FERGIE™

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User Manual

Princeton Instruments

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Princeton Instruments

Fergie™ Imaging Spectrometer System Manual

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Revision History

Issue	Date	List of Changes
Issue 1	January 10, 2017	This is the initial release of this document.

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Chapter 1: About this Manual

Thank you for purchasing a Fergie™ Imaging Spectrograph System from Princeton Instruments. For over two decades Princeton Instruments has been the legendary name behind the most revolutionary spectroscopy and imaging products for cutting edge research.

Please read the manual carefully before operating the system. This will help you optimize the many features of this system to suit your research needs.

If you have any questions about the information contained in this manual, contact the Princeton Instruments customer service department. Refer to Contact Information on page 58 for complete contact information.

1.1 Intended Audience

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

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

1.2 Related Documentation

Table 1-1 provides a list of related documentation and user manuals that may be useful when working with the Fergie camera system. To guarantee up-to-date information, always refer to the current release of each document listed.

Table 1-1: Related Documentation

Document Number	Document Title
4411-0157	Fergie 785 nm Multimode Diode Laser Source User Manual
–	Fergie Imaging Spectrograph System Data Sheet

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

ftp://ftp.piacton.com/Public/Manuals/Princeton Instruments

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

1.3 Document Organization

This manual includes the following chapters and appendices:

- Chapter 1, About this Manual

  This chapter provides information about the organization of this document, as well as related documents, safety information, and conventions used throughout the manual.
- Chapter 2, Fergie Imaging Spectrograph

  This chapter provides information about the components included with a standard Fergie Imaging Spectrograph system, as well as options that are available for purchase from Princeton Instruments.
- Chapter 3, Install LightField for Fergie

  This chapter provides information about the installation of Princeton Instruments' *LightField for Fergie* data acquisition software.
- Chapter 4, Changing Gratings

  This chapter provides the procedures necessary to remove and replace a grating on the Fergie Imaging Spectrograph system.
- Chapter 5, Internal Shutter

  This chapter provides the procedures necessary to remove and replace the internal shutter on a Fergie Imaging Spectrograph system.
- Chapter 6, System Configuration

  This chapter provides information about the installation, configuration, and calibration of a Fergie Imaging Spectrograph system.
- Chapter 7, System Operation

  This chapter provides information about using *LightField for Fergie* to acquire spectrographic data.
- Appendix A, Technical Specifications

  This appendix provides technical specifications and data for the Fergie Imaging Spectrograph system.
- Appendix B, Outline Drawings

  This appendix provides outline drawings of the Fergie Imaging Spectrograph system.
- Warranty and Service

  Provides warranty information for the Fergie Imaging Spectrograph system. Contact information is also provided.

1.4 Safety Information

This section provides information about all Laser Warning symbols, as well as other safety-related symbols used within this manual.

CAUTION!

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure

1.4.1 Safety Related Symbols Used in this Manual

CAUTION!

A **Caution** provides detailed information about actions and/or hazards that may result in damage to the equipment being used, including but not limited to the possible loss of data.

WARNING!

A **Warning** provides detailed information about actions and/or hazards that may result in personal injury or death to individuals operating the equipment.

WARNING! RISK OF ELECTRIC SHOCK!

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

1.4.2 Laser Warning Symbols

This section illustrates typical Laser Warning Labels related to the operation of the Fergie Imaging Spectrometer System and the Fergie Diode Laser Source.

Figure 1-1: Typical Laser Aperture Label

4411-0154_0001

Figure 1-2: Typical Laser Warning Label

4411-0154_0002

1.5 Fergie Safety Information

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

WARNINGS!

1. If the Fergie system is used in a manner not specified by Princeton Instruments, the protection provided by the equipment may be impaired.
2. If the equipment or the wall outlet is damaged, the protective grounding could be disconnected. Do not use damaged equipment until its safety has been verified by authorized personnel. Disconnecting the protective earth terminal, inside or outside the apparatus, or any tampering with its operation is also prohibited.

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

WARNING!

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

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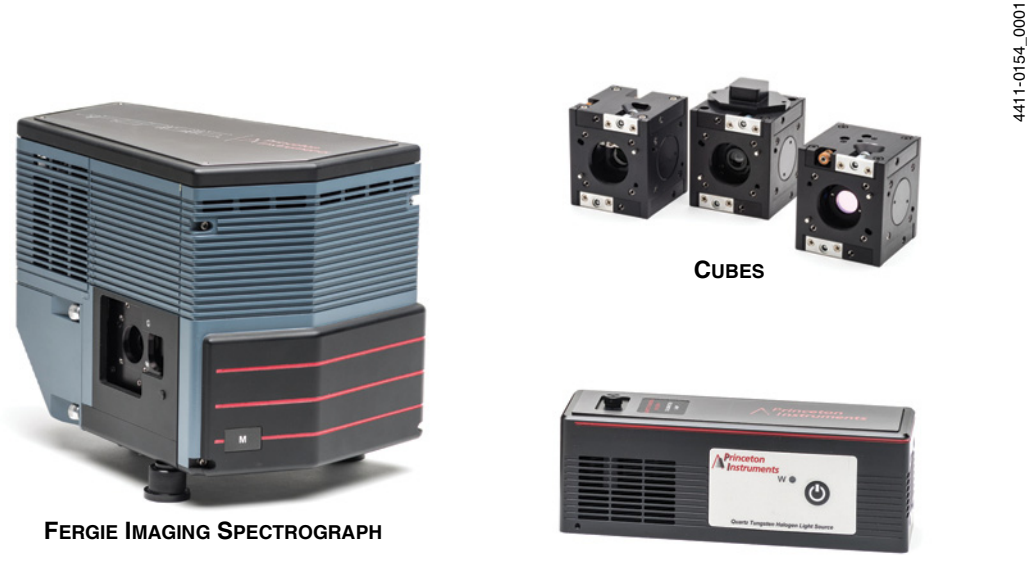
Chapter 2: Fergie Imaging Spectrograph

This chapter provides an introduction to, and overview information about, Princeton Instruments' Fergie Imaging Spectrograph System.

Fergie is an integrated 80.8 mm focal length imaging spectrograph with a built in 256 x 1024 (row x column) TEC cooled back-illuminated CCD detector and a motorized single turret grating drive. Its proprietary optical design produces diffraction limited imaging with zero coma or astigmatism at any wavelength across the entire focal plane of the sensor.

Figure 2-1 shows the items typically included as part of a standard Fergie Imaging Spectrograph System.

Figure 2-1: Typical Fergie System Components



The following items are included as standard equipment with every Fergie system:

- Fergie Software: Powered by LightField;

  Each Fergie ships with fully featured software power by Princeton Instruments' 64-bit LightField software. For users requiring a full license to run other PI hardware, please contact your local sales associate.

- Laser Cut Entrance Slit;

  A precision laser cut slit is shipped with each unit. Each slit is laser engraved with its width on the handled end of the slit carrier.

  NOTE:

  Additional slits are sold separately.

- Diffraction Grating;

  Each Fergie is shipped with a user replaceable reflection grating already installed in the instrument. Additional gratings may be purchased separately.
- Focusing Cube;

  A focusing cube FER-CUBE1-VIS is shipped with each Fergie. The focusing cube houses an f/4 double achromatic lens with a clear aperture diameter of 7.5 mm.
- USB 3.0 data interface cable;
- External power supply.

2.1 Experiment Interface Panel

Figure 2-2 illustrates Fergie's Experiment Interface Panel.

Figure 2-2: Fergie Experiment Interface Panel

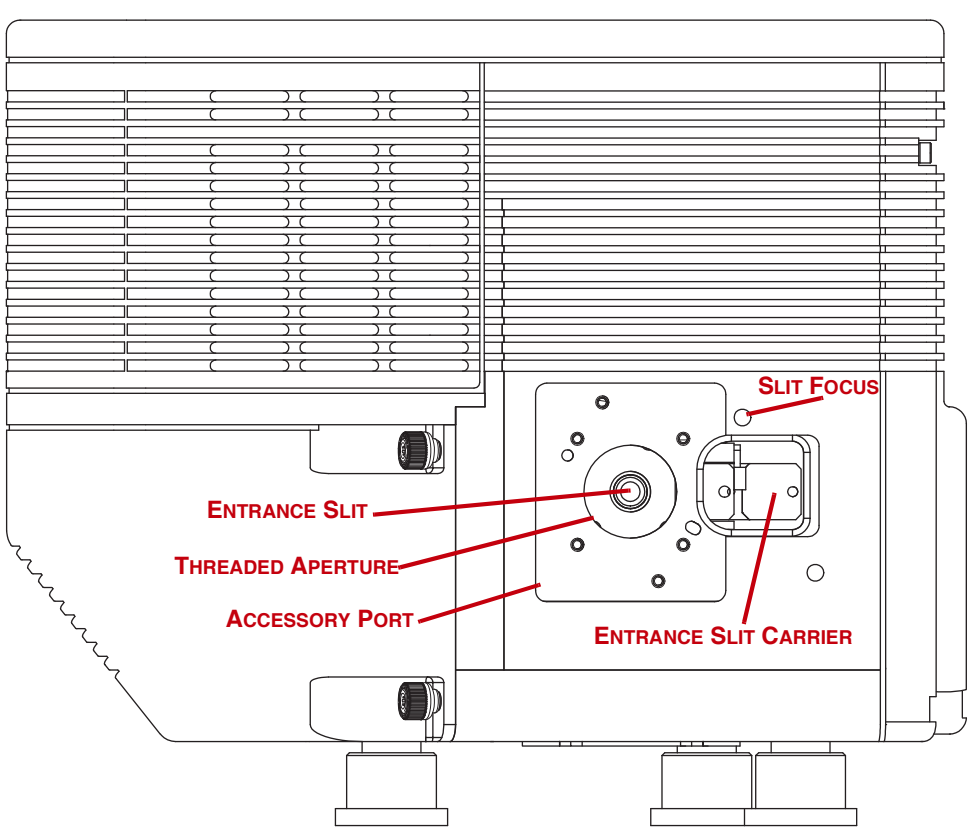


Table 2-1 provides information about experiment interface ports and equipment.

Table 2-1: Experiment Interface Ports and Equipment

Item	Description
Accessory Port	Compatible with Fergie Cubes; Extensible to Thorlabs® 30 mm Cage System.
Entrance Slit	User-changeable entrance slit.
Entrance Slit Carrier	User-changeable entrance slit carrier.
Slit Focus	Requires a 5/64" Allen Wrench. Used to focus the system.
Threaded Aperture	SM-1, 1-inch diameter.

2.2 Power and Data Interface Panel

Figure 2-3 illustrates the Fergie Power and Data Interface Panel where all data input/output ports, as well as the input power connector, are located.

Figure 2-3: Fergie Power and Data Interface Panel

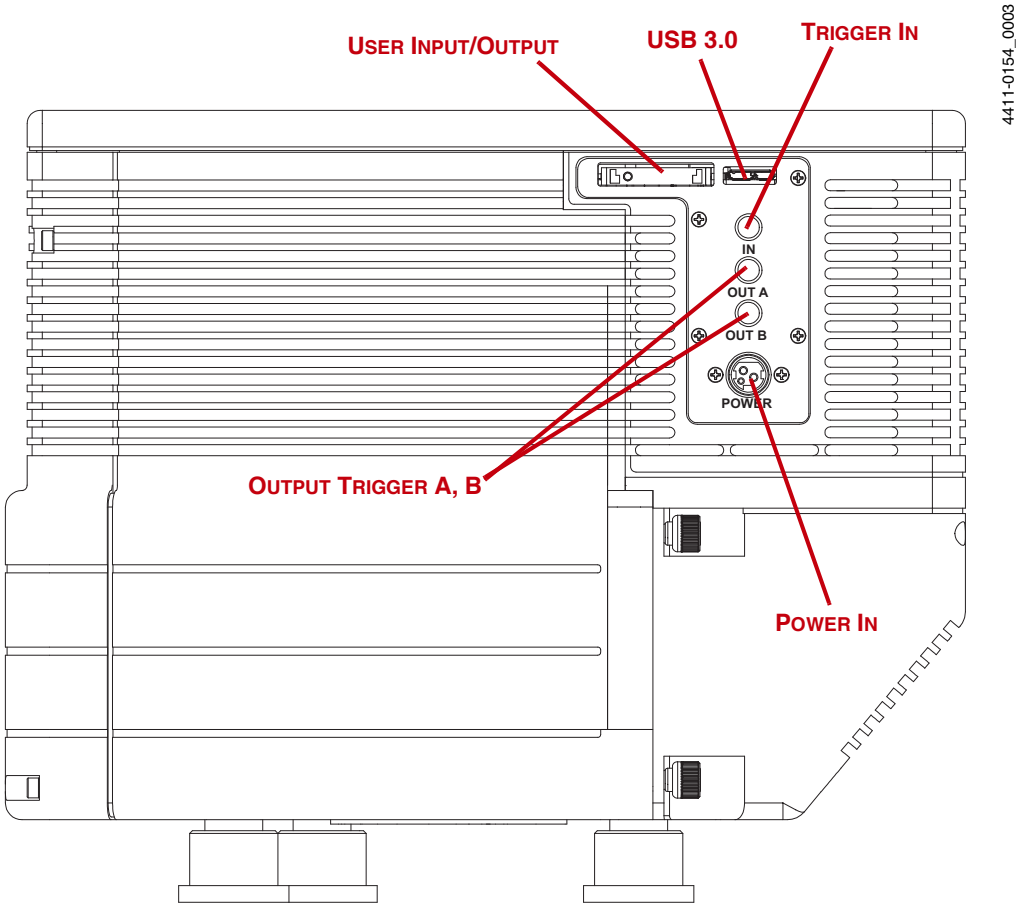


Table 2-2 provides information about the power and data interface ports.

