



Keo *Synopticx*

Data Acquisition Software

User Manual

Version 1.4.22
December 2021

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Table of Contents

1	Introduction	7
1.1	Terminology.....	7
1.2	Changes from Previous Versions.....	8
2	System Requirements	11
2.1	Software Requirements	11
2.2	Computer Requirements	11
2.3	Instrument Compatibility	12
3	Installation.....	13
3.1	Installing <i>Synopticx</i>	13
3.2	Removing <i>Synopticx</i>	13
3.3	Upgrading <i>Synopticx</i>	13
4	Operational Overview	15
4.1	Acquisition Modes	15
4.1.1	Schedule Mode.....	15
4.1.1.1	Free-Run Mode	15
4.1.1.2	Synchronized Mode.....	16
4.1.2	Continuous Mode	17
4.1.3	Acquire Mode	17
4.2	Creating and Managing Projects	17
4.3	Application Settings	18
4.4	Project Configuration.....	18
4.4.1	Site Setup	18
4.4.2	Instrument Settings	18
4.4.3	Device Manager	19
4.4.4	Data Output	19
4.4.4.1	Image Data	19
4.4.4.2	Count Data	19
4.4.5	Filter Setup.....	20
4.4.6	Acquisition Setup	20
4.4.7	Acquisition Schedule.....	20
4.5	Connecting.....	20
4.6	Starting an Acquisition.....	21

4.7	Stopping an Acquisition.....	22
4.8	Disconnecting.....	22
5	User Interface Overview	23
5.1	Region 1: The Ribbon Toolbar.....	23
5.2	Region 2: General Information.....	23
5.3	Region 3: Operating Status.....	24
5.4	Region 4: Preview Thumbnail	24
5.5	Region 5: Thumbnails.....	24
6	The Ribbon Toolbar	25
6.1	The Home Tab.....	25
6.1.1	The Project Group.....	25
6.1.2	The Instrument Connection Group	26
6.1.3	The Acquisition Group.....	26
6.1.3.1	The Run Schedule Button	26
6.1.3.2	The Run Continuous Button	27
6.1.3.3	The Run Acquire Button	27
6.1.3.4	The Stop Button	27
6.2	The Setup Tab.....	27
6.3	The Image Display Tab	28
6.3.1	The Image Information Display Group	28
6.3.1.1	The Show Image Histogram Button	28
6.3.1.2	The Show Image Cross Section Button	29
6.3.2	The Zoom Group	30
6.3.2.1	The Zoom In and Zoom Out Buttons	30
6.3.2.2	The Zoom To Selection Button	30
6.3.2.3	The Zoom To Fit Button.....	31
6.3.2.4	The Zoom 1:1 Button	31
6.3.3	The Selection Group	31
6.3.3.1	The Show Information Button	31
6.3.3.2	The Clear Selection Button	32
6.3.3.3	The Center on Selection Button.....	32
6.3.4	The Image Display Group.....	32
6.3.4.1	The Equalize Button.....	32
6.3.4.2	The 5/95 Crop Button.....	33
6.3.4.3	The Apply to Thumbnails Button.....	34
7	Settings Dialogs.....	35
7.1	Application Settings	35
7.1.1	System Log Options	36
7.1.2	Startup Options.....	36
7.1.3	Crash Recovery and Reporting	36

7.2	Site Setup	37
7.3	Instrument Settings	38
7.3.1	Instrument Selection	38
7.3.2	Filterwheel/Shutter Controller	39
7.3.3	Temperature Control	40
7.3.4	Additional Settings	40
7.3.4.1	Sentry Camera Settings	40
7.3.4.2	Arges Photometer Additional Settings	46
7.3.4.3	Arges-VF Photometer Additional Settings	46
7.4	Device Manager.....	47
7.4.1	Available Devices	48
7.4.1.1	Keo SunShield Settings	48
7.4.1.2	Keo SunShield v2 Settings.....	49
7.5	Data Output	49
7.5.1.1	Image Data	49
7.5.1.2	Count Data	50
7.6	Filter Setup.....	50
7.7	Acquisition Setup.....	51
7.7.1	Acquisition Setup – Sentry Imagers.....	51
7.7.2	Acquisition Setup – Arges and Arges-VF Photometers.....	51
7.8	Schedule Configuration	52
7.8.1	Scheduling Mode.....	53
7.8.2	The Schedule.....	53
7.9	Continuous and Acquire Mode Acquisition Configuration	55
7.9.1	Camera Settings	56
7.9.2	Acquisition Settings.....	56
7.9.2.1	Sentry Imager Acquisition Settings.....	57
7.9.2.2	Arges and Arges-VF Photometer Acquisition Settings	58
7.9.3	File Saving Settings.....	58
8	Advanced Topics	61
8.1	Automatically Run Schedule Mode Acquisition	61
8.1.1	Windows Start Menu Startup Folder	62
8.1.2	Windows Task Scheduler.....	62
9	Troubleshooting	63
9.1	My CCD camera is not detected in Synoptics	63
9.1.1	Reinstallation of Device Drivers	63
9.2	My instrument is not being automatically detected.....	63
10	Technical Support.....	65
Appendix A	Device Driver Installation.....	67

A1	Keo Scientific Filterwheel / Shutter Controller	67
A2	FTDI USB-to-Serial Device.....	67
A3	Princeton Instruments Cameras (64-bit)	68
A3.1	Install PICam	68
A4	Princeton Instruments PIXIS and ProEM Cameras (32-bit)	69
A4.1	Install PVCAM	69
A4.2	Register the camera.....	69
A5	Andor iXon Camera.....	70
A6	Hamamatsu H7421 Photon Counting Head	71
A7	Hamamatsu C8855 Counting Unit.....	71
A8	Samsung SLA-12240 Zoom Lens	72
Appendix B	SYNDAT File Specification	73
B1	File Structure	73
B2	File Signature.....	73
B3	Header Version	73
B4	Header.....	73
B5	Data.....	74
B5.1	Data Timestamp Format	74
B5.2	Data Value Format	74

1 Introduction

Thank you for purchasing Keo *Synopticx* for use with your Keo Scientific instrumentation. As of the time of writing Keo *Synopticx* supports the Keo *Sentry* scientific imager, the Keo *Scout* scientific imager, and the Keo *Arges-VF* photometer systems. When used together (*Synopticx* and instrumentation system), they form an easy to use, highly versatile data acquisition system.

Through an intuitive graphical user interface (GUI), *Synopticx* allows you to define an imaging schedule which will be used for automated capture of data. This involves coordinating the selection of the proper filter, setting the proper exposure settings, and shutter operation. Optionally, the positions of the Sun and Moon can be used to automatically start and stop data acquisition when certain position thresholds are exceeded.

If at any point you have a question about *Synopticx* or need technical support to resolve an issue, please don't hesitate to contact us using the contact information found in Section 10.

1.1 Terminology

Throughout this user manual, many different terms are used to describe different parts of your Keo Instrumentation System. These are defined in this section.

Camera	The camera sensor (CCD, EMCCD, CMOS, etc) that is integrated into your Instrument. There are several different types of cameras used on Keo Instruments and not all Instruments have a Camera.
Ephemeris	The positions of the sun and moon that are used by the schedule mode of operation to automatically start and stop image acquisition.
External Shutter	The Keo 'capping' shutter typically located at the front of the device before the Filterwheel. Note that not all Keo instruments have External Shutters.
Filterwheel	The part of the instrument that selects which filter is currently inserted in the optical path. This includes the wheel itself as well as any attached electronics.
Front Lens	The lens located on the front of your imager. There are several different lenses available ranging from all-sky to narrow field-of-views. Some Keo instruments may not have a Front Lens.
Imaging Optics	The Keo designed optics that link the Camera, Filter Wheel, and Front Lens together.
Instrument	This refers to your complete Keo System including the Camera, Filter Wheel, Imaging Optics, and any other components that make up the system.
Internal Shutter	This is the shutter that is built into your Camera. Note that not all Cameras have an internal shutter and not all Keo Instruments have a Camera.

1.2 Changes from Previous Versions

Changes from previous versions with the same minor revision (e.g. 1.3.x) are briefly described here from newest to oldest release. For a full listing of changes, refer to the changelog.txt file found in the Synopticx installation directory or on our FTP site.

Version 1.4.22

This version adds support for Keo Zodiac Patrol Spectrographs with manual slits and fixed grisms.

The following things were also fixed/changed:

- Added data flipping (horizontal and vertical) for Andor iXon and iKon cameras.
- Fixed crash when ephemeris go out of range on some single-position instruments.

Version 1.4.21

This version is a small emergency release to fix an application crash in acquisition setup dialog for Princeton Instruments camera with electron-multiplying qualities.

Version 1.4.20

This version fixes and improves the following photometer related features:

- Data files can now be created every minute, hour, or day.
- Fixed photometer data acquisition being off by one gate-time interval.
- Fixed photometer data files not being closed when ephemeris go out of range.
- Fixed photometer scheduling to better account for acquisition overhead.

Version 1.4.19

This version adds support for Andor iXon internal shutter control and fixes some Andor iXon pre-amp gain settings being missing.

Version 1.4.18

This version fixes Princeton camera settings being reset after opening the continuous/acquire dialog and the auto-detection of NIRvana cameras.

Version 1.4.17

This version fixes ZWO cameras getting stuck when doing very short exposures.

Version 1.4.16

This version changes/fixes the following things:

- Added pixel bias correction and readout mode settings for Princeton Instruments settings in 64-bit
- Added estimation of readout time for PI cameras in 64-bit.
- Fixes PI cameras getting stuck when doing very short exposures in 64-bit.

Version 1.4.15

This version fixes a schedule display issue and the installation of prerequisites.

Version 1.4.14

This version adds 64-bit support for Princeton Instruments cameras (e.g. PIXIS, ProEM, and NIRvana). Instead of installing the 32-bit PVCAM, users should install 64-bit PICam. On 64-bit systems it is no longer required that you run the RSConfig utility to detect connected cameras. Note that users on 32-bit systems should continue to use PVCAM since PICam only supports 64-bit environments.

The following things were also fixed/changed:

- Updated Atik Camera SDK to the latest version. Note that this requires the uninstallation of the old driver and installation of a new driver.
- Changed multi-frame schedule-mode acquisitions to display and save the data as it is acquired rather than at the end of the multi-frame acquisition.
- Fixed display of images that are taller than they are wide (e.g. when using a region of interest).
- Fixed errors reported during instrument auto-detect about Scout instrument not responding.

Version 1.4.13

This was a small emergency release to fix a bug preventing Princeton Instruments cameras from starting acquisition.

Version 1.4.12

This version fixed a number of bugs:

- Fixed application crash when opening Instrument Settings dialog.
- Fixed application crash when opening Schedule dialog after renaming filters.
- Fixed startTime image metadata not being correct for multi-exposure acquisitions.

Version 1.4.11

This version adds 64-bit support for the Arges/Arges-VF Photometers and fixes several small photometer related bugs. It also adds auto-detection of the zoom lens controller used in the photometers.

Version 1.4.7-1.4.10

These versions fixed a number of small bugs.

- Progress bar display in acquire mode was not displaying properly.
- Fix PNG metadata being saved into iTXt chunks instead of desired tEXt chunks.
- Fix some camera settings not populating properly in acquire/continuous settings.
- Fix images not saving properly on non-english language systems.
- Fix crash when trying to start schedule mode acquisition with no schedule defined.

Version 1.4.6

This version adds support for the Keo Scout Imager instrument and changed the way filters and acquisitions are scheduled. Previously, filters were configured and then added to the imaging schedule. Each filter was restricted to a single combination of settings. Now, in version 1.4.6, an additional level of control has been added.

First, you configure your filters with a label, description, and wavelength. Next, you create acquisitions where each acquisition is configured with the acquisition settings to use for it (including which filter to use). Finally, these acquisitions are added to the imaging schedule (in the same way that filters were added to it previously). This means that you can now define multiple acquisitions that use the same filter but different acquisition settings (for example you can use your 630nm filter with both a 1s exposure and a 10s exposure

and each of these can be added to the schedule independently. The option to collect multiple frames for each acquisition has also been added so that you can collect, for example, 10 frames for every acquisition.

Additionally, the schedule was modified with the following changes:

- Dark frame options (start of night, hourly, end of night) were removed. Dark frames are now configured by creating an acquisition with the dark frame option selected and then adding these acquisitions to the imaging schedule.
- A pre- and post- schedule were added. Previously at the start of the night the main schedule would start running and would end at the end of the night. Now, when the night starts the pre-schedule is run once, then the main schedule is repeated until the end of the night, and then the post-schedule is run once. To capture start or end of night dark frames, enter the dark acquisitions into the pre- and post- schedules. You can also create and include acquisitions for bias frames or any other acquisition you wish to collect only at the start or end of the night.

Finally, this version adds a 64-bit native version of the application. At this time this version does not support Princeton Instruments sensors or the Arges Photometers but all other sensors and instruments are fully supported. Both 32-bit and 64-bit versions of the application will be provided until support for all cameras and instruments is complete.

Version 1.3.9

This version adds support for Atik CCD cameras.

Version 1.3.8

Added support for Keo SunShield v2 to the Device Manager. This latest version of our SunShield product features additional functionality such as feedback on open/closed state, temperature monitoring, and an external trigger input.

Version 1.3.4

Added support for ZWO CMOS cameras.

Version 1.3.3

Added support for the Keo Arges Photometer instrument and fixed numerous bugs relating to the Arges/Arges-VF family of instruments.

Version 1.3.0

This version added the Device Manager. The Instrument Settings dialog is still used for configuring the primary instrument but any additional devices (e.g. Keo SunShield) are now configured through the Device Manager. See Section 7.4 for details on the Device Manager.

With the release of version 1.3.0 Synopticx now supports 64-bit operating systems for some instrument configurations. See Section 2.1 for details on the configurations supported (and not supported).

Older Versions

Changes from older versions can be found in the changelog.txt file found in the Synopticx installation directory or on our FTP site.

2 System Requirements

2.1 Software Requirements

Keo *Synopticx* is a Microsoft Windows based application that will run on Windows based PCs provided that they are running one of the following supported operating systems:

- Windows 8
- Windows 10

Synopticx may run on Windows XP, Vista, or 7 but these platforms are no longer supported, and your experience may vary. It is our recommendation to use Windows 10 Pro.



Important Information

If using Windows 10, it is highly recommended to use the Pro or Enterprise version of the operating system which allows for disabling of automatic updates and reboots. The Home edition does not allow for this to be configured and your system *will* decide at some point to reboot itself in the middle acquisition.

As of version 1.4.14, *Synopticx* is now provided in both 32-bit and 64-bit versions and both versions currently support all Keo Scientific instrument configurations.

It is required that you install the device drivers for your instrument prior to using Keo *Synopticx*. Please refer to Section 3 for detailed instructions on installing *Synopticx* and the required drivers.

2.2 Computer Requirements

Any modern computer system that meets the software requirements will be sufficient for running Keo *Synopticx* software. As a general recommendation, Keo Scientific suggests a computer with an Intel Core i5 series processor or better with 4GB of RAM and a 128GB SSD hard drive. Additionally, a larger storage drive is recommended for the data acquired by the system.



Important Information

Computers and operating systems all undergo frequent revision. The following information only gives the minimum computer requirements. Please contact Keo Scientific to assess your specific needs.

It is recommended that the computer have a minimum vertical display resolution of 800 pixels (e.g. 1280x800). This will allow you to interact with the entire *Synopticx* interface without having to minimize the ribbon control bar or scroll the window.



Important Information

Since all system events are synchronized to the system clock, it is recommended that you use NTP (Network Time Protocol – <http://ntp.org/>) to precisely synchronize your system clock with a low-stratum time server. Ideally, a stratum 0 GPS antenna would be used. A Windows version of NTP can be found here: <http://www.meinberg.de/english/sw/ntp.htm>

2.3 Instrument Compatibility

As of the time of writing, Keo Synopticx supports the following Keo Scientific instruments.

Instrument Family	Variants		Date of Manufacture
Keo Sentry Scientific Imager	Filter Arrangements	Multi-Filter Filterwheel	2004+
		Single-Filter Filter Drawer	
	Cameras	All Princeton Instruments Sensors	
		Andor iXon DU-888 EMCCD	
		Andor iKon CCD	
		ZWO ASI174 CMOS	
		Atik 4000 CCD	
	Thermal Controllers	Omega CNI32 Series	
		Athena 16 Series	
		No Thermal Controller ¹	
Keo Scout Scientific Imager	Filter Arrangements	Multi-Filter Filterwheel	2018+
	Cameras	QImaging QI825 CCD	
	Thermal Controllers	Keo Thermal Controller	
Keo Arges and Arges-VF Photometer	Filter Arrangements	Multi-Filter Filterwheel	2015+
		Single-Filter Filter Drawer	
	Photon Counting Head	Hamamatsu H7421-50	
	Counting Unit	Hamamatsu C8855	
Keo Zodiac Patrol Spectrograph	Slit Arrangements	Single Fixed Slit	2021+
	Cameras	All Princeton Instruments Sensors	
		Andor iXon DU-888 EMCCD	
		Andor iKon CCD	
		ZWO ASI174 CMOS	
		Atik 4000 CCD	
	Thermal Controllers	Omega CNI32 Series	
		No Thermal Controller ²	
Keo SunShield Clamshell	All Variants are Supported		2015+

¹ Synopticx can be configured for a Sentry imager that does not have a thermal controller.

² Synopticx can be configured for a Zodiac spectrograph that does not have a thermal controller.

3 Installation

For *Synopticx* to function properly, the device drivers for the various hardware components that make up your instrument (CCD, filterwheel, counting unit, etc) must be installed. Please refer to Appendix A for instructions for installing your device drivers. This section will only describe the *Synopticx* installation process.

3.1 Installing *Synopticx*

Synopticx is distributed by installation CD as well as digital download from our FTP site. The installation procedure is the same for both – locate the installation file and then run the installer application.



Important Information

Please ensure you have installed the device drivers for your instrument before installing *Synopticx*.

Synopticx is now distributed with both a 32-bit and 64-bit version. We recommend using the 64-bit version of *Synopticx* if possible.

1. Insert the *Synopticx* installation CD into your computer or locate the downloaded installer³.
2. Launch the *Synopticx Installer <version> (64-bit).exe* application. (<version> will denote the version of the installer, e.g. “*Synopticx Installer 1.4.11 (64-bit).exe*”).
3. The installer will walk you through the installation process.



