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# **panoptes-pocs Documentation**

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**Project PANOPTES**

**May 10, 2024**



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**WELCOME TO POCS DOCUMENTATION!**



## PROJECT PANOPTES

PANOPTES is an open source citizen science project designed to find [transiting exoplanets](#) with digital cameras. The goal of PANOPTES is to establish a global network of robotic cameras run by amateur astronomers and schools (or anyone!) in order to monitor, as continuously as possible, a very large number of stars. For more general information about the project, including the science case and resources for interested individuals, see the [project overview](#).





POCS (PANOPTES Observatory Control System) is the main software driver for a PANOPTES unit, responsible for high-level control of the unit.

For more information, see the full documentation at: <https://pocs.readthedocs.io>.

## 3.1 Install

### 3.1.1 POCS Environment

If you are running a PANOPTES unit then you will most likely want an entire PANOPTES environment, which includes the necessary tools for operation of a complete unit.

There is a bash shell script that will install an entire working POCS system on your computer. Some folks even report that it works on a Mac.

To install POCS via the script, open a terminal and enter (you may be prompted for your `sudo` password):

```
curl -fsSL https://install.projectpanoptes.org > install-pocs.sh
bash install-pocs.sh
```

Or using `wget`:

```
wget -qO- https://install.projectpanoptes.org > install-pocs.sh
bash install-pocs.sh
```

The install script will ask a few questions at the beginning of the process. If you are unsure of the answer the default is probably okay.

In addition to installing POCS, the install script will create the Config Server and Power Monitor services, which will automatically be restarted upon reboot of the computer.

### 3.1.2 POCS Module

If you want just the POCS module, for instance if you want to override it in your own OCS (see [Huntsman-POCS](#) for an example), then install via pip:

```
pip install panoptes-pocs
```

If you want the extra features, such as Google Cloud Platform connectivity, then use the extras options:

```
pip install "panoptes-pocs[google,focuser,testing]"
```

### Running POCS

POCS requires a few things to properly run:

1. A `panoptes-utils` config-server running to provide dynamic configuration.
2. An Observatory instance that has details about the location of a POCS unit (real or simulated), which hardware is available, etc.

A minimal working example with a simulated Observatory would be:

```
import os
from panoptes.utils.config.server import config_server
from panoptes.pocs.core import POCS

os.environ['PANDIR'] = '/var/panoptes'
conf_server = config_server('conf_files/pocs.yaml')
I 01-20 01:01:10.886 Starting panoptes-config-server with config_file='conf_files/pocs.
→yaml'
S 01-20 01:01:10.926 Config server Loaded 17 top-level items
I 01-20 01:01:10.928 Config items saved to flask config-server
I 01-20 01:01:10.934 Starting panoptes config server with localhost:6563

pocs = POCS.from_config(simulators=['all'])
I 01-20 01:01:20.408 Initializing PANOPTES unit - Generic PANOPTES Unit - Mauna Loa
→Observatory
I 01-20 01:01:20.419 Making a POCS state machine from panoptes
I 01-20 01:01:20.420 Loading state table: panoptes
S 01-20 01:01:20.485 Unit says: Hi there!
W 01-20 01:01:20.494 Scheduler not present
W 01-20 01:01:20.495 Cameras not present
W 01-20 01:01:20.496 Mount not present
I 01-20 01:01:20.497 Scheduler not present, cannot get current observation.

pocs.initialize()
W 01-20 01:01:28.386 Scheduler not present
W 01-20 01:01:28.388 Cameras not present
W 01-20 01:01:28.389 Mount not present
S 01-20 01:01:28.390 Unit says: Looks like we're missing some required hardware.
Out[10]: False
```

For a more realistic usage, see the full documentation at: <https://pocs.readthedocs.io>.

For actually deploying a PANOPTES unit, refer to the [Operating Guider](#).

## Developing POCS

See [Coding in PANOPTES](#)

## Testing

To test the software, you can use the standard `pytest` tool from the root of the directory.

By default all tests will be run. If you want to run one specific test, give the specific filename as an argument to `pytest`:

```
pytest tests/test_mount.py
```

## 3.2 Links

- PANOPTES Homepage: <https://www.projectpanoptes.org>
- Forum: <https://forum.projectpanoptes.org>
- Documentation: <https://pocs.readthedocs.io>
- Source Code: <https://github.com/panoptes/POCS>



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### 4.1 panoptes

#### 4.1.1 panoptes namespace

##### Subpackages

##### panoptes.pocs package

##### Subpackages

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##### Subpackages

##### panoptes.pocs.camera.gphoto package

##### Submodules

##### panoptes.pocs.camera.gphoto.base module

**class** panoptes.pocs.camera.gphoto.base.**AbstractGPhotoCamera**(\*arg, \*\*kwargs)

Bases: *AbstractCamera*, *ABC*

Abstract camera class that uses gphoto2 interaction.

##### Parameters

**config** (*Dict*) – Config key/value pairs, defaults to empty dict.

**command**(cmd: *List[str] | str*, check\_exposing: *bool* = *True*)

Run gphoto2 command.

**connect**()

##### property cooling\_power

Get current power level of the camera's image sensor cooling system (typically as a percentage of the maximum).

Note: this only needs to be implemented for cameras which have cooled image sensors, not for those that don't (e.g. DSLRs).

**get\_command\_result**(*timeout: float = 10*) → List[str] | None

Get the output from the command.

Accepts a *timeout* param for communicating with the process.

Returns a list of strings corresponding to the output from the gphoto2 camera or *None* if no command has been specified.

**get\_property**(*prop: str*) → str

Gets a property from the camera

**classmethod gphoto\_file\_download**(*port: str, filename\_pattern: str, only\_new: bool = True*)

Downloads (newer) files from the camera on the given port using the filename pattern.

**property is\_exposing**

True if an exposure is currently under way, otherwise False.

**load\_properties**() → dict

Load properties from the camera.

Reads all the configuration properties available via gphoto2 and returns as dictionary.

**process\_exposure**(*metadata, \*\*kwargs*)

Converts the CR2 to FITS then processes image.

**set\_properties**(*prop2index: Dict[str, int] = None, prop2value: Dict[str, str] = None*)

Sets a number of properties all at once, by index or value.

#### Parameters

- **prop2index** (*dict* or *None*) – A dict with keys corresponding to the property to be set and values corresponding to the index option.
- **prop2value** (*dict* or *None*) – A dict with keys corresponding to the property to be set and values corresponding to the literal value.

**set\_property**(*prop: str, val: str | int, is\_value: bool = False, is\_index: bool = False*)

Set a property on the camera.

#### Parameters

- **prop** (*str*) – The property to set.
- **val** (*str*, *int*) – The value to set the property to.
- **is\_value** (*bool*) – If True, then the value is a literal value. Default False.
- **is\_index** (*bool*) – If True, then the value is an index. Default False.

#### Raises

**ValueError** – If the property is not found.

**classmethod start\_tether**(*port, filename\_pattern: str = '%Y%m%dT%H%M%S.%C'*)

Start a tether for gphoto2 auto-download on given port using filename pattern.

**property target\_temperature**

Get current value of the target temperature for the camera's image sensor cooling control.

Note: this only needs to be implemented for cameras which have cooled image sensors, not for those that don't (e.g. DSLRs).

**property temperature**

Get current temperature of the camera's image sensor.

Note: this only needs to be implemented for cameras which can provided this information, e.g. those with cooled image sensors.

**property uid: str**

A six-digit serial number for the camera

**panoptes.pocs.camera.gphoto.canon module**

```
class panoptes.pocs.camera.gphoto.canon.Camera(readout_time: float = 1.0, file_extension: str = 'cr2',
                                                connect: bool = True, *args, **kwargs)
```

Bases: [AbstractGPhotoCamera](#)

**property bit\_depth**

ADC bit depth.

**connect()**

Connect to Canon DSLR.

Gets the serial number from the camera and sets various settings.

**property egain**

Image sensor gain in e-/ADU as reported by the camera.

```
classmethod get_shutterspeed_index(seconds: float, return_minimum: bool = False)
```

Looks up the appropriate shutterspeed setting for the given seconds.

If the given seconds does not match a set shutterspeed, the 'bulb' setting is returned.

**panoptes.pocs.camera.gphoto.remote module**

```
class panoptes.pocs.camera.gphoto.remote.Camera(endpoint: AnyHttpUrl = 'http://localhost:6565',
                                                *args, **kwargs)
```

Bases: [Camera](#)

A remote gphoto2 camera class.

```
command(cmd, endpoint: AnyHttpUrl = None)
```

Run the gphoto2 command remotely.

This assumes the remote camera service is running at the endpoint specified on the camera object or passed to the method.

```
get_command_result(timeout: float = 10) → List[str] | None
```

Get the output from the remote camera service.

**property is\_exposing**

True if an exposure is currently under way, otherwise False.

## Module contents

### panoptes.pocs.camera.simulator package

#### Submodules

### panoptes.pocs.camera.simulator.ccd module

```
class panoptes.pocs.camera.simulator.ccd.Camera(name='Simulated SDK camera', driver=<class
'panoptes.pocs.camera.simulator.ccd.SDKDriver'>,
target_temperature=<Quantity 0. deg_C>, *args,
**kwargs)
```

Bases: [AbstractSDKCamera](#), [Camera](#), [ABC](#)

#### connect()

Connect to camera simulator

The simulator merely marks the *connected* property.

#### property cooling\_enabled

Get current status of the camera's image sensor cooling system (enabled/disabled).

Note: this only needs to be implemented for cameras which have cooled image sensors, not for those that don't (e.g. DSLRs).

#### property cooling\_power

Get current power level of the camera's image sensor cooling system (typically as a percentage of the maximum).

Note: this only needs to be implemented for cameras which have cooled image sensors, not for those that don't (e.g. DSLRs).

#### property target\_temperature

Get current value of the target temperature for the camera's image sensor cooling control.

Note: this only needs to be implemented for cameras which have cooled image sensors, not for those that don't (e.g. DSLRs).

#### property temperature

Get current temperature of the camera's image sensor.

Note: this only needs to be implemented for cameras which can provided this information, e.g. those with cooled image sensors.

```
class panoptes.pocs.camera.simulator.ccd.SDKDriver(library_path=None, **kwargs)
```

Bases: [AbstractSDKDriver](#)

#### get\_SDK\_version()

Get the version of the SDK

#### get\_devices()

Get connected device UIDs and corresponding device nodes/handles/IDs.



## panoptes.pocs.camera.simulator.dslr module

**class** panoptes.pocs.camera.simulator.dslr.**Camera**(name='Simulated Camera', \*args, \*\*kwargs)

Bases: [AbstractCamera](#)

**property** bit\_depth

ADC bit depth.

**connect**()

Connect to camera simulator

The simulator merely marks the *connected* property.

**property** gain

Image sensor gain in e-/ADU as reported by the camera.

**take\_observation**(observation, headers=None, filename=None, \*args, \*\*kwargs)

Take an observation

**Gathers various header information, sets the file path, and calls**

*take\_exposure*. Also creates a *threading.Event* object and a *threading.Thread* object. The Thread calls *process\_exposure* after the exposure had completed and the Event is set once *process\_exposure* finishes.

### Parameters

- **observation** (*Observation*) – Object describing the observation
- **headers** (*dict* or *Header*, *optional*) – Header data to be saved along with the file.
- **filename** (*str*, *optional*) – pass a filename for the output FITS file to override the default file naming system.
- **blocking** (*bool*) – If method should wait for observation event to be complete before returning, default False.
- **\*\*kwargs** (*dict*) – Optional keyword arguments (*exptime*, *dark*)

### Returns

The metadata from the event.

### Return type

*dict*

## Module contents

### Submodules

## panoptes.pocs.camera.camera module

**class** panoptes.pocs.camera.camera.**AbstractCamera**(name='Generic Camera', model='simulator', port=None, primary=False, \*args, \*\*kwargs)

Bases: [PanBase](#)

Base class for all cameras.

**filter\_type**

Type of filter attached to camera. If a filterwheel is present this will return the `filterwheel.current_filter` property, otherwise it will return the value of the `filter_type` keyword argument, or if that argument was not given it will query the camera driver, e.g. 'M' for unfiltered monochrome camera, 'RGGB' for Bayer matrix colour camera.

**Type**`str`**focuser**

Focuser for the camera, default None.

**Type**``panoptes.pocs.focuser.AbstractFocuser`|None`**filter\_wheel**

Filter wheel for the camera, default None.

**Type**``panoptes.pocs.filterwheel.AbstractFilterWheel`|None`**uid**

Unique identifier of the camera.

**Type**`str`**is\_primary**

If this camera is the primary camera for the system, default False.

**Type**`bool`**model**

The model of camera, such as 'gphoto2', 'sbig', etc. Default 'simulator'.

**Type**`str`**name**

Name of the camera, default 'Generic Camera'.

**Type**`str`**port**

The port the camera is connected to, typically a usb device, default None.

**Type**`str`**temperature**

Current temperature of the image sensor.

**Type**`astropy.units.Quantity`**target\_temperature**

image sensor cooling target temperature.

**Type**

astropy.units.Quantity

**temperature\_tolerance**

tolerance for image sensor temperature.

**Type**

astropy.units.Quantity

**cooling\_enabled**

True if image sensor cooling is active.

**Type**

bool

**cooling\_power**

Current image sensor cooling power level in percent.

**Type**

astropy.unit.Quantity

**egain**

Image sensor gain in e-/ADU as reported by the camera.

**Type**

astropy.units.Quantity

**gain**

The gain setting of the camera (ZWO cameras only).

**Type**

int

**bitdepth**

ADC bit depth in bits.

**Type**

astropy.units.Quantity

**image\_type**

Image format of the camera, e.g. 'RAW16', 'RGB24' (ZWO cameras only).

**Type**

str

**timeout**

max time to wait after exposure before TimeoutError.

**Type**

astropy.units.Quantity

**readout\_time**

approximate time to readout the camera after an exposure.

**Type**

float

**file\_extension**

file extension used by the camera's image data, e.g. 'fits'

**Type**

str

**library\_path**

path to camera library, e.g. `‘/usr/local/lib/libfli.so’` (SBIG, FLI, ZWO)

**Type**

`str`

**properties**

A collection of camera properties as read from the camera.

**Type**

`dict`

**is\_connected**

True if camera is connected.

**Type**

`bool`

**is\_cooled\_camera**

True if camera has image sensor cooling capability.

**Type**

`bool`

**is\_temperature\_stable**

True if image sensor temperature is stable.

**Type**

`bool`

**is\_exposing**

True if an exposure is currently under way, otherwise False.

**Type**

`bool`

**is\_ready**

True if the camera is ready to take an exposure.

**Type**

`bool`

**can\_take\_internal\_darks**

True if the camera can take internal dark exposures.

**Type**

`bool`

**Notes**

The port parameter is not used by SBIG or ZWO cameras, and is deprecated for FLI cameras. For these cameras serial\_number should be passed to the constructor instead. For SBIG and FLI this should simply be the serial number engraved on the camera case, whereas for ZWO cameras this should be the 8 character ID string previously saved to the camera firmware. This can be done using ASICAP, or `panoptes.pocs.camera.libasi.ASIDriver.set_ID()`.

**autofocus**(*seconds=None, focus\_range=None, focus\_step=None, cutout\_size=None, keep\_files=None, take\_dark=None, merit\_function='vollath\_F4', merit\_function\_kwargs=None, mask\_dilations=None, coarse=False, make\_plots=None, blocking=False, \*args, \*\*kwargs*)

Focuses the camera using the specified merit function. Optionally performs a coarse focus to find the approximate position of infinity focus, which should be followed by a fine focus before observing.

#### Parameters

- **seconds** (*scalar, optional*) – Exposure time for focus exposures, if not specified will use value from config.
- **focus\_range** (*2-tuple, optional*) – Coarse & fine focus sweep range, in encoder units. Specify to override values from config.
- **focus\_step** (*2-tuple, optional*) – Coarse & fine focus sweep steps, in encoder units. Specify to override values from config.
- **cutout\_size** (*int, optional*) – Size of square central region of image to use, default 500 x 500 pixels.
- **keep\_files** (*bool, optional*) – If True will keep all images taken during focusing. If False (default) will delete all except the first and last images from each focus run.
- **take\_dark** (*bool, optional*) – If True will attempt to take a dark frame before the focus run, and use it for dark subtraction and hot pixel masking, default True.
- **merit\_function** (*str/callable, optional*) – Merit function to use as a focus metric, default `vollath_F4`.
- **merit\_function\_kwargs** (*dict or None, optional*) – Dictionary of additional keyword arguments for the merit function.
- **mask\_dilations** (*int, optional*) – Number of iterations of dilation to perform on the saturated pixel mask (determine size of masked regions), default 10
- **coarse** (*bool, optional*) – Whether to perform a coarse focus, otherwise will perform a fine focus. Default False.
- **(bool (make\_plots))** – Whether to write focus plots to images folder, default behaviour is to check the focuser `autofocus_make_plots` attribute.
- **optional** – Whether to write focus plots to images folder, default behaviour is to check the focuser `autofocus_make_plots` attribute.
- **blocking** (*bool, optional*) – Whether to block until autofocus complete, default False.

#### Returns

Event that will be set when autofocusing is complete

#### Return type

`threading.Event`

#### Raises

**ValueError** – If invalid values are passed for any of the focus parameters.

#### property `bit_depth`

ADC bit depth.

#### property `can_take_internal_darks`

True if the camera can take internal dark exposures. This will be true of cameras that have an internal mechanical shutter and can be commanded to keep that shutter closed during the exposure. For cameras that either lack a mechanical shutter or lack the option to keep it closed light must be kept out of the camera during dark exposures by other means, e.g. an opaque blank in a filterwheel, a lens cap, etc.

**abstract connect()**

**property cooling\_enabled**

Get current status of the camera's image sensor cooling system (enabled/disabled).

Note: this only needs to be implemented for cameras which have cooled image sensors, not for those that don't (e.g. DSLRs).

**property cooling\_power**

Get current power level of the camera's image sensor cooling system (typically as a percentage of the maximum).

Note: this only needs to be implemented for cameras which have cooled image sensors, not for those that don't (e.g. DSLRs).

**property egain**

Image sensor gain in e-/ADU as reported by the camera.

**property exposure\_error**

Error message from the most recent exposure or None, if there was no error.

**property file\_extension**

File extension for images saved by camera

**property filter\_type**

Image sensor filter type (e.g. 'RGGB') or name of the current filter (e.g. 'g2\_3')

**get\_cutout**(*seconds*, *file\_path*, *cutout\_size*, *keep\_file=False*, *\*args*, *\*\*kwargs*)

Takes an image and returns a thumbnail cutout.

Takes an image, grabs the data, deletes the FITS file and returns a cutout from the centre of the image.

**Parameters**

- **seconds** (*astropy.units.Quantity*) – exposure time, Quantity or numeric type in seconds.
- **file\_path** (*str*) – path to (temporarily) save the image file to.
- **cutout\_size** (*int*) – size of the square region of the centre of the image to return.
- **keep\_file** (*bool*, *optional*) – if True the image file will be deleted, if False it will be kept.
- **\*args** – passed to the *take\_exposure* method
- **\*\*kwargs** – passed to the *take\_exposure* method

**property has\_filterwheel**

Return True if the camera has a filterwheel, False if not.

