

# ELT – MICADO

Phase C

## ScopeSim instrument packages for MICADO

ELT-TRE-MCD-56306-0059

Issue: 1.0

Date: 12. April 2021

Prepared:

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2021-12-04

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### Change record

Issue/Rev.	Date	Section/Parag. affected	Reason/Initiation/Documents/Remarks
0.1	2020-10-15	All	(KL) Layout initialised
0.2	2020-12-04	All	(KL) Added new data, tables, plots to all sections
1.0	2021-04-12	All	(KL) Minor corrections

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## **Chapter 1**

# **Introduction**

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## 1.1 Applicable Documents

Nr	Doc. Nr	Doc. Title	Issue	Date
AD 1	ELT-ICD-MCD-56306-0058	SimCADO User Manual	1.0	2021-04-12
AD 2	ELT-ICD-MCD-56306-0060	ScopeSim - A modular astronomical instrument data simulation environment	1.0	2021-04-12
AD 3	ELT-TRE-MCD-56300-0014	MICADO Masks, Stops, and Filters Description	2.9	2020-12-04



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## 1.2 Document Scope

This document aims to serve as a reference for the contents of the instrument packages relevant to the implementation of the MICADO instrument simulator using the [ScopeSim](#) package. The information provided here is a snapshot of the FDR release (Dec. 2020) of the these packages. It is possible that changes will made to files contained in the packages. For more up-to-date information, the reader is referred to the [online GitHub repository](#).

This document does not provide an overview of how to use the MICADO packages with [ScopeSim](#). For this the reader should consult the online documentation for [ScopeSim](#) or either of the two accompanying documents AD 1 and AD 2.

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## 1.3 Overview of the Instrument Packages relevant to MICADO

The MICADO instrument simulator has moved from using the stand alone SimCADO package to using the generic astronomical instrument simulator ScopeSim. As the ScopeSim code is instrument agnostic, all data related to creating instrument models are contained inside instrument packages, which are hosted on the [instrument reference database \(IRDB\)](#).

### 1.3.1 Primary MICADO packages

This document is primarily concerned with describing the contents of the two major MICADO instrument descriptions: MICADO and MICADO\_Sci. These two packages serve two different audiences:

1. The MICADO package contains all information available pertaining to the optical effects expected for the MICADO optical system. The primary user of this package will be the data flow system. The primary use case for this package is the creation of raw data frames for testing the algorithms of the reduction pipelines for the different modes of MICADO. This package is large and therefore computationally expensive and slow.
2. The MICADO\_Sci package contains a subset of the effects in the MICADO package. The primary users of this package will be the science team and outside astronomers interested in simulating observations with the future MICADO instrument. The goal of this package is enable observations to be simulated quickly, so that the user can quickly iterate on observation strategies and/or target choices. As such this package contains only the effects which cause the major optical aberrations. It is by nature not complete, but aims to provide a level of detail sufficient for the majority of observation feasibility studies for MICADO

### 1.3.2 Support packages

The MICADO packages, as the names suggest, only describe the contents of the MICADO instrument. Observations with MICADO will however rely on the ELT infrastructure, which can be decomposed into several parts: Location, Telescope, Relay optics. Each of these additional parts can be considered as closed optical elements in the full observational optical system. Indeed the relay optics element is a replacable element in the optical path (with MAORY vs stand-alone mode) Hence each of these optical elements have been given their own instrument package, and are referred to as support packages.

The support packages needed to simulate MICADO observations are also described in this document. Specifically these are:

- Armazones
- ELT
- MAORY
- Stand-alone relay optics

For each observation the Armazones and ELT packages are required. However only one of MAORY or the stand-alone relay optics packages are required.

### 1.3.3 Adding content to the packages

The contents of the packages are currently in the public domain. The raw data is [hosted on Github](#).

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Periodically this data is compiled into an instrument package and uploaded to the ScopeSim server. It is these packages which are downloaded by ScopeSim when setting up an observation simulation.

New data or Effect objects can be added by submitting a pull request to the [Github repository](#).

### 1.3.4 Contents of packages

Each package contains three types of files:

1. configuration,
2. effect descriptions, and
3. raw data

The configuration files are responsible for controlling which effects and which parameters and values are used when generating the optical model for an observation simulation. The effect files describe which classes and which values should be used when applying an effect to the photon flux of the target object, e.g. which PSF kernel should be applied at which wavelength. The raw data files provide the raw data needed by the Effect objects, e.g. the bitmaps of the PSF kernels.

In the following sections each optical element is described. Each optical element contains a description of all the optical Effects associated with it, as well as a list of the configuration keywords and values required by the effect. If an Effect required data from an external file (e.g. PSF kernels, linearity curves, etc), these data are presented as part of each Effect object - either in the `Table` or `Data` sections.

#### Note

The raw data will not always be displayed directly.

A representation of the data will be presented where available. For further details the reader is directed to view the data directly on the [IRDB](#)

## **Chapter 2**

# **MICADO Pipeline package**

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## 2.1 Summary of Effects in Optical Elements:

element	name	class	included	z_orders
armazones	armazones_atmo_default_ter_curve	AtmosphericTERCurve	True	[111, 511]
armazones	armazones_atmo_dispersion	AtmosphericDispersion	False	[231]
armazones	armazones_atmo_skycalc_ter_curve	SkycalcTERCurve	False	[112, 512]
ELT	scope_surface_list	SurfaceList	True	[20, 120, 520]
ELT	scope_vibration	Vibration	True	[244, 744]
ELT	eso_combined_reflection	TERCurve	False	[10, 110, 510]
MICADO	micado_static_surfaces	SurfaceList	True	[20, 120, 520]
MICADO	micado_ncpas_psf	NonCommonPathAberration	True	[241, 641]
MICADO	filter_wheel_1	FilterWheel	True	[124, 224, 524]
MICADO	filter_wheel_2	FilterWheel	True	[124, 224, 524]
MICADO	pupil_wheel	FilterWheel	True	[124, 224, 524]
micado_detector_array	full_detector_array	DetectorList	False	[90, 290, 390, 490]
micado_detector_array	detector_window	DetectorList	True	[90, 290, 390, 490]
micado_detector_array	qe_curve	QuantumEfficiencyCurve	True	[113, 513]
micado_detector_array	exposure_action	SummedExposure	True	[860]
micado_detector_array	dark_current	DarkCurrent	True	[830]
micado_detector_array	detector_linearity	LinearityCurve	True	[840]
micado_detector_array	shot_noise	ShotNoise	True	[820]
micado_detector_array	readout_noise	PoorMansHxRGReadoutNoise	True	[811]
default_ro	relay_psf	FieldConstantPSF	True	[262, 662]
default_ro	relay_surface_list	SurfaceList	True	[20, 120, 520]
MAORY	maory_surface_list	SurfaceList	True	[20, 120, 520]
MAORY	maory_generic_psf	FieldConstantPSF	True	[262, 662]
MICADO_IMG_LR	micado_wide_field_mirror_list	SurfaceList	True	[20, 120, 520]
MICADO_IMG_LR	micado_adc_3D_shift	AtmosphericDispersionCorrection	False	[632, 232]
MICADO_IMG_HR	zoom_mirror_list	SurfaceList	True	[20, 120, 520]
MICADO_IMG_HR	micado_adc_3D_shift	AtmosphericDispersionCorrection	False	[632, 232]
MICADO_SPEC	spec_mode_optics	SurfaceList	True	[20, 120, 520]
MICADO_SPEC	spectroscopic_slit_aperture	ApertureMask	True	[80, 280, 380]
MICADO_SPEC	micado_spectral_traces	SpectralTraceList	True	[70, 270]

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## 2.2 OpticalElement: "MICADO"

**Element:** instrument

**Alias:** INST

**Description:** Effects from the MICADO common optics

### 2.2.1 Global properties

```

temperature : -190
filter_file_format : filters/TC_filter_{\}.dat
element_name : MICADO

```

### 2.2.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
MICADO	micado_static_surfaces	SurfaceList	True	[20, 120, 520]
MICADO	micado_ncpas_psf	NonCommonPathAberration	True	[241, 641]
MICADO	filter_wheel_1	FilterWheel	True	[124, 224, 524]
MICADO	filter_wheel_2	FilterWheel	True	[124, 224, 524]
MICADO	pupil_wheel	FilterWheel	True	[124, 224, 524]

#### 2.2.2.1 SurfaceList: "micado\_static\_surfaces"

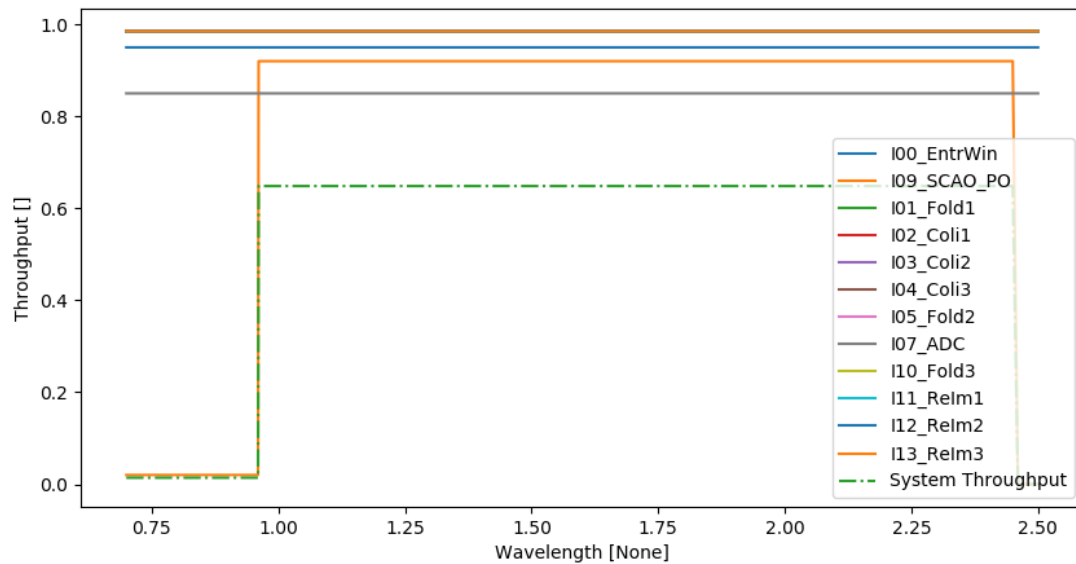
**Included by default:** True

**File Description:** surfaces list for wide field optics

**Class Description:** <no docstring>

**Changes:**

- 2019-01-28 (KL) Changed column names and added units to header
- 2019-07-10 (KL) Shortened the list to only the swappable mirrors
- 2020-08-25 (KL) Updated angle\_unit to degree from degrees (why has astropy not complained until now?)
- 2020-10-10 (KL) Added SCAO pick-off dichroic after CM17 conversation



name	outer	inner	angle	temperature	action	filename
I00_EntrWin	0.5	0.0	0	0	transmission	TER_entrance_window.dat
I09_SCAO_PO	0.5	0.0	45	-190	reflection	TER_SCAO_dichroic.dat
I01_Fold1	0.5	0.0	45	-190	reflection	TER_mirror_gold.dat
I02_Coli1	0.4	0.0	10	-190	reflection	TER_mirror_gold.dat
I03_Coli2	0.2	0.0	10	-190	reflection	TER_mirror_gold.dat
I04_Coli3	0.2	0.0	10	-190	reflection	TER_mirror_gold.dat
I05_Fold2	0.2	0.0	45	-190	reflection	TER_mirror_gold.dat
I07_ADC	0.2	0.0	0	-190	transmission	TER_full_adc.dat
I10_Fold3	0.2	0.0	45	-190	reflection	TER_mirror_gold.dat
I11_ReIm1	0.2	0.0	10	-190	reflection	TER_mirror_gold.dat
I12_ReIm2	0.2	0.0	10	-190	reflection	TER_mirror_gold.dat
I13_ReIm3	0.2	0.0	10	-190	reflection	TER_mirror_gold.dat

## Data

## Meta-data

```

filename : LIST_MICADO_mirrors_static.dat
name : micado_static_surfaces
temperature : -190
filter_file_format : filters/TC_filter_{\}.dat

```

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```

element_name : MICADO
author : Kieran Leschinski
source : Ric's SPIE 2018 PPT presentation
date_created : 2018-11-19
date_modified : 2019-07-10
status : Design, pre PDR list of all static MICADO surfaces
type : mirror:list
outer_unit : m
inner_unit : m
angle_unit : degree
temperature_unit : deg_C
z_order : [20, 120, 520]
include : True
ignore_wings : False
wave_min : !SIM.spectral.wave_min
wave_max : !SIM.spectral.wave_max
wave_unit : !SIM.spectral.wave_unit
wave_bin : !SIM.spectral.spectral_resolution
report_plot_include : True
report_table_include : True
minimum_throughput : !SIM.spectral.minimum_throughput
etendue : !TEL.etendue

```

### 2.2.2.2 NonCommonPathAberration: "micado\_ncpas\_psf"

**Included by default:** True

**File Description:** Effective NCPA induced PSF kernel

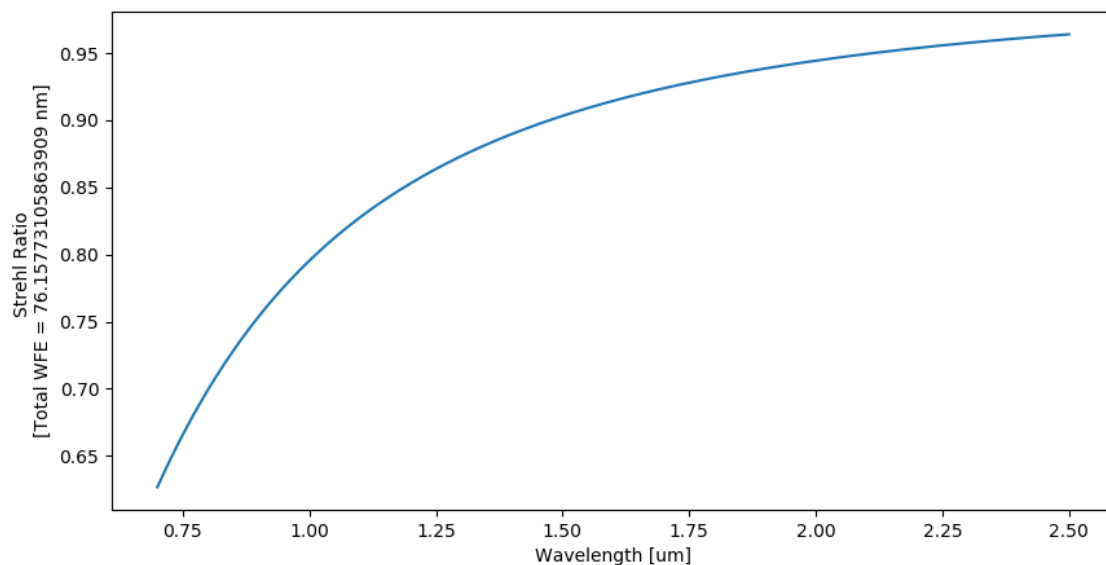
**Class Description:** Needed: pixel\_scale

**Changes:**

- 2018-11-19 (KL) updated meta data to new format



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## Data

### Meta-data

```

        filename : INST_MICADO_wavefront_error_budget.dat
        name      : micado_ncpas_psf
        temperature : -190
filter_file_format : filters/TC_filter_{\}.dat
        element_name : MICADO
        pixel_scale : 0.004
        author      : Kieran Leschinski
        sources     : Ric Davies email
        date_created : 2016-11-21
        date_modified : 2018-11-19
        type        : instrument:wavefront_errors_list
        status      : Idea - based on the WFE budget and emails with Ric
        wfe_rms_unit : nm
        z_order     : [241, 641]
        include     : True
        flux_accuracy : 0.001
        sub_pixel_flag : False
        convolve_mode : full
        wave_key     : WAVE0
        normalise_kernel : True
report_plot_include : True

```