By default, the installer will add an application shortcut to your desktop that looks like the one to the left. There will also be an entry in your *Start Menu* under:

Start Menu > All Programs > Keo Scientific Ltd > Synopticx > Synopticx

Either of these can be used to launch the application.

3.2 Removing *Synopticx*

Keo *Synopticx* can be removed using the normal application uninstallation process in Windows. Navigate to “Programs and Features” in the Control Panel, select *Synopticx* from the list, and choose the “Uninstall” option from the top menu bar.

Control Panel > Programs and Features

3.3 Upgrading *Synopticx*

³ The latest version of *Synopticx* can be downloaded from our FTP site (<ftp://ftp.keoscientific.com>) using the credentials provided by Keo Scientific at the time of purchase. If you have misplaced these credentials please contact support to retrieve them.

Your installation of *Synopticx* can be upgraded to a newer version by running the new installer application. The old version will be upgraded automatically as part of the installation process.



Important Information

Your project file will be automatically upgraded if necessary upon launching the new version of *Synopticx*.

4 Operational Overview

After the system has been initially configured, *Synopticx* can run unattended for weeks or even months at a time autonomously acquiring data. It will automatically start and stop each night as the sun and moon enter and leave the configured acceptable ranges. This section provides a general overview of how to use *Synopticx*.

4.1 Acquisition Modes

Synopticx has three acquisition modes: Schedule Mode, Continuous Mode, and Acquire Mode. These modes are used to accomplish different tasks. Commonly, Continuous and Acquire mode are used while determining the settings to use for your imaging schedule exposures. These modes provide a very quick and easy way to test many different settings to find the ideal exposure parameters. These ideal parameters are then entered into the project configuration and used by Schedule mode to automate data acquisition for several weeks or months at a time.

4.1.1 Schedule Mode

This is the 'normal' operating mode that is driven by a schedule of acquisition events and the sun and moon position (as defined in Site Setup – see Section 7.27.2). While the sun and moon are not in their acceptable ranges, the system will be in the Standby state. Once the sun and moon enter an acceptable range then the system enters the Running state by running the pre-schedule once and then repeatedly running the schedule until the sun and moon leave their acceptable ranges. When this happens, the post-schedule is run once and then the system halts data acquisition and returns to the Standby state.

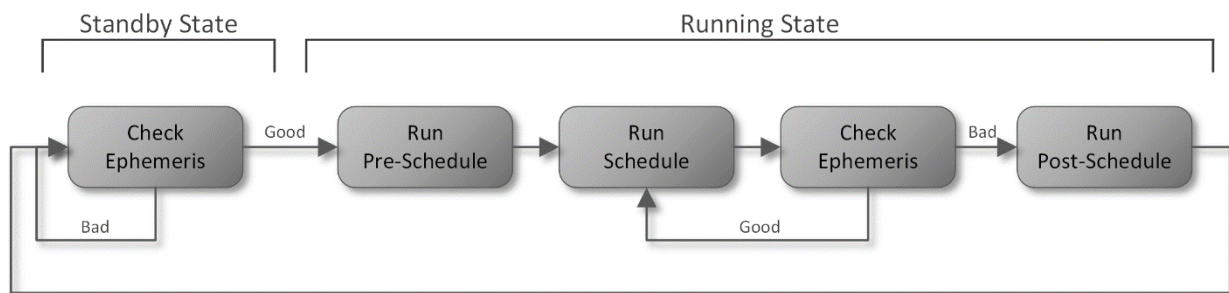


Figure 1: Overall Schedule Mode Sequence of Events

When entering the Standby state, *Synopticx* will disable any hardware cooling which allows the hardware to return to ambient temperature. Note that some devices (e.g. Princeton Instruments PIXIS) have the option of maintaining cooling even while in the standby state. See Section 7.3.4.1 for more information.

There are two different schedule modes that can be used to define the data acquisition schedules: Free-Run and Synchronized.

4.1.1.1 Free-Run Mode

Free-Run is the simpler of the two schedule driven modes. In it you simply define the order in which to cycle through the acquisitions. As soon as one acquisition is complete, the filter is changed and the next

acquisition is started. See Section 7.8.1 for more information on setting up the data acquisition schedule in this mode.

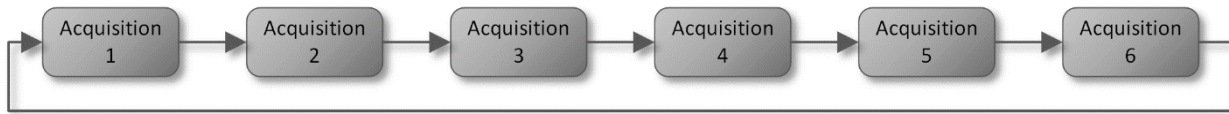


Figure 2: Example Free-Run Acquisition Schedule

4.1.1.2 Synchronized Mode

Synchronized mode is more complex than Free-Run mode in that you define the precise start time of each acquisition within a one-minute period. The start times are defined using a 'cadence' for each acquisition which is simply the period (in seconds) between runs of the same acquisition. See Section 7.8.2 for more information on setting up the data acquisition schedule in this mode.

As an example of this, refer to the figure below.

Acquisition	Cadence	Start Times
1	20s	0s, 20s, 40s
2	20s	5s, 25s, 45s
3	60s	10s
4	60s	13s
5	20s	15s, 35s, 55s
6	60s	50s

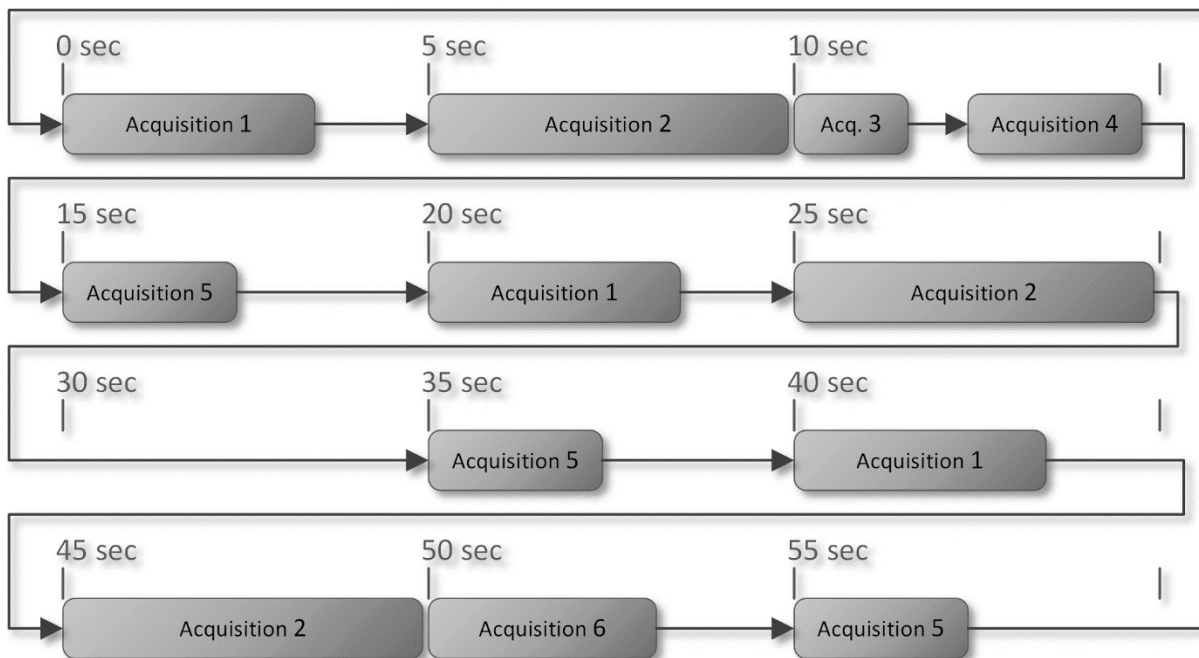


Figure 3: Example Synchronized Acquisition Schedule

4.1.2 Continuous Mode

Continuous mode, also commonly referred to as ‘focus’ mode, allows you to continuously capture data using constant exposure and filter settings. This mode is most commonly used for focusing an imager since it allows you to get a continuous stream of images in the preview image window. It also serves as a quick way to see a snapshot of what is currently happening.



Important Information

This mode does not save any data to disk. All acquired data is streamed to the preview display thumbnail and then discarded.

Data acquisition will occur at as fast of a rate the camera or instrument will allow based on the settings configured in the Continuous Acquisition Settings dialog. The maximum frame rate that is achievable is dependent on the capabilities of the instrument.



Important Information

Synopticx is not designed for the video frame rates some cameras can achieve using a smaller region-of-interest.

4.1.3 Acquire Mode

Acquire mode is similar to continuous mode with the exception that it allows you to save the acquired data to disk and only capture a pre-defined amount of data (after which point acquisition is halted). This mode is commonly used during initial experimentation while trying to determine the optimal acquisition settings to use for each filter. You can define those settings and run an acquisition for several frames, then tweak your settings, and run it again. You will very quickly be able to determine the ideal acquisition settings to use for Schedule mode.

4.2 Creating and Managing Projects

Synopticx uses an XML based configuration file (project file) to store the various settings that have been configured. These project files have a “.syn” file extension and can be re-opened by *Synopticx* to reload the settings they contain. You may have several project files you use to test various settings and then upon deciding on optimal settings you will have a project file that contains these settings. With *Synopticx* it is very easy to save and load these project files – it is done in the same way as most Windows applications. Simply use the New, Save, Save-As, and Open buttons to manage your project files (see Section 6.1.1 for details on these buttons).

The very first time *Synopticx* is opened it will start with a blank project. From here you can start configuring the system as described in the following sections. If instead you want to start a new project based on a current one, use the Save-As option to create a copy of the currently open project and then continue to modify your project settings as required.

**Important Information**

Synopticx does not auto-save the project file so it is important that you regularly use the Save option to save your settings.

4.3 Application Settings

There are a few settings that are *Synopticx* specific and not project specific. These settings will persist between different projects and can be modified using the Application Settings dialog (see Section 7.1).

If you are having technical problems with *Synopticx*, please change the Logging Level setting to '+ Debug' and then reproduce the error or problem you were seeing. This will produce extra information in the system log file that can be used to help track down the problem. You can submit your system log file to technical support by sending an email to support@keoscientific.com. Please also include a description of the problem and a copy of the project save file.

4.4 Project Configuration

Before *Synopticx* can start acquiring data it must be configured to know about the attached instrument and how you would like to acquire data. This is done using the various settings dialogs detailed in Section 7. Here we will discuss briefly the different settings that need to be configured before data acquisition can begin.

4.4.1 Site Setup

Synopticx needs to know where it is geographically so that it can calculate the positions of the sun and moon. These calculated positions are used together with the ephemeris limits you define to automatically start and stop *Synopticx* data acquisition. The site location and ephemeris limits are configured in the Site Setup dialog (see Section 7.2).

The Site Setup dialog also allows for defining a Site ID' and Imager ID. These values are stored into the metadata of the collected data for use in data post-processing.

4.4.2 Instrument Settings

There are multiple different types of instruments that can be used with *Synopticx* and each one can have several different configurations. *Synopticx* needs to know what type of instrument it will be used with and the Instrument Settings dialog is where you configure this (see Section 7.3).

The easiest way to configure the instrument settings is to use the Auto Detect Instrument button. This will automatically scan your system looking for attached devices that are compatible with *Synopticx*. Upon finding attached devices *Synopticx* will automatically configure the required settings.

**Important Information**

Older 'legacy' instruments do not have the features required to fully configure *Synopticx* with the 'Auto Detect Instrument' feature. After the auto detect process completes, the user will still have to manually enter a few settings.

After the auto detect process has completed, you can then make changes to the settings as required to match your desired experimental parameters. All of the settings configured in this dialog will be used as the

defaults for your experiment. Some of the settings can be changed on a per-filter basis using the Filter Setup dialog (e.g. camera CCD gain) but most of these settings will persist throughout the experiment.

Successfully configuring the instrument settings will allow access to the Filter Setup dialog. Access to this dialog is blocked until *Synopticx* knows how many filters the instrument has.

4.4.3 Device Manager

Any devices that are not the core instrument (*Sentry* imager or *Arges/Arges-VF* photometer) can be configured through the Device Manager. Refer to Section 7.4.1 for details on the devices that can be configured.

4.4.4 Data Output

While running an acquisition there will be data to save and the details of where and how to save this data can be configured in the Data Output dialog (see Section 7.4). Depending on the type of data there will be different options presented.

4.4.4.1 Image Data

Image data will be stored as follows:

```
<ROOT>\<YYYY>\<MM>\<DD>\<HH>\<SITEID>_<DATE>_<TIME>_<LABEL>[_DARK].<EXT>
```

where:

<ROOT>	The 'Root Directory' as configured in Data Output dialog (e.g. 'D:\Data')
<YYYY>	The year the acquisition started in format YYYY (e.g. '2015')
<MM>	The month the acquisition started in format MM (e.g. '11')
<DD>	The day the acquisition started in format DD (e.g. '05')
<HH>	The hour the acquisition started in format HH (e.g. '19')
<SITEID>	The 'Site ID' as configured in Site Setup dialog (e.g. 'YYC')
<DATE>	The date the acquisition started in format YYYYMMDD (e.g. '20151105')
<TIME>	The time the acquisition started in format HHmmSS (e.g. '191254')
<LABEL>	The 'Filter Label' as configured in Filter Setup (e.g. '6300')
<DARK>	Optional: '_DARK' will be appended to the filename for all dark frames
<EXT>	The file extension for the datatype as configured in Data Output dialog (e.g. 'png')

For example, an image that was acquired on 2015-11-05 at 19:12:54 with filter 6300 would be stored to:

```
D:\Data\2015\11\05\19\YYC_20151105_191254_6300.png
```

4.4.4.2 Count Data

Count data will be stored as follows:

```
<ROOT>\<YYYY>\<MM>\<DD>\<SITEID>_<DATE>_<TIME>_<LABEL>[_DARK].<EXT>
```

where:

<ROOT>	The 'Root Directory' as configured in Data Output dialog (e.g. 'D:\Data')
<YEAR>	The year the acquisition started in format YYYY (e.g. '2015')
<MONTH>	The month the acquisition started in format MM (e.g. '11')
<DAY>	The day the acquisition started in format DD (e.g. '05')
<SITEID>	The 'Site ID' as configured in Site Setup dialog (e.g. 'YYC')
<DATE>	The date the acquisition started in format YYYYMMDD (e.g. '20151105')
<TIME>	The time the acquisition started in format HHmmSS (e.g. '191254')
<LABEL>	The 'Filter Label' as configured in Filter Setup (e.g. '6300')

<DARK>	Optional: ‘_DARK’ will be appended to the filename for all dark frames
<EXT>	The file extension for the datatype as configured in Data Output dialog (e.g. ‘png’)

For example, data that was acquired on 2015-11-05 at 19:12:54 with filter 6300 would be stored to:

```
D:\Data\2015\11\05\YYC_20151105_191254_6300.syndat
```

4.4.5 Filter Setup

Depending on the type of instrument, you may have only one filter or you may have a filterwheel with multiple filters. *Synopticx* allows for you to configure each of these filters with a label, description, and wavelength specific to that filter. This can be done using the Filter Setup dialog (see Section 7.4). Each filter that is installed in the instrument must be added and configured here before it can be added to an acquisition.

Successfully configuring the filter settings will allow access to the Acquisition Setup dialog. Access to this dialog is blocked until the filters have been configured.

4.4.6 Acquisition Setup

After defining the device’s filters, individual acquisition configurations need to be configured using the Acquisition Setup dialog (see Section 7.7). The settings configured here will be used during Schedule Mode acquisitions. Each filter can be used in multiple acquisitions if desired which allows for a large degree of flexibility in how acquisitions are scheduled.



Important Information

Changing exposure times when using the Synchronized schedule mode (see Section 4.1.1.2) will result in the acquisition schedule being invalidated. This will require you to re-configure the schedule using the Acquisition Schedule dialog.

4.4.7 Acquisition Schedule

The final piece of information *Synopticx* needs before being able to run a Schedule Mode acquisition is the order in which to collect the acquisitions for the Pre-Schedule, Schedule, and Post-Schedule. This can be configured using the three Schedule Configuration dialogs (see Section 7.8). These dialogs allow you to configure the schedule mode (Free-Run or Synchronized) and enter the order of acquisitions for that schedule. Refer to Section 4.1.1 for more information regarding the schedule mode options, and Section 7.8 for more information about using the Acquisition Schedule Setup dialogs.

4.5 Connecting

Before *Synopticx* can start collecting data from the instrument, it must connect to and configure the various devices that make up the instrument. It does this using the instrument settings as previously configured. Starting any acquisition (by using the Run Schedule, Run Continuous, or Run Acquire buttons) will automatically connect to and configure the instrument before starting the acquisition. The Connect button on the Home tab can also be used to manually command the system to connect to and configure the devices without starting an acquisition afterwards. After manually connecting to the instrument, *Synopticx* will stay connected until it is commanded to disconnect with the Disconnect button.

**Important Information**

Upon completing an acquisition, *Synopticx* will always return to its pre-acquisition connection state. If the system was connected before the user started an acquisition, it will remain connected after the acquisition completes. Likewise, if the system was disconnected before the user started an acquisition, it will disconnect automatically upon completing the acquisition.

Since the connecting process can take 30 seconds or more (up to 20 minutes if a device requires cooling), it is often desirable to manually connect to the instrument first so that each acquisition does not have to run through the connection process before acquiring data.

Manually connecting to the instrument before starting an acquisition has several benefits. Several of these are listed below.

- It allows you to see the current camera and filter wheel temperatures before running an acquisition.
- It prevents *Synopticx* from issuing a filter wheel reset before starting every acquisition. If you are using the continuous and acquire modes of operation, waiting 30 seconds before every acquisition quickly becomes a waste of time.
- It provides an easy way to check if your instrument connection settings are correct. The connection process will fail and provide an error if the settings are not correct.

When *Synopticx* connects to the instrument, it performs the following steps:

1. *Synopticx* opens a connection to each of the devices that make up the instrument.
2. The instrument is configured using the instrument settings (see Section 7.3 for more information on instrument settings).
3. Any devices requiring cooling have their coolers enabled. At this point they will start cooling to their operational temperature.
4. If the instrument has a filter wheel, it will now perform a homing cycle whereby it searches for the 'home' position. This can take up to 30 seconds to complete.