**property has\_focuser**

Return True if the camera has a focuser, False if not.

**property is\_connected**

Is the camera available via gphoto2

**property is\_cooled\_camera**

True if camera has image sensor cooling capability

**property is\_exposing**

True if an exposure is currently under way, otherwise False.

**property is\_observing**

True if an observation is currently under, otherwise False.

**property is\_ready**

True if camera is ready to start another exposure, otherwise False.

**property is\_temperature\_stable**

True if image sensor temperature is stable, False if not.

See also: See *temperature\_tolerance* for more information about the temperature stability. An uncooled camera, or cooled camera with cooling disabled, will always return False.

**process\_exposure(metadata, \*\*kwargs)**

Processes the exposure.

This checks if the file exists and if so calls `_do_process_exposure`.

**Parameters**

**metadata** (*dict*) – Header metadata saved for the image.

**Raises**

**FileNotFoundError** – If the FITS file isn't at the specified location.

**property readiness**

Dictionary detailing the readiness of the camera system to take an exposure.

**property readout\_time**

Readout time for the camera in seconds

**take\_exposure**(*seconds=<Quantity 1. s>*, *filename=None*, *metadata=None*, *dark=False*, *blocking=False*, *timeout=<Quantity 10. s>*, *\*args*, *\*\*kwargs*) → [Thread](#)

Take an exposure for given number of seconds and saves to provided filename.

**Parameters**

- **seconds** (*u.second*, *optional*) – Length of exposure.
- **filename** (*str*, *optional*) – Image is saved to this filename.
- **metadata** (*dict*, *optional*) – Add key/value as FITS header. Does not support nested dicts.
- **dark** (*bool*, *optional*) – Exposure is a dark frame, default False. On cameras that support taking dark frames internally (by not opening a mechanical shutter) this will be done, for other cameras the light must be blocked by some other means. In either case setting dark to True will cause the *IMAGETYP* FITS header keyword to have value 'Dark Frame' instead of 'Light Frame'. Set dark to None to disable the *IMAGETYP* keyword entirely.
- **blocking** (*bool*, *optional*) – If False (default) returns immediately after starting the exposure, if True will block until it completes and file exists.
- **timeout** (*astropy.Quantity*) – The timeout to use for the exposure, default 10 seconds. The timeout gets added to the *seconds* and the *self.readout\_time* to get the total timeout for the exposure. If the exposure takes longer than this then a *panoptes.utils.error.Timeout* exception will be raised.

**Returns**

The readout thread, which joins when readout has finished.

**Return type**`threading.Thread`**Raises**

- **error.PanError** – If camera is not connected.
- **error.Timeout** – If the exposure takes longer than total *timeout* to complete.

**take\_observation**(*observation*, *headers=None*, *filename=None*, *blocking=False*, *\*\*kwargs*) → `dict`

Take an observation

**Gathers various header information, sets the file path, and calls**

*take\_exposure*. Also creates a *threading.Event* object and a *threading.Thread* object. The Thread calls *process\_exposure* after the exposure had completed and the Event is set once *process\_exposure* finishes.

**Parameters**

- **observation** (*Observation*) – Object describing the observation
- **headers** (*dict* or *Header*, *optional*) – Header data to be saved along with the file.
- **filename** (*str*, *optional*) – pass a filename for the output FITS file to override the default file naming system.
- **blocking** (*bool*) – If method should wait for observation event to be complete before returning, default False.
- **\*\*kwargs** (*dict*) – Optional keyword arguments (*exptime*, *dark*)

**Returns**

The metadata from the event.

**Return type**`dict`**property target\_temperature**

Get current value of the target temperature for the camera's image sensor cooling control.

Note: this only needs to be implemented for cameras which have cooled image sensors, not for those that don't (e.g. DSLRs).

**property temperature**

Get current temperature of the camera's image sensor.

Note: this only needs to be implemented for cameras which can provided this information, e.g. those with cooled image sensors.

**property temperature\_tolerance**

Get current value of the image sensor temperature tolerance.

If the image sensor temperature differs from the target temperature by more than the temperature tolerance then the temperature is not considered stable (by *is\_temperature\_stable*) and, for cooled cameras, *is\_ready* will report False.

**property uid**

Return unique identifier for camera.

**property waiting\_for\_readout**

True if the most recent readout has not finished. Should be set in *write\_fits*



**write\_fits**(*data*, *header*, *filename*)

Write the FITS file.

This is a thin-wrapper around the *fits\_utils.write\_fits* method that marks the readout as complete.

## panoptes.pocs.camera.fli module

**class** panoptes.pocs.camera.fli.**Camera**(*name*='FLI Camera', *target\_temperature*=<Quantity 25. deg\_C>, \*args, \*\*kwargs)

Bases: *AbstractSDKCamera*

**connect**()

Connect to FLI camera.

Gets a 'handle', serial number and specs/capabilities from the driver

**property cooling\_enabled**

Current status of the camera's image sensor cooling system (enabled/disabled).

Note: For FLI cameras this is always True, and cannot be set.

**property cooling\_power**

Current power level of the camera's image sensor cooling system (as a percentage of the maximum).

**property is\_exposing**

True if an exposure is currently under way, otherwise False

**property target\_temperature**

Current value of the target temperature for the camera's image sensor cooling control.

Can be set by assigning an astropy.units.Quantity.

**property temperature**

Current temperature of the camera's image sensor.

## panoptes.pocs.camera.libasi module

**class** panoptes.pocs.camera.libasi.**ASIDriver**(*library\_path*=None, \*\*kwargs)

Bases: *AbstractSDKDriver*

**close\_camera**(*camera\_ID*)

Close camera with given integer ID

**disable\_dark\_subtract**(*camera\_ID*)

Disable dark subtraction.

May need to call this as dark current subtraction settings persist in the registry on Windows.

**enable\_dark\_subtract**(*camera\_ID*, *dark\_file\_path*)

Enable dark subtraction (not implemented).

You almost certainly wouldn't want to use this as it only works with images taken in RGB8 format and only with dark frames saved as .BMP files. Far better to do dark subtraction in post-processing.

**get\_ID(*camera\_ID*)**

Get string ID from firmware for the camera with given integer ID

The saved ID is an array of 8 unsigned chars for some reason.

**get\_SDK\_version()**

Get the version of the ZWO ASI SDK

**get\_camera\_mode(*camera\_ID*)**

Get current trigger mode for camera with given integer ID.

**get\_camera\_property(*camera\_index*)**

Get properties of the camera with given index

**get\_camera\_property\_by\_id(*camera\_ID*)**

Get properties of the camera with a given integer ID.

**get\_camera\_supported\_mode(*camera\_ID*)**

Get supported trigger modes for camera with given integer ID.

**get\_control\_caps(*camera\_ID*)**

Gets the details of all the controls supported by the camera with given integer ID

**get\_control\_value(*camera\_ID*, *control\_type*)**

Gets the value of the control *control\_type* from camera with given integer ID

**get\_devices()**

Gets currently connected camera info.

**Returns**

**All currently connected camera serial numbers with corresponding integer camera IDs.**

**Return type**

`dict`

**Notes**

If a camera does not have a serial number it will attempt to fall back to string ID. Cameras with neither serial number nor string ID will be left out of the dictionary as they have no unique identifier.

**get\_dropped\_frames(*camera\_ID*)**

Get the number of dropped frames during video capture.

**get\_exposure\_data(*camera\_ID*, *width*, *height*, *image\_type*)**

Get image data from exposure on camera with given integer ID

**get\_exposure\_status(*camera\_ID*)**

Get status of current exposure on camera with given integer ID

**get\_gain\_offset(*camera\_ID*)**

Get pre-setting parameters.

**get\_num\_of\_connected\_cameras()**

Get the count of connected ASI cameras

**get\_num\_of\_controls**(*camera\_ID*)

Gets the number of control types supported by the camera with given integer ID

**get\_product\_ids**()

Get product IDs of cameras supported by the SDK.

**get\_roi\_format**(*camera\_ID*)

Get the ROI size and image format setting for camera with given integer ID

**get\_serial\_number**(*camera\_ID*)

Get serial number of the camera with given integer ID.

The serial number is an array of 8 unsigned chars, the same as string ID, but it is interpreted differently. It is displayed in ASICAP as a 16 digit hexadecimal number, so we will convert it the same 16 character string representation.

**get\_start\_position**(*camera\_ID*)

Get position of the upper left corner of the ROI for camera with given integer ID

**Parameters**

**camera\_ID** (*int*) – integer ID of the camera

**Returns**

**x, y coordinates of the upper left**

corner of the ROI. Note, these are in binned pixels.

**Return type**

(astropy.units.Quantity, astropy.units.Quantity)

**get\_trigger\_output\_io\_conf**(*camera\_ID*)

Get external trigger configuration of the camera with given integer ID.

**get\_video\_data**(*camera\_ID*, *width*, *height*, *image\_type*, *timeout*)

Get the image data from the next available video frame

**init\_camera**(*camera\_ID*)

Initialise camera with given integer ID

**open\_camera**(*camera\_ID*)

Open camera with given integer ID

**pulse\_guide\_off**(*camera\_ID*, *direction*)

Turn off PulseGuide on ST4 port of given camera in given direction.

**pulse\_guide\_on**(*camera\_ID*, *direction*)

Turn on PulseGuide on ST4 port of given camera in given direction.

**send\_soft\_trigger**(*camera\_ID*, *start\_stop\_signal*)

Send out a soft trigger on camera with given integer ID.

**set\_ID**(*camera\_ID*, *string\_ID*)

Save string ID to firmware of camera with given integer ID

The saved ID is an array of 8 unsigned chars for some reason. To preserve some sanity this method takes an 8 byte UTF-8 string as input.

**set\_camera\_mode**(*camera\_ID*, *mode\_name*)

Set trigger mode for camera with given integer ID.

**set\_control\_value**(*camera\_ID, control\_type, value*)

Sets the value of the control control\_type on camera with given integer ID

**set\_roi\_format**(*camera\_ID, width, height, binning, image\_type*)

Set the ROI size and image format settings for the camera with given integer ID

**set\_start\_position**(*camera\_ID, start\_x, start\_y*)

Set position of the upper left corner of the ROI for camera with given integer ID

**set\_trigger\_output\_io\_conf**(*camera\_ID, pin, pin\_high, delay, duration*)

Set external trigger configuration of the camera with given integer ID.

**start\_exposure**(*camera\_ID*)

Start exposure on the camera with given integer ID

**start\_video\_capture**(*camera\_ID*)

Start video capture mode on camera with given integer ID

**stop\_exposure**(*camera\_ID*)

Cancel current exposure on camera with given integer ID

**stop\_video\_capture**(*camera\_ID*)

Stop video capture mode on camera with given integer ID

**class** panoptes.pocs.camera.libasi.**BayerPattern**(*value, names=None, \*values, module=None, qualname=None, type=None, start=1, boundary=None*)

Bases: [IntEnum](#)

Bayer filter type

**BG** = 1

**GB** = 3

**GR** = 2

**RG** = 0

**class** panoptes.pocs.camera.libasi.**CameraInfo**

Bases: [Structure](#)

Camera info structure

**bayer\_pattern**

Structure/Union member

**bit\_depth**

Structure/Union member

**camera\_ID**

Structure/Union member

**e\_per\_adu**

Structure/Union member

**has\_ST4\_port**

Structure/Union member

**has\_cooler**

Structure/Union member

**has\_mechanical\_shutter**

Structure/Union member

**is\_USB3\_camera**

Structure/Union member

**is\_USB3\_host**

Structure/Union member

**is\_color\_camera**

Structure/Union member

**is\_trigger\_camera**

Structure/Union member

**max\_height**

Structure/Union member

**max\_width**

Structure/Union member

**name**

Structure/Union member

**pixel\_size**

Structure/Union member

**supported\_bins**

Structure/Union member

**supported\_video\_format**

Structure/Union member

**unused**

Structure/Union member

```
class panoptes.pocs.camera.libasi.CameraMode(value, names=None, *values, module=None,
                                              qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

Camera status

**END** = -1

**NORMAL** = 0

**TRIG\_FALL\_EDGE** = 3

**TRIG\_HIGH\_LEVEL** = 5

**TRIG\_LOW\_LEVEL** = 6

**TRIG\_RISE\_EDGE** = 2

**TRIG\_SOFT\_EDGE** = 1

**TRIG\_SOFT\_LEVEL = 4**

**class** panoptes.pocs.camera.libasi.**ControlCaps**

Bases: `Structure`

Structure for caps (limits) on allowable parameter values for each camera control

**control\_type**

Structure/Union member

**default\_value**

Structure/Union member

**description**

Structure/Union member

**is\_auto\_supported**

Structure/Union member

**is\_writable**

Structure/Union member

**max\_value**

Structure/Union member

**min\_value**

Structure/Union member

**name**

Structure/Union member

**unused**

Structure/Union member

**class** panoptes.pocs.camera.libasi.**ControlType**(*value, names=None, \*values, module=None, qualname=None, type=None, start=1, boundary=None*)

Bases: `IntEnum`

Control types

**ANTI\_DEW\_HEATER = 21**

**AUTO\_MAX\_BRIGHTNESS = 12**

**AUTO\_MAX\_EXP = 11**

**AUTO\_MAX\_GAIN = 10**

**AUTO\_TARGET\_BRIGHTNESS = 12**

**BANDWIDTHOVERLOAD = 6**

**BRIGHTNESS = 5**

**COOLER\_ON = 17**

**COOLER\_POWER\_PERC = 15**

**EXPOSURE = 1**

```
FAN_ON = 19
FLIP = 9
GAIN = 0
GAMMA = 2
HARDWARE_BIN = 13
HIGH_SPEED_MODE = 14
MONO_BIN = 18
OFFSET = 5
OVERCLOCK = 7
PATTERN_ADJUST = 20
TARGET_TEMP = 16
TEMPERATURE = 8
WB_B = 4
WB_R = 3
```

```
class panoptes.pocs.camera.libasi.ErrorCode(value, names=None, *values, module=None,
                                             qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

Error codes

```
BUFFER_TOO_SMALL = 13
CAMERA_CLOSED = 4
CAMERA_REMOVED = 5
END = 18
EXPOSURE_IN_PROGRESS = 15
GENERAL_ERROR = 16
INVALID_CONTROL_TYPE = 3
INVALID_FILEFORMAT = 7
INVALID_ID = 2
INVALID_IMGTYPE = 9
INVALID_INDEX = 1
INVALID_MODE = 17
INVALID_PATH = 6
INVALID_SEQUENCE = 12
```

**INVALID\_SIZE** = 8

**OUTOF\_BOUNDARY** = 10

**SUCCESS** = 0

**TIMEOUT** = 11

**VIDEO\_MODE\_ACTIVE** = 14

```
class panoptes.pocs.camera.libasi.ExposureStatus(value, names=None, *values, module=None,
                                                  qualname=None, type=None, start=1,
                                                  boundary=None)
```

Bases: `IntEnum`

Exposure status codes

**FAILED** = 3

**IDLE** = 0

**SUCCESS** = 2

**WORKING** = 1

```
class panoptes.pocs.camera.libasi.FlipStatus(value, names=None, *values, module=None,
                                              qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

Flip status

**BOTH** = 3

**HORIZ** = 1

**NONE** = 0

**VERT** = 2

```
class panoptes.pocs.camera.libasi.GuideDirection(value, names=None, *values, module=None,
                                                  qualname=None, type=None, start=1,
                                                  boundary=None)
```

Bases: `IntEnum`

Guider direction

**EAST** = 2

**NORTH** = 0

**SOUTH** = 1

**WEST** = 3

```
class panoptes.pocs.camera.libasi.ID
```

Bases: `Structure`

**id**

Structure/Union member



```
class panoptes.pocs.camera.libasi.ImgType(value, names=None, *values, module=None,
                                          qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

Supported video format

**END** = -1

**RAW16** = 2

**RAW8** = 0

**RGB24** = 1

**Y8** = 3

```
class panoptes.pocs.camera.libasi.SupportedMode
```

Bases: `Structure`

Array of supported CameraModes, terminated with CameraMode.END

**modes**

Structure/Union member

```
class panoptes.pocs.camera.libasi.TrigOutput(value, names=None, *values, module=None,
                                          qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

External trigger output.

**NONE** = -1

**PINA** = 0

**PINB** = 1

## panoptes.pocs.camera.libfli module

Low level interface to the FLI library

Reproduces in Python (using ctypes) the C interface provided by FLI's library.

