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Learning with Simulators

<u>AcquireStar</u>

AcquireStar Wizard

Filter Offset Wizard

First Light Wizard

Focus Convergence Wizard

Temperature Compensation Wizard

Running Vcurves

Profile Window

Image Calibration

Running FocusMax with Simulators

Running FocusMax With Simulators

MaxIm

MaxIm

Options for creating simulated stars using MaxIm

- 1. Five star pattern
 - This option does not require a telescope connection
 - o The Simulator camera must be selected in MaxIm Camera Control / Setup tab



- 2. PinPoint
 - This option requires a Simulator telescope to be connected and tracking in order to read the telescope coordinates for PinPoint to generate the field.



3. ASCOM DSS Camera

- This option requires a Simulator telescope to be connected and tracking in order to read the telescope coordinates for the driver to return DSS stars
- o This requires an internet connection



5 Star Pattern

5 Star Pattern

MaxIm can be setup to generate a simulator 5 artificial star pattern which can be used to learn basic FocusMax functions



1. Open menu 'File/Configurations' and select 'Simulator' then press Open

🕹 F	ocusMax	v5			_		×
File	Open	Camera	Focuser	Telescope	Wizard	Set	Help
	Configu	irations					
	System		>	on	6		
	Save Im	ages	>	Ħ		Stop	
	Import	Vcurve Dat	a	tor			
	Exit			-			
S	ystem			-			
Tel	lescope						
	Log						
	Jog					_	
F	Profile				Find Focus	Exp	ose
Fo	cus Plot]	2	3	Acqui	reSta	5
Mana	age Conf	igurations					×
urrent	configur	ation: Sin	nulator				
efault							Onen
imulat	or						
							New
							Delete

2. Press the System button then press the small square button and select "Simulator 1" or "Simulator 2" (optional) to load setup configuration

The second secon			:		
File Open Camera	Focuser Telescope W	izard Set Help	5		
System Tem	p Position				
1 2 6.6 6.5	2500 2500	Stop			
Focus Focus	n 1 er ASCOM Simulator Fo	cusi 🗖 Temp]		
System Came	ra Simulator				
Telescope	m System1				
Log Focus	n 2- er ASCOM Simulator Fo	cusi 🗖 Temp Comp			
Jog Syste	ra Simulator				
Profile Run S	cript]		
Focus Plot		Map			
🎝 System					×
\leftarrow \rightarrow \checkmark \uparrow \bullet This PC \rightarrow	Documents → FocusMax V5 → C	onfigurations > Simu	lator v Č) 🔎 Search Sim	ulator
Organize 🔻 New folder				-	≣ ▼ 🔳 💡
Photometry	^ Name ^		Date modified	Туре	Size
Pictures	BackupFiles		7/30/2021 12:57 PM	File folder	
Std Needed	DataFiles		8/10/2021 1:07 PM	File folder	
System Volume Information	Images		8/10/2021 1:09 PM	File folder	
📙 TheSkyX Pro Database Add (Di LogFiles		8/11/2021 7:30 AM	File folder	
Virtual Machines Backup	Scripts		3/26/2021 11:06 AM	File folder	
TOSHIBA EXT (Z:)	System Testing ini		6/30/2021 7:30 AM	Configuration sett	7 KB
💣 Network	System1.ini		8/11/2021 7:41 AM	Configuration sett	8 KB
ASCOM	System1_TS.ini		5/6/2021 8:17 AM	Configuration sett	5 KB
Astronomy	📓 System2.ini		8/10/2021 1:59 PM	Configuration sett	1 KB
Bill FMx5 Files	~				
File name:				✓ System Data (*.ir	ni) 🗸
				Open -	Cancel
				open I•	

- 3. Open FocusMax Preferences (Menu / Open / Preferences) to configure the hardware.
 - o Select MaxIm DL under 'Camera control'
 - Set camera 'Number' assignment, generally, Camera #1 is the main imaging camera and camera #2 is the second (guiding) camera
 - o Select Simulator focusers for both Systems
 - Press colored 'Connect' buttons to connect to the camera(s) and focuser(s). A blue line will appear if the hardware is connection was successfully established.

 \circ $\;$ There is no need to set the telescope simulator with this option.

Preferences:	System #1	– 🗆 X
Exit		
Setup Autofocus	Camera Focuse	t Telescope
Camera	Telescope	
Filter Wheel	ASCOM Telescope Driver for TheSky.	
Focuser	System 1: System1 Camera control Number	
Telescope	MaxIm DL - I - Filter Wheel	Focuser
	Simulator Simulator	ASCOM Simulator Focuser Driver
AcquireStar	System 2: System2	
General	Camera control Number	
	Maxim DL - 2 - Filter Wheel	Focuser
	Simulator No Filter Wheel	ASCOM Simulator Focuser Driver

- 3. Configure MaxIm camera simulator
 - Set the 'Camera Model' = Simulator
 - o Noise = On
 - O Guide errors = Both
 - \circ FWHM = 5

Setup Simulator				? ×
Simulator Version 6 Copyright (C) 1999-	.13.3 2016 Diffraction Limited	d		ок
Support: www.cyar	nogen.com			Cancel
Camera Model				
Simulator	-			Advanced
Noise	Guide Errors	FWHM	Guide Angle	Guide Direction
Off 🗨	Off 🗨	Default(5) 💌	0 degrees 💌	Normal 👻

Press advanced button

- O Set the array size 1530 x 1020 (default 768 x 511)
- Normalize ADU units to 0.1 sec (guider also) which will boost the intensity of each star in the 5 star pattern by a factor of 10
- o Pixel Width 10 & Height 10
- o Uncheck Color and Full frame operation

Connect to the camera

Simulator Configuration	×
Array Size Width 1530	Pixel Dimensions Width 10
Height 1020	Height 10
✓ Normalize ADU values to	0.1 sec exposure
Normalize guider ADU val	ues to 0.1 sec
Color sensor	Apply bgd compensation
Full-frame operation only	Differential Guiding
ОК	Cancel

4. Running FocusMax in Simulator Mode

Press the FocusMax 'Find' button which should find the brightest star in the 5 'star' image.





5. Run the FirstLight Wizard to generate a set of Vcurves - note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel.

- Press the 'Focus' button to focus the system using simulator camera and focuser.
- Press 'Select' button to use the cursor to select a single star to use for autofocus.
- Open Preferences/Autofocus and set the Focus process to 'Multi-Star', press the Focus button.

Simulated Stars with PinPoint

Using PinPoint to Generate Simulated Star Field

You can generate a simulated star field with MaxIm if the Full Version of PinPoint is installed.

FocusMax must have a connection to the (simulator) telescope and the telescope must be tracking in order to generate a simulated star field.



1. Open menu 'File/Configurations' and select 'Simulator' then press Open

Configurations n Stop Save Images > n Save Images > or Exit System - Telescope Log - Jog - - Jog - - Focus Plot 1 2 3 Manage Configuration: Simulator - Simulator - - - Open New - - Delete - - -	Elle	Onen	C	Feetreen	Telescono	Winned	Cat L	X
System Save Images Import Vcurve Data Exit System Telescope Log Jog Find Expose Focus Plot 1 2 Manage Configurations rrent configuration: Simulator Open New Delete	File	Configu	irations	Focuser	lelescope	vvizaro	Set	heip
Save Images Import Vcurve Data Exit System Telescope Log Jog Profile Focus Plot 1 2 3 Find Expose Focus Select AcquireStar Manage Configurations rrent configuration: Simulator ault Nulator Open New Delete		System		>	on	6		
Import Vcurve Data Exit System Telescope Log Jog Profile Focus Plot 1 2 3 Find Expose Focus Select AcquireStar Anage Configurations rent configuration: Simulator New Delete		Save Im	ages	>	H		Stop	
Exit system Telescope Log Jog Jog Profile Focus Plot 1 2 Anage Configurations rent configuration: Simulator New Delete		Import	Vcurve Dat	a	tor			_
System Telescope Log Jog Jog Profile Focus Plot 1 2 Anage Configurations Year Configuration: Simulator Ault Ulator Open New Delete		Exit						
Telescope Log Jog Jog Profile Focus Plot 1 2 Anage Configurations rent configuration: Simulator ault Ulator	5	ystem			-			
Log Jog Profile Focus Plot 1 2 3 Focus Select AcquireStar AcquireStar AcquireStar rent configuration: Simulator ault Ulator Open New Delete	Tel	lescope						
Jog Profile Focus Plot 1 2 3 Focus Select AcquireStar AcquireStar AcquireStar Trent configuration: Simulator ault Ulator Open New Delete		Log						
Profile I </td <td></td> <td>Jog</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>		Jog						
Focus Plot 1 2 3 AcquireStar Manage Configurations > rrent configuration: Simulator ault Open New Delete	F	Profile				Find	Expos	e
Manage Configurations > Trent configuration: Simulator Tault Tulator New Delete	Fo	cus Plot]]	2	3	Acqui	reStar	5
rrent configuration: Simulator	Mana	age Conf	igurations					×
iault hulator Delete	rrent	configur	ation: Sin	nulator				
New	ault							ben
Delete	iuiat	or						ew
Delete								
							De	lete
							De	lete

1. Press the System button then press the small square button and select "Simulator 1" or "Simulator 2" (optional) to load setup configuration

TocusMax V5	_		<		
File Open Camera Foo	user Telescope Wiza	ard Set Hel	р		
System Temp	Position				
1 2 6.6 6.5 6.5	2500 2500	Stop			
Focus System 1 Focuser	ASCOM Simulator Focu	JSI Comp	1		
System Camera	Simulator				
Telescope	System1				
Log Focuser	ASCOM Simulator Focu	ISI Comp]		
Camera	Simulator				
System System	System2				
Profile Run Scrip	t	Man			
Focus Plot					
System					×
\leftrightarrow \rightarrow \checkmark \uparrow \Box \rightarrow This PC \rightarrow Docu	ments > FocusMax V5 > Con	nfigurations > Simu	ulator ~ 킨	,	ulator
Organize 🔻 New folder					
Photometry	Name		Date modified	Туре	Size
Pictures	BackupFiles		7/30/2021 12:57 PM	File folder	
Std Needed	DataFiles		8/10/2021 1:07 PM	File folder	
System Volume Information	Images		8/10/2021 1:09 PM	File folder	
TheSkyX Pro Database Add Oi	LogFiles		8/11/2021 7:30 AM	File folder	
Virtual Machines Backup	Tomp		3/20/2021 11:00 AM	File folder	
TOSHIBA EXT (Z:)	System Testing.ini		6/30/2021 7:24 AM	Configuration sett	7 KB
鹶 Network	System1.ini		8/11/2021 7:41 AM	Configuration sett	8 KB
ASCOM	System1_TS.ini		5/6/2021 8:17 AM	- Configuration sett	5 KB
Astronomy	📓 System2.ini		8/10/2021 1:59 PM	Configuration sett	1 KB
Bill FMx5 Files					
File name:				✓ System Data (*.ir	ni) 🗸 🗸
<u>.</u>				Onen 🚽	Cancel
				open It	.d