After the homing cycle is complete, the system is considered 'connected'. This is indicated by the Connect button appearing in the pressed state (see Section 6.1.2).

**Important Information**

Even though the system is 'connected', the background color of the 'Operating Status' window will remain red since there is no current acquisition in progress.

4.6 Starting an Acquisition

There are three different acquisition modes available in *Synopticx*. These are explained in detail in Section 4.1. These acquisition modes can be started using the Run Schedule, Run Continuous, or Run Acquire buttons found on the Home tab.

4.7 Stopping an Acquisition

When any acquisition is currently running, the Stop button on the Home tab can be used to abort the acquisition and return the system to the Stopped state. Under normal conditions, this button is used to stop a running schedule mode acquisition to allow changes to be made, or to stop a continuous mode acquisition will normally run continuously until manually stopped. Acquire mode acquisitions will stop automatically upon completing the defined acquisition (see Section 7.9 for details on configuring an acquire mode acquisition).



Important Information

When an acquisition is commanded to stop, the currently acquiring data will complete before the system returns to the 'Stopped' state.

When running in Schedule Mode, stopping an acquisition will trigger the 'At the end of every night' dark frame collection to run if it has been selected in the Acquisition Schedule Setup dialog. To cancel running the dark frame collection click the Stop button a second time and it will immediately stop the acquisition.

4.8 Disconnecting

There are two situations when you might want to disconnect from the instrument: when shutting down the system or when modifying any instrument settings (the settings found in the Instrument Settings dialog – see Section 7.3). If you will be performing further acquisitions without modifying the Instrument Settings, it is not necessary to disconnect first. Application settings, site setup, data output, filter setup, and the acquisition schedule can all be configured with the system in the connected state.

The Disconnect button on the Home tab can be used to manually shut down and disconnect from the instrument. After successfully disconnecting, the Disconnect button will appear in the pressed state (see Section 6.1.2).

Closing the *Synopticx* application will also automatically disconnect from the instrument.

5 User Interface Overview

The main graphical user interface (GUI) can be broken down into five different sub-regions as shown below in Figure 4. Each of these regions' purpose is briefly explained below.

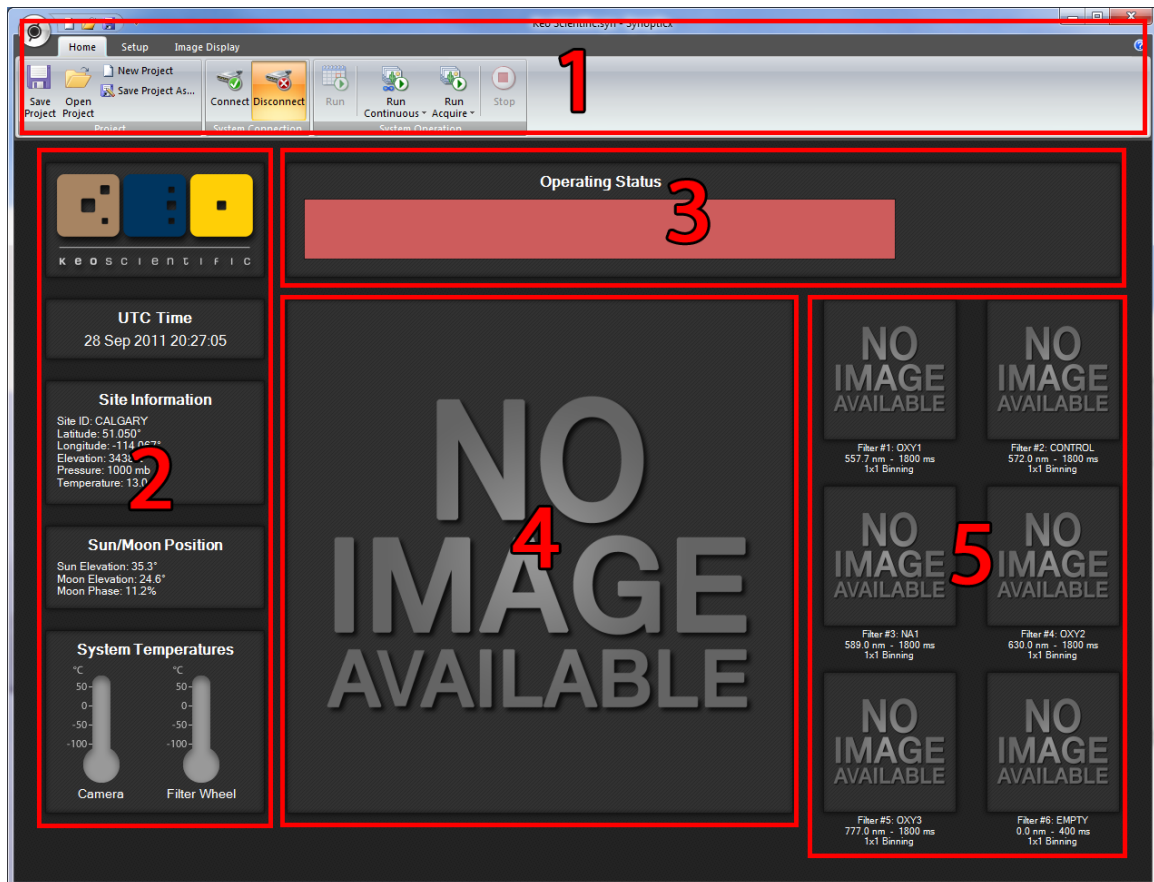


Figure 4: Main User Interface

5.1 Region 1: The Ribbon Toolbar

The ribbon toolbar provides access to system operation controls, configuration settings, and image/data display options. Further information about the different tab groups and buttons can be found in Section 6.

5.2 Region 2: General Information

This region provides the user with a few pieces of information pertinent to the current operation of the system. At the top, the current Coordinated Universal Time (UTC) is displayed. This value is synchronized to the system clock so it is only as accurate as the system it is running on. See the note in Section 4.1 on using a NTP server for precisely synchronizing your system clock.

Below the UTC display is the Site Information panel. This is the information that has been entered into the Site Setup dialog found on the Setup tab. See Section 7.2 for more information.

The Sun/Moon Position panel uses the information entered in the Site Setup dialog to calculate the current position of the sun and moon.

The System Temperatures panel will display the current temperature of the CCD and filterwheel if the system has one. Note that these controls will remain greyed-out until *Synopticx* connects to the respective devices.

5.3 Region 3: Operating Status

The Operating Status panel provides insight into what the system is currently doing by displaying messages to the user. All messages displayed in this window will have a timestamp associated with them. Below is an example of a message that could be displayed in the Operating Status window. At any given time, a quick glance at this window should be enough to determine what the system is currently doing.

[2015-11-04 19:40:10 UTC] Changing to filter #1 ...

The background color of the Operating Status panel is used to indicate the current system state.

Background Color	Meaning
Red	Stopped: No data acquisition taking place
Green	Running: Data acquisition in progress
Orange	Standby: Sun and Moon are out of range, data acquisition has been paused

5.4 Region 4: Preview Thumbnail

Depending on the type of data being acquired, this will display either an image (for instruments with a camera) or a 2D line plot (for instruments with a counting unit).

For instruments with a camera, the Preview Thumbnail will display the most recently acquired image.

For instruments with a counting unit, the Preview Thumbnail will display a real-time readout of the currently acquiring data. For example, if capturing 20x 100ms gates for a single data acquisition, the count for each of the gates will be display as they are acquired.

For both types of instruments, when a thumbnail (from region 5) is selected, the Preview Thumbnail will display the data from that thumbnail instead of the latest or currently acquiring data.

5.5 Region 5: Thumbnails

This region displays the most recently acquired data for each filter installed in the system. Selecting one of these thumbnails will load the data into the Preview Thumbnail (region 4) and allow for some basic data manipulation from the ribbon toolbar (see Section 6.3 for more information). The selected data will remain in the Preview Thumbnail until it is deselected by clicking anywhere else on the GUI.

6 The Ribbon Toolbar

The ribbon toolbar is what you use to interact with *Synoptix*. It has three main Tabs and each tab has a variety of different Buttons which are grouped into Groups. The application Orb is accessible from any tab and provides easy access to the Project Management group functions. The following sections provide details of the functions of each button in each group on each tab.

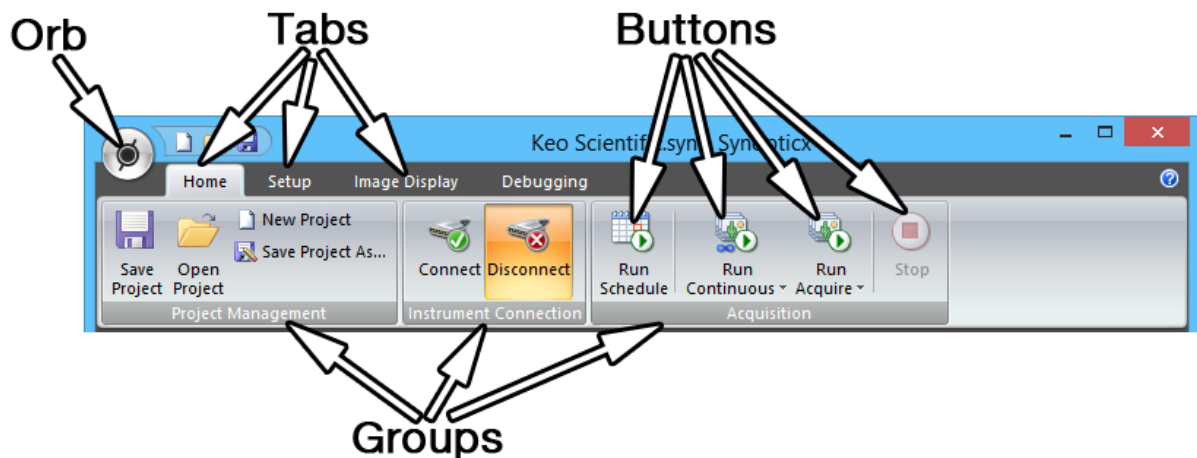


Figure 5: Overview of the Ribbon Toolbar

6.1 The Home Tab

The Home tab is the default tab where system wide operations can be performed. You can work with project files, connect or disconnect from the instrument, and run/stop an acquisition.

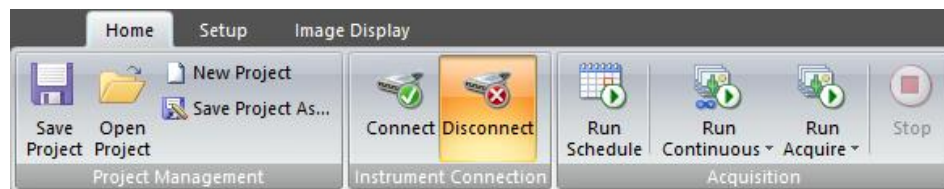


Figure 6: The Home Tab

6.1.1 The Project Group

This group allows you to save a project, open a project, start a new blank project, and save your current project under a new name. These all perform as they would in any other Windows application.



Figure 7: Project Group Buttons

6.1.2 The Instrument Connection Group

The two buttons found in this group (Connect and Disconnect) are used to manage the connection to the Instrument. See Section 4.5 for more details on when and how to use these buttons.



Figure 8: Imager Connection Group Buttons

Pressing either of these buttons will trigger their respective functions (to connect or disconnect from the instrument). After successfully connecting or disconnecting, the buttons will remain selected to indicate the current connection status.



Figure 9: Connected



Figure 10: Disconnected



Important Information

Even though the system is Connected, the background color of the Operating Status panel will remain red since there is no current acquisition in progress.

6.1.3 The Acquisition Group

This group is used to start and stop the different acquisition modes (see Section 4.1 for more information about the different acquisition modes). While the system is running in any of the three acquisition modes, all of the buttons except for the Stop button will be disabled.

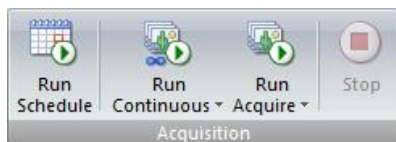


Figure 11: Acquisition Group Buttons

6.1.3.1 The Run Schedule Button

The Run Schedule button starts a regular Schedule Mode acquisition. This mode is driven by the schedule and settings defined on the Setup tab.



Important Information

This acquisition mode is disabled until a valid acquisition schedule has been defined.

6.1.3.2 The Run Continuous Button

This button starts a continuous mode (focus mode) acquisition. After starting *Synopticx*, the first time you press this button the Acquisition Configuration dialog is presented for you to enter the acquisition settings to use. Any further presses of this button will skip the dialog and immediately start imaging with the last used settings.

To access the Acquisition Configuration dialog to change your acquisition settings, select the lower drop-down portion of the button and select the Edit Continuous Configuration button.

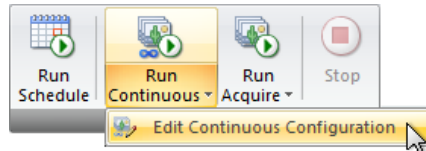


Figure 12: Edit Continuous Configuration

See Section 7.9 for more information on the Acquisition Configuration dialog.

6.1.3.3 The Run Acquire Button

This button starts an acquire mode acquisition. As with the Run Continuous button, the first time you press this button after starting *Synopticx* will result in the Acquisition Configuration dialog being shown. Any further presses of this button will immediately start an acquisition using the previously used settings.

To access the Acquisition Configuration dialog to change your acquisition settings, select the lower drop-down portion of the button and select the Edit Acquisition Configuration button.



Figure 13: Edit Acquisition Configuration

See Section 7.9 for more information on the Acquisition Configuration dialog.

6.1.3.4 The Stop Button

This button will stop any currently running acquisition and return *Synopticx* to the Stopped state. If data is currently being acquired, the current acquisition will be completed before the system is stopped.

6.2 The Setup Tab

The Setup tab is where the various operational parameters of *Synopticx* can be modified. It is broken into two groups: System and Project Settings. System settings are persistent between different projects while the settings found in the Project Settings group are saved into the project XML file and are unique to an individual project.

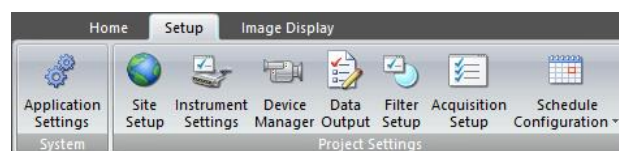


Figure 14: The Setup Tab

Each of the buttons in these groups launches a corresponding dialog box where you can edit the various settings. Details on each of the settings dialogs can be found in Section 7.

6.3 The Image Display Tab

The Image Display tab allows you to manipulate the Preview Thumbnail to better visualize the data being displayed. This buttons on this tab are organized into four functional groups which are detailed in the following sections.



Figure 15: The Image Display Tab



Important Information

The Image Display tab will only be visible when your instrument has a camera used to capture images.

6.3.1 The Image Information Display Group

The two buttons in this group toggle the display of two different visualizing tools.

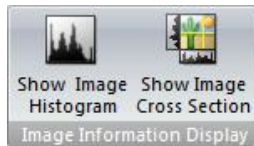


Figure 16: Image Information Display Group Buttons

6.3.1.1 The Show Image Histogram Button

This button toggles the image histogram on or off. This histogram is a representation of the distribution of data values of the currently displayed image. As you use the various image display controls, the histogram will update to reflect the distribution of new displayed image.

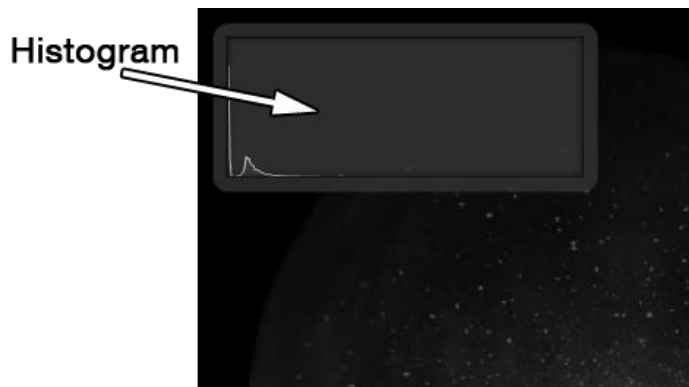


Figure 17: Histogram Display

As you move your cursor around the preview image, the histogram will 'jump' away. This is to let you view the image under the histogram and makes selecting a point easier by not requiring you to first turn off the histogram.



Important Information

The histogram always displays the data distribution of the currently displayed image. If you have enabled any image display options that alter the values of the displayed image ('Equalize' and/or '5/95 Crop') the histogram will be updated to reflect the new, adjusted image.

6.3.1.2 The Show Image Cross Section Button

Enabling this option will plot a 2D graph of the pixel values along each of the yellow selection lines. As the image is zoomed and panned, these 2D graphs will update to show only the range visible in the image.

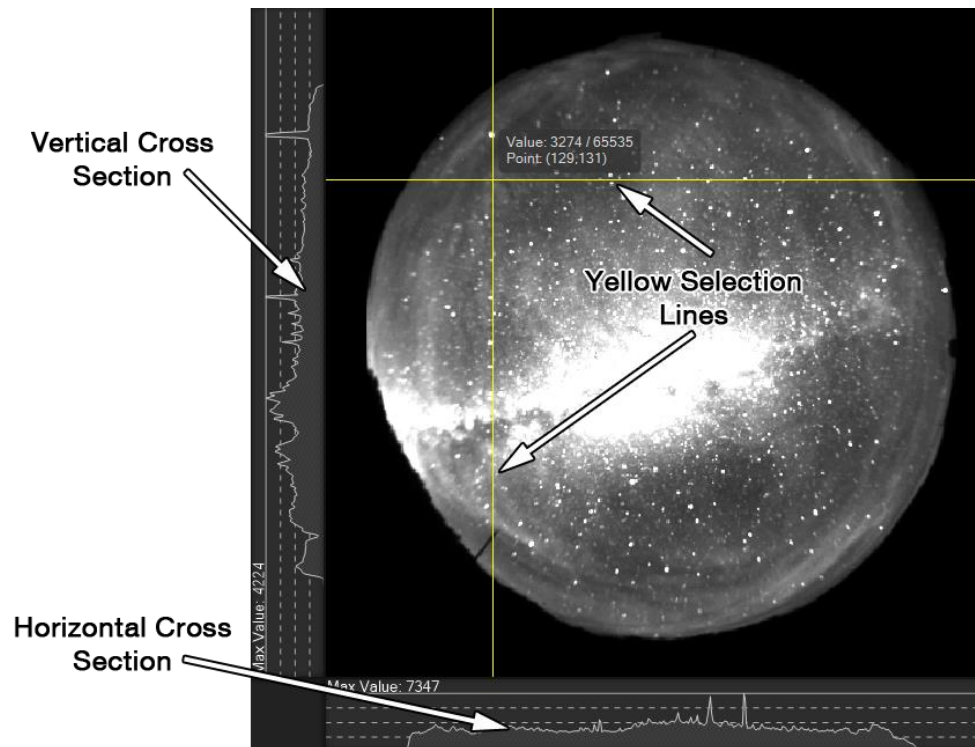


Figure 18: Image Cross Sections

You can highlight the nearest data point by moving your mouse cursor over one of the image cross sections. This will highlight the data point with a light-green dot and display the value on the top bar of the cross section display.