Table 2-2: Power and Data Interface Panel

Port	Description
User Input/Output	General purpose input/output port.
Output Trigger A, B	Fully programmable output triggers using the integrated Timing Generator.
Power In	Power input from external power supply provided with the Fergie system.
Trigger In	Allows data acquisition and readout to be synchronized with external events. Positive or negative edge triggering is programmable.
USB 3.0	Control signals and data are transmitted between Fergie and host computer via this port.

2.3 Fergie System Maintenance

WARNING!

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

2.3.1 Camera

Although there is no periodic maintenance that needs to be performed on a Fergie spectrograph, users are advised to wipe it down with a clean damp cloth from time to time. This operation should only be done on the external surfaces and with all covers secured. In dampening the cloth, use clean water only, and wring out all excess water. The cloth should only be slightly damp, not wet (i.e., no water should drip off the cloth.)

No soap, solvents or abrasives should be used. Not only are they not required, but they could damage the finish of the surfaces on which they are used.

2.3.2 Repairs

Because the Fergie system contains no user-serviceable parts, repairs must be performed by Princeton Instruments. Should the system need repair, contact Princeton Instruments customer support for instructions. Refer to Contact Information on page 58 for complete information.

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

2.4 Available Accessories

Refer to Table 2-3 for information about accessories that are available for use with Fergie.

Table 2-3: Available Fergie System Accessories (Sheet 1 of 3)

Accessory	Features	Part Number
Fergie Wavelength Stabilized Multimode 785 nm Laser	Fiber coupled 475 mW Power, narrow laser line Ideal for Raman spectroscopy	FER-LAS-785
Fergie Wavelength Calibration Reference Lamp	Atomic Emission Lamp. Switchable Mercury (Hg) and Neon-Argon (Ne-Ar). Allows automated spectral wavelength calibration USB interface	FER-CAL-WL
Fergie QTH Calibration Lamp	**A**llows automated reactive intensity calibration Stabilized optical output NIST traceable USB interface	FER-CAL-QTH
Fergie Basic Cube	**A**llows easy mating to Fergie entrance or other Fergie accessories Compatible with Thorlabs cage system	FER-CUBE0

Table 2-3: Available Fergie System Accessories (Sheet 2 of 3)

Accessory	Features	Part Number
Fergie Focusing Cube	Contains achromatic doublet for focusing incoming light on to the Fergie slit Precision X-Z stage for fine focus and slit alignment Optimized for: • UV (250-425, CUBE1-UV) • VIS(400-700, CUBE1-VIS) • NIR(650-1050, CUBE1-NIR)	FER-CUBE1-UV FER-CUBE1-VIS FER-CUBE1-NIR
Fergie Raman Filter Cube: 785 nm	Includes: • Mounted 785 nm narrow band laser line filter; • PI long pass dichroic filter (127 cm^{-1} edge); • Matching edge filter (OD 6) with precision built in angle tuning adjustment Optimized for 785 nm Raman	FER-CUBE2-785
Fergie Sample Chamber Cube	Includes: • 2 lenses; • 4 optical ports • Sample chamber for 12.5 mm cuvette (not included); • Light cover.	FER-CUBE3
Fergie Beam Splitter Cube	Allows splitting of beam paths in 50:50 (CUBE4-50), 70:30 (CUBE4-70), or 90:10 (CUBE4-90) optical ratios without beam walk off. Contains precisely aligned and mounted non-polarizing cubic beam splitter	FER-CUBE4-50 FER-CUBE4-70 FER-CUBE4-90
Fergie Filter Cube	5-position filter CUBE for 1/2 inch diameter filters. Filters not included.	FER-CUBE5
Fergie Fiber Port	**A**llows easy attachment of fibers via FC/PC terminal and aspheric collimating lens to Fergie Optimized for: • Visible applications VIS (400-700 nm, FP-VIS); • NIR (650-1050 nm, FP-NIR)	FER-FP-VIS FER-FP-NIR
Fergie Slit	Additional interchangeable input slit. Precision laser-cut slit available in the following widths: • 10 µm; • 25 µm; • 50 µm; • 100 µm; • 150 µm; • 200 µm. 3.3 mm tall	FER-SLIT

Table 2-3: Available Fergie System Accessories (Sheet 3 of 3)

Accessory	Features	Part Number
Fergie SM1 to C-mount Adapter	Enables coupling to C-mount lenses and microscope interfaces.	FER-ADAPT-SM 1-C
Fergie 785 nm Raman Probe	105 µm FC/PC excitation fiber and 400 µm FC/PC collection fiber. Ideally suited for use with FER-LIN-ARY linear fiber array for maximum efficiency.	FER-PROBE-785 RAM
Fergie Linear Fiber Array	Array of fifty 50 µm fibers circularly packed at the collection end terminated with an FC/PC connector delivering light to a 3.0 mm tall linear array. Maximizes light gathering power without loss in spectral resolution. Includes self aligning Fergie fiber adapter.	FER-FIBER-LIN
Fergie Bifurcated Linear Fiber Array	Two collection ends each equipped with twenty-five 50 µm fibers circularly packed with FC/PC connectors leading into a split linear array 2 x 1.5 mm tall. Ideal for absorption spectroscopy where a live reference channel is required. Maximizes light gathering power without loss in spectral resolution. Includes self aligning Fergie fiber adapter.	FER-FIBER-BI-L IN
Fergie Laser Excitation Fiber	105 µm multimode fiber for coupling laser excitation light from Fergie laser.	FER-FIBER-LAS
Fergie Fiber Patch Cable	400 µm multimode fiber for coupling light from QTH lamp for absorption/transmission spectroscopy.	FER-FIBER-PTH

Chapter 3: Install *LightField for Fergie*

This chapter provides the installation procedure for *LightField for Fergie* application software.

3.1 Prerequisites

Before beginning to install *LightField for Fergie*, verify that:

- The operating system on the desired host computer is either Windows Vista (64-bit) or Windows 7 (64-bit);
- The host computer supports USB 3;

  If it does not support USB 3, refer to the host computer manufacturer's instructions for installing a USB 3 interface card;
- The host computer is connected to the Internet. An Internet connection is required for product activation.

3.2 Installation Procedure

Perform the following procedure to install *LightField for Fergie* on the host computer:

1. Insert the *LightField for Fergie* Installation CD into the CD drive on the host computer, and follow the on-screen prompts.
2. After the installation has been completed, reboot the host computer.
3. Connect the Fergie system components to the host computer and apply power.
4. Launch *LightField for Fergie*, activate it, and begin experiment configuration.

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Chapter 4: Changing Gratings

This chapter provides information about removing and installing a Fergie grating.

4.1 Required Tools

The following tools are required to remove and install a Fergie grating carrier:

- #2 phillips head screwdriver with a 4-inch shaft (minimum);
- 0.050” allen wrench;
- 5/64” allen wrench;
- 1/8” hex driver.

4.2 Grating Carrier Replacement Procedure

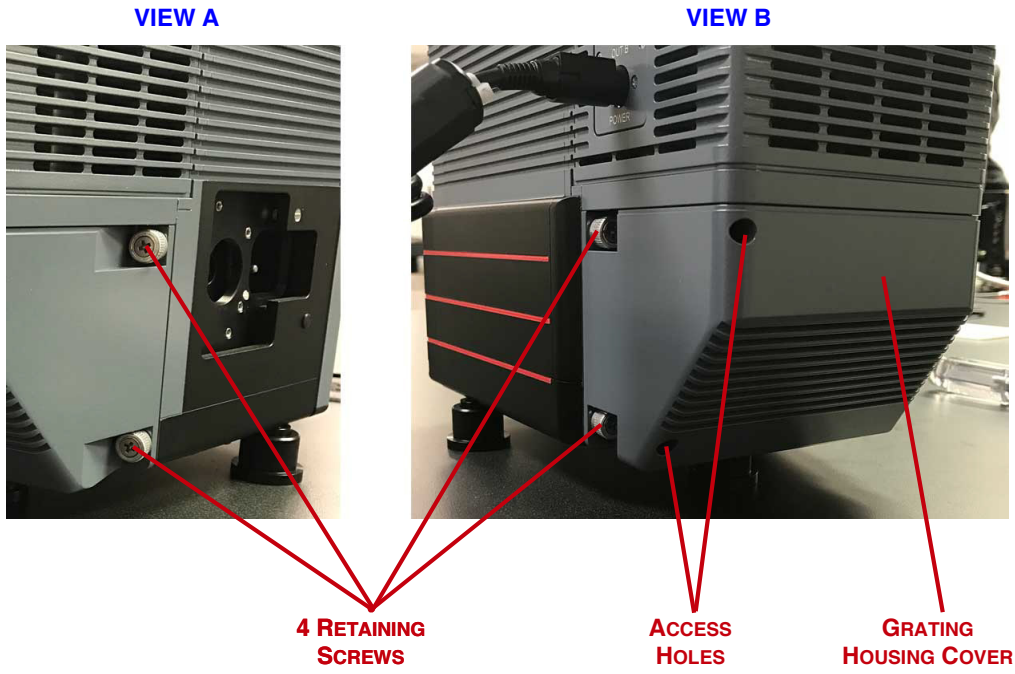
Perform the following procedure to replace a Fergie Grating Carrier:

1. Use the #2 phillips head screwdriver to loosen/remove each of the four (4) phillips head screws securing the Grating Housing Cover to the Fergie chassis. See Figure 4-1.

NOTE:

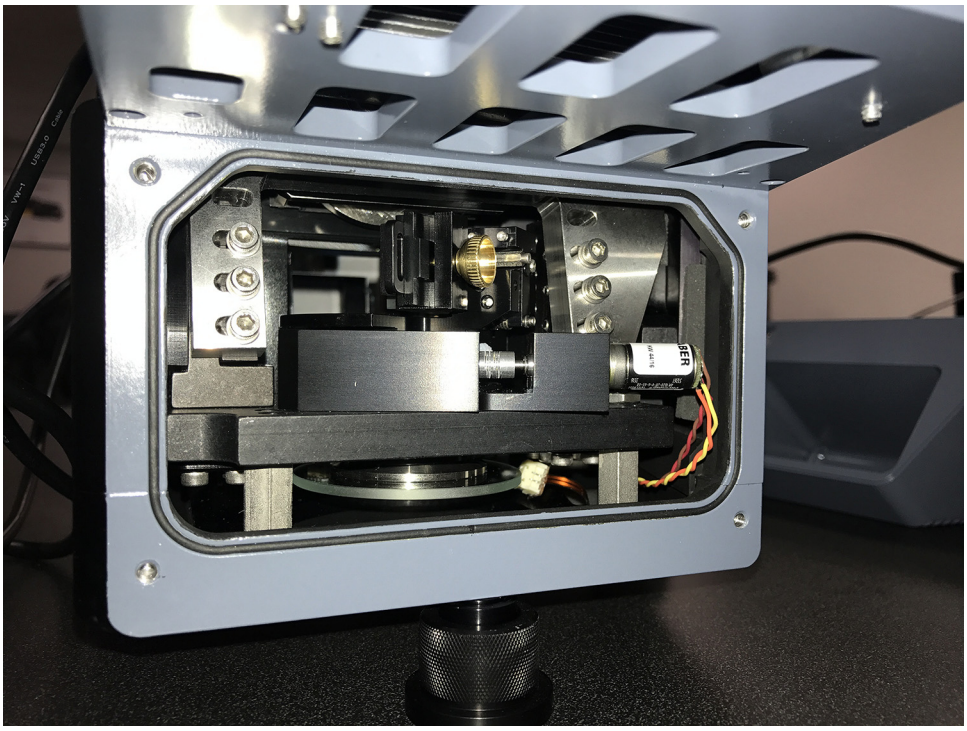
The two (2) phillips head screws shown in Figure 4-1, **VIEW B**, are accessed by inserting the screwdriver through the two access holes indicated.

Figure 4-1: Removing the Fergie Grating Housing Cover



2. Remove the Grating Housing to expose the rear of the grating drive. See Figure 4-2

Figure 4-2: Fergie Grating Drive [Rear View]



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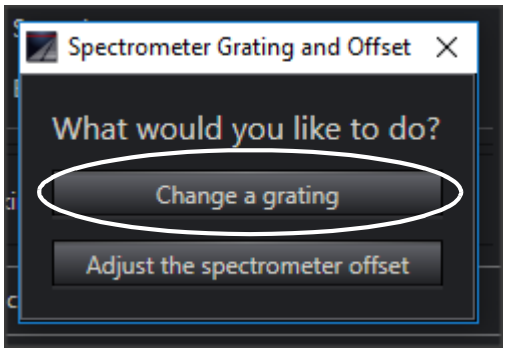
3. If not already running, launch *LightField for Fergie*.
4. Open the **LightField Spectrometer Grating and Offset** add-in.
5. When prompted, select **Change a grating**. See Figure 4-3.