- 2. Configure MaxIm camera simulator
 - Select the 'Camera Model' = Simulator
 - o Noise = On
 - Guide errors = Both
 - \circ FWHM = 5

Setup Simulator				? ×
Simulator Version 6. Copyright (C) 1999-2 Support: www.cyan	13.3 2016 Diffraction Limited ogen.com	j		OK Cancel
Camera Model Simulator	•			Advanced
Noise Off 🗨	Guide Errors Off	FWHM Default(5)	Guide Angle 0 degrees 💌	Guide Direction

Press advanced button

- O Set the array size 1530 x 1020 (default 768 x 511)
- Normalize ADU units to 0.1 sec (guider also)
- o Pixel Width 10 & Height 10
- Uncheck Color and Full frame operation
 Connect to the camera

Simulator Configuration	×					
Array Size	Pixel Dimensions					
Width 1530	Width 10					
Height 1020	Height 10					
Normalize ADU values to 0.1 sec exposure						
Normalize guider ADU va	alues to 0.1 sec					
Color sensor	Apply bgd compensation					
Full-frame operation only 🔲 Differential Guiding						
ОК	Cancel					

- 3. Open FocusMax Preferences (Menu / Open / Preferences)
 - o Select MaxIm DL under 'Camera control'.
 - Set camera Number assignment, generally, Camera #1 is the main imaging camera and camera #2 is the second (guiding) camera which is not required.
 - o Select Simulator focusers for both System1 and System2 (optional)
 - Select the simulator telescope connection such as TheSky Controlled Telescope and set the telescope to simulator in the planetarium software.
 - Press colored 'Connect' buttons to connect to your hardware. A blue line will appear if the hardware is connection was successfully established. A black line will appear if the telescope is tracking which is required for simulated stars to be generated.

The second secon	ystem #1	- 🗆 X							
Exit									
Setup Autofocus	Connect Camera Focuser Telescope								
Camera	Telescope ASCOM Telescope Driver for TheSky.								
Filter Wheel									
Focuser	System 1: System1 Camera control Number								
Telescope	MaxIm DL + 1 + Filter Wheel Focuser								
	Simulator Simulator ASCOM Sim	ulator Focuser Driver							
AcquireStar	Durate an Or Durate and								
General	Camera control Number								
	MaxIm DL + 2 + Filter Wheel Focuser								
	Simulator No Filter Wheel ASCOM Sin	nulator Focuser Driver							

4. Open Preferences/Autofocus and set FocusMax focus process to Single-Star.

Preferences: S	System #1								_			\times
Exit												
Setup	Autofocus											
Getup	Process		Slot	Filter	Tgt Bin	Focus Bin	Base exp	Max exp	Tgt Flux x1000			
Autofocus	Single-Star		1	E	2	1	1.00	10.00	300			
	Method		2	С	2	1	1.00	10.00	300			
Camera	Advanced -		3	U	1	2	10.00	30.00	200			
			4	В	1	1	2.00	10.00	200			
Filter Wheel	Filter		5	V	2	1	2.00	10.00	200			
	Current filter 👻		6	R	2	1	1.00	10.00	200			
Focuser	Near Focus HFD Samples		/	1	2	1	10.00	10.00	200			
Telescope	0											
AcquireStar	Final Focus											
	Images 5											
General	Focus offset 0											
		- Move			Conve	rgence			Return	Start	Positi	on –
	Run AcquireStar on failure	O In			Enable	Ste	eps Sa 5	mples			Max	
	Enable A. I.	Settle time	s	ec	M e	lax num xposure	ber s 25		Enable		6]

5. Setup PinPoint

- o Open the AcquireStar window and select PinPoint as the 'Plate solve method'.
- Enable 'Simulate starfield' (requires the telescope to be connected and tracking).

Sector Preferences: S	System #1							_	Х
Exit									
Setup	AcquireStar			Pi	nPoint		P	Plate Solve	
Autofocus		Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag	_		
		1	E	2	5.00	7.5			
Camera		2	С	2	5.00	7.5			
		3	U	4	15.00	3.0			
Filter Wheel		4 5	V	з 1	10.00	5.5			
Focuser		6	R	3	10.00	8.0	-		
Telescone	Min altitude	0 N a	lax Ititude	90.0 No. star	s 3	:	Simulate starfield	⊻	
Telescope	Sort star list Flu	IX		- Ord	er Descend	ing 🗸	brighter to	dimmer	
AcquireStar	Goto zenith 🗹]		Sync 🔲	Maxe	error 1.0	arc mir	า	
General	Blind slew] M	leridia	in cross 🔲	Atten	npts 3			
	Return slew 🔽] <u>P</u>	ointing	g filter		Plate	e solve me	thod	
	Final pointing 🔽] [Curren	t filter	- 🚺	Pin	Point	-	

- Select the PinPoint Tab and set the path to your star 'Catalog' the best catalog choice is the Guide Star Catalog.
- Press the 'Test PinPoint' button to verify that you have a Full PinPoint license installed and not PinPoint LE.
- Press the 'Test Catalog' button to lookup stars in the selected star catalog, the results will be displayed in the Log.

Preferences: S Exit	System #1				_		×
Setup	AcquireStar		PinPoint		Plate	Solve	
Autofocus Camera Filter Wheel	Star Detection — Min size (pi Sigma above n	ixels) 2 nean 3] E	Border 4	pixels		
Focuser	Catalog Expar	nsion 30	%				
Telescope AcquireStar	Catalog Guide	e Star Catal	og	·			
General	Tes	t PinPoint) (Test Catalo	g		
🕹 Log		×					
08:07:10 08:07:10 ** Pi 08:07:10 PinF 08:07:10 Cata 08:07:10 Cata 08:07:10 Brig 08:07:10 Dim 08:07:10 PinF 08:07:10 Field 08:07:10 PinF	nPoint test ** Point version: 7.0.0 alog: Guide Star Catalog alog path: D:\Catalogs\GSC11\ ht catalog star mag: -2 catalog star mag: 20 ation: RA 00:00:00.0 Dec +00:00:00 search: 1 x 1 degrees Point test passed with 185 stars fou	0.0 Ind					

- 6. Running FocusMax in Simulator Mode
 - Move the focuser to the mid-point of the focuser travel. This can be determined by opening Preferences / Setup then pressing the small (chooser) focuser button to open the driver then press the Properties button. The mid-point of the focuser travel will be 0.5 x Maximum Position. (2500 in the screen example below). The simulated stars generated by PinPoint will increase in size as the focuser moves away from the focuser mid-point.

ASCON	1 Focuser Chooser			\times	
Trace	Alpaca				
Select the Properties	e type of focuser you have, the s button to configure the driv	en be su /er for y	ure to click th our focuser.	e	
ASCOM	Simulator Focuser Driver	•	Properties.		
ASCOM	Click the logo to learn more about ASCOM, a set of standards for inter-operatio astronomy software.	e n of	OK Cancel		
🔛 Focus	er Simulator Settings		-	- C	1 ×
ASCOM	Settings Maximum Step Pos: 5000 Step Size (Microns): 20 Maximum Increment 5000 Settle Time (ms) 500			-Type-	osolute elative
Capab	ilities ———	Tem	perature Sim	ulator	
✓ Te	emperature Probe	Curr	ent Temperat	ure: 6.2	5
M le	emperature Compensation	Maxi	mum Temper	rature: 20	
M St	ep size	Mini	mum Temper	rature: -20	
I Sv	nchronous	Сус	le Period (se	c): 10	
	gging	Step	os / C:	-5	
	0	ок			

- Find and slew the simulator telescope to a star that is 6th mag or fainter the star should be somewhat isolated from other nearby stars.
- o Press the 'Find' button and FocusMax will proceed to:
 - take an image
 - create a simulated star field
 - find the brightest star in the field
 - subframe the star





- Run the FirstLight Wizard to generate a set of Vcurves note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel.
- Press the Focus button to focus the system using simulator camera and focuser.
- Press Select button to use the cursor to select a single star to use for autofocus.
- O Open Preferences/Autofocus and set the Focus process to 'Multi-Star', press the Focus button.
- o Run AcquireStar Wizard to determine the optimum star magnitude for a given filter
- Run AcquireStar to automatically select a star for autofocus.

ASCOM DSS Camera

Using ASCOM DSS Camera to Generate Simulated Star Field



1. Install the Deep Sky Survey (DSS) ASCOM driver from https://sourceforge.net/projects/sky-simulator/. This camera driver will download a DSS image from the internet based on the telescope position.

Once installed setup MaxIm with the DSS driver:

- o Open MaxIm 'Camera Control' Window and select the 'Setup' tab
- o Press 'Setup Camera' button and select the ASCOM camera.
- o Press 'Advanced' button to select the ASCOM DSS Camera Driver.
- Press 'Properties' to set the telescope connection which will provide the RA & Dec coordinates for the image.

FocusMax V5 Tutorials

Deamera Control		? :	×
Expose Guide Setup			
Camera 1 Setup Camera Cooler	Camera 2 Setup Camera Cooler	Connect	
ASCOM	Simulator		
Options Dual	Options	On Off	
Simulator	No Filters	Warm Up	
Joundator		More >>	
etup ASCOM			? 2
ASCOM Plug-in Version 6.27.	2 ction limited		ОК
Support: www.cyanogen.com			Cancel
Camera Model			
ASCOM			Advanced
ASCOM Camera Choose	er	×	
Trace Alpaca			
Select the type of camera yo Properties button to config	ou have, then be sure to click th ure the driver for your camera.	e	
ASCOM DSS Camera Driver	Properties.		
Click the logo to about ASCOM, a standards for int astronomy softw	learn more a set of er-operation of rare.		
Camera Setup	×		
elect the telescope used to pro oject position. elect an optional rotator to set tation (only for skyview).	the image		
cope ASCOM.SoftwareBisque	e.Telescop Choose		
	ОК		

Cancel

Version: 6.0.5531.27655 Trace on

- 2. Find a star in the 8 10 mag range with your planetarium app and slew the simulator telescope to center the star.
 - Press the 'Find' button to take an in image note that the time to download will take some time as the image is being transferred via the internet.
 - Once the image is downloaded, FocusMax will search the image for the brightest stars (default 20) then subframe the brightest star provided the exposure time can be adjusted to meet the user defined Total Flux setting for the filter in use. If it is too bright, the the next dimmer star in the list will be tested.



- 3. Run the FirstLight Wizard to generate a set of Vcurves note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel.
 - Press the 'Focus' button to focus the system using simulator camera and focuser.
 - Press 'Select' button to use the cursor to select a single star to use for autofocus.
 - O Open Preferences/Autofocus and set the Focus process to 'Multi-Star', press the Focus button.
 - o Run AcquireStar Wizard to determine the optimum star magnitude for a given filter
 - Run AcquireStar to automatically select a star for autofocus.

TheSky

TheSky



Using DSS (Deep Sky Survey)

Images From Deep Sky Survey

TheSky is able to download and display Deep Sky Survey (DSS) images which can be plate solved with PinPoint or TheSky Image Link. This requires a license for TheSky Camera Add-on.