Figure 19: Image Slice with Highlighted Data Point



Important Information

The values shown on the cross section graphs are always the values from the raw image data. Any image display options that are enabled that change the display values of the pixels ('Equalize' and/or '5/95 Crop') will *not* affect the values displayed on these graphs. The scale of the graphs will however be affected.

6.3.2 The Zoom Group

This group of buttons is for controlling the level of zoom on the preview image.

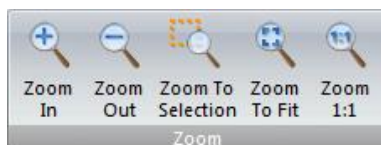


Figure 20: Zoom Group Buttons

6.3.2.1 The Zoom In and Zoom Out Buttons

These buttons will zoom in or out of the image by a factor of two each time they are clicked.



Important Information

For finer control of the zoom, you can use the mouse.

Simply press and hold both the left and right mouse button and then drag right or left to zoom in or out, respectively.

6.3.2.2 The Zoom To Selection Button

This button will zoom the preview image to the currently selected region. If there is no region currently selected, this button will be disabled.

To select a region, simply left click and hold on the first corner of your desired selection, drag to the second corner, and release. This will outline the region in a slowly moving marquee selection.

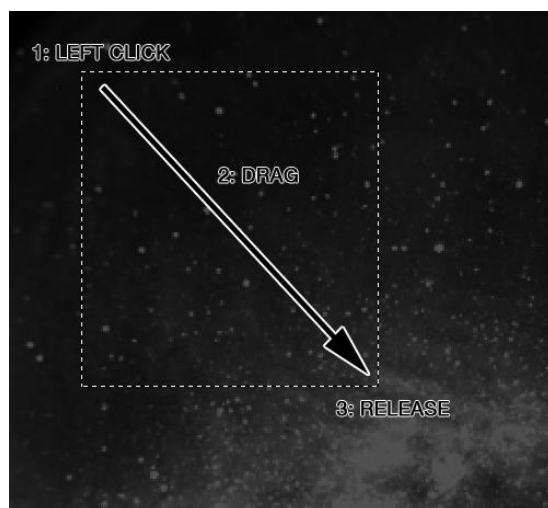


Figure 21: Selecting a Region

6.3.2.3 The Zoom To Fit Button

This button will zoom out of the image until it fully fills the preview window.

6.3.2.4 The Zoom 1:1 Button

This button will zoom the image so that there is a one to one mapping of image pixels to display pixels. This ensures that the displayed image is not being interpolated for display on your screen which can sometimes produce aliased patterns in your images which could be mistaken as actual data.

6.3.3 The Selection Group

This group of buttons allows you to do a few things with the currently selected data point.



Figure 22: The Selection Group

Buttons

A data point can be selected by simply left mouse clicking anywhere on the Preview Thumbnail. This will display the image slice lines intersecting at the selected point.



Important Information

You can quickly and easily change the currently selected data point by using the arrow keys on your keyboard.

6.3.3.1 The Show Information Button

This button toggles the selected point information display on and off. This button will be disabled if there isn't a data point currently selected. This informative display shows three key pieces of information:

1. The value of the selected pixel,
2. The maximum possible value of a pixel in the image, and
3. The x and y coordinates of the selected pixel (the origin is the top right corner of the image).

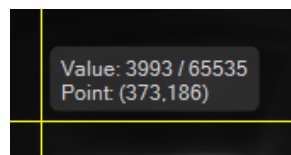


Figure 23: Selection Information Display

Item 2, the maximum possible value of a pixel in the image, is based on the bit-depth of the output amplifier used to read the image out of the CCD. Refer to your CCD's documentation for more information on the bit-depths available. This value is useful for determining if the selected pixel is close to saturation or not.

Typical values for this are: 16bit, 65535; 14bit, 16383; 12bit, 4095.

**Important Information**

The Value displayed here is always the value of the raw pixel data. If you have enabled any image adjustments that modify the displayed data values (e.g. Equalize and/or 5/95 Crop) this value will not change.

6.3.3.2 The Clear Selection Button

This button will clear the currently selected data point. It also has the effect of clearing the image cross section displays (since a point is no longer selected) and hiding the data point information display. This button will be disabled if there isn't a currently selected data point.

6.3.3.3 The Center on Selection Button

This button will shift the image display to center it on the currently selected data point.

**Important Information**

You can also move around the image by holding down the right mouse button and moving it left/right/up/down.

6.3.4 The Image Display Group

This group of buttons alters the displayed image to enable better visualization of the data.



Figure 24: The Image Display Group Buttons

6.3.4.1 The Equalize Button

This button toggles the histogram equalization function on and off. It performs a linear stretch of the histogram to fit the raw data to the full dynamic range of your display device. Due to the large dynamic range available from the camera (typically 16bits), it is very common for the signal to be dim under normal display situations. Using the equalize option will stretch the image to be displayed using the full available range.

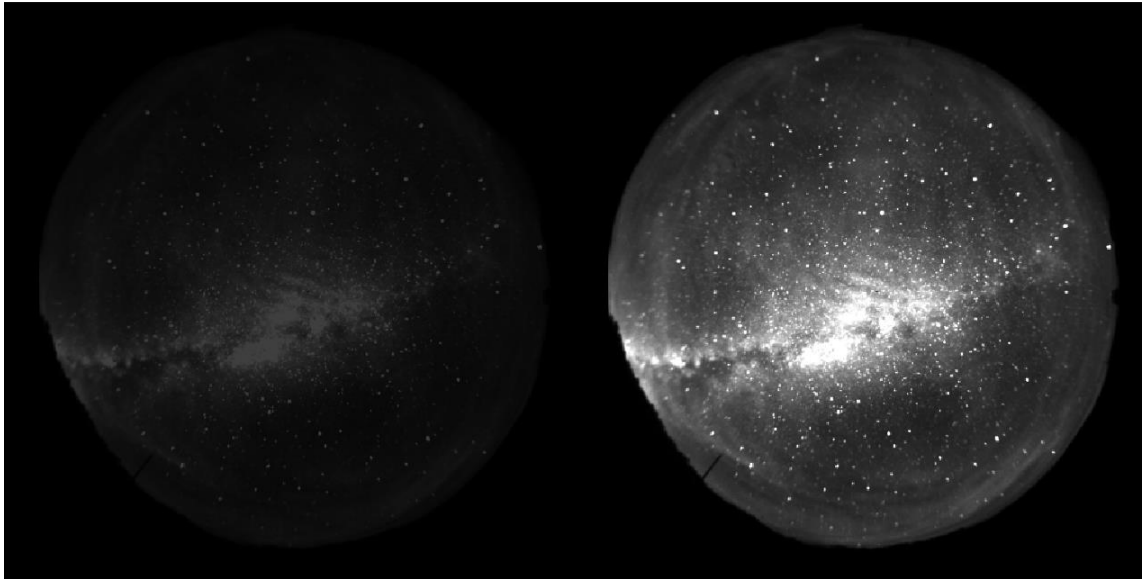


Figure 25: Raw (left) and Equalized (right) Comparison

In the example images above, the raw data has a bit-depth of 16bits which has a maximum count value of 65,535 but the maximum signal level in the data is only around 16,300. When this data is displayed, it appears dim because only 25% of the full range is being used. To better visualize this data, it can be stretched to fill the full display range.



Important Information

This feature only affects how data is displayed on the screen. All data is saved to disk without any modifications.

6.3.4.2 The 5/95 Crop Button

This button enables a mode where the histogram is cropped at both ends to remove any 'hot' or 'cold' spots (also known as 'salt & pepper' noise). This button will be disabled until the Equalize option is enabled.

A 'hot' pixel is one where the pixel is stuck on and will always have the maximum count value. If the rest of your data is well below the saturation of the sensor, these 'hot' pixels will prevent the Equalize function from working since they are detected as the data maximums and no histogram stretching will occur.

A similar situation occurs with stars in very long exposures of the night sky. These stars show up as very bright saturated spots which prevent the Equalize function from working in the same way. Cosmic rays can also produce the undesirable 'hot' spots.

Similarly, a 'cold' pixel is one where the pixel is stuck off and will always have a zero count value. For low signal applications this could cause a similar problem as a 'hot' pixel whereby the lower bounds of the histogram will be stuck at zero.

The 5/95 Crop feature can be used to solve both of these problems. It will ignore the lower and upper 5% of pixels from the image and then perform the equalization. Below is an example of an image with stars that saturate but overall low signal levels. Using the normal Equalize option will not help because these bright

spots are detected as the upper limit. Enabling 5/95 Crop will ignore those bright spots and equalize the rest of the image.

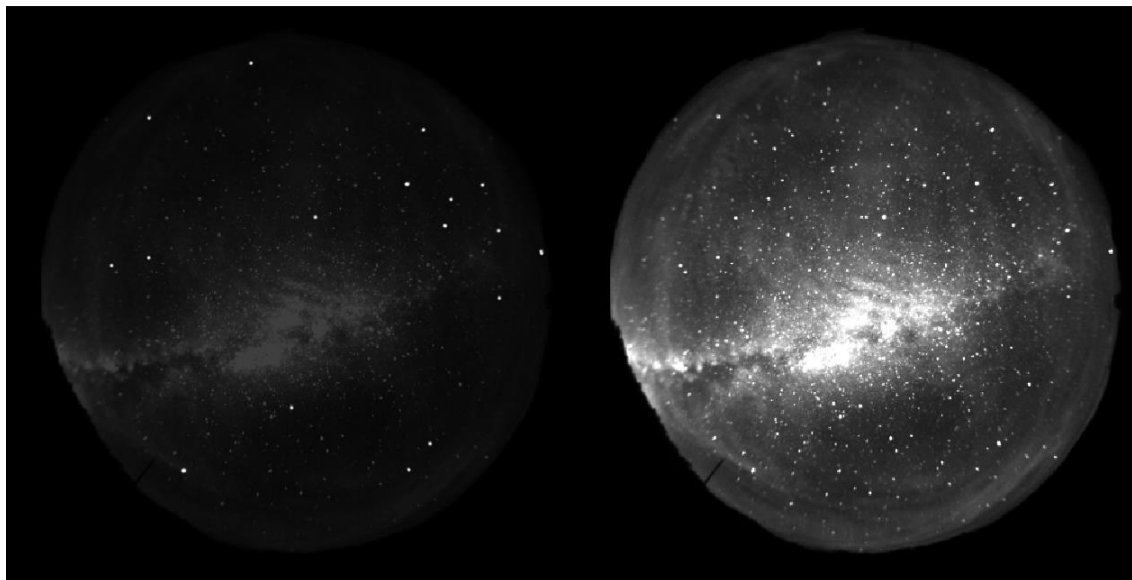


Figure 26: Equalized (left) and 5/95 Cropped (right) Comparison

6.3.4.3 *The Apply to Thumbnails Button*

This button will apply any image display settings (Equalize and/or 5/95 Crop) to the thumbnail images as well as the Preview Thumbnail.

7 Settings Dialogs

Synopticx provides several settings dialogs for configuring the system. These dialogs are accessed using the buttons provided on the ribbon toolbar. Clicking on any button will open the respective settings dialog.

7.1 Application Settings

The Application Settings dialog can be accessed using the Application Settings button on the Setup tab.

There are several application settings that can be modified to affect the operation of *Synopticx*. These settings are stored in the Windows Registry rather than in the project file so they are independent of the currently loaded project.

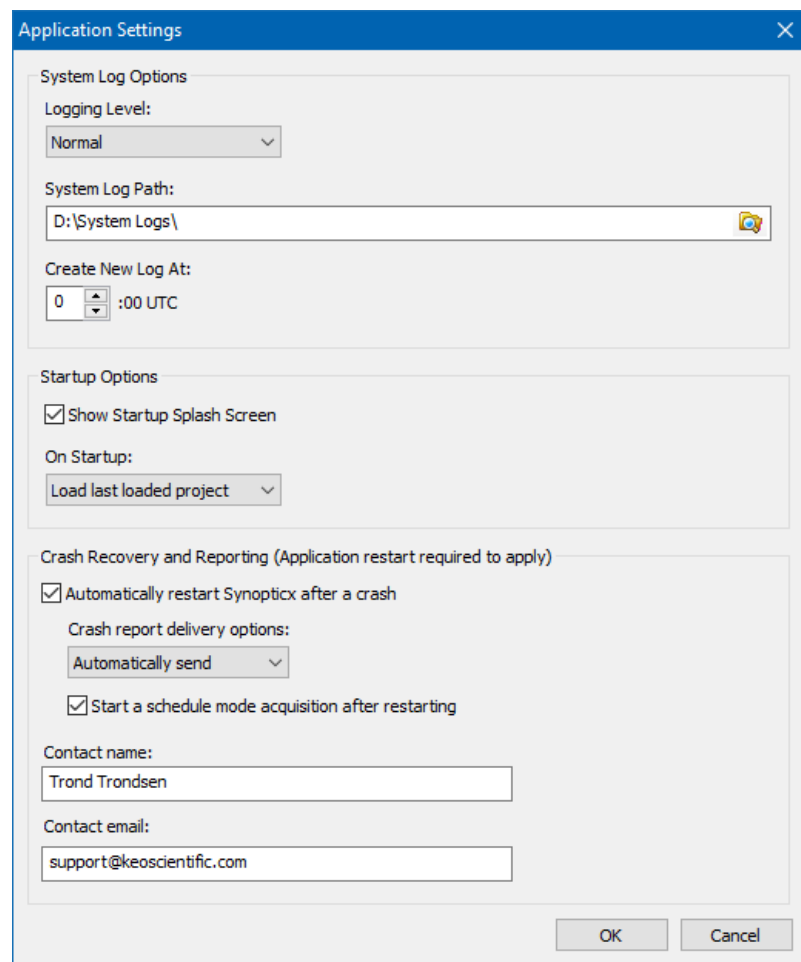


Figure 27: Application Settings Dialog

7.1.1 System Log Options

The System Log is provided as a way of logging system operations. This can be useful for verifying that there were no errors during a night's acquisitions or as a general way to check up on system operation.

The System Log can also help Keo Scientific debug any problems you are having with *Synopticx*. If you are encountering any issues in the operation of *Synopticx*, change the Logging Level option to be '+ Debug'. This will log additional information as the system is running (and as you interact with it) and will be useful in determining the cause of the problem. Please recreate the problem after enabling this option and then send the resulting log file to Keo Scientific at support@keoscientific.com.

System log files will be limited to 5MB in size. Whenever this size is exceeded, a new log file will be created with the same name as the previous one but with an incremented number at the end. For example, if the log file exceeds 5MB twice in the same day, you will end up with the following three system log files:

Original log file: *Synopticx_20160101_122345.log*

Second log file: *Synopticx_20160101_122345-2.log*

Third log file: *Synopticx_20160101_122345-3.log*

Logging Level: This option selects the level of detail to log. For normal operation use the Normal option. For debugging purposes change this to the '+ Debug' option.

System Log Path: System logs will be saved to this path. Each time *Synopticx* is started, a new system log file will be created.

Create New Log At: This setting controls the UTC hour at which system log rollover will occur. When this UTC hour is reached, the current system log file is closed and a new one created with the current date and time.

7.1.2 Startup Options

These settings affect the behavior of *Synopticx* when it is starting up.

Show Startup Splash Screen: The startup splash screen can be disabled by un-checking this option. This is purely cosmetic and will have no effect on the startup time of the application.

On Startup: This option defines whether to load the last used project or start a new one when *Synopticx* starts.

7.1.3 Crash Recovery and Reporting

By checking the 'Automatically restart *Synopticx* after a crash' option, *Synopticx* will automatically restart itself in the event of an application crash. After selecting this option, two additional options become available:

- 1) **Crash report delivery options:** Under normal circumstances, if *Synopticx* crashes the user is presented with an Error Report dialog that allows them to view the automatically collected debugging information before it is sent to Keo Scientific. At this point they can either choose to send the error report or close the program without sending the error report.

When *Synopticx* is configured to automatically restart after a crash, these settings allow *Synopticx* to either 'Automatically send' or 'Do not send' the error reports and then restart the application without any user intervention.

- 2) **Start a schedule mode acquisition after restarting:** This option will automatically start a scheduled acquisition after the application restarts. This is equivalent to the user clicking the Connect button and then the Run Schedule button.

The **Contact Name** and **Contact Email** fields allow Keo Scientific to contact you regarding any error reports that you send (either manually or automatically during a restart). Without this information Keo Scientific will not know who sent the error report and be unable to follow up regarding your issues.

7.2 Site Setup

The Site Setup dialog contains information pertinent to the location of the imager and can be accessed with the Site Setup button on the Setup tab. The Geographic Parameters are extremely important since they are used to calculate the sun and moon positions.

Figure 28: Site Setup Dialog

Site ID and Imager ID are used for your reference only as a way of distinguishing between data collected from multiple imagers at the same geographic location.

As mentioned above, the Geographic Parameters are used to calculate the current sun and moon ephemeris which are used to determine when to automatically start/stop system operation.

Latitudes can be in the range of -90° to $+90^{\circ}$ (negative indicates a southern latitude) and longitudes should be entered in the range of -180° to $+180^{\circ}$ (negative indicates a western longitude).

Sun and Moon Ephemeris Limits is where you will set your desired ephemeris limits. Checking the Ignore Lunar Position checkbox will tell the system to disregard the moon position parameters and only use the sun's position.

Typical values for Max Solar Elevation are shown below:

Civil Twilight	-6°
Nautical Twilight	-6° to -12°
Astronomical Twilight	-12° to -18°

Setting this value to $+90^{\circ}$ will result in continuous operation.