```
class panoptes.pocs.camera.libfli.FLIDriver(library_path=None, **kwargs)
```

Bases: `AbstractSDKDriver`

**FLIClose**(handle)

Close a handle to an FLI device.

**Parameters**

**handle** (`ctypes.c_long`) – handle to close

**FLIExposeFrame**(handle)

Expose a frame for a given camera.

This function exposes a frame according the settings (image area, exposure time, binning, etc.) of the camera. The settings must have been previously set to valid values using the appropriate FLISet\* methods. This function is non-blocking and returns once the exposure has stated.

**Parameters**

**handle** (`ctypes.c_long`) – handle of the camera to start the exposure on.

**FLIGetArrayArea**(*handle*)

Get the array area of the give camera.

This function finds the total area of the CCD array for a given camera. This area is specified in terms of an upper left point and a lower right point.

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the camera to get the array area of.

**FLIGetCoolerPower**(*handle*)

Get the cooler power level for a given camera.

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the camera to get the cooler power of.

**Returns**

cooler power, in percent.

**Return type**

float

**FLIGetExposureStatus**(*handle*)

Get the remaining exposure time of a given camera.

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the camera to get the remaining exposure time of.

**Returns**

remaining exposure time

**Return type**

astropy.units.Quantity

**FLIGetFWRevision**(*handle*)

Get firmware revision of a given device

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the camera device to get the firmware revision of.

**Returns**

firmware revision of the camera

**Return type**

int

**FLIGetHWRevision**(*handle*)

Get hardware revision of a given device

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the camera device to get the hardware revision of.

**Returns**

hardware revision of the cameras

**Return type**

int

**FLIGetModel**(*handle*)

Get the model of a given device.

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the device to get the model of.

**Returns**

model of the device

**Return type**

string

**FLIGetPixelSize(*handle*)**

Get the dimensions of a pixel in the array of a given device.

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the device to find the pixel size of.

**Returns**

(x, y) dimensions of a pixel.

**Return type**

astropy.units.Quantity

**FLIGetSerialString(*handle*)**

Get the serial string of a given camera.

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the camera device to get the serial strong of.

**Returns**

serial string of the camera

**Return type**

string

**FLIGetTemperature(*handle*)**

Get the temperature of a given camera.

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the camera device to get the temperature of.

**Returns**

temperature of the camera cold finger in degrees Celsius

**Return type**

astropy.units.Quantity

**FLIGetVisibleArea(*handle*)**

Get the visible array area of the give camera.

This function finds the visible area of the CCD array for a given camera. This area is specified in terms of an upper left point and a lower right point.

**Parameters**

**handle** (*ctypes.c\_long*) – handle of the camera to get the array area of.

**FLIGrabFrame(*handle*, *width*, *height*)**

Grabs an image frame from a given camera.

This function grabs the entire image frame from the specified camera and returns it as a numpy array. The width and height of the image must be specified. The width and height should be consistent with the call to FLISetImageArea() that preceded the call to FLIExposeFrame(). This function should not be called until the exposure is complete, which can be confirmed with FLIGetExposureStatus().

**Parameters**

- **handle** (*ctypes.c\_long*) – handle of the camera to grab a frame from.

- **width** (*int*) – width of the image frame in pixels
- **height** (*int*) – height of the image frame in pixels

**Returns**

image from the camera

**Return type**

`numpy.ndarray`

**FLIGrabRow**(*handle*, *width*)

Grabs a row of image data from a given camera.

This function grabs the next available row of image data from the specified camera and returns it as a numpy array. The width of the row must be specified. The width should be consistent with the call to `FLISelectImageArea()` that preceded the call to `FLIExposeFrame()`. This function should not be called until the exposure is complete, which can be confirmed with `FLIGetExposureStatus`.

**Parameters**

- **handle** (*ctypes.c\_long*) – handle of the camera to grab a row from.
- **width** (*int*) – width of the image row in pixels

**Returns**

row of image data

**Return type**

`numpy.ndarray`

**FLIList**(*interface\_type*=2, *device\_type*=256)

List available devices.

This function returns a list of available FLI devices, including the device port and model name.

**Parameters**

- **interface\_type** (*int*, *optional*) – interface to search for connected devices. Valid values are `libfli.FLIDOMAIN_USB` (default), `FLIDOMAIN_PARALLEL_PORT`, `FLIDOMAIN_SERIAL`, `FLIDOMAIN_SERIAL_1200`, `FLIDOMAIN_SERIAL_19200`, `FLIDOMAIN_INET`.
- **device\_types** (*int*, *optional*) – device type to search for. Valid values are `libfli.FLIDEVICE_CAMERA` (default), `FLIDEVICE_FILTERWHEEL`, `FLIDEVICE_HS_FILTERWHEEL`, `FLIDEVICE_FOCUSER`, `FLIDEVICE_ENUMERATE_BY_CONNECTION`, `FLIDEVICE_RAW`.

**Returns**

(port, model name) for each available device

**Return type**

list of tuples

**FLIOpen**(*port*, *interface\_type*=2, *device\_type*=256)

Get a handle to an FLI device.

This function requires the port, interface type and device type of the requested device. Valid ports can be obtained with the `FLIList()` method.

**Parameters**

- **port** (*str*) – port that the device is connected to, e.g. `/dev/fliusb0`

- **interface\_type** (*int*, *optional*) – interface type of the requested device. Valid values are libfli.FLIDOMAIN\_USB (default), FLIDOMAIN\_PARALLEL\_PORT, FLIDOMAIN\_SERIAL, FLIDOMAIN\_SERIAL\_1200, FLIDOMAIN\_SERIAL\_19200, FLIDOMAIN\_INET.
- **device\_type** (*int*, *optional*) – device type of the requested device. Valid values are libfli.FLIDEVICE\_CAMERA (default), FLIDEVICE\_FILTERWHEEL, FLIDEVICE\_HS\_FILTERWHEEL, FLIDEVICE\_FOCUSER, FLIDEVICE\_ENUMERATE\_BY\_CONNECTION, FLIDEVICE\_RAW.

**Returns**

an opaque handle used by library functions to refer to FLI hardware

**Return type**

`ctypes.c_long`

**FLISetExposureTime**(*handle*, *exposure\_time*)

Set the exposure time for a camera.

**Parameters**

- **handle** (`ctypes.c_long`) – handle of the camera to set the exposure time of.
- **exposure\_time** (*u.Quantity*) – required exposure time. A simple numeric type can be given instead of a Quantity, in which case the units are assumed to be seconds.

**FLISetFrameType**(*handle*, *frame\_type*)

Set the frame type for a given camera.

**Parameters**

- **handle** (`ctypes.c_long`) – handle of the camera to set the frame type of.
- **frame\_type** (*int*) – frame type. Valid values are libfli.FLI\_FRAME\_TYPE\_NORMAL,
- **FLI\_FRAME\_TYPE\_DARK**
- **FLI\_FRAME\_TYPE\_FLOOD**
- **FLI\_FRAME\_TYPE\_RBI\_FLUSH**.

**FLISetHBin**(*handle*, *bin\_factor*)

Set the horizontal bin factor for a given camera.

**Parameters**

- **handle** (`ctypes.c_long`) – handle of the camera to set the horizontal bin factor for.
- **bin\_factor** (*int*) – horizontal bin factor. The valid range is from 1 to 16 inclusive.

**FLISetImageArea**(*handle*, *upper\_left*, *lower\_right*)

Set the image area for a given camera.

This function sets the image area to an area specified in terms of an upperleft point and a lower right point. Note that the lower right point coordinate must take into account the horizontal and vertical bin factor settings, but the upper left coordinate is absolute.

**Parameters**

- **handle** (`ctypes.c_long`) – handle of the camera to set the image area of.
- **upper\_left** (*int*, *int*) – (x, y) coordinate of upper left point
- **lower\_right** (*int*, *int*) – (x, y) coordinate of lower right point

**FLISetNFlushes**(*handle*, *n\_flushes*)

Set the number of flushes for a given camera.

This function sets the number of the times the CCD array of the camera is flushed before exposing a frame. Some FLI cameras support background flushing. Background flushing continuously flushes the CCD eliminating the need for pre-exposure flushings.

**Parameters**

- **handle** (*ctypes.c\_long*) – handle of the camera to set the number of flushes for.
- **n\_flushes** (*int*) – number of times to flush the CCD array before an exposure. The valid range is from 0 to 16 inclusive.

**FLISetTemperature**(*handle*, *temperature*)

Set the temperature of a given camera.

**Parameters**

- **handle** (*ctypes.c\_long*) – handle of the camera device to set the temperature of.
- **temperature** (*astropy.units.Quantity*) – temperature to set the cold finger of the camera to. A simple numeric type can be given instead of a Quantity, in which case the units are assumed to be degrees Celsius.

**FLISetVBin**(*handle*, *bin\_factor*)

Set the vertical bin factor for a given camera.

**Parameters**

- **handle** (*ctypes.c\_long*) – handle of the camera to set the vertical bin factor for.
- **bin\_factor** (*int*) – vertical bin factor. The valid range is from 1 to 16 inclusive.

**get\_SDK\_version()**

Get the version of the SDK

**get\_devices()**

Gets currently connected camera info.

**Returns**

All currently connected camera serial numbers with corresponding device nodes.

**Return type**

dict

**panoptes.pocs.camera.libfliconstants module****panoptes.pocs.camera.sbig module**

```
class panoptes.pocs.camera.sbig.Camera(name='SBIG Camera', *args, **kwargs)
```

Bases: *AbstractSDKCamera*

**connect()**

Connect to SBIG camera.

Gets a 'handle', serial number and specs/capabilities from the driver

**property cooling\_enabled**

Current status of the camera's image sensor cooling system (enabled/disabled).

Can be set by assigning a bool.

**property cooling\_power**

Current power level of the camera's image sensor cooling system (as a percentage of the maximum).

**property egain**

Image sensor gain in e-/ADU as reported by the camera.

**property is\_exposing**

True if an exposure is currently under way, otherwise False

**property target\_temperature**

Current value of the target temperature for the camera's image sensor cooling control.

Can be set by assigning an `astropy.units.Quantity`.

**property temperature**

Current temperature of the camera's image sensor.

## panoptes.pocs.camera.sbigudrv module

Low level interface to the SBIG Universal Driver/Library.

Reproduces in Python (using ctypes) the C interface provided by SBIG's shared library, i.e. 1 function that does 72 different things selected by passing an integer as the first argument. This is basically a direct translation of the enums and structs defined in the library C-header to Python dicts and ctypes.Structures, plus a class (SBIGDriver) to load the library and call the single command function (SBIGDriver.\_send\_command()).

```
class panoptes.pocs.camera.sbigudrv.CFWCommand(value, names=None, *values, module=None,  
                                              qualname=None, type=None, start=1,  
                                              boundary=None)
```

Bases: `IntEnum`

Filter wheel command enum

**CLOSE\_DEVICE** = 5

**GET\_INFO** = 3

**GOTO** = 1

**INIT** = 2

**OPEN\_DEVICE** = 4

**QUERY** = 0

```
class panoptes.pocs.camera.sbigudrv.CFWError(value, names=None, *values, module=None,  
                                             qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

Filter wheel errors enum

**BAD\_COMMAND** = 2

```
BAD_MODEL = 5
BUSY = 1
CAL_ERROR = 3
DEVICE_NOT_CLOSED = 6
DEVICE_NOT_OPEN = 7
I2C_ERROR = 8
MOTOR_TIMEOUT = 4
NONE = 0
```

```
class panoptes.pocs.camera.sbigudrv.CFWGetInfoSelect(value, names=None, *values, module=None,
                                                    qualname=None, type=None, start=1,
                                                    boundary=None)
```

Bases: `IntEnum`

Filter wheel get info select enum

```
CAL_DATA = 1
DATA_REGISTERS = 2
FIRMWARE_VERSION = 0
```

```
class panoptes.pocs.camera.sbigudrv.CFWModelSelect(value, names=None, *values, module=None,
                                                    qualname=None, type=None, start=1,
                                                    boundary=None)
```

Bases: `IntEnum`

Filter wheel model selection enum

```
AUTO = 6
CFW10 = 8
CFW10_SERIAL = 9
CFW1603 = 13
CFW2 = 1
CFW402 = 5
CFW5 = 2
CFW6A = 7
CFW8 = 3
CFW9 = 10
CFWL = 4
CFWL8 = 11
```



**CFWL8G** = 12

**FW5\_8300** = 15

**FW5\_STF\_DETENT** = 19

**FW5\_STX** = 14

**FW7\_STX** = 17

**FW8\_8300** = 16

**FW8\_STT** = 18

**UNKNOWN** = 0

**class** panoptes.pocs.camera.sbigudrv.CFWParams

Bases: Structure

ctypes Structure used to hold the parameters for the CFW (colour filter wheel) command

**cfwCommand**

Structure/Union member

**cfwModel**

Structure/Union member

**cfwParam1**

Structure/Union member

**cfwParam2**

Structure/Union member

**inLength**

Structure/Union member

**inPtr**

Structure/Union member

**outLength**

Structure/Union member

**outPtr**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.CFWResults

Bases: Structure

ctypes Structure used to hold the results from the CFW (colour filter wheel) command

**cfwError**

Structure/Union member

**cfwModel**

Structure/Union member

**cfwPosition**

Structure/Union member

**cfwResults1**

Structure/Union member

**cfwResults2**

Structure/Union member

**cfwStatus**

Structure/Union member

```
class panoptes.pocs.camera.sbigudrv.CFWStatus(value, names=None, *values, module=None,
                                              qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

Filter wheel status enum

**BUSY = 2**

**IDLE = 1**

**UNKNOWN = 0**

```
class panoptes.pocs.camera.sbigudrv.EndExposureParams
```

Bases: `Structure`

ctypes Structure to hold the parameters for the End Exposure command.

**ccd**

Structure/Union member

```
class panoptes.pocs.camera.sbigudrv.EndReadoutParams
```

Bases: `Structure`

ctypes Structure to hold the parameters for the End Readout Params.

**ccd**

Structure/Union member

```
class panoptes.pocs.camera.sbigudrv.EstablishLinkParams
```

Bases: `Structure`

ctypes Structure to hold the parameters for the Establish Link command.

**sbigUseOnly**

Structure/Union member

```
class panoptes.pocs.camera.sbigudrv.EstablishLinkResults
```

Bases: `Structure`

ctypes Structure to hold the results from the Establish Link command.

**cameraType**

Structure/Union member

```
class panoptes.pocs.camera.sbigudrv.GetCCDInfoParams
```

Bases: `Structure`

ctypes Structure to hold the parameters for the Get CCD Info command, used obtain the details & capabilities of the connected camera.

**request**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.GetCCDInfoResults0

Bases: Structure

ctypes Structure to hold the results from the Get CCD Info command when used with requests 'CCD\_INFO\_IMAGING' or 'CCD\_INFO\_TRACKING'.

The firmwareVersion field is 4 digit binary coded decimal of the form XX.XX.

**cameraType**

Structure/Union member

**firmwareVersion**

Structure/Union member

**name**

Structure/Union member

**readoutInfo**

Structure/Union member

**readoutModes**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.GetCCDInfoResults2

Bases: Structure

ctypes Structure to hold the results from the Get CCD Info command when used with request 'CCD\_INFO\_EXTENDED'.

**badColumns**

Structure/Union member

**columns**

Structure/Union member

**imagingABG**

Structure/Union member

**serialNumber**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.GetCCDInfoResults4

Bases: Structure

ctypes Structure to hold the results from the Get CCD Info command when used with requests 'CCD\_INFO\_EXTENDED2\_IMAGING' or 'CCD\_INFO\_EXTENDED2\_TRACKING'.

The capabilitiesBits is a bitmap, yay.

**capabilities\_b0**

Structure/Union member

**capabilities\_b1**

Structure/Union member

**capabilities\_b2**

Structure/Union member

**capabilities\_b3**

Structure/Union member

**capabilities\_b4**

Structure/Union member

**capabilities\_b5**

Structure/Union member

**capabilities\_unused**

Structure/Union member

**dumpExtra**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.GetCCDInfoResults6**

Bases: Structure

ctypes Structure to hold the results from the Get CCD Info command when used with the request 'CCD\_INFO\_EXTENDED3'.

The sbigudrv.h C header says there should be three bitmask fields, each of type ulong, which would be 64 bits on this platform (OS X), BUT trial and error has determined they're actually 32 bits long.

**camera\_b0**

Structure/Union member

**camera\_b1**

Structure/Union member

**camera\_unused**

Structure/Union member

**ccd\_b0**

Structure/Union member

**ccd\_b1**

Structure/Union member

**ccd\_unused**

Structure/Union member

**extraBits**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.GetDriverControlParams**

Bases: Structure

ctypes Structure to hold the parameters for the Get Driver Control command, used to query the value of a specific driver control parameter.

**controlParameter**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.GetDriverControlResults**

Bases: Structure

ctypes Structure to hold the result from the Get Driver Control command, used to query the value of a specific driver control parameter

**controlValue**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.GetDriverHandleResults

Bases: Structure

ctypes Structure to hold the results from the Get Driver Handle command. The handle is the camera ID used when switching control between connected cameras with the Set Driver Handle command.

**handle**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.GetDriverInfoParams

Bases: Structure

ctypes Structure used to hold the parameters for the Get Driver Info command

**request**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.GetDriverInfoResults0

Bases: Structure

ctypes Structure used to hold the results from the Get Driver Info command

**maxRequest**

Structure/Union member

**name**

Structure/Union member

**version**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.GetLinkStatusResults

Bases: Structure

ctypes Structure to hold the results from the Get Link Status command.

**baseAddress**

Structure/Union member

**cameraType**

Structure/Union member

**comFailed**

Structure/Union member

**comTotal**

Structure/Union member

**linkEstablished**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.OpenDeviceParams

Bases: Structure

ctypes Structure to hold the parameters for the Open Device command.

**deviceType**

Structure/Union member

**ipAddress**

Structure/Union member

**lptBaseAddress**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.QueryCommandStatusParams**

Bases: Structure

ctypes Structure to hold the parameters for the Query Command Status command.

**command**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.QueryCommandStatusResults**

Bases: Structure

ctypes Structure to hold the results from the Query Command Status command.

**status**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.QueryTemperatureStatusParams**

Bases: Structure

ctypes Structure used to hold the parameters for the Query Temperature Status command.

**request**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.QueryTemperatureStatusResults**

Bases: Structure

ctypes Structure used to hold the results from the Query Temperature Status command (standard version).

**ambientThermistor**

Structure/Union member

**ccdSetpoint**

Structure/Union member

**ccdThermistor**

Structure/Union member

**enabled**

Structure/Union member

**power**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.QueryTemperatureStatusResults2**

Bases: Structure

ctypes Structure used to hold the results from the Query Temperature Status command (extended version).

**ambientTemperature**

Structure/Union member

**ccdSetpoint**

Structure/Union member

**coolingEnabled**

Structure/Union member

**externalTrackingCCDPower**

Structure/Union member

**externalTrackingCCDTemperature**

Structure/Union member

**fanEnabled**

Structure/Union member

**fanPower**

Structure/Union member

**fanSpeed**

Structure/Union member

**heatsinkTemperature**

Structure/Union member

**imagingCCDPower**

Structure/Union member

**imagingCCDTemperature**

Structure/Union member

**trackingCCDPower**

Structure/Union member

**trackingCCDSetpoint**

Structure/Union member

**trackingCCDTemperature**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.**QueryUSBInfo**

Bases: Structure

ctypes (Sub-)Structure used to hold details of individual cameras returned by 'CC\_QUERY\_USB' command

**cameraFound**

Structure/Union member

**cameraType**

Structure/Union member

**name**

Structure/Union member

**serialNumber**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.**QueryUSBResults**

Bases: Structure

ctypes Structure used to hold the results from 'CC\_QUERY\_USB' command (max 4 cameras).

**camerasFound**

Structure/Union member

**usbInfo**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.QueryUSBResults2**

Bases: Structure

ctypes Structure used to hold the results from 'CC\_QUERY\_USB2' command (max 8 cameras).

**camerasFound**

Structure/Union member

**usbInfo**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.QueryUSBResults3**

Bases: Structure

ctypes Structure used to hold the results from 'CC\_QUERY\_USB3' command (max 24 cameras).

**camerasFound**

Structure/Union member

**usbInfo**

Structure/Union member

**class panoptes.pocs.camera.sbigudrv.ReadoutInfo**

Bases: Structure

ctypes Structure to store details of an individual readout mode. An array of up to 20 of these will be returned as part of the GetCCDInfoResults0 struct when the Get CCD Info command is used with request 'CCD\_INFO\_IMAGING'.

The gain field is a 4 digit Binary Coded Decimal (yes, really) of the form XX.XX, in units of electrons/ADU.

The pixel\_width and pixel\_height fields are 6 digit Binary Coded Decimals for the form XXXXXX.XX in units of microns, helpfully supporting pixels up to 1 metre across.

**gain**

Structure/Union member

**height**

Structure/Union member

**mode**

Structure/Union member

**pixelHeight**

Structure/Union member

**pixelWidth**

Structure/Union member

**width**

Structure/Union member



**class** panoptes.pocs.camera.sbigudrv.ReadoutLineParams

Bases: Structure

ctypes Structure to hold the parameters for the Readout Line command.

**ccd**

Structure/Union member

**pixelLength**

Structure/Union member

**pixelStart**

Structure/Union member

**readoutMode**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.SBIGDriver(*library\_path=None, retries=1, \*\*kwargs*)

Bases: [AbstractSDKDriver](#)

**cfw\_get\_info**(*handle, model='AUTO'*)

Get info from the colour filter wheel

This will return the usual status information plus the firmware version and the number of filter wheel positions.

#### Parameters

- **handle** (*int*) – handle of the camera that the filter wheel is connected to.
- **model** (*str, optional*) – Model of the filter wheel to control. Default is 'AUTO', which asks the driver to autodetect the model.

#### Returns

dictionary containing the 'model', 'firmware\_version' and 'n\_positions' for the filter wheel.

#### Return type

[dict](#)

#### Raises

[RuntimeError](#) – raised if the driver returns an error

**cfw\_goto**(*handle, position, model='AUTO', cfw\_event=None, timeout=<Quantity 10. s>*)

Move colour filter wheel to a given position

This function returns immediately after starting the move but spawns a thread to poll the filter wheel until the move completes (see `_cfw_poll` method for details). This thread will log the result of the move, and optionally set a `threading.Event` to signal that it has completed.

#### Parameters

- **handle** (*int*) – handle of the camera that the filter wheel is connected to.
- **position** (*int*) – position to move the filter wheel. Must an integer  $\geq 1$ .
- **model** (*str, optional*) – Model of the filter wheel to control. Default is 'AUTO', which asks the driver to autodetect the model.
- **cfw\_event** (*threading.Event, optional*) – Event to set once the move is complete

- **timeout** (*u.Quantity, optional*) – maximum time to wait for the move to complete. Should be a Quantity with time units. If a numeric type without units is given seconds will be assumed. Default is 10 seconds.

**Returns**

dictionary containing the ‘model’, ‘position’, ‘status’ and ‘error’ values returned by the driver.

**Return type**

dict

**Raises**

**RuntimeError** – raised if the driver returns an error

**cfw\_init**(*handle, model='AUTO', timeout=<Quantity 10. s>*)

Initialise colour filter wheel

Sends the initialise command to the colour filter wheel attached to the camera specified with handle. This will generally not be required because all SBIG filter wheels initialise themselves on power up.

**Parameters**

- **handle** (*int*) – handle of the camera that the filter wheel is connected to.
- **model** (*str, optional*) – Model of the filter wheel to control. Default is ‘AUTO’, which asks the driver to autodetect the model.
- **timeout** (*u.Quantity, optional*) – maximum time to wait for the move to complete. Should be a Quantity with time units. If a numeric type without units is given seconds will be assumed. Default is 10 seconds.

**Returns**

dictionary containing the ‘model’, ‘position’, ‘status’ and ‘error’ values returned by the driver.

**Return type**

dict

**Raises**

**RuntimeError** – raised if the driver returns an error

**cfw\_query**(*handle, model='AUTO'*)

Query status of the colour filter wheel

This is mostly used to poll the filter wheel status after asking the filter wheel to move in order to find out when the move has completed.

**Parameters**

- **handle** (*int*) – handle of the camera that the filter wheel is connected to.
- **model** (*str, optional*) – Model of the filter wheel to control. Default is ‘AUTO’, which asks the driver to autodetect the model.

**Returns**

dictionary containing the ‘model’, ‘position’, ‘status’ and ‘error’ values returned by the driver.

**Return type**

dict

**Raises**

**RuntimeError** – raised if the driver returns an error

**disable\_vdd\_optimized(*handle*)**

Stops selective lowering of the CCD's Vdd voltage to ensure consistent bias structures.

There are many driver control parameters, almost all of which we would not want to change from their default values. The one exception is DCP\_VDD\_OPTIMIZED. From the SBIG manual:

The DCP\_VDD\_OPTIMIZED parameter defaults to TRUE which lowers the CCD's Vdd (which reduces amplifier glow) only for images 3 seconds and longer. This was done to increase the image throughput for short exposures as raising and lowering Vdd takes 100s of milliseconds. The lowering and subsequent raising of Vdd delays the image readout slightly which causes short exposures to have a different bias structure than long exposures. Setting this parameter to FALSE stops the short exposure optimization from occurring.

The default behaviour will improve image throughput for exposure times of 3 seconds or less but at the penalty of altering the bias structure between short and long exposures. This could cause systematic errors in bias frames, dark current measurements, etc. It's probably not worth it.

**establish\_link()****get\_sdk\_version(*request\_type*='DRIVER\_STD')**

Get the version of the SDK

**get\_ccd\_info(*handle*)**

Use Get CCD Info to gather all relevant info about CCD capabilities. Already have camera type, 'name' and serial number, this gets the rest.

**get\_devices()**

Gets currently connected camera inf.

**Returns**

All currently connected camera serial numbers with corresponding handles.

**Return type**

dict

**get\_driver\_handle()****get\_exposure\_status(*handle*)**

Returns the current exposure status of the camera, e.g. 'CS\_IDLE', 'CS\_INTEGRATING'

**get\_link\_status()****open\_device(*device\_type*)****open\_driver()****query\_temp\_status(*handle*)****readout(*handle*, *readout\_mode*, *top*, *left*, *height*, *width*)****property retries****set\_handle(*handle*)****set\_temp\_regulation(*handle*, *target\_temperature*, *enabled*)****start\_exposure(*handle*, *seconds*, *dark*, *antiblooming*, *readout\_mode*, *top*, *left*, *height*, *width*)**

**class** panoptes.pocs.camera.sbigudrv.SetDriverControlParams

Bases: Structure

ctypes Structure to hold the parameters for the Set Driver Control command, used to set the value of a specific driver control parameter

**controlParameter**

Structure/Union member

**controlValue**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.SetDriverHandleParams

Bases: Structure

ctypes Structure to hold the parameter for the Set Driver Handle command.

**handle**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.SetTemperatureRegulationParams

Bases: Structure

ctypes Structure used to hold the parameters for the Set Temperature Regulation command.

**ccdSetpoint**

Structure/Union member

**regulation**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.SetTemperatureRegulationParams2

Bases: Structure

ctypes Structure used to hold the parameters for the Set Temperature Regulation 2 command.

**ccdSetpoint**

Structure/Union member

**regulation**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.StartExposureParams2

Bases: Structure

ctypes Structure to hold the parameters for the Start Exposure 2 command. (The Start Exposure command is deprecated.)

**abgState**

Structure/Union member

**ccd**

Structure/Union member

**exposureTime**

Structure/Union member

**height**

Structure/Union member

**left**

Structure/Union member

**openShutter**

Structure/Union member

**readoutMode**

Structure/Union member

**top**

Structure/Union member

**width**

Structure/Union member

**class** panoptes.pocs.camera.sbigudrv.**StartReadoutParams**

Bases: `Structure`

ctypes Structure to hold the parameters for the Start Readout command.

**ccd**

Structure/Union member

**height**

Structure/Union member

**left**

Structure/Union member

**readoutMode**

Structure/Union member

**top**

Structure/Union member

**width**

Structure/Union member

## panoptes.pocs.camera.sdk module

