ScopeSim instrument packages for MICADO

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Contents

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	True	[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_filter	FilterCurve	True	[114, 214, 514]
MICADO	micado_ncpas_psf	NonCommonPathAberration	True	[241, 641]
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	True	[632, 232]
MICADO_IMG_HR	zoom_mirror_list	SurfaceList	True	[20, 120, 520]
MICADO_IMG_HR	micado_adc_3D_shift	AtmosphericDispersionCorrection	True	[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]
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]
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 OpticalElement: "armazones"

Element: atmosphere

Alias: ATMO

Description: Atmosphere and location details for Cerro Armazones

2.1 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
 element_name : armazones
```

2.2 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	True	[231]
armazones	armazones_atmo_skycalc_ter_curve	SkycalcTERCurve	False	[112, 512]

2.2.1 AtmosphericTERCurve: "armazones_atmo_default_ter_curve"

Included by default: `True`

File Description: atmospheric emission and transmission

Class Description: <no docstring>

Changes:

- 2019-07-24 (KL) Created file
- 2019-08-09 (KL) Updated values for airmass 1.2, pwv 2.5

Data

Meta-data

```
filename : TER_armazones_default_NIR_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 : !OBS.airmass
      pupil_angle : !OBS.pupil_angle
      pixel_scale : !INST.pixel_scale
     element_name : armazones
           author : Kieran Leschinski
           source : skycalc website for standard Armazones conditions
     date_created : 2019-07-24
    date_modified : 2019-08-09
           status : Design
             type : atmosphere:ter_curve
           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 : !SIM.spectral.wave_min
         wave_max : !SIM.spectral.wave_max
        wave_unit : !SIM.spectral.wave_unit
         wave_bin : !SIM.spectral.spectral_resolution
             area : !TEL.area
        area_unit : m2
         position : 0
```

2.2.2 AtmosphericDispersion: "armazones_atmo_dispersion"

Included by default: `True`

File Description: atmospheric dispersion

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

Changes:

-

Data

Meta-data

```
             filename : None
                 name : armazones_atmo_dispersion
             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
      element_name : armazones
          z_order : [231]
          include : True
         wave_min : !SIM.spectral.wave_min
         wave_mid : !SIM.spectral.wave_mid
         wave_max : !SIM.spectral.wave_max
sub_pixel_fraction : !SIM.sub_pixel.fraction
        num_steps : 1000
```

2.2.3 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

```
      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 : !OBS.airmass
   pupil_angle : !OBS.pupil_angle
   pixel_scale : !INST.pixel_scale
  element_name : armazones
   observatory : armazones
          wmin : 699.9999999999999
          wmax : 2499.9999999999995
         wunit : um
        wdelta : 0.09999999999999999
       z_order : [112, 512]
```

```
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
      action : transmission
        area : !TEL.area
   area_unit : m2
    position : 0
```

3 OpticalElement: "ELT"

Element: telescope

Alias: TEL

Description: The extremely large telescope

3.1 Global properties

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

3.2 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]

3.2.1 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

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
  temperature_unit : deg_C
             notes : ['2020-08-17 (KL) Coatings match those described in ESO-2
          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
minimum_throughput : !SIM.spectral.minimum_throughput
          etendue : !TEL.etendue
```

3.2.2 Vibration: "scope_vibration"

Included by default: `True`

File Description: residual vibration of telescope

Class Description: Creates a wavelength independent kernel image

Changes:

-

Data

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
   width_n_fwhms : 4
```

3.2.3 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

Data

Meta-data

```
          filename : TER_ELT_system_20190611.dat
              name : eso_combined_reflection
           include : False
       temperature : !ATMO.temperature
      element_name : ELT
        temperture : !ATMO.temperature
            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 contamination
           z_order : [10, 110, 510]
     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
```

4 OpticalElement: "MAORY"

Element: relay_optics

Alias: RO

Description: MAORY AO relay module

4.1 Global properties

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

4.2 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]

4.2.1 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) Obsolete. Use LIST_mirrors_maory_mms.tbl from now on.

Data

Meta-data