Synoptix will automatically stop data acquisition when the following Boolean formula evaluates as TRUE:

$$(\text{Current Solar Elevation} > \text{Max Solar Elevation}) \text{ OR } [(\text{Current Lunar Elevation} > \text{Max Lunar Elevation}) \text{ AND } (\text{Current Lunar Phase} > \text{Max Lunar Phase})]$$

In other words:

- When the Ignore Lunar Position option is enabled, data acquisition will stop when the sun rises above the Max Solar Elevation value.
- When the Ignore Lunar Position option is *not* enabled, data acquisition will stop if *either* of these two conditions are met:

1. The sun rises above the Max Solar Elevation angle, or
2. The moon rises above the Max Lunar Elevation angle and at the same time has a phase greater than the Max Lunar Phase. This allows for data acquisition to continue no matter the elevation of the moon as long as the lunar phase is less than the Max Lunar Phase setting.

7.3 Instrument Settings

The Instrument Settings dialog contains all the various settings needed for *Synopticx* to connect to and configure your instrument. This dialog can be accessed with the Instrument Settings button on the Setup tab. There are four main sections to this dialog:

1. Instrument Selection (top left),
2. Filterwheel/Shutter Controller (center left),
3. Temperature Control (bottom left), and
4. Additional Settings (right). For instruments with a camera, Additional Settings will display camera settings. Other instruments will display additional settings here for the particular instrument.

The screenshot shows the 'Instrument Settings' dialog box for a 'Sentry Imager'. The dialog is organized into four main sections:

- 1. Instrument Selection:** Includes dropdowns for 'Model' (Sentry Imager), 'Configuration' (Multi-Position), and 'Version' (Standard).
- 2. Filterwheel:** Includes a 'COM Port' dropdown (COM1) and a 'Number of Filter Positions' dropdown (6). There is an 'Advanced ...' button.
- 3. Temperature Control:** Includes a 'Controller Type' dropdown (Omega CNI32 Series), a 'COM Port' dropdown (COM2), a 'Setpoint (°C)' spinner (25.0), and an 'Operating Mode' dropdown (Heating). There is an 'Advanced ...' button.
- 4. Sentry Camera Settings:** Includes a 'Camera Type' dropdown (Princeton Instruments PIXIS), a 'Camera Selection' section with 'Camera Name' (VirtualCamera) and 'Description' (PI Virtual Camera) dropdowns, and a 'Refresh' button. It also has 'ADC Settings' (Readout Amplifier: Normal, Readout Rate: 2 MHz, Controller Gain: 1, Bit Depth: 16) and 'Shutter Control' (Internal Shutter: Disabled Open, External Shutter Logic: Shutter).

At the bottom of the dialog are 'OK' and 'Cancel' buttons.

Figure 29: Instrument Settings Dialog (Sentry Imager)

7.3.1 Instrument Selection

In this section the Model, Configuration, and Version of your Keo instrument should be configured. In most situations these will be automatically populated using the Auto Detect Instrument button at the very top. This button will launch the Auto Detect wizard which will search for any attached instruments. Upon finding an instrument it will automatically configure most of the settings.

Figure 30: Instrument Selection Section of Instrument Settings Dialog



Important Information

Older 'legacy' instruments do not have the features required to fully configure *SynopticX* with the 'Auto Detect Instrument' feature. After the auto detect process completes, the user will still have to manually enter a few settings.

If the Auto Detect Instrument feature does not work, then the settings can be manually configured.

Model: *SynopticX* currently supports the following models of instrument.

- Keo *Sentry* Scientific Imager
- Keo *Arges-VF* Photometer

Configuration: Each model of instrument can have the option of having a single filter or a multi-filter filterwheel.

Version: New versions of our instruments can bring new functionality that *SynopticX* needs to know about. Select the version of your instrument here.

As each of the above settings are changed, the rest of the dialog sections will update to present the options for the instrument.

7.3.2 Filterwheel/Shutter Controller

Depending on whether your instrument Configuration is Single or Multi-Position, this section will provide different settings as shown below.

Figure 31: Filterwheel Section of Instrument Settings Dialog

Figure 32: Shutter Controller Section of Instrument Settings Dialog

COM Port: This is the serial port to use for communications with the device. The Auto Detect Instrument function will automatically configure this upon detecting the instrument.

Number of Filter Positions: The number of physical filter positions on the instrument. The Auto Detect Instrument function will automatically configure this provided the instrument is not considered 'legacy'. Otherwise manually select the number of filter positions in the instrument. For Single Position instruments this option will be disabled.



Important Information

Number of Filter Positions is not necessarily the same as the number of installed filters. It is common that filterwheels not be fully filled with filters.

7.3.3 Temperature Control

Synopticx supports several different temperature controllers and this section allows for configuring which type to control.

3. Temperature Control

Controller Type: Omega CNI32 Series

COM Port: COM2 Advanced ...

Setpoint (°C): 25.0

Operating Mode: Heating

Figure 33: Temperature Control Section of Instrument Settings Dialog

Controller Type: This is the type of controller to use. All currently produced instruments use the Omega CNI32 Series temperature controllers. Only select the Athena Legacy 16 Series option if you have a very old instrument. The Auto Detect Instrument function will automatically detect connected temperature controllers (including the Athena type) so it is rare that this setting should be changed manually.

COM Port: This is the serial port to use for communications with the temperature controller. The Auto Detect Instrument function will automatically configure this upon detecting the instrument.

Setpoint: All Keo Scientific multi-filter instruments provide resistive heating to thermally stabilize the filters. Some newer models also provide cooling capabilities for use in warm environments. Enter the desired temperature to stabilize the filters at. This will default to 25°C which is ideal for the filters that are provided with our instruments.



Important Information

Although the Setpoint can be set to any value, the instrument may not be able to reach the desired temperature. Please refer to the instrument user manual for details on acceptable temperature setpoints.

Operating Mode: On instruments with optional cooling, set this to “Heating & Cooling” otherwise leave it on “Heating”. Cooling will only function if the instrument is equipped with the optional cooling add-on.

7.3.4 Additional Settings

The right hand portion of the Instrument Settings dialog is dedicated to additional settings for your instrument. Depending on the instrument type there will be different options displayed here.

7.3.4.1 Sentry Camera Settings

When the instrument model is Sentry Imager, this section of the Instrument Settings dialog will allow of selection of the camera in use by the instrument. *Synopticx* currently supports the following cameras:

- Princeton Instruments PIXIS CCD
- Princeton Instruments ProEM EMCCD
- Andor iXon EMCCD
- Andor iKon CCD
- ZWO ASI174 CMOS
- Atik CCD

Figure 34: Sentry Camera Settings

Camera Type: This specifies the type of camera to use. Changing this option will change the options available. The Auto Detect Instrument function will automatically populate this setting for newer instruments. Legacy instruments will require manual selection of the correct settings.

Please refer to the camera manufacturer's user manual for detailed information about the different settings available. The following sections provide a brief description of the setting and how they affect *Synopticx* operation.

7.3.4.1.1 Princeton Instruments PIXIS CCD Settings

The PIXIS CCD provides the following settings.

Camera Name: This will display all of cameras available for use by *Synopticx*. Any Princeton camera that has been configured with the RSConfig utility (see Appendix A3) will be listed here.

Readout Amplifier: Some PIXIS CCDs have multiple readout amplifiers (e.g. 'Normal' or 'Low Noise'). Select the one to use for all data acquisition here.

Readout Rate: Depending on the Readout Amplifier selected, there may be multiple different Readout Rates available. Generally, a faster readout rate will produce higher levels of noise in the data.

Controller Gain: Depending on the Readout Amplifier selected, there may be multiple different Controller Gains that can be used. Normally the highest gain should be used unless you have too much signal for the higher gains. Refer to the camera's user manual for details.

Setpoint: The temperature setpoint controls the operating temperature of the camera. Below is a list of default temperatures for the different PIXIS CCDs. Typical temperatures may be achieved on some but not all devices.

Table 1: PIXIS CCD Setpoints

PIXIS Version	Default	Guaranteed	Typical
1024x1024	-70 °C	-70 °C*	-80 °C
2048x2048	-55 °C	-55 °C*	-65 °C

*ambient room temperature must be 20 °C or less

Never disable cooler: Select this option to keep the CCD at setpoint temperature at all times. This will eliminate the delay waiting to cool the CCD at the start of an acquisition. Under normal situations with this option not enabled, the CCD will be allowed to warm to ambient temperature when *Synopticx* enters Standby mode or whenever it disconnects from the instrument.

Shutter Mode: This option specifies the behavior of the shutter that can be installed in the front of the PIXIS CCD unit. Most Keo instruments do not have this shutter installed. Below is a brief description of each option.

Normal: The shutter will open and close for every exposure.

Disabled Open: The shutter is held open while *Synopticx* is connected to the camera.

Disabled Closed: The shutter is held closed while *Synopticx* is connected to the camera.

Logic Output: Most Keo instruments have an external 'capping' shutter (normally located at the front of the instrument between the front lens and the filterwheel) and it is normally controlled by the camera using the External Trigger Cable provided with the instrument (see the instrument's user manual for details on this cable and where to connect it). When this cable is attached, the camera can directly control the capping shutter. There are three typical settings that could be used.

Shutter: The capping shutter will behave according to the Shutter Mode setting (see above).

Logic 1: The capping shutter is held open while *Synopticx* is connected to the camera.

Logic 0: The capping shutter is held closed while *Synopticx* is connected to the camera.



Important Information

When the camera is configured with 'Logic 0' for the External Shutter Logic, *Synopticx* will revert to using the filterwheel or shutter controller to control the capping shutter. In this mode the capping shutter will operate the same as 'Logic 1'.

7.3.4.1.2 Princeton Instruments ProEM EMCCD Settings

The ProEM EMCCD provides the following settings.

Camera Name: This will display all of cameras available for use by *Synopticx*. Any Princeton camera that has been configured with the RSConfig utility (see Appendix A3) will be listed here.

Readout Port: The ProEM EMCCD normally has two readout ports: 'Multiplying' and 'Conventional'. Select the one to use for all data acquisition here.

Readout Rate: Depending on the Readout Port selected, there may be multiple different Readout Rates available. Generally, a faster readout rate will produce higher levels of noise in the data.

Controller Gain: Depending on the Readout Amplifier selected, there may be multiple different Controller Gains that can be used. Normally the highest gain should be used unless you have too much signal for the higher gains. Refer to the camera's user manual for details.

Readout Mode: The ProEM EMCCD can operate in one of two readout modes: 'Full Frame' or 'Frame Transfer'. Refer to the camera's user manual for details on these different modes.

Vertical Shift: The **Override Vertical Shift** option can be used to specify a specific vertical shift speed to use. Under normal conditions the defaults will be sufficient.

Setpoint: The temperature setpoint controls the operating temperature of the camera. Below is a list of default temperatures for the different ProEM EMCCDs. Typical temperatures may be achieved on some but not all devices.

Table 2: ProEM EMCCD Setpoints

ProEM Version	Default	Guaranteed	Typical
1024x1024	-55 °C	-55 °C*	-65 °C

*ambient room temperature must be 20 °C or less

Never disable cooler: Select this option to keep the CCD at setpoint temperature at all times. This will eliminate the delay waiting to cool the CCD at the start of an acquisition. Under normal situations with this option not enabled, the CCD will be allowed to warm to ambient temperature when *Synopticx* enters Standby mode or whenever it disconnects from the instrument.

Shutter Mode: This option specifies the behavior of the shutter that is installed in the front of the ProEM EMCCD unit. This setting should be 'Disabled Open' for most if not all instrument configurations. Below is a brief description of each option.

Normal: The internal shutter will open and close for every exposure.

Disabled Open: The shutter is held open while *Synopticx* is connected to the camera.

Disabled Closed: The shutter is held closed while *Synopticx* is connected to the camera.

Output Logic: Most Keo instruments have an external 'capping' shutter (normally located at the front of the instrument between the front lens and the filterwheel) and it is normally controlled by the camera using the External Trigger Cable provided with the instrument (see the instrument's user manual for details on this cable and where to connect it). When this cable is attached, the camera can directly control the capping shutter. There are two typical settings that could be used.

Shutter: The capping shutter will behave according to the Shutter Mode setting (see above).

Logic 1: The capping shutter is held open while *Synopticx* is connected to the camera.

Invert Output Logic: The ProEM EMCCD does not have a 'Logic 0' option for External Shutter Logic. Instead an option is provided to invert the External Shutter Logic. This option should be used when it is desired to have the External Shutter Logic be 'Logic 0'. To do this, set the External Shutter Logic setting to 'Logic 1' and then enable the Invert External Shutter Logic option.



Important Information

When the camera is configured with 'Logic 1' for the External Shutter Logic and the Invert External Shutter Logic option enabled, *Synopticx* will revert to using the filterwheel or shutter controller to control the capping shutter. In this mode the capping shutter will operate as 'Logic 1'.

7.3.4.1.3 Andor iXon EMCCD Settings

The Andor iXon EMCCD provides the following settings. Please refer to the camera's user manual for more details on each of these settings.

Camera Name: This will display all of cameras available for use by *Synopticx*. Any installed Andor camera will be listed here.

Vertical Shift Speed: Andor provides the ability to alter the vertical shift speed used when reading out images. For most applications this can be left at its default setting. Refer to the camera's user manual for more details.

Vertical Clock Voltage Amplitude: The voltage used to 'clock' the vertical shifting can also be adjusted. For most applications this can be left at its default setting. Refer to the camera's user manual for more details.

Readout Rate: Depending on the Output Amplifier selected, there may be multiple different Readout Rates available. Generally, a faster readout rate will produce higher levels of noise in the data.

Pre-Amplifier Gain: Depending on the Output Amplifier selected, there may be multiple different Pre-Amplifier Gains that can be used. Normally the highest gain should be used unless you have too much signal for the higher gains. Refer to the camera's user manual for details.

Output Amplifier: The iXon EMCCD has two output amplifiers: 'Electron Multiplying' and 'Conventional'. Changing this option will affect the available options for Readout Rate and Pre-Amplifier Gain.

Setpoint: The temperature setpoint controls the operating temperature of the camera. Below is a list of default temperatures for the iXon EMCCDs. Typical temperatures may be achieved on some but not all devices.

Table 3: iXon EMCCD Setpoints

iXon Version	Default	Guaranteed	Typical
1024x1024	-80 °C	-80 °C*	-80 °C

*ambient room temperature must be 20 °C or less

Enable Cooler: This option lets you disable the cooler on the camera. *Synopticx* will automatically enable/disable the cooler as required. Most applications should leave this option enabled.

Fan Speed: The iXon has a multi-speed capable fan. In Keo instruments it can run at high speed all the time which will produce better cooling performance. Low speed can be used for vibration sensitive experiments.

Enable EM Gain: If using the 'Electron Multiplying' Output Amplifier, enabling this option will enable the EM gain set in EM Gain Level setting.

Enable High Gain Levels: This option unlocks EM Gain Levels higher than 255.

EM Gain Level: This sets the amount of EM gain to use.

7.3.4.1.4 Andor iKon CCD Settings

The Andor iKon CCD provides the following settings. Please refer to the camera's user manual for more details on each of these settings.

Camera Name: This will display all of cameras available for use by *Synopticx*. Any installed Andor camera will be listed here.

Vertical Shift Speed: Andor provides the ability to alter the vertical shift speed used when reading out images. For most applications this can be left at its default setting. Refer to the camera's user manual for more details.

Vertical Clock Voltage Amplitude: The voltage used to 'clock' the vertical shifting can also be adjusted. For most applications this can be left at its default setting. Refer to the camera's user manual for more details.

Readout Rate: Depending on the Output Amplifier selected, there may be multiple different Readout Rates available. Generally, a faster readout rate will produce higher levels of noise in the data.

Pre-Amplifier Gain: Depending on the Output Amplifier selected, there may be multiple different Pre-Amplifier Gains that can be used. Normally the highest gain should be used unless you have too much signal for the higher gains. Refer to the camera's user manual for details.

Setpoint: The temperature setpoint controls the operating temperature of the camera. Below is a list of default temperatures for the iKon CCDs. Typical temperatures may be achieved on some but not all devices.

Table 4: iKon EMCCD Setpoints

iKon Version	Default	Guaranteed	Typical
L 936 (2048x2048)	-80 °C	-80 °C*	-80 °C
M 934 (1024x1024)	-80 °C	-80 °C*	-80 °C

*ambient room temperature must be 25 °C or less

Enable Cooler: This option lets you disable the cooler on the camera. *Synopticx* will automatically enable/disable the cooler as required. Most applications should leave this option enabled.

Fan Speed: The iXon has a multi-speed capable fan. In Keo instruments it can run at high speed all the time which will produce better cooling performance. Low speed can be used for vibration sensitive experiments.

7.3.4.1.5 ZWO ASI174 CMOS Settings

The ZWO ASI174 CMOS camera provides the following settings. Please refer to the camera's user manual for more details on each of these settings.

Figure 35: ZWO ASI174 Settings

Camera Name: This will display any ZWO cameras that are available for use with Synoptics.

Gain: The gain to apply to the image data. It is recommended to start with this at the lowest available setting and adjust only as high as is required to achieve the desired frame rate. The higher the gain settings the higher the image noise will be present.

Gamma: Adjusts the gamma curve of the image.

Image Format: Allows for selecting the format of data retrieved from the camera. Some values only available on RGB cameras.

8-bit RAW: 8-bit raw pixel values

16-bit RAW: 16-bit raw pixel values

8-bit Mono: 8-bit greyscale converted from 24-bit RGB data

24-bit RGB: 8-bit per pixel RGB data

Note: the RAW formats are available on color RGB cameras but will require bayer processing to extract the color data.

Region of Interest: Allows for selecting a sub-region of the image.

Enable Cooler: Enables the cooler if available on the camera (-C models only).

Setpoint: Target temperature setpoint (-C models only).

7.3.4.2 Arges Photometer Additional Settings

The Arges photometer does not have any additional settings to configure since it does not have a variable field-of-view.

7.3.4.3 Arges-VF Photometer Additional Settings

The Arges-VF photometer requires a few additional settings for configuring the zoom lens.

Figure 36: Arges-VF Photometer Additional Settings

COM Port: The Zoom Lens Controller uses a virtual serial port to communicate. Select the correct one here. This setting will be automatically configured if the Auto Detect Instrument feature was used.

FoV Characterization File Path: The zoom lens field of view is characterized by Keo Scientific upon assembling the device. In order for *Synopticx* to send the zoom lens to the correct position it needs to know this characterization. Enter the path to the provided `z1cCalFile4` in this field.

