

Final_Analysis

May 15, 2023

```
[1]: import get_attenuation as gat
import numpy as np
import matplotlib.pyplot as plt
```

HAVE FUN AND ENJOY!!!
DONE BY GRETA AND FELIPE.

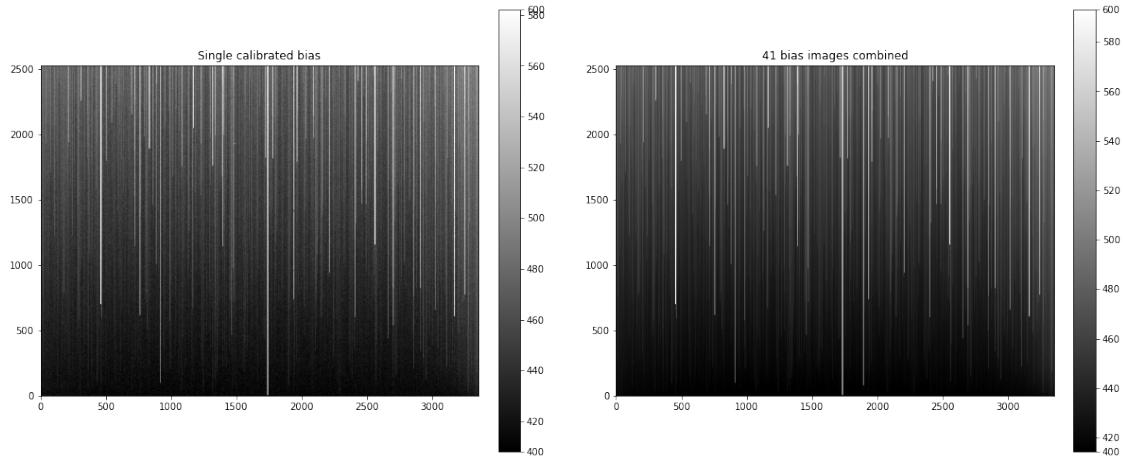
1 CAMERA 04

1.1 Master Bias

```
[2]: path = "/home/felipe/Hiwi/Data/Cam04/Bias_Cam04/"
gat.get_master_bias(path, compare = True, title = 'Master Bias Camera 04')
```

INFO:astropy:splitting each image into 66 chunks to limit memory usage to 350000000.0 bytes.

INFO: splitting each image into 66 chunks to limit memory usage to 350000000.0 bytes. [ccdproc.combiner]



1.2 Calibration Dark Frames

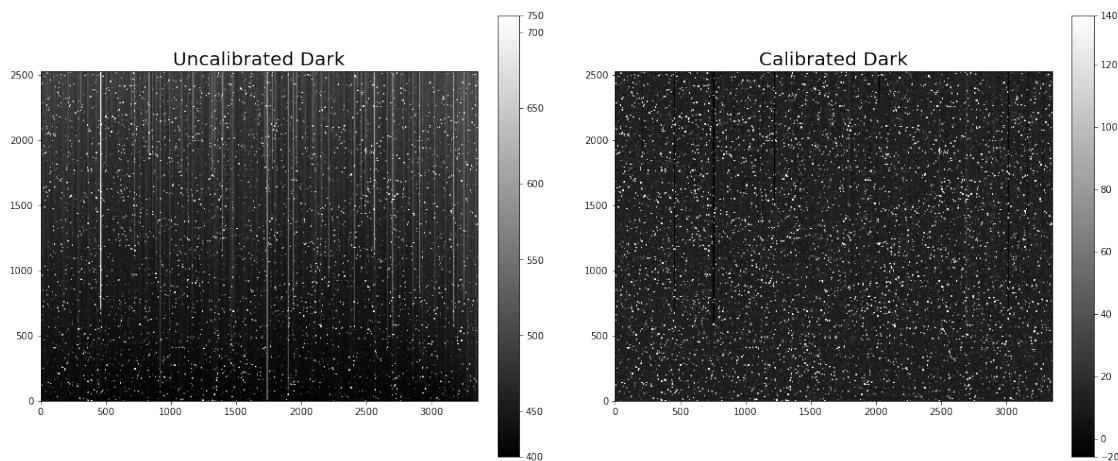
```
[5]: path_dark = "/home/felipe/Hiwi/Data/Cam04/dark_Cam04/"  
path_master_bias = "/home/felipe/Hiwi/Data/Cam04/Bias_Cam04/masterbias.fit"  
gat.get_calibrated_dark(path_dark, path_master_bias , compare = True)
```

THE CALIBRATED DARKS ARE PLACE IN:

```
/home/felipe/Hiwi/Data/Cam04/dark_Cam04/calibrated_darks/
```

INFO: astropy: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file. [astropy.nddata.ccddata]



1.3 Master Dark

```
[7]: path = "/home/felipe/Hiwi/Data/Cam04/dark_Cam04/calibrated_darks/"  
gat.get_master_dark(path, compare = True ,title = 'Master Dark Camera 04')
```

/home/felipe/Hiwi/Pycode/get_attenuation.py:368: UserWarning: COMBINED DARK ALREADY IN THE FOLDER, IT WILL BE OVERWRITTEN!

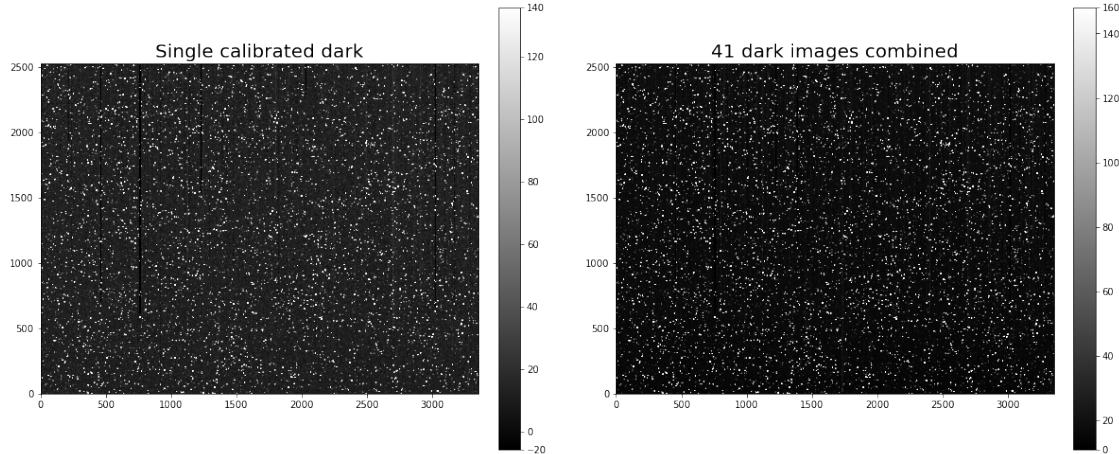
warnings.warn("COMBINED DARK ALREADY IN THE FOLDER, IT WILL BE OVERWRITTEN!")
INFO: astropy: splitting each image into 66 chunks to limit memory usage to 350000000.0 bytes.

EXPOSURE TIME OF YOUR DARK FRAMES ARE [5.0] SECONDS.

INFO: splitting each image into 66 chunks to limit memory usage to 350000000.0 bytes. [ccdproc.combiner]

INFO: astropy: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file. [astropy.nddata.ccddata]



1.4 Calibration Flat Frames

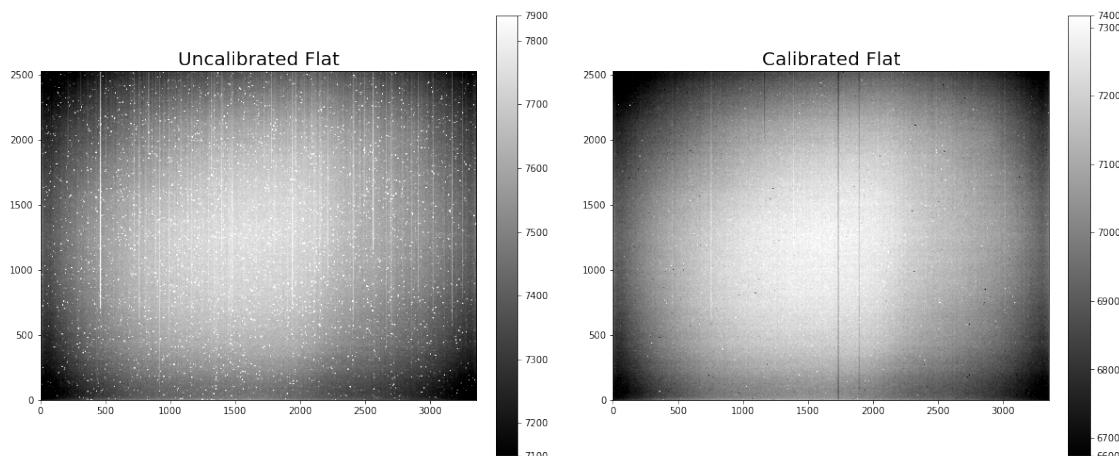
```
[8]: path_flat = "/home/felipe/Hiwi/Data/Cam04/flat_Cam04/"
path_master_bias = "/home/felipe/Hiwi/Data/Cam04/Bias_Cam04/masterbias.fit"
path_master_dark = "/home/felipe/Hiwi/Data/Cam04/dark_Cam04/calibrated_darks/
    ↪masterdark5.fit"
gat.get_calibrated_flat(path_flat, path_master_dark, path_master_bias =_
    ↪path_master_bias , compare = True )
```

THE CALIBRATED FLATS ARE PLACE IN:

/home/felipe/Hiwi/Data/Cam04/flat_Cam04/calibrated_flats/
EXPOSURE TIME OF YOUR FLAT FRAMES IS 5.0 SECONDS.

INFO:astropy:using the unit adu passed to the FITS reader instead of the unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file. [astropy.nddata.ccddata]



1.5 Master Flat

```
[9]: path = "/home/felipe/Hiwi/Data/Cam04/flat_Cam04/calibrated_flats/"  
gat.get_master_flat(path, compare = True)
```

INFO:astropy:splitting each image into 41 chunks to limit memory usage to 350000000.0 bytes.

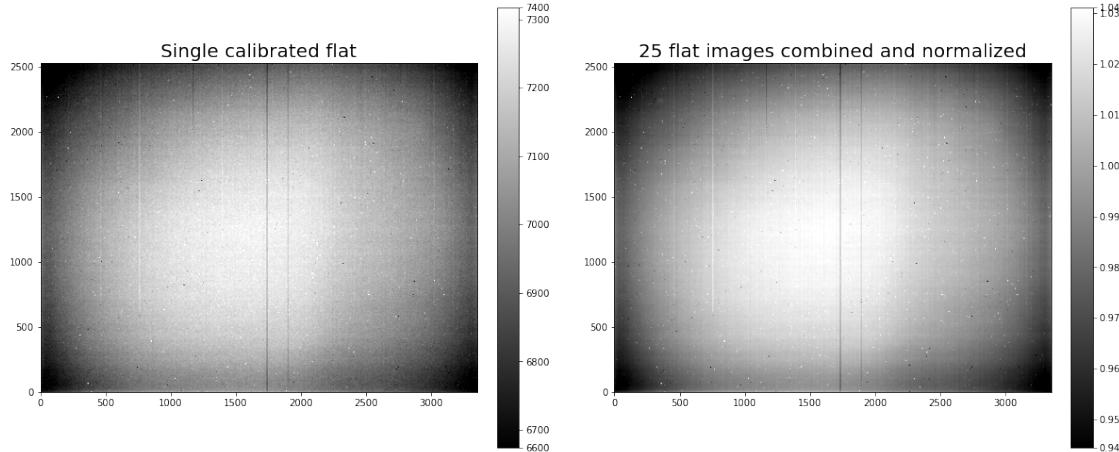
INFO: splitting each image into 41 chunks to limit memory usage to 350000000.0 bytes. [ccdproc.combiner]

/home/felipe/Hiwi/Pycode/get_attenuation.py:743: UserWarning: We will overwrite a new combined flat if it was already there!

warnings.warn("We will overwrite a new combined flat if it was already there!")