```
            filename : LIST_mirrors_MCAO_MAORY.tbl
                name : maory_surface_list
         temperature : !ATMO.temperature
        psf_filename : None
        element_name : MAORY
              author : Kieran Leschinski
              source : Ciliegi+ 2018 SPIE, "MAORY for ELT - preliminary design o
        date_created : 2018-11-19
       date_modified : 2018-11-19
              status : Design - pre PDR list of MAORY mirrors
                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
minimum_throughput : !SIM.spectral.minimum_throughput
          etendue : !TEL.etendue
```

4.2.2 FieldConstantPSF: "maory_generic_psf"

Included by default: `True`

File Description: MAORY field varying MCAO PSF

Class Description: <no docstring>

Changes:

-

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
           ETYPE : CONSTPSF
            ECAT : -1
           EDATA : 1
         XOFFSET : 0
         YOFFSET : 0
         z_order : [262, 662]
         include : True
   flux_accuracy : 0.001
```

```
  sub_pixel_flag : False
   convolve_mode : full
        wave_key : WAVE0
normalise_kernel : True
```

5 OpticalElement: "default_ro"

Element: relay_optics

Alias: RO

Description: Simple stand-alone relay optics module

5.1 Global properties

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

5.2 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]

5.2.1 FieldConstantPSF: "relay_psf"

Included by default: `True`

File Description: SCAO PSF

Class Description: <no docstring>

Changes:

-

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
```

```
            ETYPE : CONSTPSF
             ECAT : -1
            EDATA : 1
          XOFFSET : 0
          YOFFSET : 5
          z_order : [262, 662]
          include : True
    flux_accuracy : 0.001
   sub_pixel_flag : False
    convolve_mode : full
         wave_key : WAVE0
normalise_kernel : True
```

5.2.2 SurfaceList: "relay_surface_list"

Included by default: `True`

File Description: list of surfaces in the relay optics

Class Description: <no docstring>

Changes:

- 2018-11-19 (KL) Added meta data
- 2019-01-28 (KL) Fixed YAML format in meta data
- 2020-07-18 (KL) Added all 6 mirrors from the CM16 update pdf
- 2020-07-18 (KL) Pegged temperature to atmosphere

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.pdf
       date_created : 2018-11-19
      date_modified : 2020-08-17
             status : Design - pre FDR list of stand-alone SCAO relay optics mi
               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
minimum_throughput : !SIM.spectral.minimum_throughput
            etendue : !TEL.etendue
```

6 OpticalElement: "MICADO"

Element: instrument

Alias: INST

Description: Effects from the MICADO common optics

6.1 Global properties

```
 temperature : -190
element_name : MICADO
```

6.2 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_filter	FilterCurve	True	[114, 214, 514]
MICADO	micado_ncpas_psf	NonCommonPathAberration	True	[241, 641]

6.2.1 SurfaceList: "micado_static_surfaces"

Included by default: `True`

File Description: surfaces list for wide field optics

Class Description: <no docstring>

Changes:

- {datetime.date(2019, 1, 28): '(KL) Changed column names and added units to header'}
- {datetime.date(2019, 7, 10): '(KL) Shortened the list to only the swappable mirrors'}
- {datetime.date(2020, 8, 25): '(KL) Updated angle_unit to degree from degrees (why has astropy not complained until now?)'}

Data

Meta-data

```
            filename : LIST_MICADO_mirrors_static.dat
                name : micado_static_surfaces
         temperature : -190
        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
  minimum_throughput : !SIM.spectral.minimum_throughput
            etendue : !TEL.etendue
```

6.2.2 FilterCurve: "micado_filter"

Included by default: `True`

File Description: transmission curve for filter

Class Description: Other Parameters

Changes:

-

Data

Meta-data

```
             filename : filters/TC_filter_Spec_HK.dat
                 name : micado_filter
          temperature : -190
         element_name : MICADO
          filter_name : !OBS.filter_name
     filename_format : filters/TC_filter_{}.dat
  minimum_throughput : 0.000101
               outer : 0.2
          outer_unit : m
              author : Ric Davies
              source : Ric Davies
        date_created : 2017-11-20
       date_modified : 2017-11-20
              status : Design - pre PDR list of filters
             z_order : [114, 214, 514]
             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
              action : transmission
```

```
        position : -1
    wing_flux_level : None
```

6.2.3 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

Data

Meta-data

```
          filename : INST_MICADO_wavefront_error_budget.dat
              name : micado_ncpas_psf
       temperature : -190
      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
      kernel_width : None
      strehl_drift : 0.02
          wave_min : !SIM.spectral.wave_min
          wave_max : !SIM.spectral.wave_max
```

7 OpticalElement: "MICADO_IMG_LR"

Element: instrument

Alias: INST

Description: additional effects for the wide-field imaging mode

7.1 Global properties

```
 pixel_scale : 0.004
 plate_scale : 0.26666666666
element_name : MICADO_IMG_LR
```

7.2 Effects

Summary of Effects included in this optical element:

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

7.2.1 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:

- {datetime.date(2019, 1, 28): '(KL) Changed column names and added units to header'}
- {datetime.date(2019, 7, 10): '(KL) Shortened the list to only the swappable mirrors'}

Data

Meta-data

```
            filename : LIST_MICADO_mirrors_wide.dat
                name : micado_wide_field_mirror_list
         pixel_scale : 0.004
         plate_scale : 0.26666666666
        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 mo
                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
minimum_throughput : !SIM.spectral.minimum_throughput
           etendue : !TEL.etendue
```

7.2.2 AtmosphericDispersionCorrection: "micado_adc_3D_shift"

Included by default: `True`

File Description: atmospheric disperson corrector

Class Description: <no docstring>

Changes:

-

Data

Meta-data

```
      filename : None
          name : micado_adc_3D_shift
   pixel_scale : 0.004
   plate_scale : 0.26666666666
  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
    quick_adc : True
      z_order : [632, 232]
      include : True
```

8 OpticalElement: "MICADO_IMG_HR"

Element: instrument

Alias: INST

Description: additional effects for the zoom imaging mode

8.1 Global properties

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

8.2 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	True	[632, 232]

8.2.1 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:

- {datetime.date(2019, 1, 28): '(KL) Changed column names and added units to header'}
- {datetime.date(2019, 7, 10): '(KL) Shortened the list to only the swappable mirrors'}

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 mode
                type : mirror:list
               ETYPE : SURFLIST
                EDIM : 1
```

```
        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
minimum_throughput : !SIM.spectral.minimum_throughput
          etendue : !TEL.etendue
```

8.2.2 AtmosphericDispersionCorrection: "micado_adc_3D_shift"

Included by default: `True`

File Description: atmospheric disperson corrector

Class Description: <no docstring>

Changes:

-

Data

Meta-data

```
      filename : None
          name : micado_adc_3D_shift
   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
   pupil_angle : !OBS.pupil_angle
      wave_mid : !SIM.spectral.wave_mid
    efficiency : 1
     quick_adc : True
       z_order : [632, 232]
       include : True
```

9 OpticalElement: "MICADO_SPEC"

Element: instrument

Alias: INST

Description: additional effects for the spectroscopy mode

9.1 Global properties

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

9.2 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]

9.2.1 SurfaceList: "spec_mode_optics"

Included by default: `True`

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

Class Description: <no docstring>

Changes:

- {datetime.date(2019, 1, 28): '(KL) Changed column names and added units to header'}
- {datetime.date(2019, 7, 10): '(KL) Shortened the list to only the swappable gratings'}

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 spectroscop
                type : mirror:list
               ETYPE : SURFLIST
```

```
              EDIM : 1
       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
minimum_throughput : !SIM.spectral.minimum_throughput
          etendue : !TEL.etendue
```

9.2.2 ApertureMask: "spectroscopic_slit_aperture"

Included by default: `True`

File Description: Slit mask for the short, narrow slit (3 arcsec x 20 mas)

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

Changes:

- {datetime.date(2019, 7, 10): '(KL) Created the file'}
- {datetime.date(2020, 3, 24): '(KL) Changed geometry to 3000x20mas'}

