

Automated Imaging with CCDAutoPilot 5

John Smith
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It's All About Signal-to-Noise Ratio

- Signal is fixed so minimize noise
- Read noise is also fixed by camera design
- Skyglow noise is also fixed by location
 - square root of sky glow signal in e, not ADU
- Broadband: Bury read noise in Skyglow noise
- Narrowband: Take longer exposures

Sub-Exposure Calculator

- Measure camera read noise
- Determine sky glow
- Determine number of dark frames
- Investigate impact of dithering
- Investigate impact of temperature

Sub-Exposure Calculator

Subexposure Calculator

Measure

Measure Camera

Gain1.4e/ADU

Read Noise10.0e

Binning1x1

FilterLum

Test Exposure300sec.

Measure Sky Flux

Sky Flux3.0e/sec.

Analyze

Read Noise Contribution10.0%

Minimum Sub-exposure Time159sec.

Image SensorKAF0402ME

Planned Exposure Time300sec.

Sensor Temperature-20°C

Dark Noise Contribution1.0%

Number of Stacked Frames6

☐ Stare☒ Dithered6

Focus Is Critical - Impacted by

- Temperature
- Filter
- Optical path stability
- Focuser repeatability

Focus frequently or strategically

Focus Strategically

- Determine Critical Focus Zone (CFZ)
 - Translate into focuser counts
- Determine focus for each filter
- Temperature coefficient of focus
- Number of focus runs vs. amount of data

CCDAutoPilot Tools

- Calculate CFZ
- Measure filter offsets
- Determine focuser repeatability
- Determine temperature coefficient of focus
- Many options.

Focusing

Focusing

Critical Focus Zone

Color: Green

Focal Ratio: 8.0

CFZ: 0.0022 in.

Dust Donut Calculator

Binning: 1X1

Size: 100 pixels

Distance: 0.14 in.

Units

☒ English ☐ Metric

Setup

Session

Options

Run

Guiding

Focusing

Focusing

Focus Method None

Focus Star Position X: Y:

Magnitude Range 4 to 7

☐ Center Focus Star within 300 arc-sec.

Min. Focus Star Altitude 60

☐ Refocus Every 0 min.

☐ Filter for Focusing: R

Post-Focus Offset 0

Focus Timeout 5 min.

Temperature Dependent Refocus

Temperature Source None

☐ Focus on Temp Change of 0.0

☐ Use Temp. Slope of 0.0

Focus Now

Filter Factors

Filter Name	Focus Offset	Focus Exposure	Calibration Magnitude
R	0	1.0	7.5
G	0	1.0	7.8
B	0	1.0	7.3
L	0	0.2	8.1
H	0	0.2	6.0
OIII	0	0.2	5.5

Guiding

- Find a suitable guide star
- Determine guide star exposure
- Always dither
- Specify minimum and maximum move

CCDAutoPilot Tools

- Automatic guide exposure
- Hot pixel filter
- Suggested dithering amount
- Additional guide options

Guiding

Guided Operation Unguided Operation

Dithering

Method Enhanced

Suggest

Max. Pixel Dither ± 1.3

Max. Guide Error ± 0.4

Max. Error Cycles 16

Auto Exposure

Enable Guider Auto Exposure ☒

Min. Guide Exp. 1.50

Max. Guide Exp. 4.50

Target Guide ADU 5,000

Use MaxIm Guide Star Detection ☐

Tune Hot Pixel Filter 0.30

Audible Alarm ☐ Guide Through Series Changes ☐

AO Centering None

Guided Operation Unguided Operation

Dithering

Method None

Suggest

Max. Arc-sec. Dither ± 2.0

Realign to Target Frequency (min.) 0

Meridian Flip

☒ Meridian Flip ☐ Meridian Abort

Track Past Meridian 0 min.

☐ Rotate on Flip

☐ Safety Slew

☐ Allow Sync after Flip

☒ Auto Guide Star Select after Flip

☐ Focus after Flip

☐ ReverseY After Flip

Session Planning

- Make maximum use of good nights
- Pre-define targets
- Maximize imaging data
- Flats every night

Target And Data Definition

- Frame target in TheSky
- Specify data series
- Introducing templates
- Start and end time per target
- Flat frames for each target