```

report_table_include : False
kernel_width : None
strehl_drift : 0.02
wave_min : !SIM.spectral.wave_min
wave_max : !SIM.spectral.wave_max

```

### 2.2.2.3 FilterWheel: "filter\_wheel\_1"

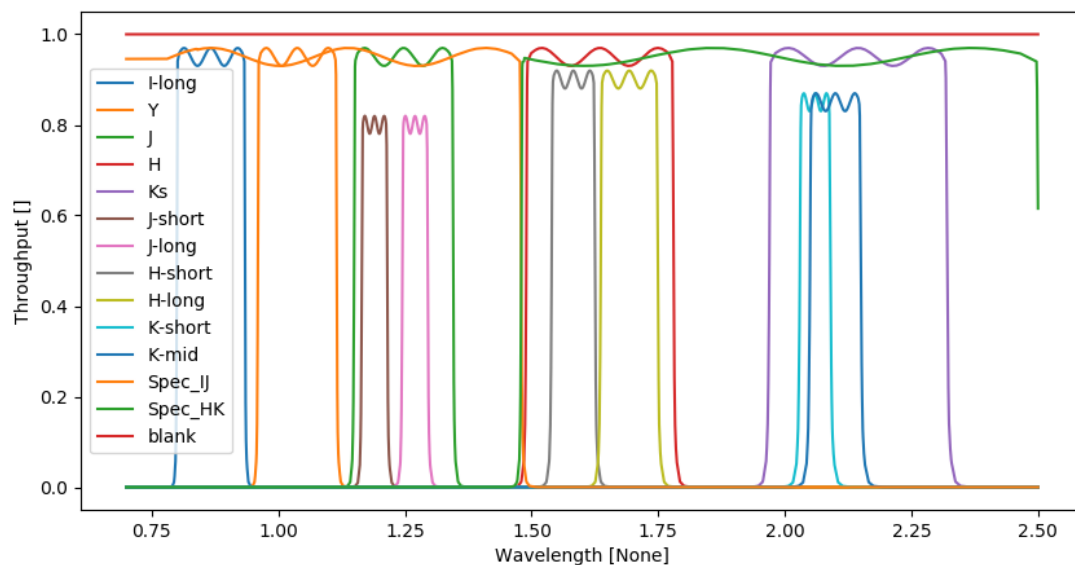
Included by default: True

File Description:

Class Description: Examples

Changes:

- 



name	centre	width	blue cutoff	red cutoff
I-long	0.8689	0.1340	0.8019	0.9359
Y	1.0396	0.1550	0.9621	1.1171
J	1.2502	0.1950	1.1527	1.3477
H	1.6395	0.2900	1.4945	1.7845
Ks	2.1500	0.3500	1.9750	2.3250

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name	centre	width	blue cutoff	red cutoff
J-short	1.1902	0.0490	1.1657	1.2147
J-long	1.2702	0.0490	1.2457	1.2947
H-short	1.5830	0.0850	1.5405	1.6255
H-long	1.6937	0.1120	1.6377	1.7497
K-short	2.0602	0.0600	2.0302	2.0902
K-mid	2.1005	0.1000	2.0505	2.1505
Spec_IJ	1.1663	0.6990	0.8168	1.5158
Spec_HK	2.0345	1.0200	1.5245	2.5445
blank	2.7545	2.7000	1.4045	4.1045

## Data

### Meta-data

```

filename : None
name : filter_wheel_1
temperature : -190
filter_file_format : filters/TC_filter_{\}.dat
element_name : MICADO
filter_names : ['I-long', 'Y', 'J', 'H', 'Ks', 'J-short', 'J-long',
filename_format : !INST.filter_file_format
current_filter : !OBS.filter_name_fw1
minimum_throughput : 0.000101
outer : 0.2
outer_unit : m
z_order : [124, 224, 524]
include : True
path :
report_plot_include : True
report_table_include : True
report_table_rounding : 4

```

#### 2.2.2.4 FilterWheel: "filter\_wheel\_2"

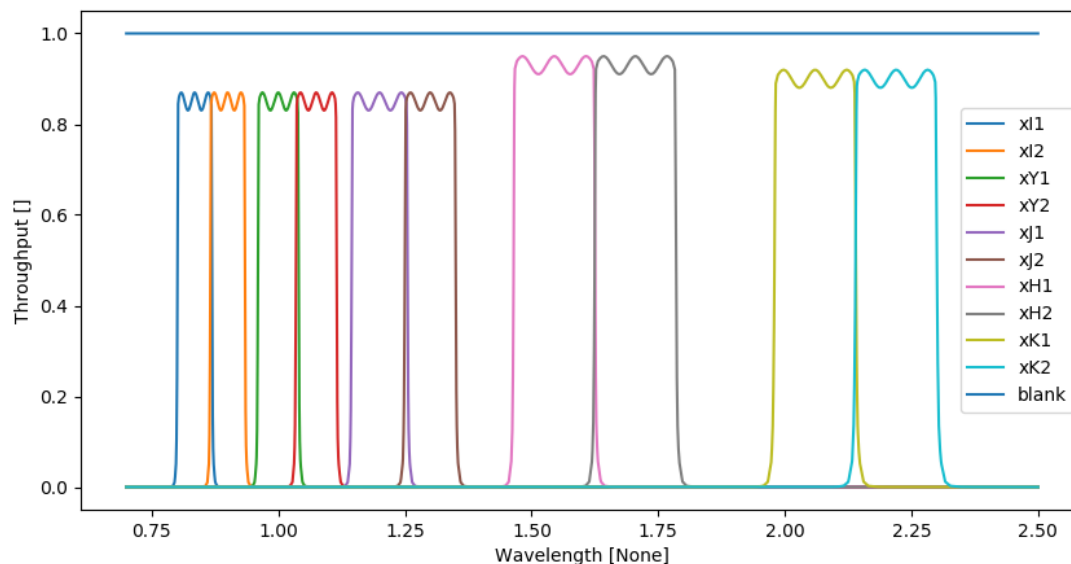
**Included by default:** True

**File Description:**

**Class Description:** Examples

**Changes:**

•



name	centre	width	blue cutoff	red cutoff
xI1	0.8355	0.0680	0.8015	0.8695
xI2	0.9005	0.0680	0.8665	0.9345
xY1	1.0006	0.0800	0.9606	1.0406
xY2	1.0756	0.0800	1.0356	1.1156
xJ1	1.2009	0.1100	1.1459	1.2559
xJ2	1.3007	0.1000	1.2507	1.3507
xH1	1.5465	0.1600	1.4665	1.6265
xH2	1.7064	0.1600	1.6264	1.7864
xK1	2.0612	0.1600	1.9812	2.1412
xK2	2.2211	0.1600	2.1411	2.3011
blank	2.7545	2.7000	1.4045	4.1045

## Data

## Meta-data

```
filename : None
name : filter_wheel_2
```

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```

temperature : -190
filter_file_format : filters/TC_filter_{\}.dat
element_name : MICADO
filter_names : ['xI1', 'xI2', 'xY1', 'xY2', 'xJ1', 'xJ2', 'xH1', 'xH2']
filename_format : !INST.filter_file_format
current_filter : !OBS.filter_name_fw2
minimum_throughput : 0.000101
    outer : 0.2
    outer_unit : m
    z_order : [124, 224, 524]
    include : True
    path :
report_plot_include : True
report_table_include : True
report_table_rounding : 4

```

### 2.2.2.5 FilterWheel: "pupil\_wheel"

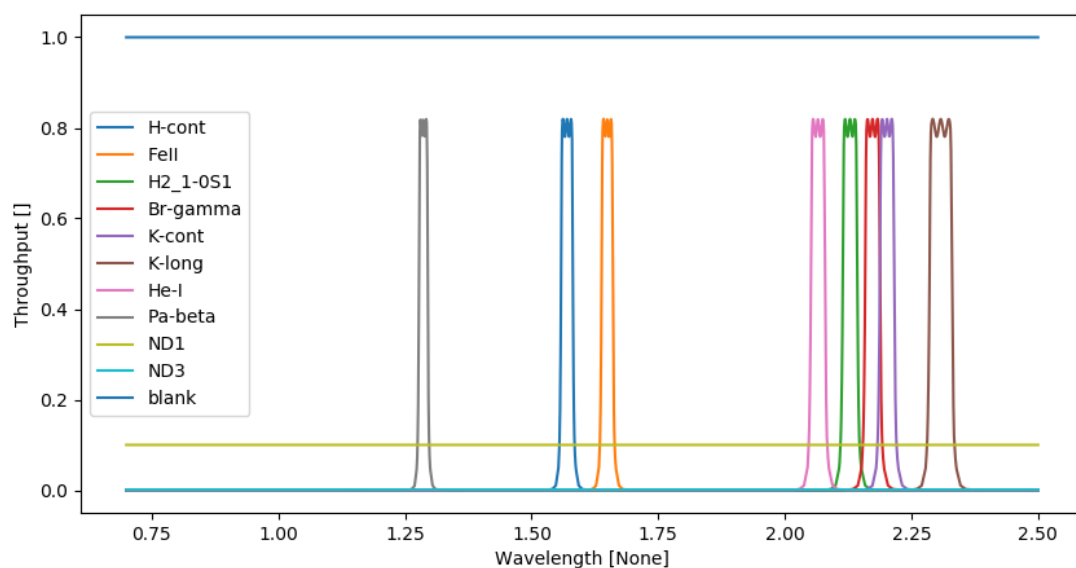
**Included by default:** True

**File Description:**

**Class Description:** Examples

**Changes:**

- 



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name	centre	width	blue cutoff	red cutoff
H-cont	1.5701	0.0220	1.5591	1.5811
FeII	1.6495	0.0210	1.6390	1.6600
H2_1-0S1	2.1289	0.0280	2.1149	2.1429
Br-gamma	2.1734	0.0280	2.1594	2.1874
K-cont	2.2019	0.0270	2.1884	2.2154
K-long	2.3081	0.0440	2.2861	2.3301
He-I	2.0656	0.0270	2.0521	2.0791
Pa-beta	1.2865	0.0170	1.2780	1.2950
ND1	2.7529	0.0000	2.7529	2.7529
ND3	2.7529	0.0000	2.7529	2.7529
blank	2.7545	2.7000	1.4045	4.1045

## Data

### Meta-data

```

        filename : None
        name : pupil_wheel
        temperature : -190
filter_file_format : filters/TC_filter_{\}.dat
        element_name : MICADO
        filter_names : ['H-cont', 'FeII', 'H2_1-0S1', 'Br-gamma', 'K-cont',
filename_format : !INST.filter_file_format
        current_filter : !OBS.filter_name_pupil
minimum_throughput : 0.000101
        outer : 0.2
        outer_unit : m
        z_order : [124, 224, 524]
        include : True
        path :
report_plot_include : True
report_table_include : True
report_table_rounding : 4

```

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## 2.3 OpticalElement: "MICADO\_IMG\_LR"

**Element:** instrument

**Alias:** INST

**Description:** additional effects for the wide-field imaging mode

### 2.3.1 Global properties

```
pixel_scale : 0.004
plate_scale : 0.266666666666
element_name : MICADO_IMG_LR
```

### 2.3.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
MICADO_IMG	micado_wide_field_mirror_list	SurfaceList	True	[20, 120, 520]
MICADO_IMG	micado_adc_3D_shift	AtmosphericDispersionCorrection	False	[632, 232]

#### 2.3.2.1 SurfaceList: "micado\_wide\_field\_mirror\_list"

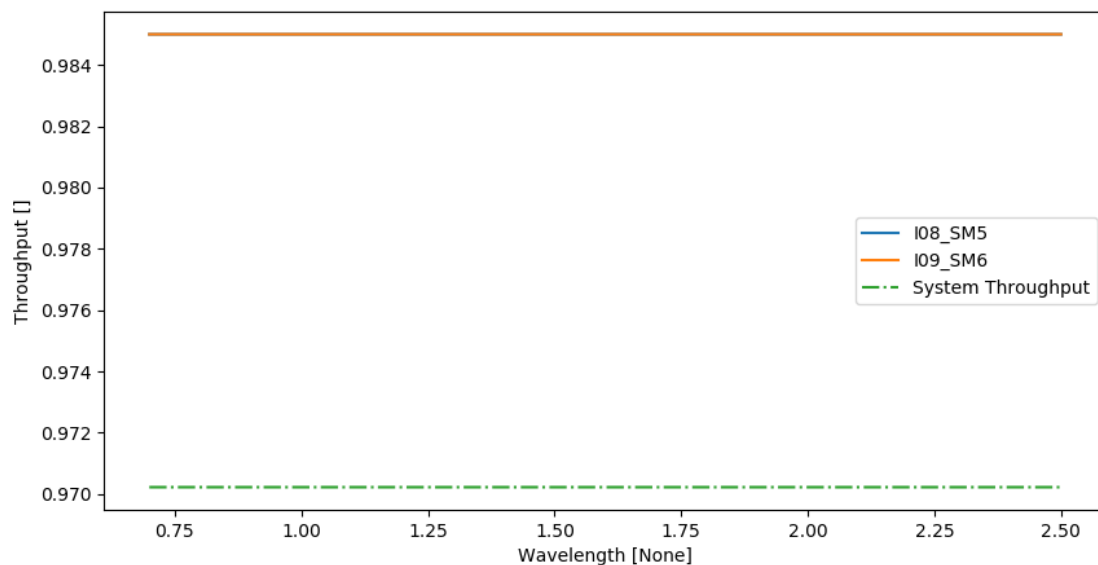
**Included by default:** True

**File Description:** list of extra mirrors needed for the wide field mode

**Class Description:** <no docstring>

**Changes:**

- 2019-01-28 (KL) Changed column names and added units to header
- 2019-07-10 (KL) Shortened the list to only the swappable mirrors



name	outer	inner	angle	temperature	action	filename
I08_SM5	0.2	0.0	0	-190	reflection	TER_mirror_gold.dat
I09_SM6	0.2	0.0	0	-190	reflection	TER_mirror_gold.dat

**Data** The list of surfaces from the rotating optics wheel that are added to the optical train when observing in the wide field mode

## Meta-data

```

filename : LIST_MICADO_mirrors_wide.dat
name : micado_wide_field_mirror_list
pixel_scale : 0.004
plate_scale : 0.266666666666
element_name : MICADO_IMG_LR
author : Kieran Leschinski
source : Ric's SPIE 2018 PPT presentation
date_created : 2018-11-19
date_modified : 2019-07-10
status : Design, pre PDR list of MICADO mirrors for wide-field
type : mirror:list
outer_unit : m
inner_unit : m
angle_unit : degree

```



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```

temperature_unit : deg_C
    z_order : [20, 120, 520]
    include : True
    ignore_wings : False
    wave_min : !SIM.spectral.wave_min
    wave_max : !SIM.spectral.wave_max
    wave_unit : !SIM.spectral.wave_unit
    wave_bin : !SIM.spectral.spectral_resolution
report_plot_include : True
report_table_include : True
    minimum_throughput : !SIM.spectral.minimum_throughput
    etendue : !TEL.etendue

```

### 2.3.2.2 AtmosphericDispersionCorrection: "micado\_adc\_3D\_shift"

**Included by default:** False

**File Description:** atmospheric dispersion corrector

**Class Description:** <no docstring>

**Changes:**

- 

**Data**

**Meta-data**

```

filename : None
    name : micado_adc_3D_shift
    include : False
pixel_scale : 0.004
plate_scale : 0.266666666666
element_name : MICADO_IMG_LR
    altitude : !ATMO.altitude
    longitude : !ATMO.longitude
    latitude : !ATMO.latitude
    airmass : !OBS.airmass
temperature : !ATMO.temperature
    humidity : !ATMO.humidity
    pressure : !ATMO.pressure
pupil_angle : !OBS.pupil_angle
    efficiency : 1
    wave_mid : !SIM.spectral.wave_mid

```

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```

        quick_adc : True
        z_order   : [632, 232]
    report_plot_include : True
    report_table_include : False

```

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## 2.4 OpticalElement: "MICADO\_IMG\_HR"

**Element:** instrument

**Alias:** INST

**Description:** additional effects for the zoom imaging mode

### 2.4.1 Global properties

```
pixel_scale : 0.0015
plate_scale : 0.1
element_name : MICADO_IMG_HR
```

### 2.4.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
MICADO_IMG_HR	zoom_mirror_list	SurfaceList	True	[20, 120, 520]
MICADO_IMG_HR	micado_adc_3D_shift	AtmosphericDispersionCorrection	False	[632, 232]

#### 2.4.2.1 SurfaceList: "zoom\_mirror\_list"

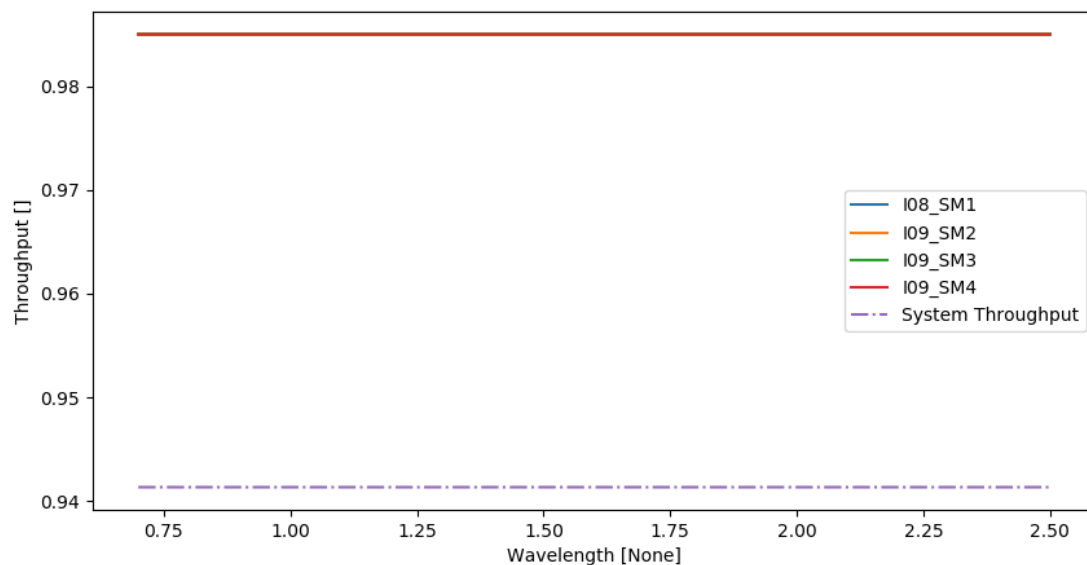
**Included by default:** True

**File Description:** list of extra mirror needed for the zoom imaging mode

**Class Description:** <no docstring>

**Changes:**

- 2019-01-28 (KL) Changed column names and added units to header
- 2019-07-10 (KL) Shortened the list to only the swappable mirrors



name	outer	inner	angle	temperature	action	filename
I08_SM1	0.2	0.0	0	-190	reflection	TER_mirror_gold.dat
I09_SM2	0.2	0.0	0	-190	reflection	TER_mirror_gold.dat
I09_SM3	0.2	0.0	0	-190	reflection	TER_mirror_gold.dat
I09_SM4	0.2	0.0	0	-190	reflection	TER_mirror_gold.dat