Data

Meta-data

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

<SpectralTrace> "list of spectral order trace geometry on the focal plane" : [1.93, 2.46]um : Ext 2 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [1.45, 1.85]um : Ext 3 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [1.16, 1.48]um : Ext 4 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [1.16, 1.39]um : Ext 5 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.97, 1.23]um : Ext 6 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.97, 1.23]um : Ext 7 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.83, 1.05]um : Ext 8 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.83, 1.05]um : Ext 9 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.83, 0.92]um : Ext 10 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.73, 0.92]um : Ext 11 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.73, 0.92]um : Ext 12 : Aperture 0 : ImagePlane 0 <Spectral-Trace> "list of spectral order trace geometry on the focal plane" : [0.65, 0.82]um : Ext 13 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.65, 0.82]um : Ext 14 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.6, 0.74]um : Ext 15 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.6, 0.73]um : Ext 16 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.6, 0.67]um : Ext 17 : Aperture 0 : ImagePlane 0 <SpectralTrace> "list of spectral order trace geometry on the focal plane" : [0.6, 0.67]um : Ext 18 : Aperture 0 : ImagePlane 0
****

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
        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 detector im
 DATE_CRE : 2018-06-29
 DATE_MOD : 2019-09-16
  HISTORY : 2019-09-16 : (KL) Added aperture-imagePlane table to EXT 1
  z_order : [70, 270]
  include : True
 wave_min : !SIM.spectral.wave_min
 wave_max : !SIM.spectral.wave_max
x_colname : x
y_colname : y
    dwave : 0.002
```

10 OpticalElement: "micado_detector_array"

Element: detector

Alias: DET

Description: A set of 9 H4RG detectors

10.1 Global properties

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

10.2 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]

10.2.1 DetectorList: "full_detector_array"

Included by default: `False`

File Description: MICADO detector array list

Class Description: A description of detector positions and properties

Changes:

- {datetime.date(2017, 8, 12): '(OC) id changed to conform with spectroscopy report'}
- {datetime.date(2018, 7, 26): '(OC) large gap (chips 5 and 6) reduced to 8 mm'}
- {datetime.date(2018, 11, 19): '(KL) updated meta data to new format'}
- {datetime.date(2019, 1, 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

... continued on next page

id	x_cen	y_cen	x_size	y_size	x_len	y_len	pixel_size	angle	gain
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

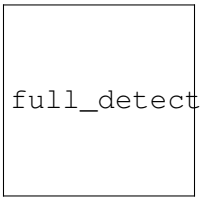
```
                filename : FPA_array_layout.dat
                    name : full_detector_array
                 include : False
          image_plane_id : 0
             temperature : -230
                     dit : !OBS.dit
                    ndit : !OBS.ndit
            element_name : micado_detector_array
        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
```

10.2.2 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
              xhw_unit : mm
              yhw_unit : mm
            pixsize_unit : mm
              angle_unit : deg
               gain_unit : electron/adu
                 z_order : [90, 290, 390, 490]
              array_dict : {'id': [1], 'pixsize': [0.015], 'angle': [0.0], 'gain':
             pixel_scale : !INST.pixel_scale
    active_detectors : all
 report_plot_include : True
report_table_include : True
             x_size_unit : mm
             y_size_unit : mm
```

10.2.3 QuantumEfficiencyCurve: "qe_curve"

Included by default: `True`

File Description: Quantum efficiency curves for each detector

Class Description: <no docstring>

Changes:

- {datetime.date(2018, 11, 19): '(KL) updated meta data to new format'}
- {datetime.date(2019, 8, 9): '(KL) Added action keyword to meta data'}

Meta-data

```
          filename : QE_detector_H2RG.dat
              name : qe_curve
     image_plane_id : 0
       temperature : -230
               dit : !OBS.dit
              ndit : !OBS.ndit
      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 - guestimated by reading off the graph in Finger+ 200
    wavelength_unit : um
            action : transmission
           z_order : [113, 513]
           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
          position : -1
```

10.2.4 SummedExposure: "exposure_action"

Included by default: `True`

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

Class Description: <no docstring>

Changes:

-

Data

Meta-data

```
          filename : None
              name : exposure_action
    image_plane_id : 0
       temperature : -230
               dit : !OBS.dit
              ndit : !OBS.ndit
      element_name : micado_detector_array
           z_order : [860]
           include : True
```

10.2.5 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
```

10.2.6 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

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
```

10.2.7 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
```

10.2.8 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
        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
```

11 OpticalElement: "MICADO_simulation_paramters"

Element: simulation

Alias: SIM

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

11.1 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
```

11.2 Effects

Summary of Effects included in this optical element:

element	name	class	included	z_orders