Session Planning

Session

M3 Ephemerides

45

° East

07:57 31 Oct

Equal

Transit

11:27 31 Oct

45

° West

14:57 31 Oct

Moon

Rise

11:43

Set

22:20

Sun

Set

17:34

Rise

06:40

Astronomical Twilight

▼

Dusk

18:57

Dawn

05:17

Dusk Flats

Darks & Bias Frames

Light Frames

Dark & Bias Frames

Dawn Flats

	Target	Active	R.A.	Dec.	PA	Loop_Series	Guide_Factor	First Start Time	First End Time
▶	M3	<input checked="" type="checkbox"/>	13 42 11.2	+28 22 34	0	1	0	08:28 27 Oct	11:28 27 Oct
	M42	<input checked="" type="checkbox"/>	05 35 05.4	-05 25 18	101.6	1	0	22:10 29 Oct	04:11 30 Oct
	M33	<input checked="" type="checkbox"/>	01 33 51.9	+30 39 29	253.2	1	0	04:11 30 Oct	10:12 30 Oct

Update

From FIT

Get

Mosaic

Loop Targets

1

Skip First Target Slew

☐

Series	Focus	Number	Time	Guide Time sec.	Delay Time sec.	Description
1 <input checked="" type="checkbox"/>	<input type="checkbox"/>	6		0.0	0	
▼	▼	▼		▼	▼	▼
2 <input checked="" type="checkbox"/>	<input type="checkbox"/>	6		0.0	0	
3 <input checked="" type="checkbox"/>	<input type="checkbox"/>	6	B	0.0	0	
4 <input type="checkbox"/>	<input type="checkbox"/>	6	L	0.0	0	
5 <input type="checkbox"/>	<input type="checkbox"/>	6	B	0.0	0	

Select Template To Load

Cluster

Cluster

ClusterDeep

GalaxyDeepStairCase

Shuffle

Staircase

Friday, August 23, 13

Goal-Oriented Imaging

- How many frames?
- Of what quality?
- File rejects separately

Data Assessment

Plate Solving | File Settings | Flat Settings | Time Estimates | Control Settings | Notifications | Wizards | Tools | Camera Options | Assess Data

☒ Enable Data Assessment

Data Assessment

☒ Use CCDInspector

Max. FWHM arc-sec.

Max. Aspect Ratio %

Max. Background ADU

☒ Move Failed Files To: ..

☐ Insert WCS into Light Frames

A Typical Result

Data Assessment Results					
	File Name	FWHM	Stars	Aspect Ratio	Background
20:56:13	Lum600s_N7331_237E.02814.fit	2.72 a-s	1661	8.0%	1996 ADU
21:07:17	Lum600s_N7331_237E.02815.fit	2.97 a-s	1480	8.0%	1982 ADU
21:18:25	Lum600s_N7331_237E.02816.fit	2.60 a-s	1885	9.0%	1974 ADU
21:31:48	Lum600s_N7331_237E.02817.fit	2.57 a-s	1915	13.0%	1967 ADU
21:43:02	Lum600s_N7331_237E.02818.fit	2.45 a-s	2045	13.0%	1958 ADU
21:54:11	Lum600s_N7331_237E.02819.fit	2.69 a-s	1808	11.0%	1944 ADU
22:05:24	Lum600s_N7331_237E.02820.fit	2.53 a-s	1933	12.0%	1915 ADU
22:18:49	Lum600s_N7331_237E.02821.fit	2.83 a-s	1599	11.0%	1884 ADU
22:29:56	Lum600s_N7331_237E.02822.fit	3.05 a-s	1438	13.0%	1869 ADU
22:40:57	Lum600s_N7331_237E.02823.fit	2.93 a-s	1552	13.0%	1853 ADU
22:52:05	Lum600s_N7331_237E.02824.fit	2.89 a-s	1557	13.0%	1845 ADU
23:06:58	Lum600s_N7331_237W.02825.fit	2.95 a-s	1517	12.0%	1827 ADU
23:28:26	Blu1200s_N7331_237W.02826.fit	2.78 a-s	1123	11.0%	1472 ADU
23:49:30	Blu1200s_N7331_237W.02827.fit	2.68 a-s	1214	10.0%	1467 ADU
00:10:38	Blu1200s_N7331_237W.02828.fit	2.79 a-s	1079	11.0%	1467 ADU
00:31:42	Blu1200s_N7331_237W.02829.fit	2.76 a-s	1079	13.0%	1466 ADU
00:53:11	Grn1200s_N7331_237W.02830.fit	2.71 a-s	1303	13.0%	1548 ADU
01:14:09	Grn1200s_N7331_237W.02831.fit	2.61 a-s	1368	14.0%	1547 ADU
01:35:08	Grn1200s_N7331_237W.02832.fit	2.69 a-s	1306	15.0%	1546 ADU
Moved to C:\Astro\20110923\Data Files\Failed\					
01:56:28	Grn1200s_N7331_237W.02833.fit	2.54 a-s	1339	14.0%	1547 ADU
02:17:52	Red1200s_N7331_237W.02834.fit	2.81 a-s	1177	12.0%	1471 ADU
02:39:00	Red1200s_N7331_237W.02835.fit	2.73 a-s	1240	14.0%	1476 ADU
03:00:09	Red1200s_N7331_237W.02836.fit	3.23 a-s	790	13.0%	1479 ADU
03:21:22	Red1200s_N7331_237W.02837.fit	3.50 a-s	693	15.0%	1484 ADU
Moved to C:\Astro\20110923\Data Files\Failed\					