Default FoV: After loading the FoV Characterization File, you will be able to select a default FoV from the ones available. In a Schedule Mode acquisition, all filters will use this Default FoV unless you configure them otherwise.

7.4 Device Manager

The Device Manager dialog is used to configure any additional devices that are not part of the main instrument. For example, the Keo *SunShield* device can be configured through the Device Manager.

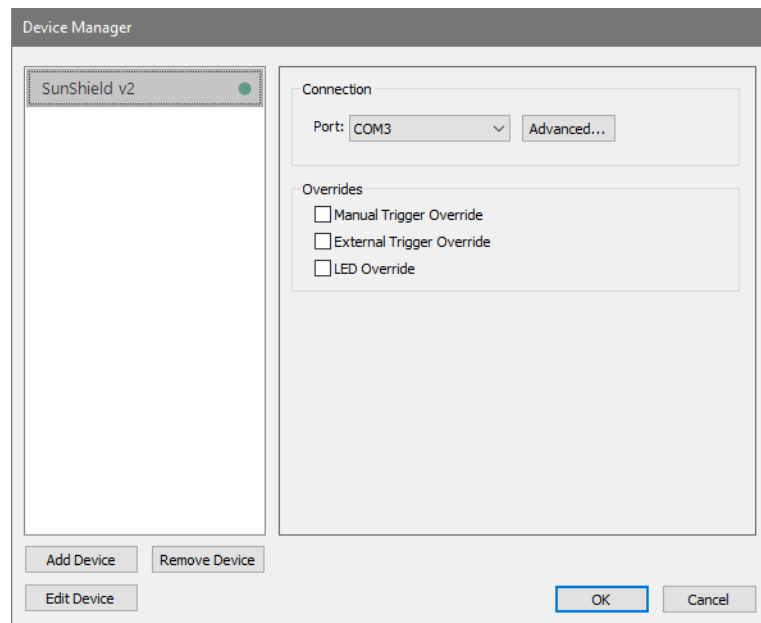


Figure 37: Device Manager Dialog

The Device Manager will list all configured devices in the left list and display the selected device's settings on the right. Devices are managed using the Add, Remove, and Edit Device buttons found in the bottom left of the dialog.

Clicking the **Add Device** button will open the Add Device dialog where you can select the device you wish to add. Available devices are displayed on the left and a brief description is shown on the right after selecting a device. Details on available devices and their available settings can be found in Section 7.4.1.

⁴ This file is provided on its own CD with your *Synopticx* installation. Contact Keo Scientific for a copy of this file if you have misplaced the one that shipped with your instrument.

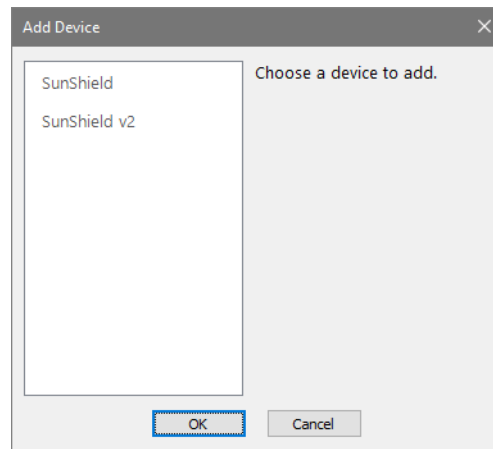


Figure 38: Add Device Dialog

The **Remove Device** button will remove the currently selected device from the Device Manager.

Each device can be renamed, disabled, or set as a virtual device (to simulate a real device) using the **Edit Device** button.

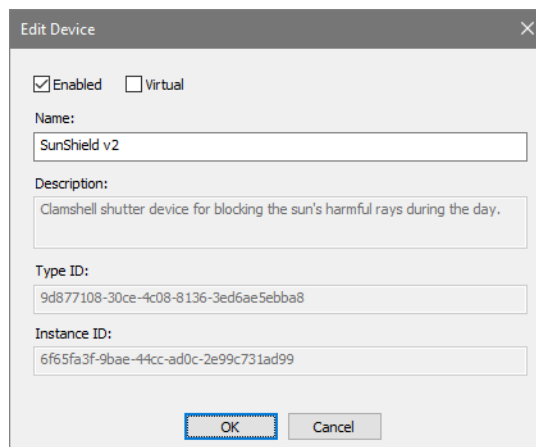


Figure 39: Edit Device Dialog

Enabled: This setting lets you disable a device (it will no longer be controlled by *Synopticx*) without fully deleting it from the Device Manager.

Virtual: Configuring a device to be virtual will allow *Synopticx* to continue to operate as normal even though the device may not actually be attached to the computer. This is useful for debugging purposes and will most likely not be used unless recommended by Keo Scientific support.

Name: The name of the device as it appears in the Device Manager can be configured here.

7.4.1 Available Devices

As of the time of writing, the following devices can be configured through the Device Manager.

- Keo *SunShield*
- Keo *SunShield v2*

7.4.1.1 Keo *SunShield* Settings

The original Keo *SunShield* device has only one configurable setting: the serial port.

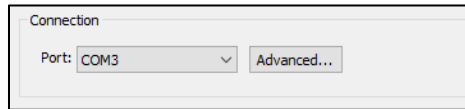


Figure 40: Keo SunShield Settings

Once configured, the *SunShield* device will automatically close anytime *Synopticx* enters the Standby state and will automatically open when data acquisition is resumed. Disconnecting from the instrument will also open the *SunShield*.

7.4.1.2 Keo *SunShield* v2 Settings

The second generation of our *SunShield* product included several new features and these can be configured through the Device Manager.

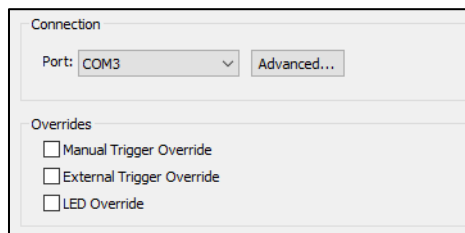


Figure 41: Keo SunShield v2 Settings

Port: The serial port the *SunShield* is connected to. Note that although this device is USB, it is installed as a COM port on the computer. If you are unsure of the port to select, you can use the **Advanced...** button to open the Advanced COM Settings dialog where you can use the **Test Settings...** button to test the selected port settings.

Overrides: These overrides control the configuration of the overrides in the *SunShield* device. Refer to the Keo *SunShield* user manual for details on what these overrides do.

7.5 Data Output

Depending on the type of instrument, *Synopticx* will be either collecting images or counts. These two types of data are displayed differently on the screen (as images and a line plot) and they are also saved to disk in different formats. The settings to control the output data are configured using the Data Output dialog which is accessed using the Data Output button on the Setup tab.

7.5.1.1 Image Data

Image data is saved in the formats specified (PNG and/or TIFF) in folders organized by year/month/day/hour within the 'Root Directory' specified. Images saved as PNG will have embedded header information containing the following specifics of that image.

Site Information: Site ID, latitude, longitude, time.

Filter Information: Imager filter number, filter wavelength, filter label, filter description.

Camera Information: Exposure, binning, readout speed, image bit depth, pre-amp gain, EM-gain (if applicable), CCD temperature, filter wheel temperature (if applicable), shutter open/closed.



Important Information

For a quick way of viewing embedded header information, Keo Scientific recommends using TweakPNG (<http://entropymine.com/jason/tweakpng/>). Simply open the saved PNG files in TweakPNG and it will show you all the saved metadata.

If you wish to develop your own custom routine for reading this data, information on the structure of a PNG file can be found here: <http://www.libpng.org/pub/png/spec/1.2/PNG-Structure.html#Chunk-layout>.

7.5.1.2 Count Data

Count data is saved in a proprietary 'SYNDAT' format in folders organized by year/month/day within the 'Root Directory' specified. See Appendix B for the specifications of the 'SYNDAT' file format. For quick review of the data you can open a SYNDAT file in any text editor to view the contents. The SYNDAT file format includes a header that contains the following specifics of the data contained in the file.

Site Information: Site ID, latitude, longitude.

Filter Information: Filter number, filter wavelength, filter label, filter description.

Acquisition Information: Gate time, number of gates, field of view, and shutter open/closed.

When running in Schedule Mode, data for each filter is saved to its own SYNDAT file. Additionally, each hour of observation will be stored into a new SYNDAT file. For example, if acquiring with all 6 filters then you will get 6 SYNDAT files created per hour (one per filter).

Dark data is also saved independently from normal data so you will get additional SYNDAT files for each filter for each dark data collection. See Section **Error! Reference source not found.** for more details on dark data capture.

7.6 Filter Setup

The Filter Setup dialog is accessed with the Filter Setup button on the Setup tab and is where you will configure each of the filters you have installed in your filter wheel (or if using a single-filter system just the one). The filter number (first column on the left) corresponds to the physical location in the filter wheel.

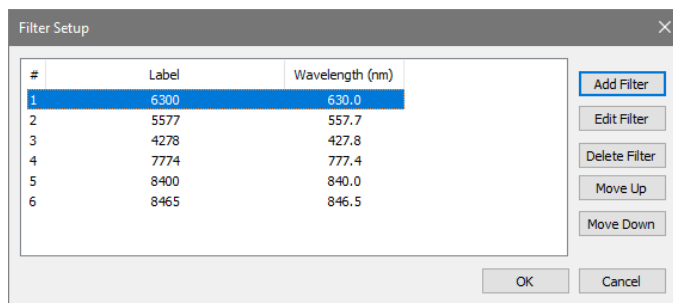


Figure 42: Filter Setup Dialog

The labels defined in this dialog will be used to select a filter when defining acquisitions and when using the Acquire/Continuous acquisition modes.

7.7 Acquisition Setup

These settings will be used when data is acquired for each acquisition during a Schedule Mode acquisition. Depending on your type of instrument the settings available for each acquisition will differ.

To add an acquisition, click the Add button. This will open the Add a New Acquisition dialog where you can enter the relevant parameters. If your acquisitions are in the wrong order, simply use the Move Up and Move Down buttons to move the selected acquisition up and down the list. Editing an existing acquisition can be done with the Edit button or by double clicking on the desired acquisition.

7.7.1 Acquisition Setup – Sentry Imagers

When the instrument is a Sentry imager, each acquisition can be configured with a Label, Filter, Exposure, Number of Exposures, Dark Frame, Binning, CCD Gain, and EM Gain (if camera is an EMCCD).

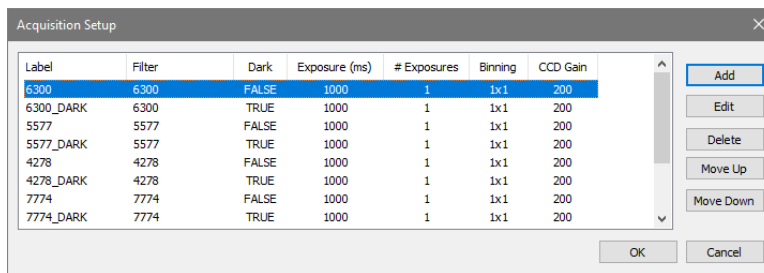


Figure 43: Acquisition Setup Dialog (Sentry Imager)

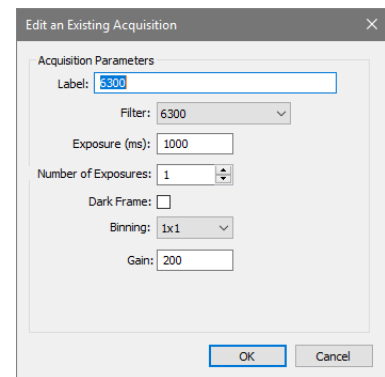


Figure 44: Sentry Acquisition Dialog

Label: This label is used throughout the application as a way to refer to the acquisition. It is also used in the naming of the data files produced from this acquisition. This label can be up to 32 characters long and contain any character that is valid in a filename. Best practice is to use letters (a-z,A-Z), numbers (0-9), and a few select special characters (-,_,.).

Filter: This is the filter to use for this acquisition.

Exposure: This defines the exposure length for the acquisition in milliseconds.

Number of Exposures: This defines the number of exposures to capture for this acquisition.

Dark Frame: This indicates whether the acquisition will be done with the shutter open or closed.

Binning: This selects the binning setting to use for the acquisition.

CCD Gain: This defines the CCD gain to be used for this filter.

EM Gain: (Optional) This defines the EM gain to be used for this filter. This setting is only available for EMCCD type cameras.

7.7.2 Acquisition Setup – Arges and Arges-VF Photometers

When the instrument is an *Arges* or *Arges-VF* photometer, each acquisition can be configured with a Label, Filter, Dark Frame, Gate Time, and Number of Gates. Additionally, if the device is an *Arges-VF* photometer, then the FoV will also be configurable (the *Arges* photometer has a fixed FoV so this setting is not configurable).

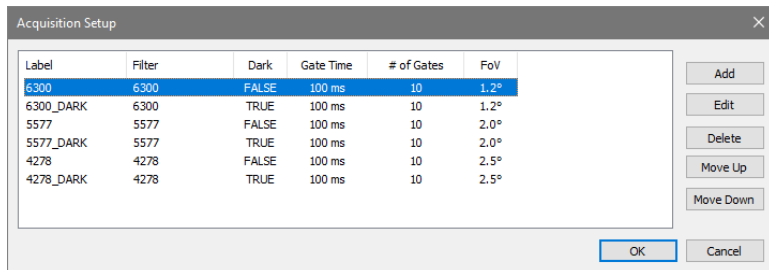


Figure 45: Acquisition Setup Dialog (Arges-VF Photometer)

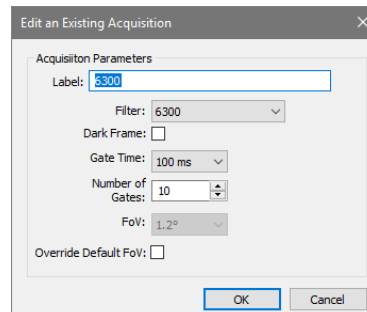


Figure 46: Arges-VF Acquisition Dialog

Label: This label is used throughout the application as a way to refer to the acquisition. It is also used in the naming of the data files produced from this acquisition. This label can be up to 32 characters long and contain any character that is valid in a filename. Best practice is to use letters (a-z,A-Z), numbers (0-9), and a few select special characters (-,_,.).

Filter: This is the filter to use for this acquisition.

Gate Time: Select a gate time setting for this filter.

Number of Gates: the number of gates to capture for this filter. Total exposure time will be Gate Time x Number of Gates. For example, with a Gate Time of 100ms and Number of Gates of 10, the total effective data acquisition time will be 1000ms.

FoV: The field of view to use for this filter. Select one of the available options. FoV will default to the one specified in Instrument Settings unless the Override Default FoV option is also selected. Note: this setting is only available for the *Arges-VF* photometer.

Override Default FoV: Use this option to specify a FoV for this filter that is different from the one defined in Instrument Settings. Note: This setting is only available for the *Arges-VF* photometer.

7.8 Schedule Configuration

The Schedule Configuration dialogs are used to define the data acquisition schedules for use in a Schedule Mode acquisition. There are three separate dialogs that can be accessed.

The main Schedule Configuration dialog can be accessed by clicking on the Schedule Configuration button.

The Pre- or Post-Schedule Configuration dialogs can be accessed by first selecting the lower drop-down portion of the Schedule Configuration button and then selecting the Pre- or Post-Schedule Configuration button as shown below in Figure 47.

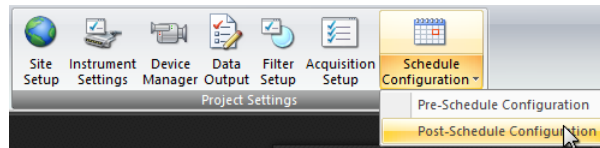


Figure 47: Selecting Post-Schedule Configuration

Each acquisition schedule can operate in two different modes, Free-Run and Synchronized, and features an intuitive drag-and-drop interface for placing filters in the schedule.

7.8.1 Scheduling Mode

There are two different options for the scheduling mode: Free-Run and Synchronized. See Section 4.1.1 for more details on the different modes.

Free-Run: Use this mode when you want to simply cycle through all the filters (or a subset of them) in a particular order.

Synchronized: Use this mode when you want to prescribe a 'cadence' for each filter and have each exposure start at a prescribed second in the minute.

After selecting the mode, the schedule will change to reflect the mode of operation. In Free-Run mode, the number of timeslots will be equal to the number of installed filters while in Synchronized mode, there will be 60 timeslots corresponding to each second of a minute. See Figure 48 and Figure 49 for a depiction of the different scheduling modes.

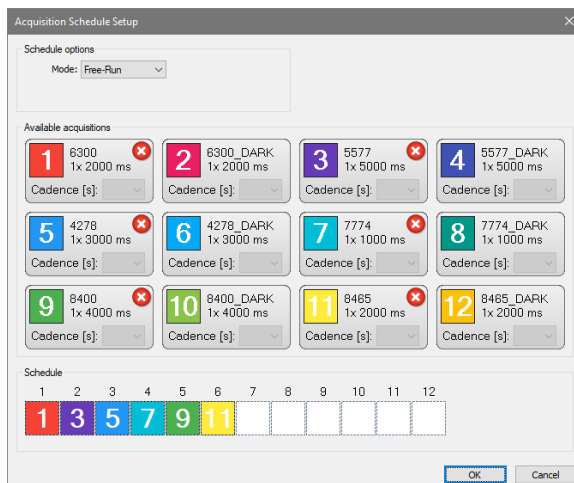


Figure 48: Acquisition Schedule Dialog (Free-Run Mode)

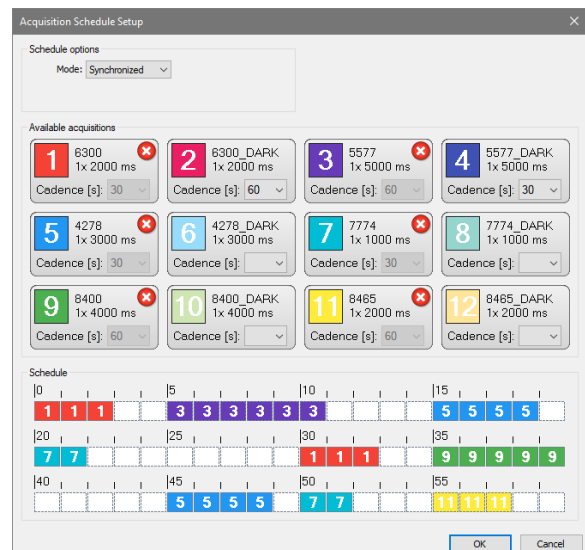


Figure 49: Acquisition Schedule Dialog (Synchronized Mode)

7.8.2 The Schedule

To create an acquisition schedule, you will drag-and-drop filters from the Available Filters section to the Schedule section.