## Data

### Meta-data

```

filename : LIST_MICADO_mirrors_zoom.dat
name : zoom_mirror_list
pixel_scale : 0.0015
plate_scale : 0.1
element_name : MICADO_IMG_HR
author : Kieran Leschinski
source : Ric's SPIE 2018 PPT presentation
date_created : 2018-11-19
date_modified : 2019-07-10
status : Design, pre PDR list of swappable mirrors for zoom mod
type : mirror:list
ETypes : SURFLIST
EDIM : 1

```

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```

outer_unit : m
inner_unit : m
angle_unit : degree
temperature_unit : deg_C
z_order : [20, 120, 520]
include : True
ignore_wings : False
wave_min : !SIM.spectral.wave_min
wave_max : !SIM.spectral.wave_max
wave_unit : !SIM.spectral.wave_unit
wave_bin : !SIM.spectral.spectral_resolution
report_plot_include : True
report_table_include : True
minimum_throughput : !SIM.spectral.minimum_throughput
etendue : !TEL.etendue

```

#### 2.4.2.2 AtmosphericDispersionCorrection: "micado\_adc\_3D\_shift"

**Included by default:** False

**File Description:** atmospheric dispersion corrector

**Class Description:** <no docstring>

**Changes:**

- 

**Data**

**Meta-data**

```

filename : None
name : micado_adc_3D_shift
include : False
pixel_scale : 0.0015
plate_scale : 0.1
element_name : MICADO_IMG_HR
altitude : !ATMO.altitude
longitude : !ATMO.longitude
latitude : !ATMO.latitude
airmass : !OBS.airmass
temperature : !ATMO.temperature
humidity : !ATMO.humidity
pressure : !ATMO.pressure

```

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```

pupil_angle : !OBS.pupil_angle
  wave_mid : !SIM.spectral.wave_mid
  efficiency : 1
  quick_adc : True
  z_order : [632, 232]
report_plot_include : True
report_table_include : False

```

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## 2.5 OpticalElement: "MICADO\_SPEC"

**Element:** instrument

**Alias:** INST

**Description:** additional effects for the spectroscopy mode

### 2.5.1 Global properties

```
pixel_scale : 0.004
plate_scale : 0.2666666667
element_name : MICADO_SPEC
```

### 2.5.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
MICADO_SPEC	spec_mode_optics	SurfaceList	True	[20, 120, 520]
MICADO_SPEC	spectroscopic_slit_aperture	ApertureMask	True	[80, 280, 380]
MICADO_SPEC	micado_spectral_traces	SpectralTraceList	True	[70, 270]

#### 2.5.2.1 SurfaceList: "spec\_mode\_optics"

**Included by default:** True

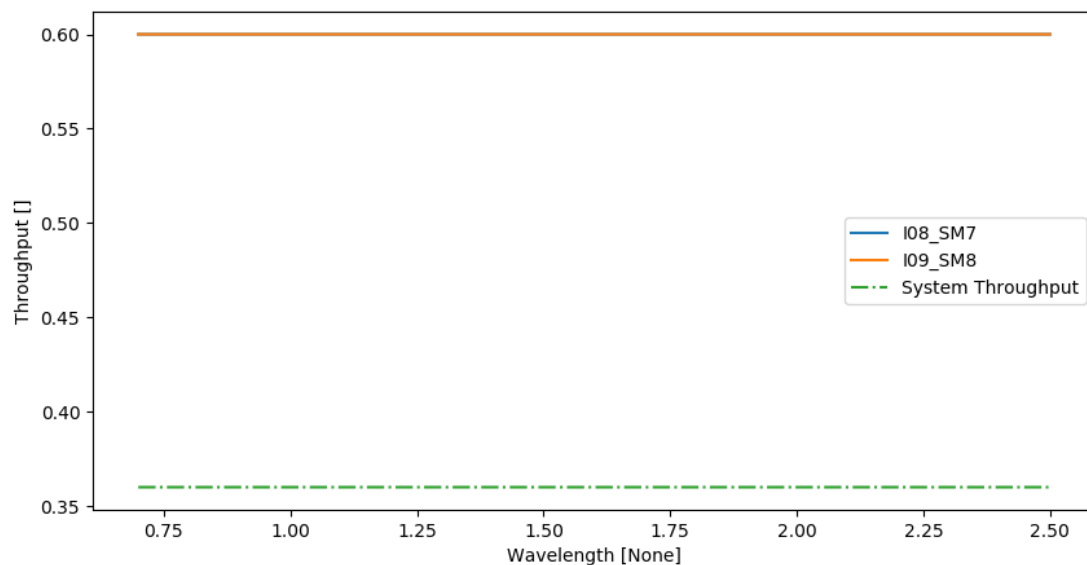
**File Description:** list of extra mirrors needed for the spectroscopy mode

**Class Description:** <no docstring>

**Changes:**

- 2019-01-28 (KL) Changed column names and added units to header
- 2019-07-10 (KL) Shortened the list to only the swappable gratings

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name	outer	inner	angle	temperature	action	filename
I08_SM7	0.2	0.0	0	-190	reflection	TER_grating.dat
I09_SM8	0.2	0.0	0	-190	reflection	TER_grating.dat

## Data

## Meta-data

```

filename : LIST_MICADO_mirrors_spec.dat
name : spec_mode_optics
pixel_scale : 0.004
plate_scale : 0.2666666667
element_name : MICADO_SPEC
author : Kieran Leschinski
source : Ric's SPIE 2018 PPT presentation
date_created : 2018-11-19
date_modified : 2019-07-10
status : Design, pre PDR list of swappable optics for spectroscopy
type : mirror:list
ETypes : SURFLIST
EDIM : 1
outer_unit : m
inner_unit : m

```



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```

        angle_unit : degree
    temperature_unit : deg_C
        z_order : [20, 120, 520]
        include : True
    ignore_wings : False
        wave_min : !SIM.spectral.wave_min
        wave_max : !SIM.spectral.wave_max
        wave_unit : !SIM.spectral.wave_unit
        wave_bin : !SIM.spectral.spectral_resolution
    report_plot_include : True
    report_table_include : True
        minimum_throughput : !SIM.spectral.minimum_throughput
        etendue : !TEL.etendue

```

### 2.5.2.2 ApertureMask: "spectroscopic\_slit\_aperture"

**Included by default:** True

**File Description:** Slit mask for the short, wide slit (3 arcsec x 50 mas)

**Class Description:** Only provides the on-sky window coords of the Aperture

**Changes:**

- 2019-07-10 (KL) Created the file
- 2020-03-24 (KL) Changed geometry to 3000x50mas

**Data**

x	y
-1.5000	-0.0250
1.5000	-0.0250
1.5000	0.0250
-1.5000	0.0250

**Meta-data**

```

        filename : !OBS.slit_file
        name : spectroscopic_slit_aperture
    pixel_scale : 0.004
    plate_scale : 0.2666666667
    element_name : MICADO_SPEC

```

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```

author : Kieran Leschinski
source : My imagination
date_created : 2019-07-10
date_modified : 2019-07-10
status : Guess - in the train on the way home from CM13
type : aperture:slit_geometry
x_unit : arcsec
y_unit : arcsec
z_order : [80, 280, 380]
include : True
no_mask : True
angle : 0
shape : rect
conserve_image : True
id : 0
report_plot_include : False
report_table_include : True
report_table_rounding : 4

```

### 2.5.2.3 SpectralTraceList: "micado\_spectral\_traces" : 17 traces

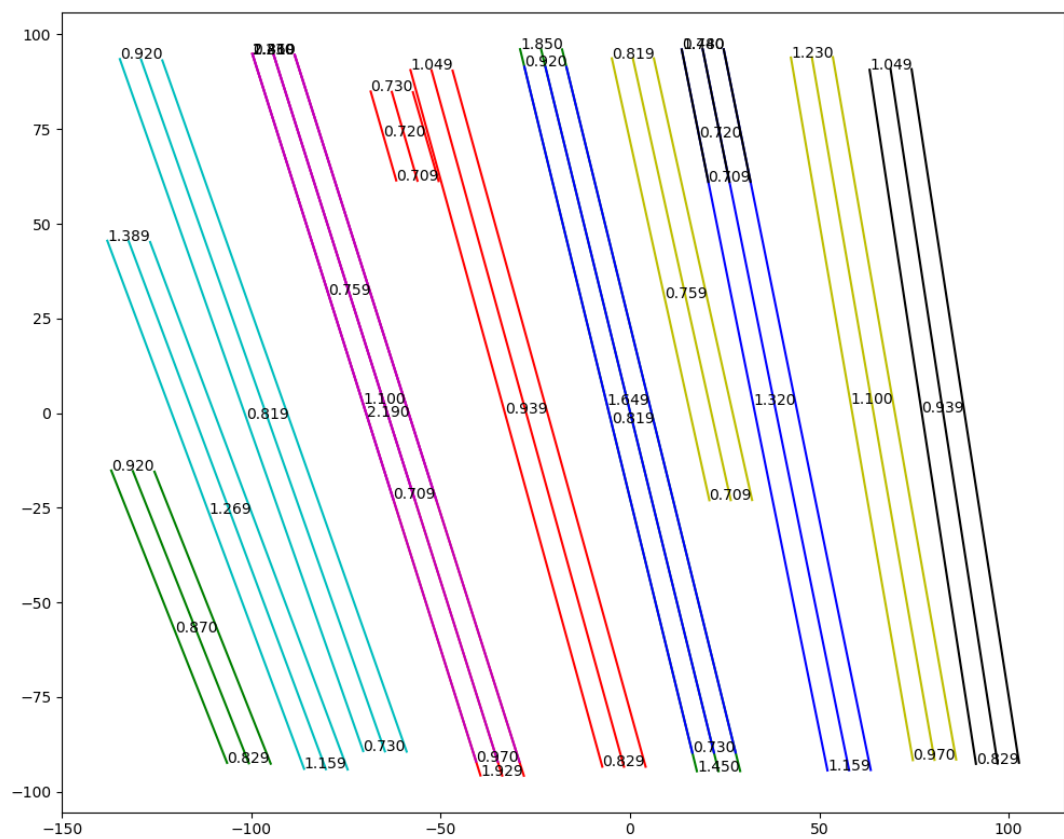
**Included by default:** True

**File Description:** list of spectral order trace geometry on the focal plane

**Class Description:** List of spectral trace geometries for the detector plane

**Changes:**

-



## Data

## Meta-data

```
filename : !OBS.trace_file
name : micado_spectral_traces
pixel_scale : 0.004
```

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```

plate_scale : 0.2666666667
element_name : MICADO_SPEC
wave_colname : lam
s_colname : xi
col_number_start : 1
invalid_value : 0
SIMPLE : True
BITPIX : 8
NAXIS : 0
EXTEND : True
FILETYPE : Spectral Layout Definition
AUTHOR : Oliver Czoske
DATE : 2018-09-16
SOURCE : Frank Grupp
ORIGDATE : 2018-06-29
STATUS : Design PDR
ECAT : 1
EDATA : 2
DESCRIPT : Maps spectral traces from long slit aperture to detect
DATE_CRE : 2018-06-29
DATE_MOD : 2019-09-16
HISTORY : 2019-09-16 : (KL) Added aperture-imagePlane table to E
z_order : [70, 270]
include : True
wave_min : !SIM.spectral.wave_min
wave_mid : !SIM.spectral.wave_mid
wave_max : !SIM.spectral.wave_max
x_colname : x
y_colname : y
center_on_wave_mid : False
dwave : 0.002
report_plot_include : True
report_table_include : False

```

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## 2.6 OpticalElement: "micado\_detector\_array"

**Element:** detector

**Alias:** DET

**Description:** A set of 9 H4RG detectors

### 2.6.1 Global properties

```
image_plane_id : 0
  temperature : -230
    dit : !OBS.dit
    ndit : !OBS.ndit
  element_name : micado_detector_array
```

### 2.6.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
micado_detector_array	full_detector_array	DetectorList	False	[90, 290, 390, 490]
micado_detector_array	detector_window	DetectorList	True	[90, 290, 390, 490]
micado_detector_array	qe_curve	QuantumEfficiencyCurve	True	[113, 513]
micado_detector_array	exposure_action	SummedExposure	True	[860]
micado_detector_array	dark_current	DarkCurrent	True	[830]
micado_detector_array	detector_linearity	LinearityCurve	True	[840]
micado_detector_array	shot_noise	ShotNoise	True	[820]
micado_detector_array	readout_noise	PoorMansHxRGReadoutNoise	True	[811]

#### 2.6.2.1 DetectorList: "full\_detector\_array"

**Included by default:** False

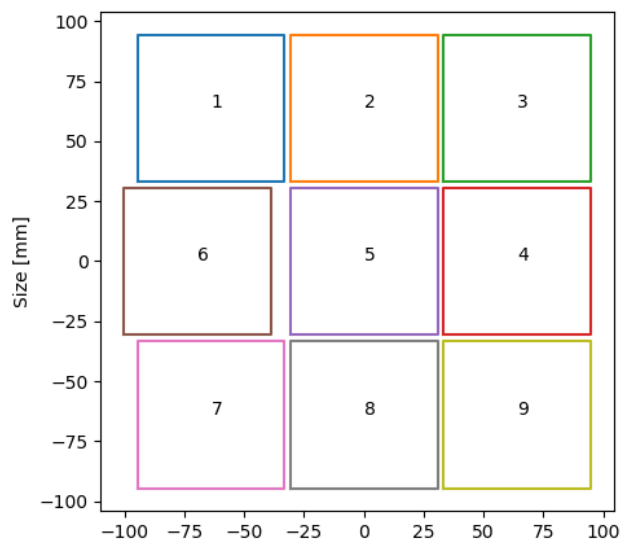
**File Description:** MICADO detector array list

**Class Description:** A description of detector positions and properties

**Changes:**

- 2017-08-12 (OC) id changed to conform with spectroscopy report
- 2018-07-26 (OC) large gap (chips 5 and 6) reduced to 8 mm
- 2018-11-19 (KL) updated meta data to new format

- 2019-01-28 (KL) moved units into header



id	x_cen	y_cen	x_size	y_size	x_len	y_len	pixel_size	angle	gain
1	-63.84	63.84	61.44	61.44	4096	4096	0.015	0.0	1.0
2	0.0	63.84	61.44	61.44	4096	4096	0.015	0.0	1.0
3	63.84	63.84	61.44	61.44	4096	4096	0.015	0.0	1.0
4	63.84	0.0	61.44	61.44	4096	4096	0.015	0.0	1.0
5	0.0	0.0	61.44	61.44	4096	4096	0.015	0.0	1.0
6	-69.44	0.0	61.44	61.44	4096	4096	0.015	0.0	1.0
7	-63.84	-63.84	61.44	61.44	4096	4096	0.015	0.0	1.0
8	0.0	-63.84	61.44	61.44	4096	4096	0.015	0.0	1.0
9	63.84	-63.84	61.44	61.44	4096	4096	0.015	0.0	1.0

## Data

### Meta-data

```

filename : FPA_array_layout.dat
name : full_detector_array
include : False
image_plane_id : 0
temperature : -230

```

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```

        dit : !OBS.dit
        ndit : !OBS.ndit
        element_name : micado_detector_array
    active_detectors : all
        author : Oliver Czoske
        sources : E-MCD-FPA-572089EB.uda, ELT-TRE-MCD-56300-0011
        date_created : 2017-06-28
        date_modified : 2018-07-26
        type : detector:chip_list
        x_cen_unit : mm
        y_cen_unit : mm
        xhw_unit : mm
        yhw_unit : mm
        x_len_unit : pix
        y_len_unit : pix
        pixsize_unit : mm
        angle_unit : deg
        gain_unit : electron/adu
        z_order : [90, 290, 390, 490]
        pixel_scale : !INST.pixel_scale
    report_plot_include : True
    report_table_include : True
        x_size_unit : mm
        y_size_unit : mm

```

### 2.6.2.2 DetectorList: "detector\_window"

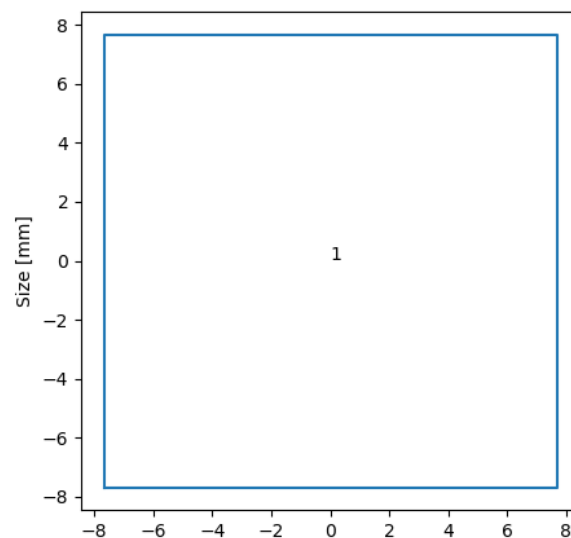
**Included by default:** True

**File Description:**

**Class Description:** A description of detector positions and properties

**Changes:**

-



id	pixel_size	angle	gain	x_cen	y_cen	x_size	y_size
1	0.015	0.0	1.0	0.0	0.0	15.36	15.36