```
class panoptes.pocs.camera.sdk.AbstractSDKCamera(name='Generic SDK camera', driver=<class
    'panoptes.pocs.camera.sdk.AbstractSDKDriver'>,
    library_path=None, filter_type=None,
    target_temperature=None, *args, **kwargs)
```

Bases: `AbstractCamera`

**property properties**

A collection of camera properties as read from the camera

```
class panoptes.pocs.camera.sdk.AbstractSDKDriver(name, library_path=None, *args, **kwargs)
```

Bases: `PanBase`

**abstract** `get_SDK_version()`

Get the version of the SDK

**abstract** `get_devices()`

Get connected device UIDs and corresponding device nodes/handles/IDs.

**property version**

## panoptes.pocs.camera.zwo module

```
class panoptes.pocs.camera.zwo.Camera(name='ZWO ASI Camera', gain=100, image_type=None, *args,  
                                       **kwargs)
```

Bases: *AbstractSDKCamera*

**property bit\_depth**

ADC bit depth

**connect**(enable\_cooling=False)

Connect to ZWO ASI camera.

Gets 'camera\_ID' (needed for all driver commands), camera properties and details of available camera commands/parameters.

**property cooling\_enabled**

Current status of the camera's image sensor cooling system (enabled/disabled)

**property cooling\_power**

Current power level of the camera's image sensor cooling system (as a percentage).

**property egain**

Image sensor gain in e-/ADU for the current gain, as reported by the camera.

**property gain**

Current value of the camera's gain setting in internal units.

See *egain* for the corresponding electrons / ADU value.

**property image\_type**

Current camera image type, one of 'RAW8', 'RAW16', 'Y8', 'RGB24'

**property is\_exposing**

True if an exposure is currently under way, otherwise False

**start\_video**(seconds, filename\_root, max\_frames, image\_type=None)

**stop\_video**()

**property target\_temperature**

Current value of the target temperature for the camera's image sensor cooling control.

Can be set by assigning an `astropy.units.Quantity`

**property temperature**

Current temperature of the camera's image sensor

## Module contents

`panoptes.pocs.camera.create_cameras_from_config`(*config=None, cameras=None, auto\_primary=True, recreate\_existing=False, \*args, \*\*kwargs*)

Create camera object(s) based on the config.

Creates a camera for each camera item listed in the config. Ensures the appropriate camera module is loaded.

### Parameters

- **config** (*dict* or *None*) – A config object for a camera or *None* to lookup in config-server.
- **cameras** (*list* of *panoptes.pocs.camera.Camera* or *None*) – A list of camera objects or *None*.
- **auto\_primary** (*bool*) – If *True*, when no camera is marked as the primary camera, the first camera in the list will be used as primary. Default *True*.
- **recreate\_existing** (*bool*) – If *True*, a camera object will be recreated if an existing camera with the same *uid* is already assigned. Should currently only affect cameras that use the *sdk* (i.g. not DSLRs). Default *False* raises an exception if camera is already assigned.
- **\*args** (*list*) – Passed to *get\_config*.
- **\*\*kwargs** (*dict*) – Can pass a *cameras* object that overrides the info in the configuration file. Can also pass *auto\_detect* (*bool*) to try and automatically discover the ports. Any other items as passed to *get\_config*.

### Returns

**An ordered dictionary of created camera objects, with the**

camera name as key and camera instance as value. Returns an empty *OrderedDict* if there is no camera configuration items.

### Return type

*OrderedDict*

### Raises

- **error.CameraNotFound** – Raised if camera cannot be found at specified port or if *auto\_detect=True* and no cameras are found.
- **error.PanError** – Description

`panoptes.pocs.camera.get_gphoto2_cmd()`

Finds the gphoto2 command on the system

`panoptes.pocs.camera.list_connected_cameras`(*endpoint: AnyHttpUrl | None = None*)

Detect connected cameras.

Uses gphoto2 to try and detect which cameras are connected. Cameras should be known and placed in config but this is a useful utility.

### Returns

A list of the ports with detected cameras.

### Return type

*list*

## panoptes.pocs.dome package

### Submodules

#### panoptes.pocs.dome.abstract\_serial\_dome module

**class** panoptes.pocs.dome.abstract\_serial\_dome.**AbstractSerialDome**(\*args, \*\*kwargs)

Bases: [\*AbstractDome\*](#)

Abstract base class for controlling a dome via a serial connection.

Takes care of a single thing: configuring the connection to the device.

**connect()**

Connects to the device via the serial port, if disconnected.

**Returns**

Returns True if connected, False otherwise.

**Return type**

[\*bool\*](#)

**disconnect()**

Disconnect from the dome controller.

**Raises**

**An exception if unable to disconnect.** –

**property is\_connected**

True if connected to the hardware or driver.

**verify\_connected()**

Throw an exception if not connected.

#### panoptes.pocs.dome.astrohaven module

**class** panoptes.pocs.dome.astrohaven.**AstrohavenDome**(\*args, \*\*kwargs)

Bases: [\*AbstractSerialDome\*](#)

Interface to an Astrohaven clamshell dome with a Vision 130 PLC and RS-232 interface.

Experience shows that it emits a status byte about once a second, with the codes as described in the Protocol class.

**LISTEN\_TIMEOUT = 3**

**MOVE\_LISTEN\_TIMEOUT = 0.1**

**MOVE\_TIMEOUT = 10**

**NUM\_CLOSE\_FEEDBACKS = 2**

**close()**

If not known to be closed, attempts to close the dome.

Must already be connected.

Returns: True if and when closed, False if unable to close.



**property is\_closed**

True if dome is known to be closed.

**property is\_open**

True if dome is known to be open.

**open()**

If not known to be open, attempts to open the dome.

Must already be connected.

Returns: True if and when open, False if unable to open.

**property status**

Return a dict with dome's current status.

`panoptes.pocs.dome.astrohaven.Dome`

alias of [\*AstrohavenDome\*](#)

**class** `panoptes.pocs.dome.astrohaven.Protocol`

Bases: `object`

`A_CLOSE_LIMIT = 'X'`

`A_IS_CLOSED = '1'`

`A_OPEN_LIMIT = 'x'`

`BOTH_CLOSED = '0'`

`BOTH_OPEN = '3'`

`B_CLOSE_LIMIT = 'Y'`

`B_IS_CLOSED = '2'`

`B_OPEN_LIMIT = 'y'`

`CLOSE_A = 'A'`

`CLOSE_B = 'B'`

`CLOSE_BOTH = 'C'`

`OPEN_A = 'a'`

`OPEN_B = 'b'`

`OPEN_BOTH = 'O'`

`RESET = 'R'`

`STABLE_STATES = ('0', '3', '2', '1')`

## panoptes.pocs.dome.bisque module

**class** panoptes.pocs.dome.bisque.Dome(\*args, \*\*kwargs)

Bases: *AbstractDome*

docstring for Dome

**close()**

If not known to be closed, attempts to close the dome.

Must already be connected.

Returns: True if and when closed, False if unable to close.

**connect()**

Establish a connection to the dome controller.

The sub-class implementation can access configuration information from self.\_config; see PanBase for more common properties.

Returns: True if connected, False otherwise.

**disconnect()**

Disconnect from the dome controller.

**Raises**

**An exception if unable to disconnect.** –

**find\_home()**

**property is\_closed**

True if dome is known to be closed.

**property is\_connected**

True if connected to the hardware or driver.

**property is\_open**

True if dome is known to be open.

**property is\_parked**

**open()**

If not known to be open, attempts to open the dome.

Must already be connected.

Returns: True if and when open, False if unable to open.

**park()**

**property position**

**read(timeout=5)**

**read\_slit\_state()**

**property status**

A string representing the status of the dome for presentation.

This string is NOT for use in logic, only for presentation, as there is no requirement to produce the same string for different types of domes: a roll-off roof might have a very different status than a rotating dome that is coordinating its movements with the telescope mount.

Examples: ‘Open’, ‘Closed’, ‘Opening’, ‘Closing’, ‘Left Moving’, ‘Right Stuck’

Returns: A string.

**unpark()**

**write(value)**

## panoptes.pocs.dome.protocol\_astrohaven\_simulator module

## panoptes.pocs.dome.simulator module

**class** panoptes.pocs.dome.simulator.Dome(\*args, \*\*kwargs)

Bases: *AbstractDome*

Simulator for a Dome controller.

**close()**

If not known to be closed, attempts to close the dome.

Must already be connected.

Returns: True if and when closed, False if unable to close.

**connect()**

Establish a connection to the dome controller.

The sub-class implementation can access configuration information from self.\_config; see PanBase for more common properties.

Returns: True if connected, False otherwise.

**disconnect()**

Disconnect from the dome controller.

**Raises**

**An exception if unable to disconnect. –**

**property is\_closed**

True if dome is known to be closed.

**property is\_open**

True if dome is known to be open.

**open()**

If not known to be open, attempts to open the dome.

Must already be connected.

Returns: True if and when open, False if unable to open.

**property status**

A string representing the status of the dome for presentation.

This string is NOT for use in logic, only for presentation, as there is no requirement to produce the same string for different types of domes: a roll-off roof might have a very different status than a rotating dome that is coordinating its movements with the telescope mount.

Examples: ‘Open’, ‘Closed’, ‘Opening’, ‘Closing’, ‘Left Moving’, ‘Right Stuck’

Returns: A string.

## Module contents

**class** panoptes.pocs.dome.**AbstractDome**(\*args, \*\*kwargs)

Bases: *PanBase*

Abstract base class for controlling a non-rotating dome.

This assumes that the observatory ‘dome’ is not a classic rotating dome with a narrow slit, but instead something like a roll-off roof or clam-shell, which can be observed from when open, and that the other states (closed or moving) are not used for observing.

Adding support for a rotating dome would require coordination during observing to make sure that the opening tracks the field being observed.

**abstract close()**

If not known to be closed, attempts to close the dome.

Must already be connected.

Returns: True if and when closed, False if unable to close.

**abstract connect()**

Establish a connection to the dome controller.

The sub-class implementation can access configuration information from self.\_config; see PanBase for more common properties.

Returns: True if connected, False otherwise.

**abstract disconnect()**

Disconnect from the dome controller.

**Raises**

**An exception if unable to disconnect.** –

**abstract is\_closed()**

True if dome is known to be closed.

**property is\_connected**

True if connected to the hardware or driver.

**abstract is\_open()**

True if dome is known to be open.

**abstract open()**

If not known to be open, attempts to open the dome.

Must already be connected.

Returns: True if and when open, False if unable to open.

**abstract property status**

A string representing the status of the dome for presentation.

This string is NOT for use in logic, only for presentation, as there is no requirement to produce the same string for different types of domes: a roll-off roof might have a very different status than a rotating dome that is coordinating its movements with the telescope mount.

Examples: ‘Open’, ‘Closed’, ‘Opening’, ‘Closing’, ‘Left Moving’, ‘Right Stuck’

Returns: A string.

```
panoptes.pocs.dome.create_dome_from_config(*args, **kwargs)
```

If there is a dome specified in the config, create a driver for it.

A dome needs a config. We assume that there is at most one dome in the config, i.e. we don't support two different dome devices, such as might be the case if there are multiple independent actuators, for example slit, rotation and vents. Those would need to be handled by a single dome driver class.

```
panoptes.pocs.dome.create_dome_simulator(*args, **kwargs)
```

## panoptes.pocs.filterwheel package

### Submodules

#### panoptes.pocs.filterwheel.filterwheel module

```
class panoptes.pocs.filterwheel.filterwheel.AbstractFilterWheel(name='Generic Filter Wheel',
                                                                model='simulator',
                                                                camera=None,
                                                                filter_names=None,
                                                                timeout=None,
                                                                serial_number='XXXXXX',
                                                                dark_position=None,
                                                                focus_offsets=None, *args,
                                                                **kwargs)
```

Bases: [PanBase](#)

Base class for all filter wheels

#### Parameters

- **name** (*str*, *optional*) – name of the filter wheel
- **model** (*str*, *optional*) – model of the filter wheel
- **camera** (*pocs.camera.\*.Camera*, *optional*) – camera that this filter wheel is associated with.
- **filter\_names** (*list of str*) – names of the filters installed at each filter wheel position
- **timeout** (*u.Quantity*, *optional*) – maximum time to wait for a move to complete. Should be a Quantity with time units. If a numeric type without units is given seconds will be assumed. Default is None (no timeout).
- **serial\_number** (*str*, *optional*) – serial number of the filter wheel, default 'XXXXXX'
- **dark\_position** (*int or str*, *optional*) – used to specify either a filter wheel position or a filter name that should be used when taking dark exposures with a camera that is not able to take internal darks.
- **focus\_offsets** (*abc.Mapping*, *optional*) – Dictionary of filter\_name: focus offset pairs to apply when moving between filters. If None (default), no offsets are applied.

#### property camera

Reference to the Camera object that the FilterWheel is assigned to, if any. A filter wheel should only ever be assigned to one or zero Cameras!

#### abstract connect()

Connect to filter wheel

**property current\_filter**

Name of the filter in the current position

**filter\_name**(*position*)

Name of the filter in the given integer position.

**property filter\_names**

List of the names of the filters installed in the filter wheel

**property is\_connected**

Is the filterwheel available

**abstract property is\_moving**

Is the filterwheel currently moving

**property is\_ready****property is\_unidirectional****property model**

Model of the filter wheel

**move\_to**(*new\_position*, *blocking=False*)

Move the filter wheel to the given position.

The position can be expressed either as an integer, or as (part of) one of the names from the filter\_names list. To allow filter names of the form '<filter band>\_<serial number>' to be selected by band only position can be a substring from the start of one of the names in the filter\_names list, provided that this produces only one match.

**Parameters**

- **new\_position** (*int* or *str*) – position to move to.
- **blocking** (*bool*, *optional*) – If False (default) return immediately, if True block until the filter wheel move has been completed.

**Returns**

Event that will be set to signal when the move has completed

**Return type**

`threading.Event`

**Raises**

**ValueError** – if new\_position is not a valid position specifier for this filterwheel.

**Examples**

Substring matching is useful when the filter names contain both the type of filter and a serial number, e.g. the following selects a g band filter without having to know its full name.