INFO:astropy:using the unit adu passed to the FITS reader instead of the unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file. [astropy.nddata.ccddata]



1.6 Gain

1.6.1 Calibrating Flat Frames for Gain

```
[12]: path = "/home/felipe/Hiwi/Data/Cam04/gain_Cam04/"  
gat.get_flats_for_test(path, compare = False)
```

THE CALIBRATED FLATS ARE PLACE IN:

/home/felipe/Hiwi/Data/Cam04/gain_Cam04/calibrated_flats/

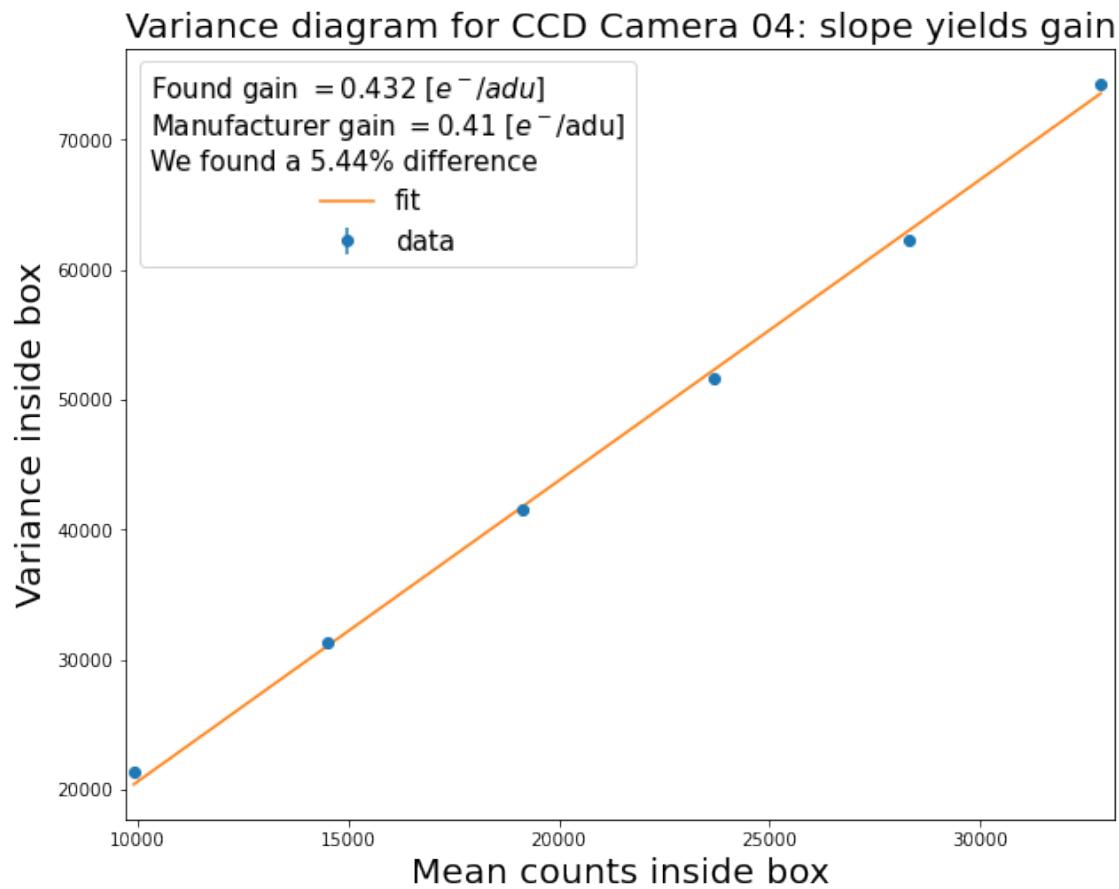
THE EXPOSURE TIMES ARE [0.001, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0] SECONDS.

1.6.2 Get Gain

```
[23]: path = "/home/felipe/Hiwi/Data/Cam04/gain_Cam04/calibrated_flats/"
position = (1600,1000)
size = 100
gain = 0.41
gat.get_gain_factor(path , position , size , gain , title = 'Variance diagram
→for CCD Camera 04: slope yields gain' , compare = False , save = True)
```

THE EXPOSURE TIMES ARE [4.0, 6.0, 8.0, 10.0, 12.0, 14.0] SECONDS.

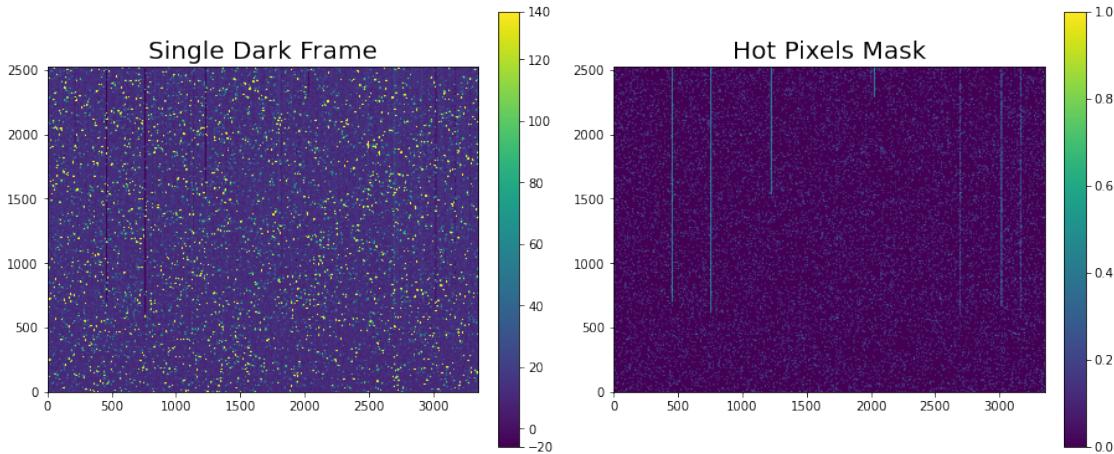
YOUR CAMERA HAS A GAIN OF 0.432 electrons/ADU.



1.7 Hot Pixels

```
[37]: path_im = "/home/felipe/Hiwi/Data/Cam04/dark_Cam04/calibrated_darks/"  
      ↪calibrated_dark4_0.fit"  
path_fol = "/home/felipe/Hiwi/Data/Cam04/Masks_Cam04/"  
gat.get_hot_pixels(path_im, path_fol ,compare = True, hot_pixels = True, cmap = ↪'viridis')
```

WE HAVE FOUN 20609 HOT PIXELS.



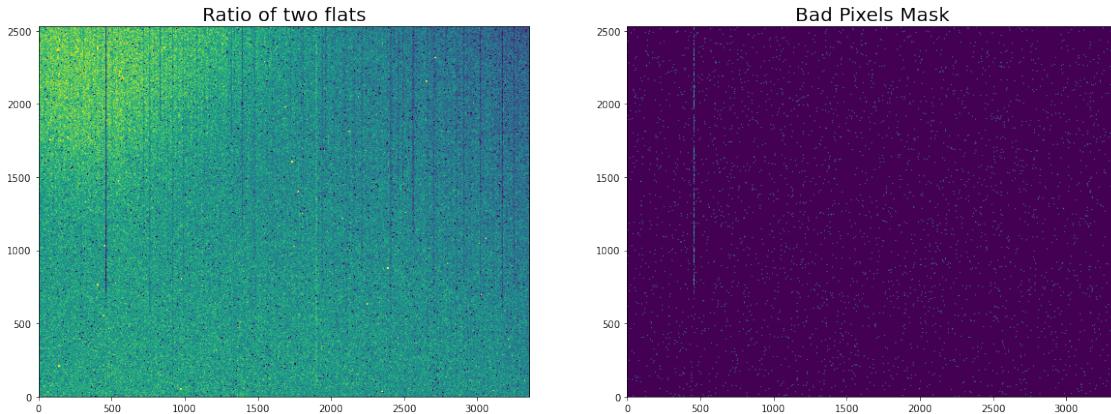
1.8 Bad Pixels

```
[36]: path1 = "/home/felipe/Hiwi/Data/Cam04/gain_Cam04/calibrated_flats/"  
      ↪calibrated_gflat04_2.fit"  
path2 = "/home/felipe/Hiwi/Data/Cam04/gain_Cam04/calibrated_flats/"  
      ↪calibrated_gflat04_6.fit"  
path_fol = "/home/felipe/Hiwi/Data/Cam04/Masks_Cam04/"  
gat.get_bad_pixels(path1, path_fol , path2 = path2 , compare = True, bad_pixels ↪= True, cmap = 'viridis')
```

IT COULD TAKE SOME TIME, BUT YOU JUST NEED TO DO IT ONCE.

THE RATIO IS 2.2617188761434264

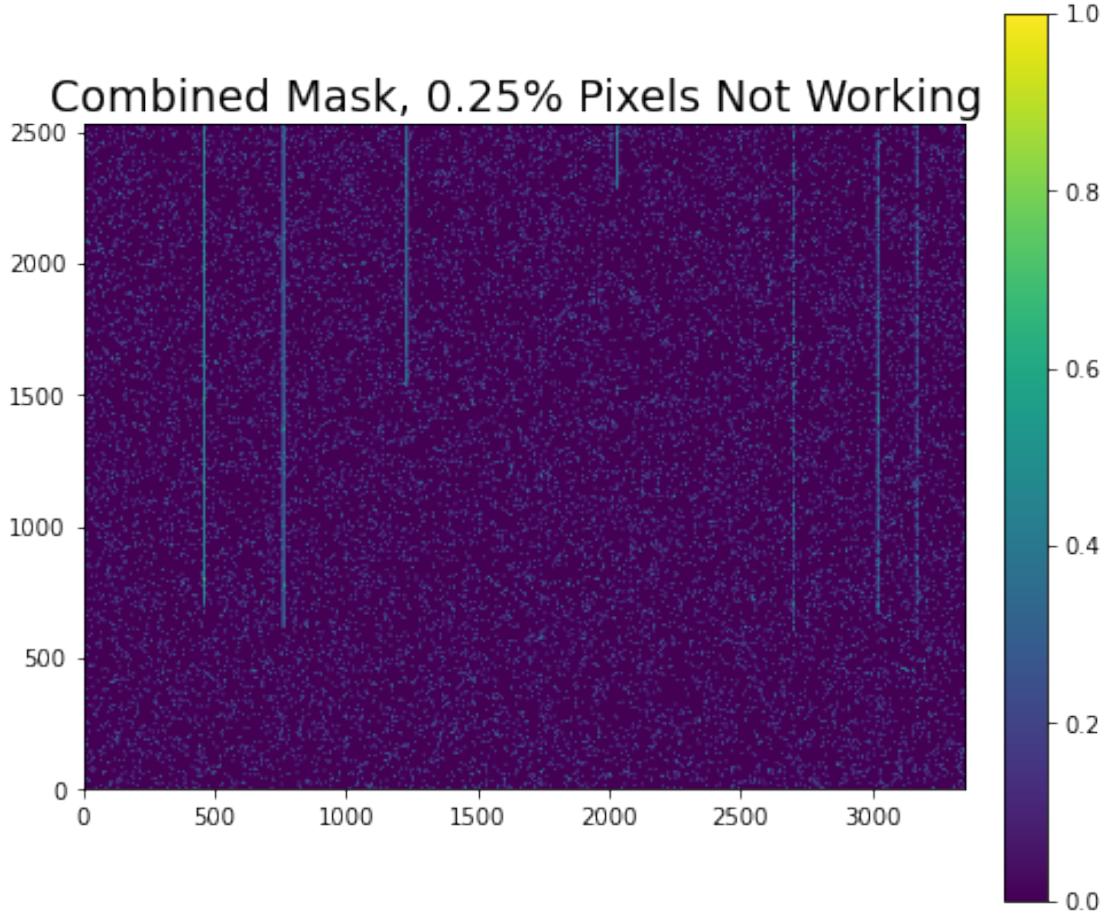
WE HAVE FOUN 3801 BAD PIXELS.



1.9 Combined Mask

```
[35]: path_fol = "/home/felipe/Hiwi/Data/Cam04/Masks_Cam04/"
darkmask = "/home/felipe/Hiwi/Data/Cam04/Masks_Cam04/mask_from_dark_current.fits"
flatmask = "/home/felipe/Hiwi/Data/Cam04/Masks_Cam04/mask_from_ccdmask.fits"
gat.get_combined_mask(darkmask, flatmask, path_fol , useless_pixels = True ,
show_mask = True, cmap = 'viridis')
```

WE HAVE FOUND IN TOTAL 21195 USELESS PIXELS, WE ARE MASKING ROUGHLY 0.25% OF THE PIXELS.