## Data

## Meta-data

```

filename : None
name      : detector_window
include   : True
image_plane_id : 0
temperature : -230
dit       : !OBS.dit
ndit      : !OBS.ndit
element_name : micado_detector_array
x_cen_unit  : mm
y_cen_unit  : mm
x_size_unit : mm
y_size_unit : mm
pixel_size_unit : mm
angle_unit  : deg
gain_unit   : electron/adu
z_order     : [90, 290, 390, 490]
array_dict  : {'id': [1], 'pixel_size': [0.015], 'angle': [0.0], 'g

```



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```

        pixel_scale : !INST.pixel_scale
        active_detectors : all
        report_plot_include : True
        report_table_include : True

```

### 2.6.2.3 QuantumEfficiencyCurve: "qe\_curve"

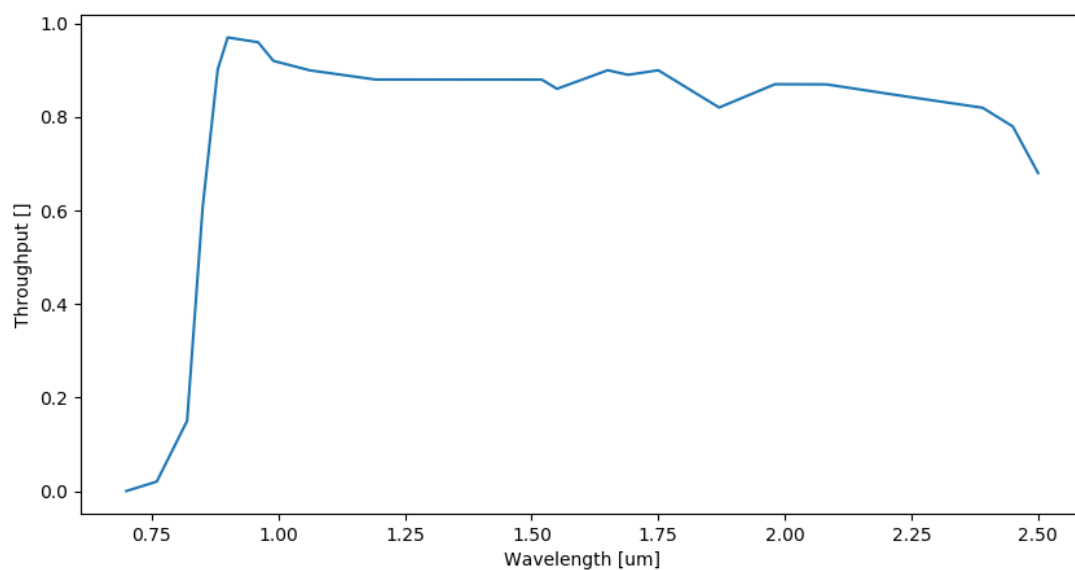
**Included by default:** True

**File Description:** Quantum efficiency curves for each detector

**Class Description:** <no docstring>

**Changes:**

- 2018-11-19 (KL) updated meta data to new format
- 2019-08-09 (KL) Added action keyword to meta data



**Data**

**Meta-data**

```

filename : QE_detector_H2RG.dat
name : qe_curve

```

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```

image_plane_id : 0
  temperature : -230
    dit : 60
    ndit : 1
  element_name : micado_detector_array
  author : Kieran Leschinski
  sources : Finger+ 2008 SPIE
  date_created : 2016-01-01
  date_modified : 2019-08-09
    type : detector:quantum_efficiency
    status : Design, guesstimated by reading off the graph in Finger
wavelength_unit : um
  action : transmission
  z_order : [113, 513]
  include : True
  ignore_wings : False
  wave_min : 0.7
  wave_max : 2.5
  wave_unit : um
  wave_bin : 0.0001
report_plot_include : True
report_table_include : False
  position : -1

```

#### 2.6.2.4 SummedExposure: "exposure\_action"

**Included by default:** True

**File Description:** Summing up sky signal for all DITs and NDITs

**Class Description:** Simulates a summed stack of `ndit` exposures

**Changes:**

- 

**Data**

**Meta-data**

```

filename : None
  name : exposure_action
image_plane_id : 0
  temperature : -230
    dit : !OBS.dit

```

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```

        ndit : !OBS.ndit
    element_name : micado_detector_array
        z_order : [860]
        include : True

```

#### 2.6.2.5 DarkCurrent: "dark\_current"

**Included by default:** True

**File Description:** MICADO dark current

**Class Description:** required: dit, ndit, value

**Changes:**

- 

**Data**

**Meta-data**

```

        filename : None
        name : dark_current
    image_plane_id : 0
        temperature : -230
        dit : !OBS.dit
        ndit : !OBS.ndit
    element_name : micado_detector_array
        value : 0.1
        z_order : [830]
        include : True

```

#### 2.6.2.6 LinearityCurve: "detector\_linearity"

**Included by default:** True

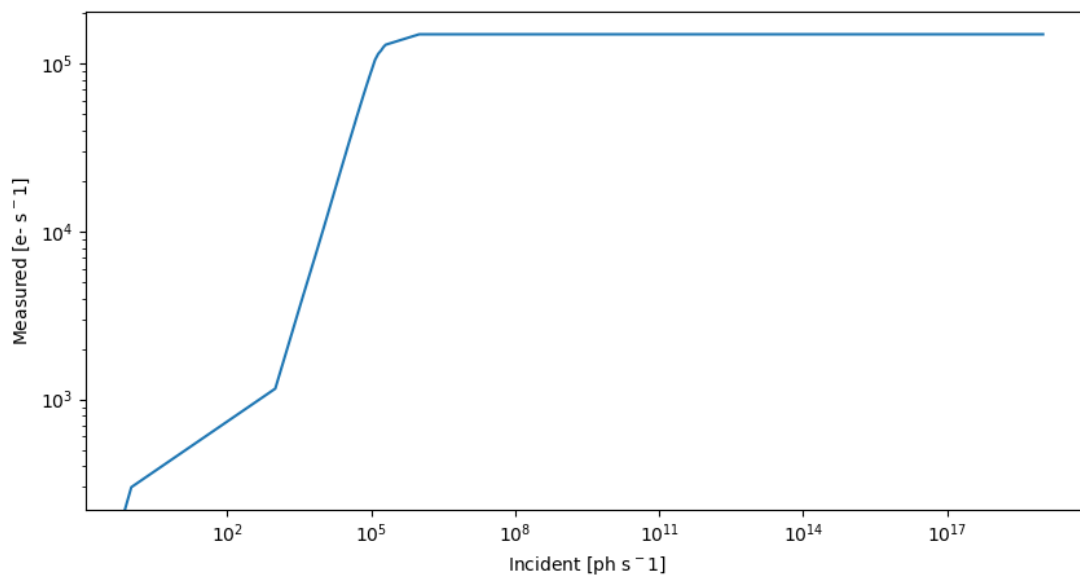
**File Description:** Linearity characteristics of H4RG chips

**Class Description:** <no docstring>

**Changes:**

- 2018-11-19 (KL) updated meta data to new format
- 2019-08-14 (KL) replaced long 1000000000 with 1e99

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## Data

## Meta-data

```

filename : FPA_linearity.dat
name      : detector_linearity
image_plane_id : 0
temperature : -230
dit       : !OBS.dit
ndit      : !OBS.ndit
element_name : micado_detector_array
author     : Kieran Leschinski
sources    : Ingraham+ 2014 - Gemini Calibrations II for H2RG
date_created : 2016-01-01
date_modified : 2018-11-19
type       : detector:linearity
status     : Design, approximated from the H2RG
incident_unit : ph
measured_unit : ph
z_order    : [840]
include    : True
report_plot_include : True
report_table_include : False

```

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### 2.6.2.7 ShotNoise: "shot\_noise"

**Included by default:** True

**File Description:** apply poisson shot noise to images

**Class Description:** <no docstring>

**Changes:**

- 

**Data**

**Meta-data**

```

filename : None
name : shot_noise
image_plane_id : 0
temperature : -230
dit : !OBS.dit
ndit : !OBS.ndit
element_name : micado_detector_array
z_order : [820]
include : True
random_seed : !SIM.random.seed

```

### 2.6.2.8 PoorMansHxRGReadoutNoise: "readout\_noise"

**Included by default:** True

**File Description:** Readout noise frames

**Class Description:** <no docstring>

**Changes:**

- 

**Data**

**Meta-data**

```

filename : None
name : readout_noise
image_plane_id : 0

```

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```

temperature : -230
      dit : !OBS.dit
      ndit : !OBS.ndit
element_name : micado_detector_array
      noise_std : 12
      n_channels : 64
      z_order : [811]
      include : True
pedestal_fraction : 0.3
      read_fraction : 0.4
      line_fraction : 0.25
      channel_fraction : 0.05
      random_seed : !SIM.random.seed
report_plot_include : False
report_table_include : False

```

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## 2.7 OpticalElement: "MICADO\_simulation\_paramters"

**Element:** simulation

**Alias:** SIM

**Description:** RC simulation paramters which need to change for a MICADO run

### 2.7.1 Global properties

```

random : \{'seed': 9001\}
spectral : \{'wave_min': 0.7, 'wave_mid': 1.6, 'wave_max': 2.5\}
computing : \{'preload_field_of_view': True\}
reports : \{'preamble_file': '../docs/preamble.rst'\}
element_name : MICADO_simulation_paramters

```

## **Chapter 3**

# **MICADO Science package**



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### 3.1 Summary of Effects in Optical Elements:

element	name	class	included	z_orders
MICADO_Sci	micado_common_optics	TERCurve	True	[10, 110, 510]
MICADO_Sci	filter_wheel	FilterWheel	True	[124, 224, 524]
micado_sci_detector	micado_detector_window	DetectorWindow	True	[90, 290, 390, 490]
micado_sci_detector	h4rg_qe_curve	QuantumEfficiencyCurve	True	[113, 513]
micado_sci_detector	exposure_action	SummedExposure	True	[860]
micado_sci_detector	dark_current	DarkCurrent	True	[830]
micado_sci_detector	shot_noise	ShotNoise	True	[820]
micado_sci_detector	h4rg_detector_linearity	LinearityCurve	False	[840]
micado_sci_detector	readout_noise	PoorMansHxRGReadoutNoise	True	[811]
MICADO_SPEC	micado_adjustable_slit	RectangularApertureMask	True	[80, 280, 380]
MICADO_SPEC	spectral_trace_3000x50mas	SpectralTraceList	True	[70, 270]
MICADO_SCAO	scao_relay_optics_ter	TERCurve	True	[10, 110, 510]
MICADO_SCAO	scao_const_psf	AnisocadoConstPSF	True	[42, 652]
MICADO_MCAO	maory_mms_ter	TERCurve	True	[10, 110, 510]
MICADO_MCAO	maory_const_psf	AnisocadoConstPSF	True	[42, 652]

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## 3.2 OpticalElement: "MICADO\_Sci"

**Element:** instrument

**Alias:** INST

**Description:** base configuration for MICADO

### 3.2.1 Global properties

```

temperature : -190
filter_file_format : filters/TC_filter_{\}.dat
element_name : MICADO_Sci

```

### 3.2.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders [3]
MICADO_Sci	micado_common_optics	TERCurve	True	10 .. 510
MICADO_Sci	filter_wheel	FilterWheel	True	124 .. 524

#### 3.2.2.1 TERCurve: "micado\_common\_optics"

**Included by default:** True

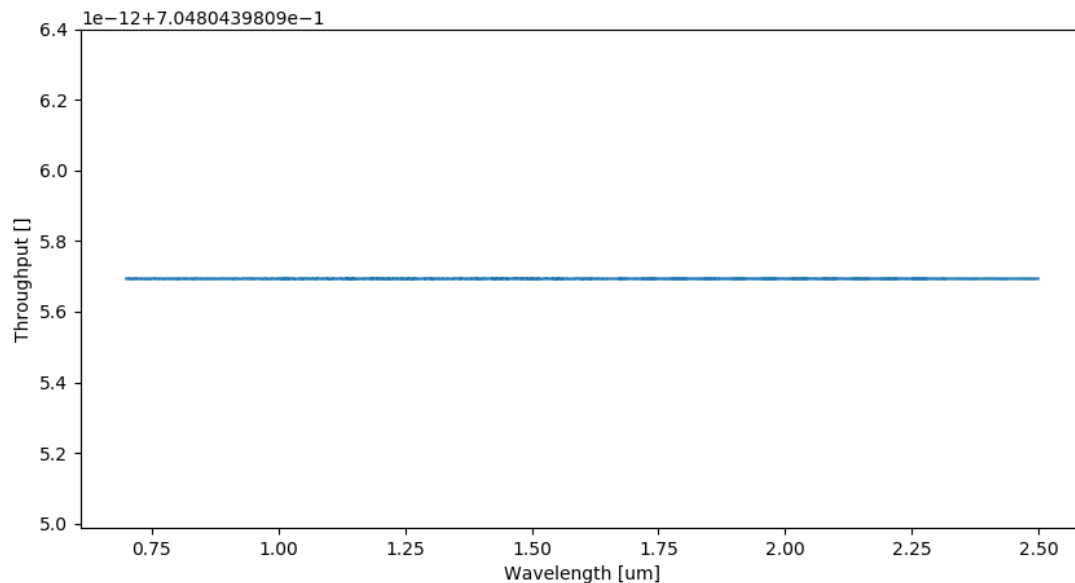
**File Description:** combined transmission for MICADO common optics

**Class Description:** Transmission, Emissivity, Reflection Curve

**Changes:**

-

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## Data

## Meta-data

```

filename : TER_MICADO_IMG_common.dat
name : micado_common_optics
temperature : -190
filter_file_format : filters/TC_filter_{\}.dat
element_name : MICADO_Sci
author : Auto-compiled from source
source : LIST_MICADO_mirrors_static.dat
date_created : 2020-08-25
date_modified : 2020-08-25
area : 0.19634954084936207
area_unit : m2
wavelength_unit : um
emission_unit : photlam
z_order : [10, 110, 510]
include : True
ignore_wings : False
wave_min : 0.7
wave_max : 2.5
wave_unit : um
wave_bin : 0.001
report_plot_include : True

```

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```
report_table_include : False
```

### 3.2.2.2 FilterWheel: "filter\_wheel"

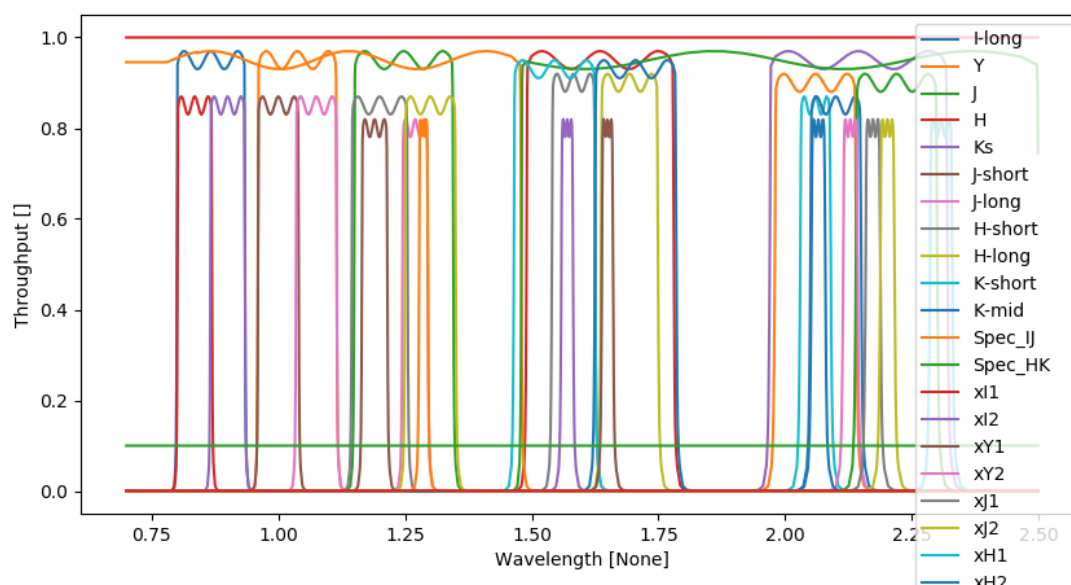
**Included by default:** True

**File Description:**

**Class Description:** Examples

**Changes:**

- 



name	centre	width	blue cutoff	red cutoff
I-long	0.8689	0.1340	0.8019	0.9359
Y	1.0396	0.1550	0.9621	1.1171
J	1.2502	0.1950	1.1527	1.3477
H	1.6395	0.2900	1.4945	1.7845
Ks	2.1500	0.3500	1.9750	2.3250
J-short	1.1902	0.0490	1.1657	1.2147
J-long	1.2702	0.0490	1.2457	1.2947
H-short	1.5830	0.0850	1.5405	1.6255

... continued on next page

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name	centre	width	blue cutoff	red cutoff
H-long	1.6937	0.1120	1.6377	1.7497
K-short	2.0602	0.0600	2.0302	2.0902
K-mid	2.1005	0.1000	2.0505	2.1505
Spec_IJ	1.1663	0.6990	0.8168	1.5158
Spec_HK	2.0345	1.0200	1.5245	2.5445
xI1	0.8355	0.0680	0.8015	0.8695
xI2	0.9005	0.0680	0.8665	0.9345
xY1	1.0006	0.0800	0.9606	1.0406
xY2	1.0756	0.0800	1.0356	1.1156
xJ1	1.2009	0.1100	1.1459	1.2559
xJ2	1.3007	0.1000	1.2507	1.3507
xH1	1.5465	0.1600	1.4665	1.6265
xH2	1.7064	0.1600	1.6264	1.7864
xK1	2.0612	0.1600	1.9812	2.1412
xK2	2.2211	0.1600	2.1411	2.3011
blank	2.7545	2.7000	1.4045	4.1045
H-cont	1.5701	0.0220	1.5591	1.5811
FeII	1.6495	0.0210	1.6390	1.6600
H2_1-OS1	2.1289	0.0280	2.1149	2.1429
Br-gamma	2.1734	0.0280	2.1594	2.1874
K-cont	2.2019	0.0270	2.1884	2.2154
K-long	2.3081	0.0440	2.2861	2.3301
He-I	2.0656	0.0270	2.0521	2.0791
Pa-beta	1.2865	0.0170	1.2780	1.2950
ND1	2.7529	0.0000	2.7529	2.7529
ND3	2.7529	0.0000	2.7529	2.7529

## Data

## Meta-data

```

filename : None
name : filter_wheel
temperature : -190
filter_file_format : filters/TC_filter_{\}.dat
element_name : MICADO_Sci
filter_names : ['I-long', 'Y', 'J', 'H', 'Ks', 'J-short', 'J-long',
filename_format : !INST.filter_file_format

```

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```

current_filter : !INST.filter_name
minimum_throughput : 0.000101
    outer : 0.2
    outer_unit : m
    z_order : [124, 224, 524]
    include : True
    path :
report_plot_include : True
report_table_include : True
report_table_rounding : 4

```

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### 3.3 OpticalElement: "SCAO"

**Element:** instrument

**Alias:** INST

**Description:** SCAO optical system

#### 3.3.1 Global properties

```
element_name : SCAO
```

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### 3.4 OpticalElement: "MICADO\_SCAO"

**Element:** instrument

**Alias:** INST

**Description:** MICADO SCAO mode effects

#### 3.4.1 Global properties

```
psf : \{'strehl': 0.8, 'wavelength': 'Ks'\}
element_name : MICADO_SCAO
```

#### 3.4.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
MICADO_SCAO	scao_relay_optics_ter	TERCurve	True	[10, 110, 510]
MICADO_SCAO	scao_const_psf	AnisocadoConstPSF	True	[42, 652]

##### 3.4.2.1 TERCurve: "scao\_relay\_optics\_ter"

**Included by default:** True

**File Description:** Combined TER curve for stand-alone relay optics module

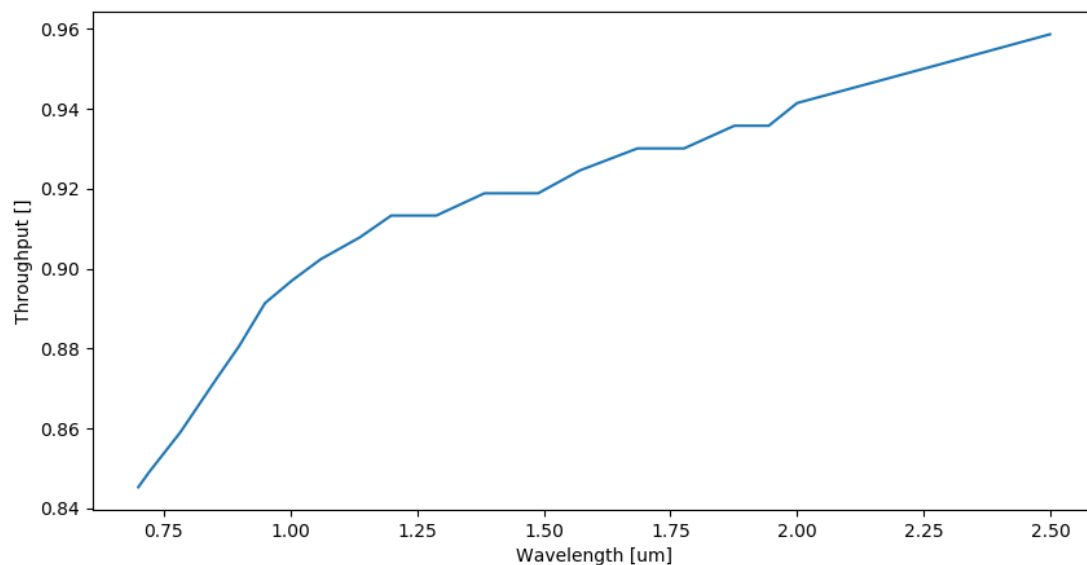
**Class Description:** Transmission, Emissivity, Reflection Curve

**Changes:**

-



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## Data

### Meta-data

```

filename : TER_MICADO_RO.dat
name : scao_relay_optics_ter
psf : \{'strehl': 0.8, 'wavelength': 'Ks'\}
element_name : MICADO_SCAO
author : Auto-compiled from source
source : LIST_RO_SCAO_mirrors.dat
date_created : 2020-08-25
date_modified : 2020-08-25
area : 0.22061834409834324
area_unit : m2
wavelength_unit : um
emission_unit : photlam
z_order : [10, 110, 510]
include : True
ignore_wings : False
wave_min : 0.7
wave_max : 2.5
wave_unit : um
wave_bin : 0.001
report_plot_include : True
report_table_include : False

```

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### 3.4.2.2 AnisocadoConstPSF: "scao\_const\_psf"

**Included by default:** True

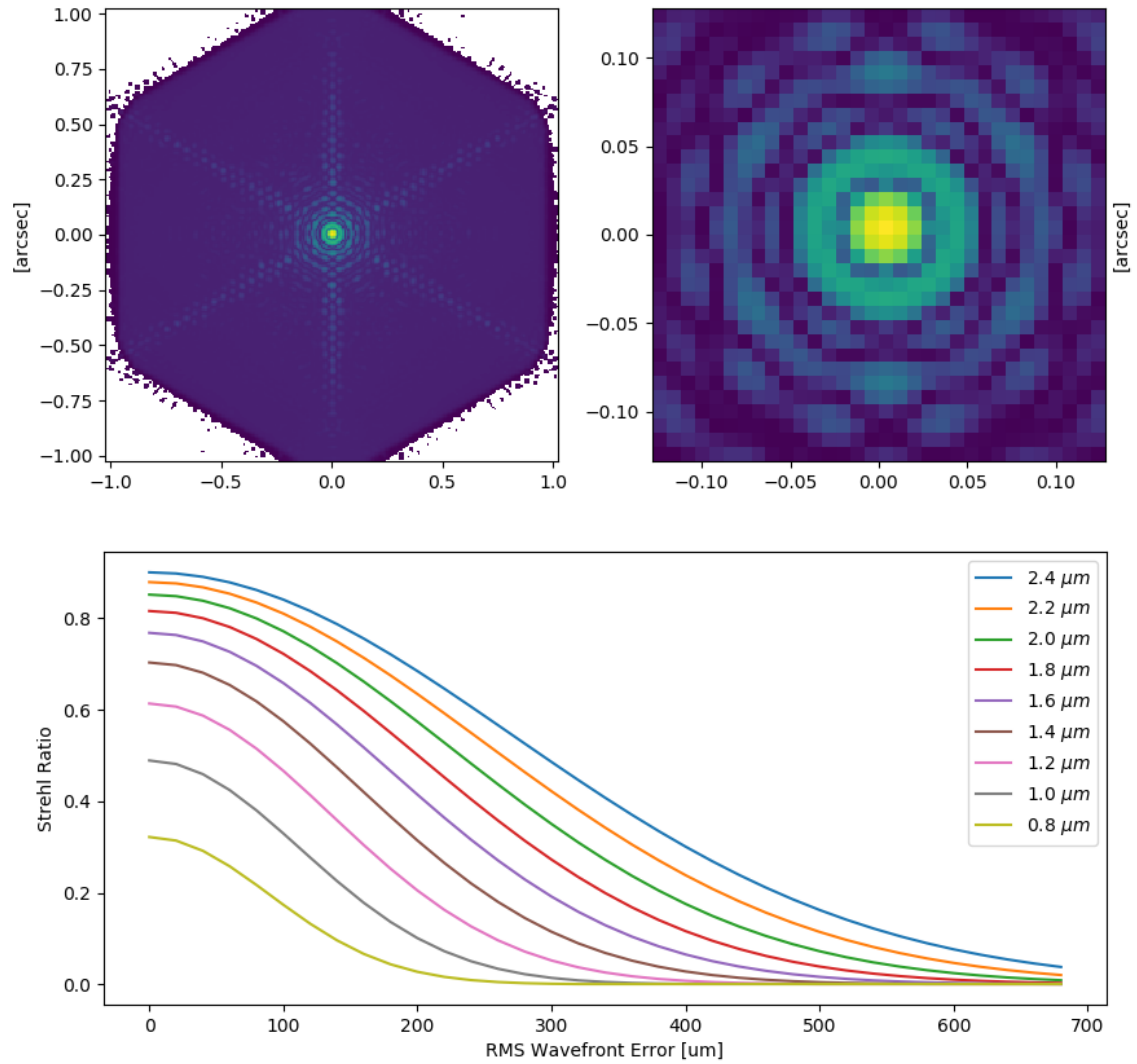
**File Description:** field constant PSF as produced by stand-alone SCAO

**Class Description:** Makes a SCAO on-axis PSF with a desired Strehl ratio at a given wavelength

**Changes:**

-

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## Data

## Meta-data

```
filename : MICADO_AnisoCADO_rms_map.fits
name : scao_const_psf
psf : \{'strehl': 0.8, 'wavelength': 'Ks'\}
```

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```

element_name : MICADO_SCAO
  strehl      : !INST.psf.strehl
  wavelength  : !INST.psf.wavelength
psf_side_length : 256
  offset      : [0, 0]
rounded_edges  : True
convolve_mode  : full
  SIMPLE      : True
  BITPIX      : -64
  NAXIS       : 2
  NAXIS1      : 35
  NAXIS2      : 9
  EXTEND      : True
  CRVAL1      : 0
  CRVAL2      : 0.8
  CRPIX1      : 1.0
  CRPIX2      : 1.0
  CDELT1      : 20
  CDELT2      : 0.2
  CUNIT1      : nm
  CUNIT2      : um
  CTYPE1      : LINEAR
  CTYPE2      : LINEAR
  LABEL1      : nmRMS
  LABEL2      : wavelength
  AUTHOR      : Kieran Leschinski
DATE_CRE      : 2019-07-30
DATE_MOD      : 2019-07-30
SOURCE        : AnisoCADO
STATUS        : Strehl as a function of wavelength and wavefront error
  ETYPE       : SRMAP
  ECAT        : -1
  EDATA       : 0
XOFFSET       : 0
YOFFSET       : 0
z_order       : [42, 652]
include       : True
flux_accuracy : 0.001
sub_pixel_flag : False
wave_key      : WAVE0
normalise_kernel : True
report_plot_include : True
report_table_include : False

```

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## 3.5 OpticalElement: "MICADO\_Sci\_SCAO\_detector\_override"

**Element:** detector

**Alias:** DET

**Description:** A settable window on the detector plane

### 3.5.1 Global properties

```
width : 1024
height : 1024
element_name : MICADO_Sci_SCAO_detector_override
```

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## 3.6 OpticalElement: "MCAO"

**Element:** instrument

**Alias:** INST

**Description:** MCAO optical system

### 3.6.1 Global properties

```
element_name : MCAO
```

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## 3.7 OpticalElement: "MICADO\_MCAO"

**Element:** instrument

**Alias:** INST

**Description:** MICADO MCAO mode effects

### 3.7.1 Global properties

```
psf : \{'strehl': 0.4, 'wavelength': 'Ks'\}
element_name : MICADO_MCAO
```

### 3.7.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
MICADO_MCAO	maory_mms_ter	TERCurve	True	[10, 110, 510]
MICADO_MCAO	maory_const_psf	AnisocadoConstPSF	True	[42, 652]

#### 3.7.2.1 TERCurve: "maory\_mms\_ter"

**Included by default:** True

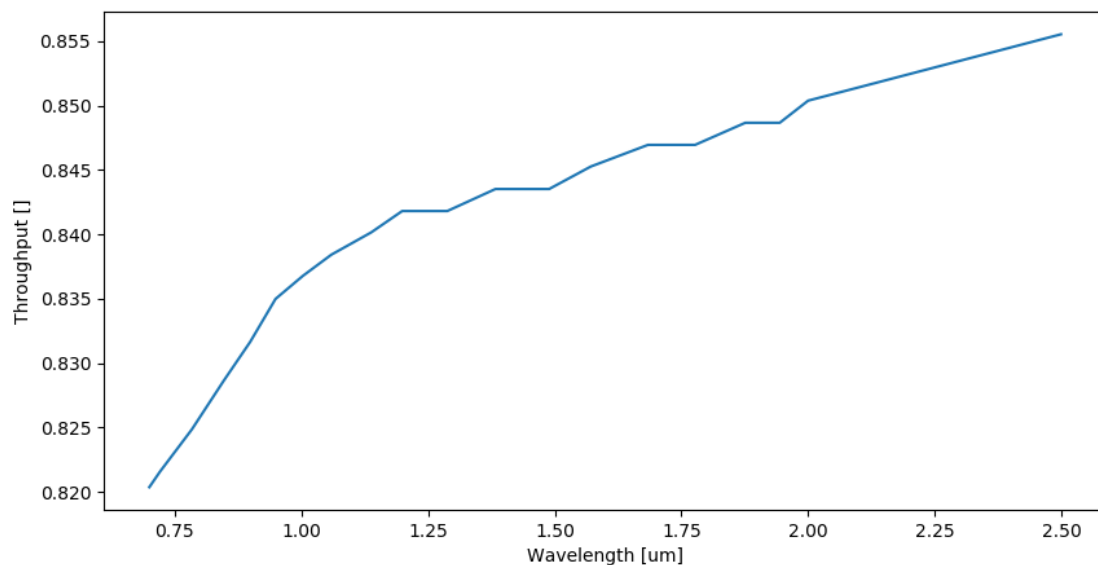
**File Description:** Combined TER curve for MAORY MMS relay optics module

**Class Description:** Transmission, Emissivity, Reflection Curve

**Changes:**

-

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## Data

### Meta-data

```

filename : TER_MAORY_MMS.dat
name : maory_mms_ter
psf : \{'strehl': 0.4, 'wavelength': 'Ks'\}
element_name : MICADO_MCAO
author : Auto-compiled from source
source : LIST_mirrors_maory_mms.tbl
date_created : 2020-08-25
date_modified : 2020-08-25
area : 0.9503317777109126
area_unit : m2
wavelength_unit : um
emission_unit : photlam
z_order : [10, 110, 510]
include : True
ignore_wings : False
wave_min : 0.7
wave_max : 2.5
wave_unit : um
wave_bin : 0.001
report_plot_include : True
report_table_include : False

```



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### 3.7.2.2 AnisocadoConstPSF: "maory\_const\_psf"

**Included by default:** True

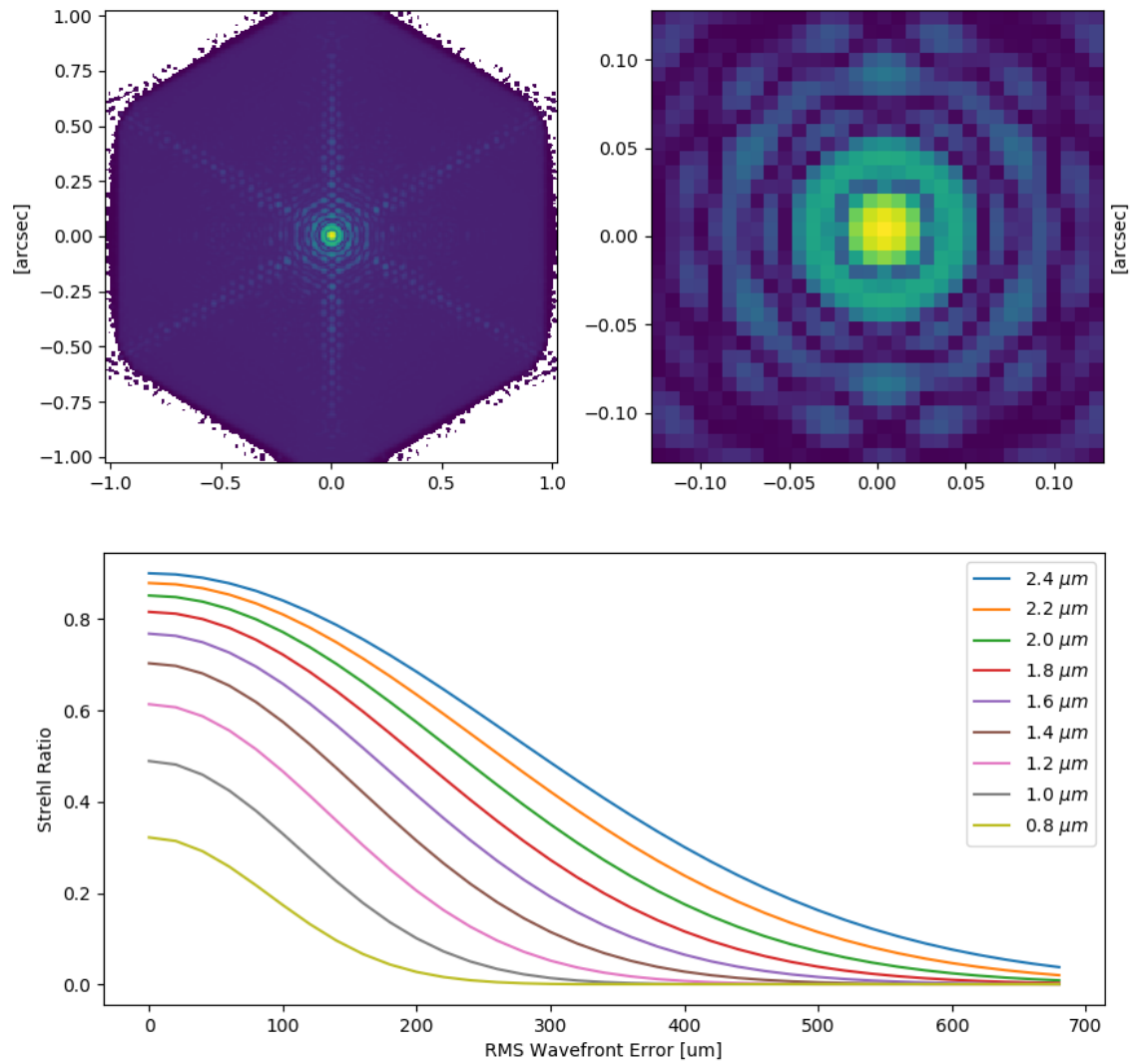
**File Description:** field constant PSF as produced by MAORY

**Class Description:** Makes a SCAO on-axis PSF with a desired Strehl ratio at a given wavelength

**Changes:**

-

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## Data

## Meta-data