```
>>> from panoptes.pocs.filterwheel.simulator import FilterWheel
>>> fw = FilterWheel(filter_names=['u_12', 'g_04', 'r_09', 'i_20', 'z_07'])
>>> fw_event = fw.move_to('g')
>>> fw_event.wait()
True
>>> fw.current_filter
'g_04'
```

**move\_to\_dark\_position**(*blocking=False*)

Move to filterwheel position for taking darks.

**move\_to\_light\_position**(*blocking=False*)

Return to last filterwheel position from before taking darks.

**property n\_positions**

Number of positions in the filter wheel

**property name**

Name of the filter wheel

**abstract property position**

Current integer position of the filter wheel

**property uid**

A serial number of the filter wheel

## panoptes.pocs.filterwheel.libefw module

**class** panoptes.pocs.filterwheel.libefw.**EFWDriver**(*library\_path=None, \*\*kwargs*)

Bases: [\*AbstractSDKDriver\*](#)

**calibrate**(*filterwheel\_ID*)

Calibrate filterwheel with given ID.

**close**(*filterwheel\_ID*)

Close connection to filterwheel with given ID.

**get\_ID**(*filterwheel\_index*)

Get integer ID of filterwheel with a given index.

**get\_SDK\_version**()

Get the version for the SDK.

**get\_devices**()

Get connected device ‘UIDs’ and corresponding device nodes/handles/IDs.

EFW SDK has no way to access any unique identifier for connected filterwheels. Instead we construct an ID from combination of filterwheel name, number of positions and integer ID. This will probably not be deterministic, in general, and is only guaranteed to be unique between multiple filterwheels on a single computer.

**get\_direction**(*filterwheel\_ID*)

Get current unidirectional/bidirectional setting of filterwheel with given ID.

**get\_num**()

Get the count of connected EFW filterwheels.

**get\_position**(*filterwheel\_ID*)

Get current position of filterwheel with given ID.

**get\_product\_ids**()

Get product IDs of supported(?) EFW filterwheels.

The SDK documentation does not explain what the product IDs returned by this function are, but from experiment and analogy with a similar function in the ASI camera SDK it appears this is a list of the

product IDs of the filterwheels that the SDK supports, not the product IDs of the connected filterwheels. There appears to be no way to obtain the product IDs of the connected filterwheel(s).

**get\_property**(*filterwheel\_ID*)

Get properties of filterwheel with given ID.

**open**(*filterwheel\_ID*)

Open connection to filterwheel with given ID.

**set\_direction**(*filterwheel\_ID*, *unidirectional*)

Set unidirectional/bidirectional for filterwheel with given ID.

**set\_position**(*filterwheel\_ID*, *position*, *move\_event=None*, *timeout=None*)

Set position of filterwheel with given ID.

This function returns immediately after starting the move but spawns a thread to poll the filter wheel until the move completes (see `_efw_poll` method for details). This thread will log the result of the move, and optionally set a `threading.Event` to signal that it has completed.

#### Parameters

- **filterwheel\_ID** (*int*) – integer ID of the filterwheel that is moving.
- **position** (*int*) – position to move the filter wheel. Must an integer  $\geq 0$ .
- **move\_event** (*threading.Event*, *optional*) – Event to set once the move is complete
- **timeout** (*u.Quantity*, *optional*) – maximum time to wait for the move to complete. Should be a `Quantity` with time units. If a numeric type without units is given seconds will be assumed.

#### Raises

`panoptes.utils.error.PanError` – raised if the driver returns an error starting the move.

**class** panoptes.pocs.filterwheel.libefw.EFWInfo

Bases: `Structure`

Filterwheel info structure.

**id**

Structure/Union member

**name**

Structure/Union member

**slot\_num**

Structure/Union member

**class** panoptes.pocs.filterwheel.libefw.ErrorCode(*value*, *names=None*, *\*values*, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Bases: `IntEnum`

**CLOSED** = 9

**END** = -1

**ERROR\_STATE** = 6

**GENERAL\_ERROR** = 7



```
INVALID_ID = 2
INVALID_INDEX = 1
INVALID_VALUE = 3
MOVING = 5
NOT_SUPPORTED = 8
REMOVED = 4
SUCCESS = 0
```

### panoptes.pocs.filterwheel.sbig module

```
class panoptes.pocs.filterwheel.sbig.FilterWheel(name='SBIG Filter Wheel', model='sbig',
                                                  camera=None, filter_names=None,
                                                  timeout=<Quantity 10. s>, serial_number=None,
                                                  *args, **kwargs)
```

Bases: [\*AbstractFilterWheel\*](#)

Class for SBIG filter wheels connected to the I2C port of an SBIG camera.

#### Parameters

- **name** (*str*, optional) – name of the filter wheel
- **model** (*str*, optional) – model of the filter wheel
- **camera** ([`pocs.camera.sbig.Camera`](#)) – camera that this filter wheel is associated with.
- **filter\_names** (*list of str*) – names of the filters installed at each filter wheel position
- **timeout** (*u.Quantity*, optional) – maximum time to wait for a move to complete. Should be a `Quantity` with time units. If a numeric type without units is given seconds will be assumed. Default is 10 seconds.
- **serial\_number** (*str*) – serial number of the filter wheel

#### `connect()`

Connect to filter wheel. Not called by `__init__` because we need the camera to be connected first. The SBIG camera `connect()` method will call this once it's OK to do so.

#### property `firmware_version`

Firmware version of the filter wheel

#### property `is_moving`

Is the filterwheel currently moving

#### property `is_unidirectional`

#### property `position`

Current integer position of the filter wheel

#### `recalibrate()`

Reinitialises/recalibrates the filter wheel. It should not be necessary to call this as SBIG filter wheels initialise and calibrate themselves on power up.

## panoptes.pocs.filterwheel.simulator module

```
class panoptes.pocs.filterwheel.simulator.FilterWheel(name='Simulated Filter Wheel',
                                                       model='panoptes.pocs.filterwheel.simulator.FilterWheel',
                                                       camera=None, filter_names=None,
                                                       timeout=<Quantity 10. s>,
                                                       serial_number=None, move_time=<Quantity
                                                       1. s>, unidirectional=True, *args, **kwargs)
```

Bases: [\*AbstractFilterWheel\*](#)

Class for simulated filter wheels.

### Parameters

- **name** (*str*, optional) – name of the filter wheel
- **model** (*str*, optional) – model of the filter wheel
- **camera** (*pocs.camera.\*.Camera*, optional) – camera that this filter wheel is associated with.
- **filter\_names** (*list of str*) – names of the filters installed at each filter wheel position
- **timeout** (*u.Quantity*, optional) – maximum time to wait for a move to complete. Should be a Quantity with time units. If a numeric type without units is given seconds will be assumed. Default is 10 seconds.
- **serial\_number** (*str*) – serial number of the filter wheel
- **move\_time** (*astropy.units.Quantity*, optional) – time to move the filter wheel by one position, optional, default 1 second.
- **unidirectional** (*bool*, optional) – If True filterwheel will only rotate in one direction, if False filterwheel will move in either to get to the requested position via the shortest path. Default is True.

### connect()

Connect to the filter wheel

### property is\_moving

Is the filterwheel currently moving

### property is\_unidirectional

### property position

Current integer position of the filter wheel

## panoptes.pocs.filterwheel.zwo module

```
class panoptes.pocs.filterwheel.zwo.FilterWheel(name='ZWO Filter Wheel', model='zwo',
                                                  camera=None, filter_names=None,
                                                  timeout=<Quantity 10. s>, serial_number=None,
                                                  library_path=None, unidirectional=True,
                                                  device_name=None, initial_filter=None, *args,
                                                  **kwargs)
```

Bases: [\*AbstractFilterWheel\*](#)

Class for ZWO filter wheels.

### Parameters

- **name** (*str*, *optional*) – name of the filter wheel.
- **model** (*str*, *optional*) – model of the filter wheel.
- **camera** (`pocs.camera.camera.AbstractCamera`) – camera that this filterwheel is associated with.
- **filter\_names** (*list of str*) – names of the filters installed at each filterwheel position.
- **timeout** (*u.Quantity*, *optional*) – maximum time to wait for a move to complete. Should be a *Quantity* with time units. If a numeric type without units is given seconds will be assumed. Default is 10 seconds.
- **serial\_number** (*str*) – serial number of the filter wheel.
- **library\_path** (*str*, *optional*) – path to the library e.g. `‘usr/local/lib/libASICamera2.so’`.
- **unidirectional** (*bool*, *optional*) – If `True` filterwheel will only rotate in one direction, if `False` filterwheel will move in either to get to the requested position via the shortest path. Default is `True` in order to improve repeatability.
- **device\_name** (*str*, *optional*) – If multiple filterwheels are connected to a single computer ‘device name’ (e.g. `‘EFW_7_0’`) can be used to select the desired one. See docstring of `pocs.filterwheel.libefw.EFWDriver.get_devices()` for details.
- **initial\_filter** (*str or int*) – Name of filter (or integer position) to move to when initialising filter.

### `connect()`

Connect to filter wheel.

### property `is_moving`

Is the filterwheel currently moving

### property `is_unidirectional`

### property `position`

Current integer position of the filter wheel

### `recalibrate()`

Reinitialises/recalibrates the filter wheel.

## Module contents

### panoptes.pocs.focuser package

### Submodules

### panoptes.pocs.focuser.astromechanics module

```
class panoptes.pocs.focuser.astromechanics.Focuser(name='Astromechanics Focuser', model='Canon
EF-232', vendor_id=1027, product_id=24577,
zero_position=-25000, baudrate=38400, *args,
**kwargs)
```

Bases: [\*AbstractSerialFocuser\*](#)

Focuser class for control of a Canon DSLR lens via an Astromechanics Engineering Canon EF/EF-S adapter.

Min/max commands do not exist for the astromechanics controller, as well as other commands to get serial numbers and library/hardware versions. However, as they are marked with the decorator `@abstractmethod`, we have to override them.

Astromechanics focuser are currently very slow to respond to position queries. When they do respond, they give the exact position that was requested by the last `move_to` command (i.e. there is no reported position error). We can therefore avoid such queries by storing the current position in memory.

**property max\_position**

Returns position of far limit of focus travel, in encoder units.

**property min\_position**

Returns position of close limit of focus travel, in encoder units.

**move\_by(*increment*)**

Move focuser by a given amount. Does not do any checking of the requested increment but will warn if the lens reports hitting a stop. :param increment: distance to move the focuser, in encoder units. :type increment: int

**Returns**

focuser position following the move, in encoder units.

**Return type**

int

**move\_to(*position*)**

Moves focuser to a new position. Does not do any checking of the requested position but will warn if the lens reports hitting a stop. :param position: new focuser position, in encoder units. :type position: int

**Returns**

focuser position following the move, in encoder units.

**Return type**

int

**property position**

Current encoder position of the focuser

## panoptes.pocs.focuser.birger module

```
class panoptes.pocs.focuser.birger.Focuser(name='Birger Focuser', model='Canon EF-232',
                                             max_command_retries=5, baudrate=115200, **kwargs)
```

Bases: [\*AbstractSerialFocuser\*](#)

Focuser class for control of a Canon DSLR lens via a Birger Engineering Canon EF-232 adapter.

**connect(*port*, *baudrate*, *\*\*kwargs*)**

Connect to the Birger focuser. :param port: The serial port. :type port: int :param baudrate: The baudrate of the serial device. :type baudrate: int :param *\*\*kwargs*: Parsed to `super().connect`

**property firmware\_version**

Returns the version string of the Birger adaptor library (firmware).

**property hardware\_version**

Returns the hardware version of the Birger adaptor.

**property lens\_info**

Return basic lens info (e.g. '400mm,f28' for a 400 mm f/2.8 lens).

**property max\_position**

Returns position of far limit of focus travel, in encoder units.

**property min\_position**

Returns position of close limit of focus travel, in encoder units.

**move\_by(increment)**

Move focuser by a given amount. Does not do any checking of the requested increment but will warn if the lens reports hitting a stop. :param increment: distance to move the focuser, in encoder units. :type increment: int

**Returns**

focuser position following the move, in encoder units.

**Return type**

int

**move\_to(position)**

Moves focuser to a new position. Does not do any checking of the requested position but will warn if the lens reports hitting a stop. :param position: new focuser position, in encoder units. :type position: int

**Returns**

focuser position following the move, in encoder units.

**Return type**

int

**property position**

Returns current focus position in the lens focus encoder units.

**panoptes.pocs.focuser.focuser module**

```
class panoptes.pocs.focuser.focuser.AbstractFocuser(name='Generic Focuser', model='simulator',
                                                    port=None, camera=None, timeout=5,
                                                    initial_position=None, autofocus_range=None,
                                                    autofocus_step=None,
                                                    autofocus_seconds=None, autofocus_size=None,
                                                    autofocus_keep_files=None,
                                                    autofocus_take_dark=None,
                                                    autofocus_merit_function=None,
                                                    autofocus_merit_function_kwargs=None,
                                                    autofocus_mask_dilations=None,
                                                    autofocus_make_plots=False, *args, **kwargs)
```

Bases: [PanBase](#)

Base class for all focusers.

**Parameters**

- **name** (*str*, optional) – name of the focuser
- **model** (*str*, optional) – model of the focuser

- **port** (*str*, *optional*) – port the focuser is connected to, e.g. a device node
- **camera** (*pocs.camera.Camera*, *optional*) – camera that this focuser is associated with.
- **timeout** (*int*, *optional*) – time to wait for response from focuser.
- **initial\_position** (*int*, *optional*) – if given the focuser will move to this position following initialisation.
- **autofocus\_range** ((*int*, *int*) *optional*) – Coarse & fine focus sweep range, in encoder units
- **autofocus\_step** ((*int*, *int*), *optional*) – Coarse & fine focus sweep steps, in encoder units
- **autofocus\_seconds** (*scalar*, *optional*) – Exposure time for focus exposures
- **autofocus\_size** (*int*, *optional*) – Size of square central region of image to use, default 500 x 500 pixels.
- **autofocus\_keep\_files** (*bool*, *optional*) – If True will keep all images taken during focusing. If False (default) will delete all except the first and last images from each focus run.
- **autofocus\_take\_dark** (*bool*, *optional*) – If True will attempt to take a dark frame before the focus run, and use it for dark subtraction and hot pixel masking, default True.
- **autofocus\_merit\_function** (*str/callable*, *optional*) – Merit function to use as a focus metric, default `vollath_F4`
- **autofocus\_merit\_function\_kwargs** (*dict*, *optional*) – Dictionary of additional keyword arguments for the merit function.
- **autofocus\_mask\_dilations** (*int*, *optional*) – Number of iterations of dilation to perform on the saturated pixel mask (determine size of masked regions), default 10
- **(bool (autofocus\_make\_plots))** – Whether to write focus plots to images folder, default False.
- **optional** – Whether to write focus plots to images folder, default False.

**autofocus**(*seconds=None, focus\_range=None, focus\_step=None, cutout\_size=None, keep\_files=None, take\_dark=None, merit\_function=None, merit\_function\_kwargs=None, mask\_dilations=None, coarse=False, make\_plots=None, filter\_name=None, blocking=False*)

Focuses the camera using the specified merit function. Optionally performs a coarse focus to find the approximate position of infinity focus, which should be followed by a fine focus before observing.

#### Parameters

- **seconds** (*scalar*, *optional*) – Exposure time for focus exposures, if not specified will use value from config.
- **focus\_range** (*2-tuple*, *optional*) – Coarse & fine focus sweep range, in encoder units. Specify to override values from config.
- **focus\_step** (*2-tuple*, *optional*) – Coarse & fine focus sweep steps, in encoder units. Specify to override values from config.
- **cutout\_size** (*int*, *optional*) – Size of square central region of image to use, default 500 x 500 pixels.
- **keep\_files** (*bool*, *optional*) – If True will keep all images taken during focusing. If False (default) will delete all except the first and last images from each focus run.

- **take\_dark** (*bool*, *optional*) – If True will attempt to take a dark frame before the focus run, and use it for dark subtraction and hot pixel masking, default True.
- **merit\_function** (*str/callable*, *optional*) – Merit function to use as a focus metric, default `vollath_F4`.
- **merit\_function\_kwargs** (*dict*, *optional*) – Dictionary of additional keyword arguments for the merit function.
- **mask\_dilations** (*int*, *optional*) – Number of iterations of dilation to perform on the saturated pixel mask (determine size of masked regions), default 10
- **coarse** (*bool*, *optional*) – Whether to perform a coarse focus, otherwise will perform a fine focus. Default False.
- **make\_plots** (*bool*, *optional*) – Whether to write focus plots to images folder. If not given will fall back on value of `autofocus_make_plots` set on initialisation, and if it wasn't set then will default to False.
- **filter\_name** (*str*, *optional*) – The filter to use for focusing. If not provided, will use last light position.
- **blocking** (*bool*, *optional*) – Whether to block until autofocus complete, default False.

**Returns**

Event that will be set when autofocusing is complete

**Return type**

`threading.Event`

**Raises**

**ValueError** – If invalid values are passed for any of the focus parameters.

**property autofocus\_error**

Error message from the most recent autofocus or None, if there was no error.

**property camera**

Reference to the Camera object that the Focuser is assigned to, if any. A Focuser should only ever be assigned to one or zero Cameras!

**property is\_connected**

Is the focuser available

**abstract is\_moving()**

True if the focuser is currently moving.

**property is\_ready****abstract max\_position()**

Get position of far limit of focus travel, in encoder units

**abstract min\_position()**

Get position of close limit of focus travel, in encoder units

**move\_by(increment)**

Move focuser by a given amount.

**Parameters**

**increment** (*int*) – distance to move the focuser, in encoder units.

**Returns**

focuser position following the move, in encoder units.

**Return type**`int`**abstract move\_to(*position*)**

Move focuser to new encoder position.

**Parameters**

**position** (`int`) – new focuser position, in encoder units.

**Returns**

focuser position following the move, in encoder units.

**Return type**`int`**property position**

Current encoder position of the focuser

**property uid**

A serial number for the focuser

**panoptes.pocs.focuser.focuslynx module**