6 0000001.GSC	3366_185.fit - FITS Viewer
Photo File Info	rmation
Photo 🔻 🚺	
Photo 🔻	
(-201,243) 0	

Setting up DSS on TheSky

 Open TheSkyX or TheSky64 Menu / Tools / Digital Sky Survey / Setup Tab. Select Web unless you own a copy of the DSS disk

🚱 Digitized Sky Survey -	-		×
Create Photo Setup			
Retrieve From			-
○ Web	ne		
Location: D:/Catalogs/Palomar		Choose	
Source			- 1
Palomar Sky Survey (10x)	(10	Dx)	
The 10x Palomar Sky Survey is included with <u>TheSky?</u> <u>Add On</u> .	<u>K Pr</u>	o Database	
		Close	

- o Setup the Simulator camera in TheSky
- o Enable Simulate photo using DSS

æ	Camera	8	×
Camer	Software Bisque Camera Simulator		
Autoguider	Connect Temp. Setup Disconnect		
Find	Progress: Max:	0%	
Elements	Take Photo Focus Tools Take Series		
Chart	Abort Show Log		
Telescope	Exposure time: 1.000 seconds		
æ	Binning: 1x1 ~ Frame: Light ~		
8	Reduction: None ~		
Rotator	Subframe Size		
ser	Automatically save photos AutoSave		
Focu	Camera Relays	-	
Wheel	-X +X		
Filter	+Y		
	Auto Contrast Setup		
	Simulate photo using DSS		
	Screen Shutter		

2. Open menu FocusMax 'File/Configurations' and select 'Simulator' then press Open

🕹 Fo	ocusMax	v5					×
File	Open	Camera	Focuser	Telescope	Wizard	Set	Help
	Configu	irations					
	System		>				
	Save Im	ages	>	Ē		Stop	
	Import	Vcurve Dat	a	tor			
	Exit						
	ystem			-			
Tel	escope						
	Log						
	Jog					_	
F	Profile				Find Focus	Exp Sel	ect
Fo	cus Plot			(Acqui	reStar	Ð
Man	age Con	figuration	5				×
urrent	t configu	ration: Sir	mulator				
efault							Open
mulat	or						\doteq
							New
							Delete

3. Press the System button then press the small square button and select "Simulator 1" or "Simulator 2" (optional) to load setup configuration

The second secon			:		
File Open Camera	Focuser Telescope W	izard Set Help	5		
System Tem	p Position				
1 2 6.6 6.5	2500 2500	Stop			
Focus Focus	n 1 er ASCOM Simulator Fo	cusi 🗖 Temp]		
System Came	ra Simulator				
Telescope	m System1				
Log Focus	n 2- er ASCOM Simulator Fo	cusi 🗖 Temp Comp			
Jog Syste	ra Simulator				
Profile Run S	cript]		
Focus Plot		Map			
🎝 System					×
\leftarrow \rightarrow \checkmark \uparrow \bullet This PC \rightarrow	Documents → FocusMax V5 → C	onfigurations > Simu	lator v Č) 🔎 Search Sim	ulator
Organize 🔻 New folder				-	≣ ▼ 🔳 💡
Photometry	^ Name ^		Date modified	Туре	Size
Pictures	BackupFiles		7/30/2021 12:57 PM	File folder	
Std Needed	DataFiles		8/10/2021 1:07 PM	File folder	
System Volume Information	Images		8/10/2021 1:09 PM	File folder	
📙 TheSkyX Pro Database Add (Di LogFiles		8/11/2021 7:30 AM	File folder	
Virtual Machines Backup	Scripts		3/26/2021 11:06 AM	File folder	
TOSHIBA EXT (Z:)	System Testing ini		6/30/2021 7:30 AM	Configuration sett	7 KB
💣 Network	System1.ini		8/11/2021 7:41 AM	Configuration sett	8 KB
ASCOM	System1_TS.ini		5/6/2021 8:17 AM	Configuration sett	5 KB
Astronomy	📓 System2.ini		8/10/2021 1:59 PM	Configuration sett	1 KB
Bill FMx5 Files	~				
File name:				✓ System Data (*.ir	ni) 🗸
				Open -	Cancel
				open I•	

- 4. Open FocusMax Preferences (Menu / Open / Preferences) to configure the hardware.
 - o Select TheSkyX or TheSky64 under 'Camera control'
 - Set camera 'Number' assignment, generally, Camera #1 is the main imaging camera and camera #2 is the second (guiding) camera which is not required.
 - o Select Simulator focusers for System1 and System2 (optional)
 - O Select the 'Telescope' driver
 - O Press colored 'Connect' buttons to connect to the camera(s), focuser(s) and telescope. A blue

line will appear if the hardware is connection was successfully established with a black line if the telescope is tracking. If the telescope is not racking then set tracking will be needed to create the DSS image.

Sector Preferences:	System #1	_		×
Exit				
Setup Autofocus	Connect Camera Focuser Telescope			
Camera	Telescope			
Filter Wheel	ASCOM Telescope Driver for TheSky.			
Focuser	System 1: System1 Camera control Number			
Telescope	TheSky64 - 1 - Filter Wheel Focuser		Dian	
AcquireStar	System 2: System2	rFocuse	rDriver	
General	Camera control Number			
	Filter Wheel Focuser			

• Press the FocusMax 'Find' button and verify that a DSS image is presented in TheSky.



5. Plate solving images with TheSky Image Link

It is important to verify that you have the latest TheSky Image Link file is installed on your computer.

- O Open TheSkyX or TheSky64 Menu / Tools / Image Link
- Click on All Sky tab to verify that you have the latest file installed (as shown below). If it is not up to date, then press the link to sign in to the Software Bisque site and download 1.7 gigabyte file.

🚱 Image Link			
Search Setup FOVI Options All Sky	Light Source Data	Astrometric Solution	
Download the All Sky Image Link Database Your All Sky Image Link Database is up-to-date. Open FITS All Sky Search Bind Image scale Search a range of image scales Image scale: 1.700 arcseconds/pixel Image scale tolerance: 1.00% Mirror option: Unknown or not sure Search visible declinations only Use All Sky Image Link for automated pointing runs Use All Sky Image Link for scripted Image Link Status:	Show light source		Show astrome

- Once installed you have the option to use 'Image Link All Sky for scripted operations Image Link' - see above screen shot
- Enable 'Use Set the Image scale for your system or enable 'Blind' or 'Search a range of image scales'
- O Open FocusMax / Preferences / AcquireStar and select TheSky method.

The second secon	System #1					_	-	×
Exit								
Setup	AcquireStar		PinPoint			Plate Solve		
Autofocus	Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag	_		
	1	Luminance	2	10.00	6.0			
Camera	2	Blue	2	10.00	6.0			
	3	Green	2	10.00	6.0			
Filter Wheel	4	Red	2	10.00	6.0			
	5	V	2	10.00	6.0			
Focuser	6	R	2	10.00	6.0	_		
Telescope	Min altitude 30.0	Max altitude	0.0 No. stars	3	Sin sta	nulate rfield 🗹		
	Sort star list Flux		✓ Order	Descending	, <mark>→</mark> bri <u>c</u>	phter to dim	mer	
AcquireStar	Goto zenith 🗹	\$	Sync 🔲	Max erro	r 1.0	arc min		
General	Blind slew 🗌	Meridian c	ross 🗌	Attempt	s 3			
	Return slew 🗹	Pointing fil	ter		Plate so	olve method		
	Final pointing 🔽	Current filt	ter	- 1	TheSk	у	-	
l								

 You may test the setup by opening the AcquireStar, clicking on Plate Solve tab and pressing 'Expose and Solve' to take an image based on the current telescope coordinates. Note - The' Expose & Solve' button will be disabled if the telescope is not connected and tracking.
Treferences: 5 Exit	System #1			- 🗆 X
Setup Autofocus Camera Filter Wheel Focuser Telescope AcquireStar General	AcquireStar Max : CCD Edit	PinPoint Solve time 60 sec le Central 75 %	Save images Scale (no bin) X 1.7 Y 1.7 Expose & Solve	Plate Solve

- Blate solving images with PinPoint
 Setup FocusMax to use TheSkyX or TheSky64 camera control

Sector Preferences:	System #1 - 🗆 🗙
Exit	
Setup Autofocus	Camera Focuser Telescope
Camera	Telescope
	ASCOM Telescope Driver for TheSky.
Filter Wheel	
	System 1: System1
Focuser	Camera control Number
Telescope	TheSky64 - 1 - Filter Wheel Focuser
	Camera Simulator Filter Wheel Simulator ASCOM Simulator Focuser Driver
AcquireStar	
	System 2 No system selected on
General	Camera control Number FocusMax system window
	Focuser

- Verify that the simulator Camera, Focuser and Telescope are connected
- o Set AcquireStar 'Plate solve method' to PinPoint or PinPoint All-Sky.
- o Enable 'Simulate starfield'.

Preferences: Sys Exit	stem #1					—	×
Setup	AcquireStar		PinPo	pint	γ	Plate Solve	
Autofocus	Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag	<u> </u>	
Camera	1	Luminance Blue	2	10.00 10.00	6.0 6.0		
	3	Green	2	10.00	6.0		
Filter Wheel	5	V	2	10.00	6.0		
Focuser	0		2	10.00	0.0 Sin		
Telescope	altitude 30.0	altitude 90	0.0 No. stars	3	sta	nfield	
A convice Otor	Sort star list Flux		✓ Order	Descending	+ brig	ghter to dimmer	
Acquirestar	Goto zenith 🗹	8	Sync 🔲	Max erro	r 1.0	arc min	
General	Blind slew	Meridian c	ross 🗖	Attempts	s <u>3</u>		
	Final pointing 🔽	Current filt	er	•	Plate so PinPoi	int/All-Sky	

- On the PinPoint tab, select the desired PinPoint catalog and set the path to the folder containing the star catalog.
- Press the Test PinPoint button to verify that the Full version of PinPoint is installed.
- Press the Test Catalog button to verify that PinPoint can read successfully locate stars int the catalog.

🕹 Preferences: Sy Exit	stem #1		- 🗆 X
Setup	AcquireStar	PinPoint	Plate Solve
Autofocus	Star Detection ———		
Camera	Min size (pixels	5) 2	Border 4 pixels
Filter Wheel	Sigma above mea	n 3	
Focuser	– Catalog – Expansio	on 30 %	
Telescope	Use stars from	n -2.0 to 20.0	
AcquireStar	Catalog Guide St Folder D:\Catalo	ar Catalog gs\GSC11	
General	Test Pir	Point	Test Catalog
🕹 Log	- 0	×	
File Open Se	et		
08:07:10 08:07:10 ** Pin 08:07:10 PinPo 08:07:10 Catal 08:07:10 Catal 08:07:10 Brigh 08:07:10 Dim o 08:07:10 Positi 08:07:10 Field 08:07:10 PinPo	Point test ** oint version: 7.0.0 og: Guide Star Catalog og path: D:\Catalogs\GSC11\ t catalog star mag: -2 :atalog star mag: 20 ion: RA 00:00:00.0 Dec +00:00:00.0 search: 1 x 1 degrees oint test passed with 185 stars found		

- On the Plate Solve Tab, set image plate scale to 1.7 arc-sec/pixel for the DSS images.
- Press the Expose and Solve button to take a simulated image and plate solve using PinPoint.