1.10 Linearity test

1.10.1 Calibrating Flat frames for linearity test

```
[ ]: # calibrating of flat was already done before, here you should do it
```

1.10.2 Getting Linearity test

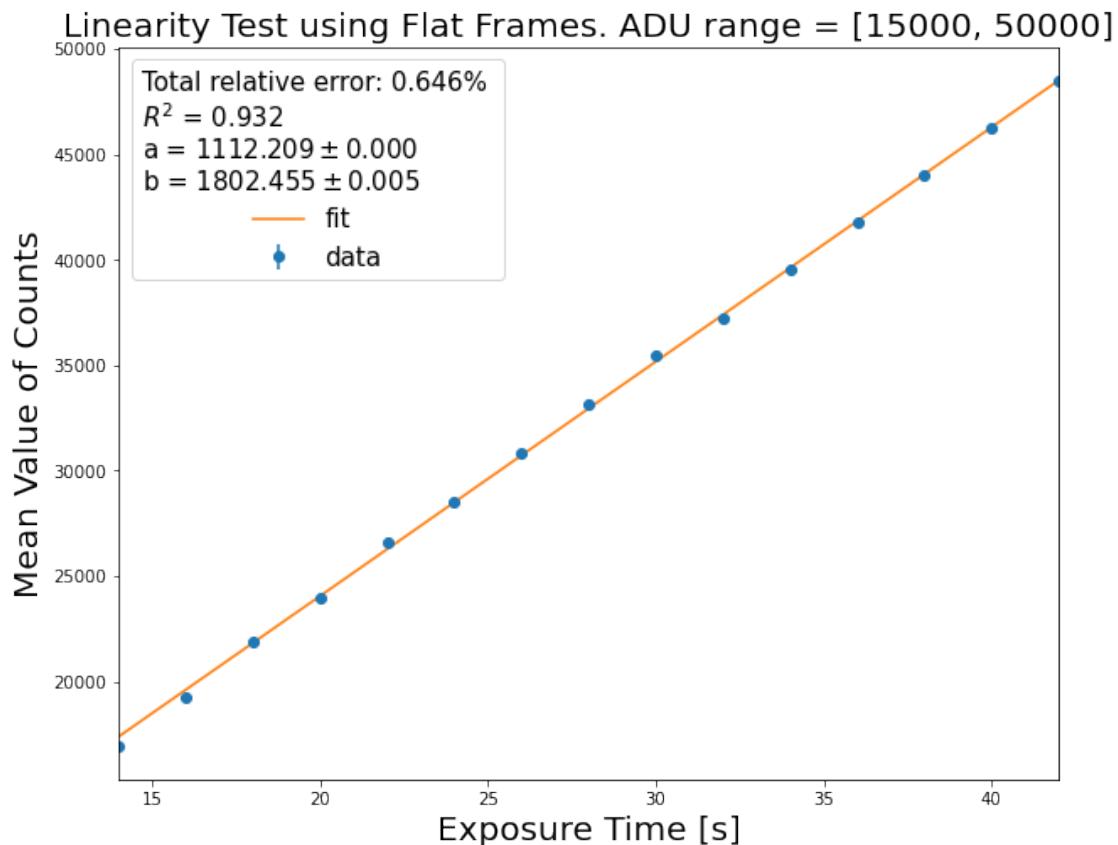
```
[3]: path = '/home/felipe/Hiwi/Data/Cam04/linearity_Cam04/flat/calibrated_flats/'
gat.linearity_test_cdd(path ,adu_max = 50000, adu_min = 15000, save = True)
```

YOUR EXPOSURE TIMES ARE [1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0, 51.0, 53.0, 55.0] SECONDS.

a	b
---	---

a	2.98e-08 -9.09e-07
b	-9.09e-07 2.98e-05

YOUR CORRELATION PARAMETER IS $R = 0.965$, IT SHOULD BE CLOSE TO 1.
 WORKING IN THE RANGE FROM 15000 TO 50000 ADU.
 YOU DATA AFTER USING THE SELECTED RANGE OF COUNTS VALUES IS: DATA = ['16927.33',
 '19271.14', '21905.18', '23928.33', '26616.69', '28551.36', '30864.75',
 '33165.43', '35463.90', '37251.29', '39515.18', '41756.45', '44017.21',
 '46253.25', '48486.30'] ADU.
 THE RELATIVE ERROR OF EACH DATA POINTS ARE: RE = ['2.567%', '1.667%', '0.380%',
 '0.492%', '1.316%', '0.196%', '0.472%', '0.671%', '0.839%', '0.379%', '0.258%',
 '0.204%', '0.112%', '0.081%', '0.060%'].
 THE TOTAL RELATIVE ERROR IS: TOTAL RE = 0.646%.



1.11 Readout noise

```
[2]: path_bias_folder = '/home/felipe/Hiwi/Data/Cam04/readout_noise_Cam04/'
readout_noise04 = gat.readout_noise(path_bias_folder, gain = 0.42)
```

INFO:astropy:splitting each image into 22 chunks to limit memory usage to 350000000.0 bytes.

INFO: splitting each image into 22 chunks to limit memory usage to 350000000.0

```

bytes. [ccdproc.combiner]
WE HAVE USED 20 BIAS FRAMES.
THE READ OUT OF THE CAMERA IS 7.402894424673784[e-]
THE EEROR IN THE CALCULATED READ OUT OF THE CAMERA IS 2.038355405711968[e-]
[[19.13727976 19.3600914 16.79221036 ... 18.79434744 14.47785686
 20.21925662]
[26.20929991 18.37603796 22.91978118 ... 17.65421115 16.68366943
 22.2912547 ]
[ 8.95799942 20.23440931 23.90767102 ... 8.70405484 21.40272835
 13.36311462]
...
[18.19375247 19.1585607 18.6809701 ... 19.84675946 12.78509292
 17.01861729]
[15.279723 17.14839021 25.9699486 ... 20.3653618 19.51657362
 12.08699091]
[10.12286695 21.05535785 18.13938316 ... 28.3653618 11.84914986
 33.9087453 ]]

```

1.12 Dark current

```
[3]: #path_dark_frames = "/home/felipe/Hiwi/Data/Cam04/dark_current_Cam04/"
#path_masterbias = "/home/felipe/Hiwi/Data/Cam04/Bias_Cam04/masterbias.fit"
#gat.dark_current_err(path_dark_frames, path_masterbias, gain = 0.42)
```

1.13 Calibrating Laser Images

```
[12]: path_science = "/home/felipe/Hiwi/Data/Cam04/laser_Cam04/"
path_master_flat = "/home/felipe/Hiwi/Data/Cam04/flat_Cam04/calibrated_flats/
  ↳combined_flat_5.fit"
path_master_bias = "/home/felipe/Hiwi/Data/Cam04/Bias_Cam04/masterbias.fit"
path_master_dark = "/home/felipe/Hiwi/Data/Cam04/dark_Cam04/calibrated_darks/
  ↳masterdark5.fit"
path_mask = "/home/felipe/Hiwi/Data/Cam04/Masks_Cam04/combined_mask.fits"
matrix_error = [readout_noise04**2]
gat.get_calibrated_ccd_image(path_science, path_master_dark, path_master_flat,
  ↳matrix_error, path_mask, path_master_bias ,gain = 0.432 , compare = True, cmap
  ↳= 'viridis')
```

THE CALIBRATED SCIENTIFIC PICTURES ARE PLACE IN:

```
/home/felipe/Hiwi/Data/Cam04/laser_Cam04/calibrated_science/
```

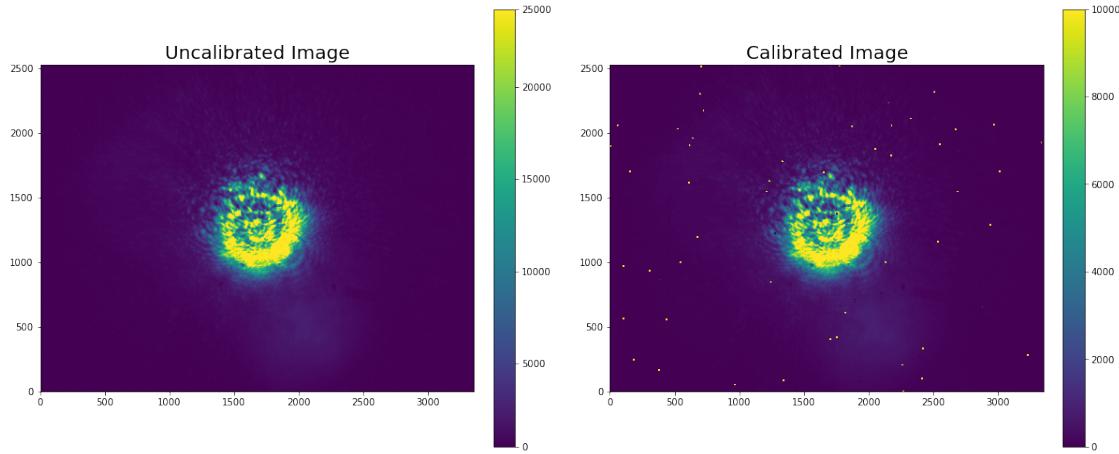
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.

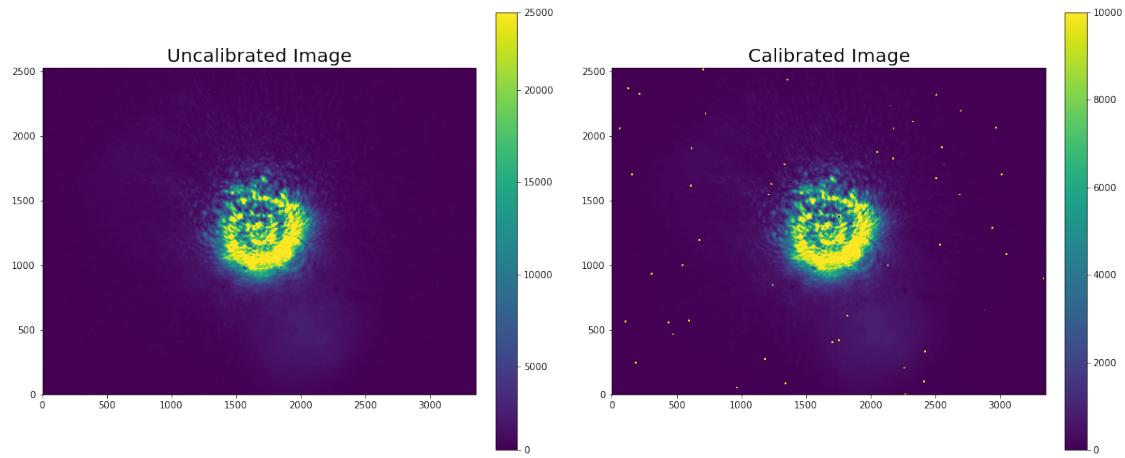
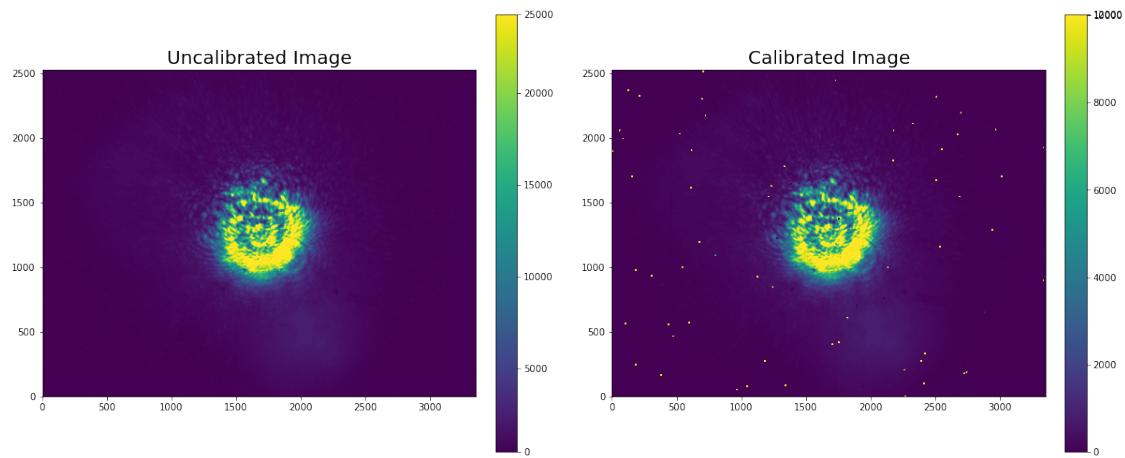
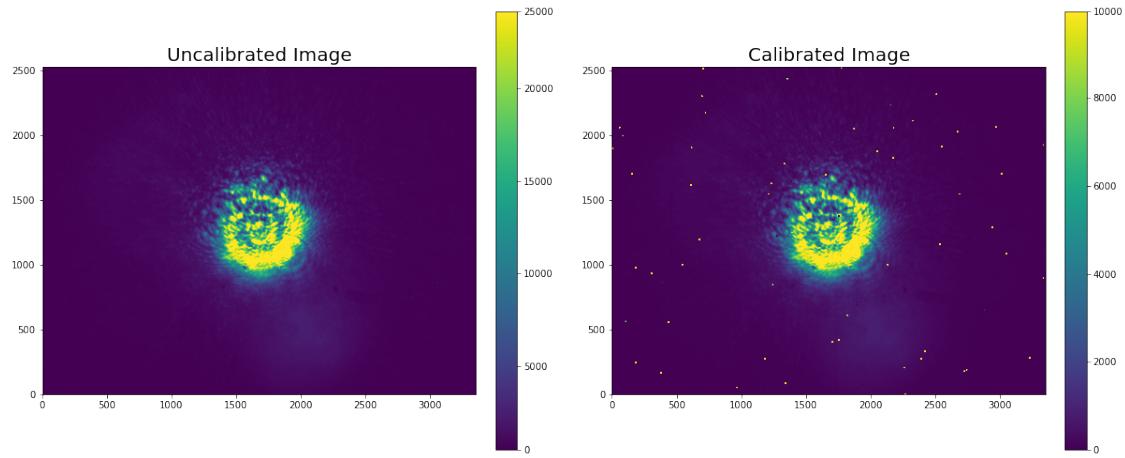
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.
[astropy.nddata.ccddata]