To drag-and-drop a filter, simply position the mouse cursor over the colored square corresponding to the filter you wish to place (Figure 50), press and hold the left mouse button and start dragging (Figure 51), drag it down to the schedule and position it over the timeslot you want it to occupy (Figure 52) and then release

the mouse button to drop it in place (Figure 53). Repeat this procedure for the remaining filters you wish to place.

To remove an already placed filter from the schedule, click the  icon on the filter you wish to remove.

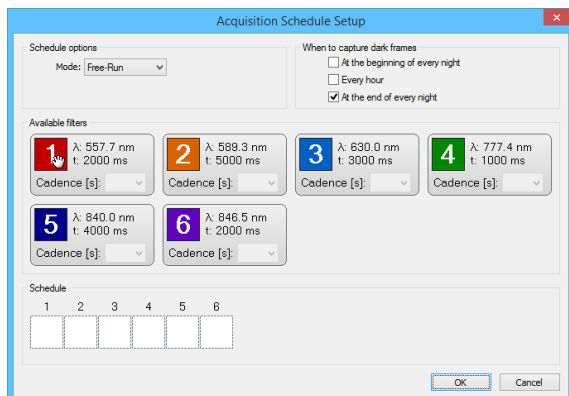


Figure 50: Mouse over Desired Filter

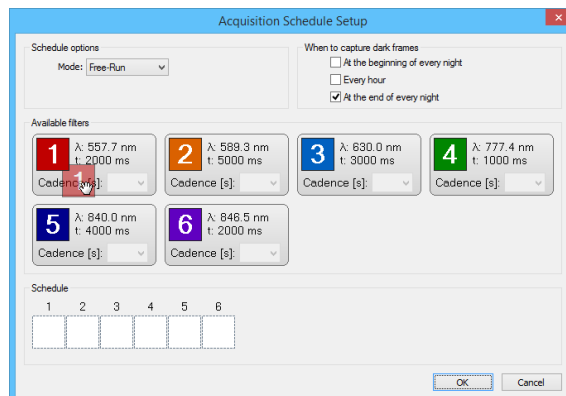


Figure 51: Dragging Desired Filter

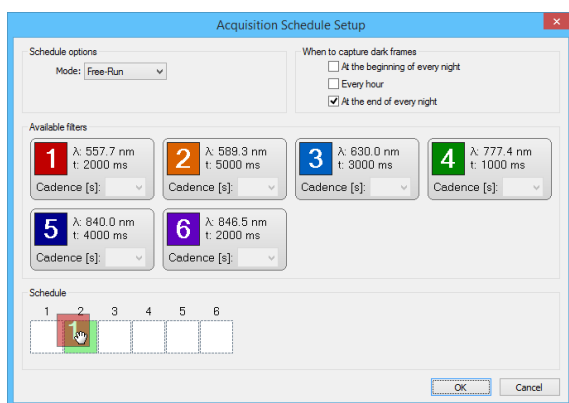


Figure 52: Selecting a Timeslot

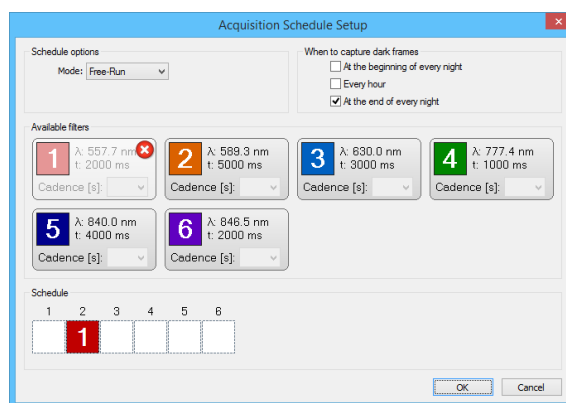


Figure 53: Scheduled Filter

When the schedule is in Synchronized mode, there is one additional step you must take before placing a filter: you must first select a cadence for the filter.

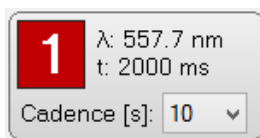


Figure 54: Filter Cadence

The cadence is the time between exposure start time of the same filter (e.g. a cadence of 20 seconds would indicate that every 20 seconds a new exposure will start on that filter). After selecting a cadence, the colored square becomes activated and you can now drag-and-drop as you would in Free-Run mode.

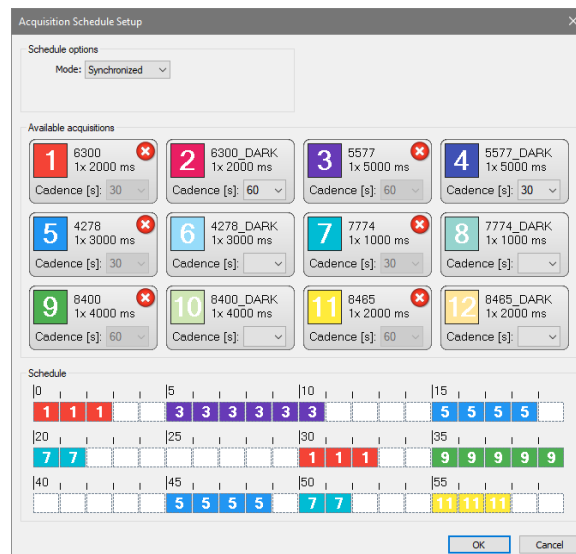


Figure 55: Synchronized Acquisition Schedule

In the example above, a synchronized acquisition schedule has been created with the following acquisition cadences and start times.

- Acquisition 1: 30s Cadence, 0s and 30s start time
- Acquisition 3: 60s Cadence, 5s start time
- Acquisition 5: 30s Cadence, 15s and 45s start time
- Acquisition 7: 30s Cadence, 20s and 50s start time
- Acquisition 9: 60s Cadence, 35s start time
- Acquisition 11: 60s Cadence, 55s start time

While placing acquisitions in the schedule in Synchronized mode, you may notice that the time period allotted for a given acquisition is larger than the exposure you have configured in the acquisition settings (for example, in Figure 55 above, acquisition 3 has a 5000ms exposure time but is allocated 7 seconds of time in the schedule). This is to provide time for the filterwheel to change positions for the next exposure.

7.9 Continuous and Acquire Mode Acquisition Configuration

When using Continuous and Acquire modes, the settings to use for these acquisitions are configured from the Acquisition Configuration dialog. This dialog can be accessed using the drop-down portion of the Run Continuous and Run Acquire buttons on the Home tab.

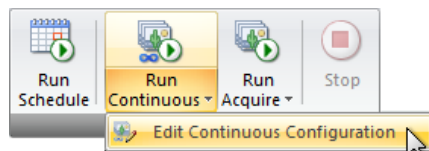


Figure 56: Edit Acquisition Configuration (Run Continuous)



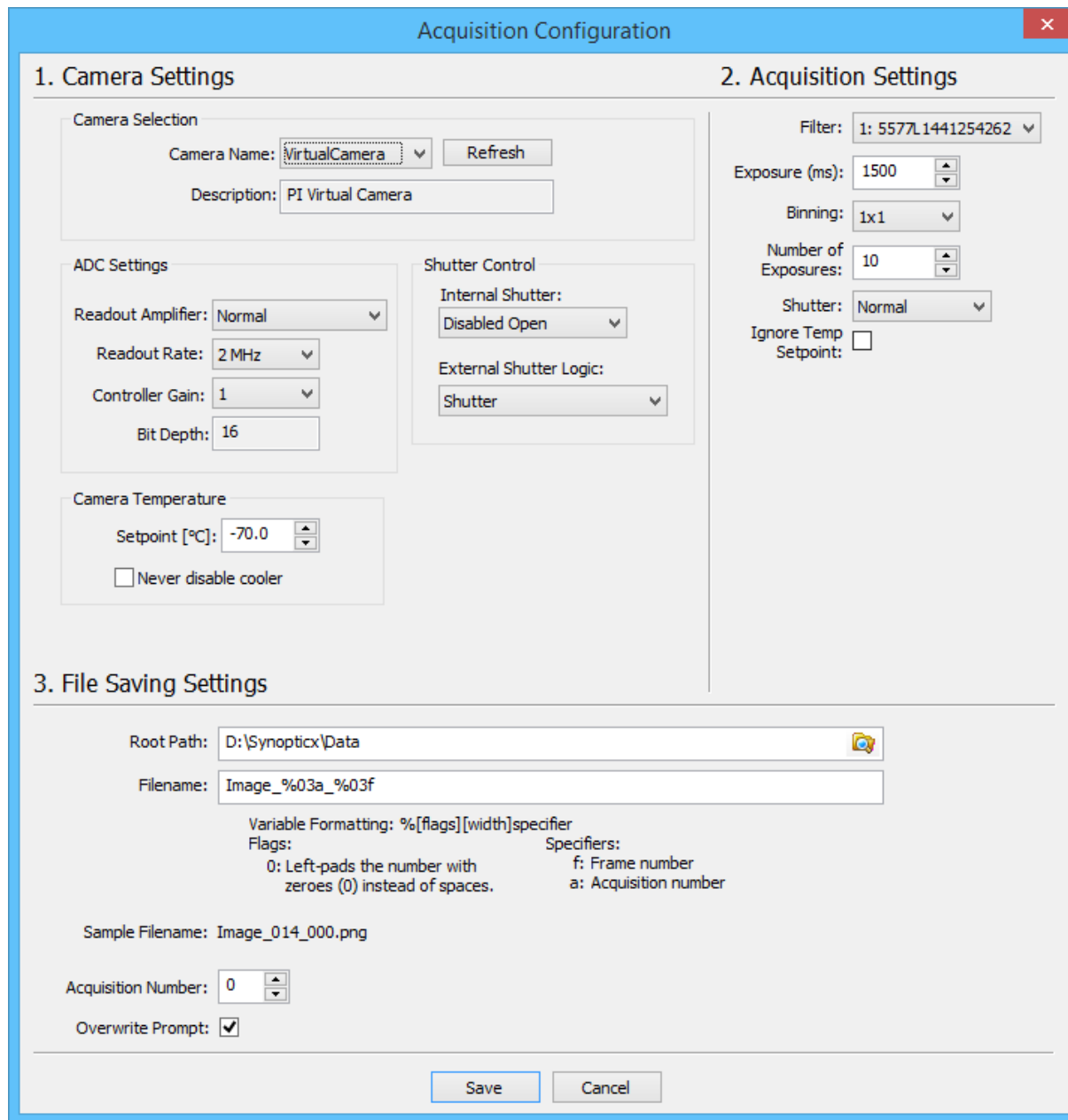
Figure 57: Edit Acquisition Configuration (Run Acquire)

The Acquisition Configuration dialog is used to configure the Continuous and Acquire mode acquisitions.

The Acquisition Configuration dialog is organized into three sections:

1. Camera Settings,
2. Acquisition Settings, and
3. File Saving Settings

For Continuous mode acquisitions, the File Saving Settings will be disabled.



The Acquisition Configuration dialog is divided into three main sections: Camera Settings, Acquisition Settings, and File Saving Settings.

1. Camera Settings

- Camera Selection:** Camera Name: VirtualCamera (dropdown), Refresh button, Description: PI Virtual Camera (text field).
- ADC Settings:** Readout Amplifier: Normal (dropdown), Readout Rate: 2 MHz (dropdown), Controller Gain: 1 (dropdown), Bit Depth: 16 (text field).
- Shutter Control:** Internal Shutter: Disabled Open (dropdown), External Shutter Logic: Shutter (dropdown).
- Camera Temperature:** Setpoint [°C]: -70.0 (spin box), Never disable cooler (checkbox).

2. Acquisition Settings

- Filter:** 1: 557L1441254262 (dropdown).
- Exposure (ms):** 1500 (spin box).
- Binning:** 1x1 (dropdown).
- Number of Exposures:** 10 (spin box).
- Shutter:** Normal (dropdown).
- Ignore Temp Setpoint:** (checkbox).

3. File Saving Settings

- Root Path:** D:\Synoptix\Data (text field with folder icon).
- Filename:** Image_%03a_%03f (text field).
- Variable Formatting:** %[flags][width]specifier
- Flags:** 0: Left-pads the number with zeroes (0) instead of spaces.
- Specifiers:** f: Frame number, a: Acquisition number.
- Sample Filename:** Image_014_000.png
- Acquisition Number:** 0 (spin box).
- Overwrite Prompt:** (checked checkbox).

Buttons: Save, Cancel.

Figure 58: Acquisition Configuration Dialog

7.9.1 Camera Settings

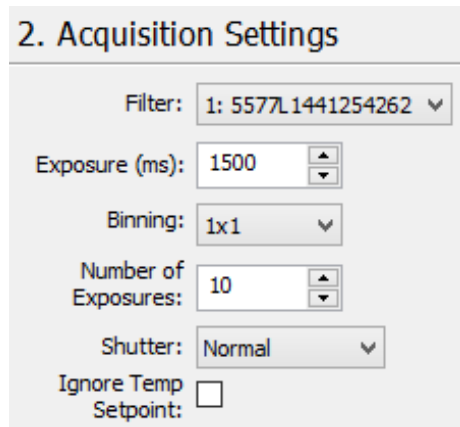
The camera settings found in this dialog function the same as the ones found in the Instrument Settings dialog, except that these settings will only apply to the Continuous or Acquire mode acquisition. For instruments that don't have a camera, this section of the dialog will display "NO AVAILABLE SETTINGS".

7.9.2 Acquisition Settings

Use the acquisition settings to define the current acquisition. Different options will be presented here depending on the type of instrument attached.

7.9.2.1 Sentry Imager Acquisition Settings

When the instrument is configured as a Sentry Imager, the settings presented here will be as shown below.



The screenshot shows a dialog box titled "2. Acquisition Settings". It contains several configuration options: "Filter:" with a dropdown menu showing "1: 5577L1441254262"; "Exposure (ms):" with a numeric input field set to "1500"; "Binning:" with a dropdown menu showing "1x1"; "Number of Exposures:" with a numeric input field set to "10"; "Shutter:" with a dropdown menu showing "Normal"; and "Ignore Temp Setpoint:" with an unchecked checkbox.

Figure 59: Sentry Imager Acquisition Settings

Filter: Select the filter to acquire data with. The list of filters is created using the information entered in the Filter Setup dialog.

Exposure: Enter the desired exposure time for the acquisition.

Binning: Enter the desired camera binning for the acquisition.

Number of Exposures: (Acquire Mode only) Enter the number of exposures to capture before ending the Acquire Mode acquisition. This setting is not available for Continuous Mode acquisitions.

Shutter: Enter the shutter mode to use for the acquisition.

Normal: The shutter will be opened and closed for each exposure. This setting will override any External Shutter Logic settings that try to force the shutter closed.

Disabled Open: The shutter will be held open for the duration of the acquisition.

Disabled Closed: The shutter will be held closed for the duration of the acquisition.

Ignore Temp Setpoint: Enable this option to skip waiting for the camera to reach temperature setpoint.

7.9.2.2 *Arges and Arges-VF Photometer Acquisition Settings*

When the instrument is configured as an *Arges* or *Arges-VF* photometer, the settings presented will be as shown below.

2. Acquisition Settings

Filter: 1: 5577L1441254262 ▼

Field of View: 5.0° ▼

Gate Time: 100 ms ▼

Number of Gates: 10 ▲ ▼

Shutter: Normal ▼

Figure 60: Arges-VF Photometer Acquisition Settings

Filter: Select the filter to acquire data with. The list of filters is created using the information entered in the Filter Setup dialog.

Field of View: Select the desired field of view for the acquisition. Note that this setting is only available for the *Arges-VF* photometer.

Gate Time: Select the desired gate time for the acquisition.

Number of Gates: (Acquire Mode only) Enter the number of gates to capture before ending the Acquire Mode acquisition. This setting is not available for Continuous Mode acquisitions.

Shutter: Enter the shutter mode to use for the acquisition.

Normal: The shutter will be opened and closed for each exposure. This setting will override any External Shutter Logic settings that try to force the shutter closed.

Disabled Open: The shutter will be held open for the duration of the acquisition.

Disabled Closed: The shutter will be held closed for the duration of the acquisition.

7.9.3 File Saving Settings

These settings are only available when running an Acquire Mode acquisition.

All data collected in Acquire Mode will be saved to the hard disk according to the setting specified here.

3. File Saving Settings

Root Path:

Filename:

Variable Formatting: %[flags][width]specifier

Flags:	Specifiers:
0: Left-pads the number with zeroes (0) instead of spaces.	f: Frame number
	a: Acquisition number

Sample Filename: Image_014_000.png

Acquisition Number:

Overwrite Prompt: ☒

Figure 61: Acquire Mode File Saving Settings

Root Path: Enter the root folder to store data in. All collected data will be stored in this folder with no subfolders.

Filename: This setting defines a file name *template* used to save your files. There are two valid parameters that you can insert into the filename field that will automatically be incremented as acquisition occurs.

The format of the variables is as follows (items in [] are optional):

%[flags][width]specifier

flags:

0: Left pads the number with zeroes (0) instead of spaces

width:

A number specifying the minimum number of characters to display for the value.

e.g. '4' would specify that the number 21 be printed as " 21" (two spaces followed by 21)

specifier:

'a': inserts the "Acquisition Number" parameter. This parameter is incremented each time an acquire mode acquisition finishes.

'f': inserts the current exposure frame number (0 indexed). This parameter is incremented after each exposure in an acquire mode acquisition and is reset to 0 after the acquisition is completed.

Example: Assuming the Acquire Mode acquisition is set up to capture 5 exposures (Number of Exposures = 5), the Current Acquisition Number is 6, and we want a filename that looks like "Image xxx - yyy.png" where 'xxx' is the current acquisition number and 'yyy' is the frame number:

We would enter a filename of "Image %03a - %03f". After the acquisition is complete, we will observe the following filenames in the root directory path:

- Image 006 – 000.png
- Image 006 – 001.png
- Image 006 – 002.png
- Image 006 – 003.png
- Image 006 – 004.png
- Image 006 – 005.png

If we were to then immediately run another Acquire Mode acquisition without editing the Acquisition Configuration settings, the following six images would be created:

- Image 007 – 000.png
- Image 007 – 001.png
- Image 007 – 002.png
- Image 007 – 003.png
- Image 007 – 004.png
- Image 007 – 005.png

Note that the Acquisition Number (%03a part of the filename) has now been incremented by one. This happens automatically after each Acquire Mode acquisition finishes.