Setup

Setup

Software In Use

Microsoft Windows NT 6.1.7601
Service Pack 1
Culture: en-US
Graphics: 96 x 96
.NET 4.0.30319.237
Free space available:
A:\ 0.0 GByte
WARNING: Low free space on A:\
C:\ 17.9 GByte
X:\ 3441.3 GByte
Y:\ 58.8 GByte
Z:\ 58.8 GByte
CCDAutoPilot Version 5.02.6
Evaluation Edition
TheSky used for mount control
TheSkyX 10.1.11, Build 5080
CCDSOft 5.00.210
TheSkyX Plate Solving
Cloud Sensor II
CCDIInspector 2.5.3

Setup

Session

Options

Run

Guiding

Focusing

Software

Camera CCDSOft

Telescope TheSkyX

Plate Solving TheSkyX

Focuser None

Rotator None

Weather Cloud Sensor

Dome None

Flat Light Source Sky

Use Control File ☐

Planning Only ☐

Disconnect

Equipment

Imager

Focal Length (mm) 535

Pixel Size (micron) 5.40

Unbinned Image Scale 2.08

☐ Use Sub-Frame Get

G2V Filters

R: R

G: G

B: B

Guider

Focal Length (mm) 535

Pixel Size (micron) 9.00

Unbinned Guider Scale 3.47

A/D Bits/Pixel 16

AO ☐ Binning 2

Method Unguided

Mount

Type Fork

Settling Time (sec.) 3.0

Guide Rate 0.5

Min. W Alt. (deg.) 5

Max E. Alt. (deg.) 90

Max W. Alt. (deg.) 90

☐ Double Slew

☐ Dec. Axis Release

☒ Precision Slew ☐ To Within 15 arc-sec. ☐ With Sync

Plate Solve Current Location

Initialize

☒ Test Rotator Direction

Options

Startup Data Acquisition Shutdown

☐ Begin Session at 21:00 22 Feb

☒ Begin Session -10 Min. Relative to Sunset Before (-). After (+)

☐ Open Dome

☒ Cooler Start Delay of 10 min.

☒ Set Imager Cooler -40 °C

☒ Set Guider Cooler -10 °C

☒ Wait for 10 min. for Coolers to Reach Setpoint(s)

☐ Run 1 arg

Startup Data Acquisition Shutdown

Dusk Flats

☒ Wait for Civil Dusk

Darks before Light Frames

☐ Run 2 arg

☐ Focus before Target Run Start

Light Frames

☒ Park Telescope

☐ Telescope Tracking Off

☐ Run 3 arg

☐ Close Dome before Darks and Dawn Flats

☐ Run 4 arg

Darks after Light Frames

☐ Run 5 arg

Dawn Flats

☐ Run 6 arg

Startup Data Acquisition Shutdown

☐ Abort Light and Dark Frames at Dawn

☒ Park Telescope after Dawn Flats

☐ Telescope Tracking Off after Dawn Flats

☐ Run 7 arg

☒ Park Rotator at 155.0

☐ Close Dome after Dawn Flats

☒ Raise Cooler Set Point by 30°C

☒ Run 8 C:\Astro_scripts\SlewTo arg

Settings

Plate Solving	File Settings	Flat Settings	Time Estimates	Control Settings	Notifications	Wizards	Tools	Camera Options	Assess Data
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G2V Calibration

R	Red	1.00
G	Green	1.00
B	Blue	1.00

☒ Auto Star Select

Measure Abort

Focus Offset Measurement

Reference Filter	Lum
Measurements/Filter	5

Measure Abort

Thanks and have a good
night's sleep while
imaging!

THIS IMAGE ACQUIRED WITH
**CCD
AutoPilot5** 