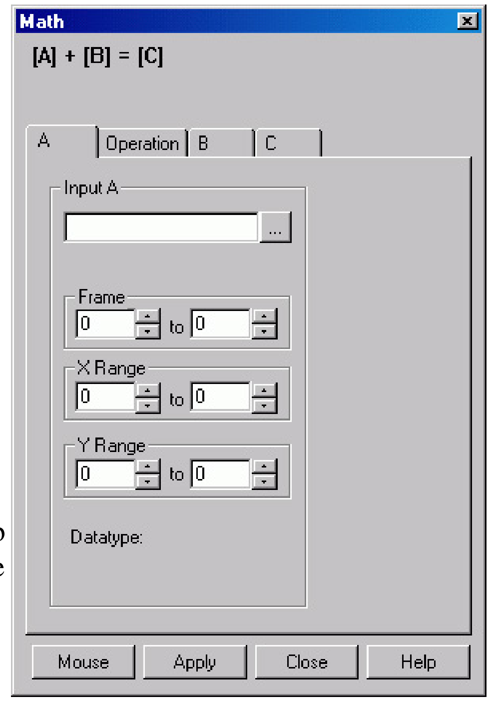

Figure 127. Math dialog box

Source Data and Destination Selection

As many as three data files can be involved in math operations and there is a corresponding tab page for each of them, **A**, **B**, and **C**. **A** and **B** are Input Files. **C** is always the Output File. Every operation requires at least one Input File and an Output File. Thus, every operation will require using tab pages **A** and **C**. In those cases where a second Input File (or a constant) is required, tab page **B** will also be used (see the online Help for detailed descriptions of the individual Math file pages).

With but a few exceptions, the parameters on the three file tab pages are the same. Brief descriptions follow.

Frame: If an input file contains multiple frames, you can specify the ones to be processed. The default is to process all frames. You additionally have the option of choosing not to write all of the frames processed to the Output File.

X and Y Range: You can specify the input file pixels to be processed. The default is to process all pixels. You additionally have the option of restricting the X and Y pixel range data written to the Output File. An alternative way to specify a region is to use the mouse to define the region on the active data display of the input file and then click on **Mouse**.

Input (Output) Filename: All three tab pages have a field for entering the filename. In each case there is a button at the end of the box which, when pressed, opens a browser to make selecting and specifying filenames and locations as simple as possible. In the case of the **B** tab page, there is additionally a field for entering a constant. Radio buttons are provided that activate one or the other of the two fields. Either a constant value or a filename can be entered, but not both.

Data Type: For the **A** and **B** tab pages, the data type is reported only and cannot be changed. In the case of the **C** (output) tab page, you can specify the data type. Data types include:

Byte: 8 bits; only the eight least significant data bits (levels 0 to 255) will be saved.

UnInt: Unsigned integer; 16 bits (0 to 65535)

Int: Signed integer; 16 bits (-32768 to 32767)

Long: Signed integer; 32 bits (-2,147,483,648 to 2,147,483,647)

Float: Floating point; 32 bits ($-1.75494351e^{-38}$ to $3.402823466\ e^{38}$)

Display Result: This checkbox appears on the **C** page only. If checked, the output image will be displayed as soon as the processing is complete.

Operations

On the **Operation** tab page, the math operations are listed as either Linear or Non-Linear. The operand(s) for math operations can be a single file, a file and a constant, or two files. In addition to allowing you to perform these operations on entire files, WinSpec also allows you to specify the frames (if multi-frame) and a region of interest (ROI).

- When working with a single file, the specified operation is performed on each pixel value of **A** and the result is written to the corresponding pixel of the Output File, **C**. The operations available are grouped under the Non-Linear heading:

Log10	Absolute Value
Natural Log	Bitwise Complement
Square Root	Binary NOT
Squared	

- When working with a single file and a constant, the operation will be performed on each pixel value of **A**, using the constant specified on the **B** tab page, and the result is written to the corresponding pixel of the Output File, **C**. The operations available are grouped under the Linear heading:

Addition	Min
Subtraction	Max
Multiplication	Bitwise AND
Division	Bitwise OR
Bitwise Exclusive OR	

- When working with two files, corresponding pixels from the two files, **A** and **B**, are operated on and the result is written to the corresponding pixel of the Output File, **C**. The operations that can be performed are the same as for a Single file and Constant described above.

Operation Descriptions

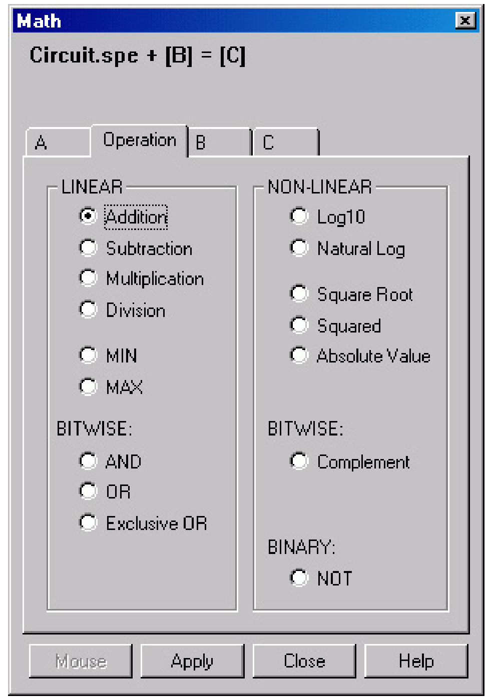

Figure 128. Operation tab page

Linear Operations

Addition: The **A** file is added, pixel by pixel, to the **B** file and the results written to the **C** file. It is also possible to add a constant entered on the **B** tab page to each point on the **A** file, with the results written to the **C** file.

Subtraction: The **B** file is subtracted, pixel by pixel, from the **A** file and the results are written to the new file. It is also possible to subtract a constant entered on the **B** tab page from each point on the **A** file, with the results written to the **C** file.

Multiplication: The **A** file is multiplied, pixel by pixel, by the **B** file and the results written to the **C** file. It is also possible to multiply each pixel of the **A** file by a constant entered on the **B** tab page, with the results written to the **C** file.

Division: The **A** file is divided, pixel by pixel, by the **B** file and the results written to the **C** file. It is also possible to divide each pixel of the **A** file by a constant entered on the **B** tab page, with the results written to the **C** file.

MIN: The **A** file is compared, pixel by pixel, with the **B** file and the smaller of the two values written to the **C** file. It is also possible to compare each pixel of the **A** file with a constant entered on the **B** tab page, with the smaller of the two values written to the **C** file.

MAX: The **A** file is compared, pixel by pixel, with the **B** file and the larger of the two values written to the **C** file. It is also possible to compare each pixel of the **A** file with a constant entered on the **B** tab page, with the larger of the two values written to the **C** file.

Non-Linear Operations

Log10: The Log10 of the **A** file is computed pixel by pixel and the results written to the **C** file.

Natural Log: The natural log of the **A** file is computed pixel by pixel and the results written to the **C** file.

Square Root: The square root of each point in the **A** file is computed and the result written to the corresponding point of the **C** file.

Squared: Each point in the **A** file is squared and the result written to the corresponding point of the **C** file.

Absolute: The absolute value of each point in the **A** file is computed and the result written to the corresponding point of the **C** file.

Bitwise Operations

AND: A bitwise AND operation is performed on the binary representation of each pixel of the **A** file and each pixel of the **B** file, with the result written to the **C** file. A twelve-bit example follows.

	Bits	**Decimal Value**
Pixel value in **A**	0 1 0 1 0 1 0 10 1 0 1	1365
Corresponding pixel value in **B**	0 0 0 0 0 0 1 1 1 1 1 1	63
Result written to **C**	0 0 0 0 0 0 0 1 0 1 0 1	21

OR: A bitwise OR operation is performed on the binary representation of each pixel of the **A** file and each pixel of the **B** file, with the result written to the **C** file. An eight-bit example follows.

	Bits	**Decimal Value**
Pixel value in **A**	0 1 0 1 0 1 0 10 1 0 1	1365
Corresponding pixel value in **B**	0 0 0 0 0 0 1 1 1 1 1 1	63
Result written to **C**	0 1 0 1 0 1 1 1 1 1 1 1	1407

Exclusive OR: A bitwise Exclusive OR operation is performed on the binary representation of each pixel of the **A** file and each pixel of the **B** file, with the result written to the **C** file. An eight-bit example follows.

	Bits	**Decimal Value**
Pixel value in **A**	0 1 0 1 0 1 0 10 1 0 1	1365
Corresponding pixel value in **B**	0 0 0 0 0 0 1 1 1 1 1 1	63
Result written to **C**	0 1 0 1 0 1 1 0 1 0 1 0	1386

Complement: For each pixel value n in the **A** file, the corresponding value in the output file **C** is set to -1-n. Otherwise stated, each 0 becomes a 1 and each 1 a 0.

Binary Operations

NOT: For each pixel in the **A** file, all non-zero values yield a zero, and all zero values (only) yield a one. The resulting values are written to the corresponding point of the **C** file.

Procedure

1. Select the operation to be performed on the Operation tab page.
2. Enter the first input filename on the **A** tab page.
3. If the operation involves two files or one file and a constant, enter the second file name on the **B** tab page or enter the value of the constant on the **B** tab page.
4. If you want to process only part of the input images, change the Frame, X Range, and Y Range values on the **A** tab page, and also on the **B** tab page if two files are involved. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. Enter the name of the output file on the **C** tab page. If you want to restrict the output data range, change the Frame, X Range, and Y Range values as appropriate.
6. Select the output file datatype.
7. If you want the output file to be displayed as soon as the processing is complete, check the Display Result box.
8. Click on **OK** to begin processing, or **Cancel** to cancel the operation.

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Chapter 13
Y:T Analysis

Introduction

Y:T Analysis allows you to easily monitor and study the way ***spectral*** data changes as a function of time. This is particularly useful in characterizing time-dependent processes. Y:T Analysis provides for defining ***areas*** on the data, where each area is a region bounded by a starting and ending wavelength and containing a certain number of pixels whose wavelength values lie within the region. The value of an area is the sum of the intensities of the pixels in the area.

If a process study produces spectral lines that change with time, it may be useful to define a separate area for each line of interest, where each line is precisely spanned by its area. The value of each area can be the sum of the total intensities defined with respect to the baseline, or the values can be *baseline-corrected*, in which case the value of each area is the sum of the intensities with respect to an imaginary line joining the first and last pixels of the area. *This latter method is more accurate with a sloping baseline.*

After areas have been defined, they can then be mathematically operated on as specified in user-entered ***equations***. These equations allow you to can add, subtract, multiply, divide or otherwise manipulate up to eight areas. You can also include constants or ***even other equations***. The Y:T analysis modes provided give you control over when the equation calculations will be performed, how many will be performed, and on which acquired data they will be performed.

Each time equation calculations are performed, one Y:T analysis value is produced for each equation. For example, in a one-hour experiment with one Y:T equation and a Y:T sample time of one minute, at the end of the hour a Y:T analysis curve sixty points in length would have been taken and stored. If two equations had been defined for the same experiment, at the end of the hour there would be two Y:T curves, each sixty points in length. *An additional Y:T curve for the time will always be provided as well.*

Y:T curves are stored and can be displayed, printed or processed the same as any other data.

Y:T Analysis Procedure

1. Establish the **Experiment Setup** parameters for acquiring the data on which the Y:T analysis is to be performed.
2. Select **Y:T Analysis** on the **Acquisition** menu. This will open the **Y:T Area and Equation Setup** dialog box (Figure 129).

3. Define the Areas and Equations for the Y:T analysis. *A detailed discussion of the Y:T Area and Equation Setup dialog box and the process of setting Areas and Equations is available in the online Help.*
4. Click **OK** in the Y:T Area and Equation Setup dialog box to close the dialog box.
5. Select **Experiment Setup** on the **Acquisition** menu.
6. Select the **Processes** tab page (Figure 130).
7. Click the **On-Line Y:T** checkbox to activate the **Y:T Setup** button. *Checking the box turns on Y:T analysis. It will take place during any data acquisition run initiated with this box checked.*

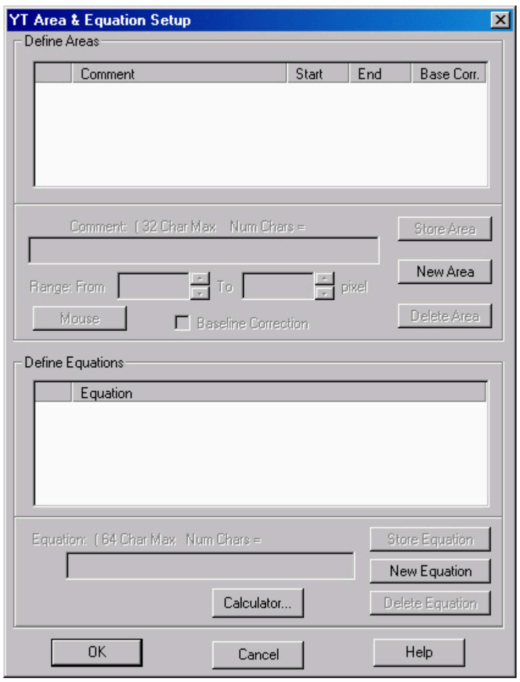

Figure 129. Y:T Area and Equation Setup dialog box

Figure 130. Processes tab page

8. Click on **Y:T Setup** to open the **Y:T Setup** dialog box (Figure 131).
9. Set the **Y:T Acquisition** mode, **Focus**, **Snapshot** or **Average** and set the **Y:T Analysis** parameters. *A detailed discussion of the Y:T Acquisition modes and parameters is available in the online Help.*
10. Click on **OK** to close the box.
11. Initiate data acquisition. As the data is acquired, Y:T points will be computed and stored as described in the online Help for the Y:T Setup dialog box. If multiple equations were defined, they would be computed in order and there would be a separate Y:T curve for each. Selecting **3D Graph** on the **Display Layout Main** page would allow all five to be viewed simultaneously. If the selection is **Graph**, only one would be visible. The keyboard cursor up/down arrow keys can be used to select the Y:T curve to be viewed and the Info box shows which strip is being displayed.

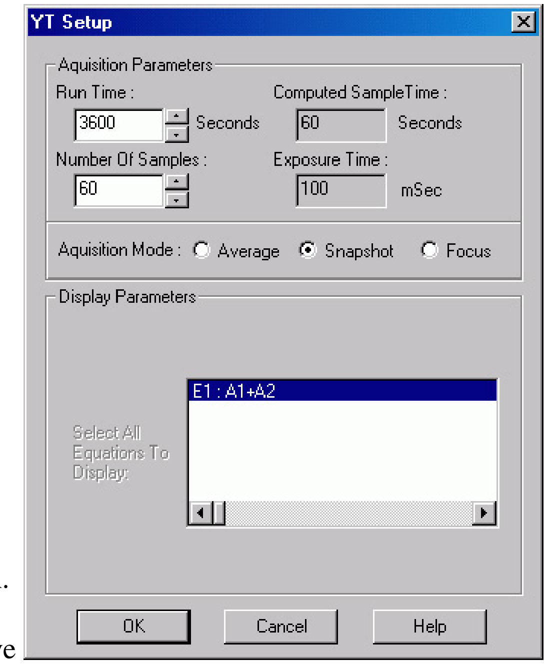

Figure 131. Y:T Setup dialog box

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Chapter 14
Gluing Spectra

Introduction

There are two ways to glue together multiple exposures into a single contiguous spectrum. The first is to take existing spectra that have already been calibrated and have the WinSpec/32 software connect the spectra at the appropriate points. The second method requires spectrometer control. With correctly calibrated spectrometer control, the WinSpec/32 software can collect spectra and move the spectrometer, automating the process of collecting a spectrum whose wavelength range can extend the full spectral range of the detector.

Gluing Existing Spectra

You can glue any series of existing data files, providing that they all have been properly calibrated in nm. The files should overlap some in order to provide complete spectral data, but this is not required by the software. Any collection of calibrated single spectrum files can be used to create a glued file. The only requirements are that:

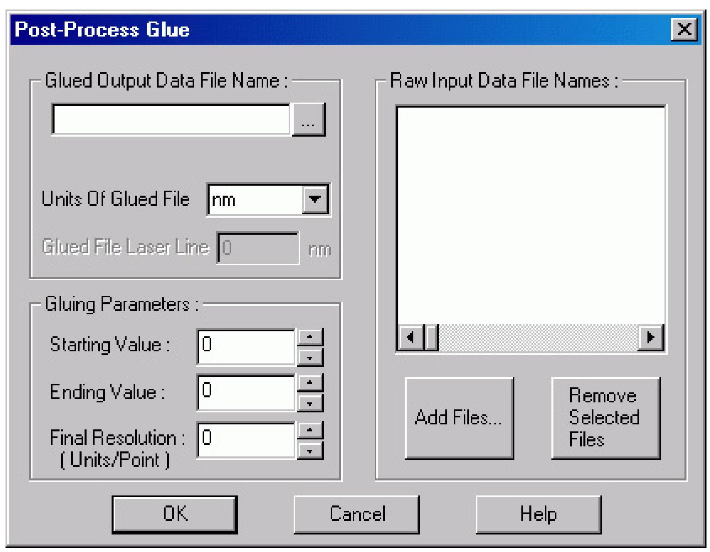

Figure 132. Post-Process Glue dialog box

- The files have been wavelength calibrated (either manually or using "AutoSpectro").
- The files have the same number of ***frames*** and ***strips*** (it is ***not*** necessary that they have the same number of pixels).

1. Take the series of data files you would like to glue and use the file manager to rename them as a series such as EXP001.SPE, EXP002.SPE, etc. You do not have to arrange these files in any particular order. These data files will not be altered in any way by the following procedure.
2. From the Process menu select **Glue**. This will open the Post-Process Glue dialog box (Figure 132). *For more information, see the online Help for this dialog box.*
3. Use the browser to select the files. The **Add Files** button opens a browser to facilitate file selection.

4. Enter the starting and ending wavelength values for the resulting file. If your wavelength range includes values that are not covered by any of the files in your series, the resulting spectrum will have some zero values. Any area where valid data was available will be used to create the glued data.
5. Enter the final resolution you would like the final data file to have. This value is in units per data point in the output file, so the lower the number the higher the resolution and the more data points the glued file will contain. For a 2400 groove per mm grating and a 0.3 m spectrometer a good final resolution would be about 0.1 nm per pixel. For a 1200 groove per mm grating this value would be 0.15 to 0.2 nm per pixel. The total number of data points in the resulting file cannot exceed 65,535.
6. Enter the Glued Output Data File Name in the field provided. The glued data will be contained in a single file.
7. If you change your mind about including one or more files in the resulting file, highlight those files in the Raw Input Data File Names listing and click on **Remove Selected Files**.
8. When you have finished selecting files, click on **SET** to execute the glue operation.

Step and Glue

If you have spectrometer control through the WinSpec software, the easiest way to create a glued spectrum is to let the software control both the data collection and the movement of the spectrometer. The software will take an exposure and, while the shutter is closed, will move the spectrometer to the next position. Unlike a monochromator with a single point detector, the wavelength calibration will not depend on the speed and timing of the stepper motor, only on its final position.

In this case you must set the amount of overlap you would like the spectra to have. The overlapping data will be averaged for a smooth transition from one exposure to the next. In addition to the glued data file, the numbered series of individual exposures remain in the computer for later processing.

1. Make sure that you have a spectrometer already installed and properly calibrated. This stepping and gluing procedure depends on having correct spectrometer calibration.
2. Click on **Calibration** on the menu bar and then on **Usage** to open the Usage dialog box.
3. Select **Auto-Spectro** in the Usage dialog box. Then select the **Calibration units** (nm, cm^{-1} or rel. cm^{-1}). Be sure the **Save as Default** button is clicked ON. Then click on **OK** to close the Usage dialog box.
4. From the Acquisition menu, select **Step and Glue**. The Step and Glue dialog box (Figure 133) will appear. *For more information, see the online Help for this dialog box.*

   Note: Again, you must have **Auto Spectro** and either **nm**, **cm^{-1}** or **rel. cm^{-1}** selected as the **Calibration Units** on the Usage dialog box (Calibration menu) in order for the Step and Glue dialog box to open. Failure to satisfy this prerequisite will generate an error message.

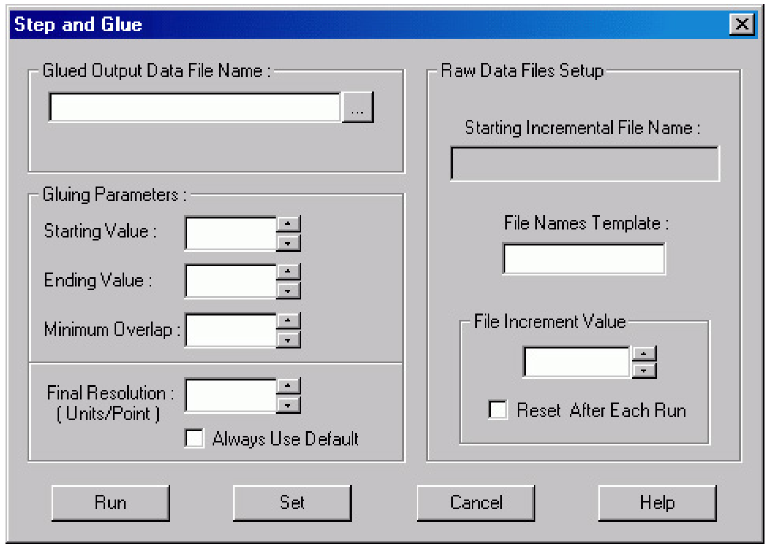

Figure 133. Step and Glue Setup dialog box

5. The glued data will be collected as a series of incremental files. These files will then be used to create a single glued data file. Enter the name of the File Name Template, such as EXP, in the File Names Template box. There is provision for setting the starting File Increment Value. As each incremental file is taken, the File Increment Value will increment by one. If the **Reset After Each Run** box is checked, the File Increment Value will reset to one and the subsequent set of incremental files will overwrite the first. If the **Reset After Each Run** box is unchecked, the File Increment Values assigned to the next and subsequent runs will start with the next digit after the last one used. No files will be overwritten.

5. Enter the **Starting Value**, the **Ending Value**, and the **Minimum Overlap** in the units selected. A good overlap would be about ten times the coverage of a single pixel. To determine the coverage of a single pixel; click on **Always Use Default**; the minimum resolution will be displayed in the Final Resolution edit box (the resolution changes as the wavelength changes, decreasing at higher wavelengths).

6. Enter a **Final Resolution** for the resulting file. Unless you require a certain resolution, it is easiest to let the computer calculate the final resolution, based on the spectrometer calibration and other known quantities. In the resulting file, each point does not represent a physical pixel. The total number of data points in the resulting file cannot exceed 65,536.

7. Click on **SET** to store the Step and Glue parameters. If the experiment is ready to run, click on the **RUN** to begin collecting data. The software will collect one exposure at each spectrometer position. It will automatically move the spectrometer to the next position (with the correct amount of overlap) and collect the next exposure. The software will collect as many exposures as needed.

During data collection, individual spectra may or may not be displayed, depending on the time between spectra.

Theory

The Glue operation is done in two stages. First the data in an input file is converted into an intermediate file with the calibration of the output file, and then the converted file is glued onto the output file.

The algorithm for the file conversion is based on the fact that the pixels have small but finite dimensions; this means that each pixel has some wavelength coverage and is not just a wavelength point. When WinSpec reports the wavelength of a pixel, it is actually the wavelength at the center of the pixel. Since WinSpec uses a polynomial wavelength calibration, the wavelength at the center of a pixel “x” is:

$$\text{Wavelength (center)} = A_0 + A_1x + \ldots + A_nx^n;$$

and the wavelengths at the edges are given by:

$$\text{Wavelength (edges)} = A_0 + A_1(x \pm ½) + \ldots + A_n(x \pm ½)^n,$$

where the “+” is for one edge and the “-“ for the other.

The intermediate and output file data points also have a finite wavelength coverage, given by the Final Resolution item on the Step and Glue or Post Process Glue dialog. For example, with a Starting Value of 400 nm, Ending Value of 700 nm, and Final Resolution of 1 nm, the Output File will have 301 data points, each with a coverage of 1 nm (The file itself will actually cover the range from 399.5 nm to 700.5 nm). The data point at 500 nm will have a wavelength coverage from 499.5 nm to 500.5 nm. The wavelength calibration of the Output File will be linear, and the wavelength at point “x” given by:

$$\text{Wavelength (center of point x)} = \text{Starting Value} + \text{Final Resolution} * (x - 1).$$

For each point in the Intermediate File, the conversion routine sums in values from all pixels whose wavelength range overlaps the wavelength range of the data point. If the pixel lies entirely within the range of the data point, then 100 % of its value is added; if a pixel partially lies in the data point’s range, then the percentage of its value that is added is equal to the percentage of the pixel’s wavelength range lying in the data point range. In the above example, if an input file pixel had a value of 1234 and a wavelength range of 498.9 nm to 499.6 nm, then the amount summed into the 500 nm point (499.5-500.5) would be

$$\{(499.6 - 499.5) / (499.6 - 498.8)\} * 1234 = 154.25,$$

where (499.6 - 499.5) is the amount of pixel in data point range, (499.6 - 498.8) is the coverage of the pixel, and 1234 the pixel’s value.

This algorithm, unlike a simple interpolation or curve fitting followed by interpolation, maintains both the general spectral shape and the intensity content of the original files (Interpolation could totally remove a peak if it were between two adjacent output data point wavelengths). The algorithm is general, and doesn’t depend on the input files having the same wavelength resolution or the same number of pixels.

In the second stage of the operation, the intermediate file is glued into the output file. The gluing is done in increasing wavelength point by point, based on the wavelength value of the point. Initially the output file contains all zeroes. Files are glued into the output using several rules, as follows.

- For cases with no overlap between data in the intermediate file and the output file, the intermediate file is just copied to the output file, point by point (pixels in the input file that are outside the wavelength range of the output file are discarded).
- For cases where the intermediate data overlaps the output data, the data from the two files are gradually blended over the overlap region. The most common overlap case for step and glue will be where the intermediate file starts after the output file has data, but before the output data has ended:

```
Output  file ….... x x x x x x x x 0 0 0 0 0 0 0 0 0 0 0 0 0 0 ...
                         | | | | |
Intermediate file        y y y y y y y y y y y y y y y y y y y ...
```

  There are five points in the above overlap region, and the result of the blending would be (left to right):

overlap point number	**blending result**
1	(5/6)x + (1/6) y
2	(4/6)x + (2/6) y
3	(3/6)x + (3/6) y
4	(2/6)x + (4/6) y
5	(1/6)x + (5/6) y

  (If there is only 1 point in the overlap region then it would have (1/2)x + (1/2) y.)

- Another case occurs when the intermediate file starts before the output and ends after the output file has data. In this case also the data is blended across the overlap region.
- Since the glue is a general algorithm, there will be cases such as the following:

```
Output file        ..... x x x x x x x x ... x x x x x x x x x x x x ...
                         | | | | | |   | | | | | | |
  Intermediate file        y y y y y y ... y y y y y y y
```

  or

```
Output file        …000000x x x ... x x x x 0000000…
                          | | |   | | | |
  Intermediate file       y y y y ... y y y y y y y y
```

  In these cases, the composition of the result will be 50% Intermediate and 50% Output.

One of the effects of the above rules is that multiple copies of the same file can be glued and the result will be the same as if only one copy had been used. The blending allows a smooth transition for files with broad spectra.

Calibration and ROI Offsets

In an ideal world, when a CCD camera was attached to a spectrograph, the center of the CCD array would coincide with the center of the spectrograph exit plane. In the real world, they can be separated by several pixels, so that when the spectrograph goes to 0 nm, the peak can show up 5 pixels to the right of the array center, for example. It is the function of the Calibration Offset is to compensate for this. It is a wavelength which, when sent to the Acton, will cause the zero order to land in the center of the array. This offset is then added to every wavelength sent to the Acton. This offset does not depend on the scan pattern of the ROI used.

A second kind of Offset is used when "x" ROIs are programmed into the CCD. The program is designed to keep the requested wavelength in the center of the ROI pattern (in the center of a full x-axis display). If a full x-axis is scanned or if the ROI is symmetrical (just ignore the first and last 10 pixels, e.g.), then this ROI Offset is zero. In the case of a very asymmetrical ROI where the first 512 pixels of a 1024 pixel array are skipped, the center of the array is "pixel" (1+1024)/2 = 512.5 and the center of the ROI is (513+1024)/2 = 768.5. If the requested wavelength went to the center of the array rather than the center of the ROI, it would be just outside the scanned pixels. The ROI Offset is used to compensate for this. In this example, the ROI Offset is 768.5-512.5 = 256 pixels. This offset is converted to the equivalent wavelength (at the requested wavelength) and subtracted (in this case) from the requested wavelength before being sent to the Acton.

Suppose you have calibrated your 1200 g/mm grating on the 275 and the calibration offset is 2.2057 nm (as reported on the Spectrograph | Calibrate | Offset menu). Using the above ROI, when you ask for 0.00 nm, the 256 pixel ROI is converted to -20.199 nm, and the value sent to the 275 is: 0+2.2057-20.199 = -17.98 nm.