Acquisition Number: This allows you to manually set the Acquisition Number variable used in file names. After each Acquire Mode acquisition completes, this value will automatically increment by one (1). Changing the filename template will automatically reset this value to zero (0).

Overwrite Prompt: When enabled this option will warn you if you will be overwriting any files that already exist.

8 Advanced Topics

This section provides information on advanced topics.

8.1 Automatically Run Schedule Mode Acquisition

Synopticx provides the ability to automatically start a Schedule Mode acquisition when the application is started. This can be used to automatically start *Synopticx* when the computer is powered on or as a way to automate when *Synopticx* should start.



Important Information

This feature will only work if the Application Settings have been configured to 'Load last loaded project' upon startup. See Section 7.1.2 for details.

A Schedule Mode acquisition can be automatically started after *Synopticx* loads by specifying the `/run` switch on the command line. This can be accomplished in 2 ways:

1. Create an application shortcut to *Synopticx* and add the `/run` switch at the end of the Target path.
 - a. First navigate to the *Synopticx* application executable (typically "C:\Program Files\Keo Scientific\Synopticx\Synopticx.exe").
 - b. Right click > Send To > Desktop (create shortcut). This places a shortcut to the application on your desktop.
 - c. Now navigate to the newly created shortcut (on your desktop), right click, and choose Properties.
 - d. In the Target field, place your cursor at the very end and add " `/run`" (note the space before the `/`).
 - e. Click OK. Now when you use this shortcut to launch *Synopticx*, it will automatically Connect and Run a Schedule Mode acquisition. Using the regular shortcut (the one installed by default with *Synopticx*) will not automatically start any acquisitions.
2. Start *Synopticx* from a script or the command line.

Simply add the " `/run`" switch after the path to the executable and *Synopticx* will automatically Connect and Run the schedule mode.

Either of the two following methods can be used to automatically start *Synopticx* and run a Schedule Mode acquisition when Windows starts.



Important Information

Windows will only automatically start an application once a user logs into the system. If the computer restarts but then stops at the login screen, no applications will be started. It is recommended that you configure your computer to automatically login to a particular user upon restarting. This will allow *Synopticx* to automatically start without any user intervention.

8.1.1 Windows Start Menu Startup Folder

The easiest way to configure Windows to automatically start an application after logging in is to place a shortcut to the program you wish to launch in the Startup folder of the Start Menu. In the below path, %USERNAME% is a placeholder for the user account *Synopticx* will be run under.

```
C:\Users\%USERNAME%\AppData\Roaming\Microsoft\Windows\
Start Menu\Programs\Startup
```

Simply place your modified shortcut (the one with the /run switch at the end) into the Startup folder and Windows will automatically run it when it logs into the current user account.

8.1.2 Windows Task Scheduler

This is a more advanced method of auto-running *Synopticx* upon user login.

1. Open Windows Task Scheduler.
Start > Control Panel > System and Security > Administrative Tools > Task Scheduler
2. On the left, click on and expand the Task Scheduler Library folder.
3. You should now see a list of all the currently scheduled tasks as well as some sub-folders for organizing tasks. Many Windows programs use the task scheduler to automate various features (auto updates, etc) so you will likely see many tasks already defined.
4. Now click on “Create Basic Task...” in the right Actions panel. This will open the Create Basic Task Wizard.
5. Give your task a name and click Next. For example, you might choose “*Synopticx* Auto-Run”.
6. Now choose when you want your task to start. We want it to start when you log on so choose the “When I log on” option and click Next.



Important Information

Despite there being a “When the computer starts” option, this will not behave as we want. *Synopticx* will not start properly without the user being logged on first.

7. Choose the “Start a program” option and click Next.
8. Now browse for the *Synopticx.exe* executable file. This should typically be “C:\Program Files\Keo Scientific\Synopticx\Synopticx.exe”.
9. In the Add arguments box, enter “/run” and click Next.
10. Now you will see a summary screen and can click Finish.
11. You should now see your new task listed with the other tasks.

9 Troubleshooting

This section contains solutions to common problems that occur while using *Synopticx* or setting up *Synopticx*.

9.1 My CCD camera is not detected in Synopticx

This can be caused by a number of things depending on the type of camera you are using. The first step is to verify that the device driver for your camera is properly installed.

1. Navigate to the Windows device manager.
 - Right-click My Computer, click Manage, and then click Device Manager.
2. Verify that your camera doesn't have any driver errors or conflicts.
 - If your camera is listed with any sort of yellow or red icon it has an error.
 - If your camera does not have a driver installed for it, it will appear under the Other Devices section of the device manager.
 - If either of these is true, proceed to reinstallation of device drivers.
3. If using a PI PIXIS camera, run the RSConfig application as outlined in Section A1.
4. Test your camera with the manufacturers provided software (WinXTest for PI Pixis and ProEM systems and Solis for Andor iXon systems).

9.1.1 Reinstallation of Device Drivers

Reinstalling your device drivers is necessary if your camera is reporting that its device driver is incorrectly installed or not installed at all.

1. Right-click on your camera in the device manager and then click Uninstall.
2. Check the "Delete the driver software for this device" option.
 - This will uninstall the device and remove all existing drivers for it that may be conflicting.
3. Unplug your camera from the host computer.
 - The best practice is to install device drivers *before* attaching the device.
4. Install the device drivers for your camera using the instructions in Section 0.
5. Plug your camera into the host computer.
 - The host computer should detect the new hardware and proceed to automatically install the device drivers for it.
6. If the device is still not installed correctly consult the installation guide provided by the camera manufacturer.

9.2 My instrument is not being automatically detected

If your instrument is not being detected by the Auto Detect Instrument feature on the Instrument Settings dialog then it is probably a connection issue.

1. Check all physical connections to the instrument to ensure they are properly connected and that there is no damage to any cables. Refer to the instrument's setup guide for details.
2. Cycle power on the instrument. Upon applying power the filter wheel should automatically start searching for the home position.

3. After the home position is found use the included SenTest application to test the instrument to ensure it is operating correctly.

10 Technical Support

In the unlikely event that you need technical support to troubleshoot a problem with *Synopticx*, please don't hesitate to contact us at support@keoscientific.com.

If at any point during your *Synopticx* experience you feel like there is something that could be improved, please let us know and we'll see what we can do to incorporate your suggestions into our product.

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Appendix A Device Driver Installation

Before installing Keo *Synopticx*, it is important that you install all of the necessary device drivers for your instrument. These device drivers are used by *Synopticx* to communicate and control the various components of the instrument. The user manual for your instrument should indicate which device drivers you need to install as well as how to install them. We have replicated that information here for convenience.

Use the table below to quickly find the instructions for the device drivers you wish to install.

Device	See Section	On Page
Keo Scientific Filterwheel / Shutter Controller	A1	67
FTDI USB-to-Serial Device	A2	67
Princeton Instruments Cameras (64-bit)	A3	68
Princeton Instruments PIXIS and ProEM Cameras (32-bit)	A4	69
Andor iXon Camera	A5	70
Hamamatsu H7741 Photon Counting Head	A6	71
Hamamatsu C8855 Counting Unit	A7	71
Samsung SLA-12240 Zoom Lens	A8	72

A1 Keo Scientific Filterwheel / Shutter Controller

The Keo Scientific Filterwheel and Shutter Controller use an RS-232 serial communication interface.

- If you are using built-in RS-232 ports, then install the drivers for the RS-232 device in your computer.
- If you are using the provided USB-to-Serial adaptors, then proceed to Section A2.

A2 FTDI USB-to-Serial Device

FTDI is a company that makes a popular chipset for providing virtual COM ports on your computer. Keo Scientific provides USB-to-Serial dongles with all instruments that require serial RS-232 connections.

If your computer is connected to the internet and is running Windows 7 or newer then simply attach the adaptors to the PC and the drivers should automatically install. These devices will show up as virtual COM ports when installed correctly.

If the automatic driver installation fails, you are using Windows XP, or you do not have access to the internet then you will have to manually install the device driver. You can find the device driver on the included Documentation and Utilities CD in the Drivers\FTDI Virtual COM Port folder or you can download the latest version from the internet <http://www.ftdichip.com/Drivers/VCP.htm>.

A3 Princeton Instruments Cameras (64-bit)

These instructions apply to Princeton Instruments cameras on 64-bit systems only. For installation on a 32-bit system, please see the next section. All Princeton Instruments camera are fully supported by *Synopticx*.

A3.1 Install PICam

PICam is the software library used by *Synopticx* to interface with Princeton Instruments cameras. The PICam installer will also install the device drivers for your camera.

1. Insert the *Synopticx* installation CD into your computer and navigate to the PICam folder.



Important Information

If your *Synopticx* installation CD does not have a PICam folder you can download the latest version of PICam from the Princeton Instruments FTP server at:

<ftp://ftp.princetoninstruments.com/Public/Software/Official/PICam/>

2. Install Picam.

A4 Princeton Instruments PIXIS and ProEM Cameras (32-bit)

These instructions apply to the Princeton Instruments PIXIS CCD and ProEM EMCCD line of cameras only. There are many different models of these cameras and they are all fully supported by *Synopticx*.



Important Information

Do not attach the camera to the computer until after you have completed the following driver installation. Failure to do so may cause problems with properly detecting the camera.

If you think you are encountering this problem, please see the troubleshooting section for ways of fixing driver installation issues.

A4.1 Install PVCAM

PVCAM is the software library used by *Synopticx* to interface with Princeton Instruments cameras. Although the required libraries are included in the *Synopticx* installation, the utility to register the camera with the system is not redistributable and must be installed by installing PVCAM. Installing PVCAM will also install the device drivers for your Princeton Instruments camera.

3. Insert the *Synopticx* installation CD into your computer and navigate to the PVCam folder.



Important Information

If your *Synopticx* installation CD does not have a PVCam folder you can download the latest version of PVCAM from the Princeton Instruments FTP server at:

<ftp://ftp.princetoninstruments.com/Public/Software/Official/PVCAM/>

4. Install PVCAM.

A4.2 Register the camera

Synopticx won't be able to detect and use your camera until it has been registered with the system.

1. Start the *Rsconfig* utility. It can be found in *Start Menu > All Programs > Princeton Instruments > Rsconfig*. Alternatively, it can be found in the program files for Princeton Instruments located at:

C:\Program Files\Princeton Instruments\rsconfig.exe



Important Information

If you are running Microsoft Windows Vista or 7, you must run *RSConfig* as an administrator to give it write permissions for your system directory. This can be accomplished by right-clicking on the application and selecting "*Run as Administrator*".

If the "*Run as Administrator*" option is not available, choose "*Properties*" and then the "*Compatibility*" tab. Under the "*Privilege Level*" section check the "*Run this program as an administrator*" box, and then click "*OK*". Then just start the application as you would normally and it will automatically be run with administrator privileges.

2. The *RSConfig* utility is shown in Figure 62 below. If your camera's drivers have been properly installed and the camera is plugged in and turned on, it will show up under the list of cameras. Feel free to keep the default name ("Camera1") or change it to something of your choosing. After you are finished choosing a name, simply click "*Done*" and your camera will be ready for use with *Synoptix*.



Important Information

The name you choose for your camera will be the same one you use in *Synoptix* to select your camera.

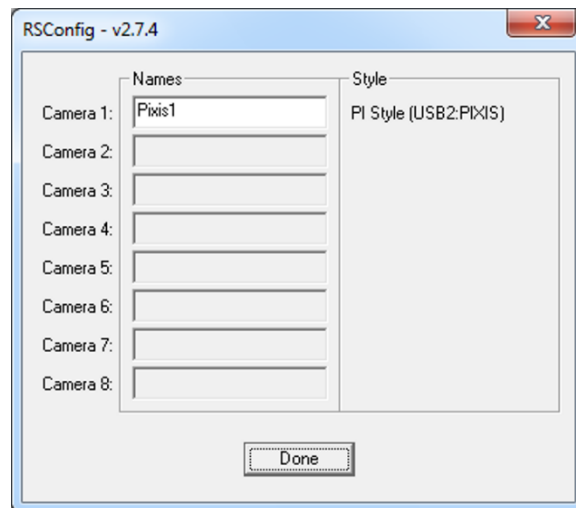


Figure 62: RSConfig Dialog Box

A5 Andor iXon Camera

These instructions apply to the Andor iXon DU-888 CCD camera only. Other models of the iXon may work but are not officially supported by Keo *Synoptix* at this time.



Important Information

These instructions assume that you have already installed the Andor PCI card in your computer and have connected the camera to the PCI card with the provided cable.

The device drivers required for the Andor iXon camera are included on the Andor Driver CD.

1. Insert the Andor Driver CD into your computer.
2. Install the Andor Drivers.



Important Information

Please refer to your iXon user manual for more details on the installation of the device drivers and troubleshooting installation problems.

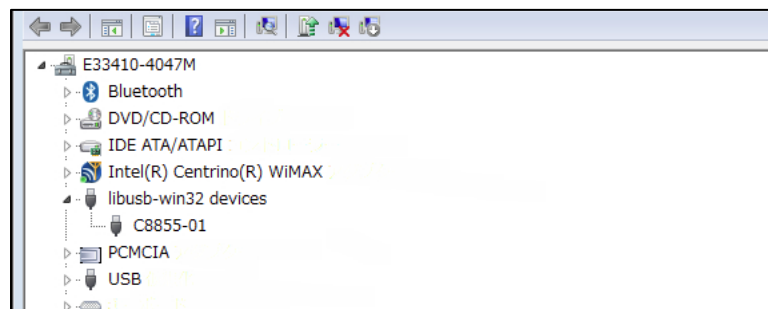
A6 Hamamatsu H7421 Photon Counting Head

This device does not directly interface with *SynopticX* so there are no device drivers needed. All counting is performed with the Hamamatsu C8855 Counting Unit.

A7 Hamamatsu C8855 Counting Unit

The Hamamatsu counter that is integrated into the *Arges* photometer system requires a USB driver to function properly. You can install this driver by following the steps below.

1. Ensure the counter is powered ON and is connected to the PC via the provided USB cable.
2. Upon connecting the counter to the PC you will see a message about the device failing to install correctly. This is normal and we will fix this in the next steps.
3. Insert the provided Documentation and Utilities CD into your PC and navigate to the `Drivers\C8855-01 Counter` folder.
4. Run Device Manager on your PC. Navigate to *Control Panel > System > Device Manager*.
5. Find the 'C8855' device in the Other Devices section of Device Manager.
6. Double click on the 'C8855' device to open the Properties page for this device.
7. Navigate to the *Driver* tab and then click the *Update Driver...* button.
8. Choose to *Browse my computer for driver software* and then select the `Drivers\C8855-01 Counter` folder from the Documentation and Utilities CD.
9. Click the *Next* button to install the driver.
10. After installation is complete you can verify that the driver installed correctly by looking in *Device Manager*. There should now be a 'C8855-01' device in the 'libusb-win32 devices' section as shown below. If the driver did not install correctly, disconnect the USB cable and AC adaptor from the counter and then restart these instructions.



A8 Samsung SLA-12240 Zoom Lens

The Keo *Arges-VF* Photometer instrument uses a Samsung zoom lens to achieve variable field of views. This zoom lens is controlled with a USB zoom lens controller that is integrated into the Keo *Arges-VF* Photometer Controller. This zoom lens controller has an integrated FTDI USB-to-Serial adaptor. Please follow the instructions in Section A2 to install this device. Once properly installed this device will appear as a virtual COM port on your computer.

Appendix B SYNDAT File Specification

When your instrument has a counting unit instead of a camera, the data that is collected has no spatial dimension to it. This data is displayed in the user interface as a line plot and saved to disk in a custom format as specified here.



Important Information

All byte values in this section are shown with hexadecimal representation.

B1 File Structure

The SYNDAT file format is an ASCII readable file with a specific format. The SYNDAT file consists of 4 chunks of data: the file signature, the header version, the header, and then the data. Details on the size and format of each of these chunks follows.

B2 File Signature

The first nine (9) bytes of the file make up the SYNDAT signature. The hexadecimal values of these bytes are

89 53 59 4E 44 41 54 0D 0A

A valid SYNDAT file will always start with these 9 bytes.

B3 Header Version

The next four (4) bytes of the file form the header version. If the size of the header ever changes, then this version will be incremented. The version is stored as a zero padded two digit number so that it is readable when opening the SYNDAT file in a text editor. For example, version 1 of the header would be stored in the file as 30 31 0D 0A where 30 is the hexadecimal representation of '0' and 31 is the hexadecimal representation of '1'.

B4 Header

Immediately following the header version chunk is the header itself. This chunk starts with '[HEADER]' and ends with '[DATA]'. The size of the header is determined by the header version and indicates where the Data chunk starts. For example, a SYNDAT file with a version 1 header will have the data chunk starting at byte 512. Any unused space in the header between the last entry and the '[DATA]' entry is filled with zeros.

Header Version	Size of Header [bytes]
1	512

The header itself contains information about the acquisition settings used to capture that data. Each entry has a name and value and is terminated with a carriage return/line feed pair (0D 0A). For example, the filter label would be stored as:

```
Filter Label: 6300L1441454265-1
```

B5 Data

The data stored in the file starts at the byte specified by the version of the header. For example, a version 1 header would result in the data starting at byte 512 of the file (assuming byte 0 is the first byte in the file).

The data is stored as ASCII readable text to allow the user to easily view the data in any text editor. Each data entry contains a timestamp and data value and is terminated with a carriage return/line feed pair (0D 0A). The timestamp and the data value are delimited with a space (20) character.

B5.1 Data Timestamp Format

The timestamps are formatted according to the ISO 8601 international standard for combined date and time formatting. This format is <date>T<time> where <date> is a complete date expression, 'T' is a delimiter, and <time> is a valid time expression. An example of such a timestamp would be:

```
2015-03-24T21:28:23.525Z
```

The date is of the format YYYY-MM-DD and the time is of the format hh:mm:ss.sssZ where 'Z' is the zone designator for zero UTC offset (or 'Zulu' time as it is known). All timestamps will be with zero UTC offset.

B5.2 Data Value Format

The actual data value is stored in its ASCII representation with no zero padding or other formatting. For example, the number 42039 would be stored as the ASCII string '42039'.