Figure 4-3: LightField Spectrometer Grating and Offset Option Dialog



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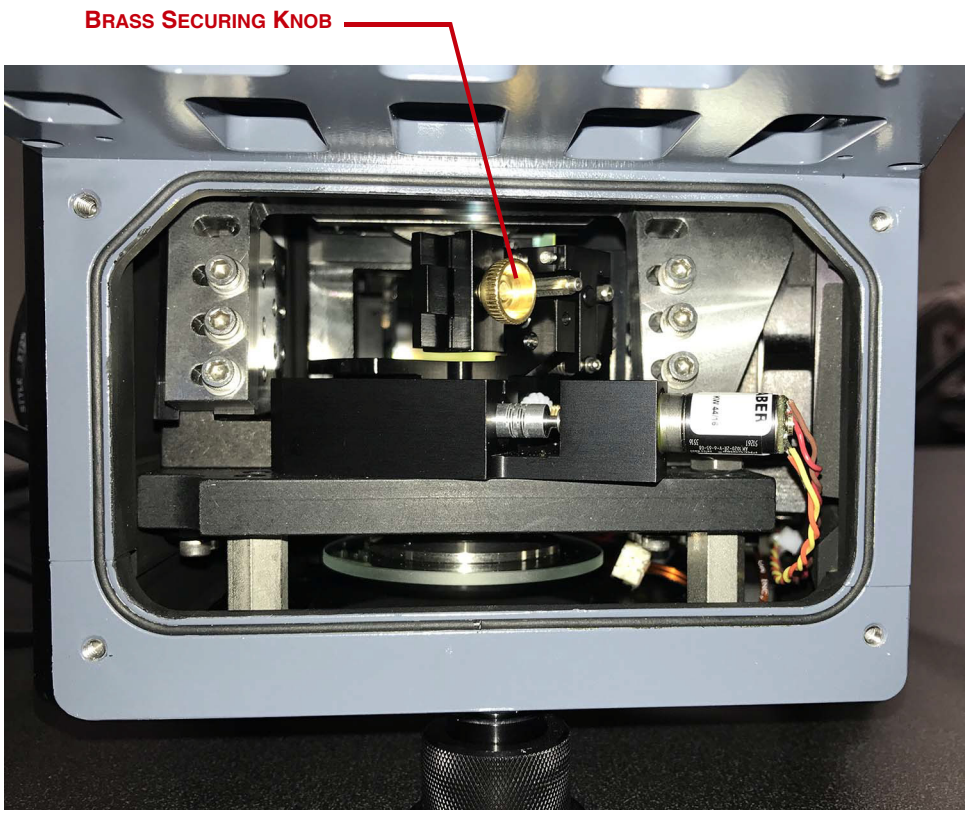
6. Locate the brass securing knob indicated in Figure 4-4

Figure 4-4: Grating Housing: Brass Securing Knob



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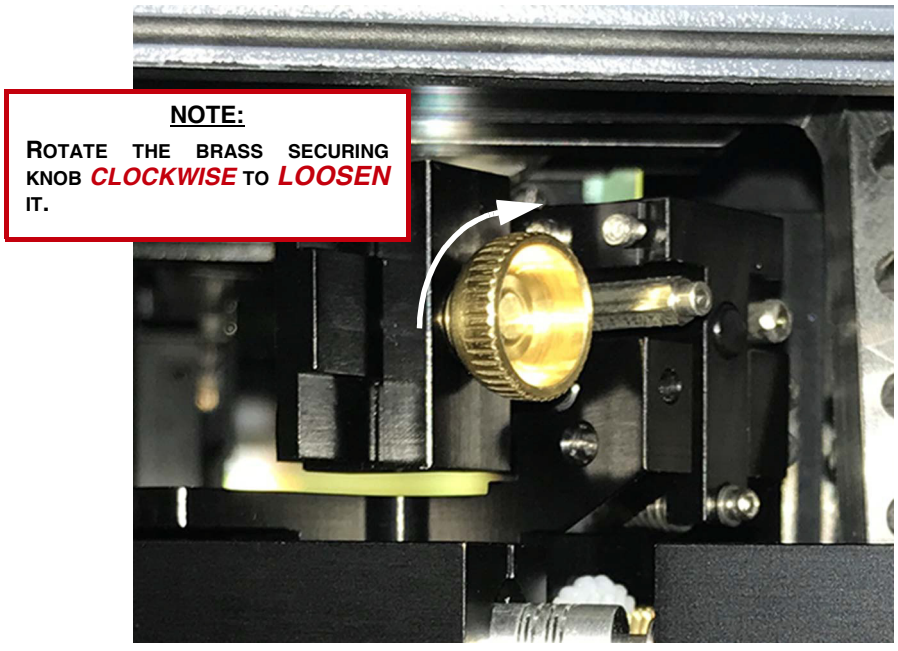
7. Carefully rotate the brass securing knob **clockwise** to loosen it. See Figure 4-5.

Figure 4-5: Loosening Brass Securing Knob



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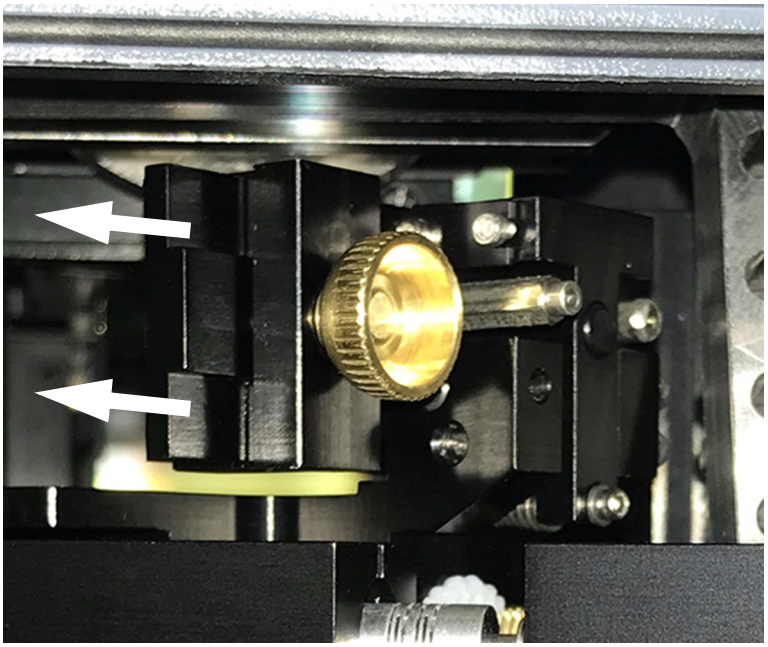
8. Once the securing knob is loosened, carefully grasp the Grating Carrier and slide it out of the unit. See Figure 4-6.

NOTE:

The Grating Carrier is magnetically retained in place, so some minor resistance may be observed when sliding it out of the unit.

Figure 4-6: Remove Grating Carrier



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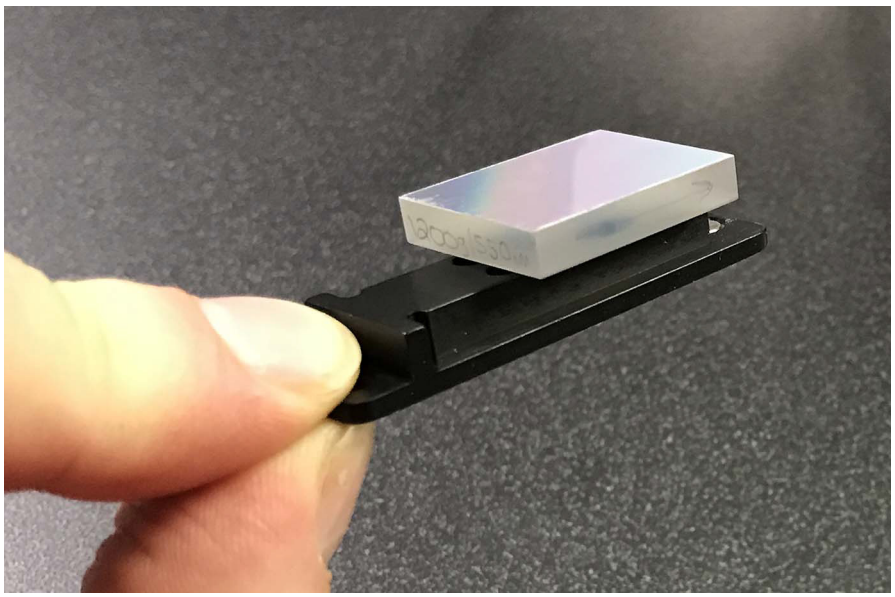
9. Place the removed Grating Carrier, shown in Figure 4-7, in the provided protective case for safe storage.

Figure 4-7: Typical Fergie Grating/Grating Carrier Assembly



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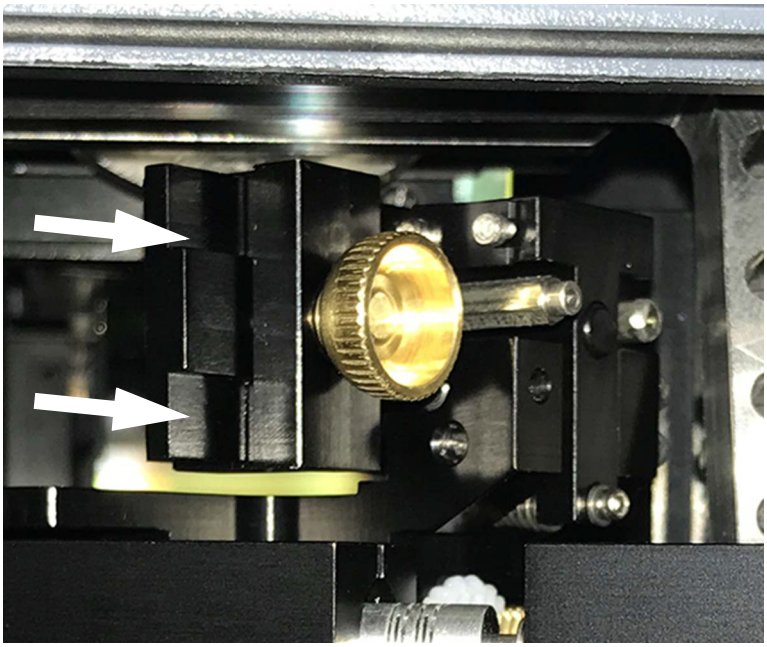
10. Select the new Grating/Grating Carrier, remove it from its storage case, and carefully slide it into place within Fergie. See Figure 4-8.

NOTE:

In addition to the brass securing knob, the Grating Carrier is magnetically retained in place. It will snap into position as it approaches its proper location.

Figure 4-8: Insert Grating Carrier



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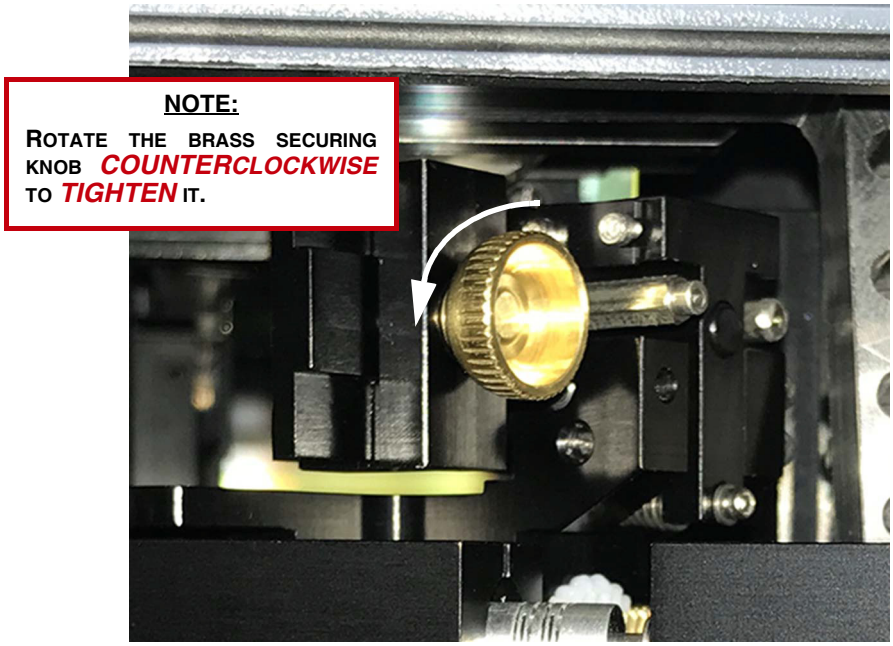
11. Once in place, carefully rotate the brass securing knob **counterclockwise** to tighten it. See Figure 4-9.