```
class panoptes.pocs.focuser.focuslynx.Focuser(port, name='FocusLynx Focuser',
                                              initial_position=None, focuser_number=1,
                                              min_position=0, max_position=None, *args, **kwargs)
```

Bases: [`AbstractFocuser`](#)

Focuser class for control of telescope focusers using the Optec FocusLynx focus controller.

This includes the Starlight Instruments Focus Boss II controller, which is “powered by Optec”

**Parameters**

- **port** (`str`) – device node of the serial port the focuser controller is connected to, e.g. `/dev/ttyUSB0`
- **name** (`str`, *optional*) – default ‘FocusLynx Focuser’
- **initial\_position** (`int`, *optional*) – if given the focuser will drive to this encoder position following initialisation.
- **focuser\_number** (`int`, *optional*) – for focus controllers that support more than one focuser set this number to specify which focuser should be controlled by this object. Default 1
- **min\_position** (`int`, *optional*) – minimum allowed focuser position in encoder units, default 0
- **max\_position** (`int`, *optional*) – maximum allowed focuser position in encoder units. If not given the value will be taken from the focuser’s internal config.

Additional positional and keyword arguments are passed to the base class, `AbstractFocuser`. See that class for a complete list.

**connect()****property firmware\_version**

Firmware version of the focuser controller



**halt()**

Causes the focuser to immediately stop any movements

**property hardware\_version**

Device type code of the focuser

**property is\_connected**

Checks status of serial port to determine if connected.

**property is\_moving**

True if the focuser is currently moving

**property max\_position**

Position of far limit of focus travel, in encoder units

**property min\_position**

Position of close limit of focus travel, in encoder units

**move\_by(*increment*, *blocking=True*)**

Moves focuser by a given amount.

**Parameters**

- **increment** (*int*) – distance to move the focuser, in encoder units. New position must be between `min_position` and `max_position`.
- **blocking** (*bool*, *optional*) – If True (default) will block until the move is complete, otherwise will return immediately.

**Returns**

**focuser position following the move. If blocking is True this will be the actual focuser position, if False it will be the target position.**

**Return type**

*int*

**move\_to(*position*, *blocking=True*)**

Moves focuser to a new position.

**Parameters**

- **position** (*int*) – new focuser position, in encoder units. Must be between `min_position` and `max_position`.
- **blocking** (*bool*, *optional*) – If True (default) will block until the move is complete, otherwise will return immediately.

**Returns**

**focuser position following the move. If blocking is True this will be the actual focuser position, if False it will be the target position.**

**Return type**

*int*

**property position**

Current focus position in encoder units

**property temperature**

Current temperature of the focuser, in degrees Celsius, as an `astropy.units.Quantity`

**property uid**

The user set ‘nickname’ of the focuser. Must be <= 16 characters

**panoptes.pocs.focuser.serial module**

```
class panoptes.pocs.focuser.serial.AbstractSerialFocuser(baudrate=None, initial_position=None,
                                                         *args, **kwargs)
```

Bases: [\*AbstractFocuser\*](#)

**connect**(\*args, \*\*kwargs)

Connect to the serial device. :param \*args: Parsed to SerialData. :param \*\*kwargs: Parsed to SerialData.

**property is\_connected**

True if the focuser serial device is currently connected.

**property is\_moving**

True if the focuser is currently moving.

**reconnect**()

Close and open serial port and reconnect to focuser.

**panoptes.pocs.focuser.simulator module**

```
class panoptes.pocs.focuser.simulator.Focuser(name='Simulated Focuser', port='/dev/ttyFAKE', *args,
                                              **kwargs)
```

Bases: [\*AbstractFocuser\*](#)

Simple focuser simulator

**connect**()

Simulator pretends to connect a focuser and obtain details, current state.

**property is\_moving**

True if the focuser is currently moving.

**property max\_position**

Returns position of far limit of focus travel, in encoder units

**property min\_position**

Returns position of close limit of focus travel, in encoder units

**move\_by**(increment)

Move focuser by a given amount

**move\_to**(position)

Move focuser to a new encorder position

## Module contents

### panoptes.pocs.mount package

### Subpackages

### panoptes.pocs.mount.ioptron package

### Submodules

### panoptes.pocs.mount.ioptron.base module

**class** panoptes.pocs.mount.ioptron.base.**Mount**(location, mount\_version=None, \*args, \*\*kwargs)

Bases: [AbstractSerialMount](#)

Mount class for iOptron mounts.

**initialize**(set\_rates=True, unpark=False, \*arg, \*\*kwargs)

Initialize the connection with the mount and setup for location.

iOptron mounts are initialized by sending the following two commands to the mount:

- MountInfo

If the mount is successfully initialized, the `_setup_location_for_mount` method is also called.

#### Returns

Returns the value from `self.is_initialized`.

#### Return type

`bool`

**property** is\_home

Mount home status.

#### Type

`bool`

**park**(ra\_direction=None, ra\_seconds=None, dec\_direction=None, dec\_seconds=None, \*args, \*\*kwargs)

Slews to the park position and parks the mount.

This still uses a custom park command because the mount will not allow the Declination axis to move below 0 degrees.

---

**Note:** When mount is parked no movement commands will be accepted.

---

#### Parameters

- **ra\_direction** (`str` or `None`) – The direction to move the RA axis. If not provided (the default), then look at config setting, otherwise ‘west’.
- **ra\_seconds** (`str` or `None`) – The number of seconds to move the RA axis at maximum move speed. If not provided (the default), then look at config setting, otherwise 15 seconds.
- **dec\_direction** (`str` or `None`) – The direction to move the Declination axis. If not provided (the default), then look at config setting, otherwise ‘north’.

- **dec\_seconds** (*str* or *None*) – The number of seconds to move the Declination axis at maximum move speed. If not provided (the default), then look at config setting, otherwise 15 seconds.

**Returns**

indicating success

**Return type**

*bool*

## panoptes.pocs.mount.ioptron.cem40 module

**class** panoptes.pocs.mount.ioptron.cem40.**Mount**(*location*, *mount\_version*='0040', \**args*, \*\**kwargs*)

Bases: *Mount*

**search\_for\_home**()

Search for the home position.

This method uses the internal homing pin on the CEM40 mount to return the mount to the home (or zero) position.

**set\_target\_coordinates**(\**args*, \*\**kwargs*)

After setting target coordinates, check number of positions.

The CEM40 can determine if there are 0, 1, or 2 possible positions for the given RA/Dec, with the latter being the case for the meridian flip.

## panoptes.pocs.mount.ioptron.ieq30pro module

**class** panoptes.pocs.mount.ioptron.ieq30pro.**Mount**(*location*, *mount\_version*='0030', \**args*, \*\**kwargs*)

Bases: *Mount*

## Module contents

**class** panoptes.pocs.mount.ioptron.**MountGPS**(*value*, *names*=None, \**values*, *module*=None, *qualname*=None, *type*=None, *start*=1, *boundary*=None)

Bases: *IntEnum*

**EXTRACTED** = 2

**OFF** = 0

**ON** = 1

**class** panoptes.pocs.mount.ioptron.**MountHemisphere**(*value*, *names*=None, \**values*, *module*=None, *qualname*=None, *type*=None, *start*=1, *boundary*=None)

Bases: *IntEnum*

**NORTHERN** = 1

**SOUTHERN** = 0

```
class panoptes.pocs.mount.ioptron.MountInfo(value, names=None, *values, module=None,
                                             qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

The return type given by the MountInfo command to identify the mount.

**CEM120** = 120

**CEM120EC** = 121

**CEM120EC2** = 122

**CEM25** = 25

**CEM26** = 26

**CEM26EC** = 27

**CEM40** = 40

**CEM40EC** = 41

**CEM60** = 60

**CEM60EC** = 61

**CEM70** = 70

**CEM70EC** = 71

**GEM28** = 28

**GEM28EC** = 29

**GEM45** = 43

**GEM45EC** = 44

**iEQ30Pro** = 30

**iEQ45Pro** = 45

**iEQ45ProAA** = 46

```
class panoptes.pocs.mount.ioptron.MountMovementSpeed(value, names=None, *values, module=None,
                                                       qualname=None, type=None, start=1,
                                                       boundary=None)
```

Bases: `IntEnum`

**SIDEREAL\_1** = 1

**SIDEREAL\_128** = 6

**SIDEREAL\_16** = 4

**SIDEREAL\_2** = 2

**SIDEREAL\_256** = 7

**SIDEREAL\_512** = 8

SIDEREAL\_64 = 5

SIDEREAL\_8 = 3

SIDEREAL\_MAX = 9

```
class panoptes.pocs.mount.ioptron.MountState(value, names=None, *values, module=None,
                                              qualname=None, type=None, start=1, boundary=None)
```

Bases: `IntEnum`

AT\_HOME = 7

GUIDING = 3

MERIDIAN\_FLIPPING = 4

PARKED = 6

SLEWING = 2

STOPPED = 0

TRACKING = 1

TRACKING\_PEC = 5

UNKNOWN = 8

```
class panoptes.pocs.mount.ioptron.MountTimeSource(value, names=None, *values, module=None,
                                                    qualname=None, type=None, start=1,
                                                    boundary=None)
```

Bases: `IntEnum`

GPS = 3

HAND\_CONTROLLER = 2

RS232 = 1

```
class panoptes.pocs.mount.ioptron.MountTrackingState(value, names=None, *values, module=None,
                                                       qualname=None, type=None, start=1,
                                                       boundary=None)
```

Bases: `IntEnum`

CUSTOM = 4

KING = 3

LUNAR = 1

SIDEREAL = 0

SOLAR = 2

## Submodules

### panoptes.pocs.mount.bisque module

**class** panoptes.pocs.mount.bisque.**Mount**(\*args, \*\*kwargs)

Bases: *AbstractMount*

**property** at\_mount\_park

Mount slewing status.

**Type**

bool

**connect**()

Connects to the mount via the serial port (*self.\_port*)

**Returns**

Returns the *self.is\_connected* property which checks the actual serial connection.

**Return type**

bool

**disconnect**()

**initialize**(unpark=False, \*args, \*\*kwargs)

Initialize the connection with the mount and setup for location.

If the mount is successfully initialized, the *\_setup\_location\_for\_mount* method is also called.

**Returns**

Returns the value from *self.is\_initialized*.

**Return type**

bool

**property** is\_home

Mount home status.

**Type**

bool

**property** is\_parked

Mount parked status.

**Type**

bool

**property** is\_slewing

Mount slewing status.

**Type**

bool

**property** is\_tracking

Mount tracking status.

**Type**

bool

**move\_direction**(*direction*='north', *seconds*=1.0, *arcmin*=None, *rate*=None)

Move mount in specified *direction* for given amount of *seconds*

**park**(*timeout*=120)

Slews to the park position and parks the mount.

---

**Note:** When mount is parked no movement commands will be accepted.

---

**Returns**

indicating success

**Return type**

bool

**query**(\*args, \*\*kwargs)

Override the query method to use the command lock.

This is required because TheSkyX cannot handle simultaneous commands. This function will block until the lock is released.

**read**(*timeout*=5)

**set\_park\_position**()

**set\_target\_coordinates**(*coords*)

Sets the RA and Dec for the mount's current target.

**Parameters**

**coords** (*astropy.coordinates.SkyCoord*) – coordinates specifying target location

**Returns**

Boolean indicating success

**Return type**

bool

**slew\_to\_home**(*blocking*=False, *timeout*=120)

Slews the mount to the home position.

---

**Note:** Home position and Park position are not the same thing

---

**Parameters**

- **blocking** (*bool*, *optional*) – If command should block while slewing to home, default False.
- **timeout** (*int*, *optional*) – Timeout in seconds, default 120.

**Returns**

indicating success

**Return type**

bool



**slew\_to\_target**(*timeout=120*, *\*\*kwargs*)

Slews to the current `_target_coordinates`

**Returns**

indicating success

**Return type**

`bool`

**slew\_to\_zero**(*blocking=False*)

Calls `slew_to_home` in base class. Can be overridden.

**unpark**()

Unparks the mount. Does not do any movement commands but makes them available again.

**Returns**

indicating success

**Return type**

`bool`

**write**(*value*)

## panoptes.pocs.mount.mount module

**class** `panoptes.pocs.mount.mount.AbstractMount`(*location*, *commands=None*, *\*args*, *\*\*kwargs*)

Bases: `PanBase`

Abstract Base class for controlling a mount. This provides the basic functionality for the mounts. Sub-classes should override the `initialize` method for mount-specific issues as well as any helper methods specific mounts might need. See “NotImplemented Methods” section of this module.

Sets the following properties:

- `self.non_sidereal_available` = False
- `self.PEC_available` = False
- `self._is_initialized` = False

**Parameters**

- **config** (*dict*) – Custom configuration passed to base mount. This is usually read from the main system config.
- **commands** (*dict*) – Commands for the telescope. These are read from a yaml file that maps the mount-specific commands to common commands.
- **location** (*EarthLocation*) – An `astropy.coordinates.EarthLocation` that contains location information.

**property** `at_mount_park`

True if mount is at park position.

**Type**

`bool`

**abstract** `connect`()

Connect to the mount.

**correct\_tracking**(*correction\_info*, *axis\_timeout*=30.0)

Make tracking adjustment corrections.

**Parameters**

- **correction\_info** (*dict[tuple]*) – Correction info to be applied, see *get\_tracking\_correction*.
- **axis\_timeout** (*float*, *optional*) – Timeout for adjustment in each axis, default 30 seconds.

**Raises**

**error.Timeout** – Timeout error.

**disconnect**()

**distance\_from\_target**()

Get current distance from target

**Returns**

An angle represeting the current on-sky separation from the target

**Return type**

u.Angle

**get\_current\_coordinates**()

Reads out the current coordinates from the mount.

---

**Note:** See *\_mount\_coord\_to\_skycoord* and *\_skycoord\_to\_mount\_coord* for translation of mount specific coordinates to *astropy.coordinates.SkyCoord*

---

**Returns**

*astropy.coordinates.SkyCoord*

**get\_ms\_offset**(*offset*, *axis*='ra')

Get offset in milliseconds at current speed

**Parameters**

- **offset** (*astropy.units.Angle*) – Offset in arcseconds
- **axis** (*str*) – The name of the axis to move, default 'ra'.

**Returns**

Offset in milliseconds at current speed

**Return type**

*astropy.units.Quantity*

**get\_target\_coordinates**()

Gets the RA and Dec for the mount's current target. This does NOT necessarily reflect the current position of the mount, see *get\_current\_coordinates*.

**Return type**

*astropy.coordinates.SkyCoord*

**get\_tracking\_correction**(*offset\_info*, *pointing\_ha*, *min\_tracking\_threshold=None*, *max\_tracking\_threshold=None*)

Determine the needed tracking corrections from current position.

This method will determine the direction and number of milliseconds to correct the mount for each axis in order to correct for any tracking drift. The Declination axis correction ('north' or 'south') depends on the movement of the camera box with respect to the pier, which can be determined from the Hour Angle (HA) of the pointing image in the sequence.

---

**Note:** Correction values below 50ms will be skipped and values above 99999ms will be clipped.

---

#### Parameters

- **offset\_info** (*OffsetError*) – A named tuple describing the offset error. See *pocs.images.OffsetError*.
- **pointing\_ha** (*float*) – The Hour Angle (HA) of the mount at the beginning of the observation sequence in degrees. This affects the direction of the Dec adjustment.
- **min\_tracking\_threshold** (*int*, *optional*) – Minimum size of tracking correction allowed in milliseconds. Tracking corrections lower than this are ignored. Default 100ms from *self.min\_tracking\_threshold*.
- **max\_tracking\_threshold** (*int*, *optional*) – Maximum size of tracking correction allowed in milliseconds. Tracking corrections higher than this are set to this value. Default 99999ms from *self.max\_tracking\_threshold*.

#### Returns

Offset corrections for each axis as needed

```
dict: {
    # axis: (arcsec, millisecond, direction)
    'ra': (float, float, str),
    'dec': (float, float, str),
}
```

#### Return type

dict

#### property has\_target

**home\_and\_park**(\*args, \*\*kwargs)

Convenience method to first slew to the home position and then park.

**abstract initialize**(\*arg, \*\*kwargs)

#### property is\_connected

Checks the serial connection on the mount to determine if connection is open

#### Type

bool

#### property is\_home

Mount home status.

#### Type

bool

**property is\_initialized**

Has mount been initialised with connection

**Type**

bool

**property is\_parked**

Mount parked status.

**Type**

bool

**property is\_slewing**

Mount slewing status.

**Type**

bool

**property is\_tracking**

Mount tracking status.

**Type**

bool

**property location**

The location details for the mount.

When a new location is set, `\_setup\_location\_for\_mount` is called, which will update the mount with the current location. It is anticipated the mount won't change locations while observing so this should only be done upon mount initialization.

**Type**

astropy.coordinates.SkyCoord

**move\_direction(*direction*='north', *seconds*=1.0)**

Move mount in specified *direction* for given amount of *seconds*

**property movement\_speed**

Movement speed when button pressed.

**Type**

bool

**park(\*args, \*\*kwargs)**

Slews to the park position and parks the mount.

The park position must be set manually first for this method to work.

Most mount subclasses will override this method to provide mount-specific park functionality.

---

**Note:** When mount is parked no movement commands will be accepted.

---

**Returns**

indicating success

**Return type**

bool

**query**(*cmd*, *params=None*, *\*\*kwargs*)

Sends a query to the mount and returns response.

Performs a send and then returns response. Will do a translate on *cmd* first. This should be the major serial utility for commands. Accepts an additional args that is passed along with the command. Checks for and only accepts one args param.

#### Parameters

- **cmd** (*str*) – A command to send to the mount. This should be one of the commands listed in the mount commands yaml file.
- **params** (*str*, *optional*) – Params to pass to serial connection

#### Examples

```
>>> from panoptes.pocs.mount import create_mount_from_config
>>> mount = create_mount_from_config()
>>> mount.query('set_local_time', '101503')
'1'
>>> mount.query('get_local_time')
'101503'
```

#### Returns

The response from the mount.

#### Return type

*str*

#### Deleted Parameters:

*\*args*: Parameters to be sent with command if required.

**abstract read**(*\*args*, *\*\*kwargs*)

**search\_for\_home**()

Search for the home position if supported.

**set\_target\_coordinates**(*coords*)

Sets the RA and Dec for the mount's current target.

#### Parameters

**coords** (*astropy.coordinates.SkyCoord*) – coordinates specifying target location

#### Returns

Boolean indicating success

#### Return type

*bool*

**abstract set\_tracking\_rate**(*direction='ra'*, *delta=1.0*)

Sets the tracking rate for the mount

**slew\_to\_coordinates**(*coords*, *\*args*, *\*\*kwargs*)

Slews to given coordinates.

#### Parameters

**coords** (*astropy.SkyCoord*) – The coordinates to slew to.

**Returns**

indicating success

**Return type**

`bool`

**slew\_to\_home**(*blocking=True, timeout=180*)

Slews the mount to the home position.

---

**Note:** Home position and Park position are not the same thing

---

**Parameters**

- **blocking**(*bool, optional*) – If command should block while slewing to home, default `True`.
- **timeout**(*int, optional*) – Maximum time spent slewing to home, default 180 seconds.

**Returns**

indicating success

**Return type**

`bool`

**slew\_to\_target**(*blocking=False, timeout=180*)

Slews to the currently assigned target coordinates.

Slews the mount to the coordinates that have been assigned by `~set_target_coordinates`. If no coordinates have been set, do nothing and return `False`, otherwise return response from the mount.

If *blocking=True* then wait for up to *timeout* seconds for the mount to reach the *is\_tracking* state. If a timeout occurs, raise a `pocs.error.Timeout` exception.