Preferences: Exit	System #1			- 🗆	×
 Preferences: Exit Setup Autofocus Camera Filter Wheel Focuser Telescope AcquireStar 	System #1 AcquireStar Max : Imag CCD	PinPoint Solve time 60 sec le Central 75 %	Save images Scale (no bin) X 1.7 Y 1.7	Plate Solve	×
General			Expose & Solve		



🗸 Log	—		×
File Open Set			
11:24:37 ** Starting Expose & Solve **			^
11:24:37 Taking pointing exposure			
11:24:37Filter: Luminance (slot 1)			
11:24:37Binning: 2			
11:24:37Exposure: 10.00 sec			
11:24:37CCD central region: 75%			
11:24:51Image: Autofocus_20210810_112	2440.fts		
11:24:51Time to read TS64 image: 0 sec			
11:24:52CCD image: 750 X 750			
11:24:52 Getting catalog stars			
11:24:53Catalog stars found: 681			
11:24:53 Finding stars in image			
11:24:54Image stars found: 4165			
11:24:54 Starting PinPoint plate solve			
11:24:54 Plate solved			
11:24:54Image bin = 2			
11:24:54Roll angle = -1.23			
11:24:54Plate scale = -3.4V -3.4H			
11:24:54Plate scale unbinned = -1.7V -1.7	H		
11:24:55Alt = 61.27 Az = 312.63			
11:24:55Plate(Topo) RA: 05:22:48.8 Dec: ·	+50:24:3	32.9	
11:24:55Plate(J2000) RA: 05:21:10.4 Dec:	+50:23:	27.0	
11:24:55Image X,Y: 374, 374			
11:24:55Full frame (1x1 bin) X,Y: 998, 998			
11:24:56 ** Plate solve was successful **			

- Run the FirstLight Wizard to generate a set of Vcurves note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel.
- Press the Focus button to focus the system using simulator camera and focuser.
- Press Select button to use the cursor to select a single star to use for autofocus.
- Open Preferences/Autofocus and set the Focus process to 'Multi-Star', press the Focus button.
- o Run AcquireStar Wizard to determine the optimum star magnitude for a given filter
- Run AcquireStar to automatically select a star for autofocus.

Nebulosity 4

Nebulosity 4



ASCOM DSS Camera

Using ASCOM DSS Camera to Generate Simulated Star Field



- Install the Deep Sky Survey (DSS) ASCOM driver from <u>https://sourceforge.net/projects/sky-simulator/</u>. This camera driver will download a DSS image from the internet based on the telescope position. Once installed:
 - o Select the ASCOM camera in 'Camera Control'
 - Press Advanced button to select the telescope connection which will provide the RA & Dec coordinates.



- 2. Find a a star in the 8 10 magnitude range using your planetarium app.
 - O Press the FocusMax 'Find' button to take an image and find the brightest star int he field.





AcquireStar

Setting up AcquireStar

Astronomers are using AcquireStar with automated telescopes to perform a periodic focus update to assure that images acquired during the night are perfectly focused. AcquireStar can be operated manually by a push of a button or through automation within a script.



AcquireStar will identify and acquire a target star for autofocus that falls within the user defined requirements.

This feature requires ThjeSky ImageLink or the full version of PinPoint. AcquireStar will not work with the current version of PinPoint LE bundled with MaxIm V3 or higher.

At the push of a button or from a script, AcquireStar will (depending on user settings):

- take short exposure and plate solve current telescope position using PinPoint or TheSky Image Link.
- o initiate a search in a star catalog to identify stars that meet the user defined magnitude range
- o identified stars will be screened for min slew altitude, side of meridian to prevent telescope flip
- o slew the telescope to the first target star in the list
- o take a short exposure and plate solve current telescope position
- o tweak telescope pointing to center target star
- o initiate autofocus routine
- o perform a return slew to original position
- o take a short exposure and plate solve current telescope position
- o tweak telescope pointing to met user defined allowable pointing error

AcquireStar Tab

AcquireStar Setup Tab

The AcquireStar Tab shows the exposure and target magnitude that will used for selecting a star from the a catalog.

The bottom portion of the window is used to define the process that AcquirStar will use in selecting and slewing the telescope to the selected stars found in the catalog.

Preferences: System	#1							_		Х
Exit										
Setup	Acquire Star			Pi	nPoint		P	late Solve)	
Autofocus		Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag				
	[1	E	2	5.00	7.5				
Camera		2	С	2	5.00	7.5				
		3	U	4	15.00	3.0				
Filter Wheel		4	в	3	10.00	5.5				
		о 6	P	2	10.00	0.0 9.0				
Focuser	l	0	K	3	10.00	0.0				
	Min altitude 30.0	0	Max altitude	90.0 No.	s 3		Simulate starfield	✓		
Telescope	Sort star list Flu	IX		✓ Ord	er Descend	ling 🗸	brighter to	dimmer		
AcquireStar	Goto zenith 🔽]		Sync 🔲	Maxe	error 1.0	arc mir	<u>ו</u>		
General	Blind slew	N	leridia	n cross 🔲	Atten	npts 3				
	Return slew 🔽	P	ointin	g filter		Plat	te solve met	thod		
	Final pointing 🔽		Curren	t filter	• i	Pir	nPoint/All-Sl	ky 🗸		

Settings for each filter (data grid):

- 'Plate Solve Bin' set the binning that will be used for plate solve. Note: consider using 3x3 or 4x4 for restrictive filters
- 'Plate Solve Exposure' set the exposure that will be used for plate solve current telescope position for each filter
- 'Target star magnitude' define the target star magnitude that will be selected from the catalog.
 Note a default of +1 magnitude will be used to set the dimmer star magnitude limit. This may be changed in the file FWi_XXX.cfg for example:

```
Filter1=E|2|5.00|30.00|200|2|10.00|7.0|1.0 ==> (Target = 7.0, Upper mag limit = 7.0 + 1.0 = 8.0)
```

Filter2=C|2|5.00|15.00|200|4|5.00|10.0|2.0 ==> (Target = 10.0, Upper mag limit = 10.0)

<mark>+ 2.0 = 12.0)</mark>

Click in the cell you wish to update then double click to change the value, press Return or leave the cell to save the changes.

Min Slew Altitude

The minimum allowed telescope slew altitude.

Number of Stars

The minimum number of stars that will be selected from the star catalog that meet the user defined parameters, default = 3.

Simulate starfields

A simulated starfield can be generated for testing and learning about the many FocusMax features.

- PinPoint or PinPoint All-Skymust be selected as the plate solve method (requires Full PinPoint not LE) or TheSky Image Link
- System 'Simulator1' or 'Simulator2' must be selected on the main FocusMax 'System' window. These files can be found in '//Configurations/Simulator'.
- o Camera Simulator must be selected and connected in the camera control app.
- Focuser (Simulator or real) must be selected and connected.
- Telescope (Simulator or real) must be connected and tracking.



Return slew

Enable to set the telescope to perform a return slew after acquiring the target star and performing the autofocus routine.

Blind slew

Enable for the telescope to perform slews blind without using astrometric plate solving to determine the precise telescope position.

Goto Zenith

AcquireStar will begin the target star selection process at the zenith and expand in 2x2 degree increments until a suitable stars are found.

Meridian Cross

AcquireStar will allow target star from being selected on the other side of the meridian. Enable this feature if you are using a mount that does not flip, such as an equatorial fork mount.

Sync

Allow the telescope to sync to current position following a successful astrometric plate solution of the current telescope position.

Max error

The maximum allowable telescope position error following a telescope slew that the user will accept before AcquireStar will attempt to fine tune the telescope position by taking another image and plate solving, default = 1 arc-min.

Attempts

The number of plate solve attempts to achieve required telescope pointing, default = 3

Plate Solve Method

- o PinPoint to plate solve the telescope pointing
- <u>PinPoint/All-Sky</u> requires an internet connection to send information to Astrometry.net plate solving service or the All-Sky may be copied to a local drive which will spped the process.
- <u>TheSky</u> Image Link to plate solve the telescope pointing. The user may enable utilize All Sky Image Link in TheSky if the appropriate catalogs have been installed

Notes

- Do not select a target star magnitude that will saturate the camera sensor for any given filter.
- The user can specify the number of stars (default = 3) to select from the star catalog before the telescope slew is initiated. If the autofocus run fails, then the second star in the list is used, followed by the 3rd, etc.

TheSky Image Link

Setting up TheSky Image Link

Images taken with TheSky Camera Add-on, MaxIm, or Nebulosity 4 may be plate solved using TheSky Image Link method.

- 1. It is important to verify that you have the latest TheSky Image Link file is installed on your computer.
 - O Open TheSky / Menu / Tools / Image Link
 - Click on All Sky tab to verify that you have the latest file installed (as shown below). If it is not up to date, then press the link to sign in to the Software Bisque site and download 1.7 gigabyte file.

🚱 Image Link			
Search Setup FOVI Options All Sky	Light Source Data	Astrometric Solution	
Download the All Sky Image Link Database Your All Sky Image Link Database is up-to-date. Open FITS All Sky Search Bind Image scale Search a range of image scales Image scale: 1.700 arcseconds/pixel Image scale tolerance: 1.00% Mirror option: Unknown or not sure Search visible declinations only Use All Sky Image Link for automated pointing runs Use All Sky Image Link for scripted Image Link Status:			
	Show light source	ces	Show astrome

- Once installed you have the option to use 'Image Link All Sky for scripted operations Image Link' - see above screen shot
- Enable 'Use Set the Image scale for your system or enable 'Blind' or 'Search a range of image scales'
- 2. Open FocusMax / Preferences / AcquireStar and select TheSky method.

description: A series of the s	n #1							_		\times
Exit										
Setup	AcquireStar			Pi	nPoint			Plate Sol	ve	
Autofocus		Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag				
		1	E	2	5.00	7.5				
Camera		2	С	2	5.00	7.5	_			
	-	3	0	4	15.00	3.0	_			
Filter Wheel	-	4	в	3	10.00	5.5	-			
	-	о 6	P	2	10.00	5.5 9.0				
Focuser	L	0	ĸ	3	10.00	0.0				
Telescope	Min altitude 30.0	D a	lax Ititude	90.0 No. star	s 3		Simulate starfield	7		
Telescope	Sort star list Flu	x			er Descend	ling 🗸	brighter t	o dimmer		
AcquireStar	Goto zenith 🗹			Sync 🔲	Maxe	error 1.0	arc m	in		
General	Blind slew	N	leridia	n cross 🔲	Atter	npts 3				
	Return slew 🔽	P	ointing	g filter		Pla	te solve m	ethod		
	Final pointing 🔽		Curren	t filter	-	T	neSky	-		

3. You may test the setup by opening the 'Plate Solve' tab and pressing 'Expose and Solve' to take an image to plate solve.

Preferences: Exit	System #1			– 🗆 X
Setup Autofocus	AcquireStar	PinPoint		Plate Solve
Camera Filter Wheel Focuser Telescope		ge O Central Region 75 %	Save images Scale (no bin) X 1.7 Y 1.7	
AcquireStar General	Edit	t Star Avoid	Expose & Solve	

PinPoint Tab

Setting up PinPoint

This PinPoint tab is used to set the Star detection parameters (if needed) and specify the star catalog to be used.

1. Setting up PinPoint

Preferences: S Exit	ÿystem #1			- • ×
Setup	AcquireStar	PinPoint	P	late Solve
Autofocus Camera Filter Wheel Focuser Telescope AcquireStar General	Star Detection Min size (pi Sigma above n Catalog Expar Use stars i Catalog Guide Folder D:\Cat	xels) 2 hean 3 hsion 30 % from -2.0 to 20.0 e Star Catalog alogs\GSC11 t PinPoint	Border 4 pixels	
Log File Open	— [Set	×		
08:07:10 08:07:10 ** F 08:07:10 Pin 08:07:10 Cat 08:07:10 Cat 08:07:10 Brig 08:07:10 Din 08:07:10 Pos 08:07:10 Fiel 08:07:10 Pin	PinPoint test ** Point version: 7.0.0 talog: Guide Star Catalog talog path: D:\Catalogs\GSC11\ ght catalog star mag: -2 n catalog star mag: 20 sition: RA00:00:00.0 Dec +00:0 Id search: 1 x 1 degrees Point test passed with 185 star:	0:00.0 s found		

Star Detection

<

- 'Min size' minimum size in pixels for star detection (default = 2)
- 'Sigma above mean' minimum standard deviation of the signal (star) above the background noise for star detection (default = 3)

>

 'Border' - the number of pixels to ignore around the perimeter of the image when plate solving (default = 4)

Catalog

'Expansion' setting will read additional stars from the catalog to aid in plate solving (default 30%)

- 'Use stars from' will extract stars in the defined magnitude range for plate solving (default -2.0 to 20.0)
- 'Catalog' lists the current catalogs that are available to be used by PinPoint. Pressing the small information button will open a text file that lists information about some of the available star catalogs. In general, the GSC is an excellent chose for most users. The ATLAS or USNO is useful if faint stars are required for narrow field of view.
- 'Folder' is the path to the chosen catalog

Buttons

- 'Test PinPoint' is used to verify that the full version of PinPoint has been installed on the PC. Unfortunately, PinPoint LE which ships with MaxIm does not provide COM plate solving capabilities.
- 'Test Catalog' will verify that AcquireStar can access, read and count the number of stars in a 1.0x1.0 degree field centered on RA 00:00:00, Dec 0:00:00 from the chosen star catalog. The results will be displayed in the Log

🕹 Log — 🗆	×
File Open Set	
12:37:57 12:37:57 ** PinPoint test ** 12:37:57 PinPoint version: 7.0.0 12:37:57 Catalog: Guide Star Catalog 12:37:57 Catalog path: D:\Catalogs\GSC11\ 12:37:57 Bright catalog star mag: -2 12:37:57 Dim catalog star mag: 20 12:37:57 Position: RA00:00:00.0 Dec +00:00:00.0 12:37:57 Field search: 1 x 1 degrees 12:37:57 PinPoint test passed with 185 stars found	^
<	~

Plate Solve Tab

Plate Solve Tab

The Plate Solve tab is used to set the desired binning and the image scale of your system and test to verify that a plate solve can be successfully performed.

Preferences: Exit	System #1			- 🗆 X	<
Exit Setup Autofocus Camera Filter Wheel Focuser Telescope AcquireStar General	AcquireStar Max 3 CCD Edit	PinPoint Solve time 60 sec le Central 75 % Region 75 %	Save images Scale (no bin) X 1.7 Y 1.7 Expose & Solve	Plate Solve	

Image

- 'CCD Central Region' will set the size of the image. If you have a large chip then consider setting this to 50% or less.
- o 'X/Y scale' is the camera unbinned scale in arc-sec / pixel.
- o Press the small button to open the Scale calculator

Tixel Scale Calculator	×
Exit	
Telescope Focal Length 72 in -	Pixel Unbinned size scale X 9.0 1.014 Y 9.0 1.014 Calculate

Max Solve Time

Set the maximum time in seconds to plate solve an image, default = 60 sec (PinPoint only).

Buttons:

- Occasionally AquireStar may locate a star in the star catalog that appears to FocusMax as double star which will result in poor or failed autofocus run.
- 'Edit Star Avoid' will open a text file that contain a list of stars that will be ignored by AcquireStar.

The file contains	s Star ID, R	a and Dec a	and mag	nitude delimited by ' '
'ID	RA	Dec	Mag	==> Any line starting with ' will be ignored. Do
not delete this I	ine			
'GSC 3097-011	5 17:52:09	.2 +42:51:28	5.8 7.11	==> sample - you may delete this line
SAO 49603	20:25:26	+42:36:18	6.9	

Simply add the known problem star to the list and AcquireStar will ignore it.

• 'Expose & Solve' will take an image and attempt to plate solve the current telescope position using the plate solve method selected on the AcquireStar Setup tab.

AcquireStar Wizard

AcquireStar Wizard

The AcquireStar Wizard will find the optimum focus star magnitude for a selected filter. The minimum focus exposure time will be set to 1.00 second to provide head-space for exposure adjustment depending on the magnitude of the star selected. Instructions for each step are provided in the left hand text box.

- 1. AcquireStar will automate the focus process by:
 - a) Take an image and plate solve the current telescope position (if desired)
 - b) Identifying focus stars from a star catalog that meet your magnitude requirements by filter
 - c) Slew the telescope to the target star
 - d) Center the star on the CCD
 - e) Initiate an autofocus run
 - f) Perform a return slew (if desired)

Tile							×	,
AcquireStar will automate the focus process by:	^	Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag		
desired)		1	E	2	5.00	7.5		
 Identifying focus stars from a star catalog 		2	С	2	5.00	7.5		
that meet your magnitude requirements by filter		3	U	4	15.00	3.0		
3) Slew the telescope to the target star		4	В	3	10.00	5.5		
4) Center the star 5) Initiate an autofocus run		5	٧	1	10.00	5.5		
6) Perform a return slew (if desired)		6	R	3	10.00	6.0		
		7	I	4	10.00	3.0		
This wizard will find the optimum focus star magnitude for a given filter.								
		Refe	erence	filter	Pointing	filter		
	\sim	С			• C		*	
Back Next Run				Filter	offset			

2. Filter off sets will be used for plate solving the telescope position. Pressing the 'Filter offset' button will open a Window which will allow you to enter the offsets. The filter off sets values do not need to be precise but should be close enough to prevent large out of focus donuts when an image is taken after a filter change. To estimate the offsets:

- a) Set the filter that provides the brightest image (typically Luminance) as the 'Reference' filter
- b) Focus the telescope with the chosen Reference filter and record the focuser position and HFD
- c) Set the next filter in place
- d) Center a star on the CCD that is appropriate for the filter

- e) Focus the telescope and note the HFD of the star
- f) Enter the offset in the data-grid as: Offset = Target filter position Reference filter position

acquireStar Wizard 🕹 🕹							×
File							
Filter offsets will be used with AcquireStar for plate solving telescope position.	^	Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag	
At this time the filter offsets do not need to be		1	E	2	5.00	7.5	
precise, the images taken must be close to		2	С	2	5.00	7.5	
focus and not large donuts which may prevent		3	U	4	15.00	3.0	
the image from being successfully plate		4	В	3	10.00	5.5	
solved.		5	V	1	10.00	5.5	
		6	R	3	10.00	6.0	
		7	1	4	10.00	3.0	
		Refe	erence	filter	Pointing	filter	
	5	С			J C	,	_
	Ť	Ľ					
Back Next Run				Filter	offset		
The AcquireStar Wizard							×
Tile							×
AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg	^	Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag	×
AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg	^	Slot	Filter	Plate Solve Bin 2	Plate Solve Exp 5.00	Tgt Star Mag 7.5	×
 AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg You may edit filter offsets by pressing the Filter 	^	Slot 1 2	Filter E C	Plate Solve Bin 2 2	Plate Solve Exp 5.00 5.00	Tgt Star Mag 7.5 7.5	×
 AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg You may edit filter offsets by pressing the Filter Offset button. 	^	Slot 1 2 3	Filter E C U	Plate Solve Bin 2 2 4	Plate Solve Exp 5.00 5.00 15.00	Tgt Star Mag 7.5 7.5 3.0	×
 AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg You may edit filter offsets by pressing the Filter Offset button. 	^	Slot 1 2 3 4	Filter E C U B	Plate Solve Bin 2 2 4 3	Plate Solve Exp 5.00 5.00 15.00 10.00	Tgt Star Mag 7.5 7.5 3.0 5.5	×
 AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg You may edit filter offsets by pressing the Filter Offset button. 	^	Slot 1 2 3 4 5	Filter E C U B V	Plate Solve Bin 2 2 4 3 1	Plate Solve Exp 5.00 5.00 15.00 10.00 10.00	Tgt Star Mag 7.5 7.5 3.0 5.5 5.5	×
 AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg You may edit filter offsets by pressing the Filter Offset button. 	^	Slot 1 2 3 4 5 6	Filter E C U B V R	Plate Solve Bin 2 2 4 3 1 3	Plate Solve Exp 5.00 5.00 15.00 10.00 10.00 10.00	Tgt Star Mag 7.5 7.5 3.0 5.5 5.5 6.0	×
 AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg You may edit filter offsets by pressing the Filter Offset button. 	^	Slot 1 2 3 4 5 6 7	Filter E C U B V R I	Plate Solve Bin 2 2 4 3 1 3 3 4	Plate Solve Exp 5.00 5.00 15.00 10.00 10.00 10.00 10.00	Tgt Star Mag 7.5 7.5 3.0 5.5 5.5 6.0 3.0	×
AcquireStar Wizard File Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg You may edit filter offsets by pressing the Filter Offset button.	~	Slot 1 2 3 4 5 6 7 7 Refe	Filter E C U B V R I	Plate Solve Bin 2 2 4 3 1 3 4 4 filter	Plate Solve Exp 5.00 5.00 15.00 10.00 10.00 10.00 10.00	Tgt Star Mag 7.5 7.5 3.0 5.5 5.5 6.0 3.0	×

Preferences: System #1						_	×
Exit							
Setup Autofocus	Rese Set fi to de	et —— Iter para fault val	ameters lues				
Camera	Filter	offset					
Filter Wheel	Slot	Filter	Offset	Reference			
	1	E	-775				
Focuser	2	С	0	Reference			
	3	U	51				
Telescope	4	В	69				
	5	V	12				
AcquireStar	6	R	8				
Conorol	7	I	-38				
General							

3. Select the filter to be used for plate solving the telescope position - typically the filter that provides the brightest image such as Luminance.

The AcquireStar Wizard							×
File							
Please select the filter to be used for plate	tar Wizard X ect the filter to be used for plate lecting 'Current filter' will use the ve filter. e reference filter is also used for dates. $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$						
current active filter		1	E	2	5.00	7.5	
		2	С	2	5.00	7.5	
		3	U	4	15.00	3.0	
Typically, the reference filter is also used for		4	В	3	10.00	5.5	
pointing updates.		5	V	1	10.00	5.5	
		6	R	3	10.00	6.0	
		7	1	4	10.00	3.0	
		Refe	erence	filter	Pointing	ı filter	
	1.	<u> </u>					
Back Next Run				Filter	offset		

- 4. You may edit the AcquireStar settings for each filter
 - a) Plate solve binning
 - b) Plate solve exposure
 - c) Focus target star magnitude

Click the cell then double click change the entry.

🕹 AcquireStar Wizard							\times
File							
You may addit the the following AcquireStar	^	Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag	
parameters for each filter:		1	E	2	5.00	7.5	
Plate solve exposure		2	С	2	5.00	7.5	
Plate solve binning		3	U	4	15.00	3.0	
Focus target star magnitude		4	В	3	10.00	5.5	
		5	V	1	10.00	5.5	
		6	R	3	10.00	6.0	
		7	I	4	10.00	3.0	
	~	Refe	erence	filter	Pointing	filter	•
Back Next Run				Filter	offset		

- 5. You may edit the autofocus parameters:
 - a) Target star binning
 - b) Focus binning
 - c) Base exposure
 - d) Max exposure
 - e) Target star flux

The AcquireStar Wizard									×
File									
To focus with narrow band filters consider: Setting Flux target to 150	^	Slot	Filter	Tgt Bin	Focus Bin	Base exp	Max exp	Tgt Flux x1000	
Select a brighter target star		1	E	2	1	1.00	10.00	300	
Try 3x3 or 4x4 binning		2	С	2	1	1.00	10.00	300	
		3	U	1	2	10.00	30.00	200	
Very may a dit the the following Autofacture		4	В	1	1	2.00	10.00	200	
narameters for each filter		5	V	2	1	2.00	10.00	200	
		6	R	2	1	1.00	10.00	200	
Focus binning		7	1	2	1	10.00	10.00	200	
Base exposure Max exposure Target star flux		Refe	erence	filter		Poir	nting filte	er	
	Υ.	С			·				•
Back Next Run					Filter of	fset			

6. Select a filter in the grid then press run to begin the measurement process.



7. The AcquireStar Wizard process:

- a) Identify multiple stars starting at the defined target magnitude (range: +1 magnitude)
- b) The telescope will slew to the first star in the list, plate solve using the 'Pointing filter'
- c) Set target filter and apply 'focus offset'
- d) Test if the star can be used as a focus star
- e) If the star is too bright, then a new star list is created of dimmer stars
- f) If the star is too dim, then a new star list is created of brighter stars
- g) A focus run is initiated once the star magnitude has been identified
- h) The AcquireStar setting is updated with the new mag setting

🕹 AcquireStar Wizard							×
File							
** Starting measurement process **	^		Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag	
** Getting stars for filter R (slot 6)		1	E	2	5.00	7.5	
Catalog magnitude range 2 to 15		2	С	2	5.00	7.5	
Creating list of stars		3	U	4	15.00	3.0	
R (slot 6)		4	В	3	10.00	5.5	
Searching catalog for 3 stars		5	V	1	10.00	5.5	
Mag range: 6.00 to 7.00		6	R	3	10.00	6.0	
Found star: GSC 2991-0699 mag: 6.09		7	I	4	10.00	3.0	
Found star: GSC 2500-1007 mag: 6.19 Found star: GSC 2991-0268 mag: 6.67 Slewing to star: GSC 2991-0699 Mag: 6.09 RA= 09:22:17.6 Dec = +38:05:58.4							
		Refe	erence	filter	Pointing	filter	
	Υ.	С			• C		•
Back Next Run				Filter	offset		

Filter Offset Wizard

Filter Offset Wizard

Filter Offset

Filter offset is a measurement of the difference in focuser steps between a given filter and a reference filter. Once this 'offset' is known you may use the reference filter to focus the telescope with a filter that provides a bright image (typically Luminance) then apply the offset steps to bring the system into focus for the target filter.

- 1. The reference filter is typically the filter that yields the brightest image in the filter wheel such as the slot containing Clear / Luminance filter.
- 2. Focusing with the reference filter will save precious observing time as the focus process will be significantly shorter than with a filter that yields a fainter image such as a narrow band filter.
- 3. The reference filter will provide more stars in the field for focus candidates then other filters.
- 4. Focus error will be introduced if the offset steps between the target filter and reference filter is not well established and statistically significant. Determining the offset will require running multiple (many) runs comparing the focus point with both filters then evaluating the runs to identify potential data outliers and determine if the data is statistically sound. Most apps that offer filter offset measurements will run one or several focus iterations for setting the offset; FocusMax V5 will allow you to build a <u>significant</u> database of measurements so that the offset step relationship can be statistically determined.

Filter Offset Wizard

- 1. The FIlter Offset Wizard is designed to walk through the process of collecting data on the number of steps between a target filter and a reference filter.
- The Wizard will store the current focus process, method and settings then set the autofocus 'Process' to SIngle-Star and 'Method' to Advanced.

arrow Filter Offset Wizard						\times
File						
This wizard will measure the filter offsets (in	^	Slot	Filter	Test Sequence		
This will allow you to focus with a reference		1	Е			
filter (say Luminance) and apply the offset		2	С			
when the line is changed.		3	U			
The reference filter can be any filter, typical is		4	В			
		5	V			
		6	R			
		7	1			
	~					
Back Next Run		Test cyc	des: 3	- Pret	ferences	

Shown is the filter contained in the active filter wheel by slot number.

2. Click in the yellow column to identify the 'Reference' filter and set the order to measure one or two target filters.

You may choose up to 2 different target filters for each run. If this is not the first filter offset run then the Reference filter must not be changed.

If temperature change during the measurement process is a concern, then it is suggested that you run only one target filter or plan to run when the temperature has stabilized.

👗 Filter Offset Wizard						×
File						
In the column labeled 'Test Sequence' Select: * Reference filter * Test order by filter (C-R-V) Max number of filters per run is 3 to reduce temperature influence that may shift focus point and resulting offset value.	~	Slot 1 2 3 4 5 6 7	Filter E C U B V R R I	Test Sequence		
Back Next Run	~	Test cyc	cles: 3	Pret	(rerences	



3. Select the number of test cycles (measurement iterations) that will be run.

🕹 Filter Offset Wizard						Х
File						
Select the number of 'Test cycles'	^	Slot	Filter	Test Sequence		
(measurements per filter)		1	Е			
		2	С	Reference		
		3	U			
		4	в	2		
		5	٧			
		6	R	1		
		7	1			
	~					
Back Next Run		Test cyc	cles: 3	- Pret	ferences	

4. AcquireStar must be setup for each filter so that the telescope may slew to an appropriate star and initiate a focus process. If AcquireStar has not been setup, you may use the AcquireStar Wizard for the filters you which to measure.

Tilter Offset Wizard					×
File					
AcquireStar will be used to select stars for the filter offset run.	^	Slot	Filter	Test Sequence	
		1	E		
The stars selected will be based on the		2	с	Reference	
AcquireStar settings for each filter. The telescope will slew between each		3	U		
selected star to collect filter offset measurements.		4	В	2	
ineasurements.		5	V		
		6	R	1	
		7	1		
	~				
Back Next Run		Test cy	cles: 3	- Pret	ferences

5. You may press the Preferences button to review the autofocus and AcquireStar settings.

Tilter Offset Wizard					×
File					
To focus with narrow band filters consider: Setting Flux target to 150	^	Slot	Filter	Test Sequence	
Select a brighter target star		1	Е		
Try 3x3 or 4x4 binning		2	С	Reference	
		3	U		Frences
Press the Preferences button to make		4	в	2	
adjustments to your inter settings.		5	٧		
		6	R	1	
		7	I		
	<				
Back Next Run		Test cyc	cles: 3	- Pref	ferences

6. Press Run to begin the measurement process.

🕹 Filter Offset Wizard						\times
File						
Press Run to begin	^	Slot	Filter	Test Sequence		
		1	Е			
		2	С	Reference		
		3	U			
		4	В	2		
		5	V			
		6	R	1		
		7	I			
	~					
Back Next Run		Test cyc	cles: 3	- Pret	ferences	

7. The Wizard will identify a list of potential target stars for each filter, slew the telescope to the first star in the list and verify that it may be used for the focus run.



8. The filter sequence (C R B : C R B : C R B) is shown and results of each filter sequence.

a Filter Offset Wizard					×
File					
Filter Sequence C R B : C R B : C R B Cycle# 1 of 3	^	Slot	Filter	Test Sequence	
Filter: C (slot 2)		1	Е		
Filter: R (slot 6) Step offset: 1. delta temp: 1.1		2	С	Reference	
		3	U		
		4	в	2	
		5	V		
		6	R	1	
		7	1		
	~				
Back Next Run		Test cyc	cles: 3	- Pret	ferences

- 9. At the conclusion of the run, the Filter Offset WIndow will be opened showing all of the offset measurements:
 - o Average offset steps.
 - o Individual offset and temperature difference
 - o Reference filter identification (Clear)

Filter Offse	t							_		×
	Sign	na limit	ts 2.5	i						
Graph	Slot	Filter	Avg Offset	1	2	3	4	5	6	
	1	Е	-775	-775:0.1						
Optimize	2	С	0	Ref						
	3	U	51	51:-0.1						
	4	В	-1	2:-0.1	-5:-0.1	0:-0.4	4:-1.1	-5:-0.1	0:-0.4	
	5	۷	12	12:-0.1						
	6	R	0	0:-0.2	-1:-0.1	-1:0.0	0:-0.2	-1:-0.1	1:0.0	
	7	1	-38	-38:0.1						

10. You may select a filter and press the 'Graph' button to show the plotted results for the filter offset and observed temperature change. The upper and lower dotted lines represent the +/- sigma limits (+/- 2.5

sigma) and the middle dotted line is the mean. Any point that is close or exceeds the upper or lower sigma lines may be considered suspect which is shown in the illustration below for point # 4 Delta Temperature.



11. The 'Optimize' function can be run if the a filter contains 6 or more data entries which will identify potential filter offset outliers for offset and temperature change. Suspect offset data is identified by Red
highlight and temperature change by Yellow. If suspect data is found, pressing 'OK' button will delete the entry from the data set.

Filter Offse	t							_		\times
	Sign	na limit	s 2.5]						
Graph	Slot	Filter	Avg Offset	1	2	3	4	5	6	
	1	Е	-775	-775:0.1						
Optimize	2	С	0	Ref						
	3	U	51	51:-0.1						
	4	В	-1	2:-0.1	-5:-0.1	0:-0.4	4:-1.1	-5:-0.1	0:-0.4	
	5	V	12	12:-0.1						
	6	R	0	0:-0.2	-1:-0.1	-1:0.0	0:-0.2	-1:-0.1	1:0.0	
	7	1	-38	-38:0.1						
FocusMax				×	<					
Suspect data d	etcted	!!								
Red: suspect fi Yellow: suspect	lter of t delta	fset tempe	rature							
Cell format: O	ffset d	lata : De	elta temp	erature						
Double click ce	ell to d	lelete e	ntry							

OK

First Light Wizard

First Light Wizard

The First Light Wizard will identify the settings needed to assure that an acceptable Vcurve can be run based on your equipment.

The First Light Wizard is designed to assist the new user in setting up the parameters for running a Vcurve for the first time.

Once the Vcurve has been created and the data is saved then FocusMax is will able to autofocus your telescope.

Running the First Light Wizard:

- Manually focus the telescope the focus does not have to be exact, just close. If you have loaded FocusMax 'Simulator1' or Simulator2' on the Setup Tab and selected a 'Simulator' focuser in Preferences the midpoint of the focuser travel can be found by:
 - o opening Preferences/Setup, press the small Chooser button next to the focuser text field then

select Properties.

- The focus position will be 1/2 the 'Maximum Step Position'.
- For example: if the Maximum Step Pos. is 5000 then the focus position while using simulators will be 2500.
- O Using the Jog button, move the focuser to the midpoint 2500
- 2. It is best if you can adjust the draw tube or move the primary mirror (SCT) so that the focus position is mid-way in the in and out travel of the focuser. This is important as FocusMax will require sufficient travel range inside and outside of focus in order to develop the full Vcurve.
- 3. Select a star near the zenith, press the Find button and verify in the Log that the resulting min/max flux falls within the boundary on the Setup tab and verify that the star is not saturated.
- 4. Select the First Light Wizard from the Wizard menu.
- 5. The wizard will prompt you at each step of the process.

🏅 First Light Wizard 🛛 🗙	🏅 First Light Wizard 🛛 🗙
This wizard will measure the characteristics of your system and automatically set up all of the critical parameters needed by FocusMax.	 Select a moderately bright near the zenith which will not saturate the camera Center the target star on the CCD chip Manually focus the CCD camera Click Next when ready
Back Next	Back Next
Tirst Light Wizard X	
The Wizard has placed the major windows on the screen. You should see the following windows: 1. MaxIm 2. Vcurve Sequence 3. Log Arrange the windows and click Next when ready	
Back Next	

6. The First Light Wizard will start by moving the focuser in small then larger increments away from the focus point as it attempts to estimate the slope of one side f the 'Vcurve'. The wizard will continue to move the focuser until it achieves the HFD setting (default = 40). If your focuser cannot reach this HFD setting then Stop and re-run the First Light Wizard and reduce the HFD value to a smaller value when prompted. This is not uncommon if the focuser is not centered in the travel range of the focuser (as per step 2 above) or the focuser has limited travel.

🍣 First Light Wizard 🛛 🕹 🗙	(
FocusMax will first attempt to determine an approximate Vcurve slope from the current focus position to HFD = 42 (default 40).	s
If your focuser has limited travel then you may want to reduce the HFD value below.	
HFD: 42	
Back Next	



- 7. Now that the First Light Wizard has estimated the Vcurve slope, it will proceed to take a series of subframe images from outside of focus, through focus to the other side of focus.
- 8. Open the Log if closed and watch the HFD change as the focuser is moved, an image taken and measured by FocusMax.
- 9. Open the Vcurve Graph from the menu to view the Vcurve in detail
 - o The graph may be resized as needed
 - o Data values may be displayed when you roll the mouse over the data points
 - The best fit hyperbola to the data is shown through the points
 - The vertical line is the 'Center' when the Vcurve was created
 - o The Left & Right tangent lines to the hyperbola are displayed
 - o The Left & Right slopes and PID are shown at the bottom of the window
 - O The V 'Center' and 'Focus position' are shown. Note:
 - The V 'Center' = 2510 is offset from the 'Focus position' = 2501 in the graph which indicates that the telescope was not in perfect focus when the Vcurve was started.
 - The end points of the 'V' the same with the left tip at are not the same with the Left = 44 HFD and the Right = 47. This difference will increase the further the 'Center' is from the true focus position and the Vcurve may fail if this difference is too large. It is important that you begin the Vcurve run as close to focus as possible.



9. The slope of the tangent line and the Position Intercept Difference (PID) will be calculated and saved in your system Profile that is active.

	Svs	tem					Posit	ion		
	Svs	stem1		Ste	ns/HFD	5.0397	- Interd	cept Total		
								erice Points		
					Slope	0.198492	3.66	10	Sigma limit 2.5	
					Std Dev.	0.00376	3.603	300	Graph PID + Slope	•
Oranh							Steps			
Graph	-	Use	Date	Time	PID	Slope	/HFD	Fit	74 0500 04000 0 05000 0 07604	Comments
	1	Y	2021-07-30	11:48:33	1.93	0.200211	4.9947	10.93073 3.38	971 2500.31028 0.05299 0.27684	Binning=1, 1
Optimize	2	Y	2021-07-29	12:57:13	11.34	0.188937	5.2928	12.55093 2.37	134 2499.34923 0.92203 0.26654	Binning=1, 1
	3	Y	2021-07-25	15:27:40	-1.41	0.202954	4.9272	19.95721 4.050	039 2500.93102 -0.54357 0.85311	Binning=1, I
Delete	4	N	2021-07-25	15:11:34	-3.08	0.210496	4.7507	20.78625 4.37	543 2499.45885 -0.76313 0.87047	Binning=1, 1
	5	N	2021-06-14	12:50:17	0.76	0.195443	5.1100	21.40689 4.18	382 2498.60966 -0.38007 0.65188	Binning=1, 1
	0	N	2021-06-14	12:42:49	10.44	0.185406	5.3930	5.13814 0.9520	04 2499.15425 1.49933 0.58408	Binning=1, 1
	/	Y	2021-00-04	11.28.11	1.52	0.200307	4.9923	15.14802 3.034	437 2500.7348 0.03612 0.85833	Binning=1, 1
	8	Y	2021-06-04	11:10:54	0.81	0.196887	5.0791	11.65434 2.294	459 2500.46486 0.60252 0.92466	Binning=1, 1
	9	N	2021-06-04	11:09:03	5.49	0.194201	5.1493	13.84228 2.688	818 2500.05911 0.43877 0.75241	Binning=1, I
	10	Y	2021-06-04	10:45:03	3.42	0.199051	5.0238	13.6731 2.721	55 2500.89846 0.24647 0.8486	Binning=1, I
	11	Y	2021-06-04	10:38:21	5.95	0.197282	5.0689	14.16422.2.794	434 2499.24258 0.48685 0.83534	Binning=1, I
	12	Y	2021-06-04	10:27:27	3.98	0.199294	5.0177	19.69805 3.92	571 2499.77547 0.20219 0.79486	Binning=1, T
	13	N	2021-06-04	10:19:31	-3.06	0.204397	4.8924	23.24795 4.75	182 2500.35648 -0.59058 0.90134	Binning=1, T
	14	Y	2021-03-27	12:55:51	1.47	0.2	5.0000	17.50705 3.50	141 2500 0 0	Binning=1, T
	15	Y	2021-03-27	12:00:55	1.55	0.2	5.0000	17.50704 3.50	141 2500 0 0	Binning=1, T

10. FocusMax will then use the results to perform an autofocus run



11. You have the option to rerun the Vcurve or exit. It is suggested that you collect multiple Vcurves



12. Pressing the Focus button on the Focus Tab which should result in a perfectly focused star.

13. Profile:

 If there are 6 or more data points in the Profile, then you may press the Optimize button which will scan the Slope and PID data and identify data entries that may be suspicious and will be flagged with yellow highlight. You will note that the 'Use' column changed the 'Y' to 'N' to exclude the data row.

	Svs	tem					Posit	on	
	Sys	stem1		Ste	ps/HFD	5.0048	- Interd	ept Total	
					Slope	0.199811	2.31	6 Sigma limit 2.5	
					Std Dev.	0.00051	1.102	06 Graph PID + Slop	e
Graph		Use	Date	Time	PID	Slope	Steps / HFD	Fit	Com
	1	Y	2021-07-30	11:48:33	1.93	0.200211	4.9947	16.93073 3.38971 2500.31028 0.05299 0.2768	4 Binni
Intimize	2	N	2021-07-29	12:57:13	11.34	0.188937	5.2928	12.55093 2.37134 2499.34923 0.92203 0.2665	4 Binni
purnizo	3	N	2021-07-25	15:27:40	-1.41	0.202954	4.9272	19.95721 4.05039 2500.93102 -0.54357 0.853	11 Binni
	4	N	2021-07-25	15:11:34	-3.08	0.210496	4.7507	20.78625 4.37543 2499.45885 -0.76313 0.870	47 Binni
Delete	5	N	2021-06-14	12:50:17	0.76	0.195443	5.1166	21.40689 4.18382 2498.60966 -0.38007 0.651	88 Binni
	6	N	2021-06-14	12:42:49	16.44	0.185406	5.3936	5.13814 0.95264 2499.15425 1.49933 0.58408	Binni
	7	Y	2021-06-04	11:28:11	1.52	0.200307	4.9923	15.14862 3.03437 2500.7348 0.03612 0.85833	Binni
	8	N	2021-06-04	11:16:54	6.81	0.196887	5.0791	11.65434 2.29459 2500.46486 0.60252 0.9246	6 Binni
	9	N	2021-06-04	11:09:03	5.49	0.194201	5.1493	13.84228 2.68818 2500.05911 0.43877 0.7524	1 Binni
	10	Y	2021-06-04	10:45:03	3.42	0.199051	5.0238	13.6731 2.72165 2500.89846 0.24647 0.8486	Binni
	11	N	2021-06-04	10:38:21	5.95	0.197282	5.0689	14.16422 2.79434 2499.24258 0.48685 0.8353	4 Binni
	12	Y	2021-06-04	10:27:27	3.98	0.199294	5.0177	19.69805 3.92571 2499.77547 0.20219 0.7948	6 Binni
	13	N	2021-06-04	10:19:31	-3.06	0.204397	4.8924	23.24795 4.75182 2500.35648 -0.59058 0.901	34 Binni
	14	Y	2021-03-27	12:55:51	1.47	0.2	5.0000	17.50705 3.50141 2500 0 0	Binni
	15	Y	2021-03-27	12:00:55	1.55	0.2	5.0000	17.50704 3.50141 2500 0 0	Binni

 Pressing the 'Graph' button will display theSlope and PID data with a line indicating the mean and dotted lines which represent the +/- sigma limits (in this example +/- 2.5 sigma). Any point that is on on beyond the dotted line are candidates to exclude from the data set which is done by double clicking the 'Y' changing the entry to 'N' in the 'Use' column. You may experiment by including / excluding various data rows and evaluate the changes in the graph and the header of the Profile window (looking for smaller Standard Deviation).



Notes:

- Set the Target Star and Focus binning to 2 if you are using a DSLR camera.
- Verify that the focus position is approximately centered in the focuser travel range (step 2). This
 is particularly important if the focuser has limited travel and may not be able to move the
 focuser to achieve the max HFD value.
- If the FistLight Wizard fails because it cannot achieve the max HFD setting (40 HFD in step 6), then reduce the max HFD value to the largest found in the Log. For example: If the default HFD setting =40 BUT the largest HFD found in Step 6 is 35 then adjust then set HFD = 35 in the text box.