Figure 4-9: Tightening Brass Securing Knob



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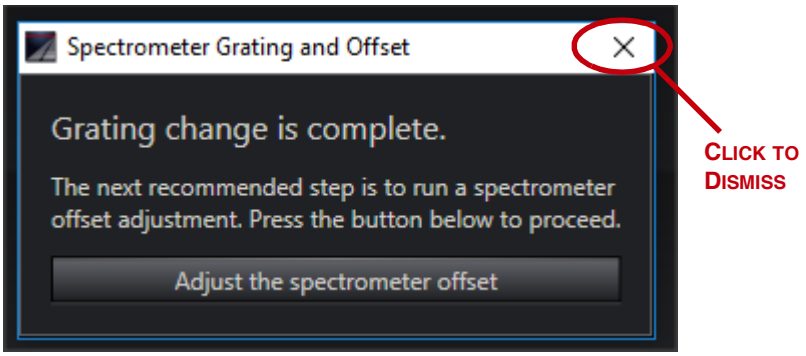
12. Within *LightField for Fergie*, select the grating that has been installed, and click **Set Grating**.
13. When the Grating Change is complete dialog is displayed, similar to that shown in Figure 4-10, dismiss it by clicking on the **X** in the upper right-hand corner.

Figure 4-10: Spectrometer Grating and Offset Dialog: Grating Change Complete



14. Now that a new Grating Carrier has been installed, it must be aligned. Proceed to Section 4.3, Grating Carrier Alignment.

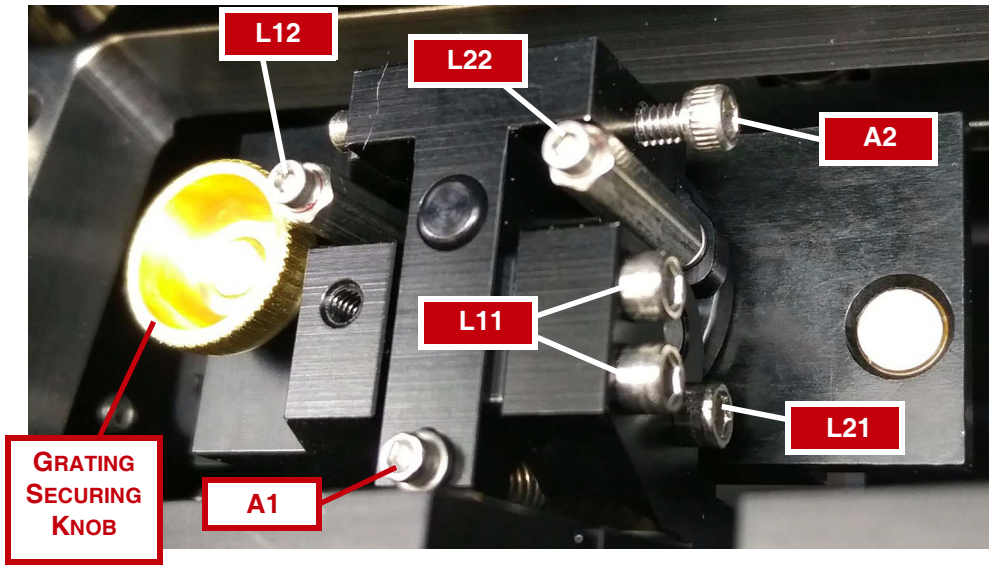
4.3 Grating Carrier Alignment

This section provides information necessary to align a Fergie Grating.

4.3.1 Grating Carrier Adjustment Screws

Figure 4-11 shows the locations of all adjustment screws required to align a Fergie Grating.

Figure 4-11: Grating Carrier Adjustment Screws



Refer to Table 4-1 for information about each adjustment screw, listed alphabetically by label/identifier.

Table 4-1: Grating Adjustment Screws

Label/Identifier	Adjustment/Purpose	Adjustment Tool
A1	Tilt adjustment.	0.050” allen wrench
A2	Tangent adjustment.	5/64” allen wrench
L11[a]	Tilt adjustment, initial lock.	5/64” allen wrench
L12	Tangent adjustment, initial lock.	0.050” allen wrench or 1/8” hex driver
L21	Tilt adjustment, final lock.	5/64” allen wrench
L22	Tangent adjustment, final lock.	0.050” allen wrench or 1/8” hex driver

a. L11 is comprised of two (2) discrete adjustment screws. See Figure 4-11 on page 26.

4.3.2 Grating Carrier Alignment Procedure

Perform the following procedure to align a grating carrier in Fergie:

1. Using the tool specified in Table 4-1, loosen the following adjustment screws:
   - L11;
   - L12;
   - L21;
   - L22.
2. Within *LightField for Fergie*, if necessary, configure the system parameters as follows:
   - **Readout –> Mode: Full Frame**;
   - **Common Acquisition Settings –> Exposure Time: 50 ms**.
3. Illuminate the entrance slit using a Mercury (Hg) atomic emission lamp.

NOTE:

If a Mercury (Hg) atomic emission lamp is not available, fluorescent room lights or any other atomic emission source that emits in the target wavelength range may be used.

4. Position the grating at 0 nm. Verify the entrance slit is installed and properly focused.
5. Figure 4-12 illustrates, in flowchart format, the procedure required to align a grating. Perform this iterative procedure until the grating is properly aligned.

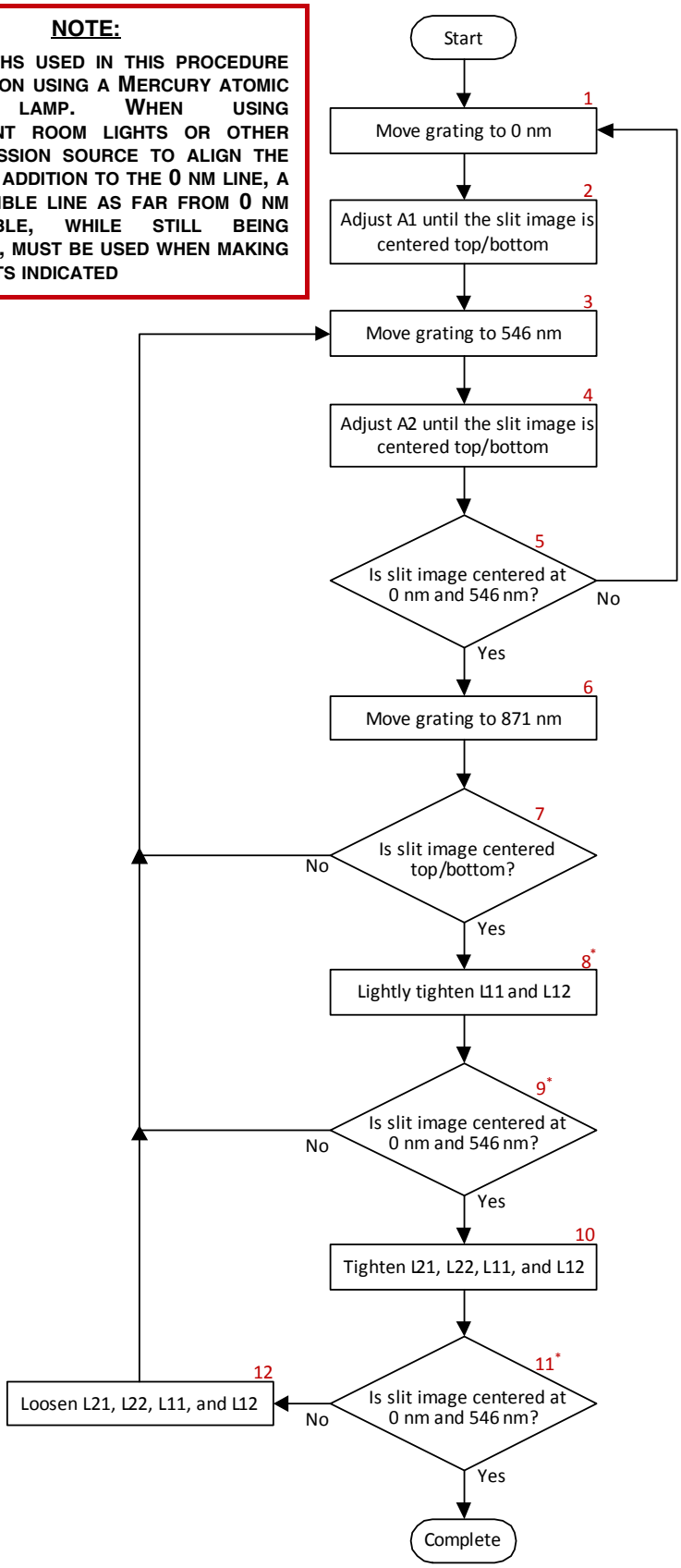
NOTE:

When using fluorescent room lights or other atomic emission source to align the grating, in addition to the 0 nm line, a second visible line as far from 0 nm as possible, while still being convenient, must be used when making adjustments indicated in Figure 4-12.

Figure 4-12: Grating Alignment Procedure Flowchart

NOTE:

WAVELENGTHS USED IN THIS PROCEDURE ARE BASED ON USING A MERCURY ATOMIC EMISSION LAMP. WHEN USING FLUORESCENT ROOM LIGHTS OR OTHER ATOMIC EMISSION SOURCE TO ALIGN THE GRATING, IN ADDITION TO THE 0 NM LINE, A SECOND VISIBLE LINE AS FAR FROM 0 NM AS POSSIBLE, WHILE STILL BEING CONVENIENT, MUST BE USED WHEN MAKING ADJUSTMENTS INDICATED



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* REFER TO Step-Specific Notes, ON PAGE 29

Step-Specific Notes

See Figure 4-11 on page 26 as required.

- **Step 8**

  If adjustment screws **L11** and **L12** are too tight, adjustments to **A1** and **A2** may not be possible. If this happens, simply loosen **L11** and **L12** and proceed to step 9.

- **Step 9**

  If it is observed that the slit image is centered at 546 nm, but is not centered at 0 nm, return to step 1.

  If it is observed that the slit image is centered at 0 nm, but is not centered at 546 nm, return to step 3.

- **Step 11**

  If it is observed that the slit image is centered at 546 nm, but is not centered at 0 nm, proceed to step 12, and then return to step 1.

  If it is observed that the slit image is centered at 0 nm, but is not centered at 546 nm, proceed as directed to step 12, and then return to step 3.

6. Proceed to Section 4.4, Replace Grating Housing Cover.

4.4 Replace Grating Housing Cover

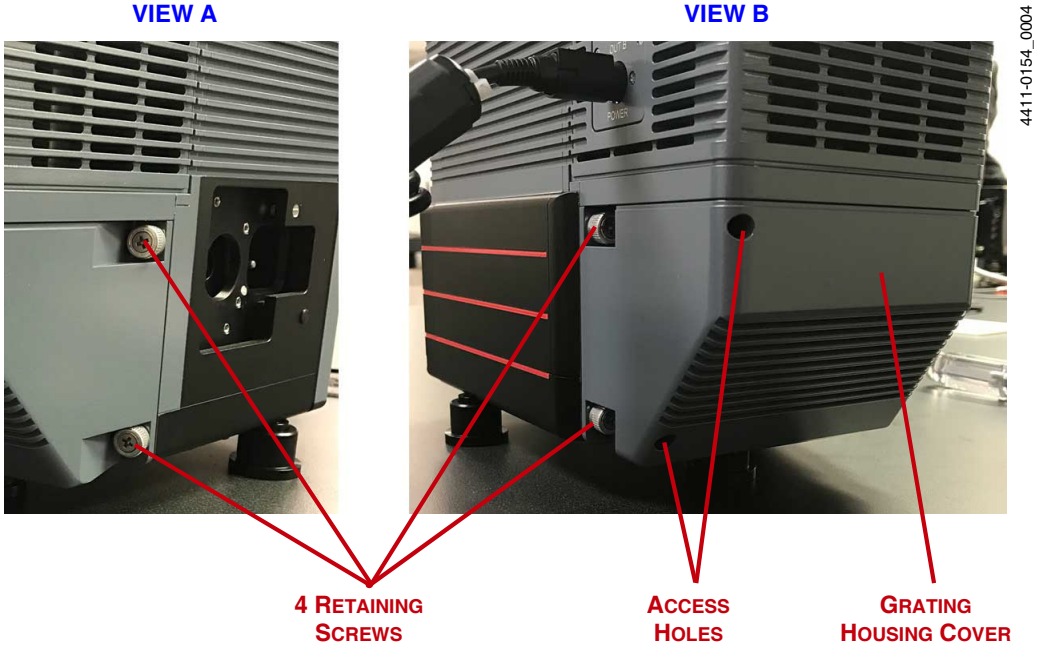
Perform the following procedure to replace the Grating Housing Cover:

1. Position the Grating Housing Cover over the Grating Drive chamber.
2. Using a #2 phillips head screwdriver, carefully tighten each of the four (4) phillips head screws to secure the Grating Housing Cover to the Fergie chassis. See Figure 4-13.

NOTE:

The two (2) phillips head screws shown in Figure 4-13, **VIEW B**, are accessed by inserting the screwdriver through the two access holes indicated.