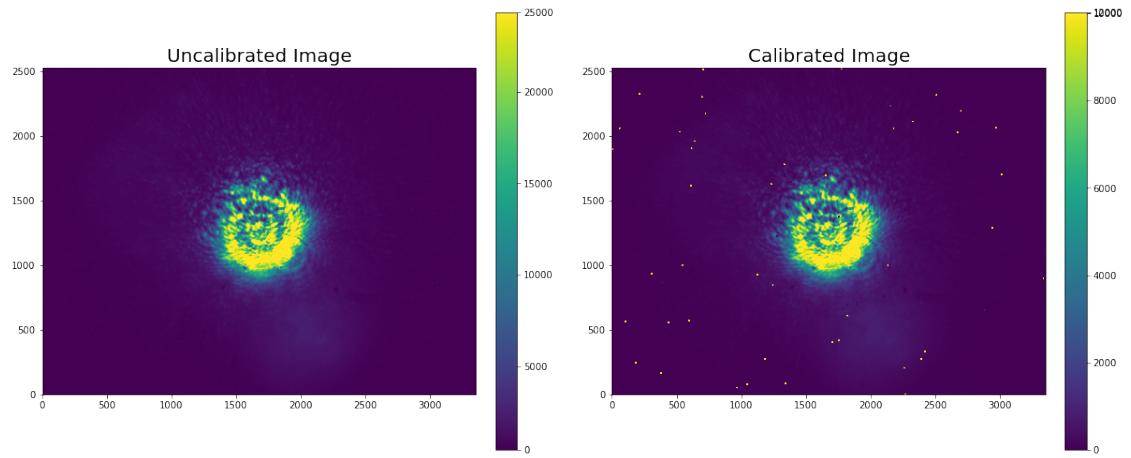
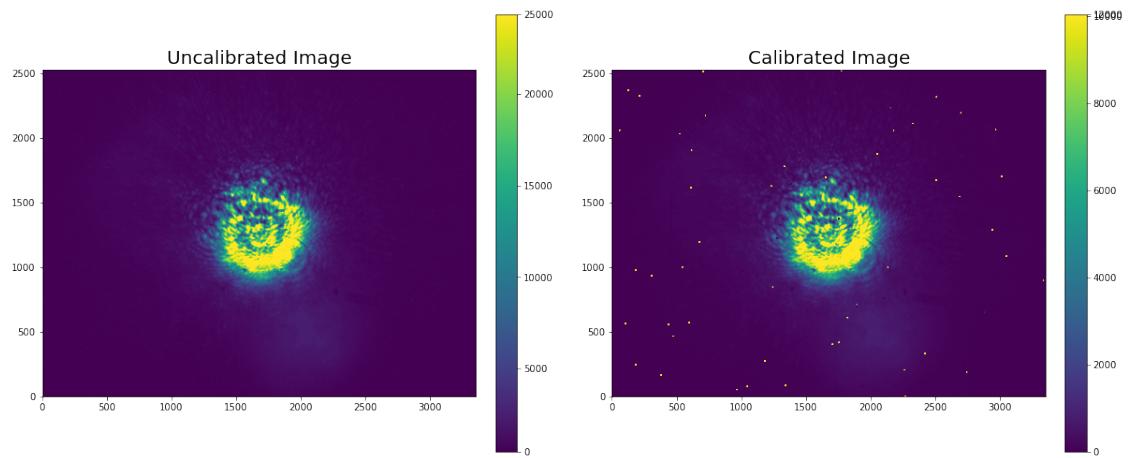
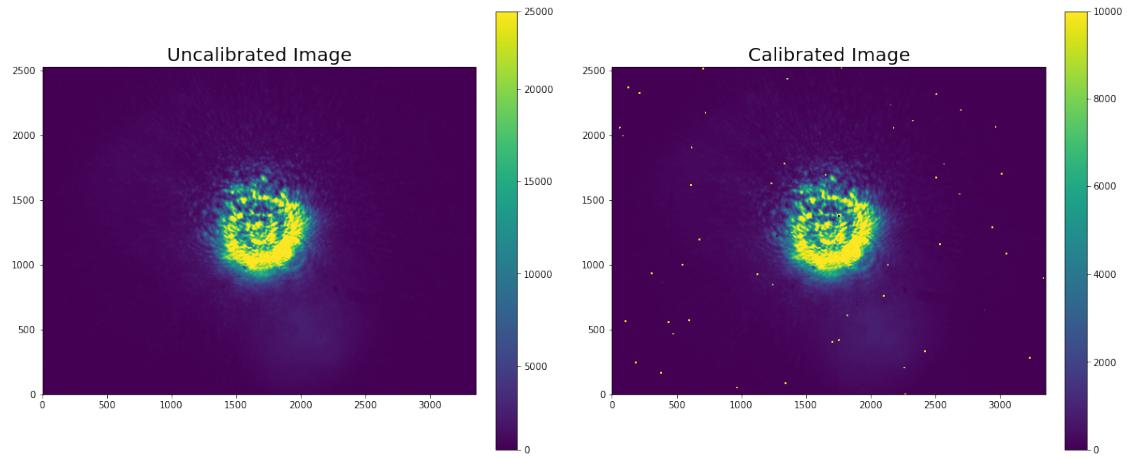
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.

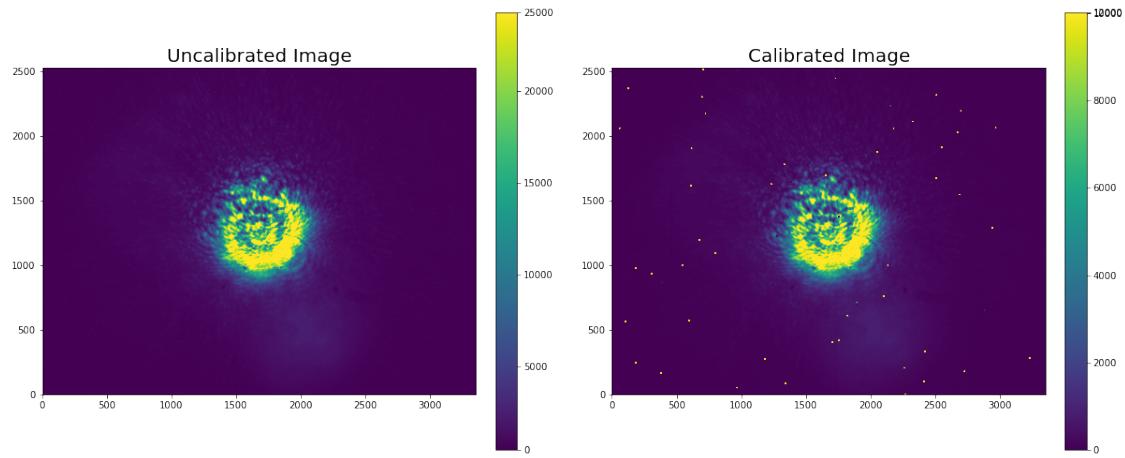
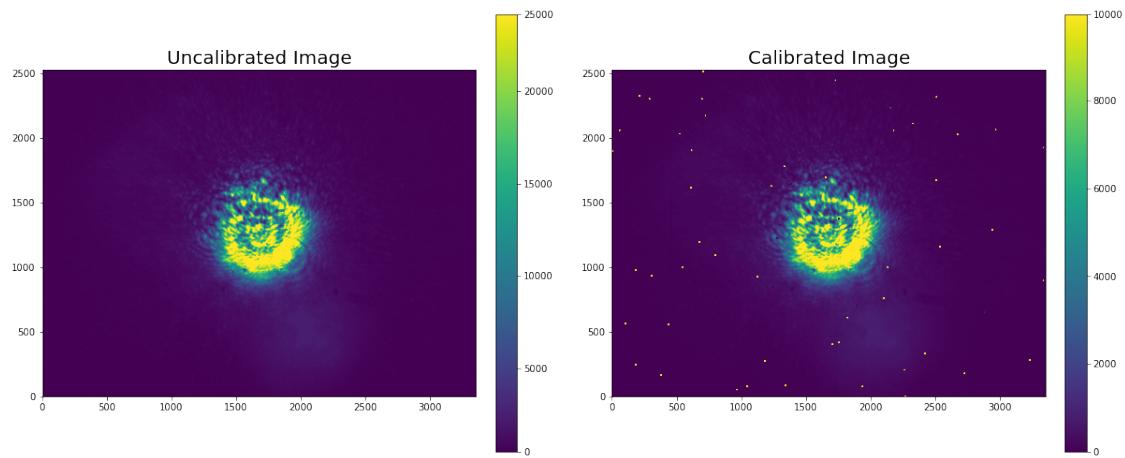
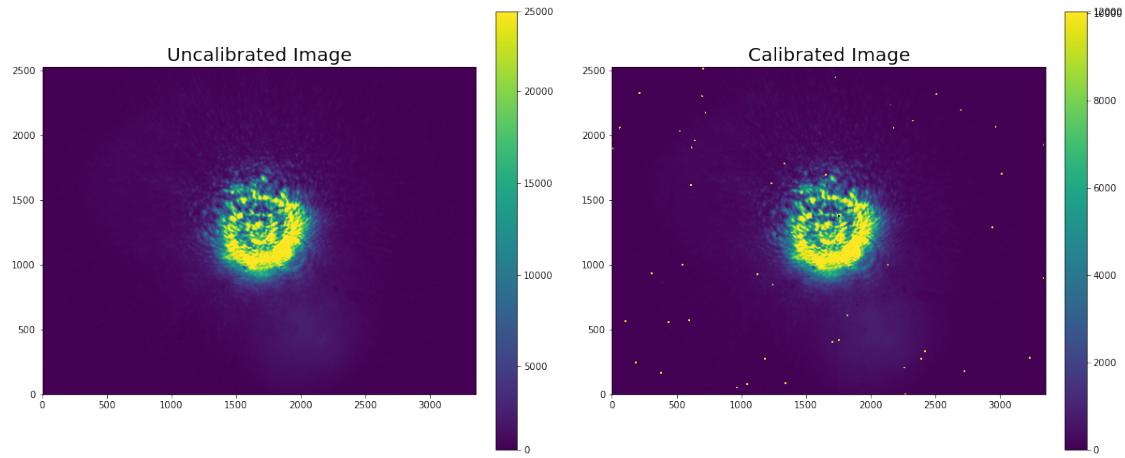
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.
[astropy.nddata.ccddata]

```
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]  
  
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]  
  
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]  
  
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]  
  
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]  
  
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]  
  
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]  
  
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]  
  
INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.  
INFO: array provided for uncertainty; assuming it is a StdDevUncertainty.  
[astropy.nddata.ccddata]
```