The ROI Offset pixel to wavelength calculation uses the results of the dispersion calibration. So, if a spectrograph is being calibrated using an asymmetrical ROI, the calibration should be iterated at least once. Because the ROI Offset is calculated separately from the Calibration Offset, once a spectrograph has been calibrated using one ROI, the ROI pattern can be changed without affecting the calibration.

Chapter 15
Post-Acquisition Mask Processes

Introduction

Several post-acquisition mask processes, including Edge Enhancement, Sharpening, Smoothing, a Custom Filter and Morphological Erode and Dilation operations, are provided in the WinSpec/32 software. These processes all use the same Input and Output tab pages but have unique Parameters tab pages. Since the Input and Output functionality is identical for all of these processes, the Input and Output tab pages are described below. The Parameters tab pages are described in the appropriate sections.

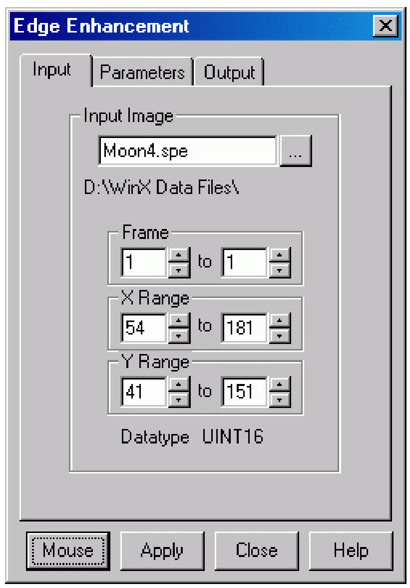

Figure 134. Input tab page

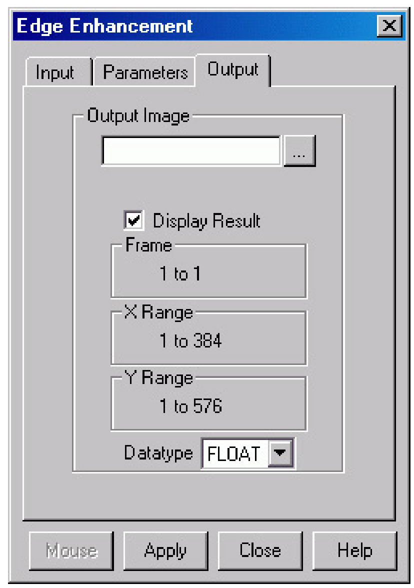

Figure 135. Output tab page

Input tab page

The Input tab page (Figure 134) selects the data to be operated on. You can specify the data file, the frames within the file, and the X and Y range on the CCD. The input data-type is reported. Note that the Mouse button at the bottom of the window allows you to use the mouse to specify the region to be processed. Simply drag a box in the data region of the active window and then click on **Mouse**. The **Frame** and **Range** parameters will assume the values of the defined region. *The **Mouse** button is only active when the **Input** tab page is selected.*

Output tab page

The Output tab page (Figure 135) allows you to name the output file. It additionally allows you to select whether the modified data is to be displayed and to select the data type. The frame and X-Y range are reported information only.

Edge Enhancement

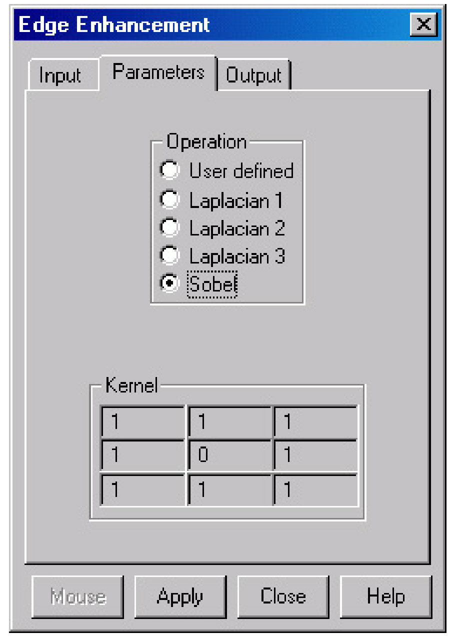

Figure 136. Edge Enhancement Parameters tab page

Parameters tab page

Edge enhancement is accomplished by mask operations defined by parameters entered on the Parameters tab page. These functions can enhance edges, sharpen or smooth features, or erode or dilate an image. How these images are processed is briefly described below.

A mask is an $n \times n$ matrix (n is 3 for all WinSpec/32 operations) that is placed over every $n \times n$ subsection of the image. Each parameter in the mask is multiplied by the corresponding value of the image. The results are summed and placed in the central position in the output file. An example will help illustrate the process.

The following is the Laplacian 1 mask, used to enhance edges.

-1	-1	-1
-1	8	-1
-1	-1	-1

Here is an example of a 3×3 subsection of an image. The middle pixel has the coordinates 100, 100.

20	20	19
20	21	20
20	19	20

Multiply each pair of corresponding numbers, and sum the products.

$$(-1 \times 20) + (-1 \times 20) + (-1 \times 19) + (-1 \times 20) +$$
$$(8 \times 21) + (-1 \times 20) + (-1 \times 20) + (-1 \times 19) + (-1 \times 20) = 10$$

The result is placed at position 100, 100 in the output image file. The mask is now placed over the 9 pixels centered at 101, 100, and the procedure is repeated.

Laplacian Masks

The three Laplacian masks on the Edge Enhancement dialog box operate just as described above. Since the sum of the mask coefficients of the Laplacians sum to zero, the result of a Laplacian operation on a region of uniform density is zero. Boundary features are enhanced by varying degrees.

Sobel Edge Detection

The Sobel edge detection method is more involved, but produces greatly enhanced features. Number the squares of the subregion of the image as follows:

A_0	A_1	A_2
A_7		A_3
A_6	A_5	A_4

The replacement for the center cell, called R, is[1]

$$R = [X^2 + Y^2]^{1/2}$$

where

$$X = (A_2 + 2A_3 + A_4) - (A_0 + 2A_7 + A_6)$$

$$Y = (A_0 + 2A_1 + A_2) - (A_6 + 2A_5 + A_4)$$

Figure 137 illustrates the effect of edge detection on an image.

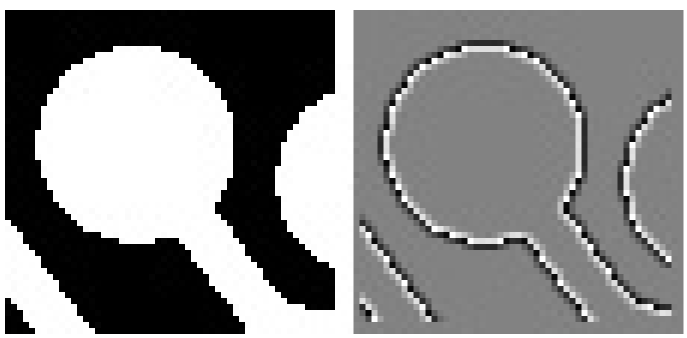

Figure 137. Original Image (left) and Edge-detected Image (right)

Edge Enhancement Procedure

Use the following procedure to perform Edge Enhancement on an image.

1. Select **Edge Enhancement** from the Process menu.
2. Enter the Input Image and Output Image names.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.

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[1] Pratt, William K., Digital Image Processing, John Wiley & Sons, New York, 1978, pp. 487-488.

4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. Select one of the Operations. Since image features vary widely, it is best to simply try the different operations to determine the best one.
6. To set a specialized 3 × 3 mask, select User Defined and change the Kernal parameters to their new values.
7. Click on **Apply** to begin processing.

Sharpening Functions

Parameters tab page

Sharpening is also accomplished by mask operations, in this case parameters entered on the Sharpening Parameters tab page. These masks, sometimes called high pass filters, enhance regions of high contrast while not affecting regions of low contrast.

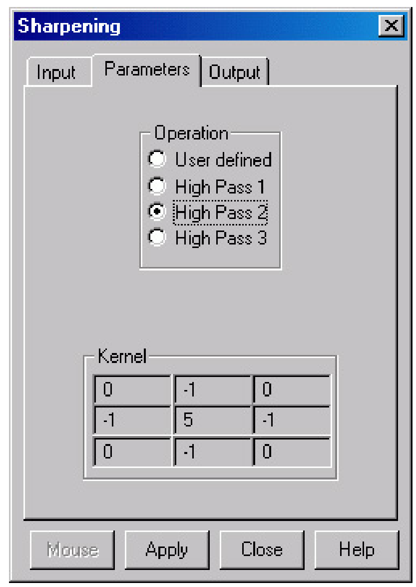

Figure 138. Sharpening Parameters tab page

Sharpening Procedure

Use the following procedure to sharpen an image.

1. Select **Sharpening** from the Process menu.
2. Enter the Input Image and Output Image names.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. Select one of the Operations. Since image features vary widely, it is best to simply try the different operations to determine the best one.
6. To set a specialized 3 × 3 mask, select User Defined and change the Kernel parameters to their new values.
7. Click on **Apply** to begin processing.

Smoothing Functions

Parameters tab page

Smoothing is also accomplished by mask operations, in this case parameters entered on the Smoothing Parameters tab page (Figure 140). These masks, sometimes called low pass filters, attenuate regions with high contrast, while leaving pixels in regions of low contrast almost unchanged. Figure 139 illustrates the smoothing filter effect.

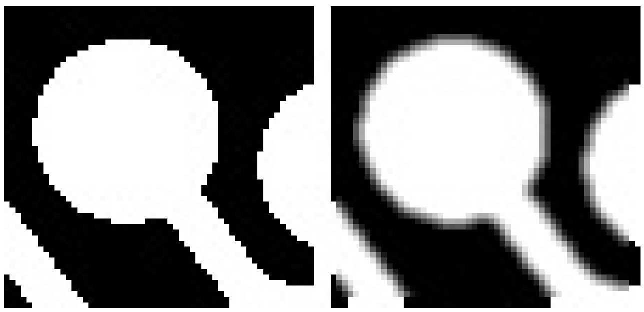

Figure 139. Original Image (left) and Smoothed Image (right)

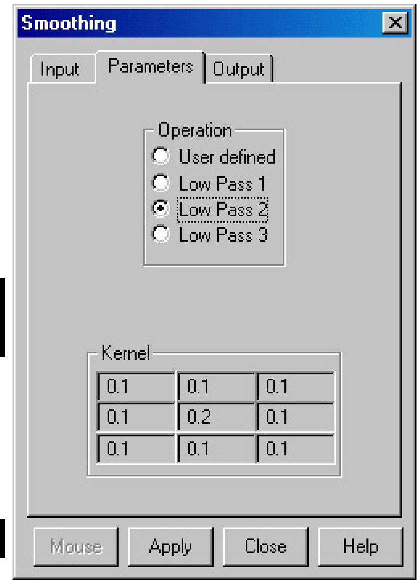

Figure 140. Smoothing Parameters tab page

Smoothing Procedure

Use the following procedure to smooth an image.

1. Select **Smoothing** from the Process menu.
2. Enter the Input Image and Output Image names.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. Select one of the Operations. Since image features vary widely, it is best to simply try the different operations to determine the best one.
6. To set a specialized 3 × 3 mask, select User Defined and change the Kernal parameters to their new values.
7. Click on **Apply** to begin processing.

Morphological Functions

Parameters tab page

Morphological operations are also accomplished by mask operations, in this case parameters entered on the Morphological Parameters tab page. There are two basic morphological mask operations, Erode and Dilate. The effect of the Erode process is to reduce the size of a white region, while Dilation increases it. The number of iterations is user-settable. All the options except for Block and User Defined perform the operation in a specific direction only. Block performs the operation in all directions. Two other choices are **Open** and **Close**. **Open** is simply a number of erodes (specified by Iterations) followed by the same number of dilates. **Close** performs the dilates first and then the erodes.

Examples of some morphological operations follow. References are found at the end of this chapter. In each case the same binary image is shown to the left and the morphologically processed image is shown to the right.

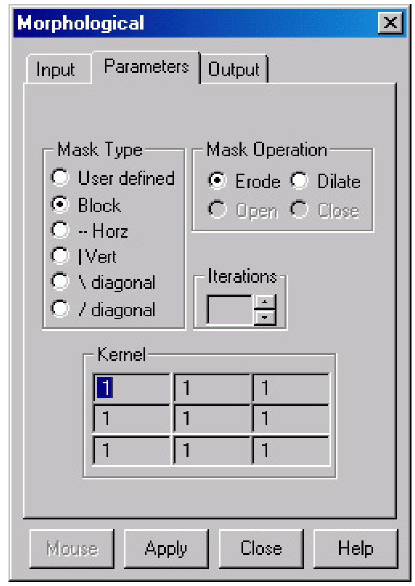

Figure 141. Morphological Parameters tab page

Figure 142. Original Image (left) and Dilated Image (right)

Figure 143. Original Image (left) and Eroded Image (right)

Figure 144. Original Image (left) and Opened Image with Three Iterations (right)

Morphological Procedure

Use the following procedure to morphologically process an image.

1. Select **Morphological** from the Process menu.
2. Enter the Input Image and Output Image names.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. Select the desired Mask Type and Mask Operation.
6. To set a specialized 3×3 mask, select User Defined and change the Kernel parameters to their new values.
7. Click on **Apply** to begin processing.

Custom Filter

Filter Matrix tab page

The Custom-Filter Filter-Matrix tab page allows you to set the filter matrix parameter values. The filter is applied to the dataset specified via the Input tab page (page 151). The processed data is saved in the file specified by the Output tab page (page 151).

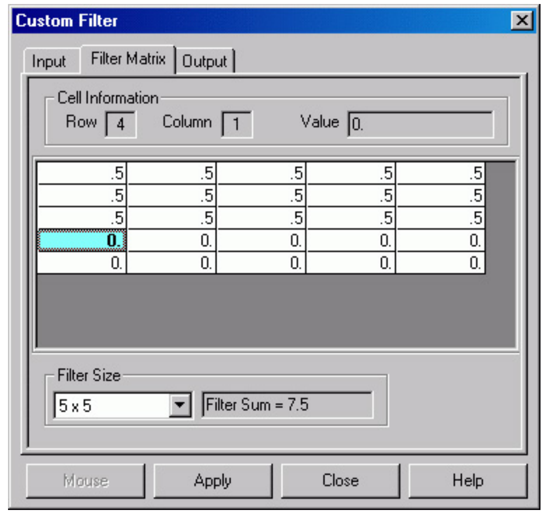

Figure 145. Filter Matrix tab page

Filtering is accomplished by mask operations defined by parameters entered in the matrix. These functions can enhance edges, sharpen or smooth features, or erode or dilate an image. How these images are processed is briefly described below.

A mask is an n × n matrix (n is 5, 7, 9 or 11) that is placed over every n × n subsection of the image. Each parameter in the mask is multiplied by the corresponding value of the image. The results are summed and placed in the central position in the output file. Users can specify the Filter Size (5×5, 7×7, 9×9 or 11×11). The Filter Sum is displayed in the adjacent box.

The **Load Defaults** button sets the matrix parameters to their factory-default values. When you click on this button, you will see a warning message "Will erase Data for ALL Filter Sizes; Continue?" with Yes/No. **"Yes" will erase ALL filter data before loading the factory default values.**

Custom Filter Procedure

Use the following procedure to apply a custom filter to an image.

1. Select **Custom Filter** from the Process menu.
2. Enter the Input Image and Output Image names.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. Define the filter by entering the appropriate values in the Filter Matrix.
6. Click on **Apply** to begin processing.

Look Up Table

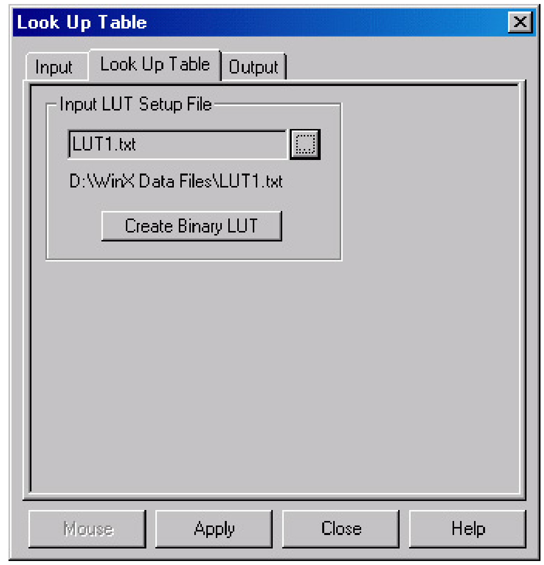

Figure 146. Look-Up Table

Look Up Table tab page

The Look Up Table function uses an ASCII text file, provided by the user, to translate pixel intensities from an input file into different intensities in an output file. The input file must be a raw data file (unsigned 16-bit image) since the Look Up Table mapping assumes a 0-65536 range of intensity values in the input file. The map file is a previously created text file (refer to pages 160 and 161 for descriptions of the LUT formats) that must be converted to a binary map file for the actual operation. After the text file is selected, clicking on the **Create Binary LUT** button converts the text information to binary format. Clicking on **Apply** then remaps the image intensities and redraws the data display window appropriately.

Look Up Table Procedure

Use the following procedure to process data using the LUT.

1. Select **Look Up Table** from the Process menu.
2. Using the **Input** and **Output** tab pages, enter the Input and Output file names.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. Load the LUT. *LUT files must be of the type *.TXT.* The file name can be entered directly or selected by using the browser (clicking on the button at the end of the field opens the browser).
6. Click on the **Create Binary LUT** button to convert the text-LUT to binary.
7. Click on **Apply** to begin convert the input data values to the output values specified per the LUT.

Look Up Table Formats

The contents of a look-up table text file are entered using an ASCII text editor and the file is saved with a .TXT extension. The format used within the file depends on the type of remapping: one-to-one remapping of intensity levels or a user-defined selection of input to output values.

Format 1

This format is for a one-to-one mapping of intensity levels. Imin and Imax (the minimum and maximum input levels, inclusive) are supplied in the first line with a comma delimiter. The subsequent values are supplied one output value per line. The mapping assumes that all of the input intensities in the specified range are represented by an output value. Therefore, the number of output values in the text file must cover the range [(Imax-Imin) + 1]. Input levels below Imin are mapped to the value of Ofirst and input levels above Imax are mapped to the value of Olast.

Imin,Imax	Imin,Imax represents inclusive input range to be remapped
Ofirst	Ofirst is the output value for Imin (or I1)
O2	O2 is the output value for I2
O3	O3 is the output value for I3
O4	O4 is the output value for I4
.	.
.	.
.	.
Olast	Olast is the output value for Imax

Example: The following example is for a one-to-one mapping. As stated previously, the entries after Imin and Imax are output levels. Based on the Imin and Imax values, there are 5 output values [(7-3) +1]. In this example, every input intensity less than 3 (Imin) gets mapped to 20, 3 (Imin) is mapped to 20, 7 (Imax) is mapped to 10, and every input intensity greater than 7 (Imax) is mapped to 10 (Olast). Input intensities 4, 5, and 6 are mapped to 22, 23, and 26 respectively.

```
3,7
20
22
23
26
10
```

Format 2

This format is not a one-to-one mapping in that input intensities between Imin and Imax, inclusive, can be omitted from the list of In,Out pairs. Imin and Imax (the minimum and maximum input levels, inclusive) are supplied in the first line with a comma delimiter. This format expects an arbitrary number of entries in the form of In,Out and the In,Out pairs may be listed in any order. The In value must be between Imin and Imax, inclusive. Anything less than Imin is mapped to the first Input mapping. Anything greater than Imax gets mapped the output value of the last In,Out pair. Any input value not specified in an In,Out pair is mapped to zero.

Imin,Imax	Imin,Imax represents inclusive input range to be remapped
Ifirst,Ofirst	Ofirst is the output value for Ifirst and for any intensity < Imin
I,O	I is the input value and O is the output value
I,O	O3 is the output value for I3
I,O	O4 is the output value for I4
.	.
.	.
.	.
Ilast,Olast	Olast is the output value for Ilast and for any intensity > Imax

Example: The following is a custom mapping. As stated previously, the entries after Imin and Imax represent are input,output levels. Imin and Imax are 3 and 7 respectively. Everything less than 3 gets mapped to 13 (the first In,Out mapping). Everything greater than 7 gets mapped to 12 (the last In,Out mapping). Since input values 3 and 4 are not represented in an In,Out pair, these intensities will be mapped to 0.

3,7

6,13

5,11

7,12

References

To explore in further detail the theory and techniques of digital image processing, we suggest the following texts:

1. *Digital Image Processing,* Gregory A. Baxes, Cascade Press, Denver, CO, 1984. ISBN: 0-945591-00-4.
2. *Digital Image Processing,* R. C. Gonzalez, P. Wintz, Addison-Wesley, Reading, MA, 1977. ISBN: 0-201-11026-1.
3. *Digital Picture Processing,* A. Rosenfeld, A. C. Kak, Vol. 1 & 2, Academic Press, New York, 1982. ISBN (Vol. 1): 0-12-1597-301-2, ISBN (Vol. 2): 0-12-597-302-0.
4. *Digital Image Processing,* W. K. Pratt, John Wiley, New York, 1978. ISBN: 0-471-01888-0.

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Chapter 16
Additional Post-Acquisition Processes

Introduction

The processes included in this chapter are accessible from **Processes** menu. These processes all use the same Input and Output tab pages but have unique Parameters tab pages. Since the Input and Output functionality is identical for all of these processes, the Input and Output tab pages are described below. The Parameters tab pages are described in the appropriate sections.

Input tab page

The Input tab page (Figure 134) selects the data to be operated on. You can specify the data file, the frames within the file, and the X and Y range on the CCD. The input data-type is reported. Note that the Mouse button at the bottom of the window allows you to use the mouse to specify the region to be processed. Simply drag a box in the data region of the active window and then click on **Mouse**. The **Frame** and **Range** parameters will assume the values of the defined region. *The **Mouse** button is only active when the **Input** tab page is selected.*

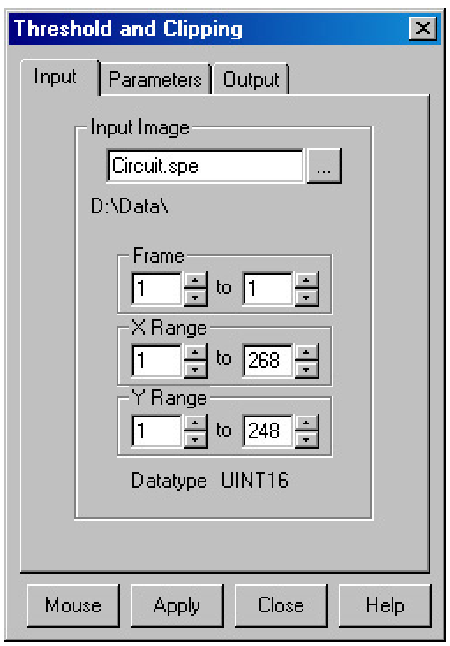

Figure 147. Input tab page

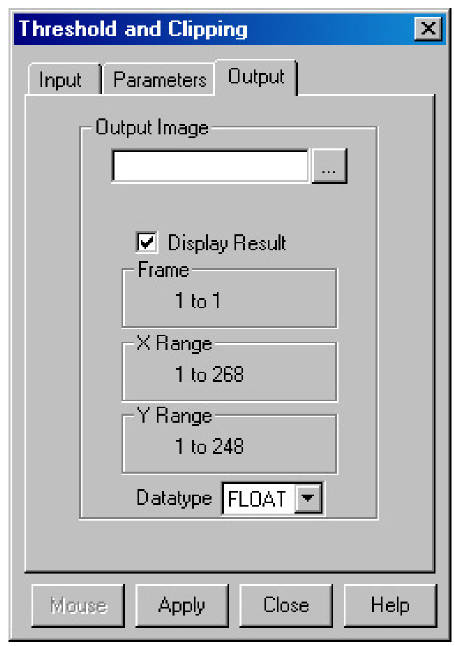

Figure 148. Output tab page

Output tab page

The Output tab page (Figure 135) allows you to name the output file. It additionally allows you to select whether the modified data is to be displayed and to select the data type. The frame and X-Y range are reported information only.

Threshold and Clipping

Clipping an image causes pixels outside the specified range to be changed. When **Clip High** is selected, all pixels with values greater than the Clip High value will be changed to the Clip High value. When **Clip Low** is selected, all pixels with values less than the Clip Low value will be changed to the Clip Low value. Selecting **Clip Both** will use both Clip High and Clip low values during the same processing step.

The **Threshold** function converts an image to binary (black and white). All intensity values below the threshold setting are zero (black). All those above become ones (white).

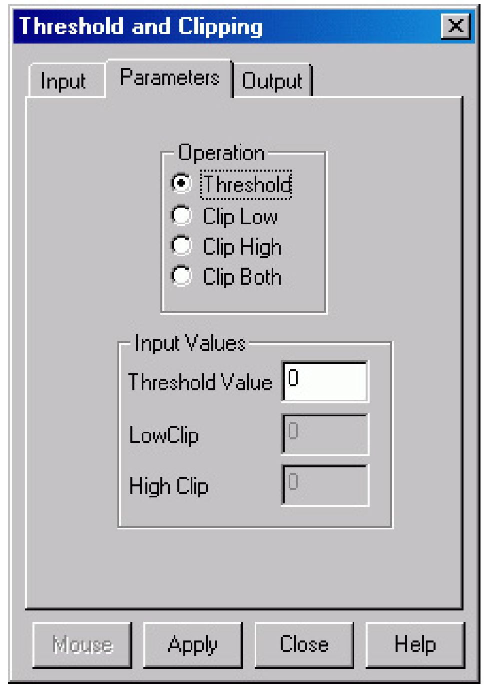

Figure 149. Threshold and Clipping Parameters tab page

Procedure

1. Select **Clipping/Threshold** from the Process menu.
2. On the **Input** tab page, if the correct input image does not appear in the Input Image box, enter the complete file name or search for a file using the browser, accessed by the button to the right of the field.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. On the **Parameters** tab page, if a clipping operation is to be performed, select the clipping option as described above. For a threshold operation, set the threshold level to the desired value.
6. Enter the name of the Output Image on the **Output** tab page. *In later editions of the software, it will additionally be possible to specify an output frame and data range.*
7. Click on **Apply** to begin processing.

Cross Section

Introduction

Selecting **Cross Section** on the Process menu opens the Cross Section window, which allows you to separately display and store horizontal and vertical cross sections of an image. Figure 150 shows two X-axis cross sections based on the same ROI. The upper data is averaged; the lower data is summed.

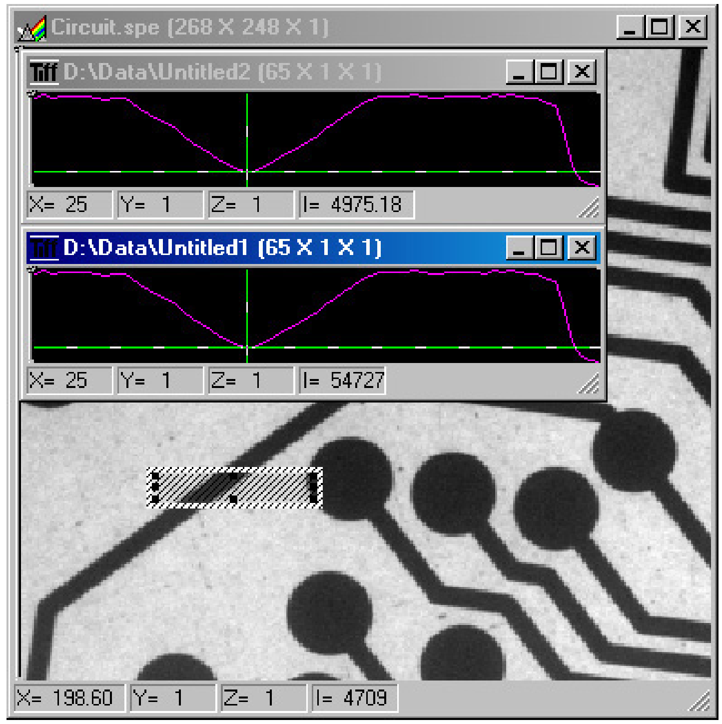

Figure 150. Example Cross Sections of an ROI

Procedure

1. Select **Cross Section** from the Process menu.
2. On the **Input** tab page, if the correct input image does not appear in the Input Image box, enter the complete file name or search for a file using the browser, accessed by the button to the right of the field.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, draw an ROI in the active window using the mouse and click the **Mouse** button at the bottom of the dialog box to enter those values.

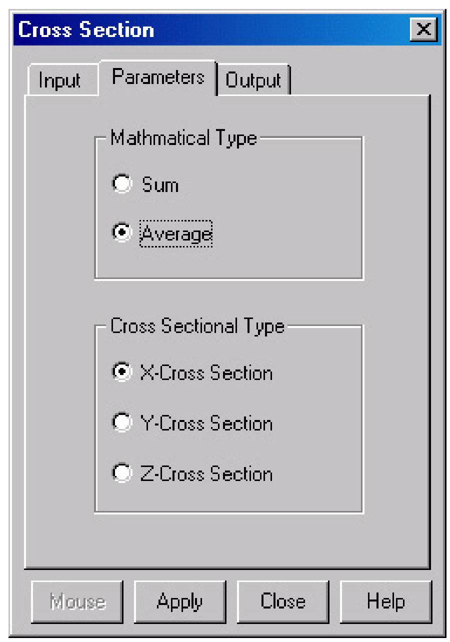

Figure 151. Cross Section Parameters tab page

5. On the **Parameters** tab page, select either **Sum** or **Average**. If Sum is selected, all pixel values in the X, Y, or Z direction, according to whether X-Cross Section, Y-Cross Section or Z-Cross Section is selected, will be summed to generate the output. If Average is selected, the average of all of the pixel values in the X, Y, or Z direction will be summed to produce the output.

6. On the Parameters tab page, select **X-Cross Section, Y-Cross Section** or **Z-Cross Section**, whichever is wanted.
7. Enter the name of the Output file on the **Output** tab page. *In later editions of the software, it will additionally be possible to specify an output frame and data range.*
8. Click on **Apply** to begin processing.

Binning and Skipping

Introduction

Selecting **Binning** on the Process menu opens the Binning and Skipping window, which allows binning to be accomplished in software after the data has been collected. The Parameters tab page allows the bin size to be set independently in the X and Y directions. The Skipping parameter allows you to define the interval between binned regions. The Skipping parameter size can be independently set for X and Y. There is also provision for either averaging or summing the binned data points. If Average is selected, each output data value will be the average of the binned data values in each region. If Average is unselected, each output data value will be the sum of the binned data values. The procedure follows.

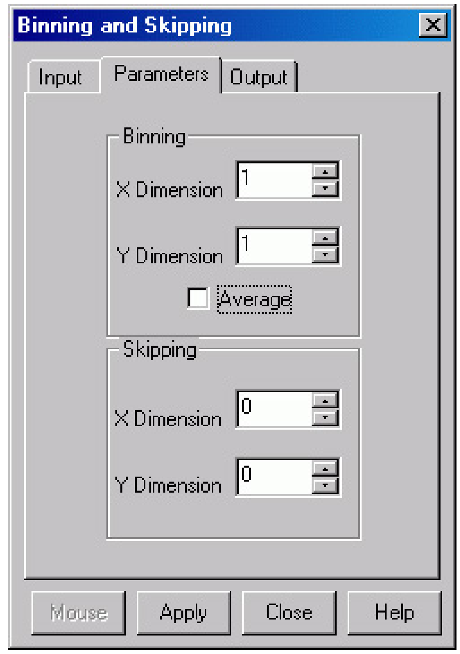

Figure 152. Postprocessing Binning and Skipping Parameters tab page

Procedure

1. Select **Binning and Skipping** from the Process menu.
2. On the **Input** tab page, if the correct input image does not appear in the Input Image box, enter the complete file name or search for a file using the browser, accessed by the button to the right of the field.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. On the **Parameters** tab page, set the X and Y bin size.
6. On the Parameters tab page, select **Average** if the binned data values are to be averaged. If the Average box is left unchecked, the binned values will be summed.
7. On the Parameters tab page, set the Skip X and Y values. Data points that fall in the skip zones do not contribute to the output. Skip values of zero are allowable, that is,

no points will be skipped. Leftover points at the end of a strip or column are discarded.

8. Enter the name of the Output file on the **Output** tab page. *In later editions of the software, it will additionally be possible to specify an output frame and data range.*
9. Click on **Apply** to begin processing.

Restrictions and Limitations

The following are some restrictions and limitations of the Binning and Skipping function.

- This function can resize an image down to a minimum of 1 pixel but WinSpec/32 cannot display an image less than 2 × 2 pixels.
- May cause data overflow in the output image if the output data type is selected as “integer”. If data to be binned will exceed 32,000 counts, select Unint or Long.
- The maximum binning and skipping size is the size of the input image. When the maximum is reached, to increase the binning size you must first decrease the skipping size, then increase the binning size.

Histogram Calculation

Introduction

Two types of histograms are available for graphing the distribution of intensities of an image. The **Histogram** operation groups pixels of a similar intensity together. The X-axis indicates the intensity, and the Y-axis displays the number of pixels in that intensity range.

The **Cumulative Histogram** operation groups pixels of a similar intensity together, once again using the X-axis to show intensity. This time, however, the Y-axis indicates the total number of pixels with intensity less than or equal to the range. Thus the Cumulative Histogram is always an increasing function.

Procedure

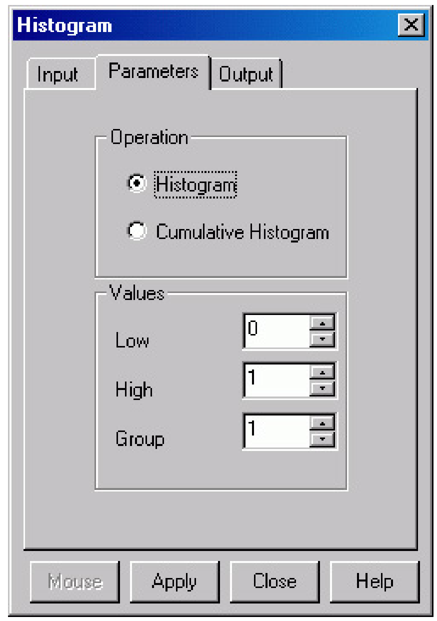

Figure 153. Postprocessing Histogram Parameter tab page

1. Select **Histogram** from the Process menu.
2. On the **Input** tab page, if the correct input image does not appear in the Input Image box, enter the complete file name or search for a file using the browser, accessed by the button to the right of the field.
3. On the **Input** tab page, select the data frame containing the data on which the operation is to be performed.
4. If you want to process only part of the Input Image, enter the appropriate X-Y range values. Alternatively, use the mouse to draw an ROI in the active window and click the **Mouse** button at the bottom of the dialog box to enter those values.
5. On the **Parameters** tab page, select either **Histogram** or **Cumulative Histogram**, whichever is wanted.
6. On the Parameters tab page, under **Values**, enter the **Low Intensity** and **High Intensity** values. These are the Y-Max and Y-min. Then enter the **Group Size**, which is the range of intensity that the software will group together as a single data point. In other words, if the Group Size is 50, pixels having intensities in the range of 1-50 will be counted and graphed as a single point on the histogram.
7. Enter the name of the Output file on the **Output** tab page. *In later editions of the software, it will additionally be possible to specify an output frame and data range.*
8. Click on **Apply** to begin processing.

Chapter 17

Printing

Introduction

WinSpec/32 can be used to print images directly. Methods are listed below both for direct printing and for using the clipboard to transfer the image to another program for printing.

Setting up the Printer

1. Open the file you want to print. Make sure that window is the active one. From the File menu, open the Print Setup dialog box (Figure 154).

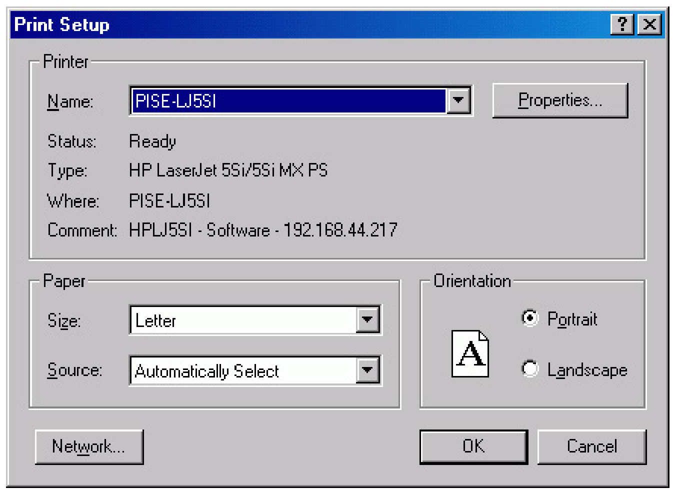

Figure 154. Print Setup dialog box

2. The Print Setup dialog box is similar to that found in many Windows programs. You can use the default printer or select a specific printer from the list of installed devices. For information on installing printer drivers, consult the Windows documentation.
   The Options button shows more features of the selected printer driver – again, a standard Windows feature.

3. Select the Paper Size and Source. The Landscape format (where the paper is wider than it is tall) is probably the best way to print out data.

4. Click on **OK** to execute the printer setup selections or **Cancel** to exit the dialog leaving the original settings unchanged.

Printing Directly from WinSpec/32

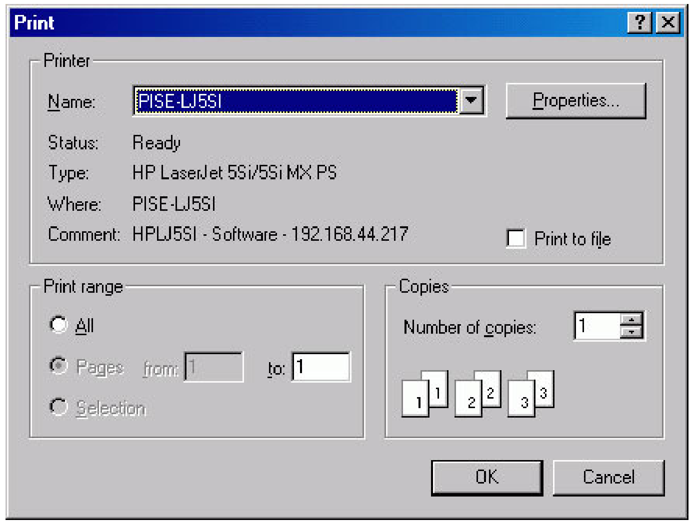

Figure 155. Print dialog box

This procedure assumes you have already set up the printer you will be using.

1. From the File menu, open the Print dialog box (Figure 155).
2. Select the number of copies and pages (if a file contains multiple frames, each will be printed as a separate page).
3. Click on **OK** to initiate the print.

Notes:

1. Once the Print Setup is properly configured, you can print the active window simply by selecting Print from the File menu (shortcut Alt, F, P) or by clicking on the Print button in the standard toolbar.
2. Color mapping to the printer may differ from that shown on the screen. To obtain the desired output color mapping, you may wish to do a screen capture and then paste the image into a graphics program for final adjustment before printing.

Print Preview

The Print Preview function gives you a quick idea of how the printed image will look. It produces an “on-screen print” that looks as closely as possible like a “real” print, allowing changes in the printer setup to be made quickly and conveniently. Figure 156 illustrates the Print Preview window.

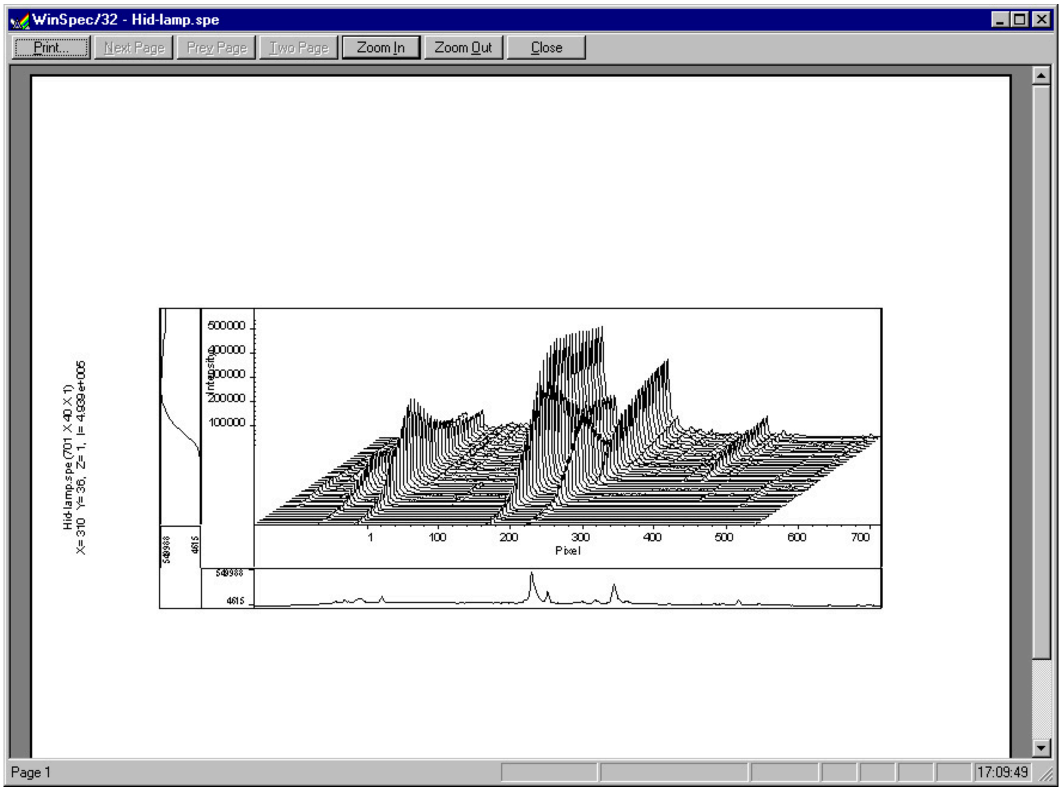

Figure 156. Print Preview window

The button functions are as follows.

Print…: Opens the Print screen so a print can be initiated.

Next Page: If the file contains multiple frames, each one will occupy a different page. The Next Page button allows you to step forward sequentially through all available pages. If the file contains only one image, the Next Page button will be grayed out.

Prev Page: Allows you to step backwards sequentially through the pages of a multiple image file.

Two Page: Causes two pages to be displayed at a time in a side-by-side layout.

Zoom In: Allows you to zoom in on the previewed page, allowing a selected area to be examined in detail. There are two zoom levels. Note that, if not at full zoom, the cursor becomes a “magnifying glass” if positioned on the image area.

Zoom Out: Allows you to return to the normal (unzoomed) preview display.

Close: Closes the Preview window and returns you to the normal WinSpec/32 display.

Printing a Screen Capture

It is also possible to do a screen capture of the entire WinSpec/32 window. This is the best way to capture such information as cross sections, scaling, and color lookup tables. A limitation of screen shots is that the resulting image is based on the resolution of the monitor, not the resolution of the image. For a 1 million pixel CCD, even a 600 × 800 video mode is not enough to show all the pixel information.

1. Display the desired image or images in WinSpec/32. Click once on the title bar of WinSpec/32 to make this the active window.
2. Press **Alt** + **Print Screen**. This copies the entire contents of the WinSpec/32 window, including image or graph displays and dialog windows, to the clipboard.

   Note: Alternatively, press **Ctrl+C** or select Copy on the Edit menu to copy an image to the clipboard. *This function only works on image displays and only on the image itself (i.e., scales and cross section information is not transferred). However, it has an advantage in that the full resolution of the image is retained.*

Many text editors and graphics programs allow images to be pasted directly from the clipboard. Paint Shop Pro, a shareware program, is one example of an inexpensive program that can edit and save clipboard screen shots.

1. Open the application. Open a new file within that application.
2. Select **Paste** from the Edit menu. This will place the contents of the clipboard into the application. If the image seems cut off, try opening a bigger blank image before pasting the clipboard. The image is now an 8-bit color or grayscale image.
3. Crop the image, if desired. This feature is available in almost any image editing program.
4. Select **Print** from the File menu. Print the file.
5. Save the file, if desired. TIFF is an excellent image format for either grayscale or color shots.

Note: Screen-capture images lose the high dynamic range of the original. The Copy function (**Ctrl+C**) retains the full resolution of the data file.

Saving as TIF and Printing

It is also possible to save an image file directly to the TIFF format by using the Save As function on the File menu. The resulting *.eps file could then be copied to a graphics editing program for further processing and then printed.

Chapter 18
Pulser Operation

Introduction

Three different pulser/timing generators are available for use with WinSpec/32. To be available, pulser support must have been installed as described in the Installation chapter. Pulser support is then accessed by selecting **Pulsers** on the **Setup** menu and then selecting the pulser to be used with the system. Available selections include the Princeton Instruments brand PG200 Pulser, the Princeton Instruments brand Programmable Timing Generator (PTG) plug-in module for the ST-133 (high power ver. 3+) and the Stanford Research Systems DG535 Digital Delay/Pulse Generator with Inhibit Option.

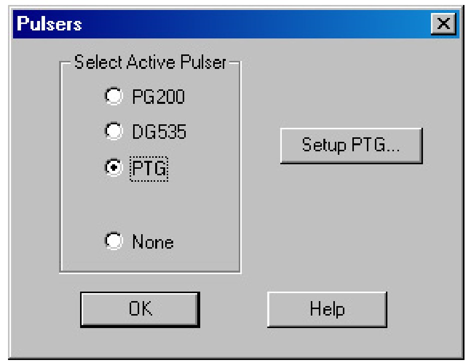

Figure 157. Pulsers dialog box

The Model PG200 is available for all Princeton Instruments intensified detectors except the PI-MAX Intensified CCD Camera, which requires the PTG or DG535. All three pulser/timing generators are programmable from WinSpec/32. Consult the applicable hardware manuals for detailed instructions on setup and connection to other devices.

PG200 Programmable Pulse Generator

The PG200 is programmed via one of the serial ports of the computer, such as COM1 or COM2. The choices provided by the tab pages are the same ones that are available using the PG200 front panel. Basic PG200 operation is reviewed in the following procedure.

1. Make sure the PG200 is connected to one of the serial ports of the computer. Later you will tell WinSpec/32 the name of this port (COM1, COM2, etc.). The software cannot automatically detect the location of the PG200.
2. Following the intensifier precautions listed in the hardware manuals, turn on the PG200 Pulser and wait for it to initialize. If the PG200 isn't turned on, the WinSpec/32 software cannot program it.
3. Select **Setup**, then **Pulsers**, then **PG200**. Then click on the **Setup PG200** button to open the PG200 dialog. *If PG200 is grayed out on the* ***Pulsers*** *dialog box, PG200 pulser support has not been installed.*
4. Click on the **Comm Port** tab.
5. Select the Comm Port type, **Serial** or **Demo**. **Serial** must be selected to control the PG200.

6. Select the PG200 Comm Port. Generally, the mouse is connected to COM1 and the Pulser is connected to COM2. COM ports 1 through 8 can be selected.

7. Once you have selected the correct port, click on **Initialize Port**, which will cause the software to search for the pulser. If it can't find the pulser on the specified port, such as would occur if the pulser were not turned on or if it were connected to a different port, you will get an error message. If this happens, check the cable connections, check that the pulser is powered, or try a different Comm port.

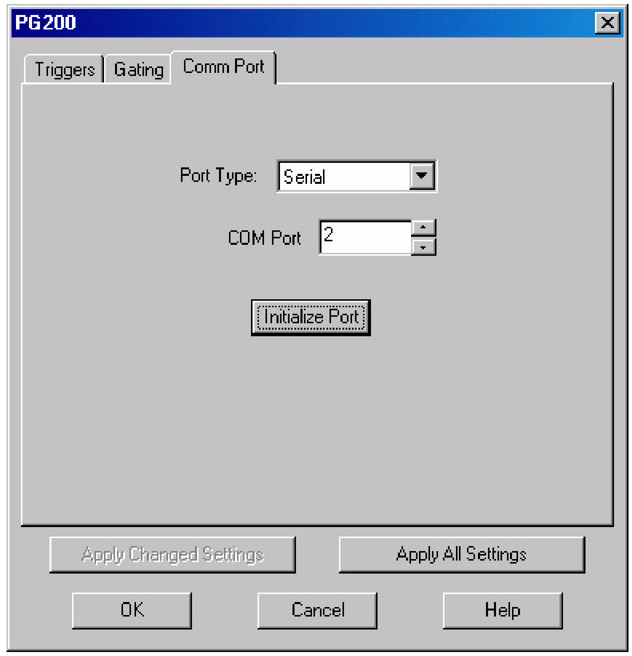

Figure 158. PG200 Comm Port tab page

8. Click on the **Triggers** tab (Figure 159).

9. Select the Trigger mode, either **Internal**, in which the PG200 free runs, or **External**, in which it is triggered from an external source.

10. If operating in the Internal trigger mode, set the **Trigger Frequency** in Hz. Consult the PG200 Manual to determine the maximum Trigger Frequency for a given set of conditions.

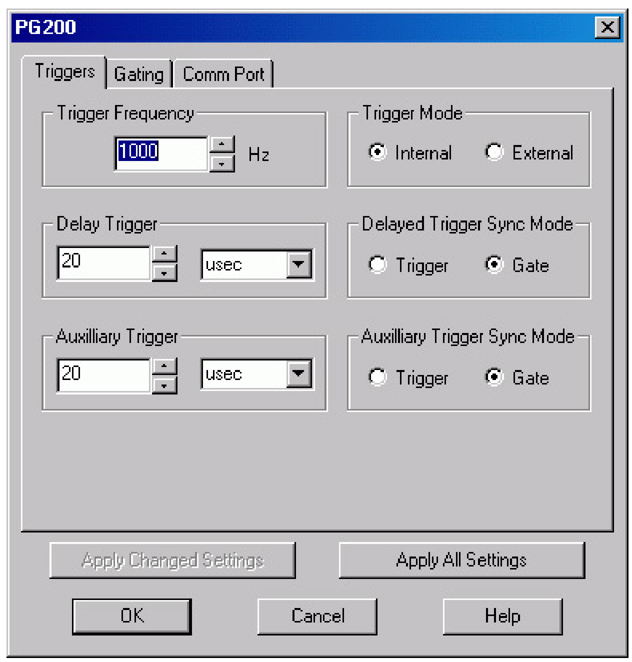

Figure 159. PG200 Triggers tab page

The PG200 **Delay Trigger** and **Auxiliary Trigger** outputs, are programmed from the Triggers tab page. They produce trigger outputs that are synchronized to and delayed from the trigger (**Trigger** Sync mode) or from the trailing edge of the gate pulse (**Gate** Sync mode). In the Gate Sync mode, as the gate pulse changes its position and width, the trigger outputs remain synchronized with the gate, moving with it. In the Trigger Sync mode, the trigger outputs do not sweep with the gate but maintain their initial position. The Delayed Trigger and Auxiliary Trigger outputs are independently programmable.

Programming the Delayed Trigger and Auxiliary Trigger Outputs

1. Set the **Delay Trigger** and **Aux Trigger** initial delay.
2. Set the **Delay Trigger** output to be synchronized to either the **Trigger** or the **Gate** pulse.
3. Set the **Aux Trigger** output to be synchronized to either the **Trigger** or the **Gate** pulse.
4. Click on the **Gating** tab (Figure 160).
5. Select **Repetitive** or **Sequential** and then click on the adjacent **Setup** button. *For safety, the **Gating Mode (HV Pulsing)** selection should be **Disabled**.*

Note: In setting the PG200 gating parameters, whether for Repetitive or Sequential operation, see your PG200 Manual for pulse width and delay limitations. Note that gate pulses are capacitively coupled in many Princeton Instruments intensified detector heads, so high duty cycles and gate widths longer than 1 ms may lead to reduced gating efficiency.

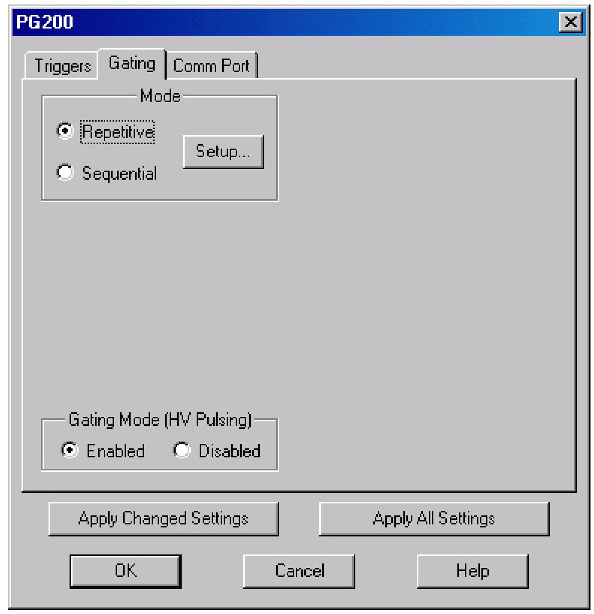

Figure 160. PG200 Gating tab page

Repetitive Mode

If **Repetitive** is selected, the Repetitive Gating setup dialog box will appear as shown in Figure 161. In the Repetitive gating mode, the Gate Width and Gate Delay remain constant over the course of the measurement. Set the Gate Width and Gate Delay to the desired values and click on **OK**. The Repetitive Gating Setup dialog box will close and you will return to the PG200 dialog box.

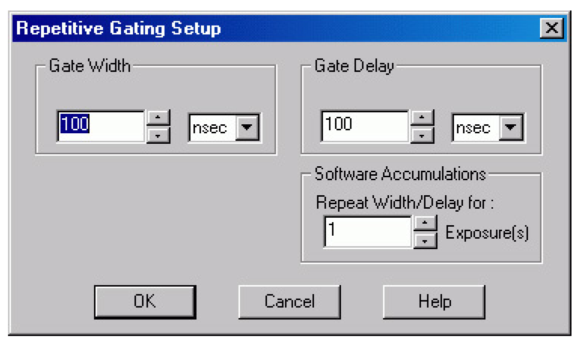

Figure 161. Repetitive Gating Setup dialog box

Sequential Mode

If Sequential is selected, the Sequential Gating Setup dialog box will appear as shown in Figure 162. In the Sequential Gating mode, the Gate Width and Gate Delay do not remain constant but change either linearly (**Fixed**) or exponentially as the measurement progresses. **Fixed** is suited to sweeping over a time interval to locate and recover an event that takes place at the same time with each iteration. **Exponential** is well suited to fluorescence decay experiments where the effect under study changes rapidly at the start of an experiment and then slower and slower, following a logarithmic curve, as the experiment progresses.

If the measurement is to be done in the sequential gating mode, set the pulsing parameters as appropriate for your intended measurement and click on **OK**. The Sequential Gating Setup dialog box will close and you return to the PG200 dialog box.

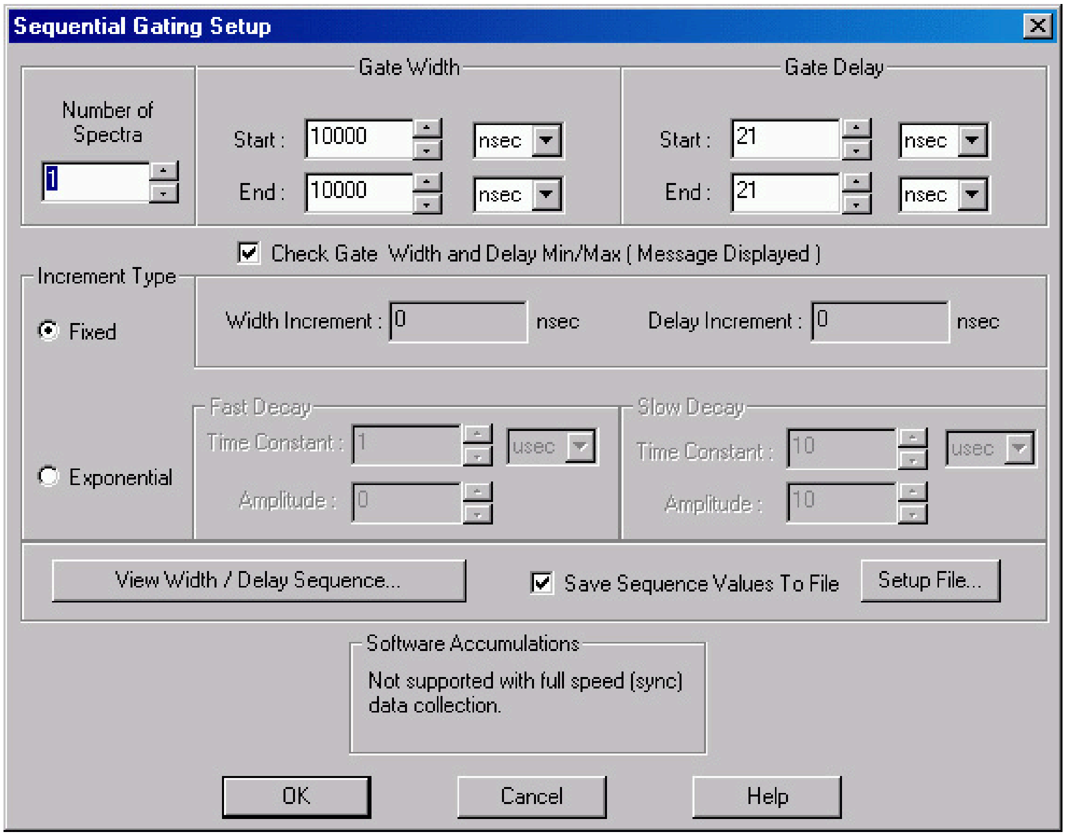

Figure 162. Sequential Gating Setup dialog box

1. Click on the **Gating** tab.
2. Select **Gating Mode (HV Pulsing) Enabled** to start gating the intensifier. Be sure you have followed all intensifier precautions stated in the hardware manuals before making this selection.
3. Click the **Apply Changed Settings** button. This writes all changed parameters to the PG200. It may take several seconds, depending on the number of parameters that have been changed. To set ***all*** of the parameters, click on the **Apply All Settings** button.
4. Click on **OK** to close the dialog box.

Programmable Timing Generator (PTG)

Unlike the PG200 and the DG535, the PTG is not a free-standing instrument but rather a plug-in module designed for installation in a special version of the ST-133 Controller. This novel and highly integrated approach to timing generator design, with its advanced high-speed electronics, low insertion delay and programmable functions, achieves superior performance as the ultimate gate controller for the PI-MAX Intensified Camera.

Basic PTG operation is reviewed in the following procedure. The individual tab page selections are discussed in detail in the online Help topics.

> **Note:** The gate functions of the PI-MAX camera are controlled by the PTG. If the system is equipped with a PI-MAX camera, the Camera State dialog box (Figure 163) will appear when the software is started. Although the software always initially places the PI-MAX in Safe mode, you have the option of restarting with the last setting (Shutter Mode or Gate Mode).

Figure 163. Camera State dialog box

1. Following the intensifier precautions stated in the hardware manuals, turn on the Controller (PTG installed). *If the Controller isn't turned on, the WinSpec/32 software won't be able to control the PTG.*
2. On the **Setup** menu select **Pulsers** to open the Pulsers dialog box.
3. Select **PTG**. Then click on the **Setup Pulser** button. The PTG dialog box (Figure 165) will open. *If PTG is grayed out on the **Pulsers** dialog box, PTG support has not been installed.*

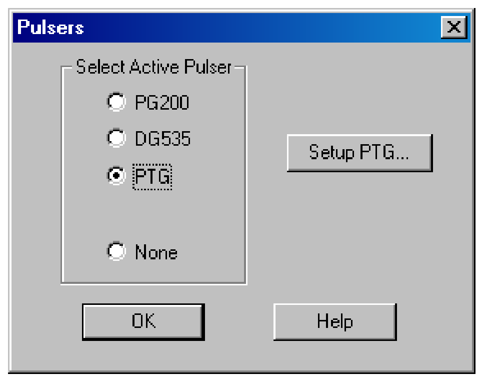

Figure 164. Pulsers dialog box

4. Select the Trigger mode, either **Internal**, in which the PTG free runs, or **External**, in which it is triggered from an external source.
5. If operating in the **Internal** trigger mode, set the trigger **Frequency** in Hz.
6. If operating in the **External** trigger mode, specify the **Threshold**, **Slope**, **Coupling** and **Impedance** appropriate for the trigger source.
7. Click on the **Gating** tab (Figure 166).

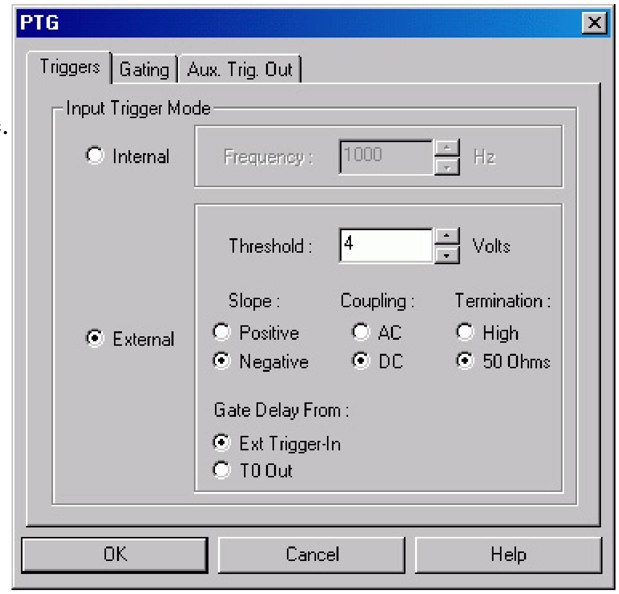

Figure 165. PTG Triggers tab page

8. Select **Bracket Pulsing On** or **Off**.

Note: Bracket pulsing is only useful in low duty factor gated measurements in the UV with the PI-MAX camera. See your PI-MAX system manual for detailed information.

9. If you select Bracket Pulsing **ON**, next select Anticipator **ON** or **OFF**. If **ON** is selected, then set the Anticipator time.

Note: The Anticipator allows Bracket Pulsing with repetitive external trigger sources. The Anticipator measures the trigger period and then turns on the bracketing pulse timed to lead the photocathode gate pulse by the set interval. For proper operation, the bracketing pulse must begin at least 500 ns before the gate pulse.

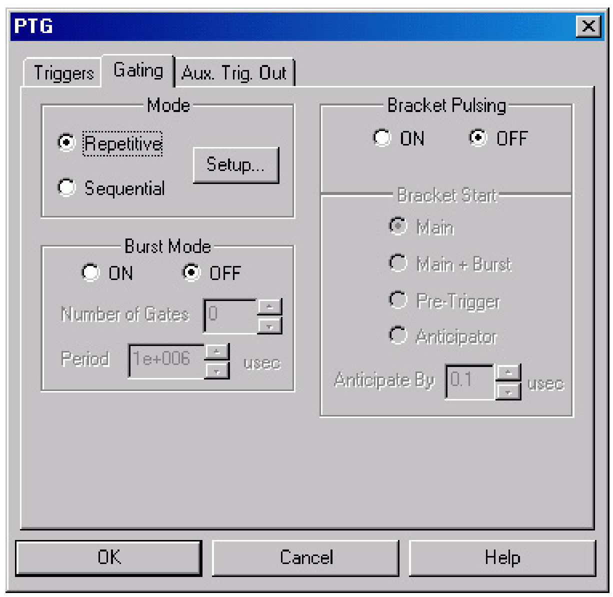

Figure 166. PTG Gating tab page

The minimum Anticipator Time is 500 ns (or the minimum PI-MAX bracket lead time from EEPROM) ***minus*** the minimum Gate Delay time. For example, with a minimum Gate Delay time of 200 ns, the software would automatically set the Anticipator time to 300 ns.

10. For Burst operation, in which each trigger initiates a burst of gate pulses, select Burst Mode ON and set the number of pulses in the burst and their period.

Note: If bracket pulsing and Burst Mode are both selected, the entire burst will be bracketed but not the individual pulses within a burst.

11. Select **Repetitive** or **Sequential** and then click on the adjacent **Setup** button.

Repetitive Mode

If Repetitive is selected, the Repetitive Gating setup dialog box will appear as shown in Figure 167. In the Repetitive gating mode, the Gate Width and Gate Delay remain constant over the course of the measurement. If operating in the Repetitive Gating mode, simply set the Gate Width and Gate Delay to the desired values and click on **OK**. The Repetitive Gating Setup dialog box will close and you will return to the PTG dialog box.

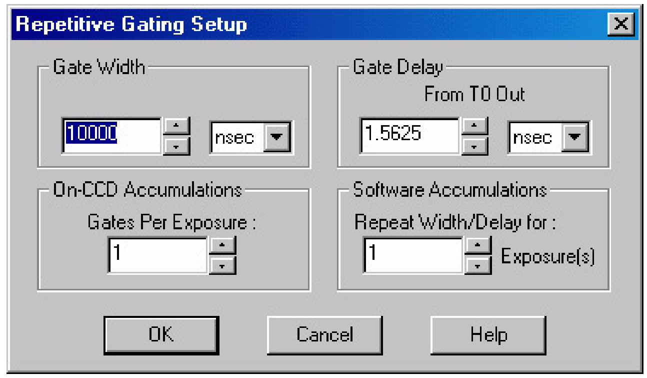

Figure 167. Repetitive Gating Setup

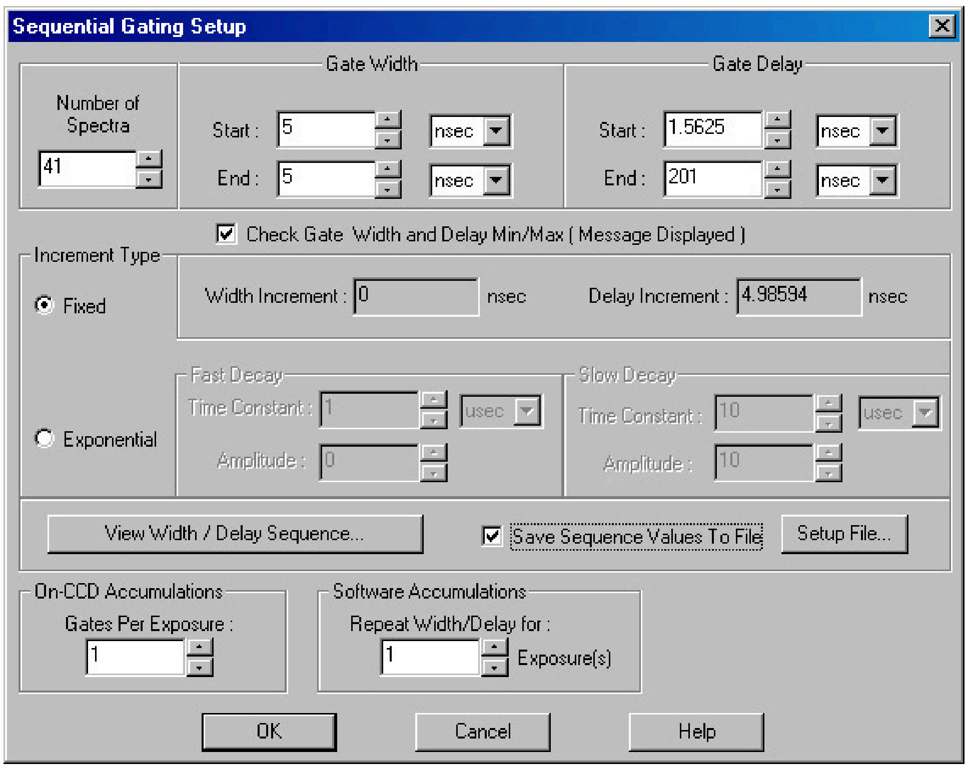

Figure 168. Sequential Gating Setup box

Sequential Mode

If Sequential is selected, the Sequential Gating Setup dialog box will appear as shown in Figure 168. In the Sequential Gating mode, the Gate Width and Gate Delay do not remain constant but change either linearly (**Fixed**) or exponentially as the measurement progresses.

Fixed is suited to sweeping over a time interval to locate and recover an event that takes place at the same time with each iteration. **Exponential** is well suited to fluorescence decay experiments where the effect under study changes rapidly at the start of an experiment and then slower and slower, following a logarithmic curve, as the experiment progresses. *Refer to the online help for a detailed discussion of the Sequential Gating setup parameters.* In any case, if the measurement is to be done in the sequential gating mode, set the gating parameters as appropriate for your intended measurement and click on **OK**. The Sequential Gating Setup dialog box will close and you return to the PTG dialog box.

12. Click the **OK** button. This writes all of the parameter values to the PTG.

Note: The PTG can also be controlled interactively as data is being collected. For more information, see the discussion of this feature starting on page 187.

DG535 Digital Delay/Pulse Generator

The DG535 is programmed via the IEEE-488 GPIB port of the computer (default GPIB address is 15). The choices provided by the tab pages are the same ones that are available using the DG535 front panel. Basic DG535 operation is reviewed in the following procedure. The individual tab page selections are discussed in detail in the online Help topics.

Note: The DG535 is used to control the PI-MAX gate functions. If the system is equipped with a PI-MAX camera, the Camera State dialog box (Figure 169) will appear when the software is started. Although the software always initially places the PI-MAX in Safe mode, you have the option of restarting with the last setting (Shutter Mode or Gate Mode).

Figure 169. Camera State dialog box

1. Make sure the DG535 is connected to the computer's IEEE-488 GPIB port. Later you will tell WinSpec/32 the DG535's GPIB address. *The default setting is 15.*
2. Following all intensifier precautions listed in the hardware manuals, turn on the DG535 and wait for it to initialize. If the DG535 isn't turned on, the WinSpec/32 software won't be able to program it.
3. Select **Setup** and then **Pulsers** to open the Pulsers dialog box.
4. Select **DG535**. Then click on the **Setup DG535** button. The DG535 dialog box will open.

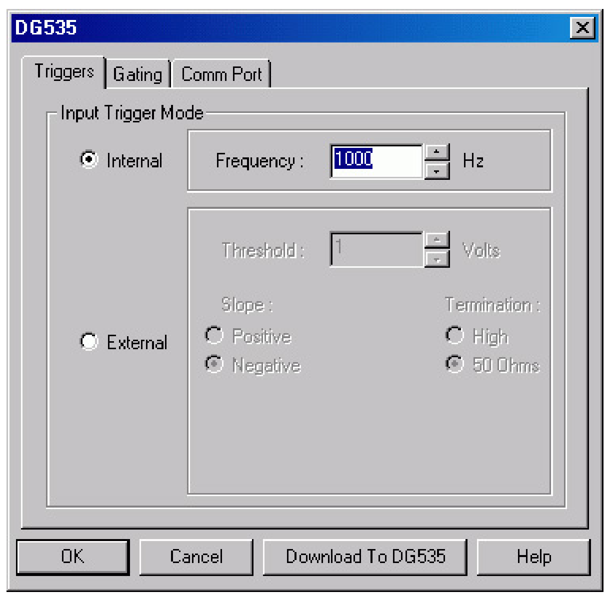

Figure 170. DG535 dialog box

5. Click on the **Comm Port** tab (Figure 171).

6. For the Port Type select GPIB. Then set the **Port Address** to the GPIB address of the DG535. *Default setting is 15.*

7. Once you have selected the correct port address, click on **Initialize Port**. If the software cannot find the pulser on this port, such as if the pulser is not turned on or if the address setting incorrect, you will get an error message. If this happens, check the address, check the cable connections and check that the pulser is powered.

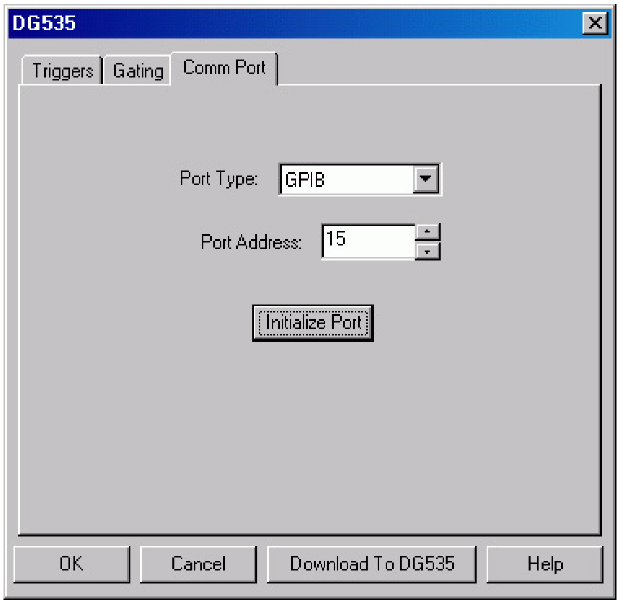

Figure 171. DG535 Comm Port tab page

8. Click on the **Triggers** tab (Figure 172).

9. Select the Trigger mode, either **Internal**, in which the DG535 free runs, or **External**, in which it is triggered from an external source.

10. If operating in the **Internal** trigger mode, set the **Trigger Frequency** in Hz. Consult the DG535 Manual to determine the maximum Trigger Frequency that can be used in your application.

11. If operating in the **External** trigger mode, specify the **Slope**, **Threshold**, and **Termination** appropriate for the trigger source.

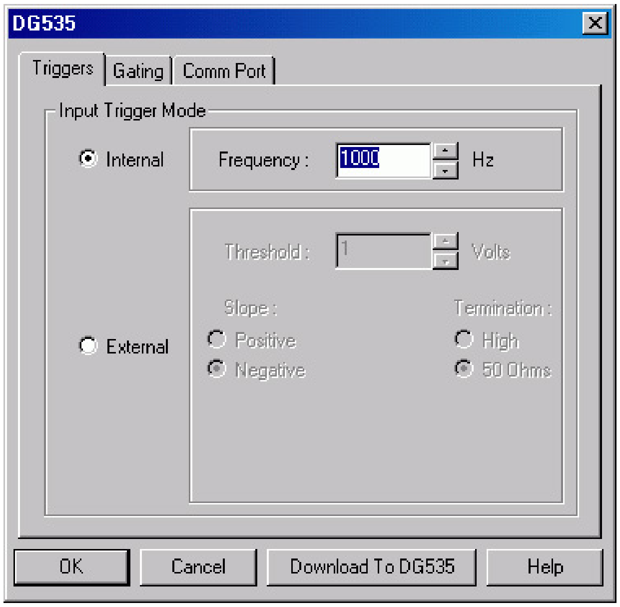

Figure 172. DG535 Triggers tab page

12. Click on the **Gating** tab to bring the Gating tab page to the front.

13. Select **Bracket Pulsing On** or **Off**.

    Note: Bracket pulsing is only useful in low duty factor gated measurements in the UV with the PI-MAX camera. See your PI-MAX manual for detailed information.

14. Select **Repetitive** or **Sequential** and then click on the adjacent **Setup** button.

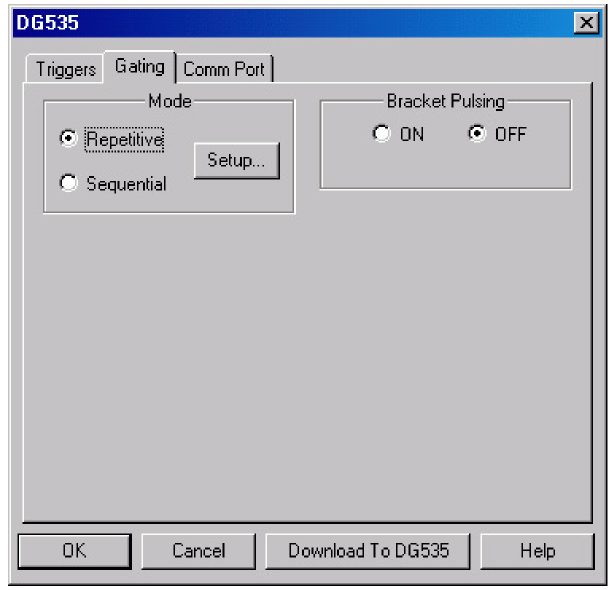

Figure 173. DG535 Gating tab page

Repetitive Mode

If Repetitive is selected, the Repetitive Gating setup dialog box will appear (Figure 174). In this mode, the Gate Width and Gate Delay remain constant over the course of the measurement.

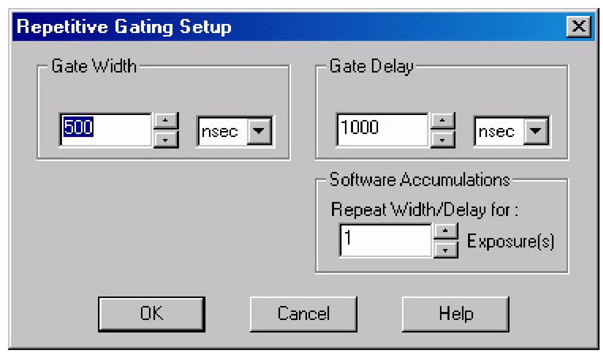

Figure 174. Repetitive Gating Setup

If operating in the Repetitive Gating mode, simply set the Gate Width and Gate Delay to the desired values and click on **OK**. The Repetitive Gating Setup dialog box will close and you will return to the DG535 dialog box.

Sequential Mode

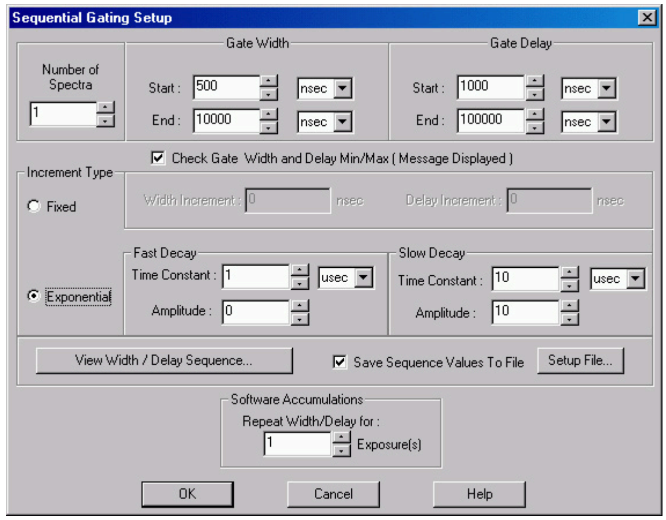

Figure 175. Sequential Gating Setup dialog box

If Sequential is selected, the Sequential Gating Setup dialog box will appear as shown in Figure 175. In the Sequential Gating mode, the Gate Width and Gate Delay do not remain constant but change either linearly or exponentially as the measurement progresses. **Linear** is suited to sweeping over a time interval to locate and recover and event that takes place at the same time with each iteration.

Exponential is well suited to fluorescence decay experiments where the effect under study changes rapidly at the start of an experiment and then slower and slower, following a logarithmic curve, as the experiment progresses. The resulting data points can be spline-fitted to generate the complete curve so that the decay constant can be calculated, even where the data derives from two decay processes occurring simultaneously.

If the measurement is to be done in the sequential gating mode, set the pulsing parameters as appropriate for your intended measurement and click on **OK**. The Sequential Gating Setup dialog box will close and you return to the DG535 dialog box.

Parameters

Number of Spectra: *With an Accumulations setting of one*, Number of Spectra equals the number of exposures, each of which is followed by a readout. After each exposure, the Gate Width and Gate Delay change as programmed before the next exposure occurs. *If multiple Accumulations are programmed*, each exposure is repeated ***n*** times, where ***n*** is the number of accumulations specified. Every accumulation is processed before the gate delay and width change for the next shot. The total number of exposures equals the specified Number of Spectra times the number of Accumulations.

ATTENTION

Accumulations can be set on the DG535 Sequential Gating Setup dialog box and on the Experiment Setup Main tab page. **The two settings must be the same for proper operation.**

Gate Width: The starting and ending gate widths are independently set. The first Shot will have the **Starting** gate width and the last Shot will have the **Ending** gate width. This is true for both the Fixed and Exponential increment type.

Gate Delay: The starting and ending gate delay values are independently set. The first Shot will be taken at the **Starting** delay with respect to T_0 and the last Shot will occur at the **Ending** delay with respect to T_0. This is true for both the Fixed and Exponential increment type.

ATTENTION

> Although the T_0 output of the DG535 marks the start of each DG535 timing cycle, the precise timing of both the gate and signal at the camera will additionally depend on a number of different delay mechanisms that can significantly affect the experiment. These are discussed for the PI-MAX camera in some detail in *Tips and Tricks* chapter of the PI-MAX instruction manual.

Check Gate Width and Delay Min/Max (Message Displayed): If this box is checked and you specify a gate width or delay outside the allowable range, a warning message (Figure 176) will be displayed. Clicking **Yes** will cause the parameter in question to be set to the limit value. Clicking **No** will cause the parameter *setting* to be retained, but the *actual* value will still be the applicable minimum or maximum. If the box isn't checked, the applicable minimum or maximum will be established automatically.

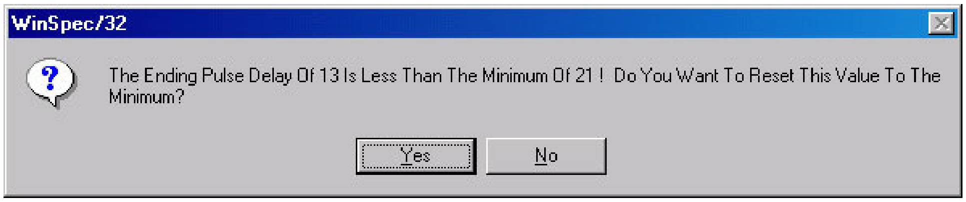

Figure 176. Range Limits Exceeded Warning

Fixed Increment Type: With this selection, the increment or change in Gate Width and Gate Delay is the same from shot to shot. The actual increments depend on the specified starting and ending values and on the Number of Spectra. The increment values are calculated and reported in the associated fields.

Exponential Increment Type: With this selection, the increment or change in Gate Width and Gate Delay changes from shot to shot. The precise delay and width of each shot with respect to T_0 is determined by the values entered for the Fast Decay and Slow Decay **Time Constant** and **Amplitude** parameters. In fluorescent decay experiments, for example, there will typically be two species contributing to the output data, one of which decays much faster than the other. For example, there might be a fast fluorophor with a decay time of at most a few nanoseconds, and a slower one with a decay time of perhaps a hundred nanoseconds. By sweeping both the delay *and* the width, and making provision for entering time constant and amplitude information for two species, the sequential exponential algorithm is ideally suited to making this type of measurement. At the start of the decay where the amplitude is high but the decay is rapid, the gate pulses are narrow and close together. Towards the end of the decay where the decay is slow, the gate pulses are further apart but much wider to accommodate the lower signal amplitude. The result is output data that is relatively constant in intensity over the decay time. This data can be easily normalized by dividing each point by the exposure time and then using a spline fit to recover the curve. The logarithm (base *e*) can then be taken to obtain a straight line (or two lines successive line segments, each with a different slope for two species). Tangents can be fitted to each segment to determine the rate constant for each species.

Fast Decay

Time Constant: In a two species system, enter the ***decay time*** of the faster of the two species. Note that it is not *essential* that you enter a value. If you have the decay time information, you will get better data if the information is entered, but acceptable results can be obtained in many situations by using the default. If there is only one species, or if you want to discard the fast decay process, simply enter zero for the *Amplitude.*

Note that the Gate Width and Gate Delay values need to be selected with some care in fluorescence decay experiments. Typically the starting gate width will be very narrow, perhaps 2 ns, and the final gate width should be wider by about the ratio of the anticipated signal amplitude decrease over the course of the measurement timebase. Similarly, the starting gate delay has to take the various insertion delays into account, and the final delay value might typically be set to a value on the order of five times the anticipated decay time of the process.

Amplitude: This is the *relative* amplitude of the fast decay with respect to the slow one. For example, if you know that the amplitude of the fast decay signal is typically five times the amplitude of the slow decay signal, you could enter “5” for the fast decay amplitude and “1” for the slow decay amplitude. Keep in mind that it is the *ratio* that is being expressed. For example, there is no difference between entering fast and slow amplitude values of “5” and “1” and entering fast and slow amplitude values of “50” and “10.” Note that the default values will give satisfactory results in many measurements.

Slow Decay

Time Constant: In a two species system, enter the ***decay time*** of the slower of the two species. Note that it is not *essential* that you enter a value. If you have the decay time information, you will get better data if the information is entered, but acceptable results can be obtained in many situations by using the default. If there is only one species, or if you want to discard the fast decay process, simply enter zero for the *fast decay Amplitude.*

Amplitude: This is the *relative* amplitude of the slow decay with respect to the fast one. For example, if you know that the amplitude of the slow decay signal is typically one-fifth the amplitude of the fast decay signal, you could enter “1” for the slow decay amplitude and “5” for the fast decay amplitude. Keep in mind that it is the *ratio* that is being expressed. For example, there is no difference between entering slow and fast amplitude values of “1” and “5” and entering fast and slow amplitude values of “10” and “50.”

View Width/Delay Sequence: Opens a dialog box listing the currently programmed sequence of gate width and gate delay values.

Save Sequence Values to File: When this box is checked, the sequence values will be saved ***on completion of the run***. The values saved are those actually used to take the data. The file could be recalled later and used for data normalization or other purposes.

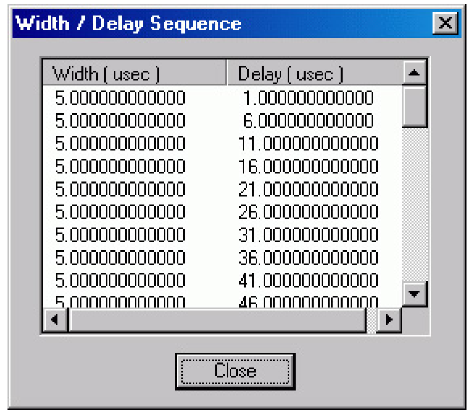

Figure 177. Gate Width/Delay Sequence dialog box

Setup File: Opens the Sequence Values File dialog box (Figure 178), which enables the following:

Ask Before Overwriting: If checked, you will be queried before a new sequence value file overwrites an existing one. If unchecked, overwriting can occur without warning.

Notify When File Has Been Saved: The file is saved at the end of the data-acquisition run. You will be notified that this has occurred if this box is checked.

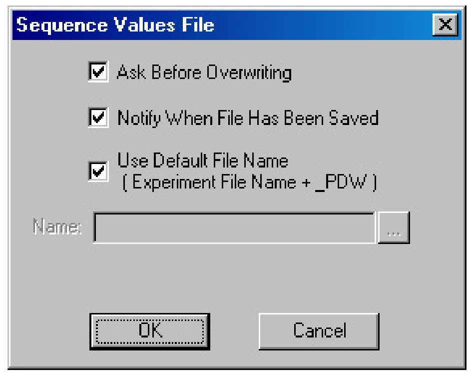

Figure 178. Sequence Values File dialog box

Use Default File Name: If checked, sequence value file name will be experiment file name, but with the extension **PDW**. If unchecked, you must enter the name in the **Name** field.

Name: If not using the default name for the sequence value file, enter the file name in the provided field. The button at the end of the box opens a browser to facilitate assigning the file location.

Software Accumulations: Sets the number of exposures to be taken for each Shot. Note that the number of Accumulations set here must be the same as the value set on the Experiment Setup Main tab page for proper operation.

15. After you have finished setting up the parameters, click on **Download to DG535**. This writes all of the parameter values to the DG535.

16. Click on **OK** to close the window.

Note: The DG535 can also be controlled interactively as data is being collected.

Timing Generator Interactive Trigger Setup

The  button on the **Custom Toolbar**, allows you to select the PTG or DG535 trigger mode (**Internal** or **External**) while acquiring data.

Internal: The Timing Generator will create its own trigger signals at the selected frequency.

External: The Timing Generator will be triggered by trigger signals that originate in an external piece of equipment.

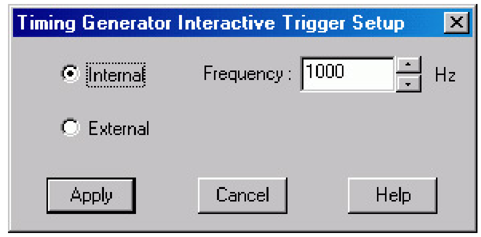

Figure 179. Timing Generator Interactive Trigger Setup

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Chapter 19
Custom Toolbar Settings

Introduction

The Custom Toolbar feature of WinSpec/32 allows you one-button access to many features or combinations of features available through the software. The Custom Toolbar layout and the number of buttons displayed on the Custom Toolbar can easily be changed.

Displaying the Custom Toolbar

1. To make the Custom Toolbar visible, select **Toolbars** and then **Custom** on the View menu. The Custom Toolbar will appear on the desktop and its default configuration will be as shown in Figure 180.
2. You can change position of the Custom Toolbar, its layout, and the number of buttons it contains.

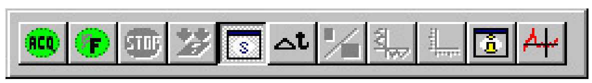

Figure 180. Default Custom Toolbar

Customizing the Toolbar

Although the **Custom Toolbar** defaults with the buttons shown in Figure 180, many additional buttons are in fact available and can be added to the button using the Customize Toolbar dialog box (Figure 181). Buttons can be added or removed at any time and the new configuration will be saved when the dialog box is closed.

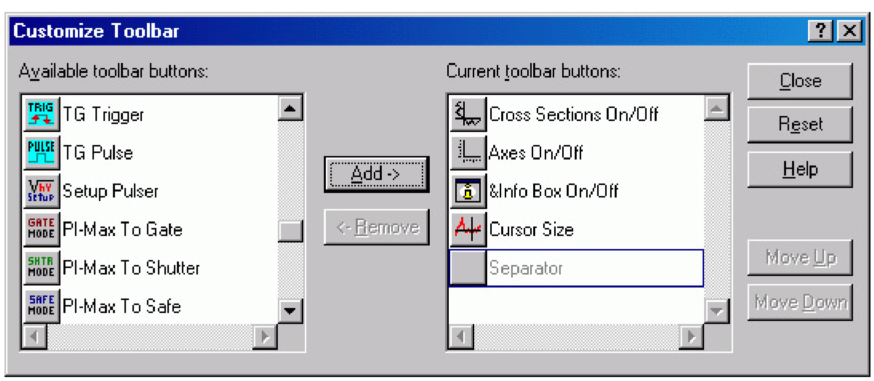

Figure 181. Customize Toolbar dialog box

Adding an Available Button

1. Open the **Customize Toolbar** dialog by clicking on **Custom Toolbar** in the Setup menu.
2. Referring to Figure 181, note that the buttons available for placement on the **Custom Toolbar** are listed on the left. Buttons already on the toolbar are on the right.
3. To add an available button to the **Custom Toolbar**, first select it from the left-hand list. You may have to scroll through the list of available buttons to find the one you want. You can choose where to place the button by selecting a button on the *right* side (which will then be highlighted). The new button will be placed *before* the highlighted one.
4. Click on the **Add** button. The button will disappear from the list of Available buttons and will be added to the list of Toolbar buttons.
5. Click on **Close** to close the dialog box.

Removing a Button

1. Open the Customize Toolbar dialog by clicking on Customize Toolbar in the Setup menu.
2. Referring to Figure 181, note that buttons already on the toolbar are listed on the right. Available but unused buttons are listed on the left.
3. To remove an available button from the **Custom Toolbar**, first select it from the right-hand list. You may have to scroll through the listed buttons to find the one you want.
4. Click on the **Remove** button. The button will disappear from the list of Toolbar buttons and will be added to the list of Available buttons.
5. Click on **Close** to close the dialog box.

Individual Dialog Item Descriptions

Available Buttons: You can select the button you wish to add to the Custom Toolbar from this section. Many buttons, each with its own preassigned function as described below, are available.

Toolbar Buttons: These are the buttons that will actually appear on the Custom Toolbar.

Add: Causes the selected button on the Available buttons list to be transferred to the Toolbar buttons list before the selected button.

Remove: Causes the selected button on the Toolbar list to be transferred to the Available Buttons list.

Close: This button closes the Custom Toolbar Assignment dialog box and implements changes made to the Custom Toolbar.

Reset: Restores the default Custom Toolbar configuration.

Help: Opens the context-sensitive help for the Custom Toolbar.

Move Up: Together with Move Down, Move Up determines the position of a given button on the Custom Toolbar. Each time this button is clicked, the selected button on the Toolbar buttons list moves up one position.

Move Down: Together with Move Up, Move Down determines the position of a given button on the Custom Toolbar. Each time this button is clicked, the selected button on the Toolbar buttons list moves down one position.

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Chapter 20

Software Options

Introduction

The WinSpec/32 options described in this chapter can also be purchased from Roper Scientific. Contact Roper Scientific Customer Support for order information.

Custom Chip (WXCstChp.opt)

Introduction

If this option has been installed, selecting **User Defined Chip** checkbox on the Controller/Camera tab page adds the Custom Chip tab page to the dialog box. The Custom Chip parameters are shown in Figure 182. The default values conform to the physical layout of the CCD array and are optimum for most measurements.

Caution

Roper Scientific does not encourage users to change these parameter settings. For most applications, the default settings will give the best results. We ***strongly advise*** contacting the factory for guidance before customizing the chip definition.

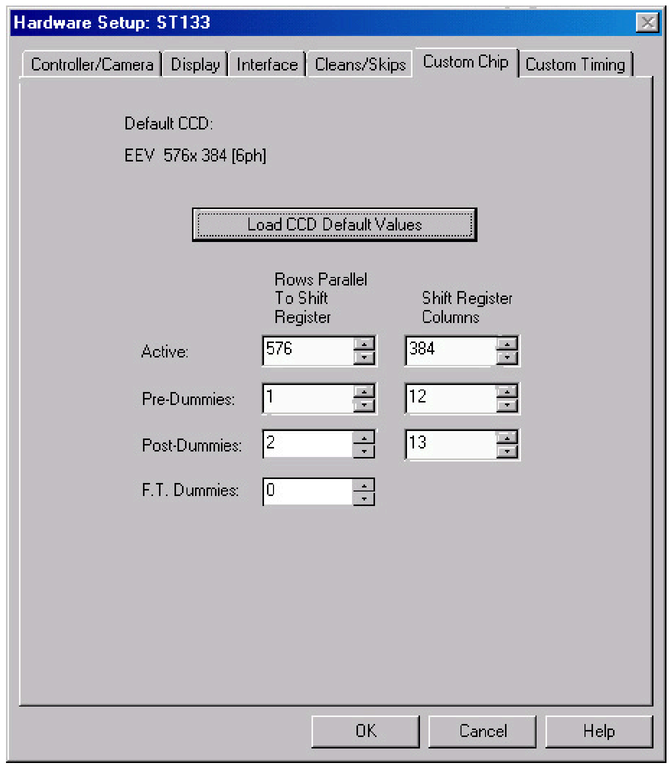

Figure 182. Custom Chip tab page

Normally, not all of the pixels in a CCD array are exposed and read out: a frame of "dummy" pixels bounds the active area. These dummy pixels are usually masked and are not normally read out. However, they could be read out by changing the chip definition in software. For example, in the case of the EEV 576 × 384 chip illustrated in Figure 182, the 576 active rows are preceded by one dummy row and followed by 2 dummy rows. In addition, there are 12 dummy columns on one side of the active region and 13 dummy columns on the other side. By changing the chip definition to increase the active area while decreasing the dummy settings, the dummy cells would be read out. By doing so, one could measure the dark charge with every readout. (Note that F.T. Dummies are chip-specific and are dummy rows at the boundary of the masked and visible areas of a frame transfer device.)

It is also possible to increase image acquisition speed by reducing the size of the active area in the definition. The result will be faster but lower resolution data acquisition. Operating in this mode would ordinarily require that the chip be masked so that only the reduced active area is exposed. This will prevent unwanted charge from spilling into the active area or being transferred to the shift register.

Custom Timing (WXCstTim.opt)

Introduction

If this option has been installed, selecting **User Defined Timing** checkbox on the Controller/ Camera (or Controller/Detector) tab page adds the Custom Timing tab page to the dialog box. The Custom Timing selections are shown in Figure 183. The default timing parameter values have been determined to give the fastest possible performance without compromising data acquisition performance.

Caution

Roper Scientific does not encourage users to change these parameter settings. For most applications, the default settings will give the best results. We ***strongly advise*** contacting the factory for guidance before customizing the chip timing parameters.

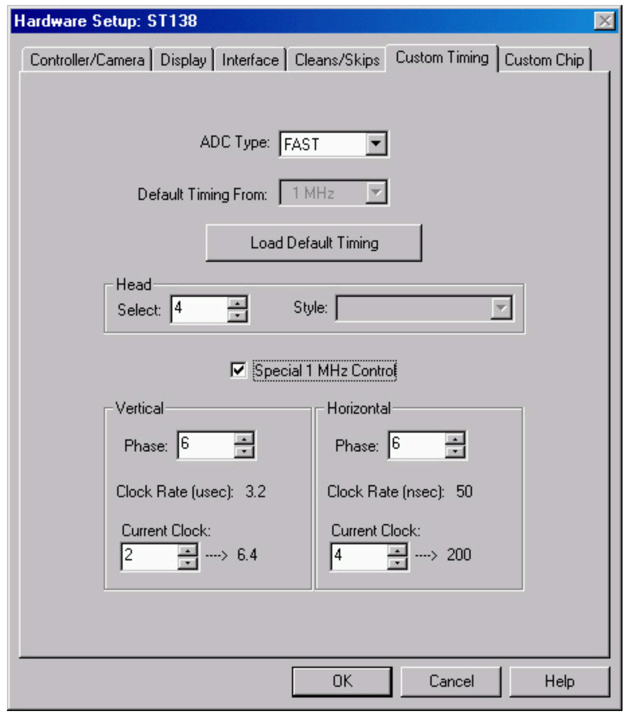

Figure 183. Custom Timing tab page

FITS (FITS.exe)

FITS (Flexible Image Transport System) is the data format most widely used within astronomy for transporting, analyzing, and archiving scientific data files. FITS is primarily designed to store scientific data sets consisting of multidimensional arrays (images) and 2-dimensional tables organized into rows and columns of information. The FITS option allows you to acquire and save WinSpec/32 data in the FITS format. This option also provides a file conversion function that allows you to convert existing WinSpec/32 .SPE data files into the FITS format. F1 help is included with the option.

Acquiring data in the FITS format starts with setting up the experiment parameters in WinSpec/32. With WinSpec still open, you then open the FITS.exe program (by opening it at its directory location or by opening it from the Execute Macro dialog box if the Macro option has been installed). When you click on **Run Experiment** on the FITS dialog box, the experiment will begin. At completion of the experiment, the data will be displayed in WinSpec and a FITS file will automatically be generated and saved.

Note: When this option is installed, the FITS.exe file is placed in the same directory as the Winspec.exe file.

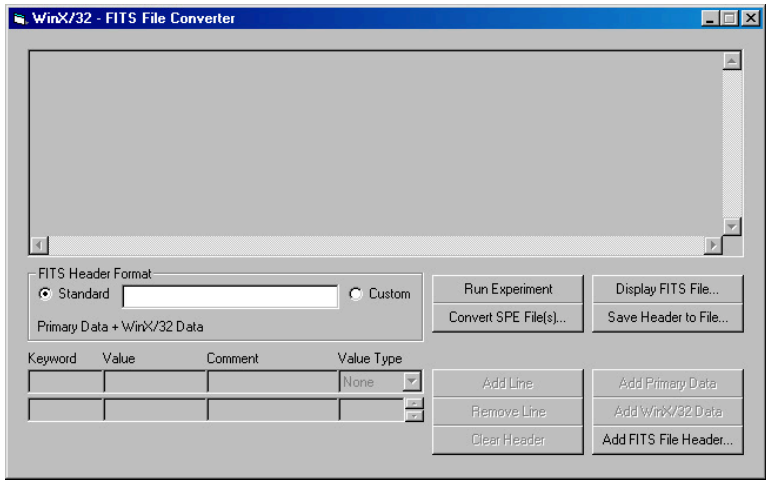

Figure 184. FITS dialog box

Macro Record (WXmacrec.opt)

Macro Record is a convenient method to automate routines and repetitive data acquisition and analysis tasks. A macro is created automatically whenever a sequence of operations is performed in WinSpec. The recorded macro generates a VBScript file that can be edited to provide maximum flexibility. For more information, refer to the WinSpec/32 online help and the PDF of the WinX32 Programming for Macro Record manual, provided as part of the option package. Typically, the manual is stored in the WinSpec32/Documentation directory when you install the option.

Note: As part of the Macro option installation, the Macro menu is added to the WinSpec/32 menu bar.

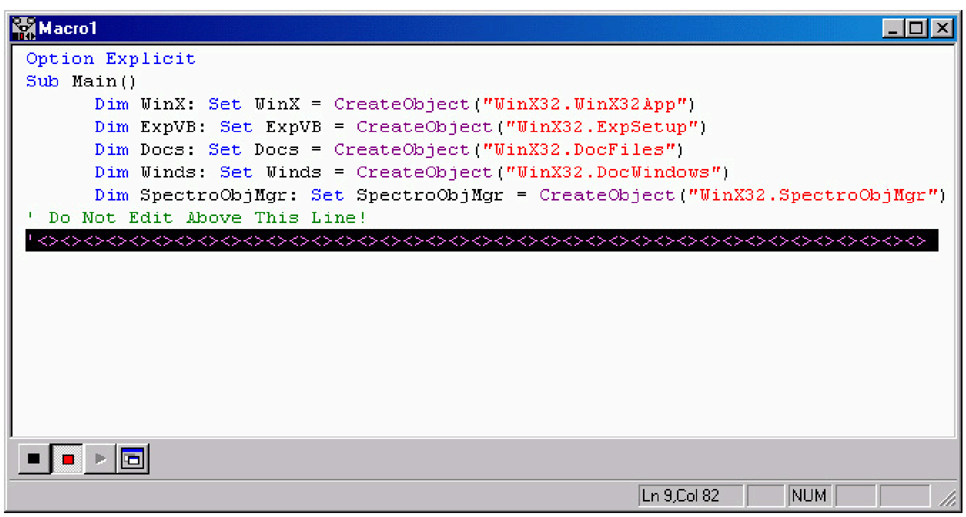

Figure 185. Macro Record dialog box

Spex Spectrograph Control (WSSpex.opt)

This option adds spectrograph support for the Spex 270M, ISA TRIAX 180, ISA TRIAX 190, ISA TRIAX 320, and the Spex Spex232 Retrofit (older Spex that have been retrofitted for RS-232 communication).

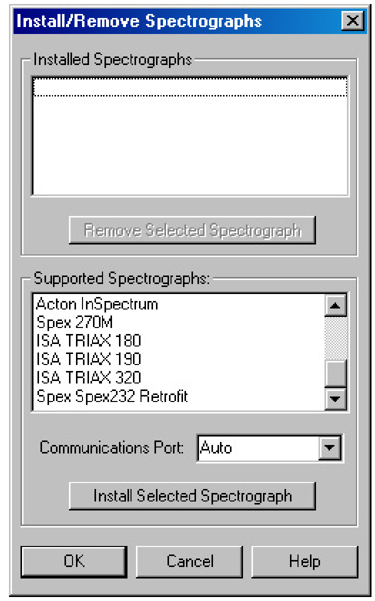

Figure 186. Install/Remove Spectrographs dialog box

Virtual Chip (WXvchip.opt)

Introduction

This option is used to set the parameters for Virtual Chip operation, a special fast-acquisition technique that allows frame rates in excess of 100 fps to be obtained. For the Virtual Chip selection be available on the WinSpec/32 Setup menu, it is necessary that:

- the system is a PentaMAX, a MicroMAX (1 MHz or 5 MHz) or an ST-133,
- the camera has a frame transfer chip such as the EEV 512 × 512 FT,
- the Frame Transfer readout mode is selected, and
- the file WXvchip.opt is present in the same directory as the executable WinSpec/32 program.

The virtual chip method of data acquisition requires that the chip be masked as shown in Figure 187. Masking can be achieved by applying a mechanical or optical mask or by positioning a bright image at the ROI against a dark background on the remainder of the array. In operation, images are continually piped down the CCD at extraordinarily high frames per second (FPS).

The mini-frame transfer region is defined by an ROI as illustrated in Figure 187. The charge from this ROI is shifted under the frame-transfer mask, followed by a readout cycle of an ROI-sized region under the mask. Since the ROI is far from the serial register, the stored image is just shifted repeatedly with the readout and the first few images collected will not contain useful data. After the readout period, the next frame is shifted under the mask and another ROI sized frame is read out. The net result is a series of images, separated by spacer regions, streaming up the CCD under the mask.

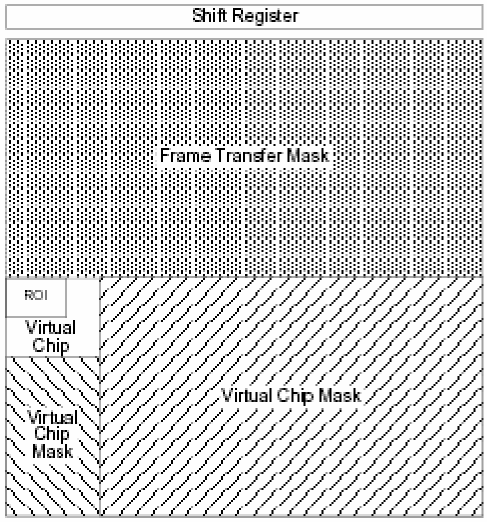

Figure 187. Virtual Chip Functional diagram

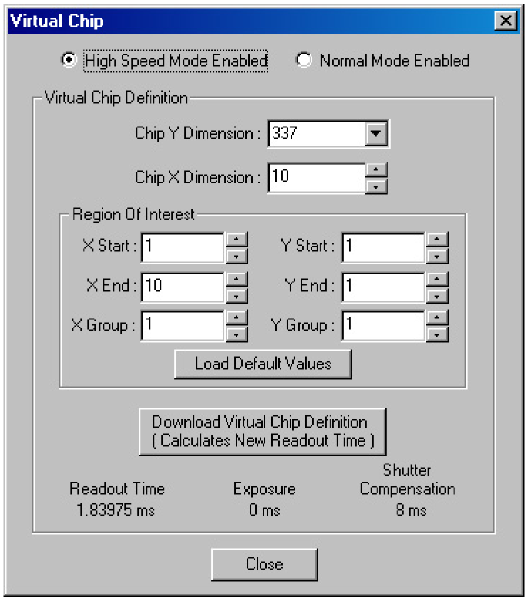

Figure 188. Virtual Chip dialog box

Virtual Chip Setup

The following procedure covers the basic hardware and software setup for Virtual Chip operation.

Equipment:

Suitable Princeton Instruments detector with 512x512FT or other frame transfer CCD array
Suitable ST-133A
PCI Interface Card and High Speed Serial (TAXI) cable
Suitable Host Computer

Software:

WinSpec/32, version 2.4 or higher
WXvchip.opt installed in the same directory as the executable WinSpec/32 program

Assumptions:

- You are familiar with the WinSpec/32 software and have read the hardware manuals.
- Masking is for a 47x47 pixel Virtual Chip with its origin at 1,1.

Procedure:

1. Verify that the power is **OFF** for **ALL** system components (including the host computer).
2. Verify that the correct line voltages have been selected and that the correct fuses have been installed in the ST-133A.
3. Connect the TAXI cable to the interface card at the host computer and to the **Serial Com** connector at the rear of the Controller. Tighten down the locking screws.
4. Connect the **Camera-Controller** cable to the **Detector** connector on the rear of the Controller and to the **Detector** connector at the rear of the camera. Tighten down the locking screws.

5. If it has not been installed already, connect a line cord from the Power Input module on the back of the Controller to a suitable AC power source.
6. Turn on the Controller.
7. Turn on the host computer and select the WinSpec/32 icon.
8. From the **Setup** menu, select **Hardware**, and enter the following settings:

   Controller/CCD tab card

   Controller: PentaMax, MicroMAX, ST-133

   Controller Version: 5

   CCD Type: appropriate frame transfer array (EEV 512x512FT, for this procedure)

   Shutter Type: None

   LOGIC OUT Output: Shutter

   Readout Mode: Frame Transfer

   Interface tab card

   Type: the appropriate interface card. For this procedure, the selection is
   High Speed PCI.

   Cleans/Skips tab card

   Number of Cleans: 1

   Number of Strips per Clean: 512

   Minimum Block Size: 2

   Number of Blocks: 5

9. From the **Acquisition** menu, select **Experiment Setup** and enter the following settings:

   Main tab card

   Exposure Time: Enter a value. The exposure time can either be greater than the readout time or it can be equal to the readout time. If you want an exposure time > readout time, enter a value larger than the readout time calculated when the virtual chip definition was downloaded. If you want an exposure time = readout time, enter 000 sec.

   Number of Images: Enter the desired number of images.

   Use Region of Interest

   Accumulations: 1

   ADC tab card

   Type: FAST

   ROI Setup tab card: Make no changes to the settings on this tab card unless you have re-enabled Normal Operating Mode. ROI setup for Virtual Chip (High Speed Mode) is performed through the Virtual Chip dialog box.

10. From the **Setup** menu, select **Virtual Chip**, and enter the following settings:

    High Speed Mode Enabled

    Virtual Chip Definition: The settings below assume a 47x47 pixel virtual chip. The X and Y dimensions are established by the external mask. The virtual chip is fully flexible in the X direction. However, the set of choices for the Y-dimension has been pre- selected for optimal performance. Note that the origin point that Roper Scientific uses for a CCD array is 1,1.

Chip Y Dimension: 47. Select this dimension from the drop down list.
Chip X Dimension: 47. Enter this dimension manually.

11. Click on the **Load Default Values** button. This enters the default ROI values. These values are: Start pixels of 1,1; End pixels based on the Chip Y and Chip X dimensions; and Groups of 1.
    - **Region of Interest:** The settings below assume a 47x47 pixel ROI (i.e., the entire virtual chip). An ROI that is a subset of the virtual chip can be defined.
      X Start: 1 **Y Start:** 1
      X End: 47 **Y End:** 47
      X Group: 1 **Y Group:** 1
    - Click on the **Download Virtual Chip Definition** button. This will download the definition, set up the ROI, and calculate the readout time.
    - Observe the calculated readout time. If you need a shorter period, change the settings (for example, enter a smaller Y-dimension or use binning in the Y-direction) and click on the **Download Virtual Chip Definition** button again.
    - Click on **Close**.

12. From the **Setup** menu, select **Environment**.

    Note: When setting up for focusing, the number of **Frames/Interrupt** should be left at 1.

    - **DMA Buffer (Mb):** By default, the buffer size is 8 Mb. Using the following formula, calculate the amount of DMA memory required:
      X × Y × #Frames × (2 bytes/pixel).
      For example, the buffer size required for a **47**x**47** virtual array acquiring 1000 frames would be **47 × 47 × 1000 frames × (2 bytes/pixel) = 4.4 Mb**. If the calculated value is greater than 8 Mb, enter the appropriate size.

      Note: This value is not enabled until you restart your computer.

    - **Frames/Interrupt:** If the number of frames is greater than 256 (the preprogrammed slot limit for a PCI card), increase the number of **Frames/Interrupt** value. Use the formula **#Frames/256** and round the result to the next highest integer to calculate that value. For example, 1000 frames/256 will result in 3.9, so enter 4.

      Note: This value should be 1 for **Focus** mode.

13. Click on **OK** after you have finished entering the Environment settings.
14. Place a suitable target in front of the camera and click on **Focus** to verify that the camera is seeing the target.
15. Make any focusing, gain, or other adjustments necessary to fine-tune the image.
16. Stop running in **Focus** mode.
17. Now click on **Acquire**.

Experimental Timing

Triggering can be achieved through the software via the **Software Trigger** timing mode (selectable on the **Experiment Setup** dialog box, **Timing Mode** tab page) or it can be achieved via the **Ext Sync** input on the rear of the camera. Triggering from the **Ext Sync** input allows you to acquire a single image per TTL pulse. If **Software Trigger** has been selected, back-to-back collection of the requested number of images will be initiated when **Acquire** is selected: no further TTL trigger input is required.

Tips

- If mechanical masking is used, the mask can be a static one (fixed dimensions) in which case, multiple masks should be made to accommodate a variety of imaging conditions. Alternatively, a more flexible mask can be manufactured by taking two thin metal sheets with a square hole the size of the exposed region of the CCD cut in the center. This would be 512 × 512 pixels at 15 microns per pixel = 7.68 mm × mm for the MicroMAX. These masks should be anodized black to prevent reflections in the optical system and they should be very flat. These two sheets can then be slid relative to one another to achieve any rectangular shape required. The sheets should be placed flat in the optical plane and their openings should be centered on the optical axis. Ideally they should be able to move with an accuracy of 2-3 pixels per step (30-45 microns) in the X and Y directions.

  Consult the factory for off-the-shelf optical masking accessories

- Running the camera in Free Run mode with 0.0 msec exposure time will result in the fastest acquisition time. Under these conditions, the acquisition time is limited by the readout time of the ROI (exposure time ▯ readout time).
- When you return the system to "Normal" chip mode (radio button on **Virtual Chip** dialog box), you should also open the **Experiment Setup** dialog box at the ROI Setup tab card and click on the **ClearAll** button to clear the ROI setup downloaded for Virtual Chip operation.
- If frame acquisition appears to be slow in Focus mode, check the **Frames/Interrupt** value on the **Environment** dialog box and reset the value to 1 if it is greater than 1.
- When processing large stacks of data, you may want to use a third-party scientific image processing package.
- Due to CCD design, you may see some edge artifacts when acquiring data from the entire virtual chip. Crop these artifacts by defining an ROI that is slightly smaller than the virtual chip dimensions.

Part 3
Reference

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Appendix A
System and Camera Nomenclature

System, Controller Type, and Camera Type Cross-Reference

Use the cross-reference table below if you need to determine the controller type and/or camera/CCD type used by your system. This table is based on the Princeton Instruments brand systems that are currently being sold by Roper Scientific, Inc. Many of these systems incorporate non-volatile RAM (NVRAM) that has been factory programmed with the default hardware setup parameters for the controller, camera, and CCD array included in your system. If you know the controller type used by your system, you should be able to download these default parameters. However, if this functionality is not available for your system, you will need to manually enter the information.

System	Controller Type	Camera/CCD Type
I-PentaMAX (Gen II or Gen III)	PentaMAX*	EEV 512x512FT
MicroMAX: 512EBFT	ST-133	EEV 512x512FT CCD57
MicroMAX: 782Y	ST-133	PID 582x782
MicroMAX: 782YHS	MicroMAX-5 MHz	PID 582x782
MicroMAX: 1024B	ST-133	EEV 1024x1024 CCD 47_10
MicroMAX: 1300B	ST-133	EEV 1300x1340B
MicroMAX: 1300Y	ST-133	PID1030x1300
MicroMAX: 1300YHS	MicroMAX-5 MHz	PID1030x1300
MicroMAX: 1300YHS-DIF	MicroMAX-5 MHz	PID1030x1300
OMA V:InGaAs 256	ST-133	InGaAs 1x256
OMA V:InGaAs 512	ST-133	InGaAs 1x512
OMA V:InGaAs 1024	ST-133	InGaAs 1x1024
PDA	ST-121**	Diode Array 1024
PI-LCX: 400	ST-133	EEV 400x1340F

* Does not support NVRAM function.

System	Controller Type	Camera/CCD Type
PI-LCX: 576	ST-133	EEV 576x384 (3 ph)
PI-LCX: 1242	ST-133	EEV 1152x1242 (3 ph)
PI-LCX: 1300	ST-133	EEV 1300x1340F
PI-MAX: 512HQ	ST-133	THM 512x512
PI-MAX: 512RB	ST-133	THM 512x512
PI-MAX: 512SB	ST-133	THM 512x512
PI-MAX: 512UV	ST-133	THM 512x512
PI-MAX: 1024HQ	ST-133	EEV 256x1024F CCD30
PI-MAX: 1024RB	ST-133	EEV 256x1024F CCD30
PI-MAX: 1024SB	ST-133	EEV 256x1024F CCD30
PI-MAX: 1024UV	ST-133	EEV 256x1024F CCD30
PI-MAX MG: 1024	ST-133	EEV 256x1024F CCD30
PI-MTE: 1300B	ST-133	EEV 1300x1340B
PI-SCX: 1242	ST-133	EEV 1152x1242(6 ph)
PI-SCX: 1300	ST-133	EEV 1300x1340F
PI-SCX: 4300	ST-133	KAF 2084x2084 SCX
PI-SX: 400	ST-133	EEV 400x1340B
PI-SX: 512	ST-133	TEK 512x512DB
PI-SX: 1024	ST-133	TEK 1024x1024DB
PI-SX: 1300	ST-133	EEV 1300x1340B
Spec-10: 100	ST-133	EEV 100x1340F
Spec-10: 100B	ST-133	EEV 100x1340B
Spec-10: 100BR	ST-133	EEV 100x1340B
Spec-10: 100R	ST-133	EEV 100x1340F
Spec-10: 120	ST-133	HAM 124x1024
Spec-10: 120B	ST-133	HAM 122x1024B
Spec-10: 256	ST-133	EEV 256x1024F CCD30

System	Controller Type	Camera/CCD Type
Spec-10: 256B	ST-133	EEV 256x1024B CCD30
Spec-10: 256E	ST-133	EEV 256x1024OE CCD30
Spec-10: 400	ST-133	EEV 400x1340F
Spec-10: 400B	ST-133	EEV 400x1340B
Spec-10: 400BR	ST-133	EEV 400x1340B
Spec-10: 400R	ST-133	EEV 400x1340F
SpectruMM:120	ST-133	HAM 124x1024
SpectruMM:120B	ST-133	HAM 122x1024B
SpectruMM:250	ST-133	HAM 252x1024
SpectruMM:250B	ST-133	HAM 250x1024B
VersArray: 512B	ST-133	TEK 512x512DB
VersArray: 512F	ST-133	TEK 512x512DF
VersArray: 1024B	ST-133	TEK 1024x1024DB
VersArray: 1024F	ST-133	TEK 1024x1024DF
VersArray: 1300B	ST-133	EEV 1300x1340B
VersArray: 1300F	ST-133	EEV 1300x1340F
VersArray^{XP}: 512B	ST-133	MAR 512x512 CCD77
VersArray^{XP}: 512F	ST-133	MAR 512x512 CCD77
VersArray^{XP}: 1KB	ST-133	EEV 1024x1024 CCD47_10
VersArray^{XP}: 1K	ST-133	EEV 1024x1024 CCD47_10

System and System Component Descriptions

The following information briefly describes Princeton Instruments brand systems and the system components. For more information, contact your Roper Scientific representative or Customer Support.

Systems:

MicroMAX: Name used for some ST-133 based imaging systems, usually with an RTE head.

MicroMAX 5 MHz: 5 MHz controller, characterized by duplex head cable.

OMA V: Cryogenically cooled Photodiode array (PDA) based system for spectroscopy applications.

PDA: Low-cost spectroscopy system uses ST-121 controller.

PentaMAX: A/D electronics are in the head so no controller is necessary. Runs with PCI card only. Both unintensified and intensified versions are available.

PI-LCX: High-performance photon counting system. Medium X-ray, direct detection

PI-MAX: ICCD design with internal high voltage power and gating. Controller is ST-133, and gating timing is provided by a DG535, PTG or other TTL timing source.

PI-MTE: Compact high-sensitivity digital imaging system designed to deliver scientific performance inside high-vacuum chambers over long operation times.
PI-SCX: X-ray diffraction, fiberoptically-coupled detector.

PI-SX: High-sensitivity, deep-vacuum interface for soft X-ray acquisition.

SPEC-10: High performance, spectroscopy system. Wide variety of CCD arrays. Thermoelectric or cryogenic cooling available.

SpectroMAX: Name used for some ST-133 based spectroscopy systems, usually with an RTE head.

VersArray: High-performance, general purpose imaging system. Wide variety of CCD arrays in imaging formats. Thermoelectric or cryogenic cooling available.

VersArray^{XP}: High-performance low-light imaging system for astronomy, MCP readout, pressure-sensitive paint (PSP) / wind tunnel testing, semiconductor failure analysis, and streak tube readout applications. Deep thermoelectric cooling (air).

Controllers:

ST-121: Diode array controllers shipped with diode array detectors, controlled by a PCI card.

ST-130: Obsolete controller but still supported in the WinSpec/32 software.

ST-133: Controller that can run the vast majority of Princeton Instruments brand cameras, including MicroMAX, PI-MAX, Spec-10, PI-LCX, PI-MTE, PI-SCX, PI-SX, OMA V, and VersArray. Different hardware types are needed to run different detectors (for example, liquid nitrogen-cooled vs. thermoelectrically-cooled).

ST-138: Older controller for TE, LN, ICCD, and ITE units. It offers a few special features such as hardware accumulator. In general, this controller is being phased out.

Cameras/Detectors:

HCTE/CCD: See **NTE/CCD and NTE 2**.

ICCD: Standard, “classic” intensified camera, requires purging, has internal high voltage power but requires external high voltage pulses for gating. Controlled by ST-133 or ST-138.

LN/CCD: Liquid nitrogen cooled detector, 1.5 liter Dewar is standard, can be run with ST-138 or ST-133.

LN/InGaAs: Indium gallium arsenide detector controlled by a ST-133 controller

MTE 2: Miniature liquid cooled camera, designed for in vacuum chamber operation, can be run with ST-133 controller. Included in a PI-MTE system.

NTE/CCD and **NTE 2:** Stands for new TE head. More cube shaped than the TE, designed for maximum cooling. NTE 2 requires high-power version of ST-133.

RTE/CCD: Round thermoelectrically cooled camera, can be run with ST-133 controllers.

TE/CCD: Water- cooled camera, can be run with ST-138 or some ST-133 controllers.

TEA/CCD: Forced air-cooled camera, can be run with ST-138 or some ST-133 controllers.

V/ICCD: Video intensified detector. Always shipped with its own control box, produces standard video out so no interface card or software required. As of Version 2.5, this detector will not be supported by WinSpec.

XTE: TE/air-cooled detector with cooling down to -100°C, can be run with ST-133 controllers.

Pulsers:

FG-100: Pulser with 5 nsec - 3 μsec gating, Gen II intensifiers only.

FG-101: Obsolete version of an ICCD unit, with internal high voltage power and gating.

PG-10: Pulser with 200 nsec to 6 msec gating, Gen II intensifiers only.

PG200: Software programmable pulser with 5 nsec to 80 msec gating. Highest performance pulser with the most features, Gen II intensifiers only

PTG: Dedicated "programmable delay generator" board that generates TTL level pulses to control intensifier gating in PI-MAX models. It is an option that sits in the third slot of an ST-133 controller.

High-Voltage Power Supplies:

IIC-100: High voltage power supply for intensified cameras without internal high voltage supplies (intensified PentaMAX, ITE, or lens-coupled intensified systems) for CW operation only. Not necessary for ICCD or PI-MAX cameras. For gated operation of intensified PentaMAX or ITE cameras buy the board version of the IIC-100, called the MCP-100, built into the pulser. During manufacture, a Model IIC-100 is configured for operation with a Gen II intensifier or with a Gen III intensifier, ***but not for operation with both types***.

IIC-200: Compact high voltage power supply for intensified cameras without internal high voltage supplies (intensified PentaMAX, ITE, or lens-coupled intensified systems) for gated and CW/Shutter operation. During manufacture, a Model IIC-200 is configured for operation with a Gen II intensifier or with a Gen III intensifier, ***but not for operation with both types***.

IIC-300: Combined image intensifier power supply and moderate performance gating pulse generator. Gated and CW/Shutter operation. PIV version available. During manufacture, a Model IIC-300 is configured for operation with a Gen II intensifier or with a Gen III intensifier, ***but not for operation with both types***.

Miscellaneous Components:

OFA: An adapter for connecting a fiber optic input to a spectrometer. Two versions are available for the best possible f/# matching, see the price list for details.

CC-100: Closed coolant circulator (not a chiller) designed for TE, TEA, or ICCD cameras

UV Lens: f/1.2 catadioptric lens only for ICCD or PI-MAX cameras

CCD Array Designators

The designators in the following list are often used on camera serial labels to identify the CCD array in the camera.

B: Back-illuminated CCD

DDA: Dual diode array CCD

F: Front illuminated CCD, in many cases no letter is used

E: CCD made by EEV

T: CCD made by Thomson

K: CCD made by Kodak

H: CCD made by Hamamatsu

HS: “High speed” MicroMAX system runs at 5 MHz

FT: Frame transfer detector

M: MPP (multi-pin phasing) CCD

P: (Usually) CCD offered exclusively by Roper Scientific

PDA: Photodiode array

R: Deep depletion

S: Usually refers to SITe arrays, also see TK

TK: CCD made by SITe (formerly Tektronix), sometimes labeled S

UV: UV-to-VIS standard lumogen coating for UV-response to 195 nm

UVAR: Permanent UV-to-NIR A/R coating on some SITe CCDs (not lumogen/metachrome)

VISAR: Permanent VIS to NIR A/R coating on some SITe CCDs (not lumogen/metachrome)

Y: Interline CCD made by Sony

/1: grade 1 CCD

/2: grade 2 CCD

/3: grade 3 CCD

64: array format is 1024 x 64 pixels

100: array format is 1340 x 100 pixels

128: array format is 1024 x 128 pixels

256: 256 element linear array

400: array format is 1340 x 400 pixels

512: array format is 512 x 512 pixels; or 512 elements for linear arrays

576: array format is 576 x 384 pixels

768: array format is 768 x 512 pixels

782: array format is 782 x 582 pixels

1000: array format is 1000 x 800 pixels

1024: array format is 1024 x 256 (EEV or Hamamatsu) or 1024 x 1024 (SITe)

1100: array format is 1100 x 330 pixels

1242: array format is 1152 x 1242 pixels

1280: array format is 1280 x 1024 pixels

1300: array format is 1300 x 1030 pixels (Sony) or 1300 x 1340 pixels (EEV)

1317: array format is 1317 x 1035 pixels

1340: array format is 1340 x 100, 400, or 1300; family is exclusive to Roper Scientific

1536: array format is 1536 x 1032 pixels

2032: array format is 2025 x 2032 pixels

2500: array format is 2500 x 600, rectangular pixels

3072: array format is 3072 x 2048 pixels

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Appendix B
Calibration Lines

MERCURY	184.91 194.17	226.22 237.83 248.20 253.65** 265.20 280.35 289.36 296.73	302.15 312.57* 313.17 334.15 365.02* 365.44 366.33	404.66* 407.78 434.75 435.84*	507.30* (2x253.65) 546.07* 576.96 579.07	625.14 (2x312.57) 626.34 (2x313.17)	730.04 (2x365.02) 760.95 (3x253.65)	
ARGON			394.90	404.44 415.86* 416.42 418.19 419.10 420.07* 425.94 427.22 430.01 433.36		696.54*	706.72 727.29 738.40 750.39 751.46 763.51** 772.38* 794.82	800.62 801.48 810.37 811.53* 826.45 840.82 842.46
NEON			336.99 341.79 344.77 346.66 347.26 352.05* 359.35		533.08 534.11 540.06 585.25** 588.19 594.48 597.55	603.00 607.43 609.62* 614.31* 616.36 621.73 626.65 630.48 633.44 638.30* 640.23* 650.65* 653.29 659.90 667.83* 671.70 692.95	702.41 703.24* 705.91 717.39 724.52 743.89 748.89 753.58 754.41	837.76 849.54 863.46 865.44 878.20 878.38 885.39
	100	200	300	400	500	600	700	800

Table 4. Wavelength Calibration Lines (in nanometers)
** indicates strong line within a wavelength group*
***indicates strongest line for the element*
() indicates 2nd or 3rd order

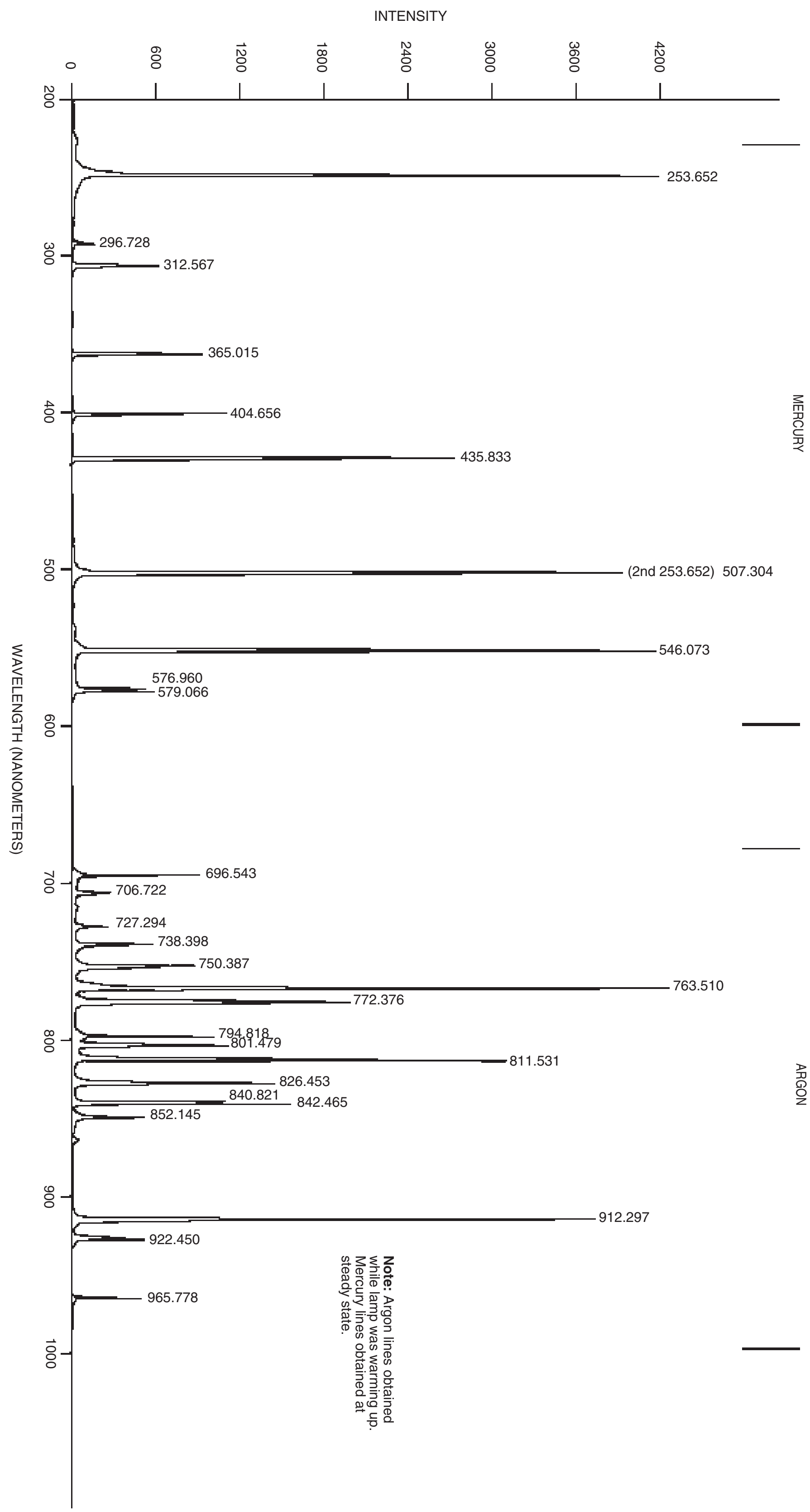

Figure 189. Wavelength Calibration Spectrum

Appendix C
Data Structure

Version 1.43 Header

All WinView or WinSpec files (version 1.43) must begin with the following 4100 byte header:

```
                        typedef WINXHEAD {
0           int dioden;          /* CCD X dimension.                       */
2           int avgexp;          /* Not used by WinView                    */
4           int exposure;        /* exposure if -1 see lexpos              */
6           int datarange;       /* Not used by WinView                    */
8           int mode;            /* Not used by WinView                    */
10          float wexsy;         /* Not used by WinView                    */
14          int asyavg;          /* Not used by WinView                    */
16          int asyseq;          /* Not used by WinView                    */
18          int linefreq;        /* Not used by WinView                    */
20          int date0;           /* Not used by WinView                    */
22          int date1;           /* Not used by WinView                    */
24          int date2;           /* Not used by WinView                    */
26          int date3;           /* Not used by WinView                    */
28          int date4;           /* Not used by WinView                    */
30          int ehour;           /* Not used by WinView                    */
32          int eminute;         /* Not used by WinView                    */
34          int noscan;          /* # of stripes collected if -1 see       */
                                 /* lnoscan.                               */
36          int fastacc;         /* Not used by WinView                    */
38          int avgtime;         /* Not used by WinView                    */
40          int dmatotal;        /* Not used by WinView                    */
42          int faccount;        /* X dimension : Actual dim of image.     */
44          int stdiode;         /* Not used by WinView                    */
46          float nanox;         /* Not used by WinView                    */
50          float calibdio[10];  /* Not used by WinView                    */
90          char fastfile[16];   /* fast access file. Not used by WinView  */
106         int asynen;          /* Not used by WinView                    */
108         int datatype;        /* 0 -> float (4 byte)                    */
                                 /* 1 -> long integer (4 byte)             */
                                 /* 2 -> integer (2 byte)                  */
                                 /* 3 -> unsigned integer (2 byte)         */
                                 /* 4 -> String/char (1 byte)              */
                                 /* 5 -> double (8 bytes) Not implemented  */
                                 /* 6 -> byte (1 byte)                     */
                                 /* 7 -> unsigned byte (1 byte)            */
110         float calibnan[10];  /* Not used by WinView                    */
150         int rtanum;          /* Not used by WinView                    */
152         int astdiode;        /* Not used by WinView                    */
154         int int78;           /* Not used by WinView                    */
156         int int79;           /* Not used by WinView                    */
158         double calibpol[4];  /* Not used by WinView                    */
190         int int96;           /* Not used by WinView                    */
192         int int97;           /* Not used by WinView                    */
194         int int98;           /* Not used by WinView                    */
196         int int99;           /* Not used by WinView                    */
198         int int100;          /* Not used by WinView                    */
200         char exprem[5][80];  /* comments                               */
600         int int301;          /* Not used by WinView                    */
602         char label[16];      /* Not used by WinView                    */
618         int gsize;           /* Not used by WinView                    */
620         int lfloat;          /* Not used by WinView                    */
```

```
622           char califile[16];   /* calibration file. Not used by WinView  */
638           char bkgdfile[16];   /* background file. Not used by WinView   */
654           int srccmp;          /* Not used by WinView                    */
656           int stripe;          /* number of stripes per frame            */
658           int scramble;        /* 0 - scramble, 1 - unscramble           */
660           long lexpos;         /* exposure val 32-bits(when exposure=-1) */
664           long lnoscan;        /* no. of scan 32-bits(when noscan = -1)  */
668           long lavgexp;        /* no. of accum 32-bits(when avgexp = -1) */
672           char stripfil[16];   /* strip file. Not used by WinView        */
688           char version[16];    /* SW version & date "01.000 02/01/90"    */
704           int controller_type; /* 1-new st120, 2-old st120,              */
                                   /* 3-st130 type 1, 4-st130 type 2,        */
                                   /* 5-st138, 6-DC131, and ST133.           */

                    /*  YT_FILE_HEADER  */
                    /* The YT variables are not used by WinView.             */
706           int    yt_file_defined;      /* set TRUE for YT data file      */
708           int    yt_fh_calib_mode;     /* calibration type               */
710           int    yt_fh_calib_type;     /* time-unit (calibration type)   */
712           int    yt_fh_element[12];    /* element number                 */
736           double yt_fh_calib_data[12]; /* data                           */
832           float  yt_fh_time_factor;    /* time-factor                    */
836           float  yt_fh_start_time;     /* start time                     */
840       int    reverse_flag;             /* set to 1 if data should be     */
                                           /* reversed, 0 don't reverse      */
                };
```

Version 1.6 Header

All WinView/WinSpec files (version 1.6) and WinView/32 and WinSpec/32 data files must begin with the following 4100 byte header. Data files created under previous versions of WinView/WinSpec *can still be read correctly*. However, files created under the new versions (1.6 and higher) ***cannot*** be read by previous versions of WinView/WinSpec.

Header Structure Listing

```
                                          Decimal Byte
                                             Offset
                                          -----------
unsigned int  dioden;           /*    0  num of physical pixels (X axis)    */
int           avgexp;           /*    2  number of accumulations per scan   */
                                /*         if > 32767, set to -1 and        */
                                /*         see lavgexp below (668)          */
int           exposure;         /*    4  exposure time (in milliseconds)    */
                                /*         if > 32767, set to -1 and        */
                                /*         see lexpos below (660)           */
unsigned int  xDimDet;          /*    6  Detector x dimension of chip       */
int           mode;             /*    8  timing mode                        */
float         exp_sec;          /*   10  alternative exposure, in secs.     */
int           asyavg;           /*   14  number of asynchron averages       */
int           asyseq;           /*   16  number of asynchron sequential     */
unsigned int  yDimDet;          /*   18  y dimension of CCD or detector.    */
char          date[10];         /*   20  date as MM/DD/YY                   */
int           ehour;            /*   30  Experiment Time: Hours (as binary) */
int           eminute;          /*   32  Experiment Time: Minutes(as binary)*/
int           noscan;           /*   34  number of multiple scans           */
                                /*       if noscan == -1 use lnoscan        */
int           fastacc;          /*   36                                     */
int           seconds;          /*   38  Experiment Time: Seconds(as binary)*/
int           DetType;          /*   40  CCD/DiodeArray type                */
unsigned int  xdim;             /*   42  actual # of pixels on x axis       */
int           stdiode;          /*   44  trigger diode                      */
float         nanox;            /*   46                                     */
float         calibdio[10];     /*   50  calibration diodes                 */
```

```
char          fastfile[16];       /*   90  name of pixel control file        */
int           asynen;             /*  106  asynchron enable flag  0 = off    */
int           datatype;           /*  108  experiment data type              */
                                  /*         0 =   FLOATING POINT            */
                                  /*         1 =   LONG INTEGER              */
                                  /*         2 =   INTEGER                   */
                                  /*         3 =   UNSIGNED INTEGER          */
float         calibnan[10];       /*  110  calibration nanometer             */
int           BackGrndApplied;    /*  150  set to 1 if background sub done   */
int           astdiode;           /*  152                                    */
unsigned int  minblk;             /*  154  min. # of strips per skips        */
unsigned int  numminblk;          /*  156  # of min-blocks before geo skps   */
double        calibpol[4];        /*  158  calibration coefficients          */
unsigned int  ADCrate;            /*  190  ADC rate                          */
unsigned int  ADCtype;            /*  192  ADC type                          */
unsigned int  ADCresolution;      /*  194  ADC resolution                    */
unsigned int  ADCbitAdjust;       /*  196  ADC bit adjust                    */
unsigned int  gain;               /*  198  gain                              */
char          exprem[5][80];      /*  200  experiment remarks                */
unsigned int  geometric;          /*  600  geometric operations rotate 0x01  */
                                  /*        reverse 0x02, flip 0x04          */
char          xlabel[16];         /*  602  Intensity display string          */
unsigned int  cleans;             /*  618  cleans                            */
unsigned int  NumSkpPerCln;       /*  620 number of skips per clean.         */
char          califile[16];       /*  622  calibration file name (CSMA)      */
char          bkgdfile[16];       /*  638  background file name              */
int           srccmp;             /*  654  number of source comp. diodes     */
unsigned int  ydim;               /*  656  y dimension of raw data.          */
int           scramble;           /*  658  0 = scrambled, 1 = unscrambled    */
long          lexpos;             /*  660  long exposure in milliseconds     */
                                  /*         used if exposure set to -1      */
long          lnoscan;            /*  664  long num of scans                 */
                                  /*         used if noscan set to -1        */
long          lavgexp;            /*  668  long num of accumulations         */
                                  /*         used if avgexp set to -1        */
char          stripfil[16];       /*  672  stripe file (st130)               */
char          version[16];        /*  688  version & date:"01.000 02/01/90"  */
int           type;               /*  704   1 = new120 (Type II)             */
                                  /*        2 = old120 (Type I )             */
                                  /*        3 = ST130                        */
                                  /*        4 = ST121                        */
                                  /*        5 = ST138                        */
                                  /*        6 = DC131 (PentaMAX)             */
                                  /*        7 = ST133 (MicroMAX/SpectroMax), */
                                  /*        8 = ST135 (GPIB)                 */
                                  /*        9 = VICCD                        */
                                  /*       10 = ST116 (GPIB)                 */
                                  /*       11 = OMA3 (GPIB)                  */
                                  /*       12 = OMA4                         */
int           flatFieldApplied;   /*  706  Set to 1 if flat field was applied */
int           spare[8];           /*  708  reserved                          */
int           kin_trig_mode       /*  724  Kinetics Trigger Mode             */
char          empty[702];         /*  726  EMPTY BLOCK FOR EXPANSION         */
float         clkspd_us;          /* 1428 Vert Clock Speed in micro-sec      */
int           HWaccumFlag;        /* 1432 set to 1 if accum done by Hardware */
int           StoreSync;          /* 1434 set to 1 if store sync used.       */
int           BlemishApplied;     /* 1436 set to 1 if blemish removal applied */
int           CosmicApplied;      /* 1438 set to 1 if cosmic ray removal done */
int           CosmicType;         /* 1440 if cosmic ray applied, this is type */
float         CosmicThreshold;    /* 1442 Threshold of cosmic ray removal.   */
long          NumFrames;          /* 1446 number of frames in file.          */
float         MaxIntensity;       /* 1450 max intensity of data (future)     */
float         MinIntensity;       /* 1454 min intensity of data (future)     */
char          ylabel[LABELMAX];   /* 1458 y axis label.                      */
unsigned int  ShutterType;        /* 1474 shutter type.                      */
float         shutterComp;        /* 1476 shutter compensation time.         */
unsigned int  readoutMode;        /* 1480 Readout mode, full, kinetics, etc. */
```

```
unsigned int  WindowSize;        /* 1482 window size for kinetics only.      */
unsigned int  clkspd;            /* 1484 clock speed for kinetics &          */
                                 /*      frame transfer.                     */
unsigned int  interface_type;    /* 1486 computer interface (isa-taxi,       */
                                 /*      pci, eisa, etc.)                    */
unsigned long ioAdd1;            /* 1488 I/O address of interface card.      */
unsigned long ioAdd2;            /* 1492 if more than one address for card.  */
unsigned long ioAdd3;            /* 1496                                     */
unsigned int  intLevel;          /* 1500 interrupt level interface card      */
unsigned int  GPIBadd;           /* 1502  GPIB address (if used)             */
unsigned int  ControlAdd;        /* 1504  GPIB controller address (if used)  */
unsigned int  controllerNum;     /* 1506  if multiple controller system will */
                                 /*       have controller # data came from.  */
                                 /*       (Future Item)                      */
unsigned int  SWmade;            /* 1508  Software which created this file   */
int           NumROI;            /* 1510  number of ROIs used. if 0 assume 1 */
                                 /* 1512 - 1630  ROI information             */
struct ROIinfo {                 /*                                          */
 unsigned int startx;            /* left x start value.                      */
 unsigned int endx;              /* right x value.                           */
 unsigned int groupx;            /* amount x is binned/grouped in hw.        */
 unsigned int starty;            /* top y start value.                       */
 unsigned int endy;              /* bottom y value.                          */
 unsigned int groupy;            /* amount y is binned/grouped in hw.        */
} ROIinfoblk[10];                /*    ROI Starting Offsets:                 */
                                 /*            ROI  1 = 1512                 */
                                 /*            ROI  2 = 1524                 */
                                 /*            ROI  3 = 1536                 */
                                 /*            ROI  4 = 1548                 */
                                 /*            ROI  5 = 1560                 */
                                 /*            ROI  6 = 1572                 */
                                 /*            ROI  7 = 1584                 */
                                 /*            ROI  8 = 1596                 */
                                 /*            ROI  9 = 1608                 */
                                 /*            ROI 10 = 1620                 */
char          FlatField[120];    /* 1632 Flat field file name.               */
char          background[120];   /* 1752 Background sub. file name.          */
char          blemish[120];      /* 1872 Blemish file name.                  */
float         software_ver;      /* 1992 Software version.                   */
char          UserInfo[1000];    /* 1996-2995 user data.                     */
long          WinView_id;        /* 2996 Set to 0x01234567L if file was      */
                                 /*      created by WinX                     */

-------------------------------------------------------------------------------
```

Calibration Structures

There are three structures for the calibrations

- The Area Inside the Calibration Structure (below) is repeated two times.

```
xcalibration,        /* 3000 - 3488 x axis calibration          */
ycalibration,        /* 3489 - 3977 y axis calibration          */
```

Start of X Calibration Structure

```
double        offset;            /* 3000  offset for absolute data scaling   */
double        factor;            /* 3008  factor for absolute data scaling   */
char          current_unit;      /* 3016  selected scaling unit              */
char          reserved1;         /* 3017  reserved                           */
char          string[40];        /* 3018  special string for scaling         */
char          reserved2[40];     /* 3058  reserved                           */
char          calib_valid;       /* 3098  flag if calibration is valid       */
char          input_unit;        /* 3099  current input units for            */
                                 /*       "calib_value"                      */
char          polynom_unit;      /* 3100  linear UNIT and used               */
                                 /*       in the "polynom_coeff"             */
```

```
char          polynom_order;     /* 3101  ORDER of calibration POLYNOM       */
char          calib_count;       /* 3102  valid calibration data pairs       */
double        pixel_position[10];/* 3103  pixel pos. of calibration data     */
double        calib_value[10];   /* 3183  calibration VALUE at above pos     */
double        polynom_coeff[6];  /* 3263  polynom COEFFICIENTS               */
double        laser_position;    /* 3311  laser wavenumber for relativ WN    */
char          reserved3;         /* 3319  reserved                           */
unsigned char new_calib_flag;    /* 3320  If set to 200, valid label below   */
char          calib_label[81];   /* 3321  Calibration label (NULL term'd)    */
char          expansion[87];     /* 3402  Calibration Expansion area         */

-------------------------------------------------------------------------------
```

Start of Y Calibration Structure

```
double        offset;            /* 3489  offset for absolute data scaling   */
double        factor;            /* 3497  factor for absolute data scaling   */
char          current_unit;      /* 3505  selected scaling unit              */
char          reserved1;         /* 3506  reserved                           */
char          string[40];        /* 3507  special string for scaling         */
char          reserved2[40];     /* 3547  reserved                           */
char          calib_valid;       /* 3587  flag if calibration is valid       */
char          input_unit;        /* 3588  current input units for            */
                                 /*       "calib_value"                      */
char          polynom_unit;      /* 3589  linear UNIT and used               */
                                 /*       in the "polynom_coeff"             */
char          polynom_order;     /* 3590  ORDER of calibration POLYNOM       */
char          calib_count;       /* 3591  valid calibration data pairs       */
double        pixel_position[10];/* 3592  pixel pos. of calibration data     */
double        calib_value[10];   /* 3672  calibration VALUE at above pos     */
double        polynom_coeff[6];  /* 3752  polynom COEFFICIENTS               */
double        laser_position;    /* 3800  laser wavenumber for relativ WN    */
char          reserved3;         /* 3808  reserved                           */
unsigned char new_calib_flag;    /* 3809  If set to 200, valid label below   */
char          calib_label[81];   /* 3810  Calibration label (NULL term'd)    */
char          expansion[87];     /* 3891  Calibration Expansion area         */

-------------------------------------------------------------------------------
```

End of Calibration Structures

```
char          Istring[40];       /* 3978  special Intensity scaling string   */
char          empty3[80];        /* 4018  empty block to reach 4100 bytes    */
int           lastvalue;         /* 4098 Always the LAST value in the header */
```

Version 2.5 Header (9/18/02)

The current data file used for WINX files consists of a 4100 (1004 Hex) byte header followed by the data. Beginning with Version 2.5, many more items were added to the header to make it a complete as possible record of the data collection. This includes spectrograph and pulser information. Many of these additions were accomplished by recycling old information that had not been used in previous versions. All data files created under previous 2.x versions of WinView/WinSpec CAN still be read correctly. HOWEVER, files created under the new versions (2.5 and higher) CANNOT be read by previous versions of WinView/WinSpec OR by the CSMA software package.

Header Structure Listing

```
                                 Decimal
                                 Byte
                                 Offset
SHORT    ControllerVersion         0     Hardware Version
SHORT    LogicOutput               2     Definition of Output BNC
```

```
WORD    AmpHiCapLowNoise           4     Amp Switching Mode
WORD    xDimDet                    6     Detector x dimension of chip.
SHORT   mode                       8     timing mode
float   exp_sec                    10    alternative exposure, in sec.
SHORT   VChipXdim                  14    Virtual Chip X dim
SHORT   VChipYdim                  16    Virtual Chip Y dim
WORD    yDimDet                    18    y dimension of CCD or detector.
char    date[DATEMAX]              20    date
SHORT   VirtualChipFlag            30    On/Off
char    Spare_1[2]                 32
SHORT   noscan                     34    Old number of scans - should always be
                                          -1
float   DetTemperature             36    Detector Temperature Set
SHORT   DetType                    40    CCD/DiodeArray type
WORD    xdim                       42    actual # of pixels on x axis
SHORT   stdiode                    44    trigger diode
float   DelayTime                  46    Used with Async Mode
WORD    ShutterControl             50    Normal, Disabled Open, Disabled Closed
SHORT   AbsorbLive                 52    On/Off
WORD    AbsorbMode                 54    Reference Strip or File
SHORT   CanDoVirtualChipFlag       56    T/F Cont/Chip able to do Virtual Chip
SHORT   ThresholdMinLive           58    On/Off
float   ThresholdMinVal            60    Threshold Minimum Value
SHORT   ThresholdMaxLive           64    On/Off
float   ThresholdMaxVal            66    Threshold Maximum Value
SHORT   SpecAutoSpectroMode        70    T/F Spectrograph Used
float   SpecCenterWlNm             72    Center Wavelength in Nm
SHORT   SpecGlueFlag               76    T/F File is Glued
float   SpecGlueStartWlNm          78    Starting Wavelength in Nm
float   SpecGlueEndWlNm            82    Starting Wavelength in Nm
float   SpecGlueMinOvrlpNm         86    Minimum Overlap in Nm
float   SpecGlueFinalResNm         90    Final Resolution in Nm
SHORT   PulserType                 94    0=None, PG200=1, PTG=2, DG535=3
SHORT   CustomChipFlag             96    T/F Custom Chip Used
SHORT   XPrePixels                 98    Pre Pixels in X direction
SHORT   XPostPixels                100   Post Pixels in X direction
SHORT   YPrePixels                 102   Pre Pixels in Y direction
SHORT   YPostPixels                104   Post Pixels in Y direction
SHORT   asynen                     106   asynchronous enable flag
                                          0 = off
SHORT   datatype                   108   experiment datatype
                                         0 = FLOATING POINT
                                         1 = LONG INTEGER
                                         2 = INTEGER
                                         3 = UNSIGNED INTEGER
SHORT   PulserMode                 110   Repetitive/Sequential
USHORT  PulserOnChipAccums         112   Num PTG On-Chip Accums
DWORD   PulserRepeatExp            114   Num Exp Repeats (Pulser SW Accum)
float   PulseRepWidth              118   Width Value for Repetitive pulse (usec)
float   PulseRepDelay              122   Width Value for Repetitive pulse (usec)
float   PulseSeqStartWidth         126   Start Width for Sequential pulse (usec)
float   PulseSeqEndWidth           130   End Width for Sequential pulse (usec)
float   PulseSeqStartDelay         134   Start Delay for Sequential pulse (usec)
float   PulseSeqEndDelay           138   End Delay for Sequential pulse (usec)
SHORT   PulseSeqIncMode            142   Increments: 1=Fixed, 2=Exponential
SHORT   PImaxUsed                  144   PI-Max type controller flag
SHORT   PImaxMode                  146   PI-Max mode
SHORT   PImaxGain                  148   PI-Max Gain
SHORT   BackGrndApplied            150   1 if background subtraction done
SHORT   PImax2nsBrdUsed            152   T/F PI-Max 2ns Board Used
WORD    minblk                     154   min. # of strips per skips
WORD    numminblk                  156   # of min-blocks before geo skps
SHORT   SpecMirrorLocation[2]      158   Spectro Mirror Location, 0=Not Present
SHORT   SpecSlitLocation[4]        162   Spectro Slit Location, 0=Not Present
SHORT   CustomTimingFlag           170   T/F Custom Timing Used
char    ExperimentTimeLocal[TIMEMAX]     172
char    ExperimentTimeUTC[TIMEMAX] 179   Experiment UTC Time as hhmmss\0
```

SHORT	ExposUnits	186	User Units for Exposure
WORD	ADCoffset	188	ADC offset
WORD	ADCrate	190	ADC rate
WORD	ADCtype	192	ADC type
WORD	ADCresolution	194	ADC resolution
WORD	ADCbitAdjust	196	ADC bit adjust
WORD	gain	198	gain
char	Comments[5][COMMENTMAX]	200	File Comments
WORD	geometric	600	geometric ops: rotate 0x01,reverse 0x02, flip 0x04
char	xlabel[LABELMAX]	602	intensity display string
WORD	cleans	618	cleans
WORD	NumSkpPerCln	620	number of skips per clean.
SHORT	SpecMirrorPos[2]	622	Spectrograph Mirror Positions
float	SpecSlitPos[4]	626	Spectrograph Slit Positions
SHORT	AutoCleansActive	642	T/F
SHORT	UseContCleansInst	644	T/F
SHORT	AbsorbStripNum	646	Absorbance Strip Number
SHORT	SpecSlitPosUnits	648	Spectrograph Slit Position Units
float	SpecGrooves	650	Spectrograph Grating Grooves
SHORT	srccmp	654	number of source comp. diodes
WORD	ydim	656	y dimension of raw data.
SHORT	scramble	658	0=scrambled, 1=unscrambled
SHORT	ContinuousCleansFlag	660	T/F Continuous Cleans Timing Option
SHORT	ExternalTriggerFlag	662	T/F External Trigger Timing Option
long	lnoscan	664	Number of scans (Early WinX)
long	lavgexp	668	Number of Accumulations
float	ReadoutTime	672	Experiment readout time
SHORT	TriggeredModeFlag	676	T/F Triggered Timing Option
char	Spare_2[10]	678	
char	sw_version[FILEVERMAX]	688	Version of SW creating this file
SHORT	type	704	1 = new120 (Type II) 2 = old120 (Type I) 3 = ST130 4 = ST121 5 = ST138 6 = DC131 (PentaMax) 7 = ST133 (MicroMax/SpectroMax) 8 = ST135 (GPIB) 9 = VICCD 10 = ST116 (GPIB) 11 = OMA3 (GPIB) 12 = OMA4
SHORT	flatFieldApplied	706	1 if flat field was applied.
char	Spare_3[16]	708	
SHORT	kin_trig_mode	724	Kinetics Trigger Mode
char	dlabel[LABELMAX]	726	Data label.
char	Spare_4[436]	742	
char	PulseFileName[HDRNAMEMAX]	1178	Name of Pulser File with Pulse Widths/Delays (for Z-Slice)
char	AbsorbFileName[HDRNAMEMAX]	1298	Name of Absorbance File (if File Mode)
DWORD	NumExpRepeats	1418	Number of Times experiment repeated
DWORD	NumExpAccums	1422	Number of Time experiment accumulated
SHORT	YT_Flag	1426	Set to 1 if this file contains YT data
float	clkspd_us	1428	Vert Clock Speed in micro-sec
SHORT	HWaccumFlag	1432	set to 1 if accum done by Hardware.
SHORT	StoreSync	1434	set to 1 if store sync used
SHORT	BlemishApplied	1436	set to 1 if blemish removal applied
SHORT	CosmicApplied	1438	set to 1 if cosmic ray removal applied
SHORT	CosmicType	1440	if cosmic ray applied, this is type
float	CosmicThreshold	1442	Threshold of cosmic ray removal.
long	NumFrames	1446	number of frames in file.
float	MaxIntensity	1450	max intensity of data (future)
float	MinIntensity	1454	min intensity of data (future)
char	ylabel[LABELMAX]	1458	y axis label.
WORD	ShutterType	1474	shutter type.
float	shutterComp	1476	shutter compensation time.

```
WORD     readoutMode               1480  readout mode, full, kinetics, etc.
WORD     WindowSize                1482  window size for kinetics only.
WORD     clkspd                    1484  clock speed for kinetics & frame
                                          transfer
WORD     interface_type            1486  computer interface(isa, taxi, pci,
                                          eisa, etc.)
SHORT    NumROIsInExperiment       1488  May be more than the 10 allowed in this
                                          header (if 0, assume 1)
char     Spare_5[16]               1490
WORD     controllerNum             1506  if multiple controller system will have
                                          controller number data came from. This
                                          is a future item.
WORD     SWmade                    1508  Which software package created this
                                          file
SHORT    NumROI                    1510  number of ROIs used. if 0 assume 1.
                                   1512 - 1630 ROI information
struct ROIinfo {
unsigned int startx                left x start value.
unsigned int endx                  right x value.
unsigned int groupx                amount x is binned/grouped in hw.
unsigned int starty                top y start value.
unsigned int endy                  bottom y value.
unsigned int groupy                amount y is binned/grouped in hw.
} ROIinfoblk[ROIMAX]
                                   ROI Starting Offsets:
                                         ROI 1 = 1512
                                         ROI 2 = 1524
                                        ROI 3 = 1536
                                        ROI 4 = 1548
                                        ROI 5 = 1560
                                        ROI 6 = 1572
                                        ROI 7 = 1584
                                        ROI 8 = 1596
                                        ROI 9 = 1608
                                        ROI 10 = 1620
char     FlatField[HDRNAMEMAX]     1632  Flat field file name.
char     background[HDRNAMEMAX]    1752  background sub. file name.
char     blemish[HDRNAMEMAX]       1872  blemish file name.
float    file_header_ver           1992  version of this file header
char     YT_Info[1000]             1996-2996 Reserved for YT information
LONG     WinView_id                2996  == 0x01234567L if file created by WinX
-----------------------------------------------------------------------------
```

Calibration Structures

There are three structures for the calibrations

- The Area Inside the Calibration Structure (below) is repeated two times.

```
xcalibration,        /* 3000 - 3488 x axis calibration          */
ycalibration,        /* 3489 - 3977 y axis calibration          */
```

Start of X Calibration Structure

```
double        offset;           /* 3000  offset for absolute data scaling   */
double        factor;           /* 3008  factor for absolute data scaling   */
char          current_unit;     /* 3016  selected scaling unit              */
char          reserved1;        /* 3017  reserved                           */
char          string[40];       /* 3018  special string for scaling         */
char          reserved2[40];    /* 3058  reserved                           */
char          calib_valid;      /* 3098  flag if calibration is valid       */
char          input_unit;       /* 3099  current input units for            */
                                /*       "calib_value"                      */
char          polynom_unit;     /* 3100  linear UNIT and used               */
                                /*       in the "polynom_coeff"             */
char          polynom_order;    /* 3101  ORDER of calibration POLYNOM       */
char          calib_count;      /* 3102  valid calibration data pairs       */
```

```
double        pixel_position[10];/* 3103  pixel pos. of calibration data     */
double        calib_value[10];   /* 3183  calibration VALUE at above pos     */
double        polynom_coeff[6];  /* 3263  polynom COEFFICIENTS               */
double        laser_position;    /* 3311  laser wavenumber for relativ WN    */
char          reserved3;         /* 3319  reserved                           */
unsigned char new_calib_flag;    /* 3320  If set to 200, valid label below   */
char          calib_label[81];   /* 3321  Calibration label (NULL term'd)    */
char          expansion[87];     /* 3402  Calibration Expansion area         */

---------------------------------------------------------------------------
```

Start of Y Calibration Structure

```
double        offset;            /* 3489  offset for absolute data scaling   */
double        factor;            /* 3497  factor for absolute data scaling   */
char          current_unit;      /* 3505  selected scaling unit              */
char          reserved1;         /* 3506  reserved                           */
char          string[40];        /* 3507  special string for scaling         */
char          reserved2[40];     /* 3547  reserved                           */
char          calib_valid;       /* 3587  flag if calibration is valid       */
char          input_unit;        /* 3588  current input units for            */
                                 /*       "calib_value"                      */
char          polynom_unit;      /* 3589  linear UNIT and used               */
                                 /*       in the "polynom_coeff"             */
char          polynom_order;     /* 3590  ORDER of calibration POLYNOM       */
char          calib_count;       /* 3591  valid calibration data pairs       */
double        pixel_position[10];/* 3592  pixel pos. of calibration data     */
double        calib_value[10];   /* 3672  calibration VALUE at above pos     */
double        polynom_coeff[6];  /* 3752  polynom COEFFICIENTS               */
double        laser_position;    /* 3800  laser wavenumber for relativ WN    */
char          reserved3;         /* 3808  reserved                           */
unsigned char new_calib_flag;    /* 3809  If set to 200, valid label below   */
char          calib_label[81];   /* 3810  Calibration label (NULL term'd)    */
char          expansion[87];     /* 3891  Calibration Expansion area         */

---------------------------------------------------------------------------
```

End of Calibration Structures

```
Char          Istring[40];       /* 3978  special Intensity scaling string   */
Char          Spare_6[76];       /* 4018  empty block to reach 4100 bytes    */
SHORT         AvGainUsed;        /* 4094  avalanche gain was used
SHORT         AvGain             /* 4096  avalanche gain value
SHORT         lastvalue;         /* 4098  Always the LAST value in the header */
```

Definition of Array Sizes

```
HDRNAMEMAX = 120      Max char str length for file name
USERINFOMAX =1000     User information space
COMMENTMAX = 80       User comment string max length(5 comments)
LABELMAX =   16       Label string max length
FILEVERMAX = 16       File version string max length
DATEMAX =    10       String length of file creation date string as ddmmmyyyy\0
ROIMAX =     10       Max size of roi array of structures
TIMEMAX =    7        Max time store as hhmmss\0
```

Start of Data

The data follows the header beginning at offset 4100. In WinView/WinSpec, the data is always stored exactly as it is collected. The order of the data depends on the placement of the shift register. In the diagram below, the shift register is on the RIGHT SIDE of the chip. Each COLUMN of data is first shifted RIGHT into the shift register and then DOWN. The data is read (and stored) in this order:

```
First column read:    XnYm, XnYm-1, ... XnY2, XnY1

Last column read :    X1Ym, X1Ym-1, ... X1Y2, X1Y1

 .-------------------------------------------.---.
 |   X1Y1       X2Y1       ...       XnY1    | S |
 |   X1Y2       X2Y2       ...       XnY2    | H |   |
 |     :          :                    :     | I |   |
 |   X1Ym-1     X2Ym-1     ...       XnYm-1  | F |   V
 |   X1Ym       X2Ym       ...       XnYm    | T |
 `-------------------------------------------|---|
                   ------>                   | | |
                                               |
                                               `-----> A/D
```

In the diagram below, the shift register is on the BOTTOM of the chip. Each ROW of data is first shifted DOWN into the shift register and then RIGHT. The data is read (and stored) in this order:

```
First row read:    XnYm, ... X2Ym, X1Ym

Last row read :    XnY1, ... X2Y1, X1Y1

 .-------------------------------------------.
 |   X1Y1       X2Y1       ...       XnY1    |
 |   X1Y2       X2Y2       ...       XnY2    |   |
 |     :          :                    :     |   |
 |   X1Ym-1     X2Ym-1     ...       XnYm-1  |   V
 |   X1Ym       X2Ym       ...       XnYm    |
 `-------------------------------------------|---.
 |              SHIFT REGISTER               | | |
                   ----->                      |
                                               `-----> A/D
```

The data is stored as sequential points and the X, Y and Frame dimensions are determined by the header.

The X dimension of the stored data is in "xdim" (Offset 42).

The Y dimension of the stored data is in "ydim" (Offset 656).

The number of frames of data stored is in "NumFrames" (Offset 1446).

Thus (modifying the statements above):

```
Char            header[4100];
unsigned int    X_dimension;
unsigned int    Y_dimension;
long            Num_frames;
```

Note that is now Direct Access of data dimensions.

```
X_dimension = (unsigned int) header[42];
Y_dimension = (unsigned int) header[664];
Num_frames  = (long)         header[1446];
```

Appendix D
Auto-Spectro Wavelength Calibration

Equations used in WinSpec Wavelength Calibration

WinSpec/32 wavelength calibration is based on the grating equation for Czerny-Turner or Ebert spectrographs (see Figure 190).

$$\mathbf{(m/d)}\lambda \mathbf{= sin}\ \alpha \mathbf{+ sin}\ \beta\text{, or } \lambda \mathbf{= (d/m)(sin}\ \alpha \mathbf{+ sin}\ \beta\mathbf{)}, \tag{1}$$

where: λ = wavelength at the center of the image plane,

m = diffraction order

d = distance between grooves (the inverse of grooves per mm), and

α, β = angles of the incident and exit beam relative to the grating normal.

The angles α and β are related to the inclusion angle, γ, and the rotational angle of the grating, ψ:

$\alpha = \psi - \gamma/\mathbf{2}$, and $\beta = \psi + \gamma/\mathbf{2}$.

Thus the grating equation can be written as:

$\mathbf{(m/d)}\ \lambda = \mathbf{sin}\ (\psi - \gamma/\mathbf{2}) + \mathbf{sin}\ (\psi + \gamma/\mathbf{2}) = \mathbf{2\ sin}\ \psi\ \mathbf{cos}\ (\gamma/\mathbf{2})$,

and the grating angle is given by:

$$\psi = \mathbf{asin}\ \{\mathbf{m}\lambda / (\mathbf{2d\ cos}\ (\gamma/\mathbf{2}))\}. \tag{2}$$

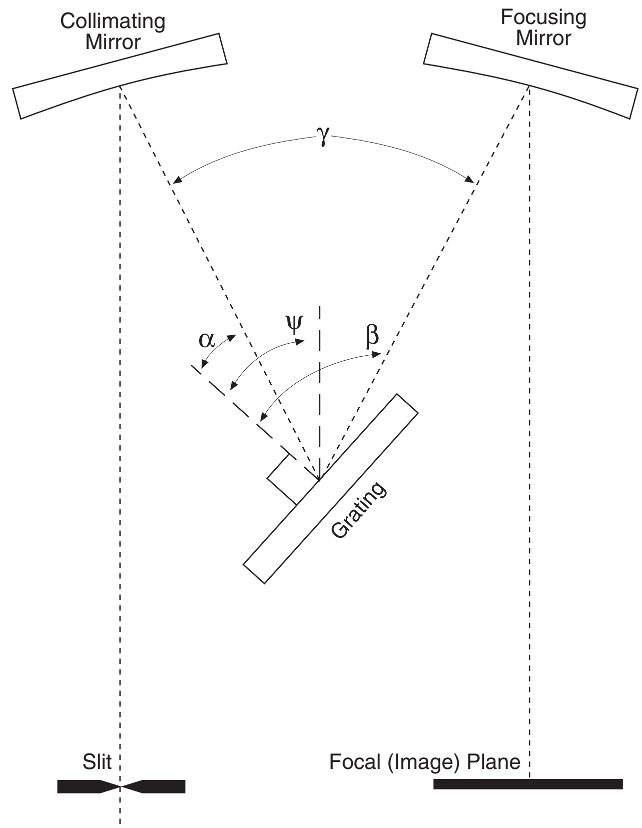

Figure 190. Relationships of α and β in terms of ψ and γ

Note that the wavelength at the **center** of the exit plane does not depend on the focal length, **f**. However, the wavelength at points off center depends on both the focal length and the detector angle, δ (the angle of the image plane relative to the plane perpendicular to the spectrograph focal axis at the center of the image plane; see Figure 191). For some wavelength λ' relatively close to λ (at the same grating angle),

$$\lambda' = (\mathbf{d/m})(\mathbf{sin}\ \alpha + \mathbf{sin}\ \beta') = (\mathbf{d/m})(\mathbf{sin}\ \alpha + \mathbf{sin}\ (\beta + \xi))$$
$$= (\mathbf{d/m})\{\mathbf{sin}\ (\psi - \gamma/\mathbf{2}) + \mathbf{sin}\ (\psi + \gamma/\mathbf{2} + \xi)\}. \qquad (3)$$

The angle ξ depends on the focal length **f**, the detector angle δ, and the distance of λ' from the center of the image plane, **nx**, where **n** is the number of pixels from the center and **x** is the pixel width; the relationship is given by:

$$\mathbf{tan}\ \xi = (\mathbf{nx\ cos}\ \delta) / (\mathbf{f} + \mathbf{nx\ sin}\ \delta), \text{ as shown in Figure 191.} \qquad (4)$$

When the image plane is perpendicular, $\delta = 0$, and this reduces to:

$$\mathbf{tan}\ \xi = (\mathbf{nx} / \mathbf{f})$$

Using the known parameters of focal length **f**, detector angle δ, number of pixels from center **n**, and pixel width **x**, first calculate the angle ξ from equation **4**. The grating angle ψ can be calculated using the known parameters center wavelength λ, diffraction order **m**, grating grooves per mm **1/d**, and inclusion angle γ, from equation **2**. Finally, the wavelength at pixel **n** is calculated using equation **3**.

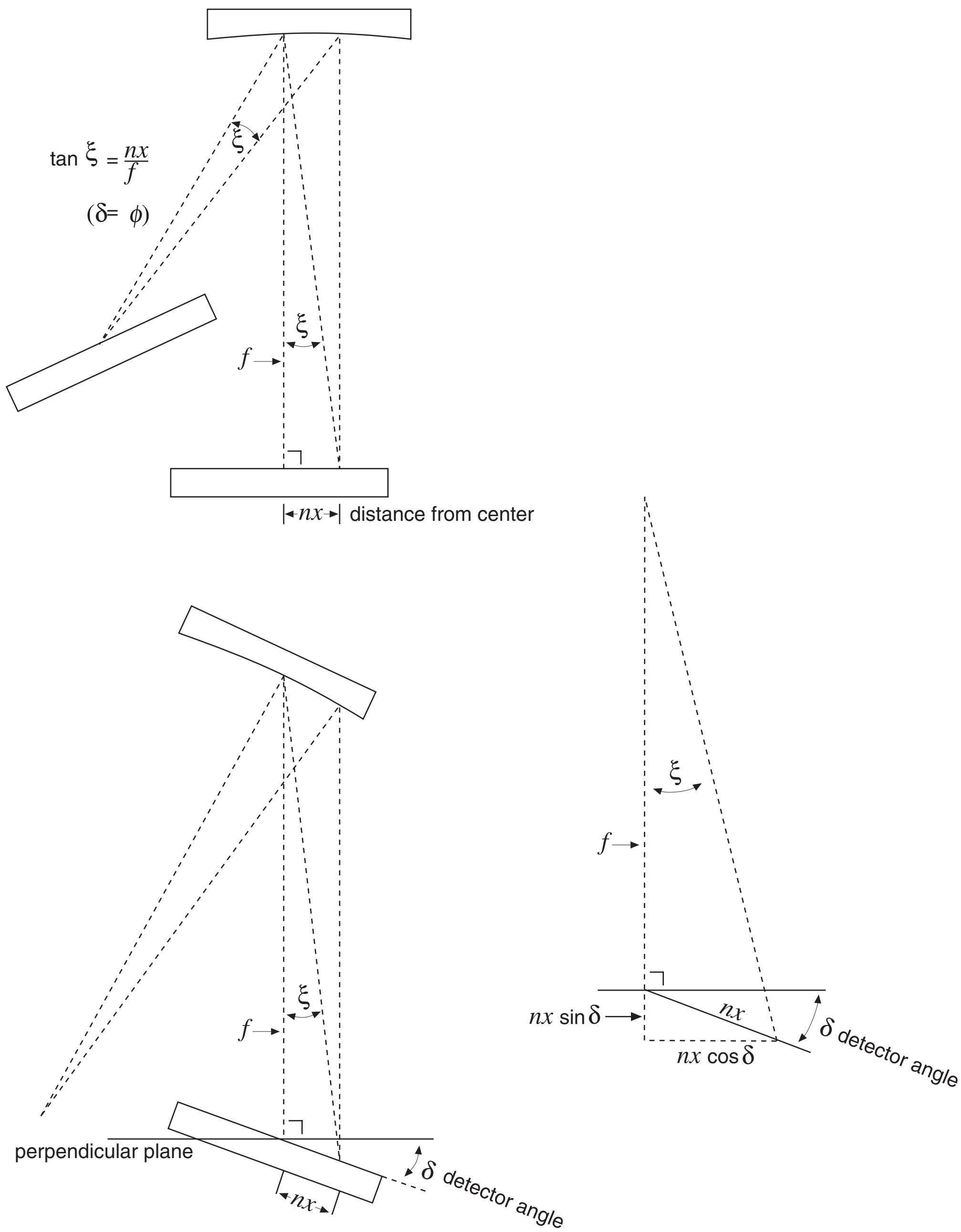

Figure 191. Relationship between ξ and the focal length, detector angle, and the distance of λ' from image plane

WinSpec X Axis Auto Calibration

When "Calibration Usage" is set to "Auto Spectro" in WinSpec/32, the X Axis calibration is done in the following steps after a wavelength change. First the wavelength is calculated at each end of the array using the method above. Then these two points, plus the third center wavelength point, are automatically fit to a 2nd order polynomial using the wavelength calibration functions.