Figure 4-13: Removing the Fergie Grating Housing Cover



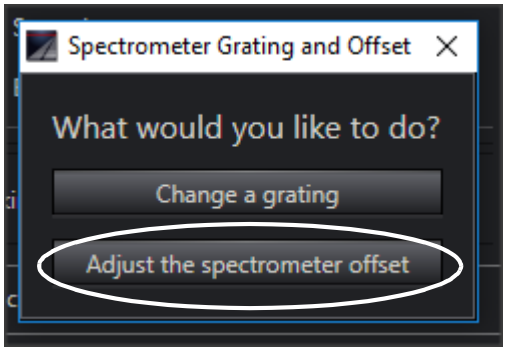
4.5 Final Alignment

Once the Grating has been aligned and the Grating Housing Cover has been reinstalled, the final step is to return to *LightField for Fergie* and adjust the spectrometer offset.

Perform the following procedure to

1. Within *LightField for Fergie*, open the **LightField Spectrometer Grating and Offset** add-in.
2. When prompted, select **Adjust the spectrometer offset**. See Figure 4-14.

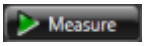
Figure 4-14: LightField Spectrometer Grating and Offset Option Dialog



4411-0154_0017

3. Click  to preview the light source

   Verify there is a strong, focused peak at 0 nm. If the peak is missing, weak, or out of focus, verify the light source is turned on as well as the system is configured properly. Acquire another image.

4. Click the 

button associated with the grating for which the offset is being calculated. *LightField for Fergie* calculates and displays the new offset value, in steps, in the **Calculated** column with the corresponding wavelength error, in nm, next to it.

   Click 

to clear the set of offset values that have just been calculated.

5. If desired, the offset may be manually fine-tuned using the four **Manual Adjustments** arrows (« < > ») provided.

6. Click 

to accept the calculated offset value, apply it to the system, and store the new value in the spectrometer's EEPROM.

Chapter 5: Internal Shutter

Each Fergie is shipped with an internal mechanical shutter that can be replaced in the field. This chapter provides information about the removal and installation of this internal shutter.

5.1 Required Tools

The following tools are required to remove and install an internal shutter on Fergie:

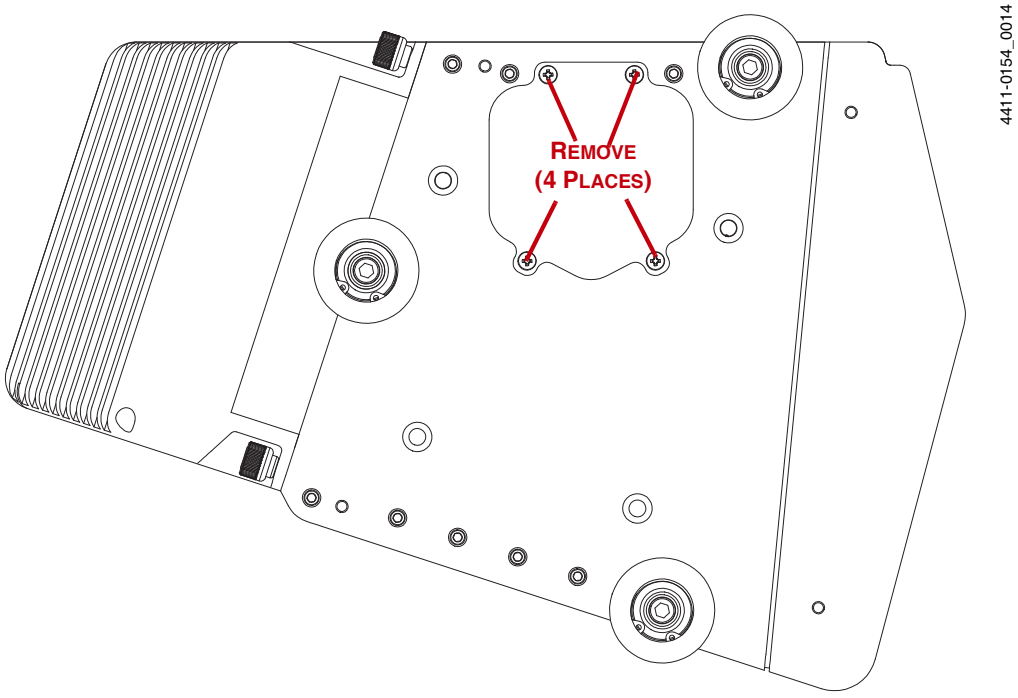
- #1 Phillips head screwdriver;
- 3/8” allen wrench.

5.2 Internal Shutter Removal Procedure

Perform the following procedure to remove the internal shutter from Fergie:

1. Disconnect all cables and other equipment/accessories from the Fergie.
2. Carefully turn the Fergie over onto a clean, flat, dry, sturdy surface so that the underside of the chassis is accessible.
3. Use a #1 Phillips head screwdriver to loosen/remove each of the four (4) Phillips head screws securing the shutter access panel to the underside of the Fergie chassis. See Figure 5-1.

Figure 5-1: Remove Shutter Access Panel: Underside of Fergie



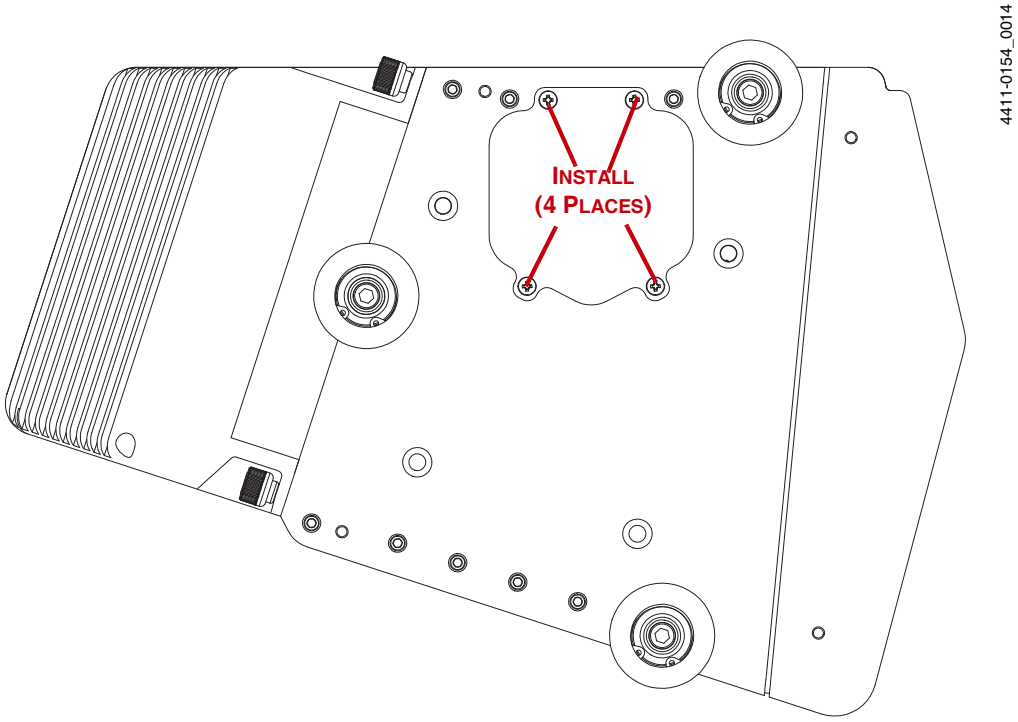
4. Once the access panel has been removed, use the 3/8” allen wrench to loosen the two allen screws that are visible.
5. Carefully disconnect the two-conductor electrical shutter cable.
6. Carefully slide the shutter down to remove it.

5.3 Internal Shutter Installation Procedure

Perform the following procedure to install an internal shutter into Fergie:

1. Carefully slide the shutter into the bottom of the Fergie chassis.
2. Carefully reconnect the two-conductor electrical shutter cable.
3. Use the 3/8” allen wrench to secure/tighten the two allen screws.
4. Replace the shutter access panel.
5. Replace the four (4) Phillips head screws to secure the shutter access panel to the underside of the Fergie chassis and use the #1 Phillips head screwdriver to tighten each screw. See Figure 5-2.

Figure 5-2: Install Shutter Access Panel: Underside of Fergie



Chapter 6: System Configuration

This chapter provides information about the configuration of a Fergie system.

6.1 Initial Setup

Perform the following procedure to setup a Fergie system:

1. If necessary, install *LightField for Fergie*. Refer to Chapter 3, Install LightField for Fergie, on page 19 for complete information.
2. Position the Fergie where it will be used.
3. Insert the slit into the slit carrier.
   - To remove the entrance slit, pull rightward on the stainless steel pin until the entrance aperture is fully exposed, and then pull outward.
   - To install the entrance slit, align the slit carrier with the entrance aperture and slide the slit leftward until it comes to a stop.

   NOTE:
   The slit is installed properly if, when sliding it rightward just enough to expose the entrance aperture and then pushing back leftward, the slit is magnetically pulled against its internal reference.
4. Connect the host end of the supplied USB 3.0 cable to the host computer and the peripheral end to the Fergie.
5. Connect the power supply shipped with Fergie to the **POWER** connector located on the side of Fergie.
6. Verify that Fergie is connected to the host computer's USB 3.0 port.

   NOTE:
   USB 3.0 ports are typically indicated by **SS** next to the standard USB logo.
7. Launch *LightField for Fergie*.

6.2 Focus the Slit

This section provides information about focusing the slit on Fergie.

6.2.1 Required Tools

The following tools are required to focus a slit:

- 5/64 allen wrench
- #1 phillips head screwdriver

6.2.2 Focus Procedure

Perform the following procedure to focus the slit:

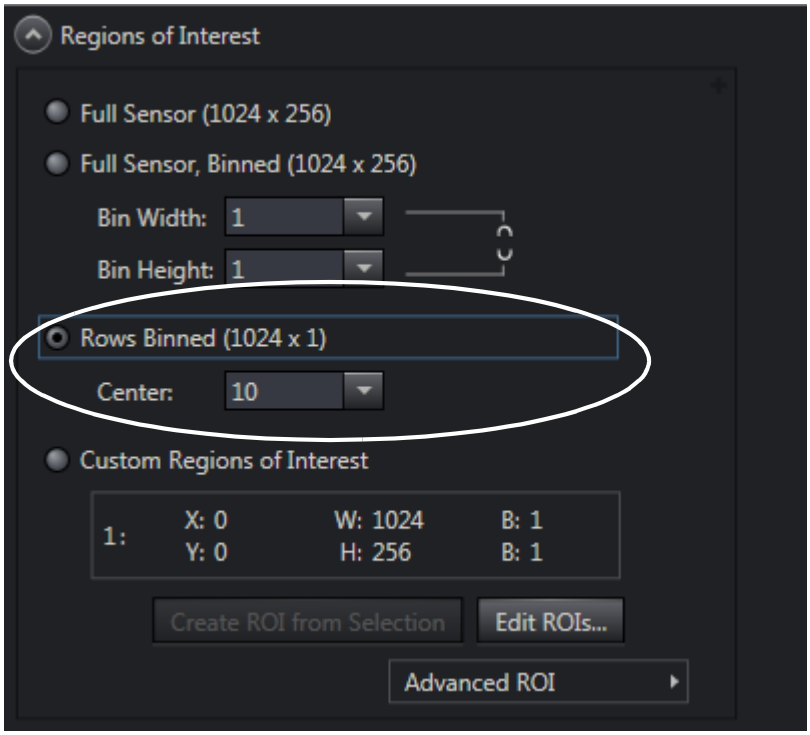
1. Illuminate the slit with light from the Fergie atomic emission wavelength calibration lamp.

NOTE:

If you do not have a Fergie wavelength atomic emission calibration lamp, use a suitable atomic emission lamp.

2. If necessary, within *LightField for Fergie*, on the **Experiment Setting** tab, open the **Regions of Interest** expander and select **Bin Center 10 rows**. See Figure 6-1.