Focus Convergence Wizard

Focus Convergence Wizard

The Focus Convergence Wizard is to assist in setting the number of convergence 'Steps' which will be used when the focuser has moved to the Near Focus position during the autofocus run. The 'Steps/HFD' is based on the measured Vcurve slope which is determined by 1/slope.

The '% HFD error' is the acceptable focus error expressed as a percentage of one HFD unit.

'Samples' is the number of consecutive points that must fall within the 'Steps' setting.

🖏 Convergence Wizard 🛛 🗙
File
** Focus Convergence Overview ** This calculator will help you to determine the Convergence 'Steps' when sampling at Near Focus to determine the focus position.
** Set the % HFD error ** Your system Steps per HFD is: 5 steps. The allowable focus error is based on a fraction of one HFD unit, a good starting point is 10%. As the '% HFD error' decreases, the number of samples required during the focus run will increase and visa versa.
** Set Samples ** 'Samples' is the number of consecutive mean focus positions that must fall within the 'Steps' (tolerance) requirement. A good starting point is 3 to 5 'Samples', increasing 'Samples' will require more measurements to be taken. If the seeing is stable, then the focus position will converge quickly with few subframes required. If seeing is poor, then more samples will be required before the focus position converges.
Steps/HFD % HFD error Steps Samples 5 10 0 3 Save

In the figure above, there are 5 steps/HFD, if the percent HFD error is set to 10% then focus will be considered converged when there are 3 consecutive data points (Samples) with a difference of 0 Steps between them. The focus plot below shows each individual calculated focus position (black) and the mean focus value (red). Note that the last three data points (red) fall within the 'Steps' of 0.



Temperature Compensation Wizard

Temperature Compensation Wizard

The Temperature Compensation Wizard is designed to collect position and temperature data over the course of one night. The output is a Log with temperature and positions that can be analyzed using the Temperature Compensation Window (Menu/Open/Temp Comp) to determine the temperature coefficient. The Temperature Log will be opened which will log the position and temperature from each autofocus run throughout the night.

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This wizard will collect temperature and focus position or used to determine the TC coefficient for automated focu compensation.	lata whic s temper	ch may b rature	e
It is recommended that you begin this wizard soon after maximize the temperature range and resulting positiona	sunset i I measu	in order t rements	to
Back Next Stop			

• Set the autofocus parameters as noted below in Preferences/Autofocus

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The following are recommended settings
Open FocusMax Preferences: 1. Set 'Autofocus Process' to Multi-Star (required).
2. Set 'Autofocus Method' to Advanced.
3. Set 'Filter' to your normal autofocus filter (Clear, Lum, Green, Blue).
4. Set 'Near Focus' Samples to 6 or more.
5. Set 'Final Focus' Samples to 3 or more.
6. Verify that 'Focus offset' is set to 0.
7. Enable 'Al' so that the autofocus runs are closer to Vcurve minima.
8. Verify that 'Return Start Position' is disabled.
9. Optional: 'Focus Convergence' may be enabled or disabled.
Back Next Stop

• Open your observatory automation app and set the following parameters. Note that the observatory automation app will be responsible of observatory control and shut down.

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Open your observatory automation app such as C 1. Verify that FocusMax is selected as the autofo 2. Select 'Multi-Star' autofocus if the option is ava 3. Set the autofocus frequency to 20 minutes or I may be collected during the night while you imag	CDAutoPilot icus process illable. ess so that s e.	: sufficent d	lata
A You may now make a connection to your form			
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• Press Start to begin collecting temperature compensation data during the observing session.

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Press 'Start' to open Use the 'Stop' button Once the run is com Compensation' Wind You may now minim your observatory aut	the TC Lo n to end TC npleted, yo dow to ana nize this wi comation a	og and be C data col u may op lyze your ndow and pp.	gin colle lection en the data (s	ecting da TC file in see Tutori your obse	ta as yo the 'Ten ials for d erving se	u observ nperature etails). ession us	e. sing
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Please see Temperature Compensation for information on analysis.

Running Vcurves

Running Vcurves

Some users find that the <u>First Light Wizard</u> is not able to characterize their system or have a working understanding of the Vcurve generation process and prefer to save time by running manual Vcurves.



- 1. Focus the telescope manually
 - Adjust the focuser so that the focus position is approximately mid-way in the full range of travel on your focuser.
 Example - an Optec TCF-S focuser has a total range of 7,000 steps so the focus position

Example - an Optec TCF-S focuser has a total range of 7,000 steps so the focus position should be adjusted to roughly 3,500 steps by adjusting the draw tube, primary mirror (SCT), etc.

• Verify that the focus position is approximately mid-way in the focus travel range (3,500 for the

above example).

- Select a 6 7th mag star (fainter for larger apertures) near the zenith and center on CCD.
- Using your imaging program, set the exposure time to a 'recommended' value of 0.5 sec and take an image. Measure the star intensity and adjust the exposure or use a brighter/fainter star until the target star intensity is mid-way in the camera's ADU range.
- Open the Vcurve window, the current focuser position will be entered in the 'Center' box.
- 2. Vcurve Parameter Settings:
 - o 'Center' is the current focuser position which is assumed to be the focus position.
 - o 'Half Width' is the movement in steps away from the Center in both directions.
 - 0
 - 'Step Incr.' sets the number of steps the focuser will move for each data point.
 - 'Steps' is the total number of moves that will be made when generating the Vcurve.
 Note that as you make adjustments in the boxes that the parameters will change once you leave the entry box or press Enter.
 - The 'Initial' and 'Final' are the end point focuser positions.
 - Enable 'Autofocus' If you want to perform an autofocus run after the Vcurve is completed.
 - o 'Repeat' setting will rerun the Vcurve using the same settings above
 - 'Images/position' setting will take multiple images and average the HFD measurements at each focuser position. This feature is useful for reducing noise and will yield a more consistent Vcurve. Downside is it takes more time and if the temperature is dripping rapidly then it may negatively impact the overall accuracy of the Vcurve.

3. Determine the Half Width

- Press the Jog button and move the focuser In or Out 100 units then press the Find button
- Continue to move the focuser until you achieve an HFD of 30+ (more is better)
- Note the focuser position
- Bring the focuser back to the focus position and press the Half Width button on the Vcurve window
- Enter the difference between the focus position and the position achieved when you manually jogged the focuser

Example:

Focuser position is 3,500 and 4,000 was the position to achieve 30 HFD.

- o Enter the difference of 500 into the Half Width box
- Adjust the Step Increment value until you see 30 40 Steps displayed
- Adjust the Step Increment until the Steps has an 'odd' number which helps sharpen the 'V' because each side of the 'V' Plot will have an even number of points.
- 4. Press the Run button and 'enjoy the show' as FocusMax characterizes your system by creating a Vcurve
- 5. Watch the 'V' plot while running a V-Curve cycle.
 - O Watch the HFD value in the Log as the points on the 'V' near the minima
 - When the HFD reaches its lowest value it will start to increase. Note: the lowest HFD position will be the approximate point of best focus.
- 6. Open the Vcurve Graph from the menu to view the Vcurve in detail
 - The graph may be resized as needed
 - Data values may be displayed when you roll the mouse over the data points
 - o The best fit hyperbola to the data is shown through the points
 - o The vertical line is the V 'Center' when the Vcurve parameters were created
 - The Left & Right tangent lines to the hyperbola are displayed

- The slope and PID are shown on the Vcurve graph
- O The 'Center' and 'Focus position' are shown. Note:
 - The V 'Center' = 2510 is offset from the 'Focus position' = 2501 in the graph which indicates that the telescope was not in perfect focus when the Vcurve was started.
 - The left tip of the 'V' = 27 HFD and the right tip = 31 HFD. This difference will increase the further the 'Center' moves away from the true 'Focus position' and the Vcurve may fail if this difference is too large. It is important that you begin the Vcurve run as close to focus as possible.



- Upon completion of the V-Curve cycle jog the focuser to the 'Focus position' before running another Vcurve cycle so that the the V 'Center' is placed at the telescope focus position. This also helps center the apex of the 'V' on the center line of the V-Curve plot.
- 7. If the lowest HFD in the Log continually changes or the apex of the 'V' in the V-Curve plot drifts this can indicate:
 - o The telescope has not reached thermal equilibrium with ambient temperature wait until the

telescope cools closer to air temperature.

- Temperature changed causing the focus point to drift wait until temperature and telescope stabilize.
- Continual drift of lowest HFD in the V-Curve Log, or centering of the 'V' on the V-Curve plot can also indicate the focuser might be slipping.

Notes:

The extremes of the Vcurve should be on the order of 30 - 40 HFD. The primary reason for the large HFD values is to improve the ability for FocusMax to determine the slope. The larger transition from max (tips of the 'V') to min (focus position) the better. This may be a challenge for some telescopes with short range of travel and/or telescopes with low focal rations which yield a shallow Vcurve.

See Profile Window

Image Calibration

Image Calibration

This feature is requested by users that may have CCD defects such as hot pixels which FocusMax may attempt to use utilize for focusing. Enable image calibration which is found on the Features tab and follow this procedure:

Preferences	_		>
Exit			
Setup Autofocus Camera	Properties Pixel size Sensor CCD Monochrome X 7.2 Y 7.2 m Full well 65535 Max Image 80 Readout mode Normal	nicrons	
Filter Wheel	Software bin 1 - CCD central 100 % Border 5 pixels Mark stars V Calibrate		
Telescope	Min Exposure Single-Star 0.1 sec Multi-Star 1	sec]
AcquireStar General	Pre-exp delay 0 sec Flush camera 0]	
	Simulator Seeing 3 - Guide errors 0 -		

MaxIm image calibration

- 1. Create a set of dark & bias frames at the binning used for the initial image and autofocus sub-frame images (see Target Star Bin and Focus Bin in Preferences/Autofocus).
- 2. The Dark frame exposures should span the range which FocusMax may use (0.1, 1, 5, 10 sec...). You may want to create a set of calibration frames from 1x1 through 4x4 just in case you decide to change bin size.
- 3. Save the calibration frames to a directory
- 4. Load the saved images into MaxIm using menu/Process/Set Calibration

MaxIm will extract the appropriate image and position in the calibration image to calibrate the FocusMax frames for the initial target star section and autofocus sub-frame images.

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Dark 1	DARK	0.50s	765 x 510	2 x 2	-25.00	2		
Bias 2	BIAS	N/A	382 x 255	4 x 4	-25.00	2		
Dark 2	DARK	0.50s	382 x 255	4 x 4	-25.00	2		
Bias 3	BIAS	N/A	1530 x 1020	1×1	-20.00	1		
Dark 3	DARK	0.11s	1530 x 1020	1×1	-20.00	1		
Dark 4	DARK	1.00s	1530 x 1020	1×1	-20.00	1		
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TheSky Camera Add-on / CCDSoft image calibration

Image Reduction will use 'AutoDark' with each light frame is taken.

TheSky

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CCDSoft

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FocusMax V5 Tutorials