**Parameters**

- **blocking**(*bool, optional*) – If command should block while slewing to home, default `False`.
- **timeout**(*int, optional*) – Maximum time spent slewing to home, default 180 seconds.

**Returns**

indicating success

**Return type**

`bool`

**slew\_to\_zero**(*blocking=False*)

Calls `slew_to_home` in base class. Can be overridden.

**property state**

Mount state.

**Type**

`bool`

**property status**

**property tracking\_rate**

Mount tracking rate

**Type**

bool

**unpark()**

Unparks the mount. Does not do any movement commands but makes them available again.

**Returns**

indicating success

**Return type**

bool

**update\_status()**

Thin-wrapper to call the status property.

**abstract write(cmd)****panoptes.pocs.mount.serial module**

```
class panoptes.pocs.mount.serial.AbstractSerialMount(location, *args, **kwargs)
```

Bases: [AbstractMount](#), [ABC](#)

**connect()**

Connects to the mount via the serial port (*self.\_port*)

**Returns**

Returns the *self.is\_connected* property (bool) which checks the actual serial connection.

**disconnect()****read(\*args)**

Reads from the serial connection.

**Returns**

Response from mount

**Return type**

str

**set\_tracking\_rate(direction='ra', delta=0.0)**

Set the tracking rate for the mount :param direction: Either *ra* or *dec* :type direction: str, optional :param delta: Offset multiple of sidereal rate, defaults to 0.0 :type delta: float, optional

**write(cmd)**

Sends a string command to the mount via the serial port.

First ‘translates’ the message into the form specific mount can understand using the mount configuration yaml file. This method is most often used from within *query* and may become a private method in the future.

---

**Note:** This command currently does not support the passing of parameters. See *query* instead.

---

**Parameters**

**cmd** (*str*) – A command to send to the mount. This should be one of the commands listed in the mount commands yaml file.

**panoptes.pocs.mount.simulator module**

**class** panoptes.pocs.mount.simulator.**Mount**(*location*, \**args*, \*\**kwargs*)

Bases: [\*AbstractMount\*](#)

Mount class for a simulator. Use this when you don't actually have a mount attached.

**connect**()

Connect to the mount.

**disconnect**()

**get\_current\_coordinates**()

Reads out the current coordinates from the mount.

---

**Note:** See *\_mount\_coord\_to\_skycoord* and *\_skycoord\_to\_mount\_coord* for translation of mount specific coordinates to `astropy.coordinates.SkyCoord`

---

**Returns**

`astropy.coordinates.SkyCoord`

**get\_ms\_offset**(*offset*, *axis*='ra')

Fake offset in milliseconds

**Parameters**

**offset** (*astropy.units.Angle*) – Offset in arcseconds

**Returns**

Offset in milliseconds at current speed

**Return type**

`astropy.units.Quantity`

**initialize**(*unpark*=False, \**arg*, \*\**kwargs*)

Initialize the connection with the mount and setup for location.

iOptron mounts are initialized by sending the following two commands to the mount:

- Version
- MountInfo

If the mount is successfully initialized, the *\_setup\_location\_for\_mount* method is also called.

**Returns**

Returns the value from *self.\_is\_initialized*.

**Return type**

`bool`

**move\_direction**(*direction*='north', *seconds*=1.0)

Move mount in specified *direction* for given amount of *seconds*



**park()**

Sets the mount to park for simulator

**query**(*cmd*, *params=None*, *\*\*kwargs*)

Sends a query to the mount and returns response.

Performs a send and then returns response. Will do a translate on *cmd* first. This should be the major serial utility for commands. Accepts an additional *args* that is passed along with the command. Checks for and only accepts one *args* param.

**Parameters**

- **cmd** (*str*) – A command to send to the mount. This should be one of the commands listed in the mount commands yaml file.
- **params** (*str*, *optional*) – Params to pass to serial connection

**Examples**

```
>>> from panoptes.pocs.mount import create_mount_from_config
>>> mount = create_mount_from_config()
>>> mount.query('set_local_time', '101503')
'1'
>>> mount.query('get_local_time')
'101503'
```

**Returns**

The response from the mount.

**Return type**

*str*

**Deleted Parameters:**

*\*args*: Parameters to be sent with command if required.

**read**(*\*args*)

**set\_tracking\_rate**(*direction='ra'*, *delta=0.0*)

Sets the tracking rate for the mount

**slew\_to\_home**(*blocking=False*, *timeout=1*)

Slows the mount to the home position.

---

**Note:** Home position and Park position are not the same thing

---

**Returns**

indicating success

**Return type**

*bool*

**slew\_to\_target**(*slew\_delay=0.5, \*args, \*\*kwargs*)

Slews to the currently assigned target coordinates.

Slews the mount to the coordinates that have been assigned by `~set_target_coordinates`. If no coordinates have been set, do nothing and return *False*, otherwise return response from the mount.

If *blocking=True* then wait for up to *timeout* seconds for the mount to reach the *is\_tracking* state. If a timeout occurs, raise a *pocs.error.Timeout* exception.

**Parameters**

- **blocking** (*bool*, *optional*) – If command should block while slewing to home, default *False*.
- **timeout** (*int*, *optional*) – Maximum time spent slewing to home, default 180 seconds.

**Returns**

indicating success

**Return type**

*bool*

**stop\_slew**(*next\_position='is\_tracking'*)

**unpark**()

Unparks the mount. Does not do any movement commands but makes them available again.

**Returns**

indicating success

**Return type**

*bool*

**write**(*cmd*)

## Module contents

`panoptes.pocs.mount.create_mount_from_config`(*mount\_info=None, earth\_location=None, \*args, \*\*kwargs*) → *AbstractMount*

Create a mount instance based on the provided config.

Creates an instance of the *AbstractMount* sub-class in the module specified in the config. Specifically, the class must be in a file called `pocs/mount/<DRIVER_NAME>.py`, and the class must be called *Mount*.

**Parameters**

- **mount\_info** – Optional param which overrides the ‘mount’ entry in config if provided. Useful for testing.
- **earth\_location** – *astropy.coordinates.EarthLocation* instance, representing the location of the mount on the Earth. If not specified, the config must include the observatory’s location (Latitude, Longitude and Altitude above mean sea level). Useful for testing.
- **\*args** – Other positional args will be passed to the concrete class specified in the config.
- **\*\*kwargs** – Other keyword args will be passed to the concrete class specified in the config.

**Returns**

An instance of the *Mount* class if the config (or *mount\_info*) is complete. *None* if neither *mount\_info* nor `config[‘mount’]` is provided.

**Raises**

**error.MountNotFound** – Exception raised when mount cannot be created because of incorrect configuration.

```
panoptes.pocs.mount.create_mount_simulator(mount_info=None, earth_location=None,
                                             db_type='memory', *args, **kwargs)
```

**panoptes.pocs.scheduler package****Subpackages****panoptes.pocs.scheduler.observation package****Submodules****panoptes.pocs.scheduler.observation.base module**

```
class panoptes.pocs.scheduler.observation.base.Exposure(image_id: str, path: pathlib.Path,
                                                         metadata: dict, is_primary: bool = False)
```

Bases: `object`

**image\_id:** `str`

**is\_primary:** `bool` = `False`

**metadata:** `dict`

**path:** `Path`

```
class panoptes.pocs.scheduler.observation.base.Observation(field, exptime=<Quantity 120. s>,
                                                           min_nexp=60, exp_set_size=10,
                                                           priority=100, filter_name=None,
                                                           dark=False, *args, **kwargs)
```

Bases: `PanBase`

```
add_to_exposure_list(cam_name: str, exposure: Exposure)
```

Add the exposure to the list and mark as most recent

```
property current_exp_num: int
```

Return the current number of exposures.

Returns the maximum size of the exposure list from each camera.

**Returns**

The size of `self.exposure_list`.

**Return type**

`int`

```
property directory: Path
```

Return the directory for this Observation.

This return the base directory for the Observation. This does *not* include the subfolders for each of the cameras.

**Returns**

Full path to base directory.

**Return type**

`str`

**property exptime****property exptimes**

Exposure time as a list.

**property first\_exposure:** `List[Dict[str, Exposure]] | None`

Return the first exposure information.

**Returns**

*image\_id* and full path of the first exposure from the primary camera.

**Return type**

`tuple`

**classmethod from\_dict**(*observation\_config*: `Dict`, *field\_class*=`'panoptes.pocs.scheduler.field.Field'`,  
*observation\_class*=`'panoptes.pocs.scheduler.observation.base.Observation'`)

Creates an *Observation* object from config dict.

**Parameters**

- **observation\_config** (`dict`) – Configuration for *Field* and *Observation*.
- **field\_class** (`str`, *optional*) – The full name of the python class to be used as default for the observation's *Field*. This can be overridden by specifying the “type” item under the *observation\_config*'s “field” key. Default: `panoptes.pocs.scheduler.field.Field`.
- **observation\_class** (`str`, *optional*) – The full name of the python class to be used as default for the observation object. This can be overridden by specifying the “type” item under the *observation\_config*'s “observation” key. Default: `panoptes.pocs.scheduler.observation.base.Observation`.

**get\_exposure**(*number*: `int` = 0) → `List[Dict[str, Exposure]] | None`

Returns the given exposure number.

**property last\_exposure:** `List[Dict[str, Exposure]] | None`

Return the latest exposure information.

**Returns**

*image\_id* and full path of most recent exposure from the primary camera

**Return type**

`tuple`

**property minimum\_duration**

Minimum amount of time to complete the observation

**property name**

Name of the `~pocs.scheduler.field.Field` associated with the observation.

**property pointing\_image**

Return the last pointing image.

**Returns**

*image\_id* and full path of most recent pointing image from  
the primary camera.

**Return type**`tuple`**reset()**

Resets the exposure information for the observation

**property seq\_time**

The time at which the observation was selected by the scheduler.

This is used for path name construction.

**property set\_duration**

Amount of time per set of exposures.

**property set\_is\_finished**

Check if the current observing block has finished, which is True when the minimum number of exposures have been obtained and integer number of sets have been completed. :returns: True if finished, False if not. :rtype: bool

**property status:** `Dict`

Observation status.

**Returns**

Dictionary containing current status of observation.

**Return type**`dict`**to\_dict()**

Serialize the object to a dict.

**panoptes.pocs.scheduler.observation.bias module**

```
class panoptes.pocs.scheduler.observation.bias.BiasObservation(position, min_nexp=None,
                                                                exp_set_size=None)
```

Bases: *Observation*

**panoptes.pocs.scheduler.observation.compound module**

```
class panoptes.pocs.scheduler.observation.compound.Observation(*args, **kwargs)
```

Bases: *Observation*

An observation that consists of different combinations of exptimes.

**property exptime**

Return current exposure time as a u.Quantity.

**property exptimes**

Exposure time as a list.

```
classmethod from_dict(*args, **kwargs)
```

Creates an *Observation* object from config dict.

## panoptes.pocs.scheduler.observation.dark module

**class** panoptes.pocs.scheduler.observation.dark.**DarkObservation**(*position*, *exptimes=None*)

Bases: *Observation*

**property** **exptime**

Return current exposure time as a u.Quantity.

## Module contents

### Submodules

## panoptes.pocs.scheduler.constraint module

**class** panoptes.pocs.scheduler.constraint.**AlreadyVisited**(*\*args*, *\*\*kwargs*)

Bases: *BaseConstraint*

Simple Already Visited Constraint

A simple already visited constraint that determines if the given *observation* has already been visited before. If given *observation* has already been visited then it will not be considered for a call to become the *current observation*.

**get\_score**(*time*, *observer*, *observation*, *\*\*kwargs*)

**class** panoptes.pocs.scheduler.constraint.**Altitude**(*horizon=None*, *obstructions=None*, *\*args*, *\*\*kwargs*)

Bases: *BaseConstraint*

Implements altitude constraints for a horizon

**get\_score**(*time*, *observer*, *observation*, *\*\*kwargs*)

**class** panoptes.pocs.scheduler.constraint.**BaseConstraint**(*weight=1.0*, *default\_score=0.0*, *\*args*, *\*\*kwargs*)

Bases: *PanBase*

**get\_score**(*time*, *observer*, *target*, *\*\*kwargs*)

**class** panoptes.pocs.scheduler.constraint.**Duration**(*horizon=None*, *\*args*, *\*\*kwargs*)

Bases: *BaseConstraint*

**get\_score**(*time*, *observer*, *observation*, *\*\*kwargs*)

**class** panoptes.pocs.scheduler.constraint.**MoonAvoidance**(*separation=<Quantity 15. deg>*, *\*args*, *\*\*kwargs*)

Bases: *BaseConstraint*

**get\_score**(*time*, *observer*, *observation*, *\*\*kwargs*)

## panoptes.pocs.scheduler.dispatch module

**class** panoptes.pocs.scheduler.dispatch.Scheduler(\*args, \*\*kwargs)

Bases: *BaseScheduler*

**get\_observation**(time=None, show\_all=False, constraints=None, read\_file=False)

Get a valid observation.

### Parameters

- **time** (*astropy.time.Time*, optional) – Time at which scheduler applies, defaults to time called
- **constraints** (*list of panoptes.pocs.scheduler.constraint.Constraint*, optional) – The constraints to check. If *None* (the default), use the *scheduler.constraints*.
- **show\_all** (*bool*, optional) – Return all valid observations along with merit value, defaults to False to only get top value
- **constraints** – The constraints to check. If *None* (the default), use the *scheduler.constraints*
- **read\_file** (*bool*, optional) – If the fields file should be reread before scheduling occurs, defaults to False.

### Returns

A tuple (or list of tuples) with name and score of ranked observations

### Return type

*tuple* or *list*

## panoptes.pocs.scheduler.field module

**class** panoptes.pocs.scheduler.field.Field(name, position, equinox='J2000', \*args, \*\*kwargs)

Bases: *FixedTarget*, *PanBase*

**property** field\_name

Flattened field name appropriate for paths

**classmethod** from\_altaz(name, alt, az, location, time=None, \*args, \*\*kwargs)

Create a Field from AltAz coords, a location, and optional time.

## panoptes.pocs.scheduler.scheduler module

**class** panoptes.pocs.scheduler.scheduler.BaseScheduler(observer, fields\_list=None, fields\_file=None, constraints=None, \*args, \*\*kwargs)

Bases: *PanBase*

**add\_observation**(observation\_config, \*\*kwargs)

Adds an *Observation* to the scheduler.

### Parameters

**observation\_config** (*dict*) – Configuration dict for *Field* and *Observation*.

**clear\_available\_observations**()

Reset the list of available observations

**property current\_observation**

The observation that is currently selected by the scheduler

Upon setting a new observation the *seq\_time* is set to the current time and added to the *observed\_list*. An old observation is reset (so that it can be used again - see *~pocs.scheduler.observation.reset*). If the new observation is the same as the old observation, nothing is done. The new observation can also be set to *None* to specify there is no current observation.

**property fields\_file**

Field configuration file

A YAML list of config items, specifying a minimum of *name* and *position* for the *~pocs.scheduler.field.Field*. `Observation`s will be built from the list of fields.

A file will be read by *~pocs.scheduler.priority.read\_field\_list* upon being set.

---

**Note:** Setting a new *fields\_file* will clear all existing fields

---

**property fields\_list**

List of field configuration items

A YAML list of config items, specifying a minimum of *name* and *position* for the *~pocs.scheduler.field.Field*. `Observation`s will be built from the list of fields.

A file will be read by *~pocs.scheduler.priority.read\_field\_list* upon being set.

---

**Note:** Setting a new *fields\_list* will clear all existing fields

---

**abstract get\_observation(\*args, \*\*kwargs)**

Get a valid observation.

**property has\_valid\_observations****observation\_available(observation, time)**

Check if observation is available at given time

**Parameters**

- **observation** (*pocs.scheduler.observation*) – An Observation object
- **time** (*astropy.time.Time*) – The time at which to check observation

**property observations**

Returns a dict of *~pocs.scheduler.observation.Observation* objects with *~pocs.scheduler.observation.Observation.field.field\_name* as the key

---

**Note:** *read\_field\_list* is called if list is None

---

**read\_field\_list()**

Reads the field file and creates valid *Observations*.

**remove\_observation(field\_name)**

Removes an *Observation* from the scheduler

**Parameters**

- **field\_name** (*str*) – Field name corresponding to entry key in *observations*



**reset\_observed\_list()**

Reset the observed list

**set\_common\_properties(*time*)**

Sets some properties common to all observations, such as end of night, moon, etc.

**property status**

## Module contents

`panoptes.pocs.scheduler.create_constraints_from_config(config=None) → List[BaseConstraint]`

`panoptes.pocs.scheduler.create_scheduler_from_config(config=None, observer=None, iers_url=None, *args, **kwargs) → BaseScheduler | None`

Sets up the scheduler that will be used by the observatory

## panoptes.pocs.sensor package

### Submodules

#### panoptes.pocs.sensor.power module

#### panoptes.pocs.sensor.remote module

**class** `panoptes.pocs.sensor.remote.RemoteMonitor(endpoint_url: str = None, sensor_name: str = None, *args, **kwargs)`

Bases: [PanBase](#)

Does a pull request on an endpoint to obtain a JSON document.

**capture**(*store\_result: bool = True*) → dict

Read JSON from endpoint url and capture data.

---

**Note:** Currently this doesn't do any processing or have a callback.

---

#### Returns

Dictionary of sensors keyed by sensor name.

#### Return type

sensor\_data (dict)

**disconnect()**

## panoptes.pocs.sensor.weather module

### Module contents

## panoptes.pocs.state package

### Subpackages

## panoptes.pocs.state.states package

### Subpackages

## panoptes.pocs.state.states.default package

### Submodules

## panoptes.pocs.state.states.default.analyzing module

`panoptes.pocs.state.states.default.analyzing.on_enter(event_data)`

## panoptes.pocs.state.states.default.housekeeping module

`panoptes.pocs.state.states.default.housekeeping.on_enter(event_data)`

## panoptes.pocs.state.states.default.observing module

`panoptes.pocs.state.states.default.observing.on_enter(event_data)`

Take an observation image.

This state is responsible for taking the actual observation image.

## panoptes.pocs.state.states.default.parked module

`panoptes.pocs.state.states.default.parked.on_enter(event_data)`

## panoptes.pocs.state.states.default.parking module

`panoptes.pocs.state.states.default.parking.on_enter(event_data)`

### panoptes.pocs.state.states.default.pointing module

panoptes.pocs.state.states.default.pointing.**on\_enter**(*event\_data*)

Pointing State

Take 30 second exposure and plate-solve to get the pointing error

### panoptes.pocs.state.states.default.ready module

panoptes.pocs.state.states.default.ready.**on\_enter**(*event\_data*)

Once in the *ready* state our unit has been initialized successfully. The next step is to schedule something for the night.

### panoptes.pocs.state.states.default.scheduling module

panoptes.pocs.state.states.default.scheduling.**on\_enter**(*event\_data*)

In the *scheduling* state we attempt to find a field using our scheduler. If field is found, make sure that the field is up right now (the scheduler should have taken care of this). If observable, set the mount to the field and calls *start\_slewing* to begin slew.

If no observable targets are available, *park* the unit.

### panoptes.pocs.state.states.default.sleeping module

panoptes.pocs.state.states.default.sleeping.**on\_enter**(*event\_data*)

### panoptes.pocs.state.states.default.slewing module

panoptes.pocs.state.states.default.slewing.**on\_enter**(*event\_data*)

Once inside the slewing state, set the mount slewing.

### panoptes.pocs.state.states.default.tracking module

panoptes.pocs.state.states.default.tracking.**on\_enter**(*event\_data*)

The unit is tracking the target. Proceed to observations.

## Module contents

## Module contents

## Submodules

## panoptes.pocs.state.machine module

**class** panoptes.pocs.state.machine.PanStateMachine(*state\_machine\_table*, *\*\*kwargs*)

Bases: Machine

A finite state machine for PANOPTES.

The state machine guides the overall action of the unit.

**after\_state**(*event\_data*)

Called after each state.

**Parameters**

**event\_data** (*transitions.EventData*) – Contains information about the event

**before\_state**(*event\_data*)

Called before each state.

**Parameters**

**event\_data** (*transitions.EventData*) – Contains information about the event

**check\_safety**(*event\_data=None*)

Checks the safety flag of the system to determine if safe.

This will check the weather station as well as various other environmental aspects of the system in order to determine if conditions are safe for operation.

---

**Note:** This condition is called by the state machine during each transition

---

**Parameters**

- **event\_data** (*transitions.EventData*) – carries information about the event if
- **machine.** (*called from the state*)

**Returns**

Latest safety flag

**Return type**

bool

**goto\_next\_state**()

Make a transition to the next state.

Each state is responsible for setting the *next\_state* property based off the logic that happens inside the state. This method will look up the transition method to reach the next state and call that method.

If no transition method is defined for whatever is set as *next\_state* then the *park* method will be called.

**Returns**

If state was successfully changed.

**Return type**

bool

**classmethod** load\_state\_table(*state\_table\_name='panoptes'*)

Loads the state table :param state\_table\_name: Name of state table. Corresponds to filename in

*\$POCS/conf\_files/state\_table/* directory or to absolute path if starts with “/”. Default ‘panoptes.yaml’.

**Returns**

Dictionary with *states* and *transitions* keys.

**Return type**

`dict`

**mount\_is\_initialized**(*event\_data*)

Transitional check for mount.

This is used as a conditional check when transitioning between certain states.

**mount\_is\_tracking**(*event\_data*)

Transitional check for mount.

This is used as a conditional check when transitioning between certain states.

**property next\_state**

**run**(*exit\_when\_done=False*, *run\_once=False*, *park\_when\_done=True*, *initial\_next\_state='ready'*)

Runs the state machine loop.

This runs the state machine in a loop. Setting the machine property *is\_running* to False will stop the loop.

**Parameters**

- **exit\_when\_done** (*bool*, *optional*) – If True, the loop will exit when *do\_states* has become False, otherwise will wait (default)
- **park\_when\_done** (*bool*, *optional*) – If True (the default), park the mount when loop completes (i.e. when *keep\_running* is False).
- **run\_once** (*bool*, *optional*) – If the machine loop should only run one time, if False (the default) loop continuously.
- **initial\_next\_state** (*str*, *optional*) – The first state the machine should move to from the *sleeping* state, default *ready*.

**stop\_states**()

Stops the machine loop on the next iteration by setting *do\_states=False*

**Module contents**

**panoptes.pocs.utils package**

**Subpackages**

**panoptes.pocs.utils.cli package**

**Submodules**

**panoptes.pocs.utils.cli.camera module**

**panoptes.pocs.utils.cli.camera.take\_pictures**(*num\_images: int = 1*, *exptime: float = 1.0*, *output\_dir: Path = '/home/panoptes/images'*, *delay: float = 0.0*)

Takes pictures with cameras.

## panoptes.pocs.utils.cli.config module

```
class panoptes.pocs.utils.cli.config.HostInfo(*, host: str = '127.0.0.1', port: int = 6563, verbose: bool = False)
```

Bases: BaseModel

Metadata for the Config Server

**host:** *str*

**port:** *int*

**property** url

**verbose:** *bool*

```
panoptes.pocs.utils.cli.config.get_value(key: str | None = <typer.models.ArgumentInfo object>, parse: bool = <typer.models.OptionInfo object>)
```

Get an item from the config

```
panoptes.pocs.utils.cli.config.main(context: Context)
```

```
panoptes.pocs.utils.cli.config.restart()
```

Restart the config server process via supervisorctl

```
panoptes.pocs.utils.cli.config.server_running()
```

Check if the config server is running

```
panoptes.pocs.utils.cli.config.set_value(key: str = <typer.models.ArgumentInfo object>, value: str = <typer.models.ArgumentInfo object>)
```

Get an item from the config

```
panoptes.pocs.utils.cli.config.setup()
```

Do initial setup of the config server

```
panoptes.pocs.utils.cli.config.status()
```

## panoptes.pocs.utils.cli.main module

## panoptes.pocs.utils.cli.mount module

```
panoptes.pocs.utils.cli.mount.park_mount(confirm: bool = False)
```

Parks the mount.

Warning: This will move the mount to the park position but will not do any safety checking. Please make sure the mount is safe to park before running this command.

```
panoptes.pocs.utils.cli.mount.search_for_home(confirm: bool = False)
```

Searches for the mount home position.

Warning: This will move the mount to the home position but will not do any safety checking. Please make sure the mount is safe to move before running this command.

`panoptes.pocs.utils.cli.mount.set_park_position(confirm: bool = False)`

Sets the park position.

Warning: This will move the mount to the park position but will not do any safety checking. Please make sure the mount is safe to move before running this command.

`panoptes.pocs.utils.cli.mount.setup_mount(confirm: bool = False)`

Sets up the mount port, type, and firmware.

## panoptes.pocs.utils.cli.network module

## panoptes.pocs.utils.cli.notebook module

`panoptes.pocs.utils.cli.notebook.check_for_jupyter()`

Check if Jupyter is installed

`panoptes.pocs.utils.cli.notebook.restart()`

Restart the jupyter server process via supervisorctl

`panoptes.pocs.utils.cli.notebook.set_password(environment: str = <typer.models.OptionInfo object>)`

Set a password for the notebook server

`panoptes.pocs.utils.cli.notebook.start(environment: str = <typer.models.OptionInfo object>, public: bool = <typer.models.OptionInfo object>, port: int = <typer.models.OptionInfo object>, notebook_dir: ~pathlib.Path = <typer.models.OptionInfo object>)`

Start a Jupyter notebook server

## panoptes.pocs.utils.cli.power module

## panoptes.pocs.utils.cli.run module

## panoptes.pocs.utils.cli.sensor module

`panoptes.pocs.utils.cli.sensor.main(context: Context)`

`panoptes.pocs.utils.cli.sensor.monitor(sensor_name: str, endpoint: str | None = <typer.models.OptionInfo object>, store: bool = <typer.models.OptionInfo object>, read_frequency: int = <typer.models.OptionInfo object>, verbose: bool = False)`

Continuously read remote sensor, optionally storing results.

## panoptes.pocs.utils.cli.weather module

`panoptes.pocs.utils.cli.weather.config`(*page*='config', *base\_url*='http://localhost:6566')

Get the configuration of the weather station.

`panoptes.pocs.utils.cli.weather.get_page`(*page*, *base\_url*)

`panoptes.pocs.utils.cli.weather.restart`(*service*: *str* = 'pocs-weather-reader')

Restart the weather station service via supervisorctl

`panoptes.pocs.utils.cli.weather.status`(*page*='status', *base\_url*='http://localhost:6566')

Get the status of the weather station.

## Module contents

### panoptes.pocs.utils.service package

#### Submodules

#### panoptes.pocs.utils.service.power module

#### panoptes.pocs.utils.service.weather module

## Module contents

#### Submodules

#### panoptes.pocs.utils.cloud module

#### panoptes.pocs.utils.error module

**exception** `panoptes.pocs.utils.error.AboveMaxExptime`(*msg*='Exposure time is too high for camera.',  
\*\**kwargs*)

Bases: [PocsError](#)

An invalid exptime for a camera, too high.

**exception** `panoptes.pocs.utils.error.BelowMinExptime`(*msg*='Exposure time is too low for camera.',  
\*\**kwargs*)

Bases: [PocsError](#)

An invalid exptime for a camera, too low.

**exception** `panoptes.pocs.utils.error.CameraBusy`(*msg*='Camera busy.', \*\**kwargs*)

Bases: [PocsError](#)

A camera is already busy.

**exception** `panoptes.pocs.utils.error.ImageSaturated`(*msg*='Image is saturated', \*\**kwargs*)

Bases: [PocsError](#)

An image is saturated.



**exception** `panoptes.pocs.utils.error.NotSafeError(msg='Not safe', **kwargs)`

Bases: `PanError`

Error for when safety fails.

**exception** `panoptes.pocs.utils.error.NotTwilightError(msg='Not twilight', **kwargs)`

Bases: `PanError`

Error for when taking twilight flats and not twilight.

**exception** `panoptes.pocs.utils.error.PocsError(msg='Problem with POCS', **kwargs)`

Bases: `PanError`

Error for a POCS level exception

## **panoptes.pocs.utils.location module**

**class** `panoptes.pocs.utils.location.SiteDetails(observer: astroplan.observer.Observer,  
earth_location:  
astropy.coordinates.earth.EarthLocation, location:  
dict)`

Bases: `object`

**earth\_location:** `EarthLocation`

**location:** `dict`

**observer:** `Observer`

`panoptes.pocs.utils.location.create_location_from_config()` → *SiteDetails*

Sets up the site and location details.

**These items are read from the ‘site’ config directive and include:**

- name
- latitude
- longitude
- timezone
- pressure
- elevation
- horizon

`panoptes.pocs.utils.location.download_iers_a_file(iers_url: str = None)`

Download the IERS A file.

This will download the IERS from the PANOPTES mirror and then set the auto download to False.

## panoptes.pocs.utils.logger module

**class** panoptes.pocs.utils.logger.PanLogger

Bases: `object`

Custom formatter to have dynamic widths for logging.

Also provides a *handlers* dictionary to track attached handlers by id.

See <https://loguru.readthedocs.io/en/stable/resources/recipes.html#dynamically-formatting-messages-to-properly-align-values-with-padding>

**format**(*record*)

```
panoptes.pocs.utils.logger.get_logger(console_log_file='panoptes.log',
                                       full_log_file='panoptes_{time:YYYYMMDD!UTC}.log',
                                       serialize_full_log=False, log_dir=None,
                                       console_log_level='DEBUG', stderr_log_level='INFO',
                                       cloud_logging_level=None)
```

Creates a root logger for PANOPTES used by the PanBase object.

Two log files are created, one suitable for viewing on the console (via *tail*) and a full log file suitable for archive and later inspection. The full log file is serialized into JSON.

Note: This clobbers all existing loggers and forces the two files.

### Parameters

- **console\_log\_file** (*str/None, optional*) – Filename for the file that is suitable for tailing in a shell (i.e., read by humans). This file is rotated daily however the files are not retained.
- **full\_log\_file** (*str/None, optional*) – Filename for log file that includes all levels and is serialized and rotated automatically. Useful for uploading to log service website. Defaults to *panoptes\_{time:YYYYMMDD!UTC}.log.gz* with a daily rotation at 11:30am and a 7 day retention policy. If *None* then no file will be generated.
- **serialize\_full\_log** (*bool, optional*) – If the full log should be written as json for log analysis, default False.
- **log\_dir** (*str/None, optional*) – The directory to place the log file, default local *logs*.
- **stderr\_log\_level** (*str, optional*) – The log level to show on stderr, default INFO.
- **console\_log\_level** (*str, optional*) – Log level for console file output, defaults to 'SUCCESS'. Note that it should be a string that matches standard *logging* levels and also includes *TRACE* (below *DEBUG*) and *SUCCESS* (above *INFO*). Also note this is not the stderr output, but the output to the file to be tailed.
- **cloud\_logging\_level** (*bool/None, optional*) – If a valid log level is specified, send logs to cloud at that level. If *None* (the default) don't send logs to the cloud.

### Returns

A configured instance of the logger.

### Return type

*loguru.logger*

## panoptes.pocs.utils.plotting module

`panoptes.pocs.utils.plotting.make_autofocus_plot(output_path, initial_thumbnail, final_thumbnail, initial_focus, final_focus, focus_positions, metrics, merit_function, line_fit=None, plot_title='Autofocus Plot', plot_width=9, plot_height=18)`

Make autofocus plots.

This will make three plots, the top and bottom plots showing the initial and final thumbnail, respectively. The middle plot will contain the scatter plot for the *metrics* for the given *focus\_positions*.

### Parameters

- **output\_path** (*str*) – Path for saving plot.
- **initial\_thumbnail** (*np.array*) – The data for the initial thumbnail.
- **final\_thumbnail** (*np.array*) – The data for the final thumbnail.
- **initial\_focus** (*int*) – The initial focus position.
- **final\_focus** (*int*) – The final focus position.
- **focus\_positions** (*np.array*) – An array of *int* corresponding the focus positions.
- **metrics** (*np.array*) – An array of *float* corresponding to the measured metrics.
- **merit\_function** (*str*) – The name of the merit function used to produce the metrics.
- **line\_fit** (*tuple(np.array, np.array)*) – A tuple for the fitted line. The first entry should be an array of *int* used to calculate fit, the second entry should be an array of the fitted values.
- **plot\_title** (*str*) – Title to use for plot
- **plot\_width** (*int*) – The plot width in inches.
- **plot\_height** (*int*) – The plot height in inches.

### Returns

Full path the saved plot.

### Return type

*str*

## panoptes.pocs.utils.theskyx module

`class panoptes.pocs.utils.theskyx.TheSkyX(host='localhost', port=3040, connect=True, *args, **kwargs)`

Bases: `object`

A socket connection for communicating with TheSkyX

**connect()**

Sets up serial connection

**property is\_connected**

**read(timeout=5)**

**write(value)**

## Module contents

### Submodules

#### panoptes.pocs.base module

**class** panoptes.pocs.base.**PanBase**(*config\_host=None, config\_port=None, \*args, \*\*kwargs*)

Bases: `object`

Base class for other classes within the PANOPTES ecosystem

Defines common properties for each class (e.g. logger, config, db).

**get\_config**(\*args, \*\*kwargs)

Thin-wrapper around client based get\_config that sets default port.

See *panoptes.utils.config.client.get\_config* for more information.

#### Parameters

- **\*args** – Passed to get\_config
- **\*\*kwargs** – Passed to get\_config

**set\_config**(key, new\_value, \*args, \*\*kwargs)

Thin-wrapper around client based set\_config that sets default port.

See *panoptes.utils.config.client.set\_config* for more information.

#### Parameters

- **key** (*str*) – The key name to use, can be namespaced with dots.
- **new\_value** (*any*) – The value to store.
- **\*args** – Passed to set\_config
- **\*\*kwargs** – Passed to set\_config

#### panoptes.pocs.core module

#### panoptes.pocs.hardware module

Information about hardware supported by Panoptes.

**class** panoptes.pocs.hardware.**HardwareName**(*value, names=None, \*values, module=None, qualname=None, type=None, start=1, boundary=None*)

Bases: `Enum`

**camera** = 'camera'

**dome** = 'dome'

**mount** = 'mount'

**night** = 'night'

**power** = 'power'

```
sensors = 'sensors'
```

```
theskyx = 'theskyx'
```

```
weather = 'weather'
```

`panoptes.pocs.hardware.get_all_names(all_names=None, without=None)`

Returns the names of all the categories of hardware that POCS supports.

Note that this doesn't extend to the Arduinos for the telemetry and camera boards, for which no simulation is supported at this time.

```
>>> from panoptes.pocs.hardware import get_all_names
>>> get_all_names()
['camera', 'dome', 'mount', 'night', 'power', 'sensors', 'theskyx', 'weather']
>>> get_all_names(without='mount') # Single item
['camera', 'dome', 'night', 'power', 'sensors', 'theskyx', 'weather']
>>> get_all_names(without=['mount', 'power']) # List
['camera', 'dome', 'night', 'sensors', 'theskyx', 'weather']
```

```
>>> # You can alter available hardware if needed.
>>> get_all_names(['foo', 'bar', 'power'], without=['power'])
['bar', 'foo']
```

#### Parameters

- **all\_names** (*list*) – The list of hardware.
- **without** (*iterable*) – Return all items except those in the list.

#### Returns

The sorted list of available hardware except those listed in *without*.

#### Return type

*list*

`panoptes.pocs.hardware.get_simulator_names(simulator=None, kwargs=None)`

Returns the names of the simulators to be used in lieu of hardware drivers.

Note that returning a list containing 'X' doesn't mean that the config calls for a driver of type 'X'; that is up to the code working with the config to create drivers for real or simulated hardware.

This function is intended to be called from *PanBase* or similar, which receives *kwargs* that may include *simulator*, *config* or both. For example:

```
get_simulator_names(config=self.config, kwargs=kwargs)

# Or:

get_simulator_names(simulator=simulator, config=self.config)
```

The reason this function doesn't just take **\*\*kwargs** as its sole arg is that we need to allow for the case where the caller is passing in *simulator* (or *config*) twice, once on its own, and once in the *kwargs* (which won't be examined). Python doesn't permit a keyword argument to be passed in twice.

```
>>> from panoptes.pocs.hardware import get_simulator_names
>>> get_simulator_names()
[]
>>> get_simulator_names('all')
['camera', 'dome', 'mount', 'night', 'power', 'sensors', 'theskyx', 'weather']
```

#### Parameters

- **simulator** (*list*) – An explicit list of names of hardware to be simulated (i.e. hardware drivers to be replaced with simulators).
- **kwargs** – The kwargs passed in to the caller, which is inspected for an arg called ‘simulator’.

#### Returns

List of names of the hardware to be simulated.

### panoptes.pocs.images module

**class** panoptes.pocs.images.**Image**(*fits\_file*: *Path*, *wcs\_file*=None, *location*=None, \*args, \*\*kwargs)

Bases: *PanBase*

**compute\_offset**(*ref\_image*)

**get\_header\_pointing**()

Get the pointing information from the header

The header should contain the *RA-MNT* and *DEC-MNT* keywords, from which the header pointing coordinates are built.

**get\_wcs\_pointing**()

Get the pointing information from the WCS

Builds the pointing coordinates from the plate-solved WCS. These will be compared with the coordinates stored in the header.

**property** **pointing\_error**

Pointing error namedtuple (delta\_ra, delta\_dec, magnitude)

Returns pointing error information. The first time this is accessed this will solve the field if not previously solved.

#### Returns

Pointing error information

#### Return type

namedtuple

**solve\_field**(*radius*=15, \*\*kwargs)

Solve field and populate WCS information.

#### Parameters

- **radius** (*scalar*) – The radius (in degrees) to search near RA-Dec. Defaults to 15°.
- **\*\*kwargs** – Options to be passed to *get\_solve\_field*.

**property wcs\_file**

WCS file name

When setting the WCS file name, the WCS information will be read, setting the *wcs* property.

**class** panoptes.pocs.images.**OffsetError**(*delta\_ra*, *delta\_dec*, *magnitude*)

Bases: `tuple`

**delta\_dec**

Alias for field number 1

**delta\_ra**

Alias for field number 0

**magnitude**

Alias for field number 2

**panoptes.pocs.observatory module****Module contents**

## 4.2 Contributors

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