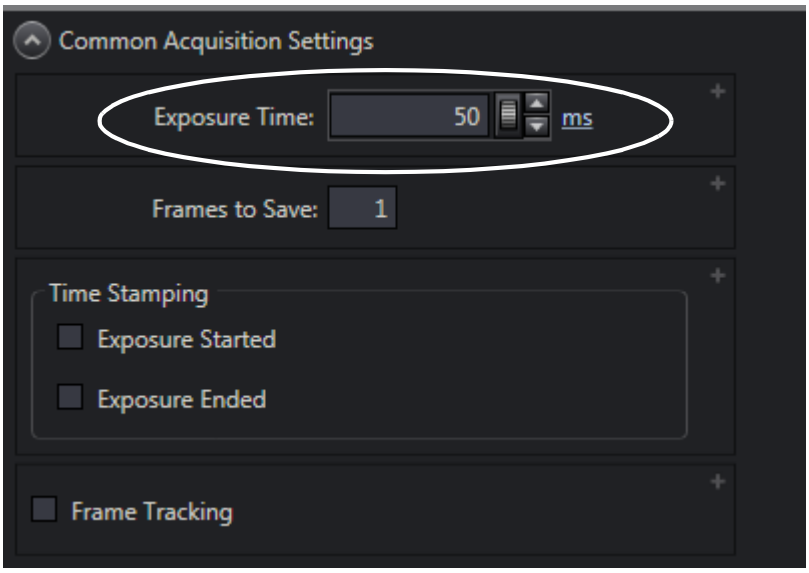
Figure 6-1: Configure Regions of Interest



4411-0154_0006

3. On the **Common Acquisition Settings** expander, configure an **Exposure Time** of 50 ms. See Figure 6-2.

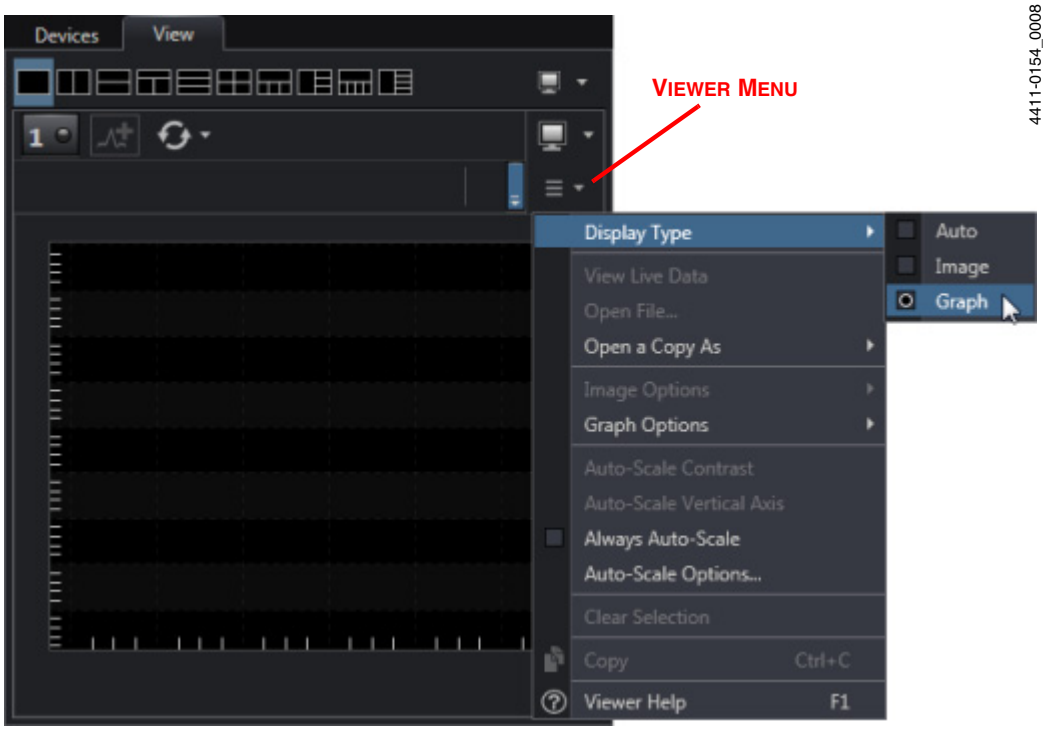
Figure 6-2: Configure Exposure Time



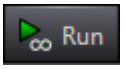
4411-0154_0007

4. Click on the **View** tab, and from within the **Viewer Menu**, select **Display Type —> Graph**. See Figure 6-3.

Figure 6-3: Configure Display Type



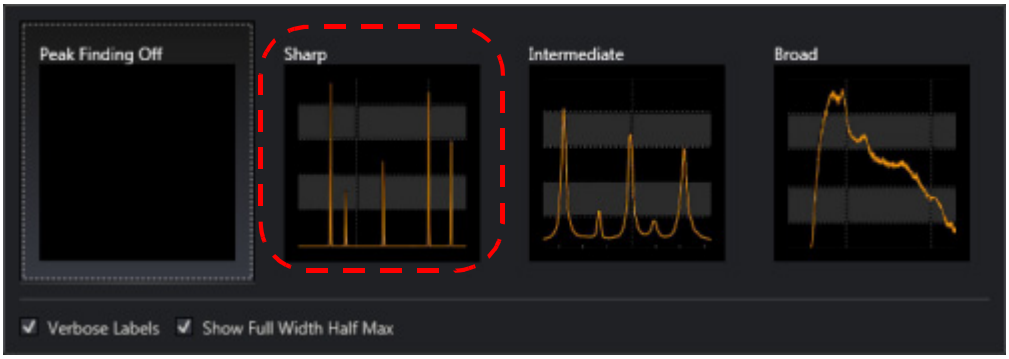
4411-0154_0008

5. Click 

at the top of the workspace to begin data acquisition.
6. Verify that there is sufficient ambient room light illuminating the slit.

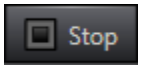
7. Click the **Peak Finding** button  and select **Sharp**. See Figure 6-4.

Figure 6-4: Peak Finding Options



8. Using the 5/64” allen wrench, turn the focus screw, located on the side of the Fergie, clockwise until the peak width has noticeably increased. Then turn the screw counter-clockwise until peak width has reached a minimum value. At this point, the slit is focused. See Figure 6-5.

Figure 6-5: Focus Adjustment Screw

9. Within *LightField for Fergie*, click 

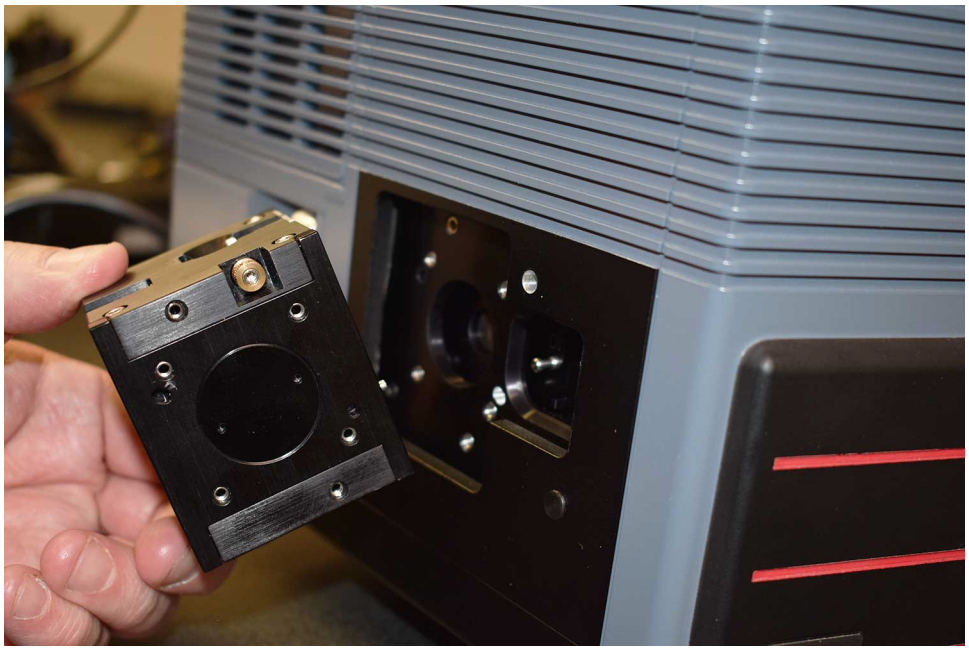
to halt data acquisition.

6.3 Attach Focusing Cube

Once the slit has been focused, perform the following procedure to install the Focusing Cube:

1. Install the Focusing Cube by aligning the stainless steel pins and carefully pressing the cube onto the instrument. See Figure 6-6.

Figure 6-6: Installing the Focusing Cube



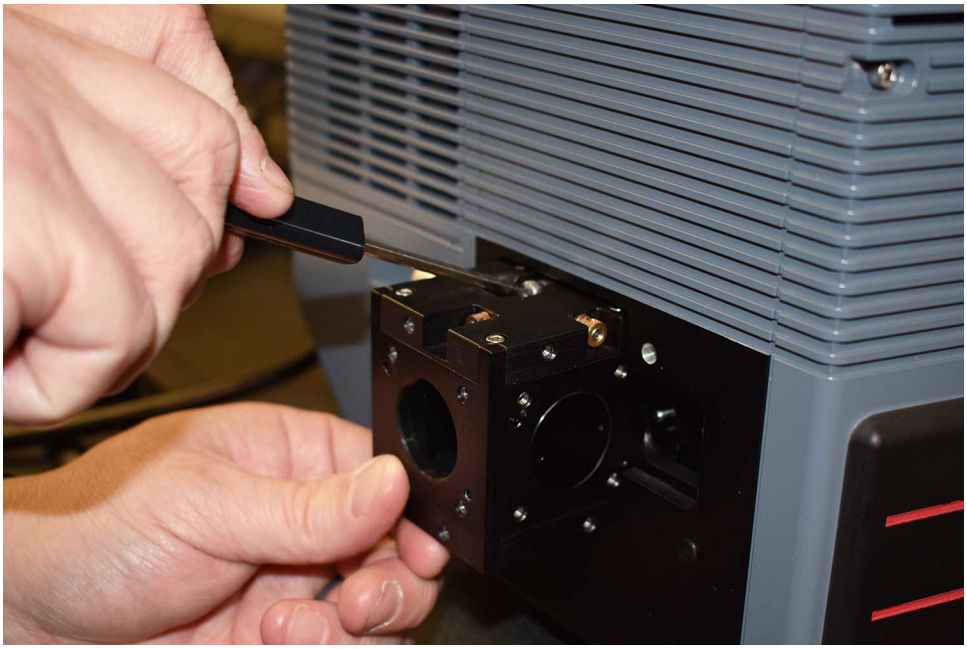
4411-0154_0011

2. Using the #1 phillips head screwdriver, turn the coupling screw clockwise until finger tight. See Figure 6-7.

NOTE:

Tightening the bottom screw is necessary only if installing additional cubes to the focusing cube.

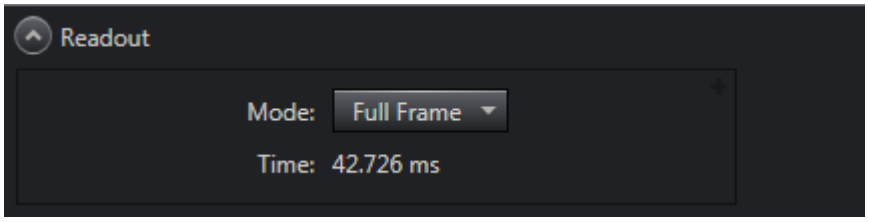
Figure 6-7: Securing the Focusing Cube



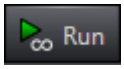
4411-0154_0012

3. Push the slit rightward to expose the full entrance aperture.
4. Within *LightField for Fergie*, from the **Readout** expander, select **Full Frame** from the **Mode** pull-down list. See Figure 6-8.

Figure 6-8: Configure Readout Mode



4411-0154_0013

5. Point the Fergie at an object that is more than 3 m [9.8 feet] away.
6. With the grating set to 0 nm, click 

and adjust the focusing screw until the image comes into best focus.

NOTE:

The horizontal lens alignment screw may require adjustment as well. However, this adjustment should only be performed following the installation of all remaining cubes and/or fore optics.

NOTE:

The installed lens is not intended for wide-field imaging. A diffraction-limited image will not be acquired. A camera lens is necessary when performing wide-field imaging.

6.3.1 Install Additional Cubes

If desired, additional cubes may be stacked onto the Focusing Cube. Figure 6-9 illustrates a typical configuration with three Cubes installed. Refer to Table 2-3, Available Fergie System Accessories, on page 16 for a list of compatible Cubes.

Figure 6-9: Typical Fergie System with Three (3) Cubes Installed

Perform the following procedure to install additional Cubes onto the input to Fergie:

1. Use the #1 phillips head screwdriver to tighten the bottom screw on the previously installed Cube.
2. Install the second Cube by aligning the stainless steel pins and carefully pressing the cube onto the existing Cube.
3. Using the #1 phillips head screwdriver, turn the coupling screw clockwise until finger tight.
4. Repeat step 1 through step 3 for each additional Cube that is to be installed on the Fergie.

6.4 Calibration

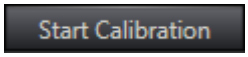
Each Fergie spectrometer is factory calibrated prior to shipment. However, it is strongly recommended that once the instrument arrives, a new IntelliCal calibration be performed.

NOTE:

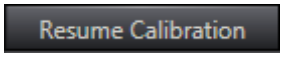
Installing and replacing the entrance slit may cause a slight offset to the calibration which must be corrected by performing a new system calibration.

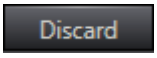
Perform the following procedure to perform an IntelliCal calibration on a Fergie spectrometer system:

1. Install an IntelliCal Light Source on the input to the Fergie system.
2. Configure the IntelliCal Light Source for the desired calibration wavelength.
3. Within *LightField for Fergie*, open the **Calibration** expander.
4. Click 

to initiate the calibration process.
5. Select the desired **Calibration Type**.
   When performing a **Broad** Calibration, select the desired **Center Wavelength(s)**.
6. Click 

to start the calibration.
7. When the calibration has been satisfactorily completed, click 

.
   - To continue the calibration process, click 

.
   - To discard the calibration results, click 

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6.5 Experiment Design

Once the system has been focused and calibrated, experiments can be designed and built by:

- Adding additional cubes to the Fergie system input;
- Interfacing with Fergie via Thorlabs® 30 mm cage system components;
- Using free space optics mounted on an optical bread board.

Chapter 7: System Operation

This chapter provides information about operating a Fergie system.

7.1 Pre-Operation Verification

Before launching *LightField for Fergie*, verify that:

- Fergie is connected to the host computer's USB 3.0 port.

  NOTE:
  USB 3.0 ports are typically indicated by **SS** next to the standard USB logo.

- The entrance slit is properly installed.
- The system hardware has been configured, focused, and calibrated as described in Chapter 6, System Configuration, beginning on page 33.
- An appropriate incoming light source has been installed on the system input.
- Fergie is powered on.

  CAUTION!
  It is important to first plug the power connector into the Fergie and then energize the power supply by connecting the line cord to an appropriate AC power receptacle.

7.2 Initialization

When Fergie is plugged in, it initializes to zero order, or 0 nm. If power is switched off and then on again, Fergie will reinitialize. Initialization provides the system with a reference, or starting position, to keep track of wavelength position, grating location, and other parameters.

7.3 Using *LightField for Fergie*

Launch *LightField for Fergie* after verifying Fergie is connected to the host computer and is powered on. When *LightField for Fergie* launches, it looks for available devices and will load corresponding icons into the **Available Devices** panel. Before designing a new experiment or running an existing one, the appropriate device icons must be dragged into the **Experiment Devices** panel. Once there is at least one device, the **Experiment Settings** panel will be populated with expanders for groups of experiment settings.

7.3.1 Add Fergie to the Experiment

Perform the following procedure add Fergie to an experiment:

1. After *LightField for Fergie* opens, an icon representing Fergie should be visible within the **Available Devices** area. See Figure 7-1.

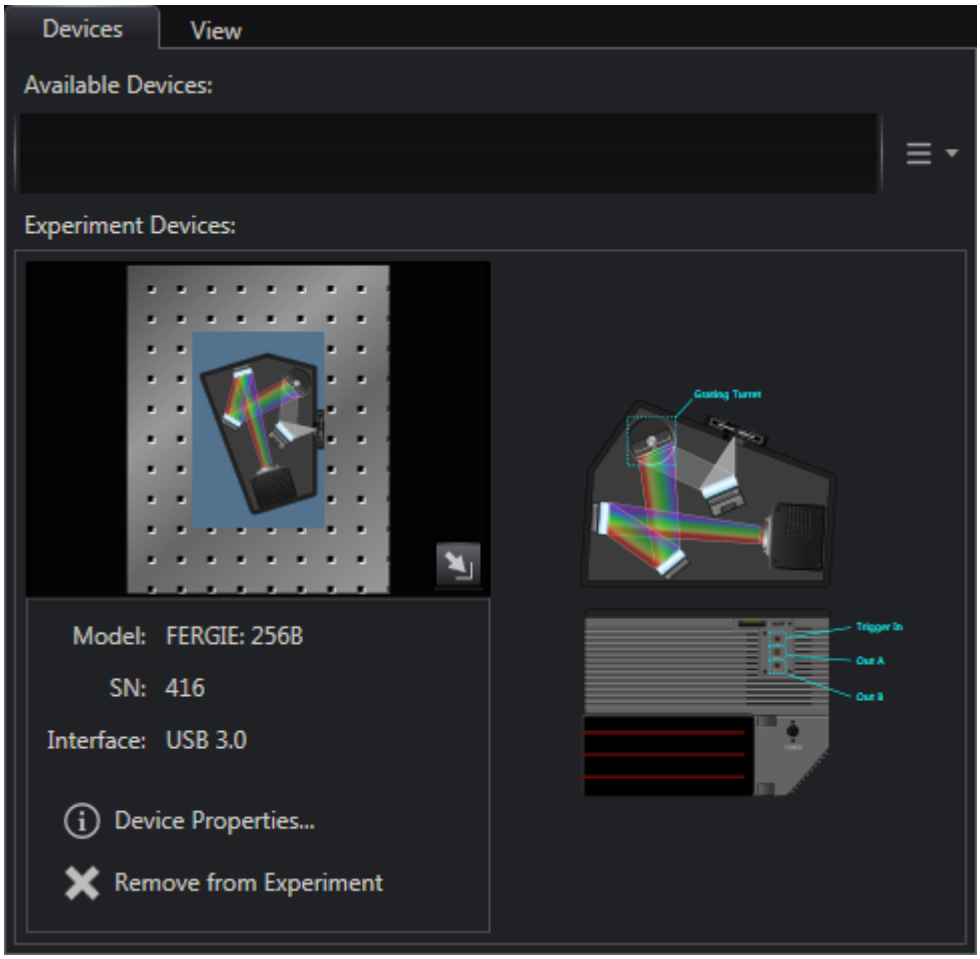
Figure 7-1: Typical *LightField for Fergie* Available Devices Panel

NOTE:

LightField for Fergie only supports Fergie spectrometers. Please contact customer support or a local sales engineer for information about how to obtain a full LightField License. Refer to Contact Information on page 58 for complete information.

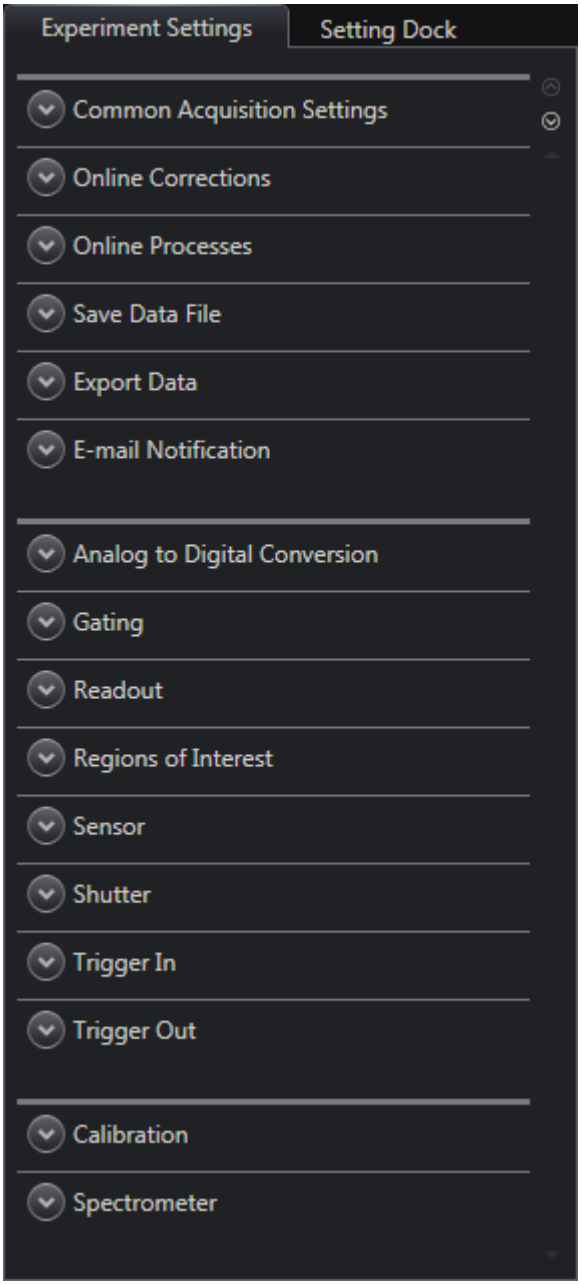
2. Within the **Available Devices** area, left-click on (and hold) the Fergie icon and then drag it into the **Experiment Devices** area. See Figure 7-2.

Figure 7-2: Typical Devices Workspace



3. The **Experiment Settings** stack is automatically populated with the appropriate set of expanders with default parameter values used. Figure 7-3 illustrates a typical **Experiment Settings** stack.

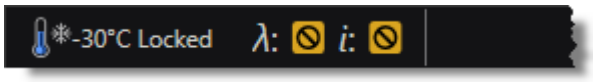
Figure 7-3: Typical Experiment Settings Stack



4411-0154_0026

4. The **Status** bar across the bottom of the *LightField for Fergie* workspace includes a status icon for **Temperature Status** which reports the current system temperature and indicates whether the programmed target temperature has been reached. See Figure 7-4.

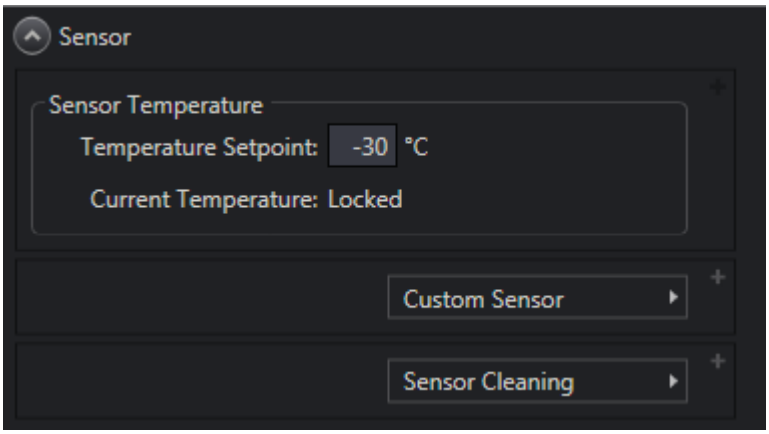
Figure 7-4: Typical Status Bar



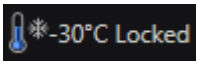
4411-0154_0027

5. Open the **Sensor** expander to program the desired target temperature for the system. See Figure 7-5.

Figure 7-5: Typical Sensor Expander

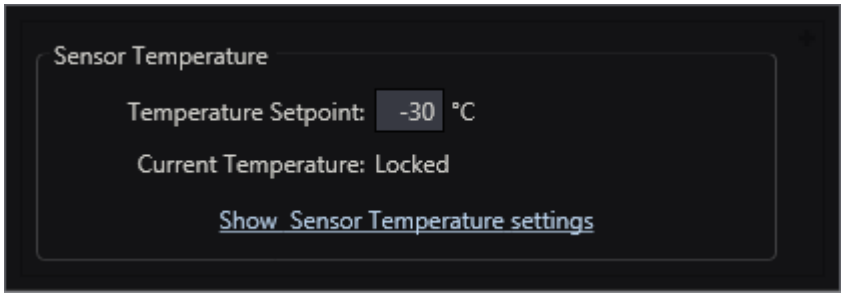


4411-0154_0028

Alternatively, click on 

to open the **Sensor Temperature** dialog, shown in Figure 7-6.

Figure 7-6: Typical Sensor Temperature Dialog

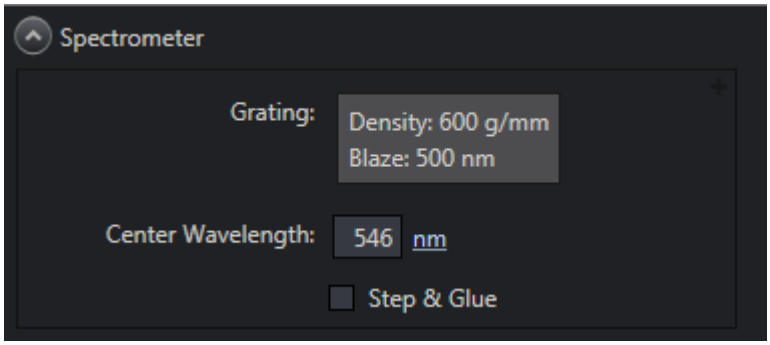


4411-0154_0029

6. Open the **Spectrometer** expander and program the desired **Center Wavelength**.

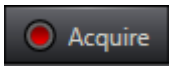
   For example, in Figure 7-7, the 600 g/mm, Blaze: 500 **Grating** has been factory installed, and the **Center Wavelength** is programmed to 546 nm for a Mercury (Hg) lamp.

Figure 7-7: Typical Spectrometer Expander



4411-0154_0030

7. Verify that an appropriate incoming light source is installed and turned on.

8. Click 

to begin data acquisition.

Appendix A: Technical Specifications

NOTE:
All specifications are subject to change.

This appendix provides technical information and specifications for the Fergie system. Additional information may be found on data sheets available on the Princeton Instruments website (www.princetoninstruments.com).

A.1 General System Specifications

Refer to Table A-1 for general system specifications.

Table A-1: General System Specifications

Parameter	Specification		
	Minimum	Nominal	Maximum
Read Noise	–	7 e^- rms @ 1 MHz 20 e^- rms @ 5 MHz	–
Vertical Shift Rate[a]	6 µsec	–	18 µsec
Non-linearity	–	–	2% @ 1 MHz
Dimensions			
Length	–	10 in [26.8 cm]	–
Width	–	7.1 in [18.0 cm]	–
Height	–	8.3 in [21.0 cm]	–
Weight	–	19.5 lbs [8.84 kg]	–

a. Software programmable

A.2 Power Specifications

All voltages required by the Fergie system are generated and delivered by an external power supply included with each Fergie system.

CAUTION!

Use of a power supply other than that provided with the Fergie system will void the system warranty. For specific power supply requirements, contact Princeton Instruments. Refer to Contact Information on page 58 for complete information.

Refer to Table A-2 for power specifications for the external Fergie power supply.

Table A-2: Power Specifications

Parameter	Specification			Units
	Minimum	Nominal	Maximum	
Input				
Voltage	90	–	246	V_{AC}
Frequency	47	–	63	Hz
Output				
Voltage	–	18	–	V_{DC}
Current	–	–	4.45	A
Power	–	–	80	W

A.3 Environmental Specifications

Refer to Table A-3 for environmental specifications.

Table A-3: Fergie Environmental Specifications

Parameter	Specification		
	Minimum	Nominal	Maximum
Storage Temperature	-20°C		+55°C
Operating Temperature	+5°C		+30°C
Operating Ambient Relative Humidity	<80% (non-condensing)		

NOTE:

The cooling performance may degrade if the room temperature is above +23°C.

A.3.1 Ventilation

A minimum of 1 inch (2.54 cm) clearance is required around all vents on the Fergie system.

When Fergie is operated within an enclosure, >30 cfm air circulation and heat dissipation of 200 W is required.

A.4 Cooling Specifications

Refer to Table A-4 for cooling specifications for a Fergie system.

Table A-4: Temperature Specifications

Specification	Cooling Temperature			Units
	Minimum	Default	Maximum	
Cooling Temperature	–	-45[a]	-48	°C
Temperature Stability	±1			°C

a. Guaranteed at ambient temperature of +20°C

A.5 CCD Specifications

Refer to Table A-5 for CCD specifications for the Fergie system.

Table A-5: CCD Specifications[a]

Parameter	Specification
CCD	Proprietary
Image Type	Monochrome
Resolution	1024 x 256
Pixel Size	13 µm x 13 µm
Active Area	13.3 mm x 3.3 mm
Frame Rate	34 fps (full frame)

a. Specifications are valid as of the publication date of this manual. For up-to-date specifications, refer to the Fergie data sheets available for download from www.princeton-instruments.com.

A.6 Optical Specifications

Refer to Table A-6 for optical specifications.

Table A-6: Optical Specifications

Parameter	Specification			Units
	Minimum	Nominal	Maximum	
Focal Length	–	80.8	–	nm
Aperture Ratio	–	f/4.0	–	–
Wavelength Range	190	–	1100	nm

A.7 Spectral Specifications

Refer to Table A-7 for spectral specifications.

Table A-7: Spectral Specifications

Parameter	Specification			Units
	Minimum	Nominal	Maximum	
Spectral Resolution	–	0.13	–	nm
Astigmatism		0[a]		–
Wavelength Accuracy[a]	–	±0.2	–	nm
Wavelength Repeatability[a]	–	±0.02	–	nm
Drive Step Size	–	0.035[a]	–	nm

a. With 1200 g/mm grating @ 435 nm

A.8 Grating Specifications

Refer to Table A-8 for information about Fergie-compatible gratings.

Table A-8: Fergie-Compatible Grating Information

Part Number	Grooves/mm	Blaze Wavelength
FER-GRT-1200-550	1200 g/mm	BLZ 550 nm
FER-GRT-1180-550	1180 g/mm	BLZ 550 nm
FER-GRT-600-750	600 g/mm	BLZ 750 nm
FER-GRT-295-575	295 g/mm	BLZ 575 nm
FER-GRT-1800-250	1800 g/mm	BLZ 250 nm

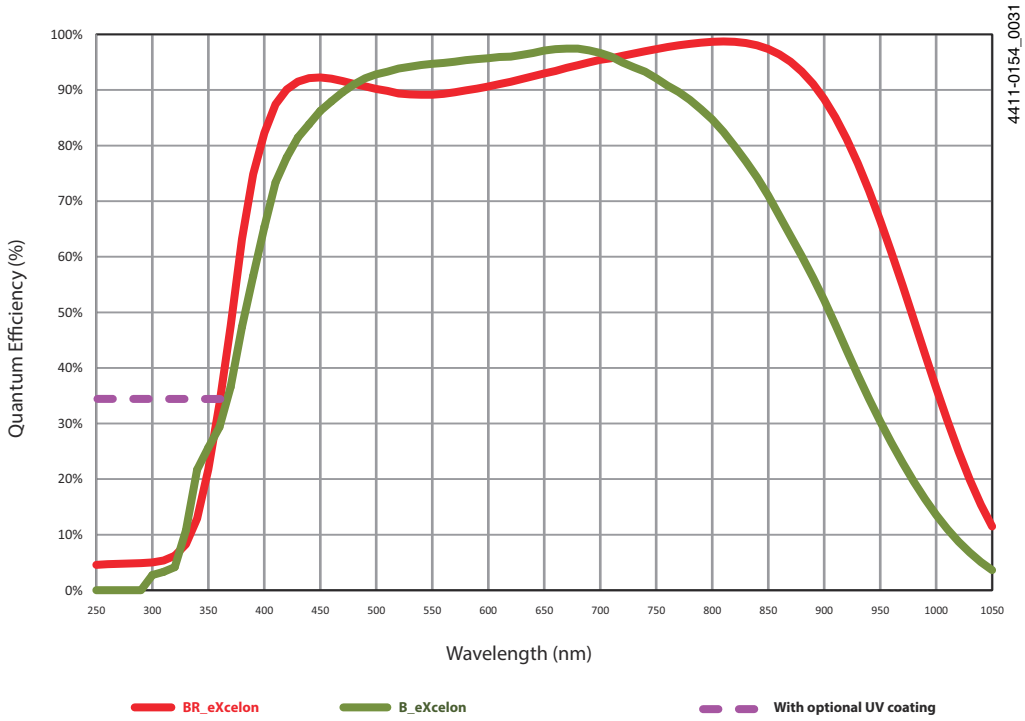
NOTE:

Contact Princeton Instruments for additional grating options. Refer to Contact Information on page 58 for complete information.

A.9 Quantum Efficiency

Figure A-1 illustrates the Quantum Efficiency of the Fergie system.

Figure A-1: Relative QE vs. Wavelength



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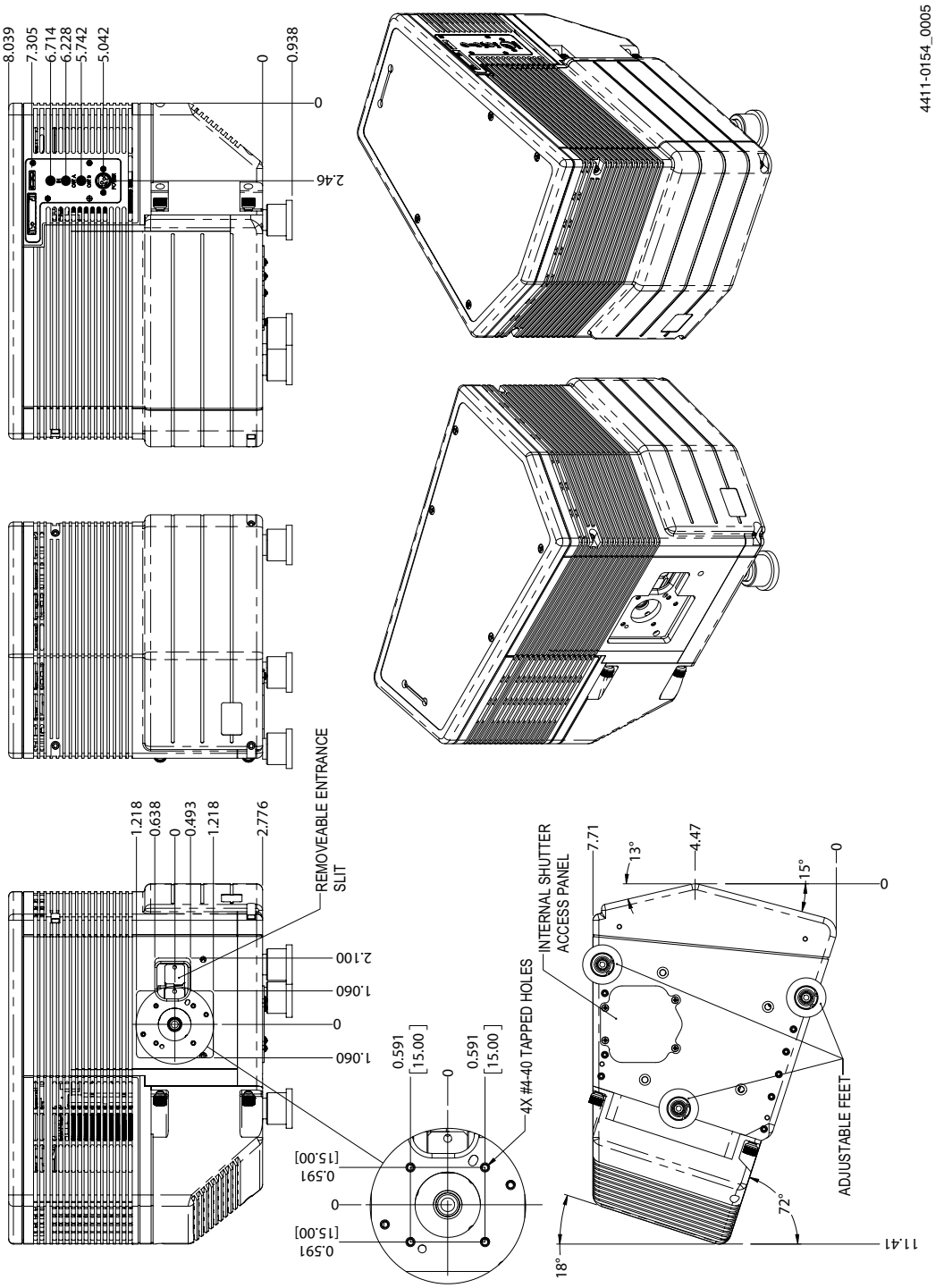
Appendix B: Outline Drawings

Figure B-1: Fergie Outline Drawing



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Warranty and Service

Limited Warranty

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

Basic Limited One (1) Year Warranty

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

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

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

XP Vacuum Chamber Limited Lifetime Warranty

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

Sealed Chamber Integrity Limited 12 Month Warranty

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

Vacuum Integrity Limited 12 Month Warranty

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

Image Intensifier Detector Limited One Year Warranty

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

X-Ray Detector Limited One Year Warranty

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

Software Limited Warranty

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

Owner's Manual and Troubleshooting

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

Your Responsibility

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

1. You must retain your bill of sale (invoice) and present it upon request for service and repairs or provide other proof of purchase satisfactory to Princeton Instruments.
2. You must notify the Princeton Instruments factory service center within (30) days after you have taken delivery of a product or part that you believe to be defective. With the exception of customers who claim a "technical issue" with the operation of the product or part, all invoices must be paid in full in accordance with the terms of sale. Failure to pay invoices when due may result in the interruption and/or cancellation of your one (1) year limited warranty and/or any other warranty, expressed or implied.
3. All warranty service must be made by the Princeton Instruments factory or, at our option, an authorized service center.
4. Before products or parts can be returned for service you must contact the Princeton Instruments factory and receive a return authorization number (RMA.) Products or parts returned for service without a return authorization evidenced by an RMA will be sent back freight collect.
5. These warranties are effective only if purchased from the Princeton Instruments factory or one of our authorized manufacturer's representatives or distributors.
6. Unless specified in the original purchase agreement, Princeton Instruments is not responsible for installation, setup, or disassembly at the customer's location.
7. Warranties extend only to defects in materials or workmanship as limited above and do not extend to any product or part which:
   - has been lost or discarded by you;
   - has been damaged as a result of misuse, improper installation, faulty or inadequate maintenance, or failure to follow instructions furnished by us;
   - has had serial numbers removed, altered, defaced, or rendered illegible;
   - has been subjected to improper or unauthorized repair;
   - has been damaged due to fire, flood, radiation, or other "acts of God," or other contingencies beyond the control of Princeton Instruments; or
   - is a shutter which is a normal wear item and as such carries a onetime only replacement due to a failure within the original 1 year Manufacturer warranty.
8. After the warranty period has expired, you may contact the Princeton Instruments factory or a Princeton Instruments-authorized representative for repair information and/or extended warranty plans.
9. Physically damaged units or units that have been modified are not acceptable for repair in or out of warranty and will be returned as received.

10. All warranties implied by state law or non-U.S. laws, including the implied warranties of merchantability and fitness for a particular purpose, are expressly limited to the duration of the limited warranties set forth above. With the exception of any warranties implied by state law or non-U.S. laws, as hereby limited, the forgoing warranty is exclusive and in lieu of all other warranties, guarantees, agreements, and similar obligations of manufacturer or seller with respect to the repair or replacement of any parts. In no event shall Princeton Instruments' liability exceed the cost of the repair or replacement of the defective product or part.
11. This limited warranty gives you specific legal rights and you may also have other rights that may vary from state to state and from country to country. Some states and countries do not allow limitations on how long an implied warranty lasts, when an action may be brought, or the exclusion or limitation of incidental or consequential damages, so the above provisions may not apply to you.
12. When contacting us for technical support or service assistance, please refer to the Princeton Instruments factory of purchase, contact your authorized Princeton Instruments representative or reseller, or visit our technical support page at www.princetoninstruments.com.

Contact Information

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

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

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

Customer Support E-mail: techsupport@princetoninstruments.com

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

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

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