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Appendix E
CD ROM Failure Work-Arounds

Although not common, there are CD drives that are not compatible with the Win ’95 long filename convention. Attempting to install on such a system causes the filenames to be truncated and the install fails, causing a message like:

An error occurred during the move data process: -113
Component: Application\WinXSystem
File Group: WinXSystem

Fortunately there are a couple of workarounds, both involving copying the install files to the customer’s hard drive first, then installing the software from that location.

1. If possible, copy the files to the customer’s hard drive via another computer that supports long file names. If the customer’s computer is part of a network then the files can be copied first to the hard drive of a computer that supports long file names, then transferred through the network to the customer’s hard drive. Check the list of files below to make sure that the long filenames remain intact. Then install the software from this location on the hard drive.
2. Copy the files to the customer’s hard drive from the customer’s CD-ROM, then fix the names of the files that were truncated. There are only 7 files that are not DOS compatible (8 + 3), so this at most a 10 minute job. Here are their abbreviated and full filenames. (Not all of these files are used in the standard installation but all are present on the CD.)
    - CLSSNA~1.CLS, rename to clsSnapIn.cls
    - PIXCMT~1.DLL, rename to PIXCMTXT32.dll
    - WINX_R~1.DOC, rename to WinX_readme.doc
    - WINX32~1.BAS, rename to Winx32Test.bas
    - WINX32~1.DOC, rename to Winx32 Automation - VB Version.doc
    - WINX32~1.FRM, rename to Winx32Test.frm
    - WINX32~1.FRX, rename to Winx32Test.frx

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Appendix F
WinSpec/32 Repair and Maintenance

Note: When WinSpec/32 is installed, it modifies the Windows Registry file. If for any reason you reinstall Windows, the Registry file may be replaced, and WinSpec/32 may not run correctly. Reinstall WinSpec/32 to correct this problem.

Install/Uninstall WinSpec/32 Components at a Later Time

After you have installed WinSpec/32, you may want to install additional WinSpec/32 files or to uninstall selected files. To do so:

1. Start the installation program and on the **WinSpec, WinView, WinXTest Selection** dialog box (Figure 192), select **Install WinSpec/32 for Windows**.

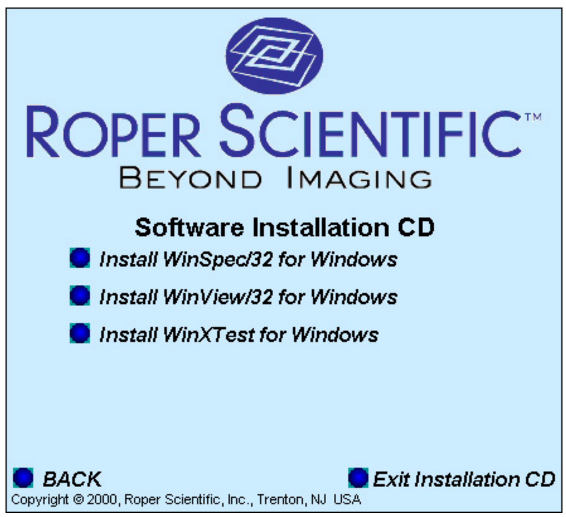

Figure 192. WinSpec, WinView, or WinXTest Selection dialog box

2. Because WinSpec/32 was previously installed, the **WinSpec Maintenance** dialog box (Figure 193) will be displayed.

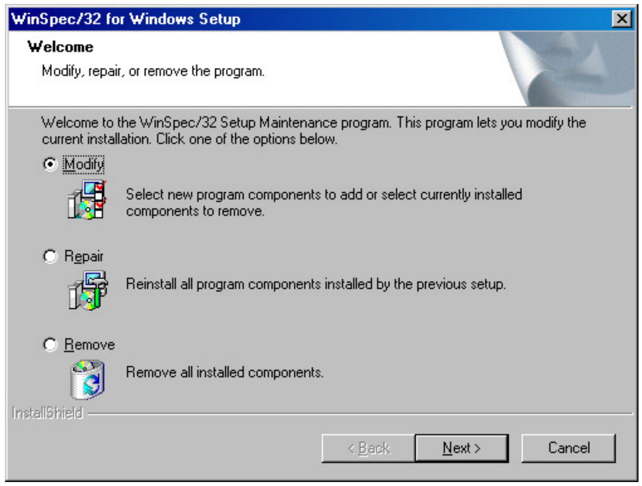

Figure 193. Maintenance dialog box

3. Select the **Modify** radio button and click on **Next**.

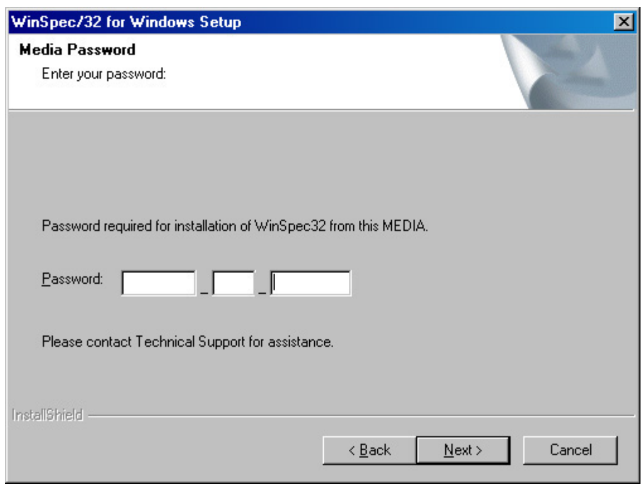

Figure 194. Media Password dialog box

4. On the **Media Password** dialog box, enter the password and click on **Next**.

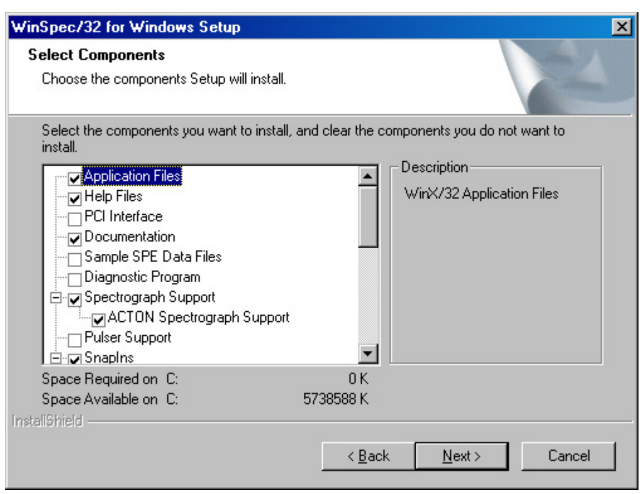

Figure 195. Select Components dialog box

5. On the **Select Components** dialog box, put a check in the box for each item you want to install and uncheck the box for each item you want to uninstall.
6. Then click on **Next** and follow the instructions on the dialog boxes.
7. Click on the **Finish** button when the **Maintenance Complete** dialog box is displayed. The **WinSpec, WinView, WinXTest Install** dialog box will be displayed after the changes have been made.
8. Exit from the installation program or choose another program to install, perform maintenance on, or uninstall.

Installing More than One Version of WinSpec/32

You can install more than one version of WinSpec/32, WinView/32 or any combination of the two on a single computer. When the Choose Destination Location dialog box is displayed, simply change the path to a new directory. If necessary, the install program will automatically create the new directory.

Caution

Do not install both the WinSpec/32 and WinView/32 software packages in the same directory.

Caution

Although several different versions of WinSpec/32 and/or WinView/32 can be installed on the same computer without conflicts, you should not run more than one version at any one time. The manner in which Roper Scientific software allocates memory for data collection precludes collecting data using two software packages at once.

It is also possible to install both 16-bit and 32-bit versions of the software in the same computer. However, keep in mind that WinSpec/32 will not operate under Windows 3.1 or 3.11. Similarly, the device drivers for the 16-bit version of WinSpec will not function properly under Win 95 or NT.

PIHWDEF.INI & SESSION.DAT

WinSpec/16 and PIHWDEF.INI: The hardware initialization file PIHWDEF.INI, is included with *16-bit versions of WinSpec software*. The file contains all of the hardware settings necessary to get started and is read the first time WinSpec is executed. At the end of the first operating session, the settings in effect are written to SESSION.DAT, which is read the next time WinSpec software is operated so that the new session will begin with the same settings that were in effect at the end of the previous one.

WinSpec/32 and the Windows Registry: WinSpec/32 doesn't need PIHWDEF.INI or SESSION.DAT, because it automatically stores the settings in the registry at the end of each operating session. However, WinSpec/32 will read the WinSpec/16 PIHWDEF.INI or SESSION.DAT if they are copied to the directory containing the WinSpec/32 software. This allows users who are upgrading from a 16-bit version of WinSpec to WinSpec/32 to transfer their previous operating settings to the new software. However, there is a constraint: if there are settings in the registry (i.e., WinSpec/32 has been operated at least once), the software won't read PIHWDEF.INI or SESSION.DAT unless the file date is newer than the date of the stored registry settings. This problem can be avoided by simply copying PIHWDEF.INI or SESSION.DAT to the WinSpec/32 directory *before* operating it the first time. If that opportunity is lost, a newer SESSION.DAT can be created by booting the 16-bit WinSpec software and then exiting the program in the usual manner. Similarly, a text editor could be used to open/edit a copy of PIHWDEF.INI and then save it so that it has the current date.

Uninstalling and Reinstalling

If you suspect any of the WinSpec/32 files have become corrupt, you should first delete all WinSpec/32 files, then reinstall the software from the CD or the FTP site. Follow the steps below to remove WinSpec/32. Note that some files may remain. They will have to be removed manually. *To reinstall, follow the procedure as described beginning on page 19.*

To uninstall WinSpec/32 from your computer:

1. Open the **Windows Control Panel**.
2. Double-click on **Add/Remove Programs**.
3. Highlight the WinSpec/32 version to uninstall and click on **Add/Remove**.

   Notes:

   1. The directory in which WinSpec/32 was originally installed will remain, as will any files it contains that were not placed there during the original installation.
   2. The Data directory created during the original installation may also be deleted. Any data files you want to save should be copied to a safe location before uninstalling.
   3. The Version # and User identification will be removed from the registry. However, the registry also contains much information that was placed there in the course of setting up and operating the software. That information will remain and will be available for use if WinSpec/32 is later reinstalled.

4. Follow the instructions on the dialog boxes.

To later reinstall the software, follow the Installing WinSpec/32 instructions provided earlier in this chapter. Use the original installation CD and any options disks purchased separately.

Appendix G

USB 2.0 Limitations

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

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

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

Table 5. Features Not Supported under USB 2.0 (continued on next page)

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

Table 5. Features Not Supported under USB 2.0

Appendix H
Troubleshooting USB 2.0

Introduction

The following information is provided for troubleshooting communication errors that may occur when computer-controller communication uses the USB 2.0 protocol.

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 WinSpec/32.

Data Overrun 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 WinSpec/32.
2. Run data acquisition in Safe Mode.
3. Add memory.
4. Use binning.
5. Increase the exposure time.
6. Close the Detector Temperature dialog box during data acquisition.
7. Defragment the hard disk.
8. Update the Orange Micro USB2 driver. See *"OrangeUSB USB 2.0 Driver Update"*, page 241.

If the problem persists, your application may be USB 2.0 bus limited. Since the host computer controls the USB 2.0 bus, there may be situations where the host computer interrupts the USB 2.0 port. In most cases, the interrupt will go unnoticed by the user. However, there are some instances when the data overrun cannot be overcome because USB 2.0 bus limitations combined with long data acquisition times and/or large data sets increase the possibility of an interrupt while data is being acquired. If your experiment requirements include long data acquisition times and/or large data sets, your application may not be suitable for the USB 2.0 interface. Therefore, we recommend replacement of the USB 2.0 interface module with our TAXI interface module and Roper Scientific PCI card. If this is not the case and data overruns continue to occur, contact Technical Support (see page 248 for contact information).

Demo is only Choice on Hardware Wizard:Interface dialog

If RSConfig.exe has not been run and there is not an installed Roper Scientific high speed PCI card, the Hardware Wizard will only present the choice "Demo" in the Interface dialog box (Figure 196). 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.

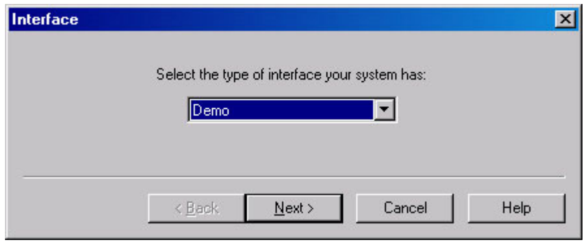

Figure 196. Hardware Wizard: Interface dialog box

At this point, you will need to exit WinSpec 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 WinSpec/32 with USB for the first time:

1. If you have not already done so, close WinSpec/32.
2. Make sure the ST-133A is connected to the host computer and that it is turned on.
3. Run RSConfig from the **Windows|Start|Programs|Roper Scientific** menu or from the directory where you installed WinSpec.
4. When the RSConfig dialog box (Figure 197) 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.

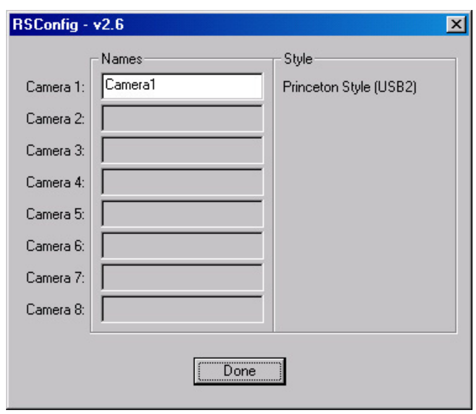

Figure 197. RSConfig dialog box

5. You should now be able to open WinSpec and, from **Setup|Hardware…,** run the Hardware Wizard.
6. When the PVCAM dialog box (Figure 198) 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.

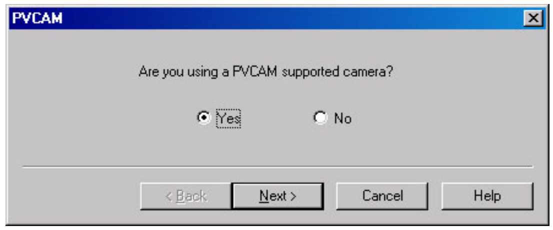

Figure 198. Hardware Wizard: PVCAM dialog box

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

If there is an installed Roper Scientific 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 WinSpec/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.

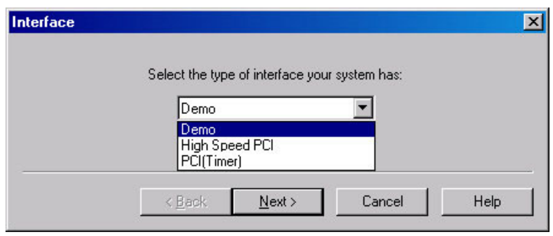

Figure 199. Hardware Wizard: Interface dialog box

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

1. If you have not already done so, close WinSpec/32.
2. Make sure the ST-133A is connected to the host computer and that it is turned on.
3. Run RSConfig from the **Windows|Start|Programs|Roper Scientific** menu or from the directory where you installed WinSpec.
4. When the RSConfig dialog box (Figure 197) appears, you can change the camera name to one that is more specific or you can keep the default name "Camera2". When you have finished, click on the **Done** button. You will next edit the generated PVCAM.INI file.

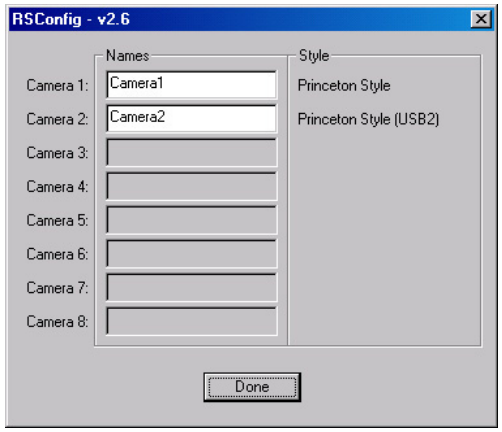

Figure 200. RSConfig dialog box: Two Camera Styles

5. 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:
[Camera_1] →	[Camera_2]
Type=1	Type=1
Name=Camera1	Name=Camera1
Driver=rspipci.sys	Driver=rspipci.sys
Port=0	Port=0
[Camera_2] →	[Camera_1]
Type=1	Type=1
Name=Camera2	Name=Camera2
Driver=apausb.sys	Driver=apausb.sys
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.

6. Save the file. With the ST-133A connected and on, open WinSpec/32.

7. Run the Hardware Wizard.

8. When the PVCAM dialog box (Figure 198) 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.

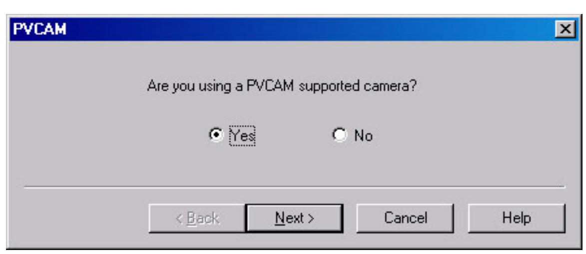

Figure 201. Hardware Wizard: PVCAM dialog box

Detector Temperature, Acquire, and Focus are Grayed Out

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

1. Check to see if the ST-133A is connected to the host computer and is turned on. If it is not connected or is connected but not turned on, go to Step 2. If it is connected and on, go to Step 3.
2. Close WinSpec, verify that the ST-133A is connected to the host computer, turn on the ST-133A, and reopen WinSpec. The formerly grayed out functions should now be available.
3. If the ST-133A is connected and 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|Roper Scientific** menu). If the USB 2.0 camera is listed as Camera 2 (Princeton Style (USB2) in Figure 202), you will have to edit the PVCAM.INI file.

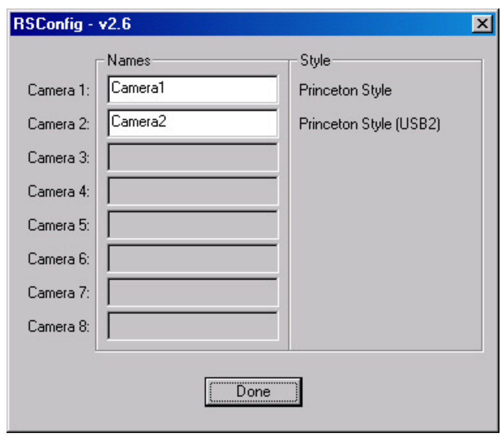

Figure 202. RSConfig dialog box: Two Camera Styles

5. 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:
[Camera_1] →	[Camera_2]
Type=1	Type=1
Name=Camera1	Name=Camera1
Driver=rspipci.sys	Driver=rspipci.sys
Port=0	Port=0
[Camera_2] →	[Camera_1]
Type=1	Type=1
Name=Camera2	Name=Camera2
Driver=apausb.sys	Driver=apausb.sys
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.

6. Save the file. With the ST-133A connected and on, open WinSpec/32. The formerly grayed out functions should now be available.

Error Creating Controller message

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

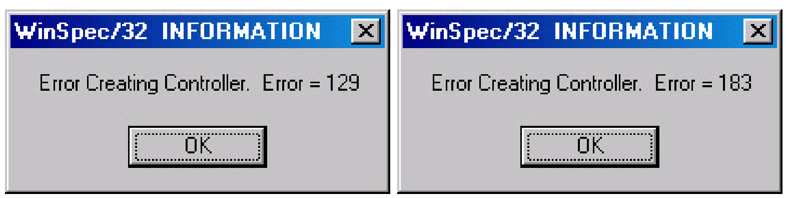

Figure 203. Error Creating Controller dialog box

Error 129: Indicates that the problem is with the PVCAM.INI file. Close WinSpec/32, run RSConfig, make sure the ST-133A is on, reopen WinSpec, and begin running the Hardware Wizard.

Error 183: Indicates that the ST-133A is off. If you are running the Hardware Wizard when this message appears, click on **OK**, turn on the ST-133A, 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.

No CCD Named in the Hardware Wizard:CCD dialog

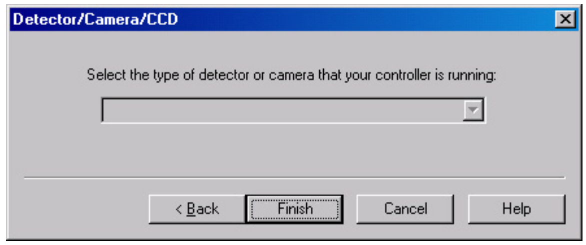

Figure 204. Hardware Wizard: Detector/Camera/CCD dialog box

If you have installed a USB 2.0 Interface Module in your ST-133A, a blank field may be displayed in the Detector/Camera/CCD dialog box (Figure 204) if the ST-133 controller was made before January 2001. Earlier versions of the ST-133 did not contain non-volatile RAM (NVRAM), which is programmed with information about the controller and the camera. PVCAM, the program under which the Roper Scientific USB works, retrieves the information stored in NVRAM so it can enter specific camera characteristics into WinSpec/32.

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

OrangeUSB USB 2.0 Driver Update

This procedure is highly recommended when a laptop computer will be used to communicate with the ST-133A. 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. Go to http:/www.devicedriver.com/usb2drivers.htm.
2. Follow the instructions there and download the correct Microsoft USB Driver to your computer (Window 2000 or Windows XP). Note where the downloaded file was saved.
3. Go to the download directory and unzip the .CAB file.
4. From the Windows **Start** menu, select **Settings|Control Panel**.
5. Select **System** and then **System Properties**.
6. Select the **Hardware** tab and click on **Device Manager** button.
7. Expand **Universal Serial Bus Controllers**.
8. Right-mouse click on **OrangeUSB USB 2.0 Host Controller** and select **Properties**.
9. 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.

10. When the **Upgrade Device Driver Wizard** appears, click on **Next**. Select the **Search for a suitable driver …** radio button.
11. On the next screen select the **Specify a location** checkbox.
12. Browse and select the location. Click on **OK**.
13. In the **Driver Files Search Results** window, check the **Install one of the other drivers** checkbox.
14. 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.

Appendix I
Glossary

A/D converter: Analog-to-digital converter. In a CCD detector system, the electronic circuitry that converts the analog information (continuous amplitudes) acquired by the detector into the digital data (quantified, discrete steps) used for image display.

ADU: Analog-to-digital unit. A number representing a CCD's output. The relationship between the ADUs generated and the number of electrons acquired on the CCD is defined by the system gain. Intensities given in ADUs provide a convenient method for comparing images and data generated by different detectors. Also referred to as *count* and *digital number*.

Anti-blooming: Blooming is caused by saturation of one or more CCD pixels. This can occur if the incoming light is too bright or when extensive serial and parallel binning is being performed. When this saturation happens, the excess charge overflows into the adjacent pixels and results in a streak or a blob appearing on the image. Anti-blooming is traditionally controlled by specific CCD architecture designs that drain the excess charge.

Avalanche Gain: Also called "on-chip multiplication gain". A technology that enables multiplication of charge (i.e., electrons) collected in each pixel of the CCD's active array. Secondary electrons are generated via an impact-ionization process that is initiated and sustained when higher-than-typical voltages are applied to an "extended" portion of the CCD's serial register. Multiplying the signal above the read noise of the output amplifier enables ultra-low-light detection at high operation speeds. (Some CCD cameras with on-chip multiplication gain utilize two output amplifiers, an "on-chip multiplication gain" amplifier that allows the camera to be used for low-light, high-speed applications and a "traditional" amplifier for wide-dynamic-range applications.)

Backlash: Applied to the movement of gratings or slits, this is the amount of play between gears when changing the direction of travel.

Bias: In a CCD detector system, the minimum intensity required for each exposure (equivalent to performing a zero-second exposure with the shutter closed). Without adding any light, the bias allows charge to be read out on the CCD while raising the intensity level high enough to ensure that the detector does not deliver a negative number to the A/D converter. (The A/D converter only works in the set of positive numbers and has no instructions for processing negative numbers.) The bias may be user settable. However, it is set at the factory and should remain stable over the lifetime of the detector system.

Binning: Hardware binning is the process of combining the charge from adjacent pixels in a CCD *before* the signal is read out by the preamplifier. A binning of 1 in both directions reads out each pixel at full X-axis resolution. A binning of 2 in both directions combines four pixels, cutting the X-axis resolution in half, but quadrupling the light-collecting area. If the CCD chip shift register is being saturated due to hardware binning, you can use software binning instead by checking **Use Software Binning** on the ROI Setup tab page. Note that software binning is not as fast as hardware binning.

Cancel button: Exits a dialog box without performing any processing. Any changes to the dialog are lost.

Close button: Closes the dialog box or window with no action taken.

Dark current: (1) The charge accumulated within a well, in the absence of light. (2) The background current that flows in a charge-coupled device or image intensifier of a camera system. Cooling the photodetector's primary imaging surface (i.e., the CCD's photoconductor or the image intensifier's photocathode) can reduce or eliminate dark current. Also called *thermally generated charge*. Dark current can be subtracted from an image.

Gating: In an intensified detector system, the application of a voltage that switches the image intensifier on and off in very short intervals. Gating improves temporal resolution. Gating can be controlled by the programmed exposure time (Shutter Mode) or is determined by the Pulser settings (Gate Mode).

Help button: Opens the context-sensitive help for the active tab page or dialog box.

Host computer: The primary or controlling computer for a detector.

Mouse button: Allows you to specify a region to be processed using the mouse. Simply drag a box in the data region of the active window and then click on **Mouse**. The **Frame** and **Range** parameters will assume the values of the defined region. Note that the **Mouse** button is only active when the **Input** tab page is selected.

MPP: Multi-pinned-phase operation. A mode that reduces the rate of dark current generation by a factor of 20 or more, relaxing CCD cooling requirements to the level where a thermoelectric cooler is sufficient for most applications. Also called *inverted operation*.

NVRAM: Non-Volatile Random Access Memory. NVRAM contains factory-programmed information about the controller and, in many cases, the camera/detector.

Process button: Causes the specified operation or process to be performed. The process is performed on the data specified on the Input tab page and saved using the file name and data type specified on the Output tab page.

PVCAM®: Programmable Virtual Camera Access Method. An exclusive (Roper Scientific) universal programming interface. A set of software library routines that implements a detector or camera's operations in a hardware-independent, platform-independent (or "virtual") suite of function calls. Once an application has been written to control one PVCAM-enabled camera, all PVCAM-enabled cameras are then compatible with that application.

ROI: Region of interest. A user-defined, rectangular area (a square is common) on a CCD that is exposed and processed as an image.

Shutter Compensation Time: The time it takes for a mechanical shutter to open or close. This time needs to be accounted for during hardware setup so the software can allow enough time for the shutter to open before starting data acquisition and allow enough time for it to close before reading out the array.

Warranty & Service

Limited Warranty: Roper Scientific Analytical Instrumentation

Roper Scientific, Inc. ("Roper Scientific," 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

Roper Scientific 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, Roper Scientific 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 Roper Scientific 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 Roper Scientific authorized representative/distributor for repair information and assistance, or visit our technical support page at www.roperscientific.com.

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

Roper Scientific 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, Roper Scientific will repair or replace, at its sole option, any defective parts, without charge to you. You must deliver the entire product to the Roper Scientific factory or, at our option, a factory-authorized service center. You are responsible for the shipping costs to return the product to Roper Scientific. International customers should contact their local Roper Scientific representative/distributor for repair information and assistance or visit our technical support page at www.roperscientific.com.

Normal Wear Item Disclaimer

Roper Scientific does not warrant certain items against defect due to normal wear and tear. These items include internal and external shutters, cables, and connectors. *These items carry no warranty, expressed or implied.*

VersArray (XP) Vacuum Chamber Limited Lifetime Warranty

Roper Scientific warrants that the cooling performance of the system will meet our specifications over the lifetime of the VersArray (XP) detector or Roper Scientific 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 24 Month Warranty

Roper Scientific warrants the sealed chamber integrity of all our products for a period of twenty-four (24) months after shipment. If, at anytime within twenty-four (24) 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 24 Month Warranty

Roper Scientific warrants the vacuum integrity of all our products for a period of up to twenty-four (24) 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 twenty-four (24) 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. Roper Scientific 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

Roper Scientific 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. Se*e 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

Roper Scientific 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. Roper Scientific 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 Roper Scientific 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 Roper Scientific 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 Roper Scientific.
2. You must notify the Roper Scientific 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 Roper Scientific factory or, at our option, an authorized service center.
4. Before products or parts can be returned for service you must contact the Roper Scientific 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 Roper Scientific factory or one of our authorized manufacturer's representatives or distributors.
6. Unless specified in the original purchase agreement, Roper Scientific 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 Roper Scientific.
8. After the warranty period has expired, you may contact the Roper Scientific factory or a Roper Scientific-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 Roper Scientific's 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 Roper Scientific factory of purchase, contact your authorized Roper Scientific representative or reseller, or visit our technical support page at www.roperscientific.com.

Contact Information

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

Roper Scientific
3660 Quakerbridge Road
Trenton, NJ 08619 (USA)

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

Technical Support E-mail: techsupport@roperscientific.com

For technical support and service outside the United States, see our web page at www.roperscientific.com. An up-to-date list of addresses, telephone numbers, and e-mail addresses of Roper Scientific's overseas offices and representatives is maintained on the web page.

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