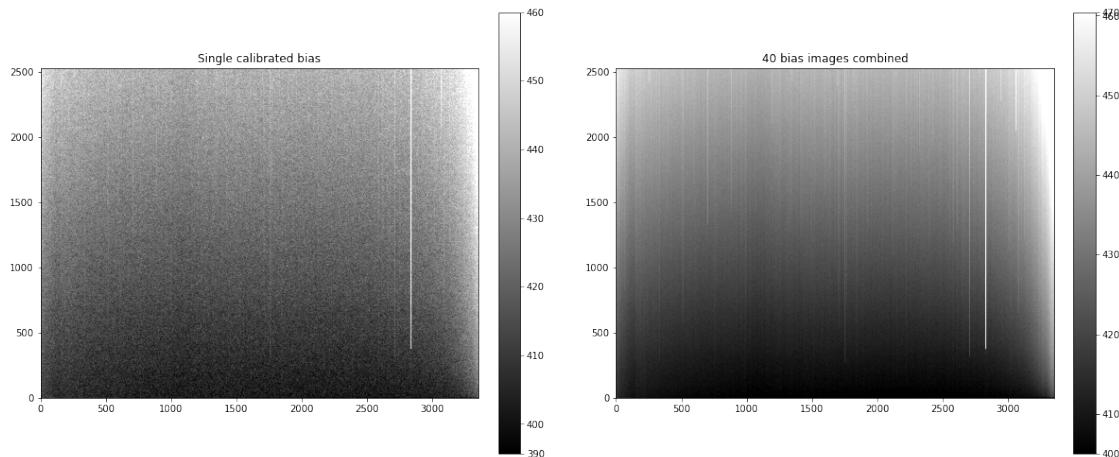
2 CAMERA 16

2.1 Master Bias

```
[11]: path = "/home/felipe/Hiwi/Data/Camera16/Bias_Cam16/"  
gat.get_master_bias(path, compare = True, title = 'Master Bias Camera 16')
```

INFO:astropy:splitting each image into 65 chunks to limit memory usage to 350000000.0 bytes.

INFO: splitting each image into 65 chunks to limit memory usage to 350000000.0 bytes. [ccdproc.combiner]



2.2 Calibration Dark Frames

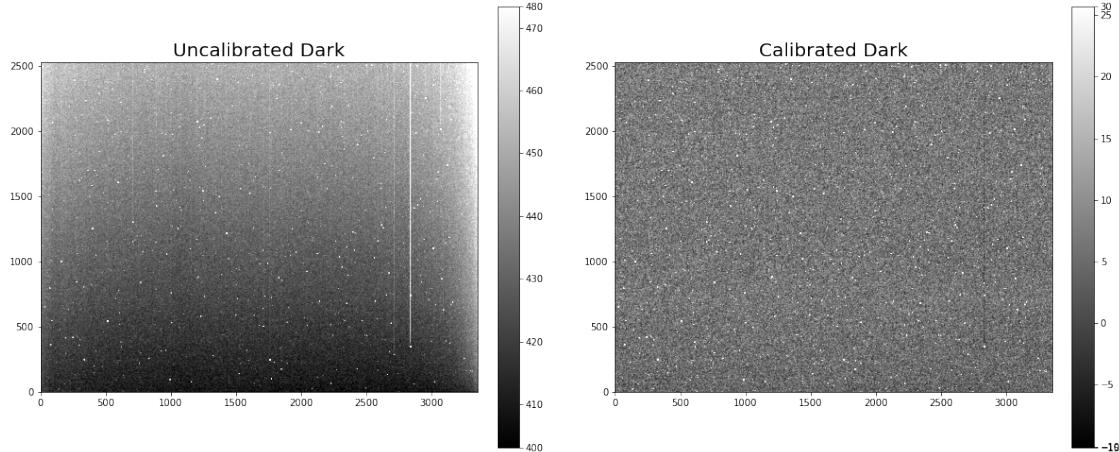
```
[12]: path_dark = "/home/felipe/Hiwi/Data/Camera16/dark_Cam16"  
path_master_bias = "/home/felipe/Hiwi/Data/Camera16/Bias_Cam16/masterbias.fit"  
gat.get_calibrated_dark(path_dark, path_master_bias , compare = True)
```

THE CALIBRATED DARKS ARE PLACE IN:

/home/felipe/Hiwi/Data/Camera16/dark_Cam16/calibrated_darks/

INFO:astropy:using the unit adu passed to the FITS reader instead of the unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file. [astropy.nddata.ccddata]



2.3 Master Dark¶

```
[13]: path = "/home/felipe/Hiwi/Data/Camera16/dark_Cam16/calibrated_darks/"
gat.get_master_dark(path, compare = True ,title = 'Master Dark Camera 04')
```

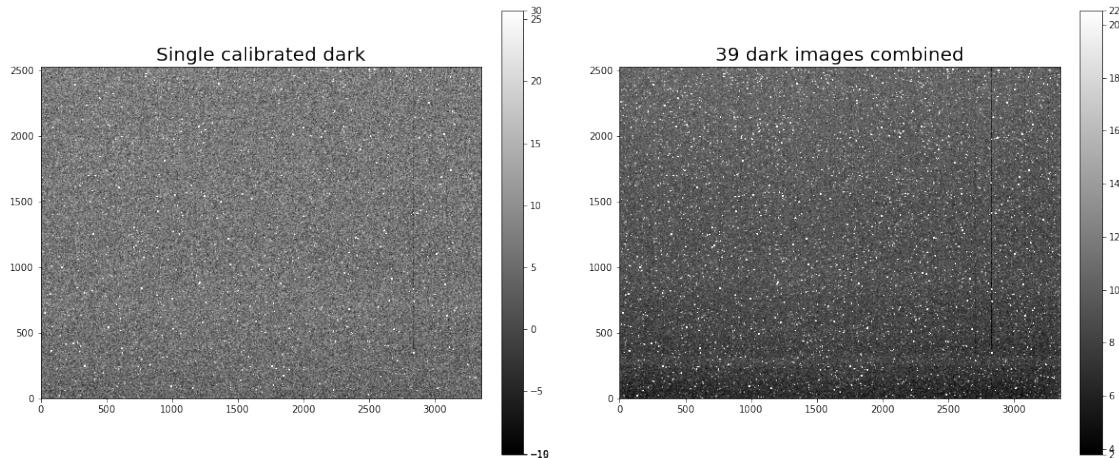
INFO:astropy:splitting each image into 63 chunks to limit memory usage to 350000000.0 bytes.

EXPOSURE TIME OF YOUR DARK FRAMES ARE [5.0] SECONDS.

INFO: splitting each image into 63 chunks to limit memory usage to 350000000.0 bytes. [ccdproc.combiner]

INFO:astropy:using the unit adu passed to the FITS reader instead of the unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file. [astropy.nddata.ccddata]



2.4 Calibration Flat Frames

```
[14]: path_flat = "/home/felipe/Hiwi/Data/Camera16/flats_Cam16/"
path_master_bias = "/home/felipe/Hiwi/Data/Camera16/Bias_Cam16/masterbias.fit"
path_master_dark = "/home/felipe/Hiwi/Data/Camera16/dark_Cam16/calibrated_darks/
    ↪masterdark5.fit"
gat.get_calibrated_flat(path_flat, path_master_dark, path_master_bias =_
    ↪path_master_bias , compare = True )
```

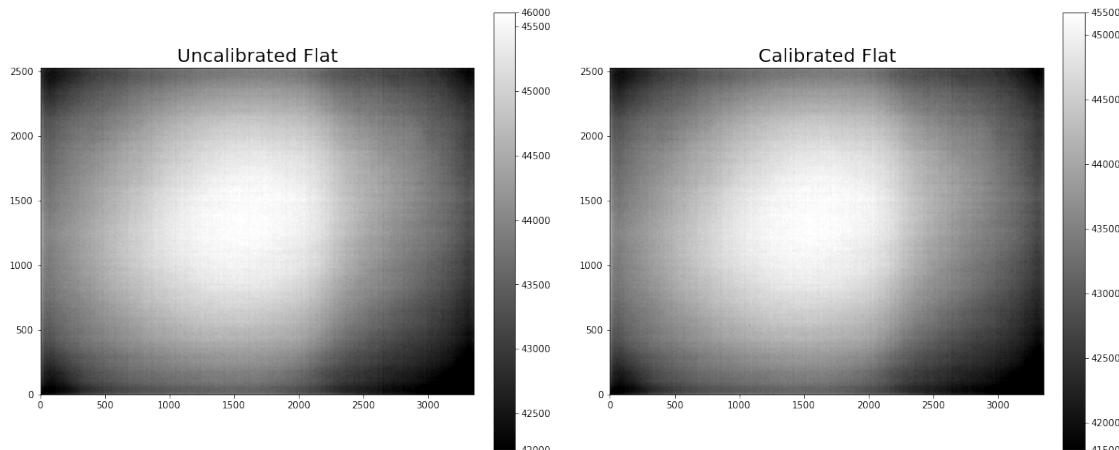
THE CALIBRATED FLATS ARE PLACE IN:

/home/felipe/Hiwi/Data/Camera16/flats_Cam16/calibrated_flats/

EXPOSURE TIME OF YOUR FLAT FRAMES IS 5.0 SECONDS.

INFO: astropy: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file. [astropy.nddata.ccddata]



2.5 Master Flat

```
[15]: path = "/home/felipe/Hiwi/Data/Camera16/flats_Cam16/calibrated_flats/"
gat.get_master_flat(path, compare = True)
```

INFO: astropy: splitting each image into 50 chunks to limit memory usage to 350000000.0 bytes.

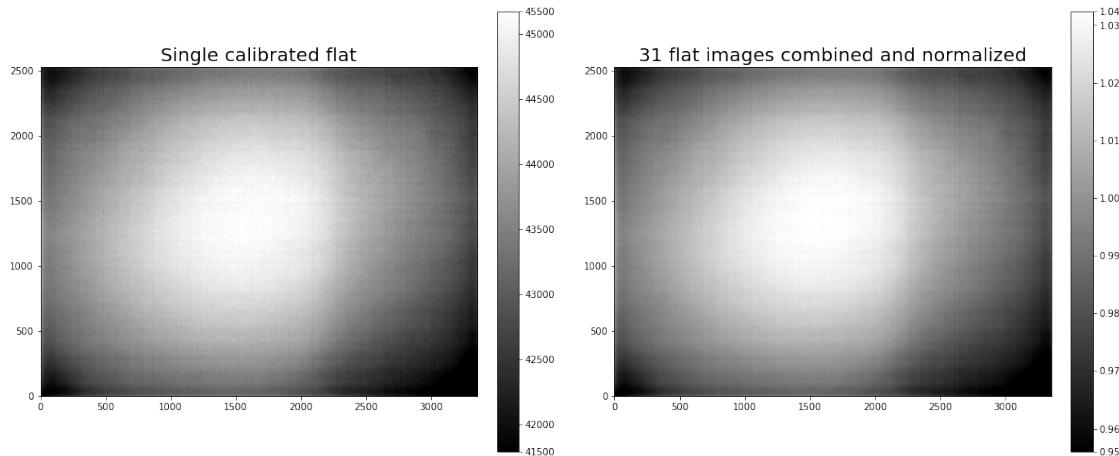
INFO: splitting each image into 50 chunks to limit memory usage to 350000000.0 bytes. [ccdproc.combiner]

/home/felipe/Hiwi/Pycode/get_attenuation.py:743: UserWarning: We will overwrite a new combined flat if it was already there!

```
    warnings.warn("We will overwrite a new combined flat if it was already
there!")
```

```
INFO:astropy:using the unit adu passed to the FITS reader instead of the unit adu in the FITS file.
```

```
INFO: using the unit adu passed to the FITS reader instead of the unit adu in the FITS file. [astropy.nddata.ccddata]
```



2.6 Gain

2.6.1 Calibrating Flat Frames for Gain

```
[17]: path = "/home/felipe/Hiwi/Data/Camera16/gain_Cam16/"  
gat.get_flats_for_test(path, compare = False)
```

THE CALIBRATED FLATS ARE PLACE IN:

/home/felipe/Hiwi/Data/Camera16/gain_Cam16/calibrated_flats/

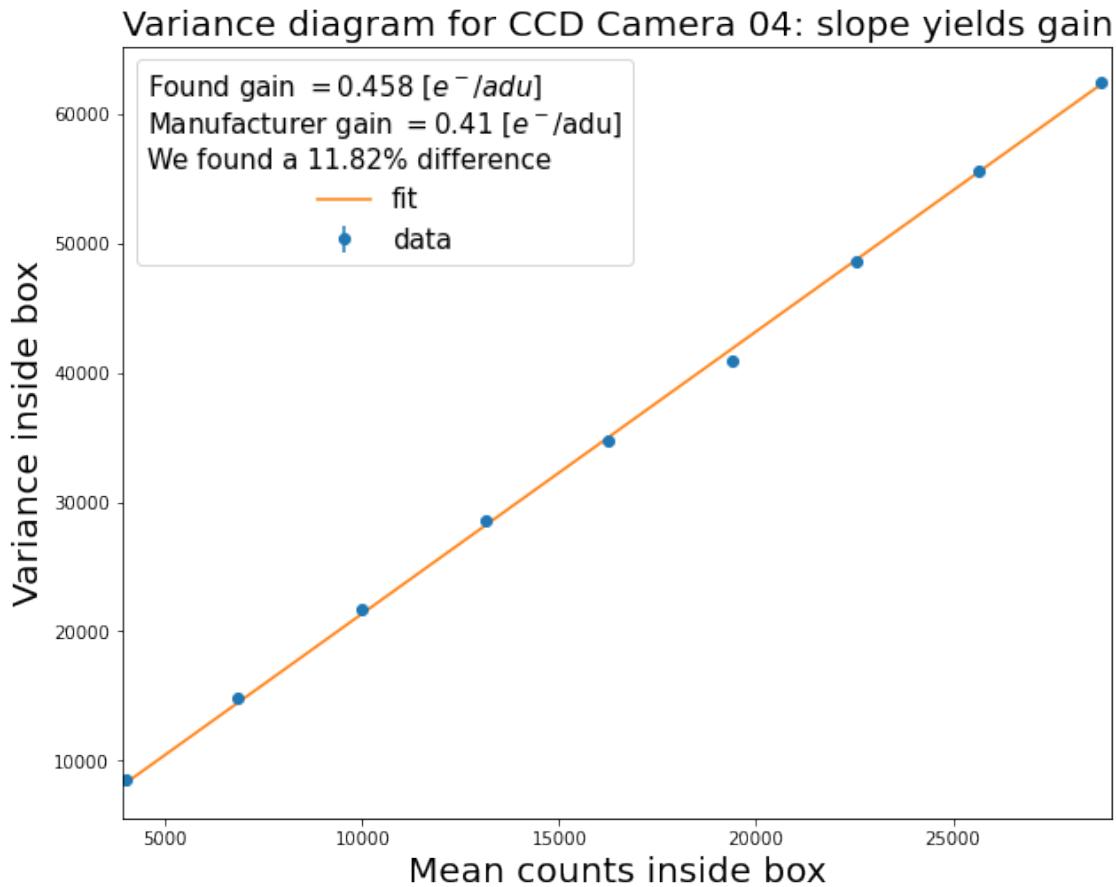
THE EXPOSURE TIMES ARE [0.001, 2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0] SECONDS.

2.6.2 Getting Linearity test

```
[20]: path = "/home/felipe/Hiwi/Data/Camera16/gain_Cam16/calibrated_flats/"  
position = (1600,1000)  
size = 100  
gain = 0.41  
gat.get_gain_factor(path , position , size , gain , title = 'Variance diagram  
for CCD Camera 04: slope yields gain' , compare = False , save = True)
```

THE EXPOSURE TIMES ARE [2.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0] SECONDS.

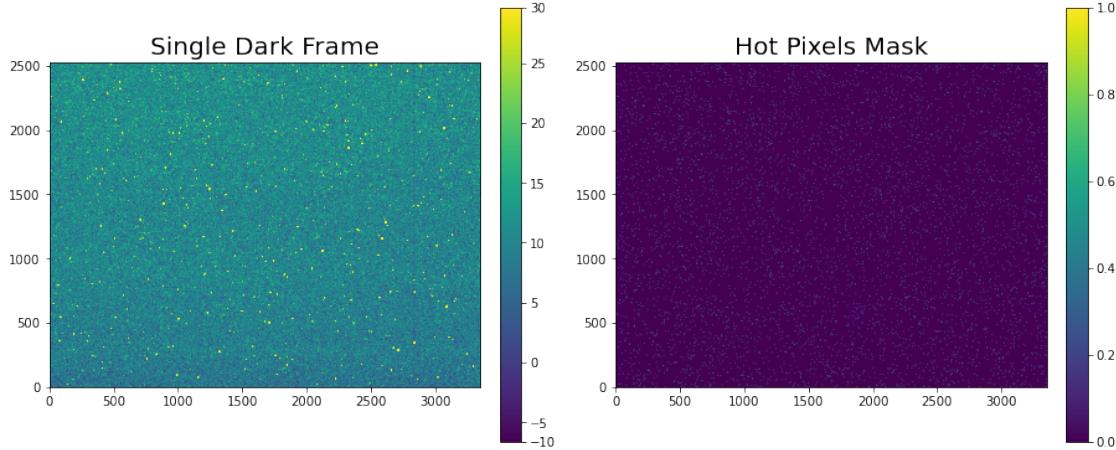
YOUR CAMERA HAS A GAIN OF 0.458 electrons/ADU.



2.7 Hot Pixels

```
[21]: path_im = "/home/felipe/Hiwi/Data/Camera16/dark_Cam16/calibrated_darks/
         ↪calibrated_dark16_21.fit"
path_fol = "/home/felipe/Hiwi/Data/Camera16/masks_Cam16"
gat.get_hot_pixels(path_im, path_fol, compare = True, hot_pixels = True, cmap = ↪
                     'viridis')
```

WE HAVE FOUND 5712 HOT PIXELS.



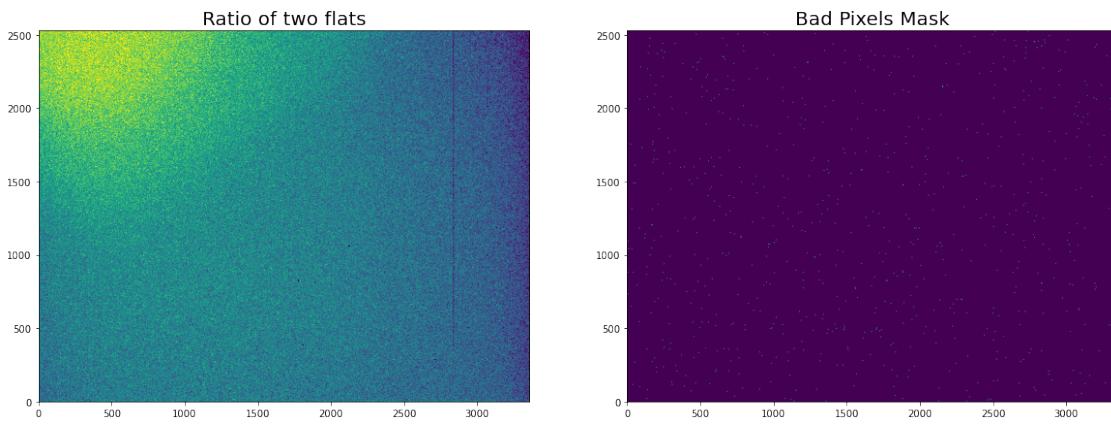
2.8 Bad Pixels

```
[22]: path1 = "/home/felipe/Hiwi/Data/Camera16/gain_Cam16/calibrated_flats/
         ↪calibrated_gflats16_14.fit"
path2 = "/home/felipe/Hiwi/Data/Camera16/gain_Cam16/calibrated_flats/
         ↪calibrated_gflats16_14(7).fit"
path_fol = "/home/felipe/Hiwi/Data/Camera16/masks_Cam16"
gat.get_bad_pixels(path1, path_fol , path2 = path2 , compare = True, bad_pixels ↪
         ↪= True, cmap = 'viridis')
```

IT COULD TAKE SOME TIME, BUT YOU JUST NEED TO DO IT ONCE.

THE RATIO IS 5.7605121036056826

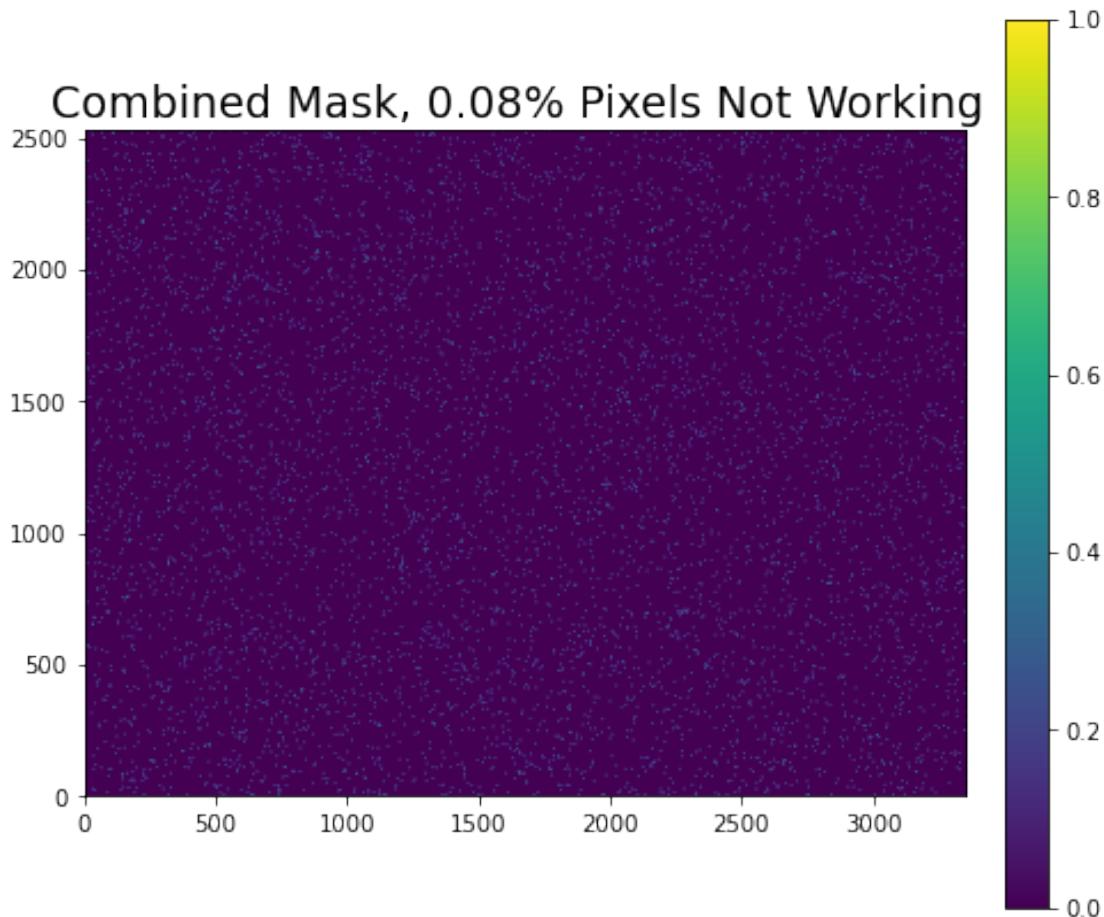
WE HAVE FOUND 771 BAD PIXELS.



2.9 Combined Mask

```
[23]: path_fol = "/home/felipe/Hiwi/Data/Camera16/masks_Cam16"  
darkmask = "/home/felipe/Hiwi/Data/Camera16/masks_Cam16/mask_from_dark_current.  
~fits"  
flatmask = "/home/felipe/Hiwi/Data/Camera16/masks_Cam16/mask_from_ccdmask.fits"  
gat.get_combined_mask(darkmask, flatmask, path_fol , useless_pixels = True ,  
~show_mask = True, cmap = 'viridis')
```

WE HAVE FOUND IN TOTAL 6377 USELESS PIXELS, WE ARE MASKING ROUGHLY 0.08% OF THE PIXELS.