```
filename : MICADO_AnisoCADO_rms_map.fits
name     : maory_const_psf
psf      : \{'strehl': 0.4, 'wavelength': 'Ks'\}
```

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```

element_name : MICADO_MCAO
  strehl      : !INST.psf.strehl
  wavelength  : !INST.psf.wavelength
psf_side_length : 256
  offset      : [0, 0]
rounded_edges  : True
convolve_mode  : full
  SIMPLE      : True
  BITPIX      : -64
  NAXIS       : 2
  NAXIS1      : 35
  NAXIS2      : 9
  EXTEND      : True
  CRVAL1      : 0
  CRVAL2      : 0.8
  CRPIX1      : 1.0
  CRPIX2      : 1.0
  CDELT1      : 20
  CDELT2      : 0.2
  CUNIT1      : nm
  CUNIT2      : um
  CTYPE1      : LINEAR
  CTYPE2      : LINEAR
  LABEL1      : nmRMS
  LABEL2      : wavelength
  AUTHOR      : Kieran Leschinski
DATE_CRE      : 2019-07-30
DATE_MOD      : 2019-07-30
SOURCE        : AnisoCADO
STATUS        : Strehl as a function of wavelength and wavefront error
  ETYPE       : SRMAP
  ECAT        : -1
  EDATA       : 0
XOFFSET       : 0
YOFFSET       : 0
z_order       : [42, 652]
include       : True
flux_accuracy : 0.001
sub_pixel_flag : False
wave_key      : WAVE0
normalise_kernel : True
report_plot_include : True
report_table_include : False

```

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## 3.8 OpticalElement: "MICADO\_Sci\_MCAO\_detector\_override"

**Element:** detector

**Alias:** DET

**Description:** A settable window on the detector plane

### 3.8.1 Global properties

```
width : 4096
height : 4096
element_name : MICADO_Sci_MCAO_detector_override
```

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## 3.9 OpticalElement: "SPEC"

**Element:** instrument

**Alias:** INST

**Description:** Spectroscopy

### 3.9.1 Global properties

```

filter_name : Spec_HK
pixel_scale : 0.004
plate_scale : 0.266666666666
element_name : SPEC

```

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## 3.10 OpticalElement: "MICADO\_SPEC"

**Element:** instrument

**Alias:** INST

**Description:** MICADO SPEC mode effects

### 3.10.1 Global properties

```
psf : \{'wavelength': '!INST.filter_name', 'strehl': 0.4\}
aperture : \{'x': 0, 'y': 0, 'width': 3, 'height': 0.05\}
element_name : MICADO_SPEC
```

### 3.10.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
MICADO_SPEC	micado_adjustable_slit	RectangularApertureMask	True	[80, 280, 380]
MICADO_SPEC	spectral_trace_3000x50mas	SpectralTraceList	True	[70, 270]

#### 3.10.2.1 RectangularApertureMask: "micado\_adjustable\_slit"

**Included by default:** True

**File Description:**

**Class Description:** <no docstring>

**Changes:**

- 

**Data**

x	y
-1.5000	-0.0250
1.5000	-0.0250
1.5000	0.0250
-1.5000	0.0250

**Meta-data**

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```

        filename : None
            name : micado_adjustable_slit
            psf : \{'wavelength': 'Ks', 'strehl': 0.4\}
        aperture : \{'x': 0, 'y': 0, 'width': 3, 'height': 0.05\}
    element_name : MICADO_SPEC
        width : !INST.aperture.width
        height : !INST.aperture.height
        x : !INST.aperture.x
        y : !INST.aperture.y
    z_order : [80, 280, 380]
    include : True
    pixel_scale : !INST.pixel_scale
    no_mask : True
    angle : 0
    shape : rect
    conserve_image : True
    id : 0
    report_plot_include : False
    report_table_include : True
    report_table_rounding : 4
        x_unit : arcsec
        y_unit : arcsec

```

### 3.10.2.2 SpectralTraceList: "spectral\_trace\_3000x50mas" : 1 traces

**Included by default:** True

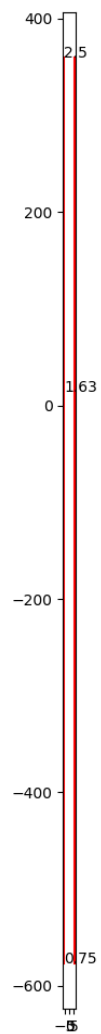
**File Description:**

**Class Description:** List of spectral trace geometries for the detector plane

**Changes:**

-

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## Data

## Meta-data

```

filename : TRACE_SCI_3arcsec.fits
name : spectral_trace_3000x50mas
psf : \{'wavelength': 'Ks', 'strehl': 0.4\}

```



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```

        aperture : \{'x': 0, 'y': 0, 'width': 3, 'height': 0.05\}
    element_name : MICADO_SPEC
center_on_wave_mid : True
        SIMPLE : True
        BITPIX : 8
        NAXIS : 0
        EXTEND : True
        ECAT : 1
        EDATA : 2
        z_order : [70, 270]
        include : True
    pixel_scale : !INST.pixel_scale
    plate_scale : !INST.plate_scale
        wave_min : !SIM.spectral.wave_min
        wave_mid : !SIM.spectral.wave_mid
        wave_max : !SIM.spectral.wave_max
        x_colname : x
        y_colname : y
        s_colname : s
        wave_colname : wavelength
    col_number_start : 0
        dwave : 0.002
        invalid_value : None
    report_plot_include : True
    report_table_include : False

```

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### 3.11 OpticalElement: "MICADO\_Sci\_SPEC\_detector\_override"

**Element:** detector

**Alias:** DET

**Description:** A settable window on the detector plane

#### 3.11.1 Global properties

```
width : 800
height : 1024
element_name : MICADO_Sci_SPEC_detector_override
```

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## 3.12 OpticalElement: "4mas"

**Element:** instrument

**Alias:** INST

**Description:** wide-field imager : 4mas/pix

### 3.12.1 Global properties

```

filter_name : Ks
pixel_scale : 0.004
plate_scale : 0.266666666666
element_name : 4mas

```

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### 3.13 OpticalElement: "1.5mas"

**Element:** instrument

**Alias:** INST

**Description:** zoom imager : 1.5mas/pix

#### 3.13.1 Global properties

```

filter_name : Ks
pixel_scale : 0.0015
plate_scale : 0.1
element_name : 1.5mas

```

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### 3.14 OpticalElement: "micado\_sci\_detector"

**Element:** detector

**Alias:** DET

**Description:** List of MICADO detector effects relevant for astronomers

#### 3.14.1 Global properties

```
image_plane_id : 0
  temperature : -230
    dit : !OBS.dit
    ndit : !OBS.ndit
  width : 4096
  height : 4096
    x : 0
    y : 0
  element_name : micado_sci_detector
```

#### 3.14.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
micado_sci_detector	micado_detector_window	DetectorWindow	True	[90, 290, 390, 490]
micado_sci_detector	h4rg_qe_curve	QuantumEfficiencyCurve	True	[113, 513]
micado_sci_detector	exposure_action	SummedExposure	True	[860]
micado_sci_detector	dark_current	DarkCurrent	True	[830]
micado_sci_detector	shot_noise	ShotNoise	True	[820]
micado_sci_detector	h4rg_detector_linearity	LinearityCurve	False	[840]
micado_sci_detector	readout_noise	PoorMansHxRGReadoutNoise	True	[811]

##### 3.14.2.1 DetectorWindow: "micado\_detector\_window"

**Included by default:** True

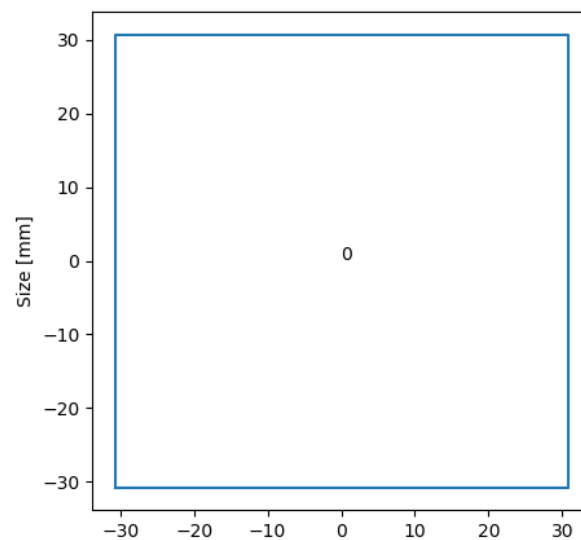
**File Description:**

**Class Description:** For when a full DetectorList is too cumbersome

**Changes:**

-

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id	x_cen	y_cen	x_size	y_size	angle	gain	pixel_size
0	!DET.x	!DET.y	!DET.width	!DET.height	0	1	0.015

## Data

## Meta-data

```

filename : None
name : micado_detector_window
orig_units : pixel
x_cen_unit : pixel
y_cen_unit : pixel
x_size_unit : pixel
y_size_unit : pixel
pixel_size_unit : mm
angle_unit : deg
gain_unit : electron/adu
image_plane_id : 0
temperature : -230
dit : !OBS.dit
ndit : !OBS.ndit
element_name : micado_sci_detector
z_order : [90, 290, 390, 490]
include : True

```

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```

pixel_scale : !INST.pixel_scale
active_detectors : all
report_plot_include : True
report_table_include : True

```

### 3.14.2.2 QuantumEfficiencyCurve: "h4rg\_qe\_curve"

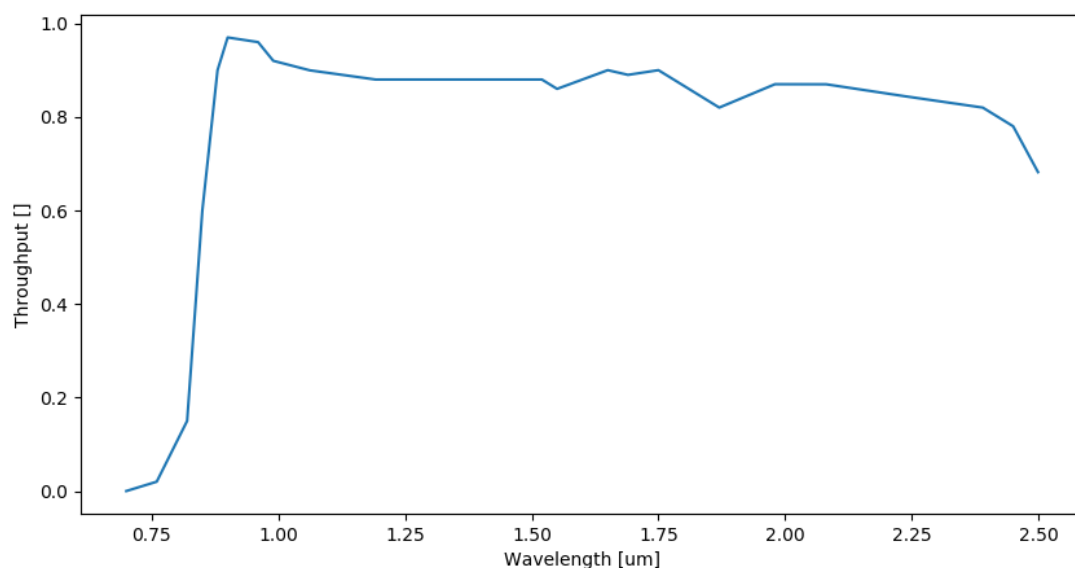
**Included by default:** True

**File Description:** Quantum efficiency curves for each detector

**Class Description:** <no docstring>

**Changes:**

- 2018-11-19 (KL) updated meta data to new format
- 2019-08-09 (KL) Added action keyword to meta data



**Data**

**Meta-data**

```

filename : QE_detector_H2RG.dat
name : h4rg_qe_curve

```

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```

image_plane_id : 0
  temperature : -230
    dit : 60
    ndit : 1
    width : 4096
    height : 4096
    x : 0
    y : 0
  element_name : micado_sci_detector
  author : Kieran Leschinski
  sources : Finger+ 2008 SPIE
  date_created : 2016-01-01
  date_modified : 2019-08-09
    type : detector:quantum_efficiency
    status : Design, guestimated by reading off the graph in Finger
wavelength_unit : um
  action : transmission
  z_order : [113, 513]
  include : True
  ignore_wings : False
  wave_min : 0.7
  wave_max : 2.5
  wave_unit : um
  wave_bin : 0.001
report_plot_include : True
report_table_include : False
position : -1

```

### 3.14.2.3 SummedExposure: "exposure\_action"

**Included by default:** True

**File Description:** Summing up sky signal for all DITs and NDITs

**Class Description:** Simulates a summed stack of ndit exposures

**Changes:**

- 

**Data**

**Meta-data**

```
filename : None
```



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```

        name : exposure_action
image_plane_id : 0
    temperature : -230
        dit : !OBS.dit
        ndit : !OBS.ndit
    width : 4096
    height : 4096
        x : 0
        y : 0
    element_name : micado_sci_detector
    z_order : [860]
    include : True

```

#### 3.14.2.4 DarkCurrent: "dark\_current"

**Included by default:** True

**File Description:** MICADO dark current

**Class Description:** required: dit, ndit, value

**Changes:**

- 

**Data**

**Meta-data**

```

        filename : None
        name : dark_current
image_plane_id : 0
    temperature : -230
        dit : !OBS.dit
        ndit : !OBS.ndit
    width : 4096
    height : 4096
        x : 0
        y : 0
    element_name : micado_sci_detector
    value : 0.1
    z_order : [830]
    include : True

```

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### 3.14.2.5 ShotNoise: "shot\_noise"

**Included by default:** `True`

**File Description:** apply poisson shot noise to images

**Class Description:** <no docstring>

**Changes:**

- 

#### Data

#### Meta-data

```

filename : None
name : shot_noise
image_plane_id : 0
temperature : -230
dit : !OBS.dit
ndit : !OBS.ndit
width : 4096
height : 4096
x : 0
y : 0
element_name : micado_sci_detector
z_order : [820]
include : True
random_seed : !SIM.random.seed

```

### 3.14.2.6 LinearityCurve: "h4rg\_detector\_linearity"

**Included by default:** `False`

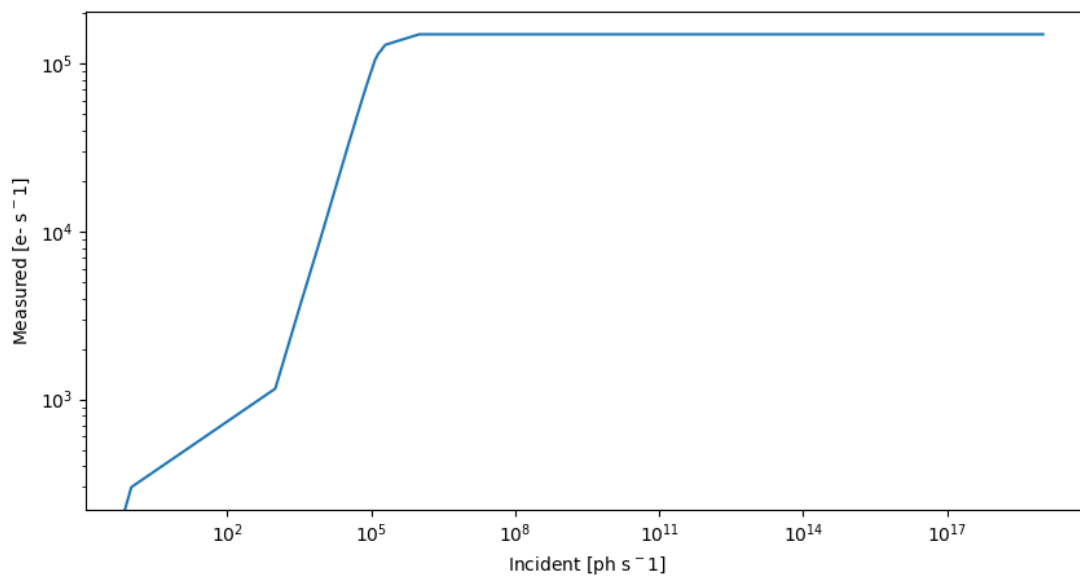
**File Description:** Linearity characteristics of H4RG chips

**Class Description:** <no docstring>

**Changes:**

- 2018-11-19 (KL) updated meta data to new format
- 2019-08-14 (KL) replaced long 1000000000 with 1e99

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## Data

## Meta-data

```

filename : FPA_linearity.dat
name : h4rg_detector_linearity
include : False
image_plane_id : 0
temperature : -230
dit : !OBS.dit
ndit : !OBS.ndit
width : 4096
height : 4096
x : 0
y : 0
element_name : micado_sci_detector
author : Kieran Leschinski
sources : Ingraham+ 2014 - Gemini Calibrations II for H2RG
date_created : 2016-01-01
date_modified : 2018-11-19
type : detector:linearity
status : Design, approximated from the H2RG
incident_unit : ph
measured_unit : ph
z_order : [840]
```

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```
report_plot_include : True
report_table_include : False
```

### 3.14.2.7 PoorMansHxRGReadoutNoise: "readout\_noise"

**Included by default:** True

**File Description:** Readout noise frames

**Class Description:** <no docstring>

**Changes:**

- 

**Data**

**Meta-data**

```
filename : None
name : readout_noise
image_plane_id : 0
temperature : -230
dit : !OBS.dit
ndit : !OBS.ndit
width : 4096
height : 4096
x : 0
y : 0
element_name : micado_sci_detector
noise_std : 12
n_channels : 64
z_order : [811]
include : True
pedestal_fraction : 0.3
read_fraction : 0.4
line_fraction : 0.25
channel_fraction : 0.05
random_seed : !SIM.random.seed
report_plot_include : False
report_table_include : False
```

## **Chapter 4**

# **Support packages**

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## 4.1 OpticalElement: "armazones"

**Element:** atmosphere

**Alias:** ATMO

**Description:** Atmosphere and location details for Cerro Armazones

### 4.1.1 Global properties

```

altitude : 3060
longitude : -70.1918
latitude : -24.5899
temperature : 7
humidity : 0.1
pressure : 0.755
pwv : 2.5
airmass : !OBS.airmass
pupil_angle : !OBS.pupil_angle
pixel_scale : !INST.pixel_scale
background : \{'filter_name': 'Ks', 'value': 13.6, 'unit': 'mag'\}
spectrum : \{'filename': 'TER_armazones_default_FULL_IMG.dat'\}
element_name : armazones

```

### 4.1.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
armazones	armazones_atmo_default_ter_curve	AtmosphericTERCurve	True	[111, 511]
armazones	armazones_atmo_dispersion	AtmosphericDispersion	False	[231]
armazones	armazones_atmo_skycalc_ter_curve	SkycalcTERCurve	False	[112, 512]

#### 4.1.2.1 AtmosphericTERCurve: "armazones\_atmo\_default\_ter\_curve"

**Included by default:** True

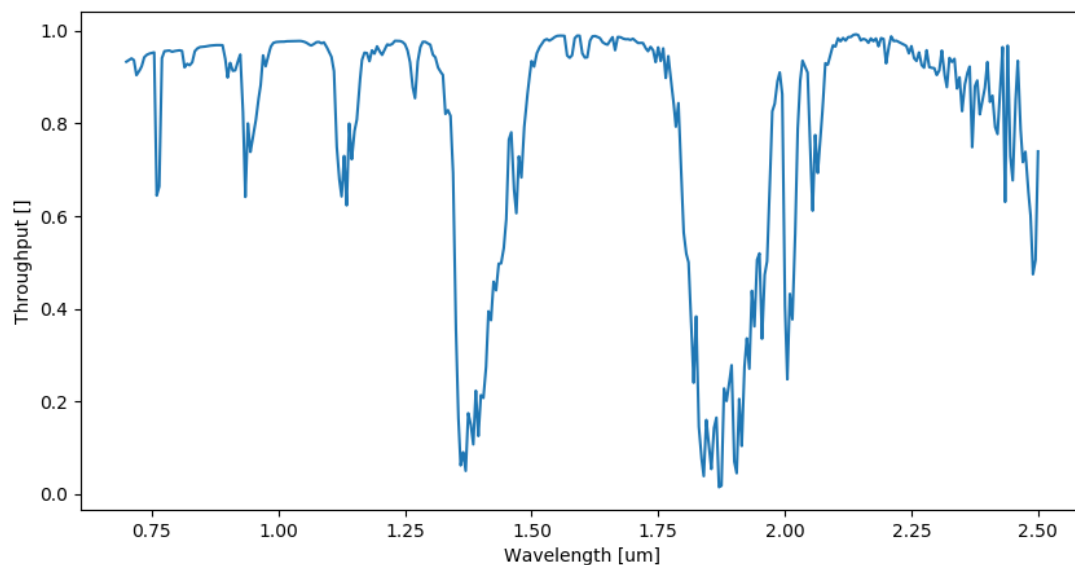
**File Description:** atmospheric emission and transmission

**Class Description:** <no docstring>

**Changes:**

- 2020-10-29 (MV) Created file

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## Data

### Meta-data

```

filename : TER_armazones_default_FULL_IMG.dat
  name   : armazones_atmo_default_ter_curve
include  : True
altitude : 3060
longitude : -70.1918
latitude : -24.5899
temperature : 7
humidity   : 0.1
pressure   : 0.755
  pwv      : 2.5
  airmass   : 1.2
pupil_angle : 0
pixel_scale : 0.004
background : \{'filter_name': 'Ks', 'value': 13.6, 'unit': 'mag'\}
spectrum   : \{'filename': 'TER_armazones_default_FULL_IMG.dat'\}
element_name : armazones
  area      : 0
rescale_emission : \{'filter_name': 'Ks', 'filename_format': 'filters/TC_
author      : Miguel Verdugo
source      : skycalc_ipy tool for standard Armazones conditions
date_created : 2020-10-29

```

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```

date_modified : 2020-10-29
  status      : Design
    type      : atmosphere:ter_curve
  wdelta     : 10
    wmin      : 300
    wmax      : 15000
  season     : entire year
    time      : entire night
  action     : transmission
wavelength_unit : um
  emission_unit : ph s-1 m-2 um-1 arcsec-2
    z_order    : [111, 511]
  ignore_wings : False
    wave_min   : 0.7
    wave_max   : 2.5
  wave_unit   : um
    wave_bin   : 0.0001
report_plot_include : True
report_table_include : False
  position    : 0

```

#### 4.1.2.2 AtmosphericDispersion: "armazones\_atmo\_dispersion"

**Included by default:** False

**File Description:** atmospheric dispersion

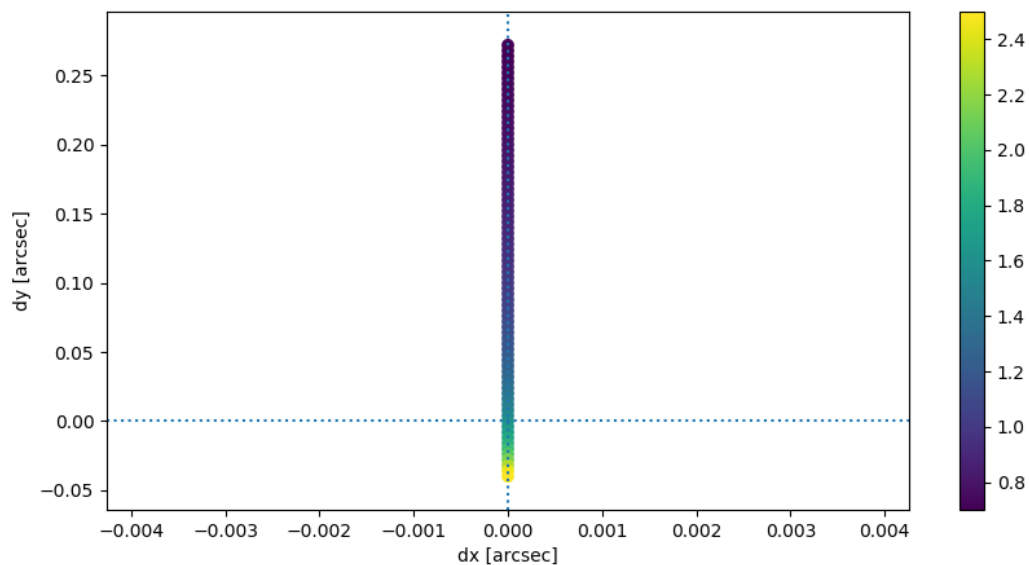
**Class Description:** Used to generate the wavelength bins based on shifts due to the atmosphere

**Changes:**

-



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## Data

### Meta-data

```

filename : None
  name : armazones_atmo_dispersion
  include : False
  altitude : 3060
  longitude : -70.1918
  latitude : -24.5899
  temperature : 7
  humidity : 0.1
  pressure : 0.755
    pwv : 2.5
  airmass : 1.2
  pupil_angle : 0
  pixel_scale : 0.004
  background : \{'filter_name': 'Ks', 'value': 13.6, 'unit': 'mag'\}
  spectrum : \{'filename': 'TER_armazones_default_FULL_IMG.dat'\}
  element_name : armazones
    z_order : [231]
  report_plot_include : True
  report_table_include : False
    wave_min : 0.7
    wave_mid : 1.6

```

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```

        wave_max : 2.5
sub_pixel_fraction : 1
        num_steps : 1000
           z0 : 33.55730976192071
          temp : 7
        rel_hum : 10.0
          pres : 755.0
           lat : -24.5899
            h : 3060

```

#### 4.1.2.3 SkycalcTERCurve: "armazones\_atmo\_skycalc\_ter\_curve"

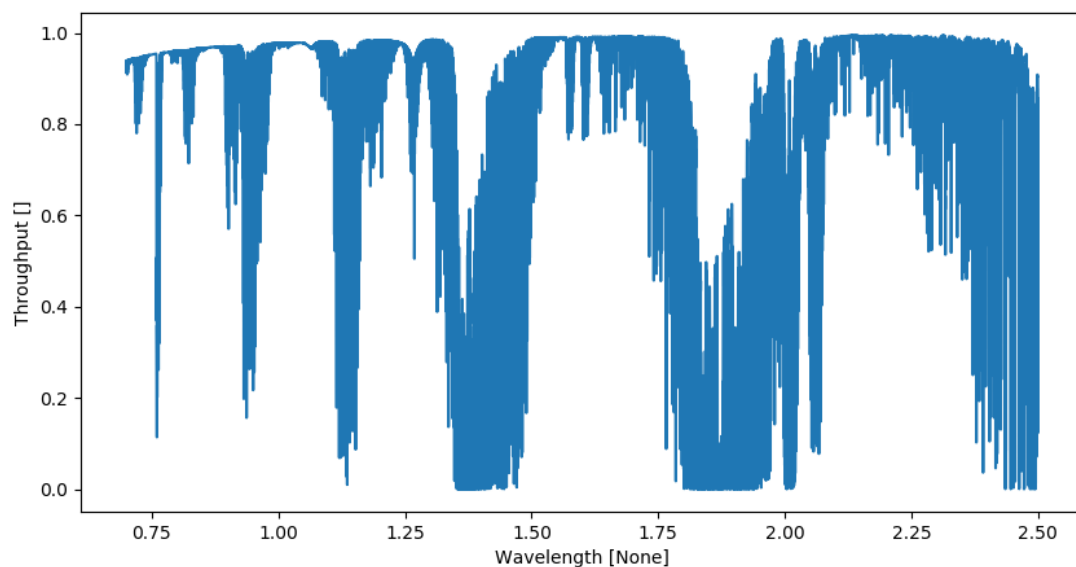
**Included by default:** False

**File Description:** atmospheric spectra pulled from the skycalc server

**Class Description:** <no docstring>

**Changes:**

- 



**Data**

**Meta-data**

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```

filename : None
  name : armazones_atmo_skycalc_ter_curve
  include : False
  altitude : 3060
  longitude : -70.1918
  latitude : -24.5899
  temperature : 7
  humidity : 0.1
  pressure : 0.755
  pwv : 2.5
  airmass : 1.2
  pupil_angle : 0
  pixel_scale : 0.004
  background : \{'filter_name': 'Ks', 'value': 13.6, 'unit': 'mag'\}
  spectrum : \{'filename': 'TER_armazones_default_FULL_IMG.dat'\}
element_name : armazones
observatory : armazones
  wmin : 699.9999999999999
  wmax : 2499.999999999995
  wunit : um
  wdelta : 0.09999999999999999
  z_order : [112, 512]
ignore_wings : False
  wave_min : 0.7
  wave_max : 2.5
  wave_unit : um
  wave_bin : 0.0001
report_plot_include : True
report_table_include : False
  action : transmission
  position : 0

```

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## 4.2 OpticalElement: "ELT"

**Element:** telescope

**Alias:** TEL

**Description:** The extremely large telescope

### 4.2.1 Global properties

```
temperature : !ATMO.temperature
element_name : ELT
```

### 4.2.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
ELT	scope_surface_list	SurfaceList	True	[20, 120, 520]
ELT	scope_vibration	Vibration	True	[244, 744]
ELT	eso_combined_reflection	TERCurve	False	[10, 110, 510]

#### 4.2.2.1 SurfaceList: "scope\_surface\_list"

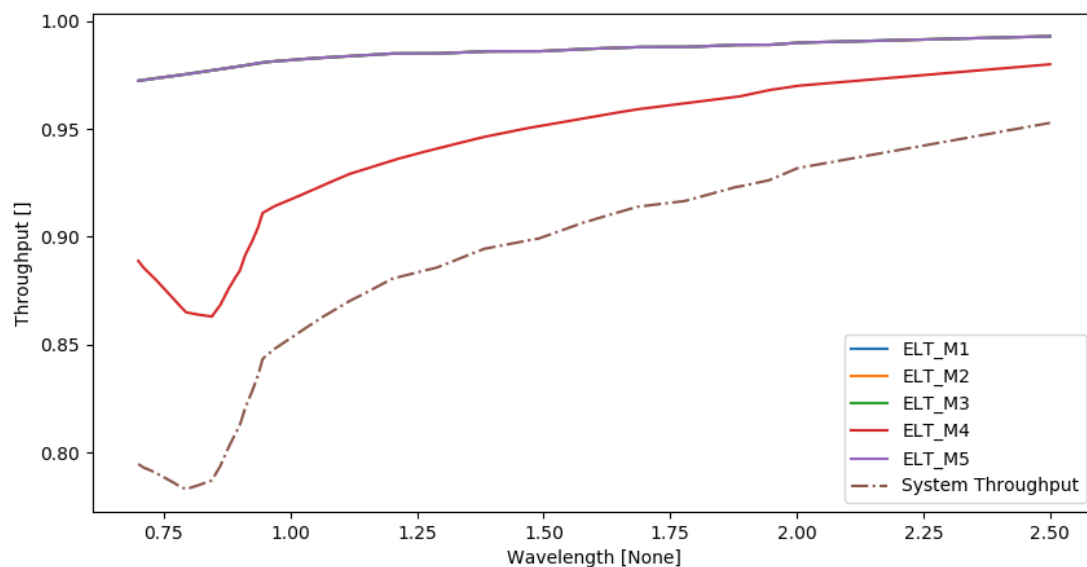
**Included by default:** True

**File Description:** list of ELT surfaces

**Class Description:** <no docstring>

**Changes:**

- 2018-11-19 (KL) Added meta data, added Action column
- 2019-01-28 (KL) Fixed YAML format in meta data
- 2020-08-17 (KL) Updated M1 and M4 dimensions according to ESO-253082\_4 sect 4.7 "all-glass" diameter
- 2020-08-17 (KL) Pegged temperature to the atmosphere



name	outer	inner	angle	temperature	action	filename
ELT_M1	36.9	10.95	0.0	!ATMO.temperature	reflection	TER_ELT_mirror_mgf2agal.dat
ELT_M2	4.2	0.545	0.0	!ATMO.temperature	reflection	TER_ELT_mirror_mgf2agal.dat
ELT_M3	3.8	0.14	0.0	!ATMO.temperature	reflection	TER_ELT_mirror_mgf2agal.dat
ELT_M4	2.54	0.536	7.75	!ATMO.temperature	reflection	TER_ELT_mirror_aluminium.da
ELT_M5	2.66	0.0	37.25	!ATMO.temperature	reflection	TER_ELT_mirror_mgf2agal.dat

## Data

## Meta-data

```

filename : LIST_mirrors_ELT.tbl
name : scope_surface_list
temperature : !ATMO.temperature
element_name : ELT
author : Oliver Czoske, Kieran Leschinski
source : ESO ELT DRM, ESO-253082_4
date_created : 2018-11-19
date_modified : 2020-08-17
status : Design, pre MICADO-FDR mirror list
outer_unit : m
inner_unit : m
angle_unit : degree

```

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```

temperature_unit : deg_C
    notes : ['2020-08-17 (KL) Coatings match those described in ES
z_order : [20, 120, 520]
include : True
ignore_wings : False
wave_min : !SIM.spectral.wave_min
wave_max : !SIM.spectral.wave_max
wave_unit : !SIM.spectral.wave_unit
wave_bin : !SIM.spectral.spectral_resolution
report_plot_include : True
report_table_include : True
minimum_throughput : !SIM.spectral.minimum_throughput
etendue : !TEL.etendue

```

#### 4.2.2.2 Vibration: "scope\_vibration"

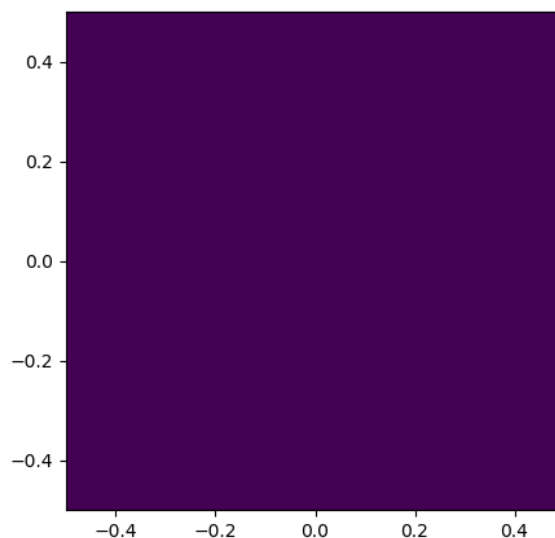
**Included by default:** True

**File Description:** residual vibration of telescope

**Class Description:** Creates a wavelength independent kernel image

**Changes:**

- 



**Data**

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## Meta-data

```

filename : None
name : scope_vibration
temperature : 7
element_name : ELT
fwhm : 0.001
pixel_scale : 0.004
z_order : [244, 744]
include : True
flux_accuracy : 0.001
sub_pixel_flag : False
convolve_mode : full
wave_key : WAVE0
normalise_kernel : True
report_plot_include : True
report_table_include : False
width_n_fwhms : 4

```

### 4.2.2.3 TERCurve: "eso\_combined\_reflection"

**Included by default:** False

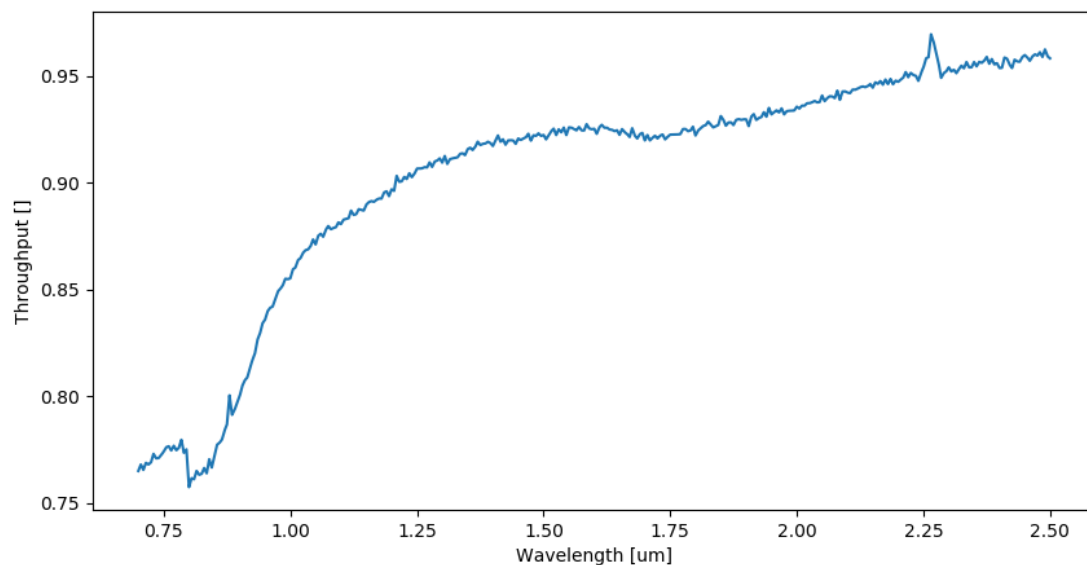
**File Description:** single combined reflection curve for clean ELT 5 mirror combination

**Class Description:** Transmission, Emissivity, Reflection Curve

#### Changes:

- 2019-11-06 (KL) Converted from .xlsx to .dat file, added ScopeSim meta data
- 2020-07-09 (KL) Added inner and outer dimensions to meta, for use with MICADO-Sci
- 2020-08-17 (KL) Added emissivity column according to ESO-253082\_4, sect 4.12.2

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## Data

### Meta-data

```

filename : TER_ELT_system_20190611.dat
name : eso_combined_reflection
include : False
temperature : 7
element_name : ELT
temperture : 7
author : R. Holzloehner
source : See ESO-306070 and ESO-293390 for background.
date_created : 2018-09-18
date_modified : 2019-06-11
type : TERCurve
status : design
action : reflection
outer : 37.3
outer_unit : m
inner : 11.1
inner_unit : m
wavelength_unit : um
notes : ['Baseline coatings.', 'Fresh coatings without contami
z_order : [10, 110, 510]
ignore_wings : False

```



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```

        wave_min : 0.7
        wave_max : 2.5
        wave_unit : um
        wave_bin  : 0.0001
    report_plot_include : True
    report_table_include : False

```

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## 4.3 OpticalElement: "MAORY"

**Element:** relay\_optics

**Alias:** RO

**Description:** MAORY AO relay module

### 4.3.1 Global properties

```
temperature : !ATMO.temperature
psf_filename : None
element_name : MAORY
```

### 4.3.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
MAORY	maory_surface_list	SurfaceList	True	[20, 120, 520]
MAORY	maory_generic_psf	FieldConstantPSF	True	[262, 662]

#### 4.3.2.1 SurfaceList: "maory\_surface\_list"

**Included by default:** True

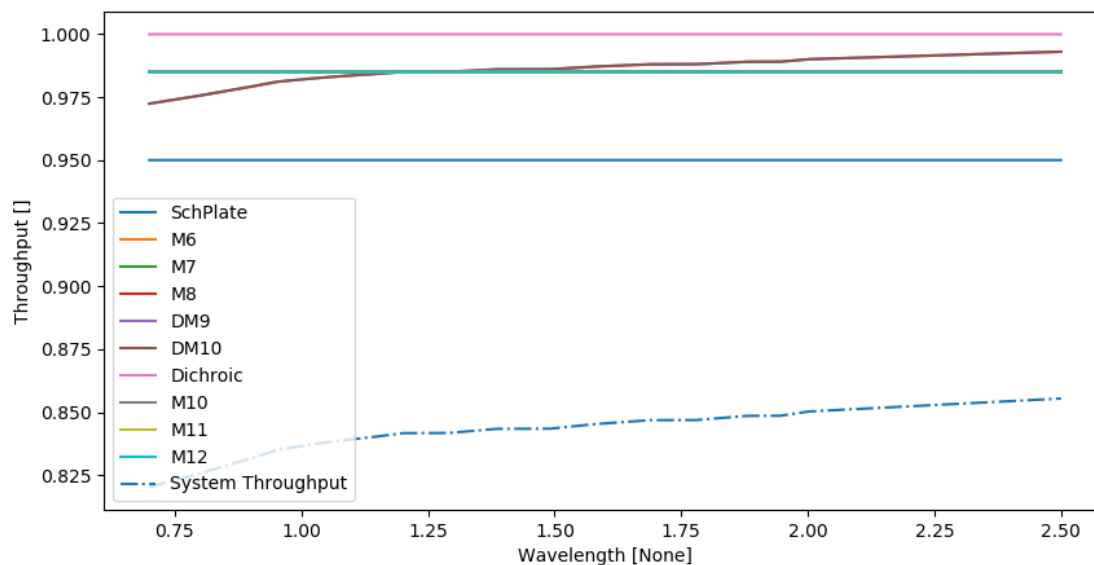
**File Description:** list of surfaces in MAORY

**Class Description:** <no docstring>

**Changes:**

- 2018-11-19 (KL) Added meta data, changed Dichr. filename
- 2019-01-28 (KL) Fixed YAML format in meta data
- 2020-06-22 (KL) Updated file to match the MMS configuration from Carmelo
- 2020-08-17 (KL) Pegged temperature to atmosphere
- 2020-12-03 (KL)

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name	outer	inner	angle	temperature	action	filename
SchPlate	1.1	0.0	0.0	!ATMO.temperature	transmission	TER_entrance_window.dat
M6	1.1	0.0	0.0	!ATMO.temperature	reflection	TER_MAORY_mirror_silver.da
M7	0.7	0.0	0.0	!ATMO.temperature	reflection	TER_MAORY_mirror_silver.da
M8	0.85	0.0	0.0	!ATMO.temperature	reflection	TER_MAORY_mirror_silver.da
DM9	0.75	0.0	0.0	!ATMO.temperature	reflection	TER_MAORY_mirror_mgf2aga
DM10	0.75	0.0	0.0	!ATMO.temperature	reflection	TER_MAORY_mirror_mgf2aga
Dichroic	0.6	0.0	0.0	!ATMO.temperature	reflection	TER_MAORY_lgs_dichroic.dat
M10	0.6	0.0	0.0	!ATMO.temperature	reflection	TER_MAORY_mirror_silver.da
M11	0.8	0.0	45.0	!ATMO.temperature	reflection	TER_MAORY_mirror_silver.da
M12	0.8	0.0	0.0	!ATMO.temperature	reflection	TER_MAORY_mirror_silver.da

## Data

## Meta-data

```

filename : LIST_mirrors_maory_mms.tbl
name      : maory_surface_list
temperature : !ATMO.temperature
psf_filename : None
element_name : MAORY
author    : Kieran Leschinski

```

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```

        source : Carmelo Archidiacono private email
    date_created : 2018-11-19
    date_modified : 2020-06-22
        status : Design, new MAORY MMS design
    outer_unit : m
    inner_unit : m
    angle_unit : degree
    temperature_unit : deg_C
        z_order : [20, 120, 520]
        include : True
    ignore_wings : False
        wave_min : !SIM.spectral.wave_min
        wave_max : !SIM.spectral.wave_max
        wave_unit : !SIM.spectral.wave_unit
        wave_bin : !SIM.spectral.spectral_resolution
    report_plot_include : True
    report_table_include : True
    minimum_throughput : !SIM.spectral.minimum_throughput
        etendue : !TEL.etendue

```

#### 4.3.2.2 FieldConstantPSF: "maory\_generic\_psf"

**Included by default:** True

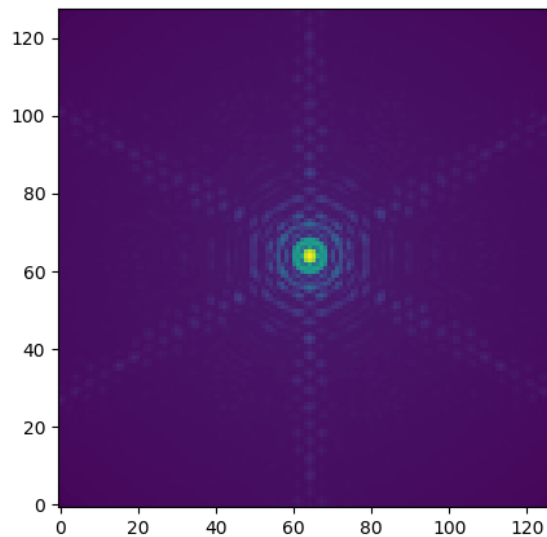
**File Description:** MAORY field varying MCAO PSF

**Class Description:** <no docstring>

**Changes:**

-

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## Data

### Meta-data

```

filename : PSF_MCAO_ConstPSF_40_18_6.fits
name : maory_generic_psf
temperature : 7
psf_filename : None
element_name : MAORY
warning : Default PSF is not Field Varying. See Documentation
SIMPLE : True
BITPIX : 8
NAXIS : 0
EXTEND : True
AUTHOR : Kieran Leschinski
DATE_CRE : 2019-07-30
DATE_MOD : 2019-07-30
SOURCE : AnisoCADO
STATUS : Best guess for a MAORY ConstantPSF with AnisoCADO
ETypes : CONSTPSF
ECAT : -1
EDATA : 1
XOFFSET : 0
YOFFSET : 0
z_order : [262, 662]
```

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```

        include : True
    flux_accuracy : 0.001
    sub_pixel_flag : False
    convolve_mode : full
        wave_key : WAVE0
    normalise_kernel : True
    report_plot_include : True
    report_table_include : False

```

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## 4.4 OpticalElement: "default\_ro"

**Element:** relay\_optics

**Alias:** RO

**Description:** Simple stand-alone relay optics module

### 4.4.1 Global properties

```

temperature : !ATMO.temperature
psf_filename : None
element_name : default_ro

```

### 4.4.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders
default_ro	relay_psf	FieldConstantPSF	True	[262, 662]
default_ro	relay_surface_list	SurfaceList	True	[20, 120, 520]

#### 4.4.2.1 FieldConstantPSF: "relay\_psf"

**Included by default:** True

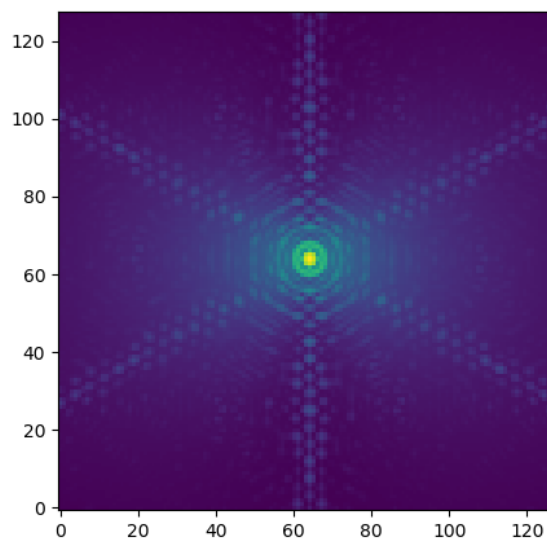
**File Description:** SCAO PSF

**Class Description:** <no docstring>

**Changes:**

-

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## Data

### Meta-data

```

filename : PSF_SCAO_ConstPSF_0_5off.fits
name : relay_psf
temperature : 7
psf_filename : None
element_name : default_ro
warning : Default PSF is NOT field varying. See documentation.
SIMPLE : True
BITPIX : 8
NAXIS : 0
EXTEND : True
AUTHOR : Kieran Leschinski
DATE_CRE : 2019-07-30
DATE_MOD : 2019-07-30
SOURCE : AnisoCADO
STATUS : Best guess for a standard observations
ETypes : CONSTPSF
ECAT : -1
EDATA : 1
XOFFSET : 0
YOFFSET : 5
z_order : [262, 662]
```





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name	outer	inner	angle	temperature	action	filename
MIC_RO_M1	0.505	0.0	45.0	!ATMO.temperature	reflection	TER_MICADO_mirror_mgf2aga
MIC_RO_M2	0.51	0.0	10.0	!ATMO.temperature	reflection	TER_MICADO_mirror_mgf2aga
MIC_RO_M3	0.184	0.0	10.0	!ATMO.temperature	reflection	TER_MICADO_mirror_mgf2aga
MIC_RO_M4	0.53	0.0	10.0	!ATMO.temperature	reflection	TER_MICADO_mirror_mgf2aga
MIC_RO_M5	0.406	0.0	20.0	!ATMO.temperature	reflection	TER_MICADO_mirror_mgf2aga
MIC_RO_M6	0.406	0.0	35.0	!ATMO.temperature	reflection	TER_MICADO_mirror_mgf2aga

## Data

### Meta-data

```

filename : LIST_RO_SCAO_mirrors.dat
name : relay_surface_list
temperature : !ATMO.temperature
psf_filename : None
element_name : default_ro
author : Oliver Czoske, Kieran Leschinski
source : P12_RelayOptics_Status_2020-06-23-MICADO-CM16-RO-v2.pd
date_created : 2018-11-19
date_modified : 2020-08-17
status : Design, pre FDR list of stand-alone SCAO relay optics
type : mirror:list
outer_unit : m
inner_unit : m
angle_unit : degree
temperature_unit : deg_C
z_order : [20, 120, 520]
include : True
ignore_wings : False
wave_min : !SIM.spectral.wave_min
wave_max : !SIM.spectral.wave_max
wave_unit : !SIM.spectral.wave_unit
wave_bin : !SIM.spectral.spectral_resolution
report_plot_include : True
report_table_include : True
minimum_throughput : !SIM.spectral.minimum_throughput
etendue : !TEL.etendue

```