2.10 Linearity test

2.10.1 Calibrating Flat frames for linearity test

```
[24]: # calibrating of flat was already done before, here you should do it
```

2.10.2 Getting Linearity test

```
[25]: path = '/home/felipe/Hiwi/Data/Camera16/linearity_Cam16/flat16/calibrated_flats/'
gat.linearity_test_cdd(path ,adu_max = 50000, adu_min = 15000, save = True)
```

YOUR EXPOSURE TIMES ARE [1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 12.0, 14.0, 16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0, 30.0, 32.0, 34.0, 36.0, 38.0, 40.0, 42.0, 44.0, 46.0, 48.0, 50.0] SECONDS.

a b

a	4.72e-08	-1.24e-06
b	-1.24e-06	3.51e-05

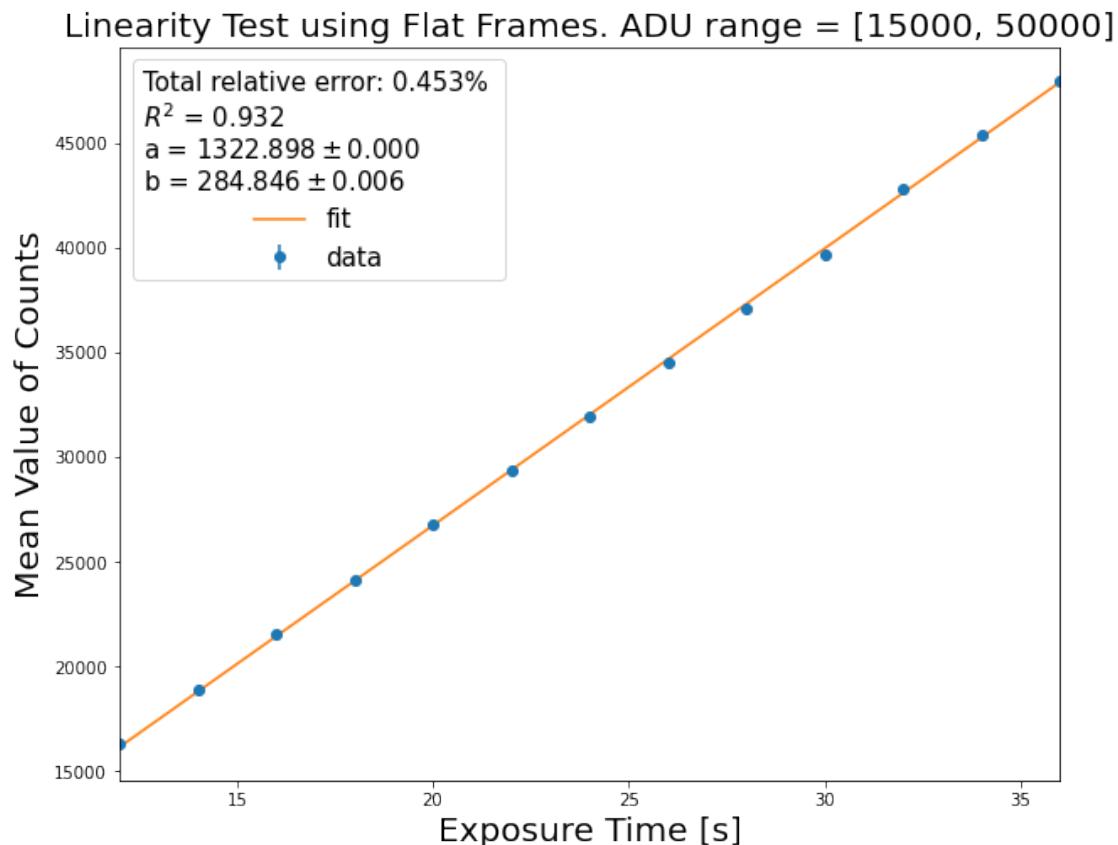
YOUR CORRELATION PARAMETER IS $R = 0.965$, IT SHOULD BE CLOSE TO 1.

WORKING IN THE RANGE FROM 15000 TO 50000 ADU.

YOU DATA AFTER USING THE SELECTED RANGE OF COUNTS VALUES IS: DATA = ['16325.65', '18931.85', '21555.58', '24164.13', '26757.03', '29345.62', '31937.94', '34513.44', '37089.58', '39677.63', '42856.92', '45410.22', '47997.83'] ADU.

THE RELATIVE ERROR OF EACH DATA POINTS ARE: RE = ['1.027%', '0.672%', '0.487%', '0.279%', '0.053%', '0.146%', '0.301%', '0.481%', '0.633%', '0.736%', '0.562%', '0.324%', '0.185%'].

THE TOTAL RELATIVE ERROR IS: TOTAL RE = 0.453%.



2.11 Readout Noise

```
[3]: path_bias_folder = '/home/felipe/Hiwi/Data/Camera16/readout_noise_Cam16/'  
readout_noise16 = gat.readout_noise(path_bias_folder, gain = 0.41)
```

INFO:astropy:splitting each image into 22 chunks to limit memory usage to 350000000.0 bytes.

INFO: splitting each image into 22 chunks to limit memory usage to 350000000.0 bytes. [ccdproc.combiner]
WE HAVE USED 20 BIAS FRAMES.
THE READ OUT OF THE CAMERA IS 8.393406880189799[e-]
THE EEROR IN THE CALCULATED READ OUT OF THE CAMERA IS 2.1430443635406617[e-]
[[20.1325444 12.94760775 20.79039973 ... 23.67734282 16.10284617
 22.07211828]
[17.55472709 21.28687228 18.45432977 ... 18.36274121 20.96480822
 19.40747331]
[14.92981416 15.66864373 19.57205255 ... 22.62020561 24.38281849
 14.49796871]
...
[16.41953341 25.17670146 18.64788454 ... 15.54648973 14.12139185
 13.5061289]
[22.33127529 19.1247244 25.96836694 ... 20.68128805 14.40569314
 19.51430887]
[13.53948391 10.66903915 19.14385959 ... 12.98457888 14.20258915
 15.0307976]]

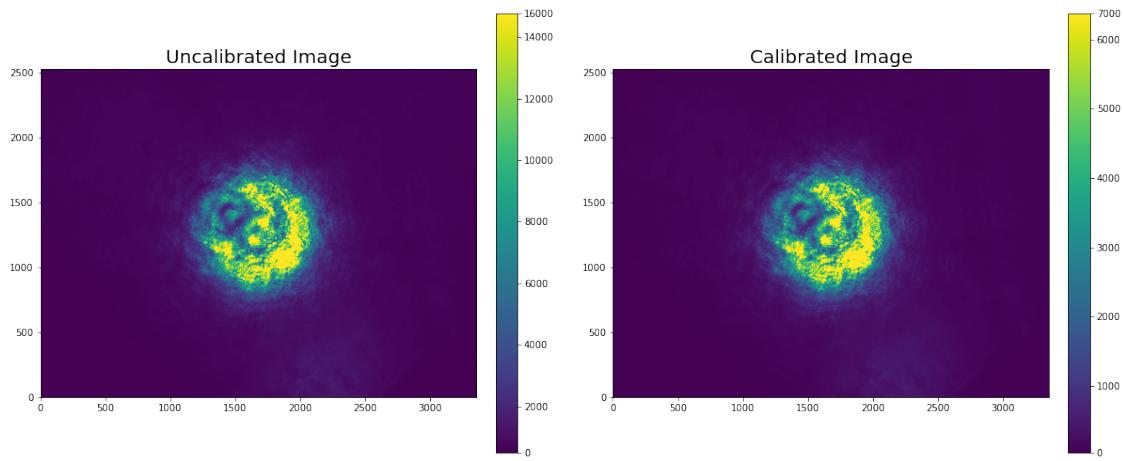
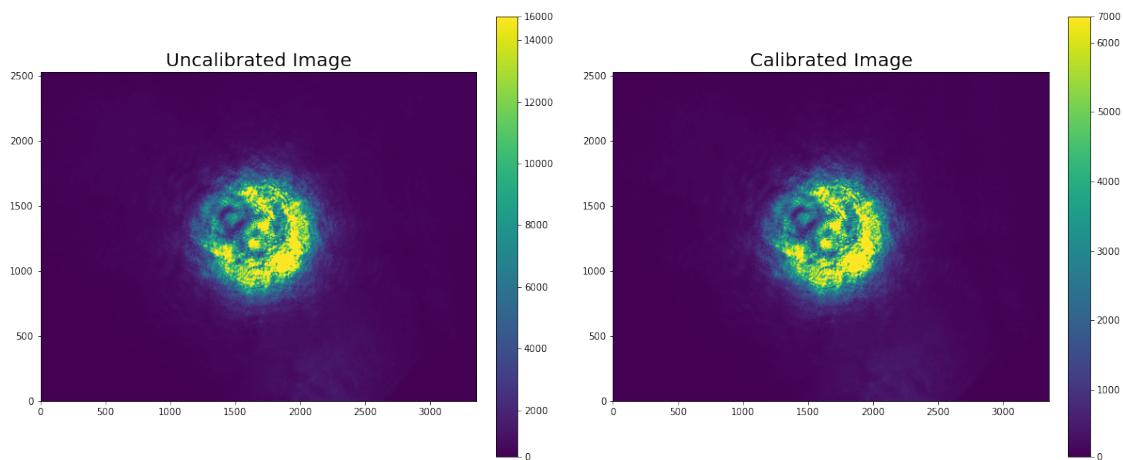
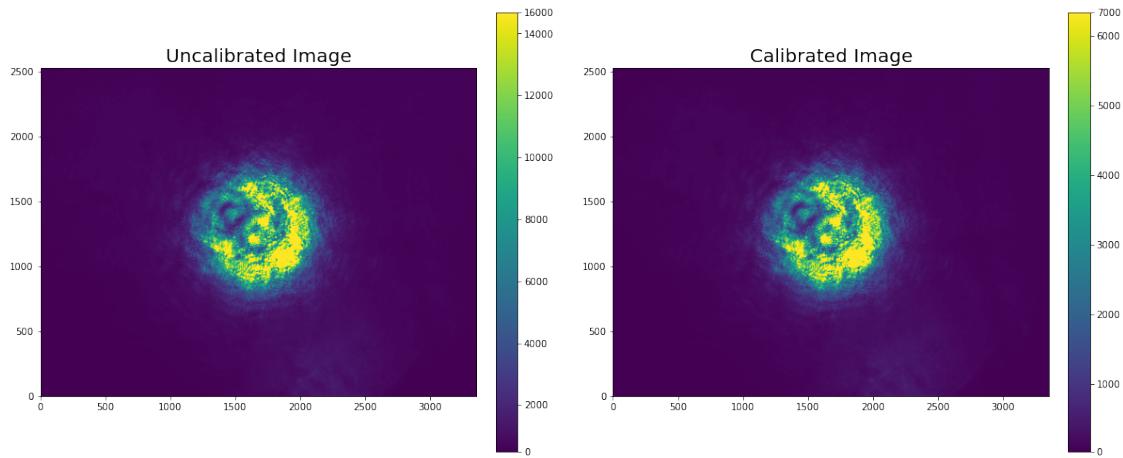
2.12 Calibrating Laser Images

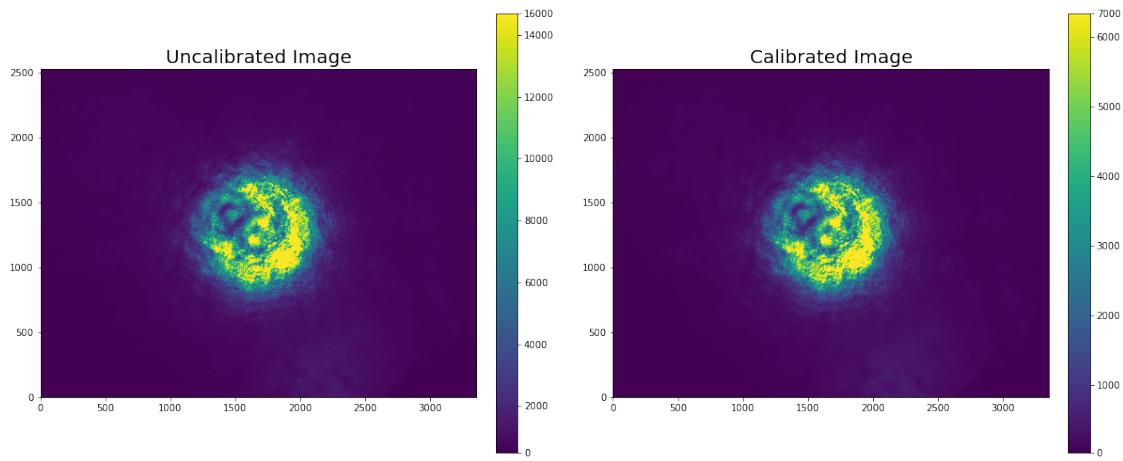
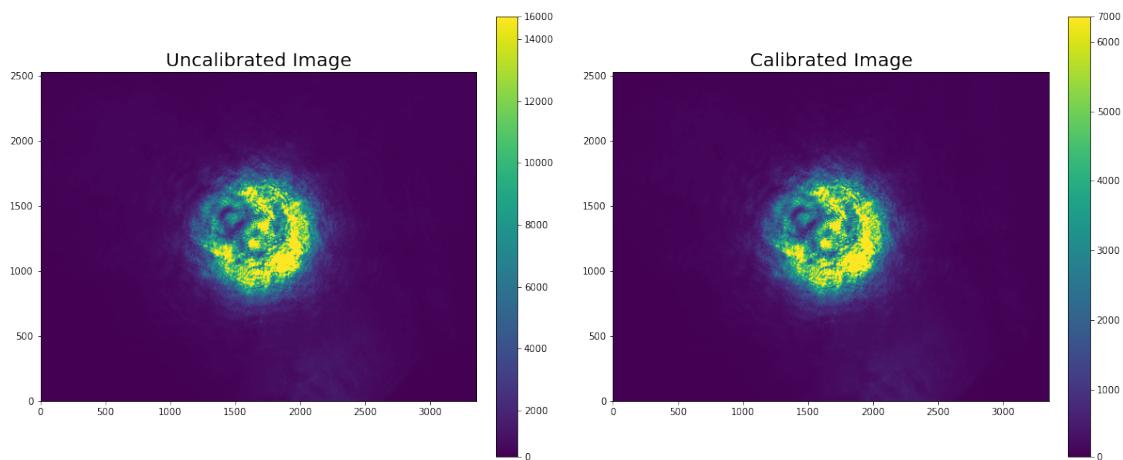
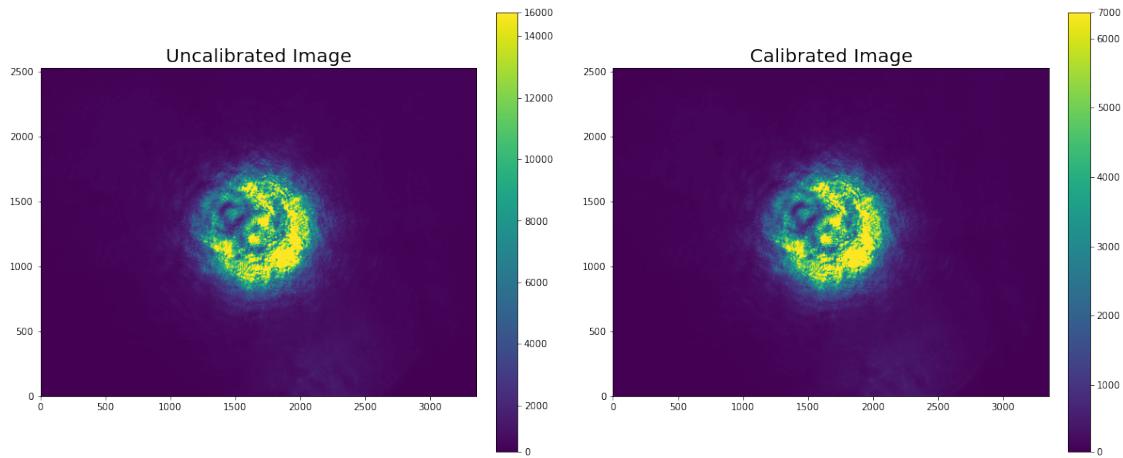
```
[11]: path_science = "/home/felipe/Hiwi/Data/Camera16/laser_Cam16/"  
path_master_flat = "/home/felipe/Hiwi/Data/Camera16/flats_Cam16/calibrated_flats/  
˓→combined_flat5.fit"  
path_master_bias = "/home/felipe/Hiwi/Data/Camera16/Bias_Cam16/masterbias.fit"  
path_master_dark = "/home/felipe/Hiwi/Data/Camera16/dark_Cam16/calibrated_darks/  
˓→masterdark5.fit"  
path_mask = "/home/felipe/Hiwi/Data/Camera16/masks_Cam16/combined_mask.fits"  
matrix_error = [readout_noise16**2]  
gat.get_calibrated_ccd_image(path_science, path_master_dark, path_master_flat,  
˓→matrix_error, path_mask, path_master_bias ,gain = 0.458 , compare = True, cmap  
˓→= 'viridis')
```

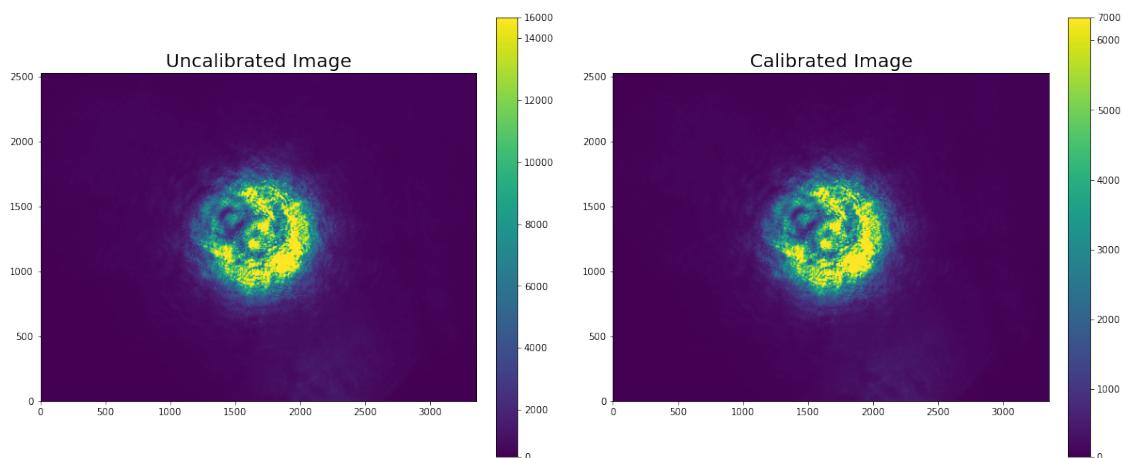
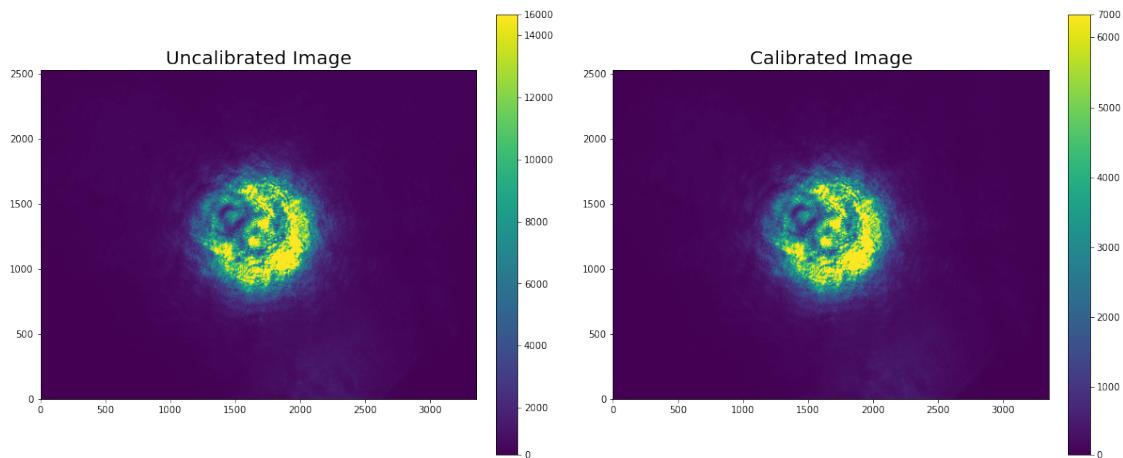
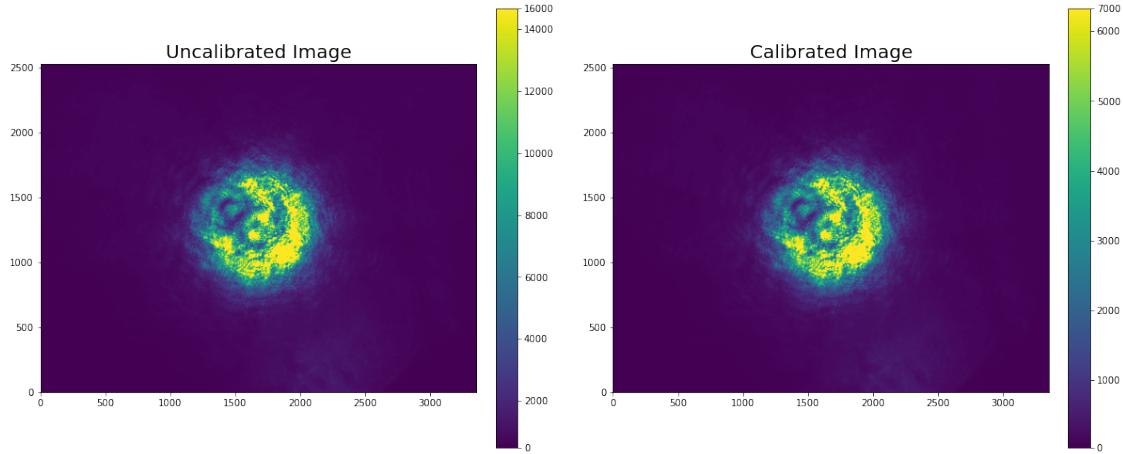
THE CALIBRATED SCIENTIFIC PICTURES ARE PLACE IN:

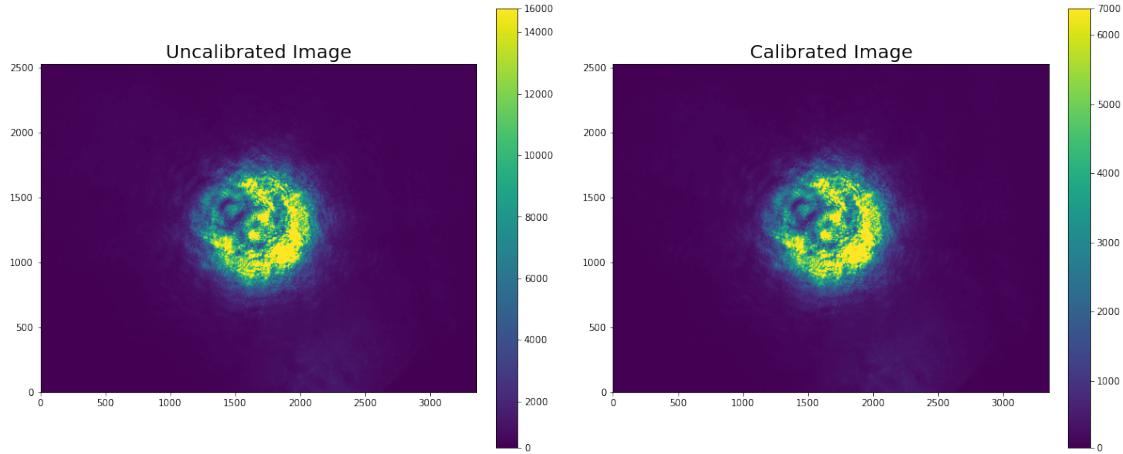
/home/felipe/Hiwi/Data/Camera16/laser_Cam16/calibrated_science/

INFO:astropy:array provided for uncertainty; assuming it is a StdDevUncertainty.









3 ATTENUATION LIGHT OF “DIRTY LaB”

```
[13]: path_image1 = "/home/felipe/Hiwi/Data/Cam04/laser_Cam04/calibrated_science/
        ↵reduced_laser2.5exp10_58.fit"
path_image2 = "/home/felipe/Hiwi/Data/Camera16/laser_Cam16/calibrated_science/
        ↵reduced_laser2.5exp10_58.fit"
gat.att(path_image1, path_image2)
```

INFO:astropy:using the unit adu passed to the FITS reader instead of the unit electron in the FITS file.

INFO:astropy:using the unit adu passed to the FITS reader instead of the unit electron in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit electron in the FITS file. [astropy.nddata.ccddata]

INFO: using the unit adu passed to the FITS reader instead of the unit electron in the FITS file. [astropy.nddata.ccddata]

Result: 2.9660224263767323 [m]⁻¹

Error: 0.004433943755554029 [m]⁻¹

[]:

[]:

[]:

[]:

[]:

[]: