

1.0_Brown_Reformatting

January 18, 2018

1 HELP - Bootes Master List Creation

This notebook presents the creation of the HELP master list on the Bootes field. This field was originally ingested into HeDAM based on a masterlist produced by Eduardo Gonzales-Solares. Ken Duncan subsequently retrieved Michael Brown's precompiled masterlist for the Bootes field and therefore this notebook only contains some simple naming changes and astrometry correction. The original catalogue is described in DMU_0.

This notebook was run with herschelhelp_internal version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

1.1 I - Column selection

Out[6]: <IPython.core.display.HTML object>

Out[8]: <IPython.core.display.HTML object>

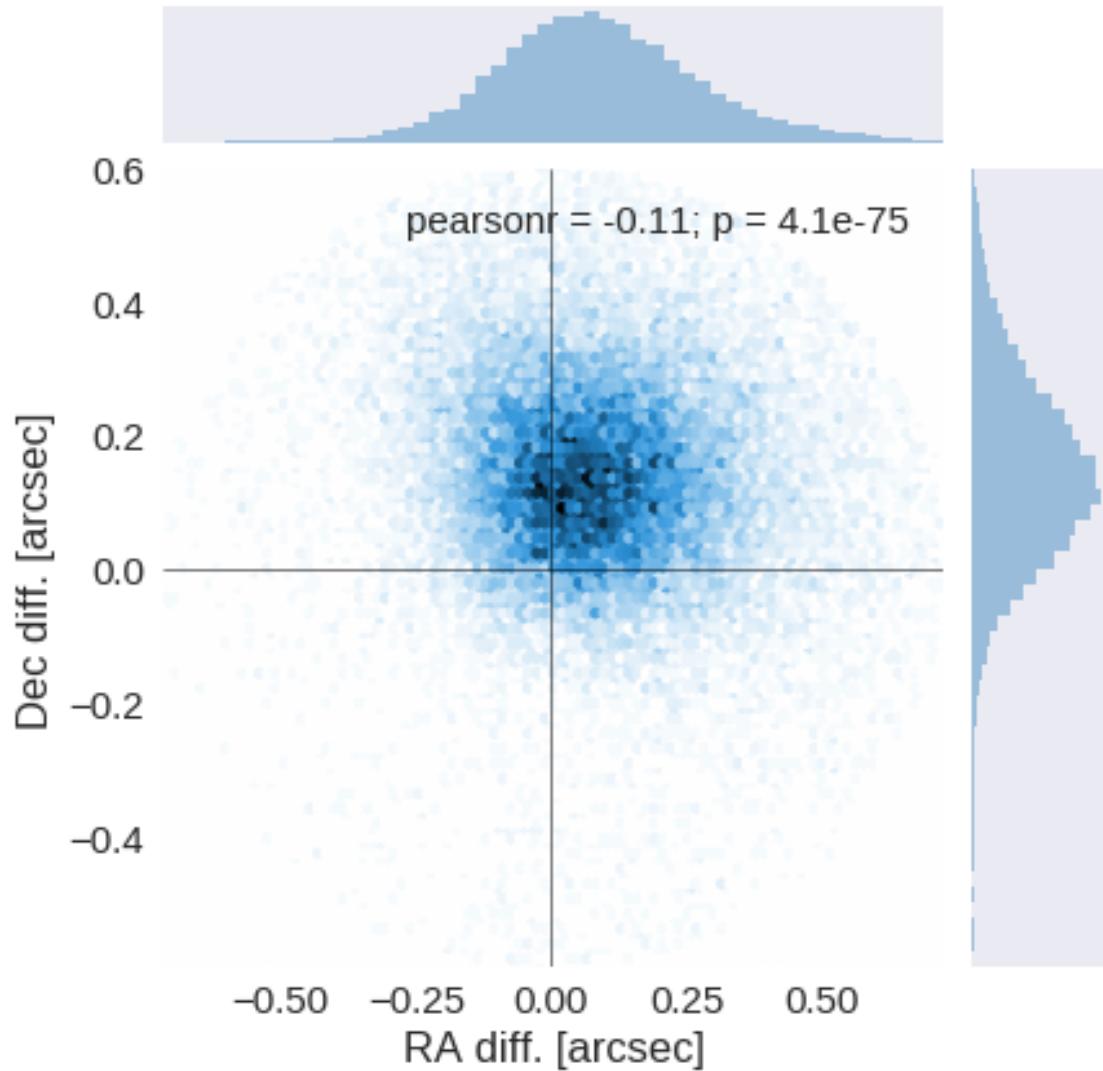
1.2 II - Removal of duplicated sources

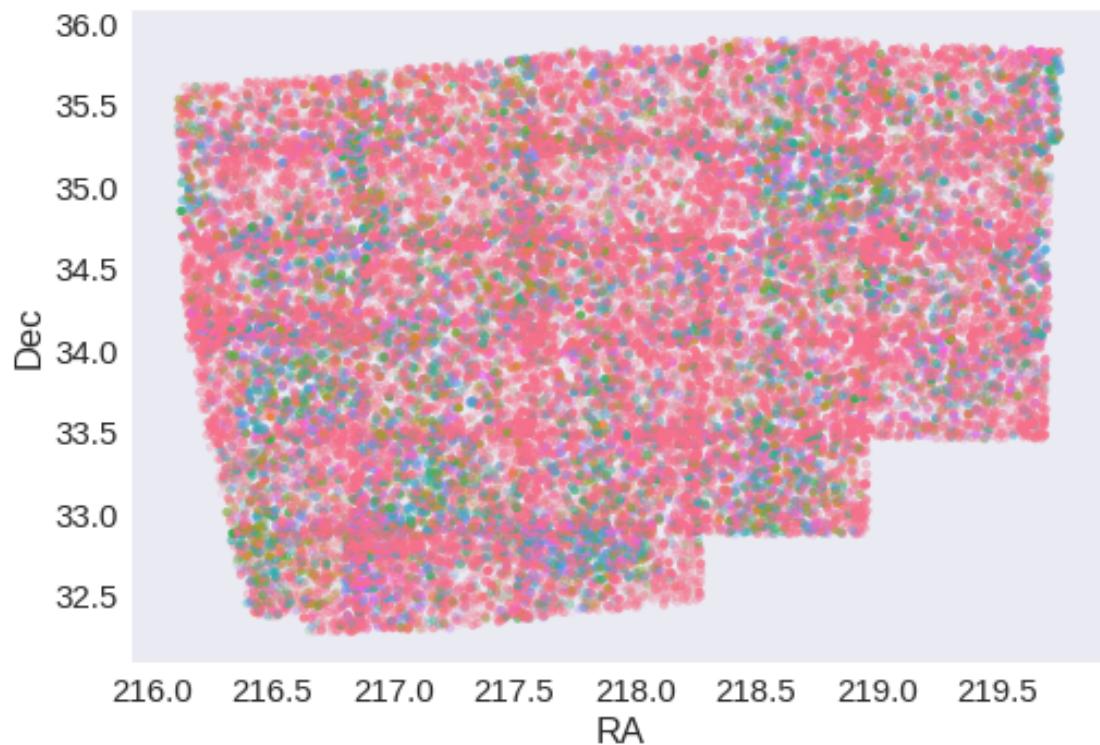
We remove duplicated objects from the input catalogues.

Out[9]: 'SORT_COLS = [\'merr_ap_gpc1_r\', \'merr_ap_gpc1_g\', \'merr_ap_gpc1_i\', \'merr_ap_gpc1_r\']'

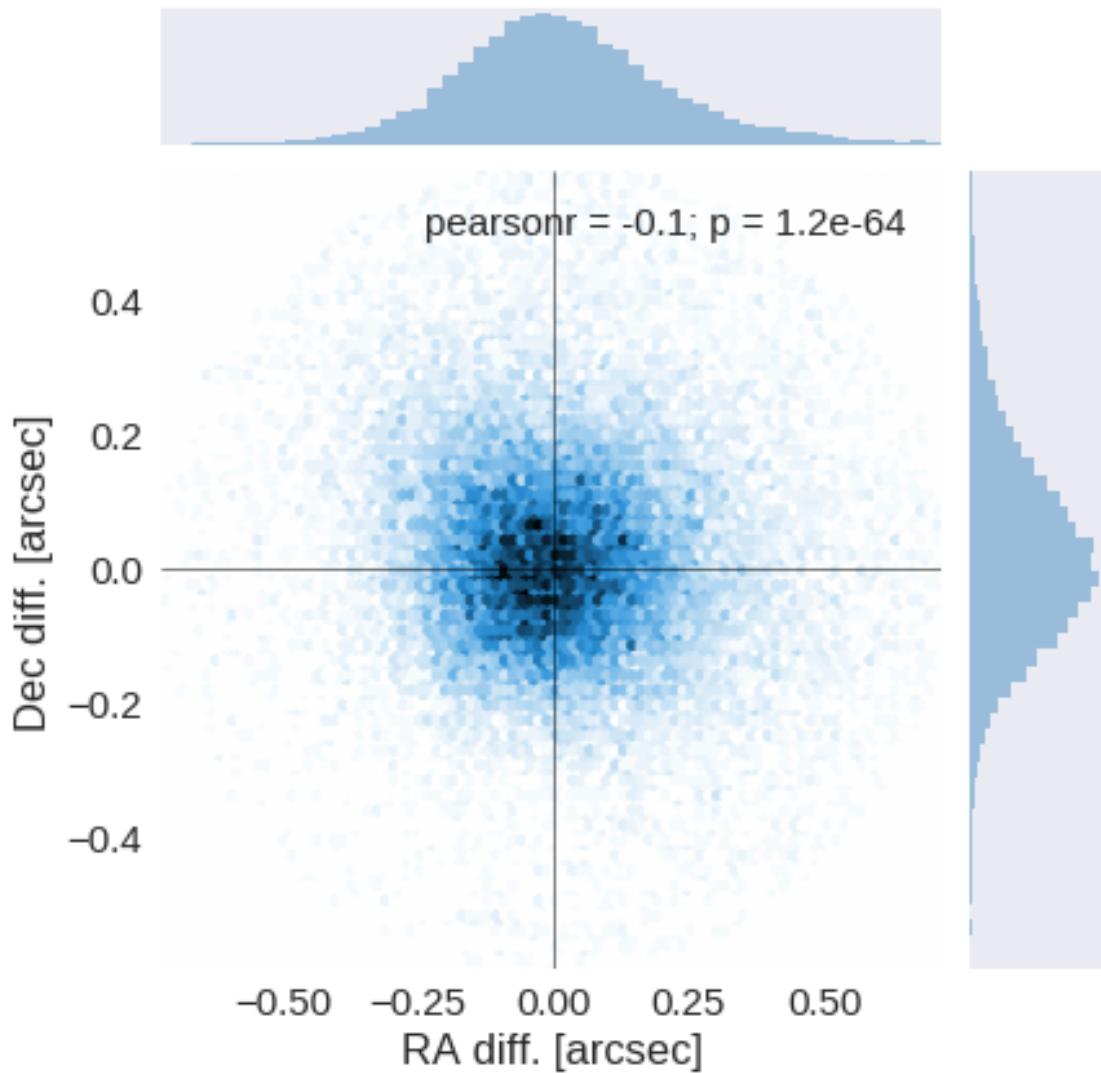
1.3 III - Astrometry correction

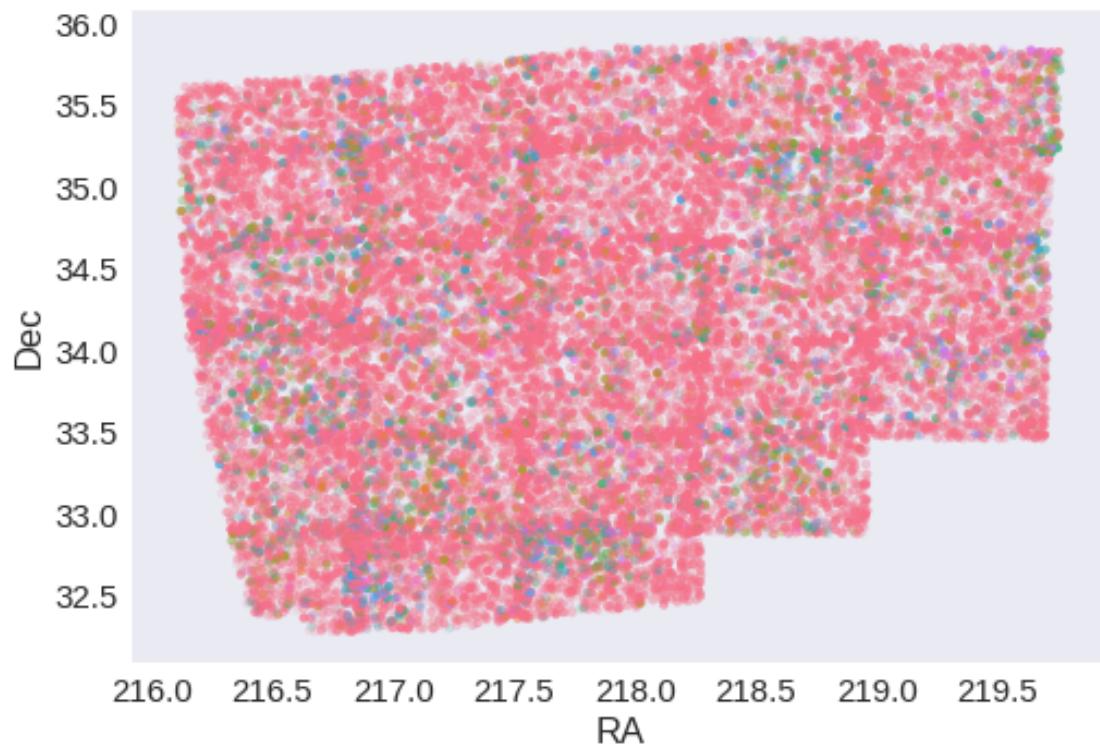
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.



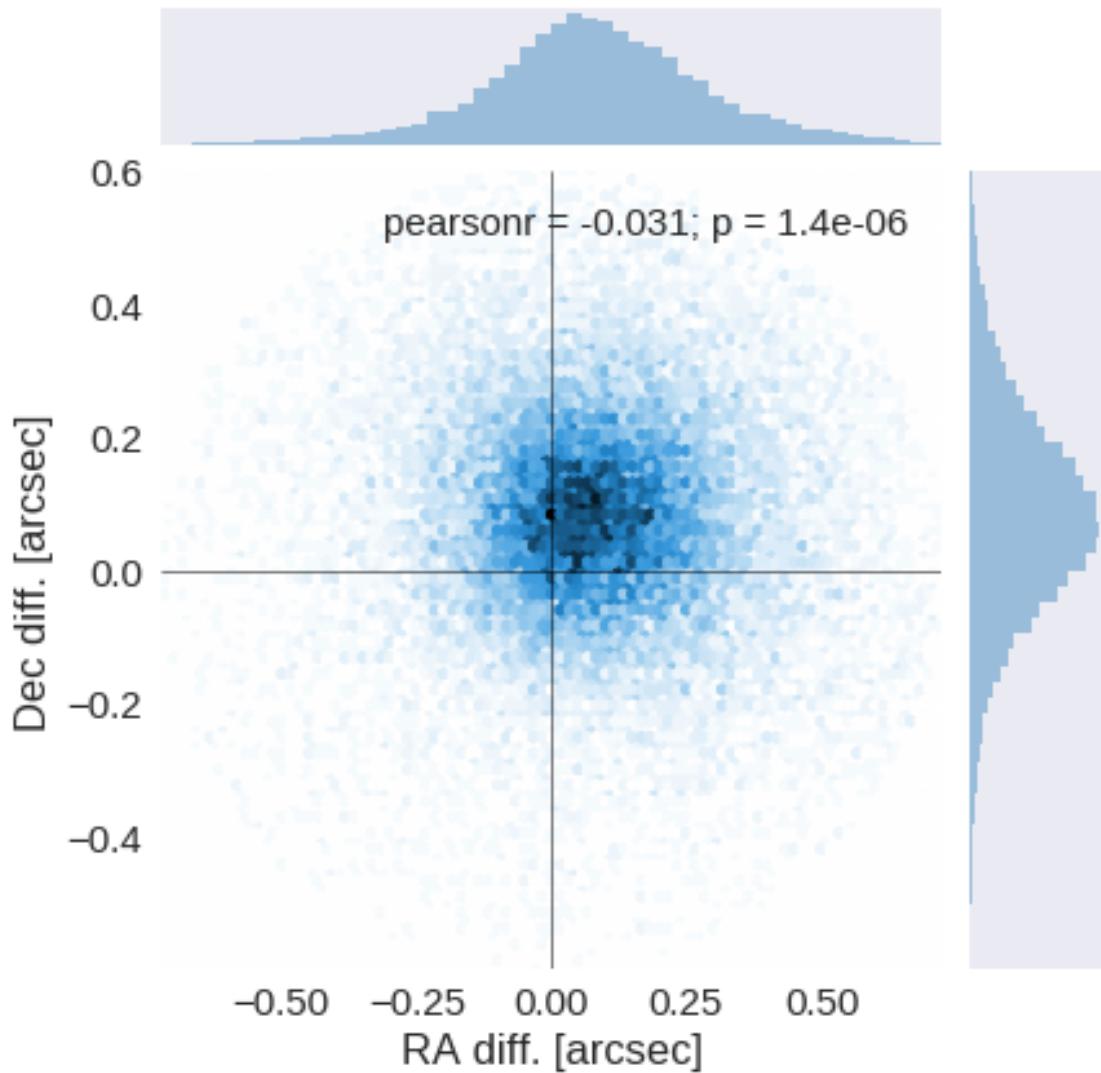


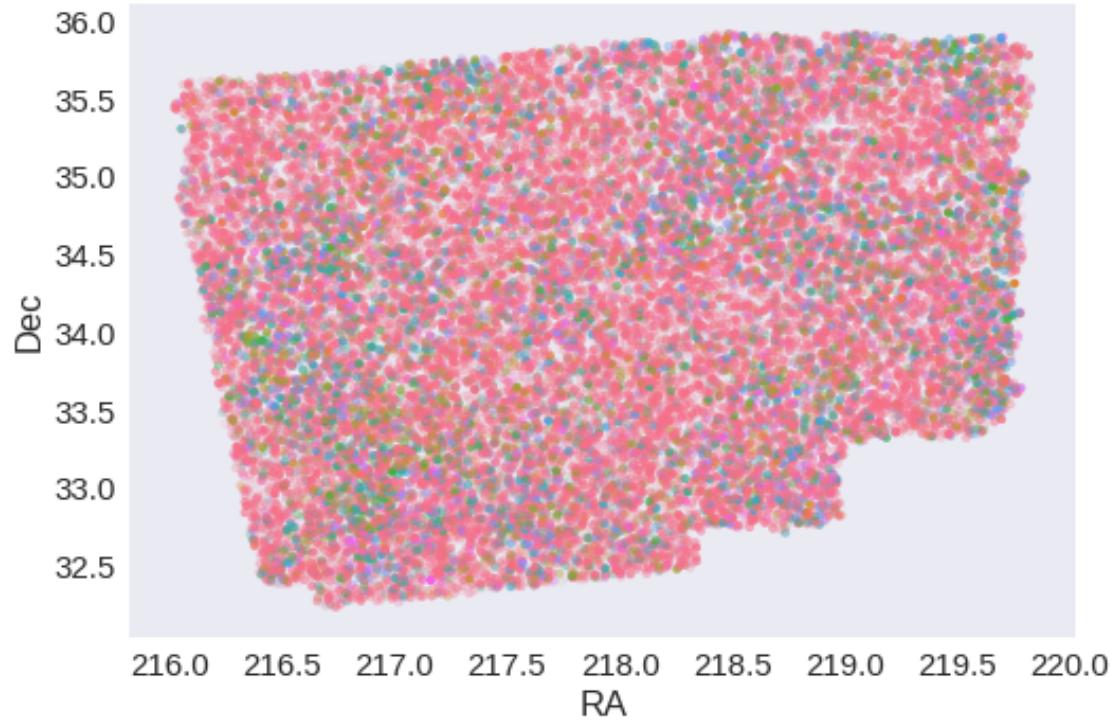
RA correction: -0.0735978168904694 arcsec
Dec correction: -0.12698051759514328 arcsec



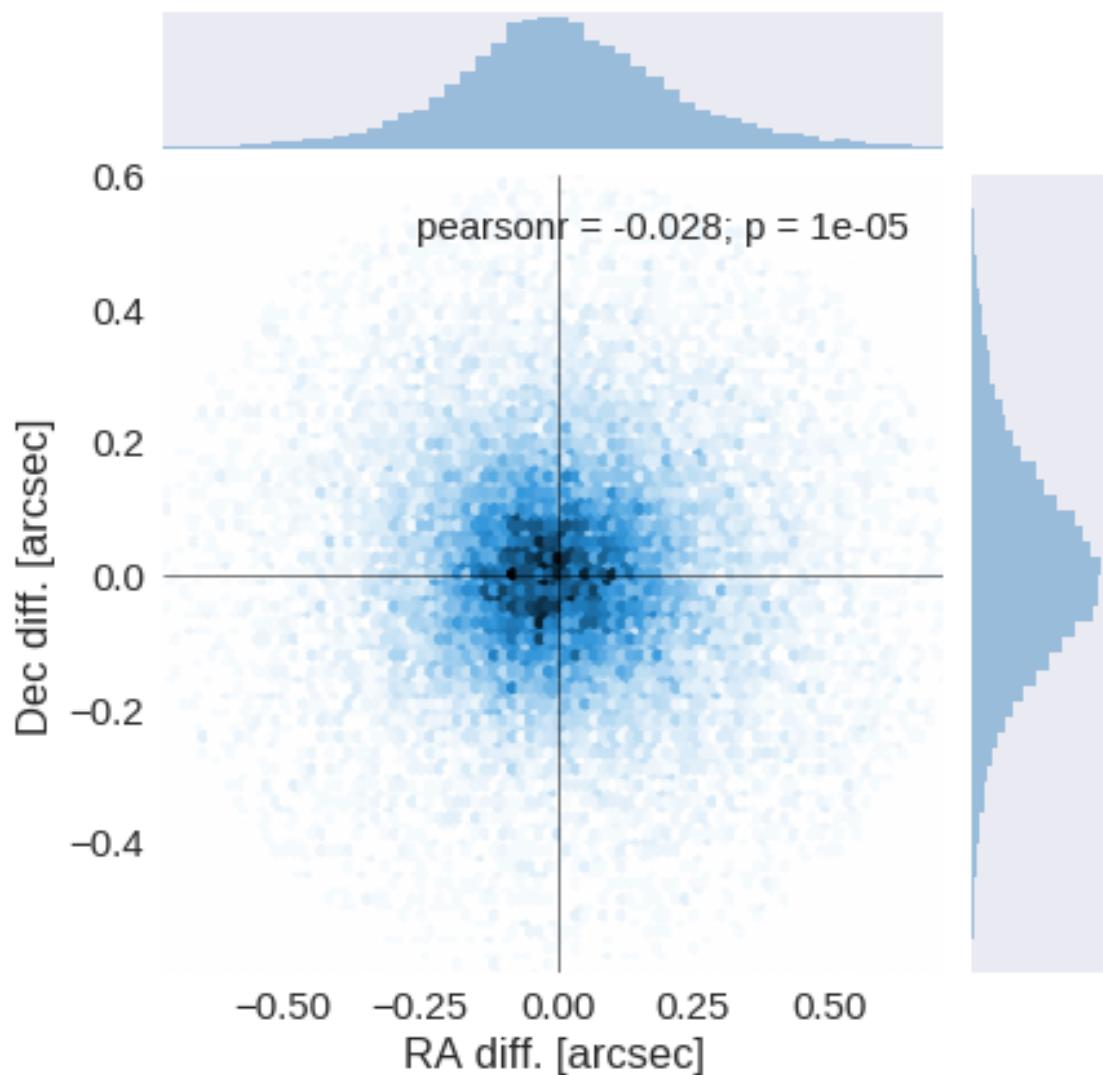


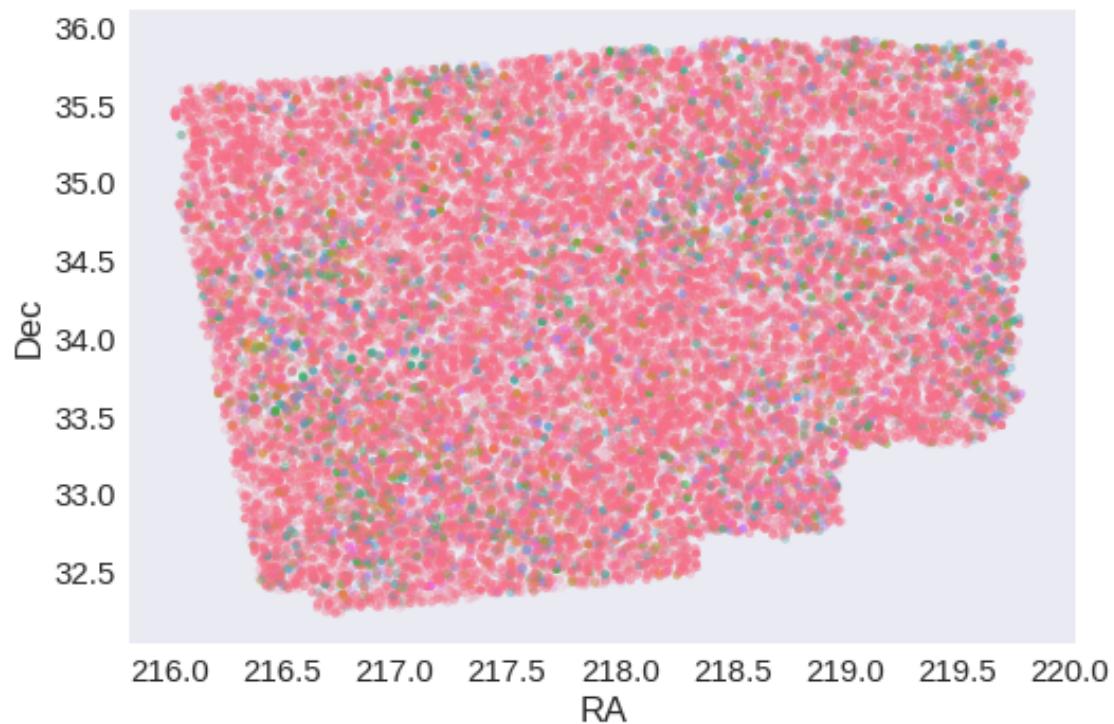
We then correct the other catalogue



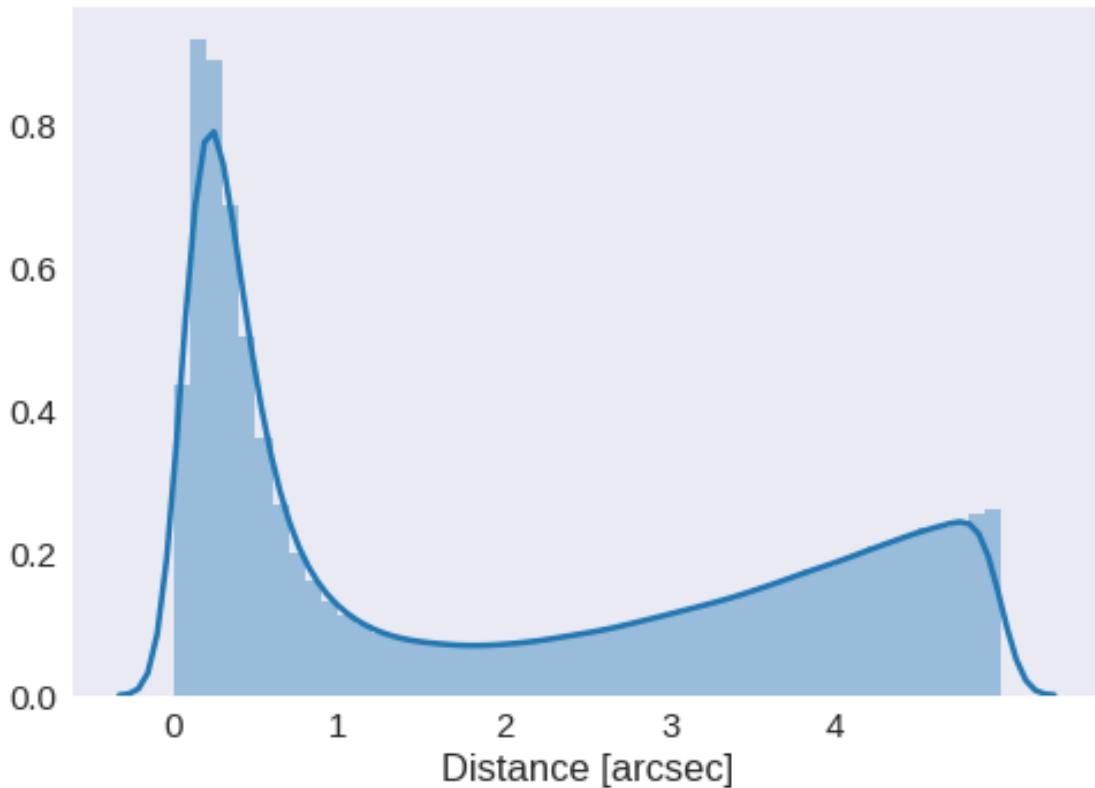


RA correction: -0.07916888162640134 arcsec
Dec correction: -0.08063874360573209 arcsec





2 Merging



There are 1580405 sources only in the first catalogue

There are 185203 sources only in the second catalogue

There are 486485 sources in both catalogues

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/_main_.py:5: R
```

Out[23]: <IPython.core.display.HTML object>

2.1 IV - Flagging Gaia objects

38129 sources flagged.

3 V - Adding HELP unique identifiers and field columns

The HELP IDs are not unique!!!

4 VI - Saving to disk

1.1 DECaLS

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of DECam Legacy Survey data

This catalogue comes from dmu0_DECaLS.

In the catalogue, we keep:

- The object_id as unique object identifier;
- The position;
- The u, g, r, i, z, Y aperture magnitude (2'');
- The u, g, r, i, z, Y kron fluxes and magnitudes.

We check for all ugrizY then only take bands for which there are measurements

This notebook was run with herschelhelp_internal version:
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```
WARNING: UnitsWarning: '1/deg^2' did not parse as fits unit: Numeric factor not supported by FITS
WARNING: UnitsWarning: 'nanomaggy' did not parse as fits unit: At col 0, Unit 'nanomaggy' not supported
WARNING: UnitsWarning: '1/nanomaggy^2' did not parse as fits unit: Numeric factor not supported by FITS
WARNING: UnitsWarning: '1/arcsec^2' did not parse as fits unit: Numeric factor not supported by FITS
```

1.2 I - Aperture correction

To compute aperture correction we need to determine two parameters: the target aperture and the range of magnitudes for the stars that will be used to compute the correction.

Target aperture: To determine the target aperture, we simulate a curve of growth using the provided apertures and draw two figures:

- The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude.
- The mean gain (loss when negative) of magnitude is each aperture compared to the previous (except for the first of course).

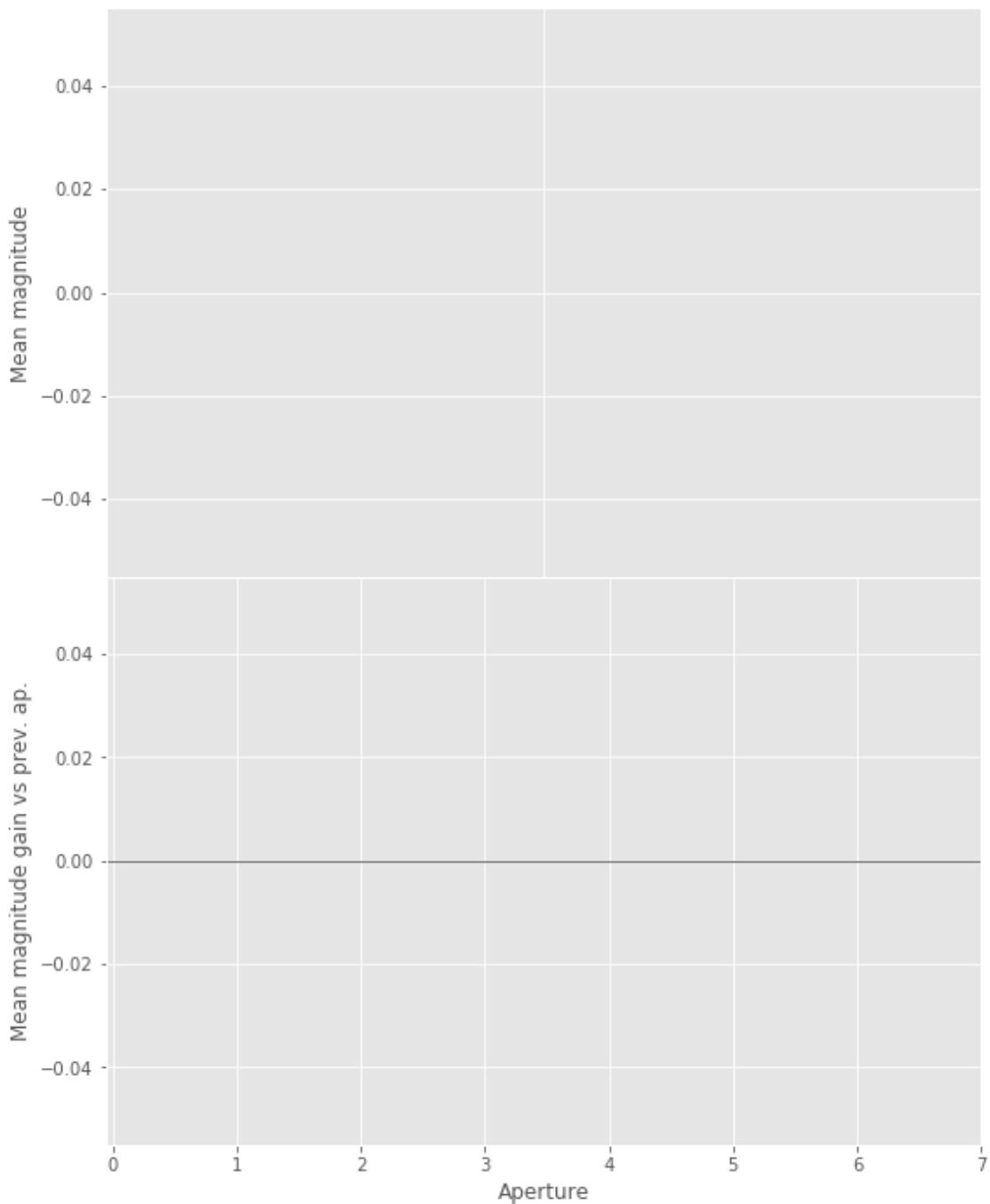
As target aperture, we should use the smallest (i.e. less noisy) aperture for which most of the flux is captured.

Magnitude range: To know what limits in aperture to use when doing the aperture correction, we plot for each magnitude bin the correction that is computed and its RMS. We should then use the wide limits (to use more stars) where the correction is stable and with few dispersion.

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: divide by zero encountered in double division
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:80: RuntimeWarning: invalid value encountered in double division
  errors = 2.5 / np.log(10) * errors_on_fluxes / fluxes
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value encountered in double division
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
```

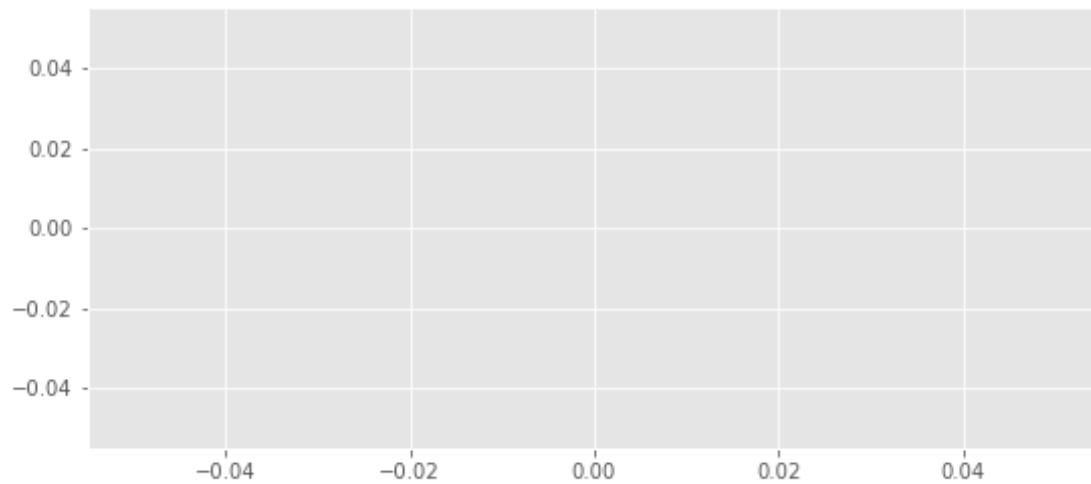
1.2.1 1.a u band

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:56: RuntimeWarning: Mean of empty slice
  warnings.warn("Mean of empty slice", RuntimeWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:56: RuntimeWarning: Mean of empty slice
  warnings.warn("Mean of empty slice", RuntimeWarning)
```

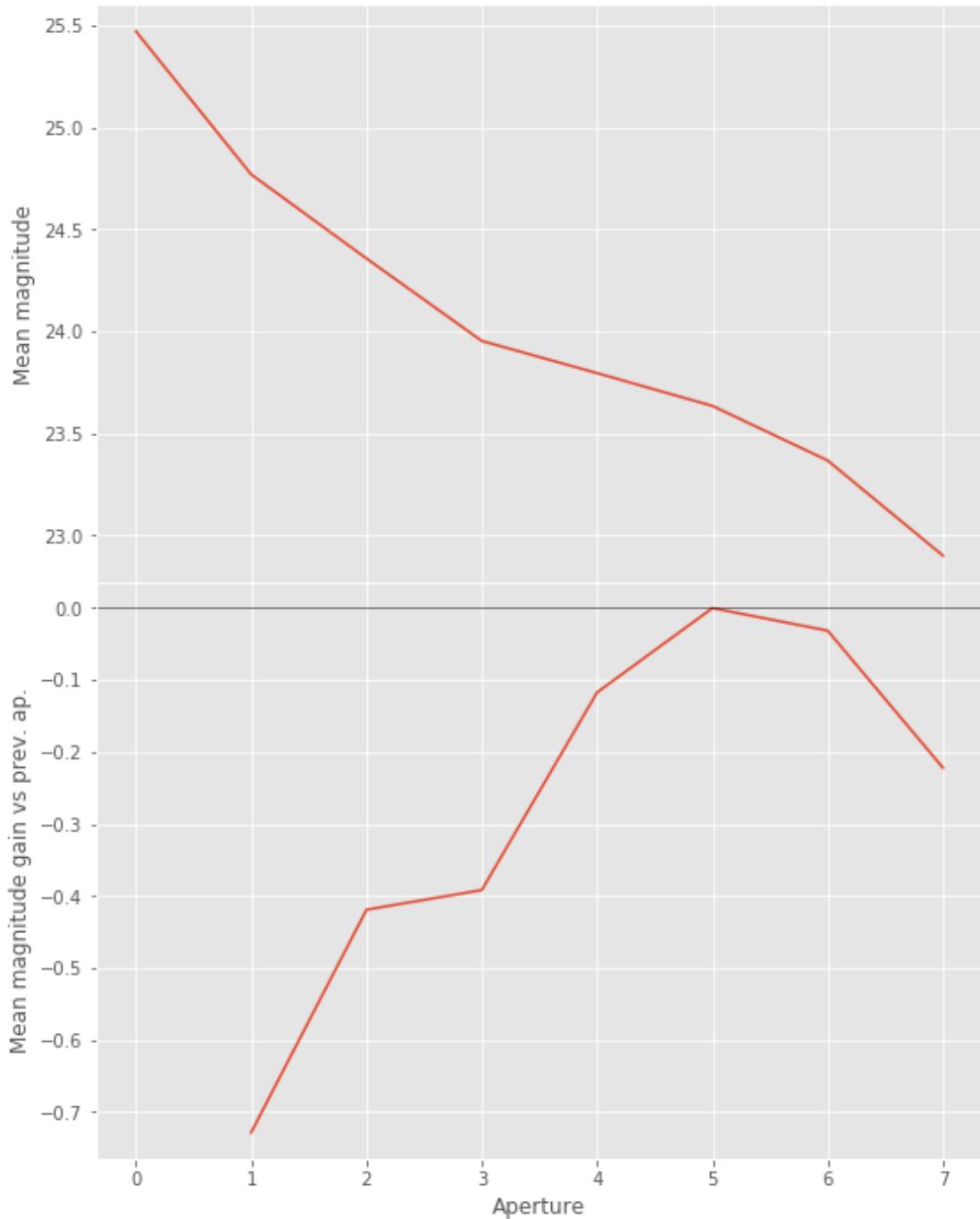


u band is all nan

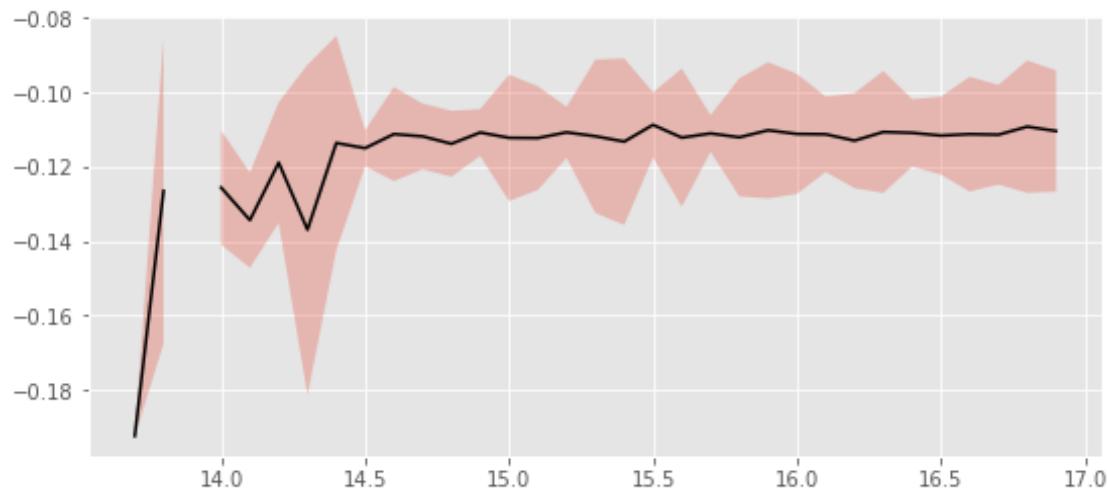
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:  
    warnings.warn("All-NaN slice encountered", RuntimeWarning)
```



1.2.2 I.a - g band



We will use aperture 5 as target.



We will use magnitudes between 16.0 and 19.0

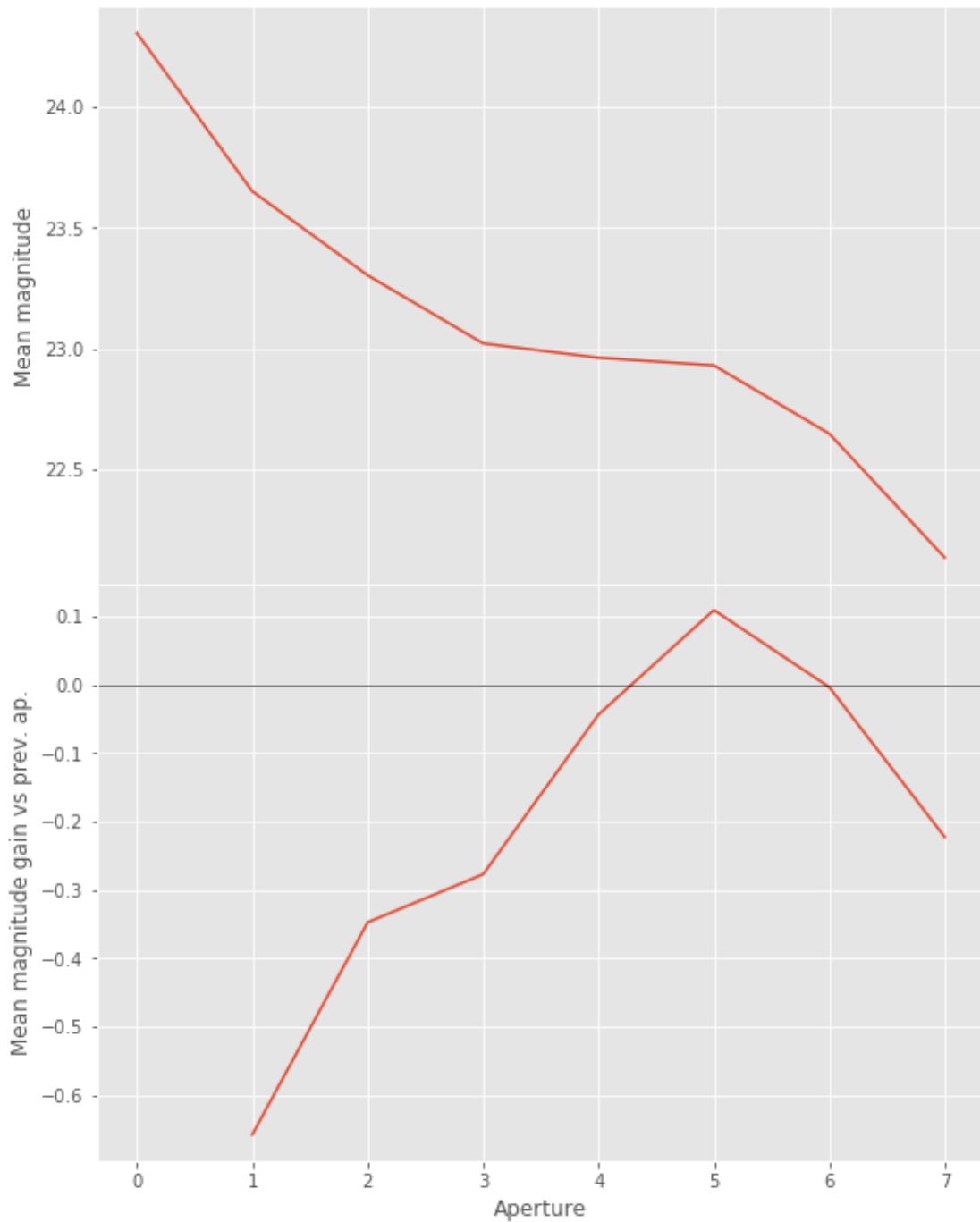
Aperture correction for g band:

Correction: -0.11073624215552513

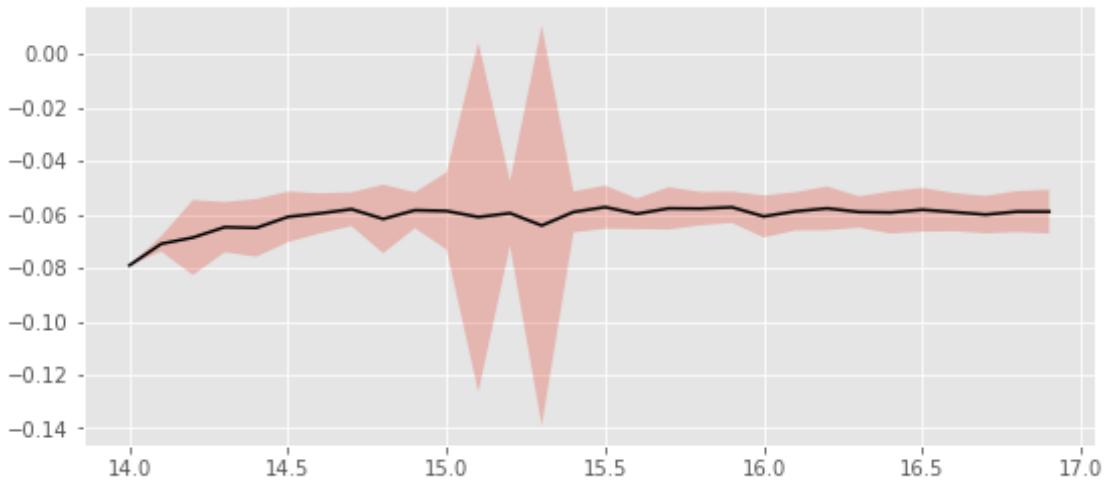
Number of source used: 2953

RMS: 0.013882524930034707

1.2.3 I.b - r band



We will use aperture 5 as target.



We use magnitudes between 16.0 and 18.0.

Aperture correction for r band:

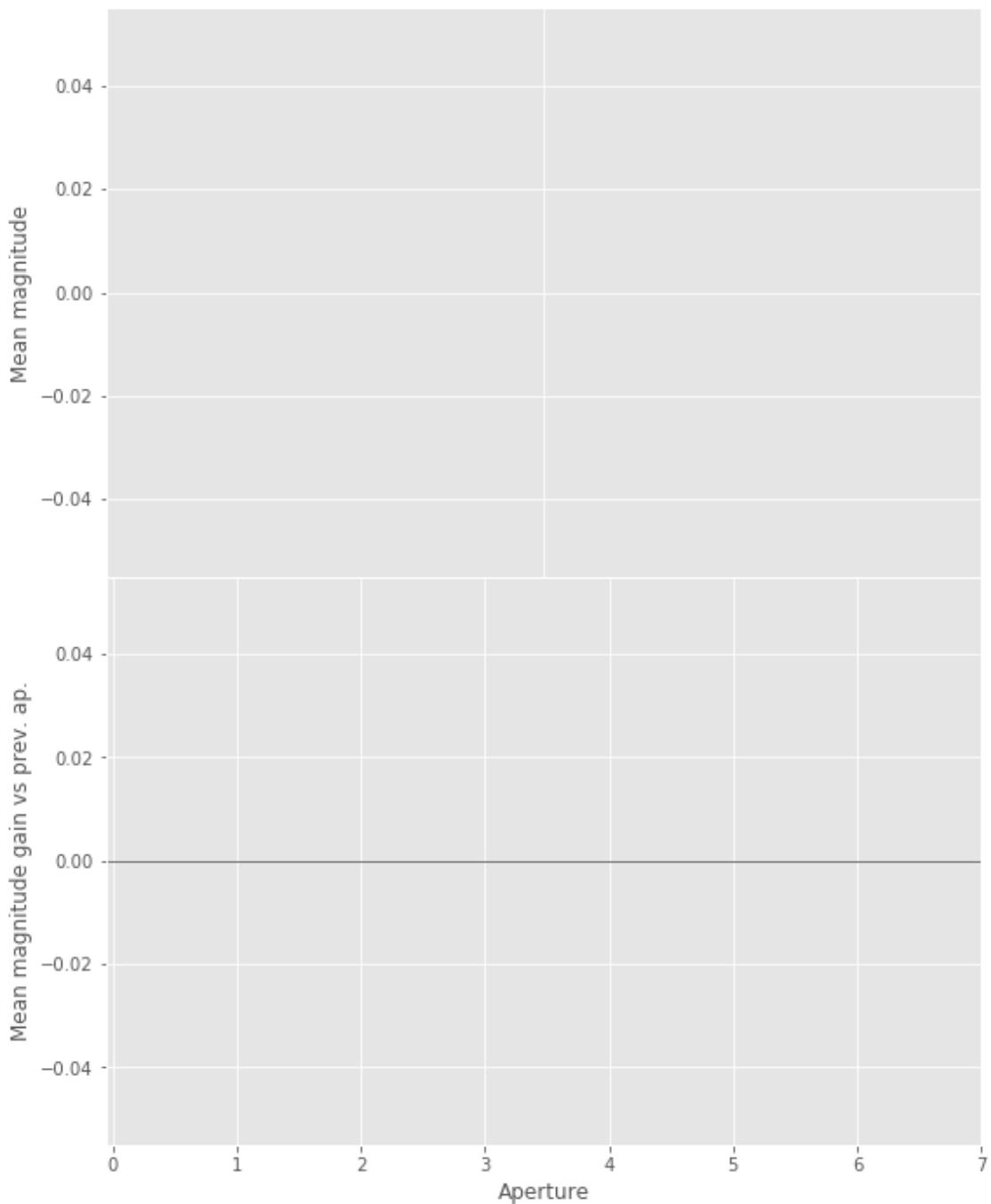
Correction: -0.058869338118242354

Number of source used: 2426

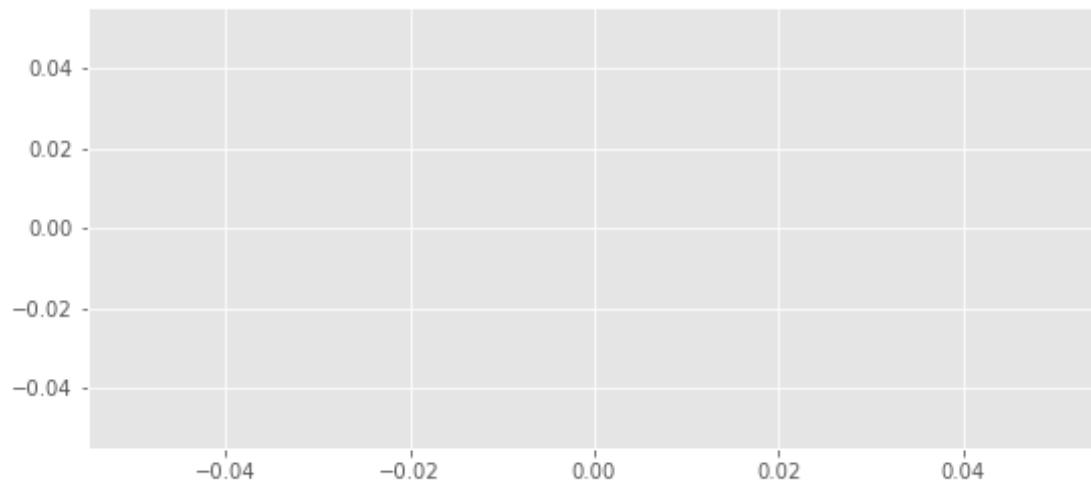
RMS: 0.00786347074114361

1.2.4 I.d - i band

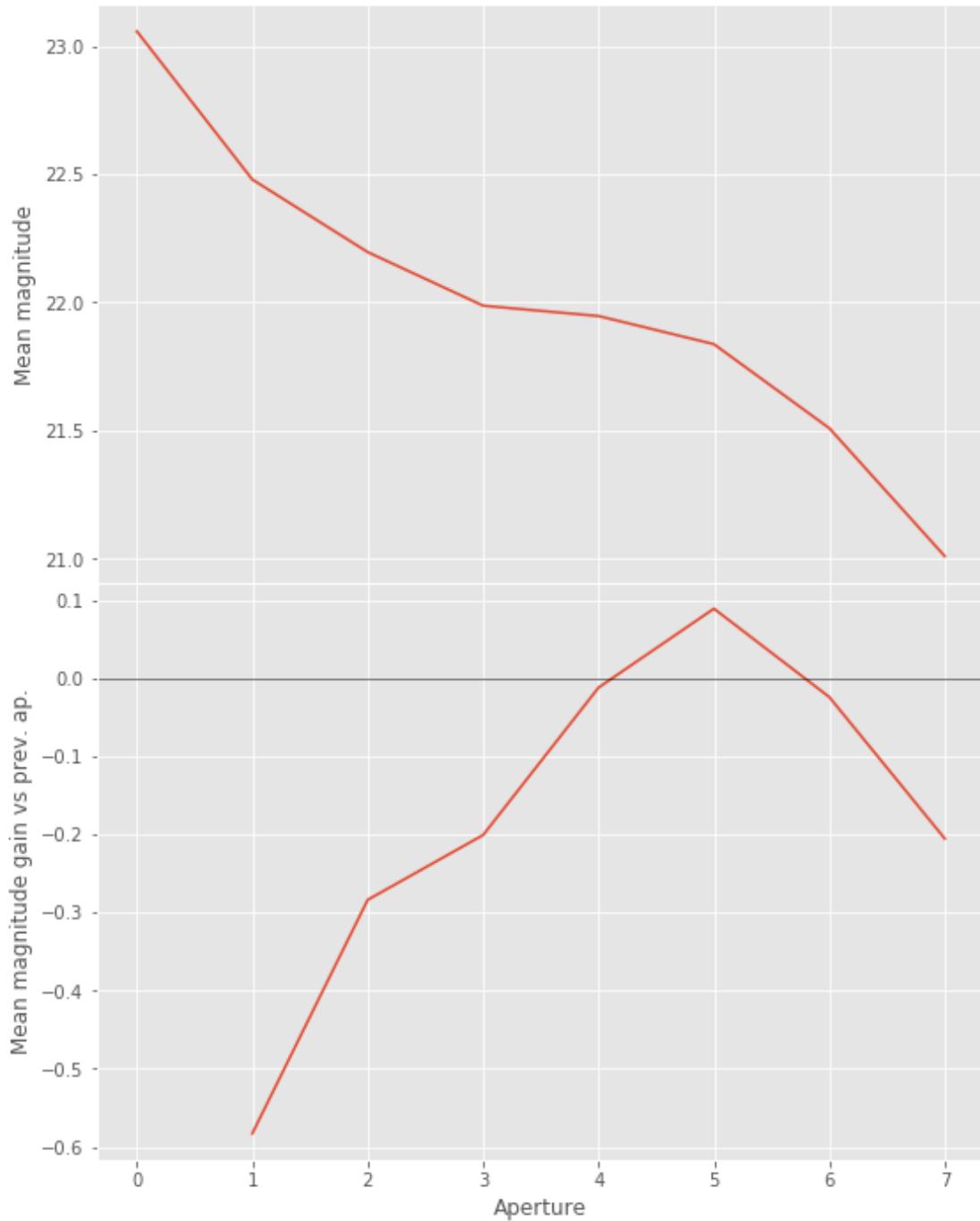
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:  
    warnings.warn("Mean of empty slice", RuntimeWarning)  
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:  
    warnings.warn("Mean of empty slice", RuntimeWarning)
```



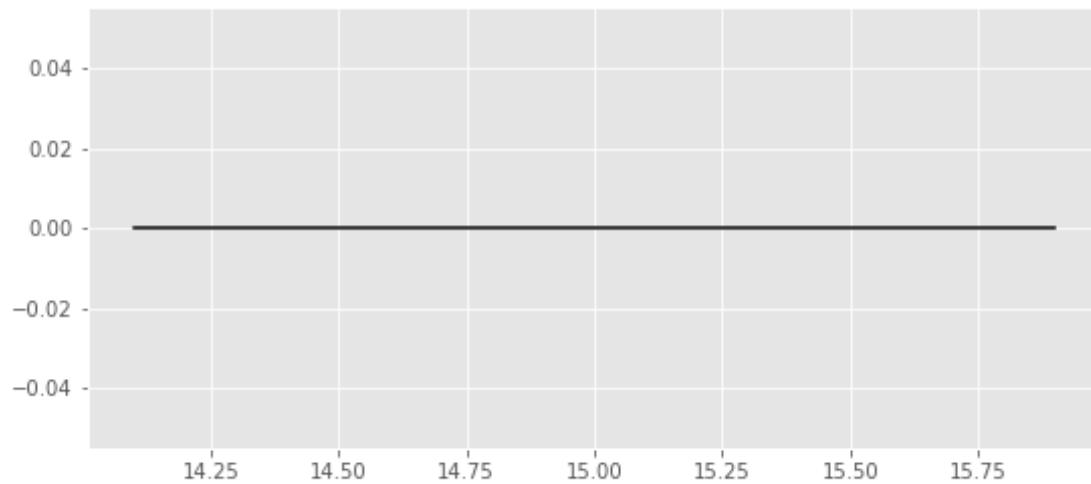
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:  
    warnings.warn("All-NaN slice encountered", RuntimeWarning)
```



1.2.5 I.e - z band



We will use aperture 4 as target.



We use magnitudes between 16.0 and 17.5.

Aperture correction for z band:

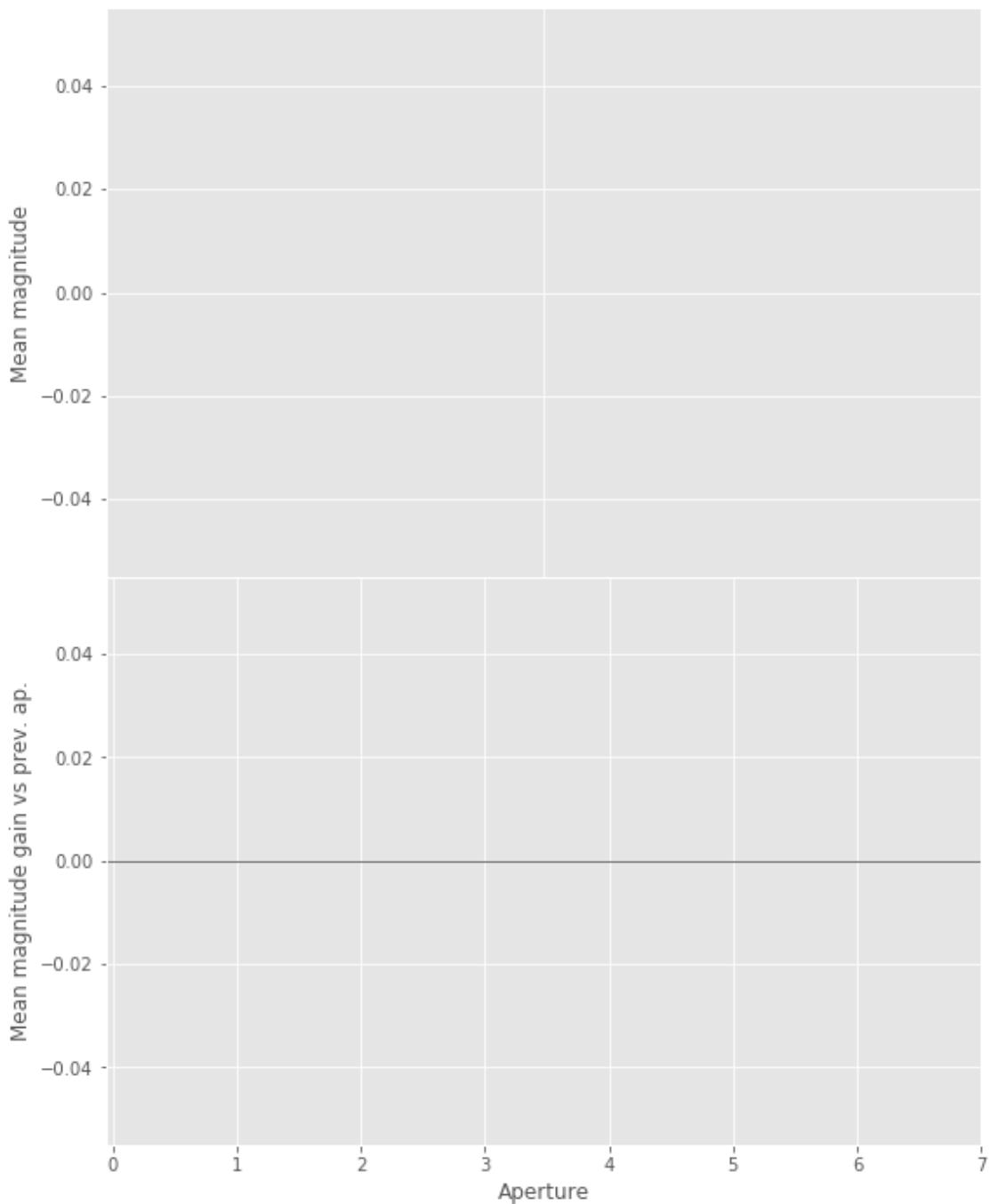
Correction: -0.054092454637959975

Number of source used: 4630

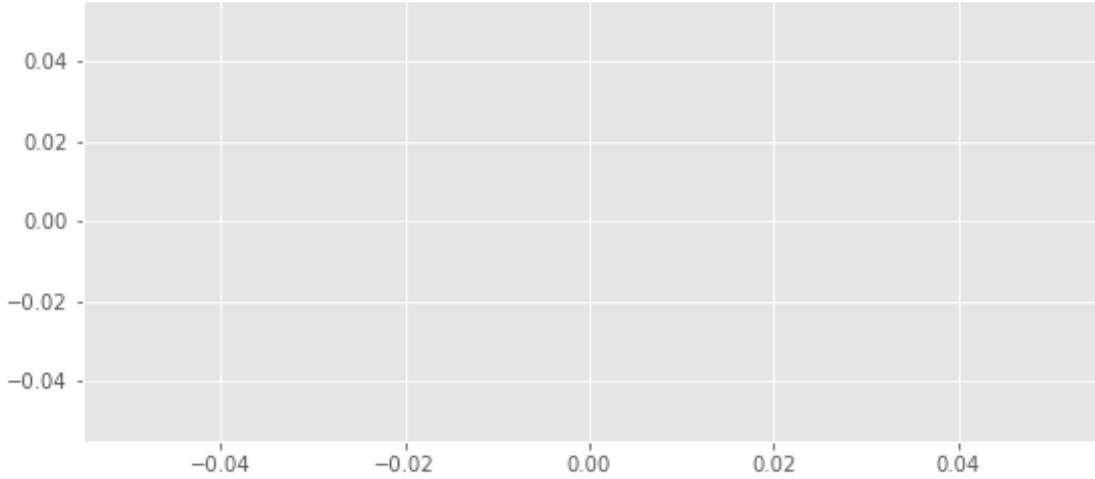
RMS: 0.016963778211100684

1.2.6 If - Y band

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:  
    warnings.warn("Mean of empty slice", RuntimeWarning)  
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:  
    warnings.warn("Mean of empty slice", RuntimeWarning)
```



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:  
    warnings.warn("All-NaN slice encountered", RuntimeWarning)
```



1.3 II - Stellarity

Legacy Survey does not provide a 0 to 1 stellarity so we replace items flagged as PSF according to the following table:

$$P(star) = \frac{\prod_i P(star)_i}{\prod_i P(star)_i + \prod_i P(galaxy)_i}$$

where i is the band, and with using the same probabilities as UKDISS:

HSC flag	UKIDSS flag	Meaning	P(star)	P(galaxy)	P(noise)	P(saturated)
0	-9	Saturated	0.0	0.0	5.0	95.0
	-3	Probable galaxy	25.0	70.0	5.0	0.0
	-2	Probable star	70.0	25.0	5.0	0.0
	-1	Star	90.0	5.0	5.0	0.0
	0	Noise	5.0	5.0	90.0	0.0
	+1	Galaxy	5.0	90.0	5.0	0.0

1.4 II - Column selection

```
WARNING: UnitsWarning: '1/deg^2' did not parse as fits unit: Numeric factor not supported by FITS
WARNING: UnitsWarning: 'nanomaggy' did not parse as fits unit: At col 0, Unit 'nanomaggy' not supported
WARNING: UnitsWarning: '1/nanomaggy^2' did not parse as fits unit: Numeric factor not supported
WARNING: UnitsWarning: '1/arcsec^2' did not parse as fits unit: Numeric factor not supported by FITS
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value encountered in multiply
    magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
```

Out[27]: <IPython.core.display.HTML object>

1.5 III - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
```

```
Check the NumPy 1.11 release notes for more information.
```

```
    ma.MaskedArray.__setitem__(self, index, value)
```

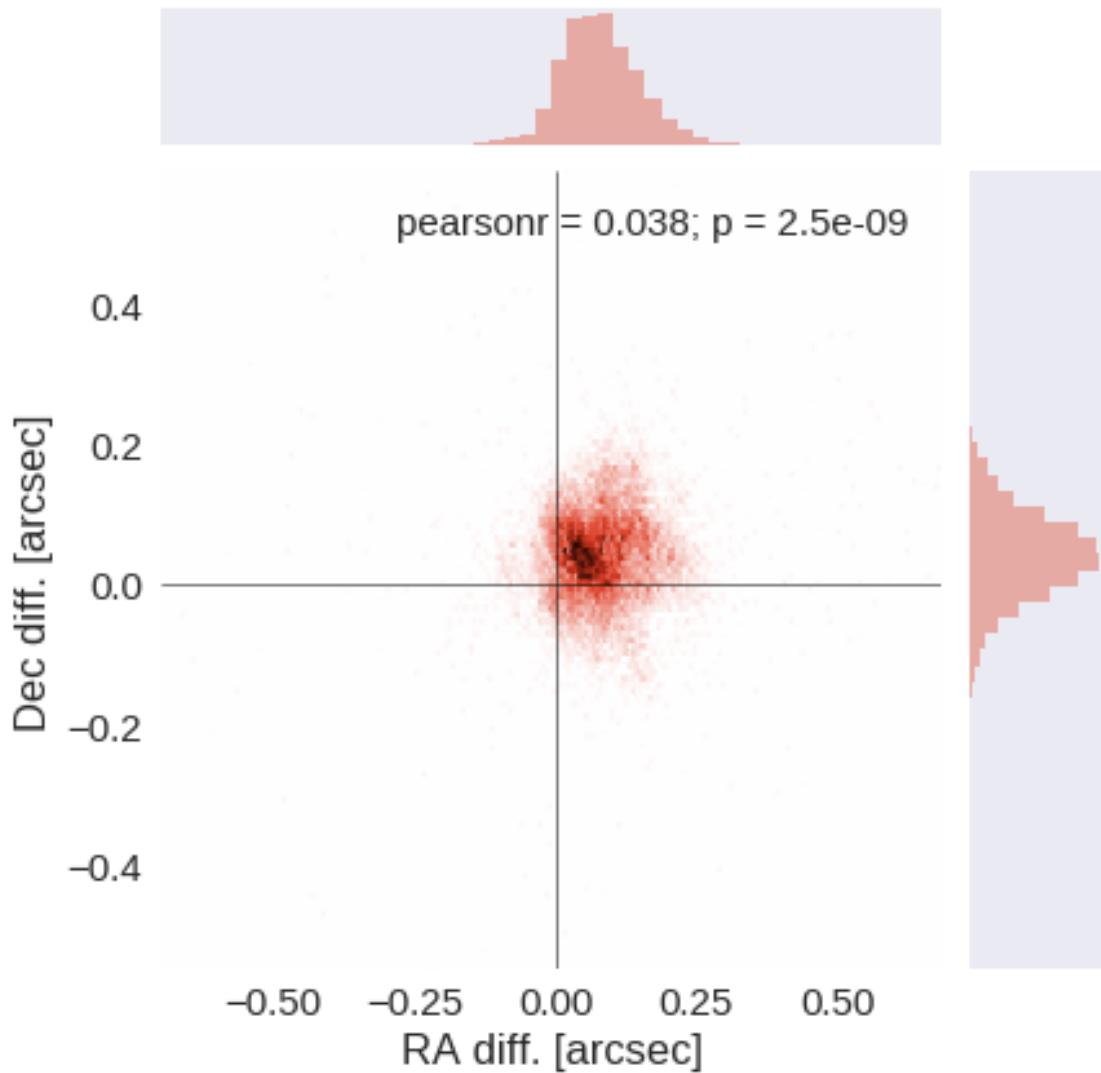
The initial catalogue had 362677 sources.

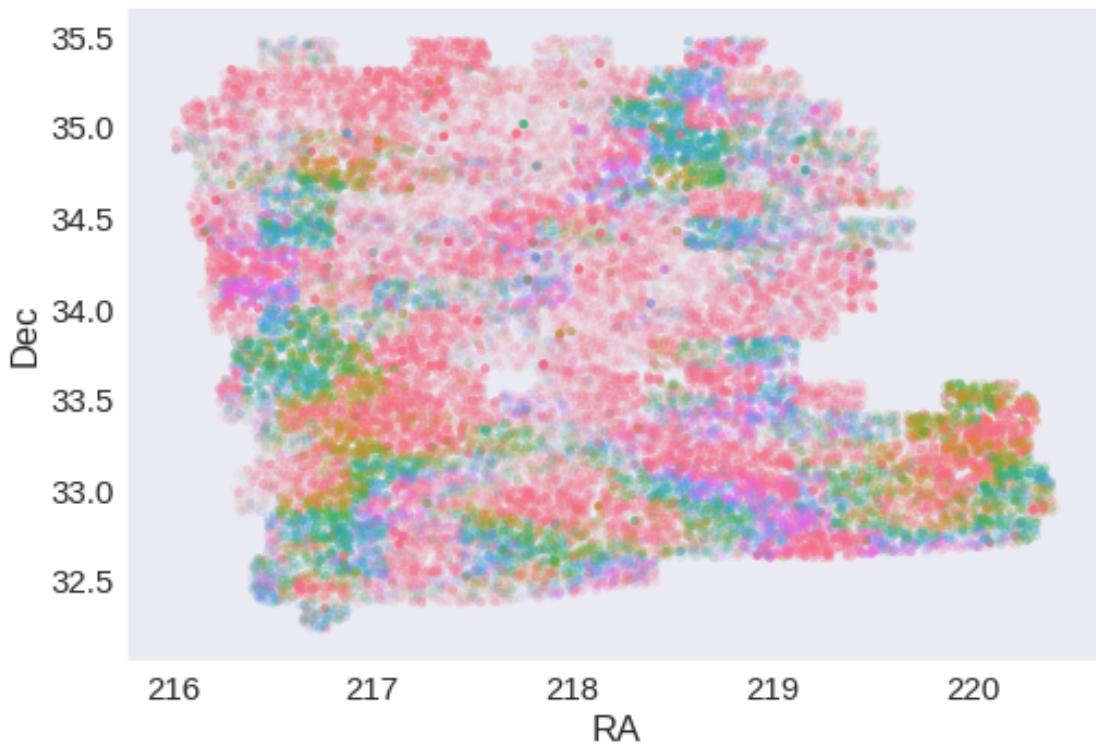
The cleaned catalogue has 362638 sources (39 removed).

The cleaned catalogue has 39 sources flagged as having been cleaned

1.6 III - Astrometry correction

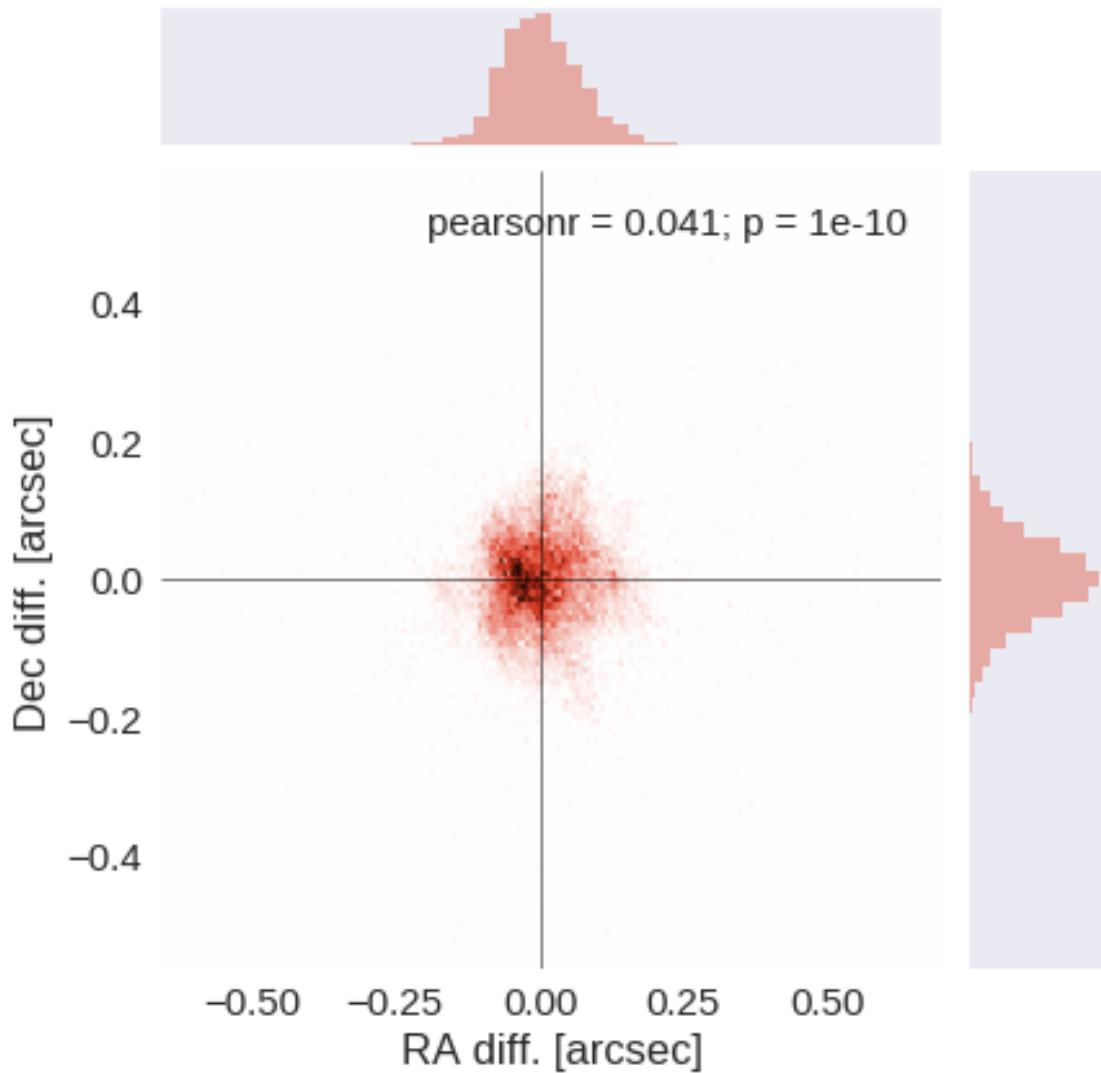
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.





RA correction: -0.07634788760242373 arcsec

Dec correction: -0.04301923179923506 arcsec





1.7 IV - Flagging Gaia objects

25228 sources flagged.

2 V - Saving to disk

1.2 DataFusion-Spitzer

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of Spitzer datafusion data

The Spitzer catalogues were produced by the datafusion team are available in dmu0_DataFusion-Spitzer. Lucia told that the magnitudes are aperture corrected.

In the catalouge, we keep:

- The internal identifier (this one is only in HeDaM data);
- The position;
- The fluxes in aperture 2 (1.9 arcsec);
- The “auto” flux (which seems to be the Kron flux);
- The stellarity in each band

A query of the position in the Spitzer heritage archive show that the SERVS-ELAIS-N1 images were observed in 2009. Let’s take this as epoch.

This notebook was run with herschelhelp_internal version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

1.2 I - Column selection

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value enco  
magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
```

Out [6]: <IPython.core.display.HTML object>

1.3 II - Removal of duplicated sources

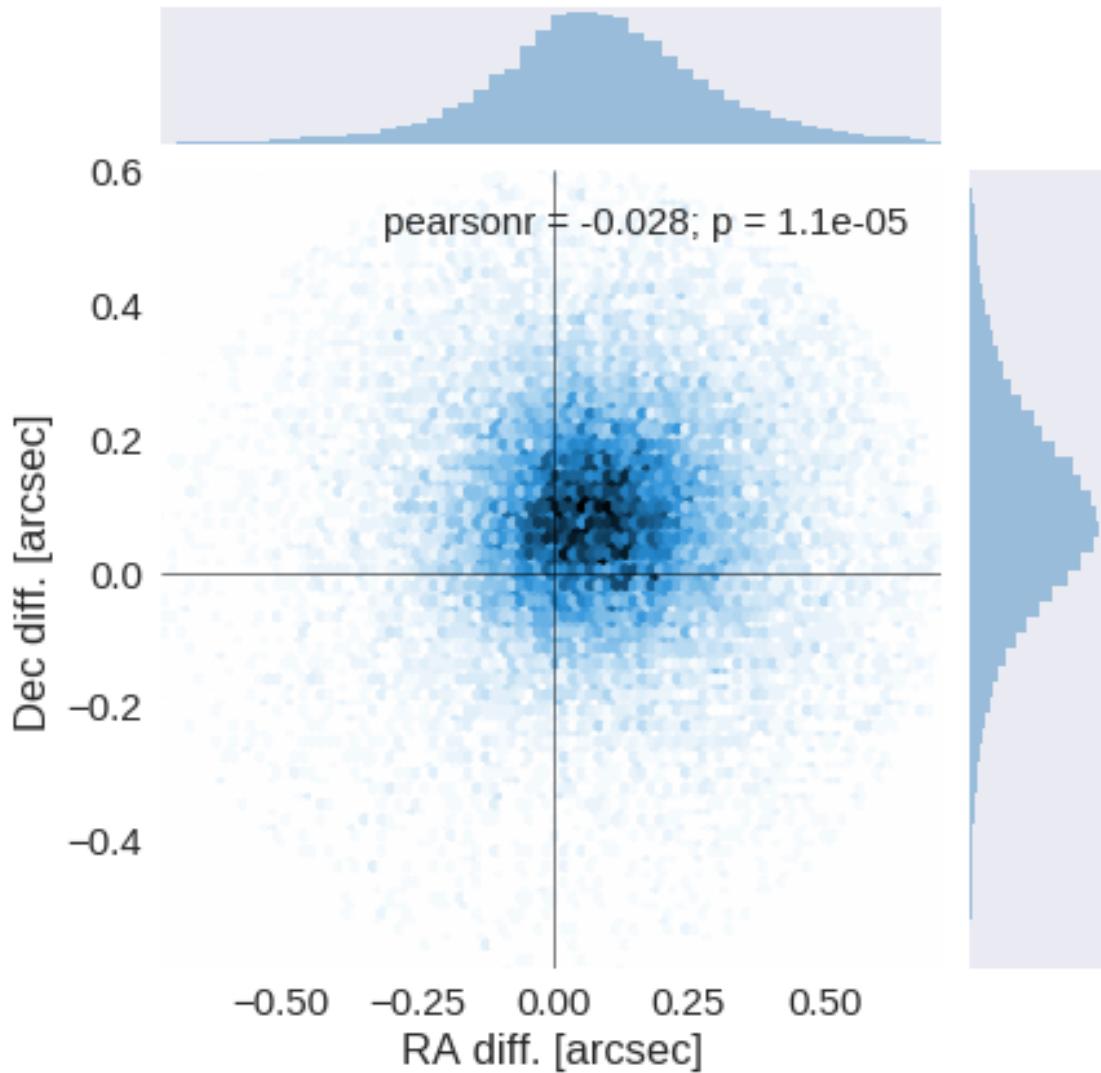
We remove duplicated objects from the input catalogues.

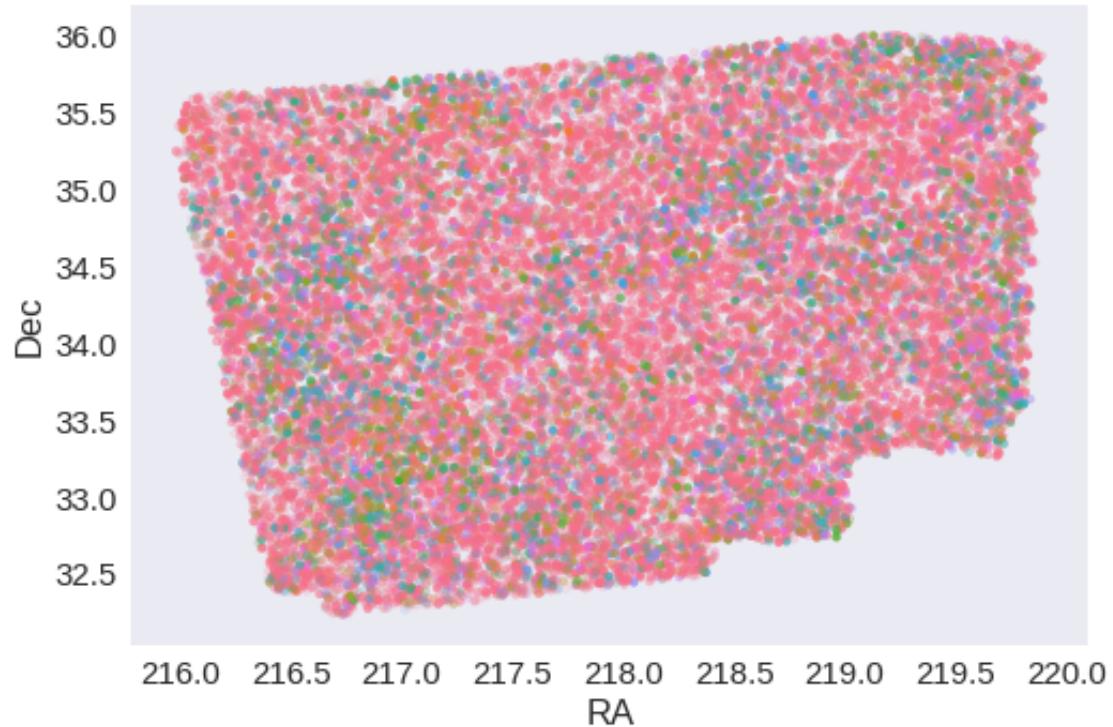
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10  
Check the NumPy 1.11 release notes for more information.  
ma.MaskedArray.__setitem__(self, index, value)
```

The initial catalogue had 1142840 sources.
The cleaned catalogue has 1142840 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned

1.4 III - Astrometry correction

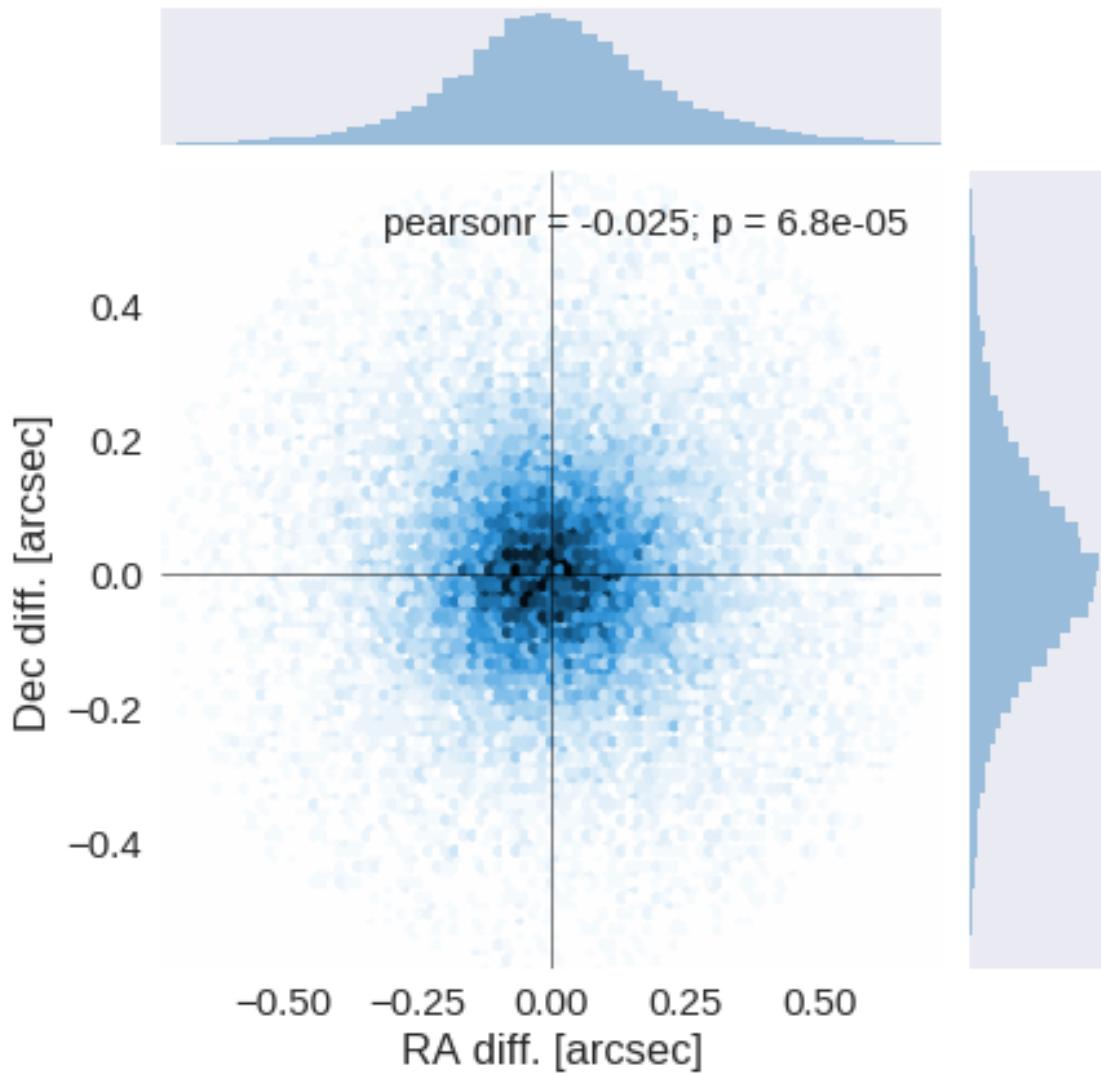
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

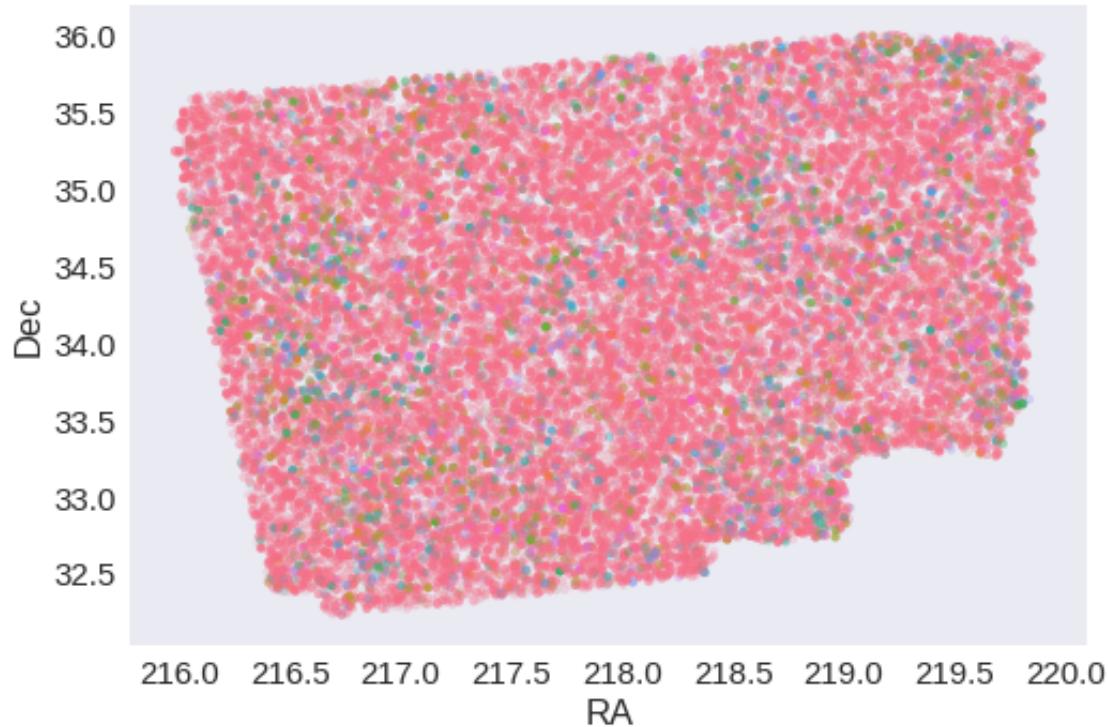




RA correction: -0.0809307827921657 arcsec

Dec correction: -0.08064486934244997 arcsec





1.5 IV - Flagging Gaia objects

28423 sources flagged.

1.6 V - Saving to disk

1.3 IBIS

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of IBIS data

The catalogue comes from dmu0_IBIS.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band in aperture 4 ($1.2 * \sqrt{2}$ arcsec = 1.7 arcsec).
- The kron magnitude to be used as total magnitude (no “auto” magnitude is provided).

We don't know when the maps have been observed. We will use the year of the reference paper.

This notebook was run with herschelhelp_internal version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

1.2 I - Column selection

1.2.1 I.i - Aperture correction

1.2.2 I.ii - Vega-like to AB

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
ma.MaskedArray.__setitem__(self, index, value)
```

Out [8]: <IPython.core.display.HTML object>

1.3 II - Removal of duplicated sources

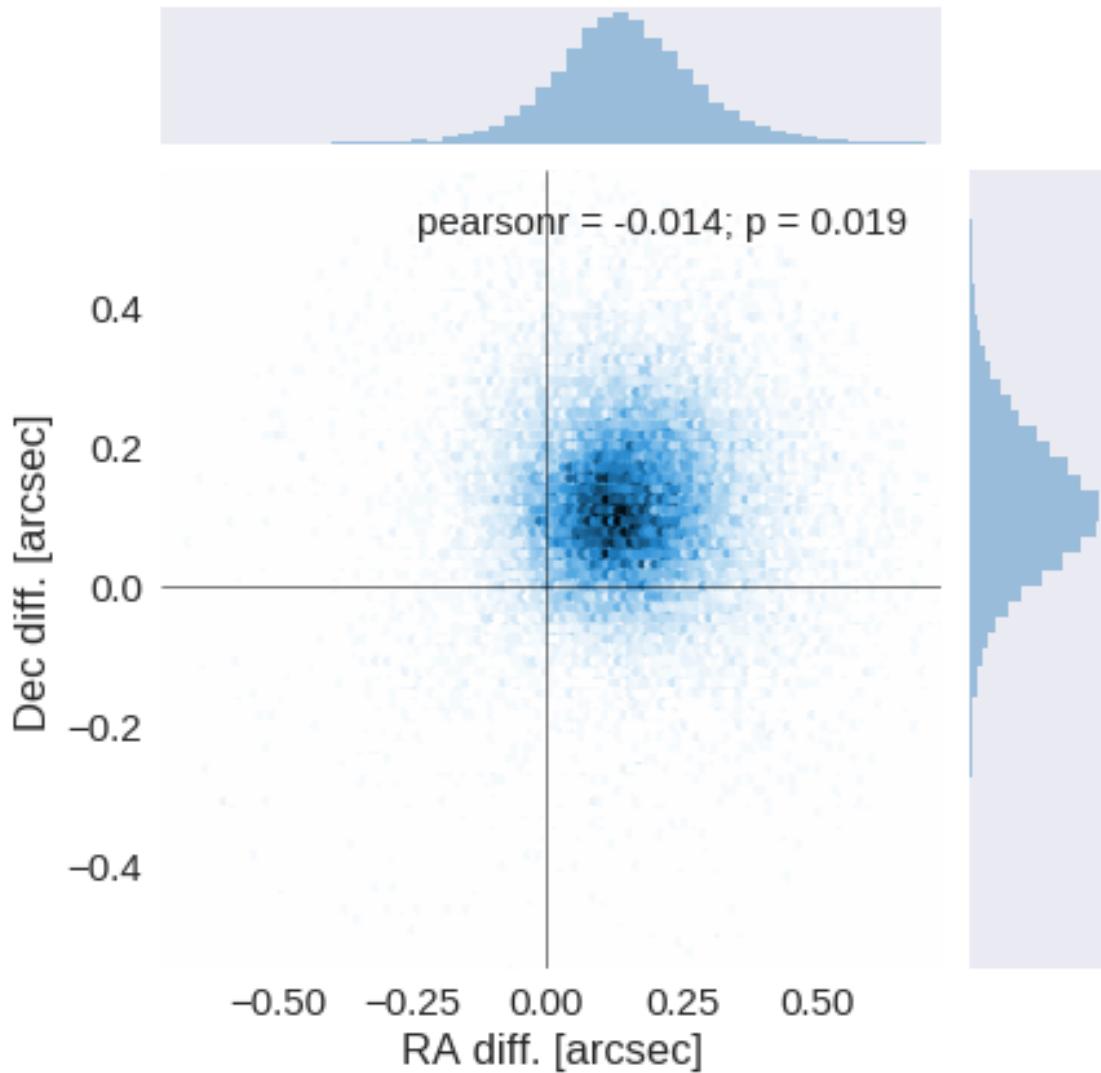
We remove duplicated objects from the input catalogues.

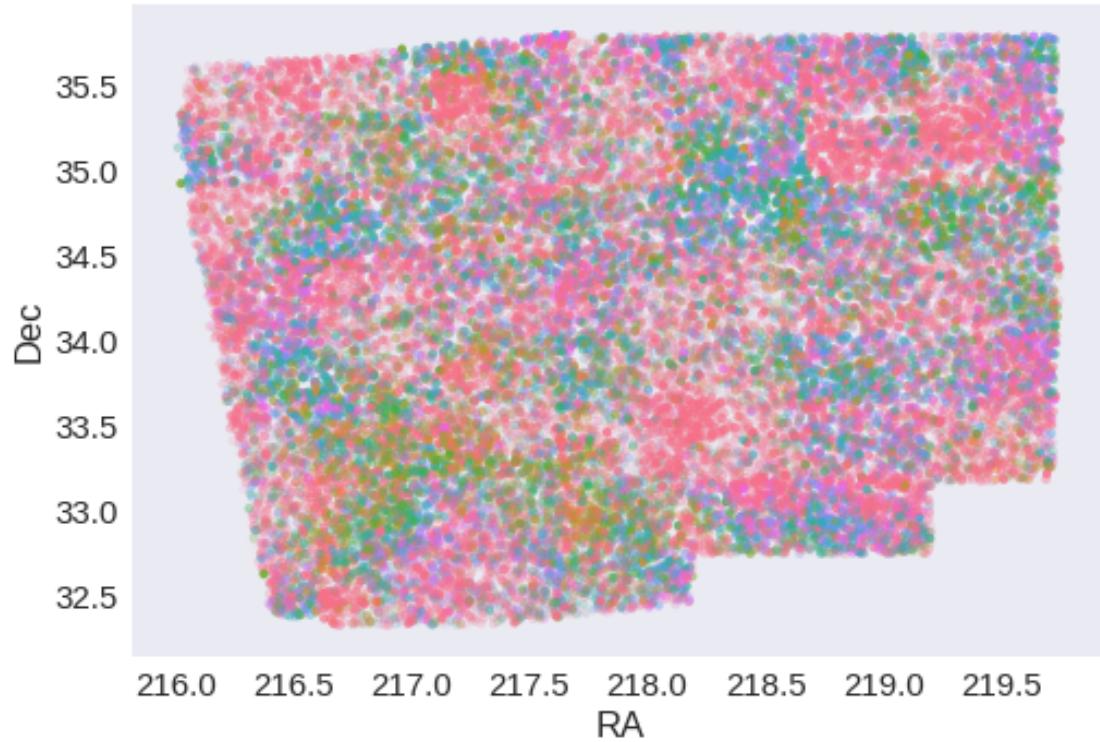
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
ma.MaskedArray.__setitem__(self, index, value)
```

The initial catalogue had 389594 sources.
The cleaned catalogue has 389594 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned

1.4 III - Astrometry correction

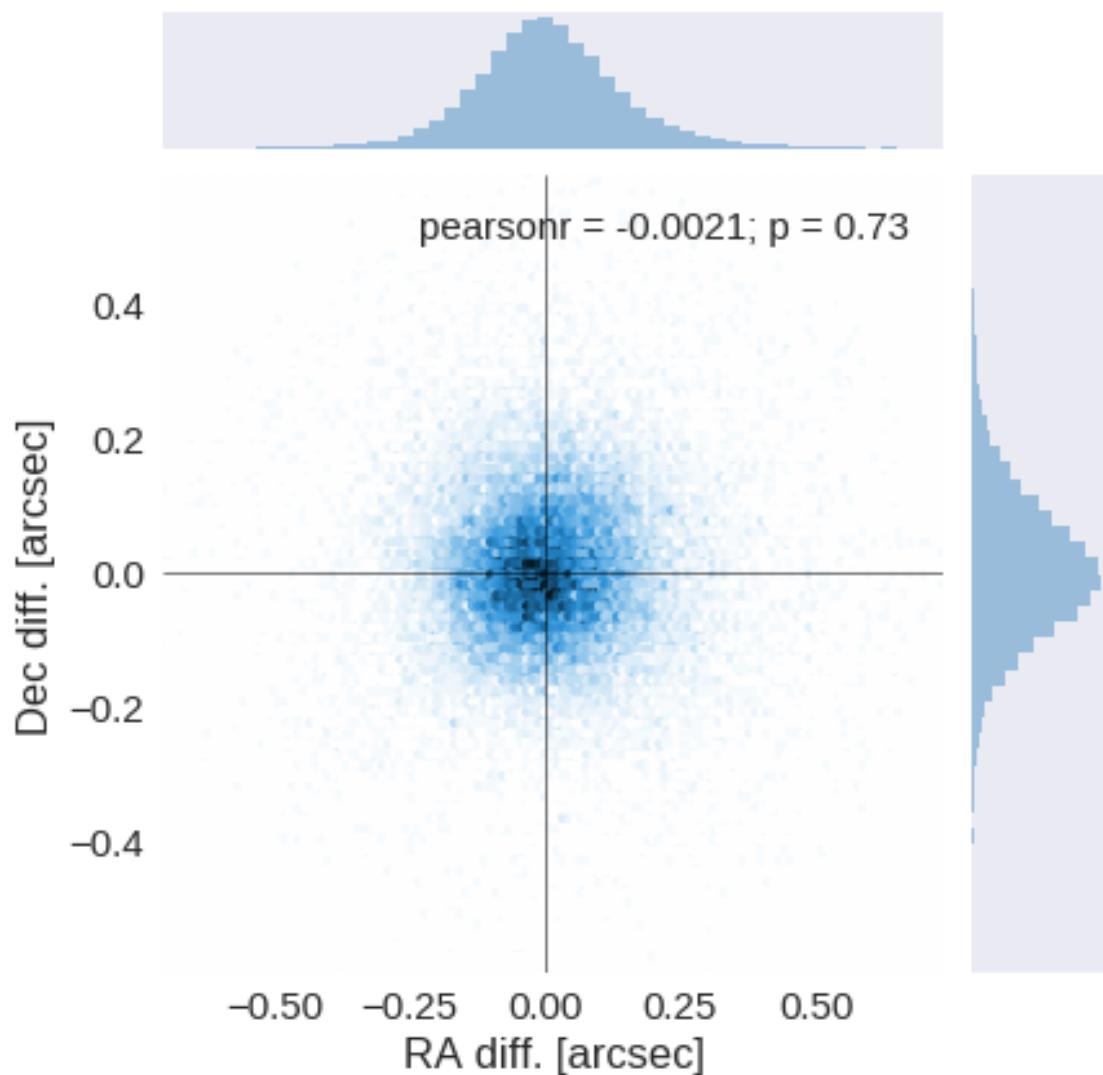
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

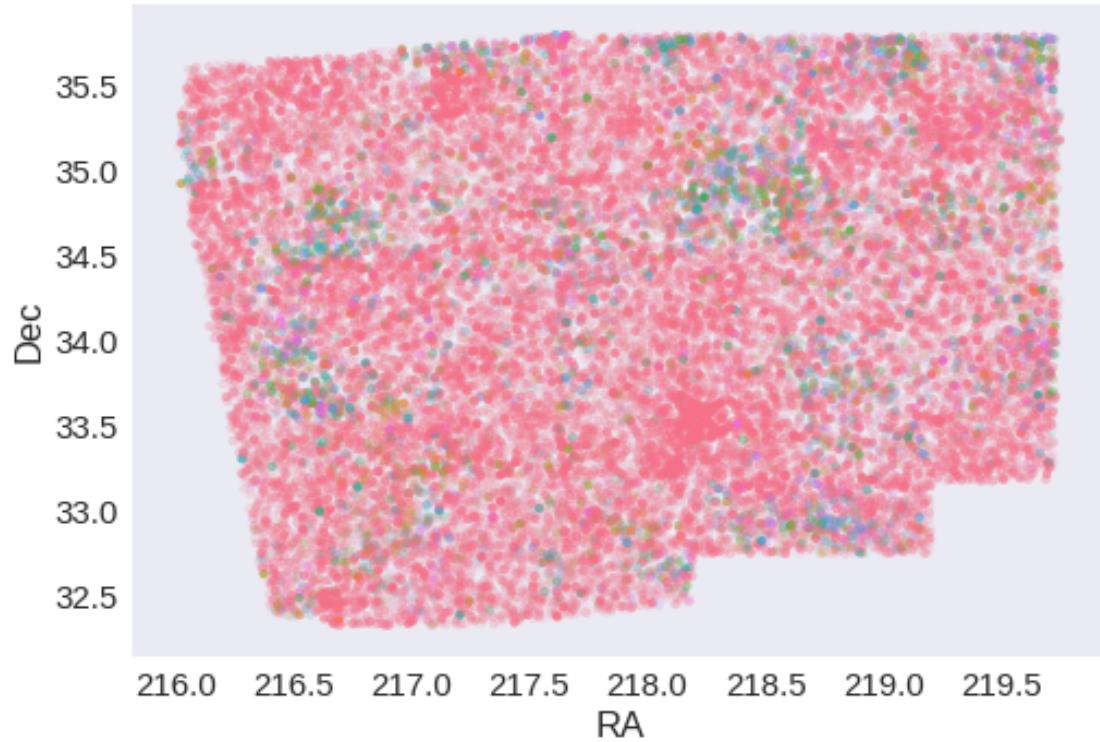




RA correction: -0.14042821500197533 arcsec

Dec correction: -0.11290194161972522 arcsec





1.5 IV - Flagging Gaia objects

28013 sources flagged.

2 V - Saving to disk

1.4_LegacySurvey

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of Legacy Survey data

The catalogue comes from `dmu0_LegacySurvey`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture fluxes. Are these aperture corrected?
- The kron magnitude to be used as total magnitude (no “auto” magnitude is provided).

We don't know when the maps have been observed. We will use the year of the reference paper.

This notebook was run with `herschelhelp_internal` version:
`33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)`

```
WARNING: UnitsWarning: '1/deg^2' did not parse as fits unit: Numeric factor not supported by FITS
WARNING: UnitsWarning: 'nanomaggy' did not parse as fits unit: At col 0, Unit 'nanomaggy' not supported
WARNING: UnitsWarning: '1/nanomaggy^2' did not parse as fits unit: Numeric factor not supported
WARNING: UnitsWarning: '1/arcsec^2' did not parse as fits unit: Numeric factor not supported by FITS
```

1.2 I - Aperture correction

To compute aperture correction we need to determine two parameters: the target aperture and the range of magnitudes for the stars that will be used to compute the correction.

Target aperture: To determine the target aperture, we simulate a curve of growth using the provided apertures and draw two figures:

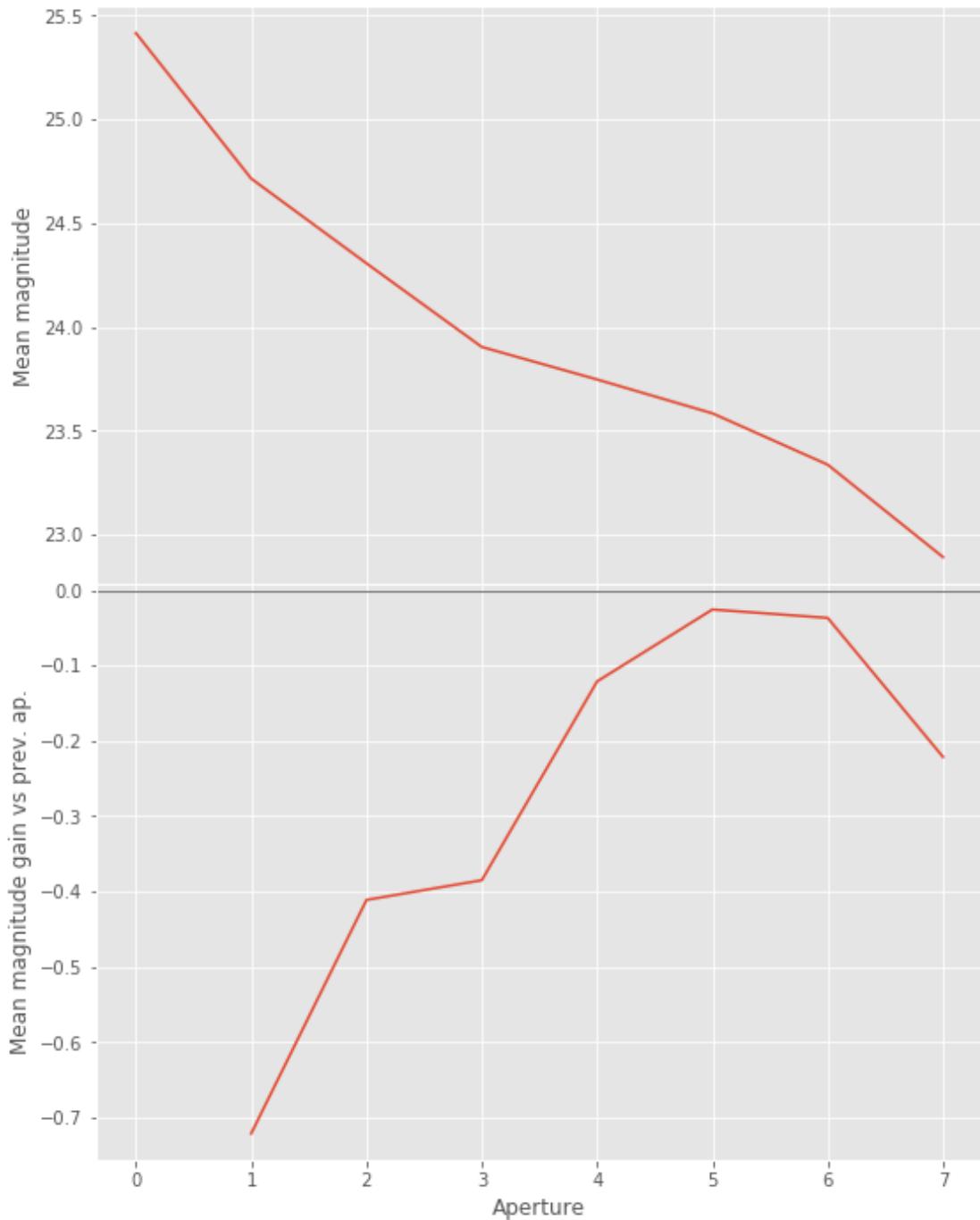
- The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude.
- The mean gain (loss when negative) of magnitude is each aperture compared to the previous (except for the first of course).

As target aperture, we should use the smallest (i.e. less noisy) aperture for which most of the flux is captured.

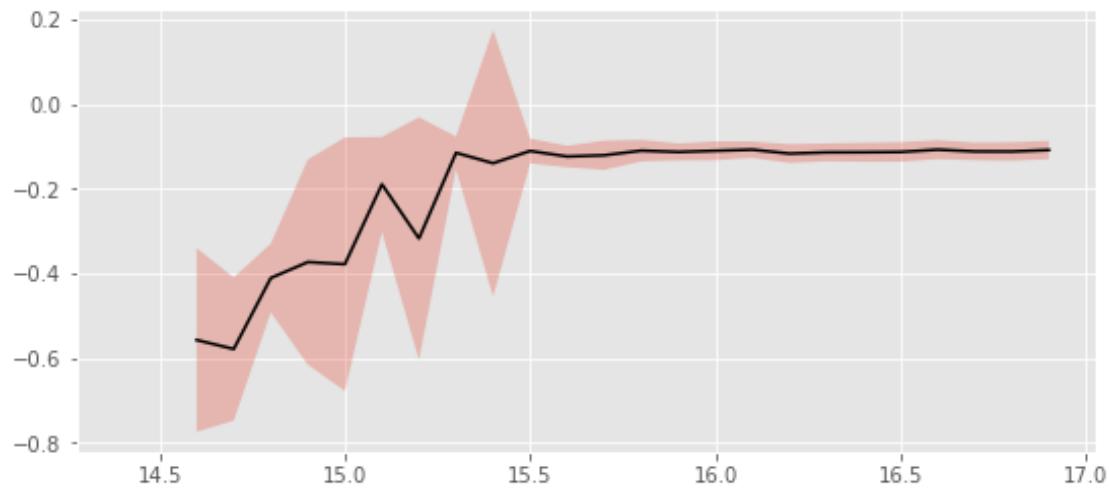
Magnitude range: To know what limits in aperture to use when doing the aperture correction, we plot for each magnitude bin the correction that is computed and its RMS. We should then use the wide limits (to use more stars) where the correction is stable and with few dispersion.

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value encountered in log10
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: divide by zero encountered in log10
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:80: RuntimeWarning: invalid value encountered in log
  errors = 2.5 / np.log(10) * errors_on_fluxes / fluxes
```

1.2.1 I.a - g band



We will use aperture 5 as target.



We will use magnitudes between 17.0 and 18.5

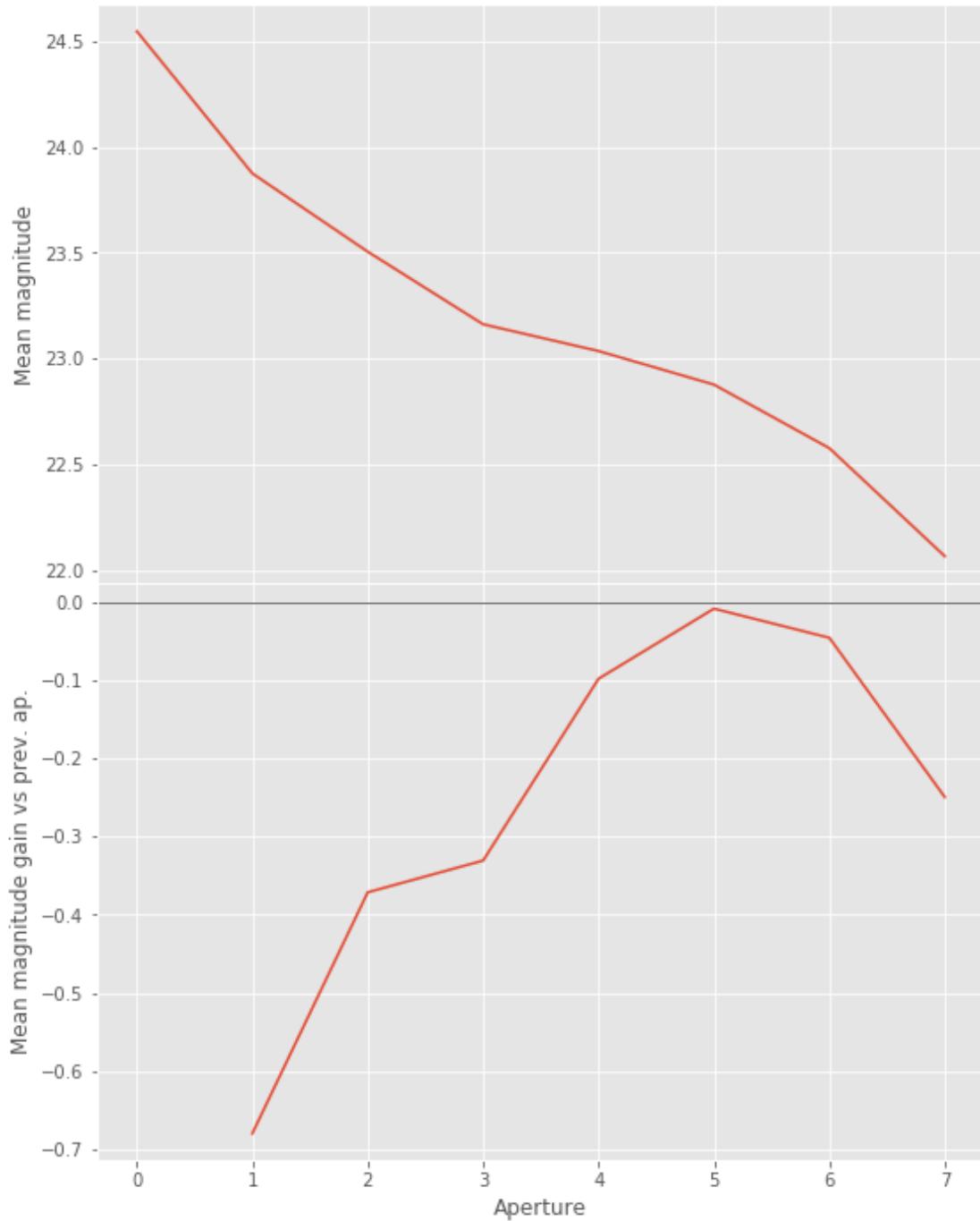
Aperture correction for g band:

Correction: -0.1112329500973459

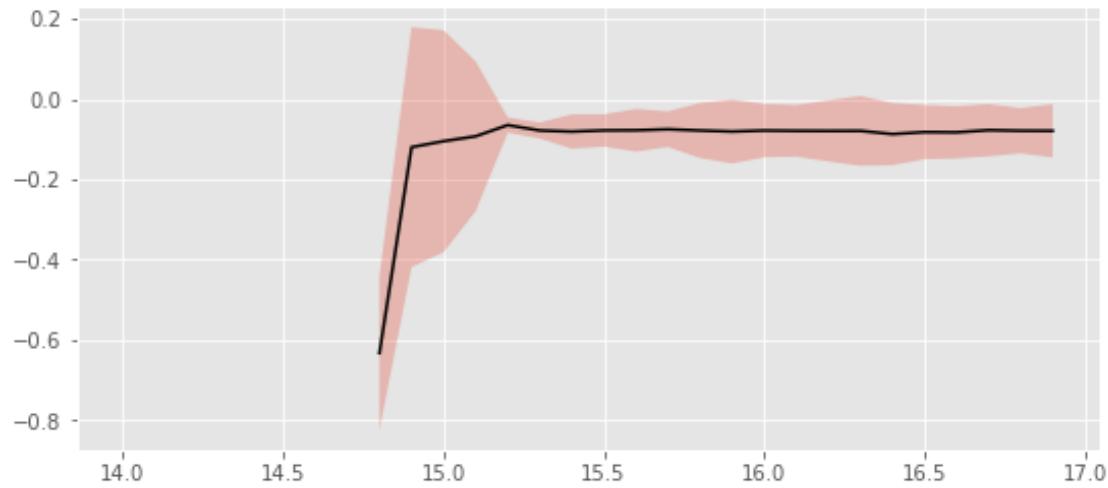
Number of source used: 3560

RMS: 0.022124753607535737

1.2.2 I.b - r band



We will use aperture 5 as target.



We use magnitudes between 17.0 and 18.5.

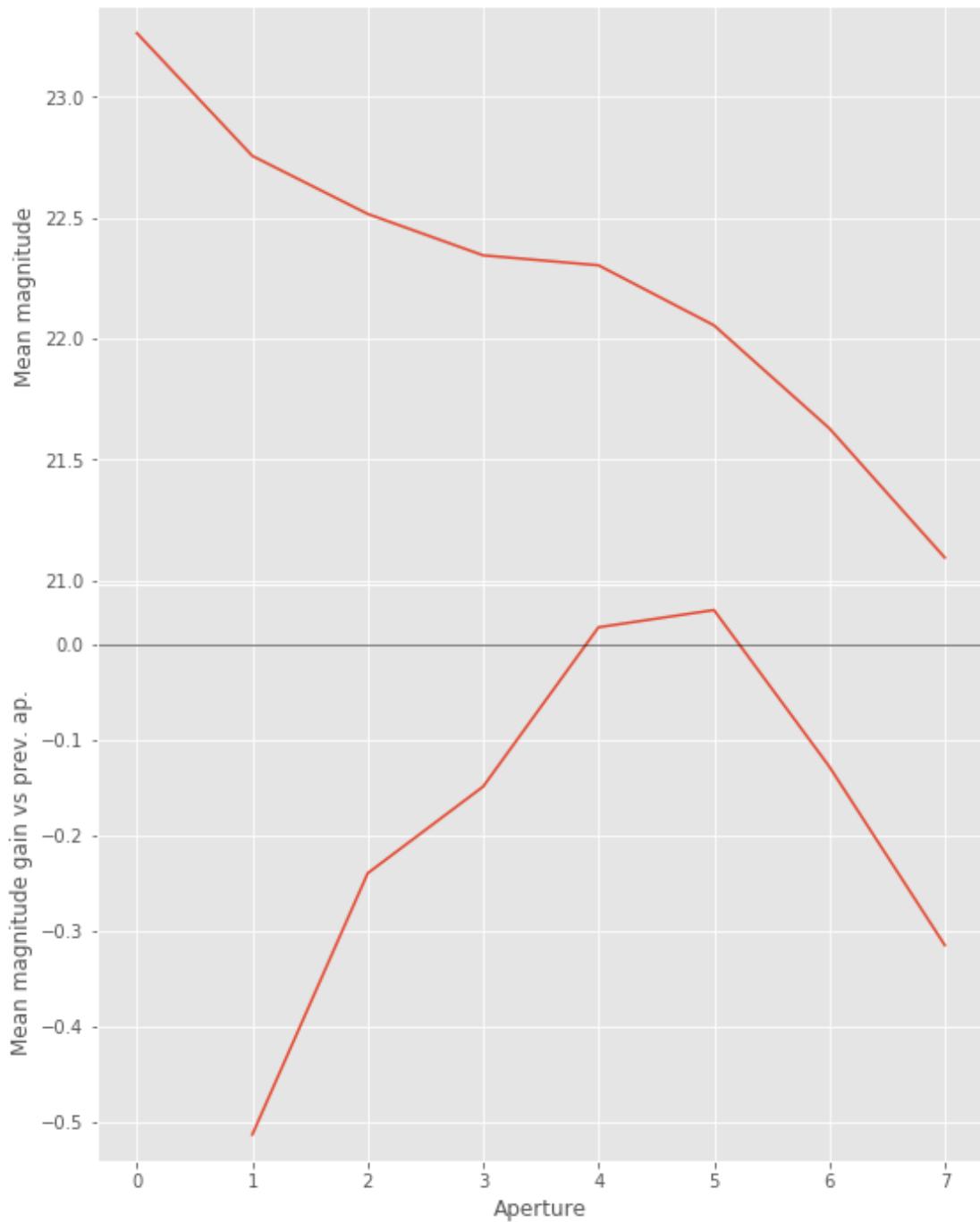
Aperture correction for r band:

Correction: -0.07934247926094429

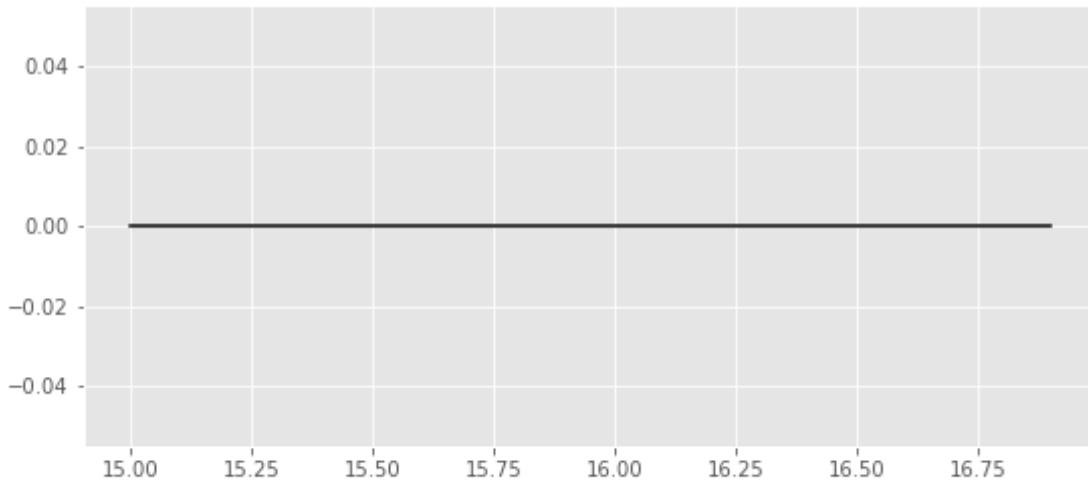
Number of source used: 5270

RMS: 0.06568411657907589

1.2.3 I.c - z band



We will use aperture 4 as target.



We use magnitudes between 16.0 and 17.5.

Aperture correction for z band:

Correction: -0.04477088405269569

Number of source used: 3874

RMS: 0.022095969378372594

1.3 II - Stellarity

Legacy Survey does not provide a 0 to 1 stellarity so we replace items flagged as PSF according to the following table:

$$P(star) = \frac{\prod_i P(star)_i}{\prod_i P(star)_i + \prod_i P(galaxy)_i}$$

where i is the band, and with using the same probabilities as UKDISS:

HSC flag	UKIDSS flag	Meaning	P(star)	P(galaxy)	P(noise)	P(saturated)
0	-9	Saturated	0.0	0.0	5.0	95.0
	-3	Probable galaxy	25.0	70.0	5.0	0.0
	-2	Probable star	70.0	25.0	5.0	0.0
	-1	Star	90.0	5.0	5.0	0.0
	0	Noise	5.0	5.0	90.0	0.0
	+1	Galaxy	5.0	90.0	5.0	0.0

1.4 II - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/_main_.py:19:
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: divide by zero enc
    magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value encountered in log10
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:80: RuntimeWarning: divide by zero encountered in log
  errors = 2.5 / np.log(10) * errors_on_fluxes / fluxes
```

Out[19]: <IPython.core.display.HTML object>

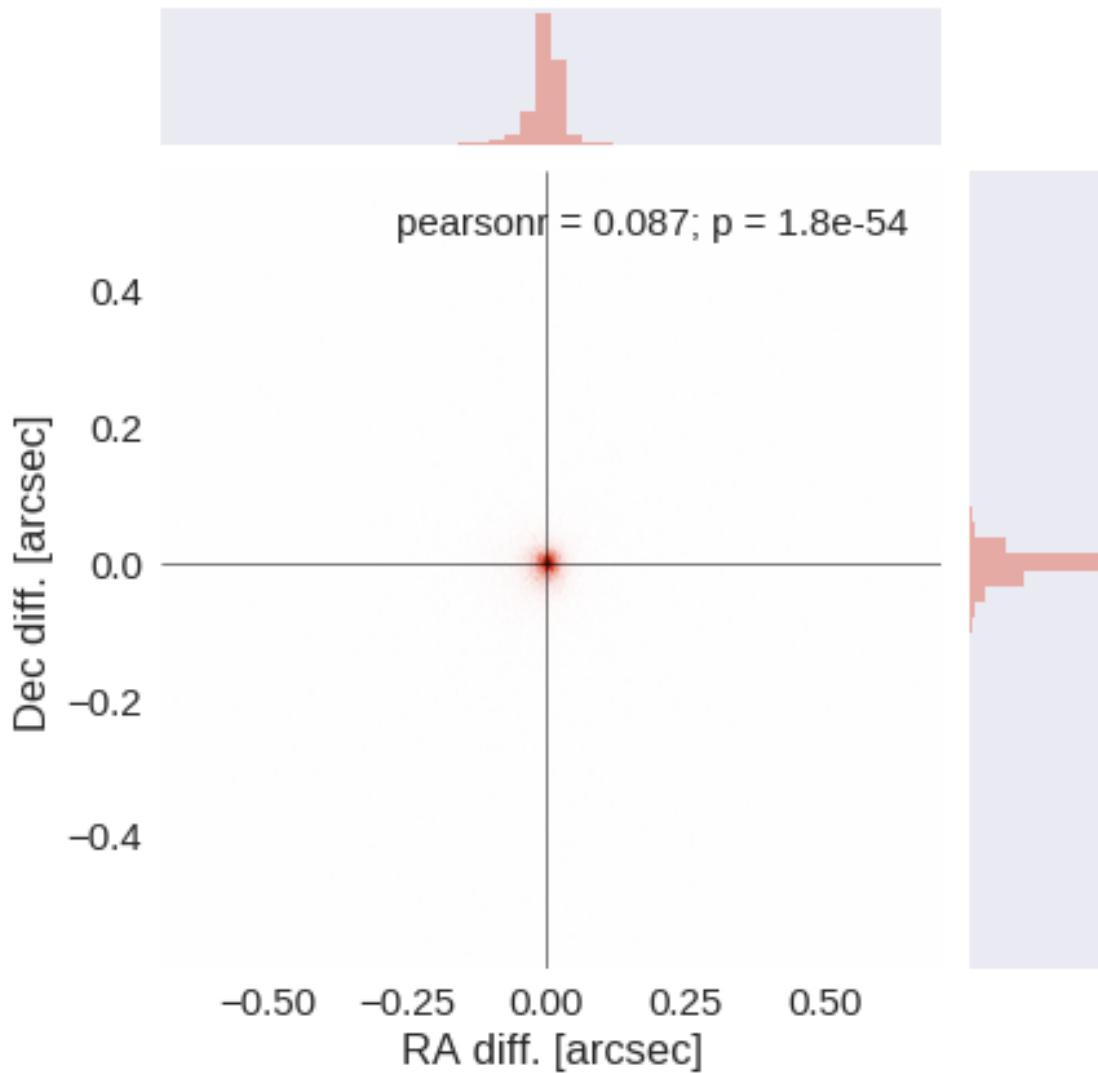
1.5 III - Removal of duplicated sources

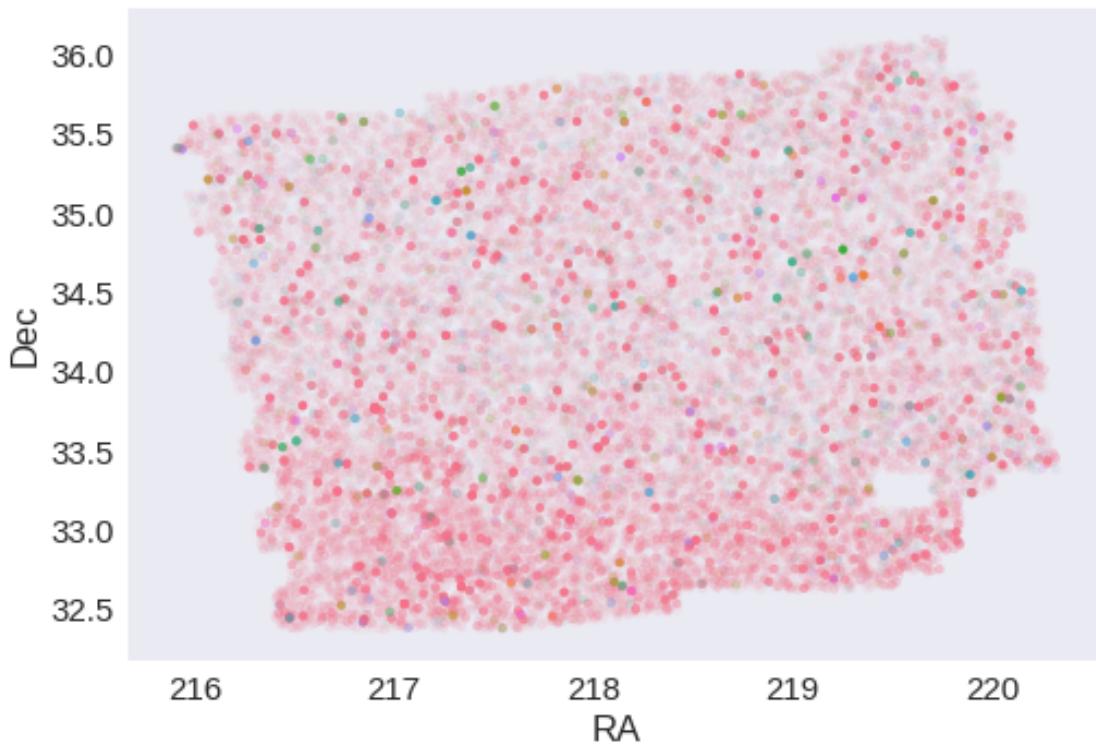
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 561690 sources.
The cleaned catalogue has 549975 sources (11715 removed).
The cleaned catalogue has 11557 sources flagged as having been cleaned
```

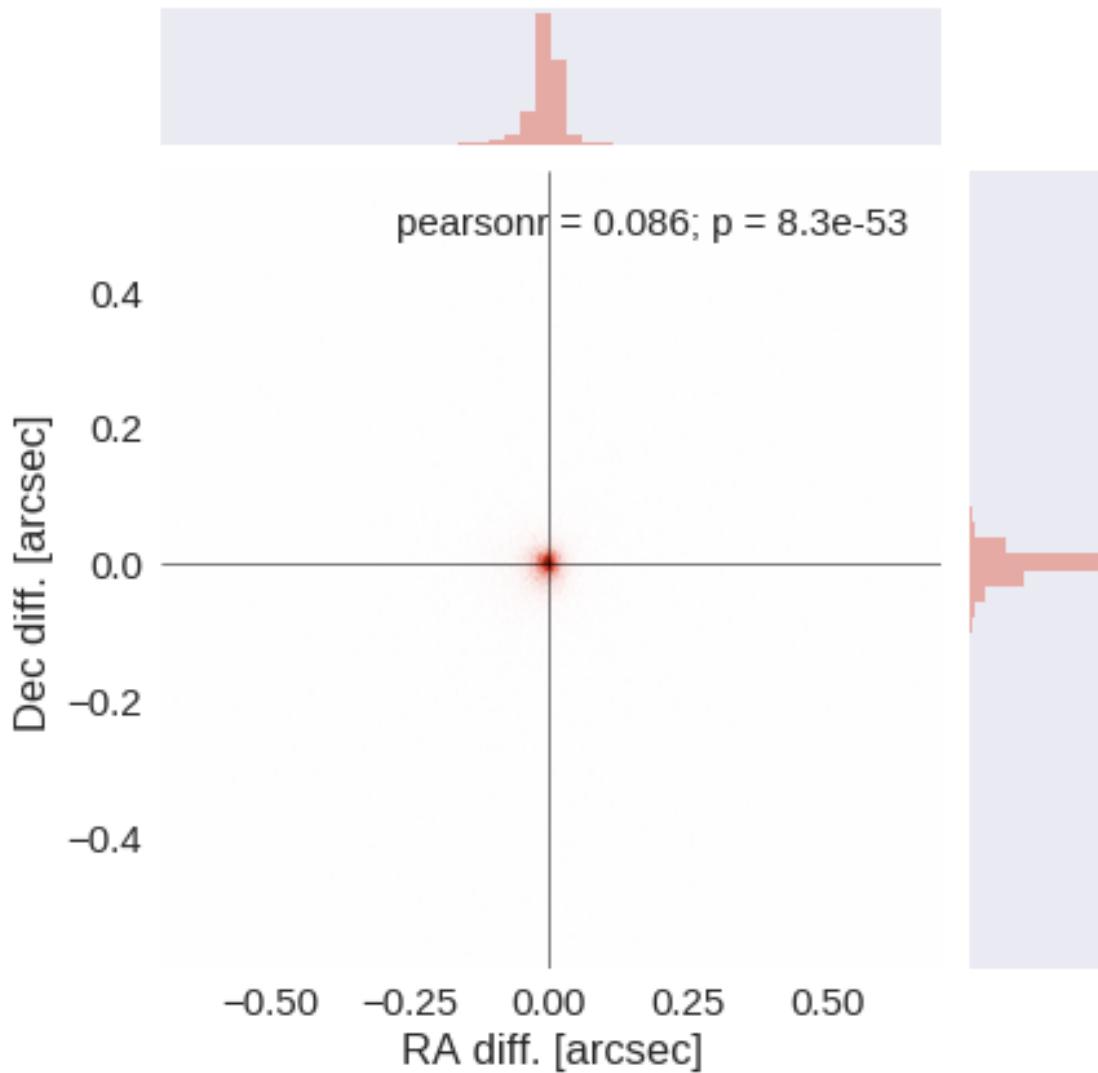
1.6 III - Astrometry correction

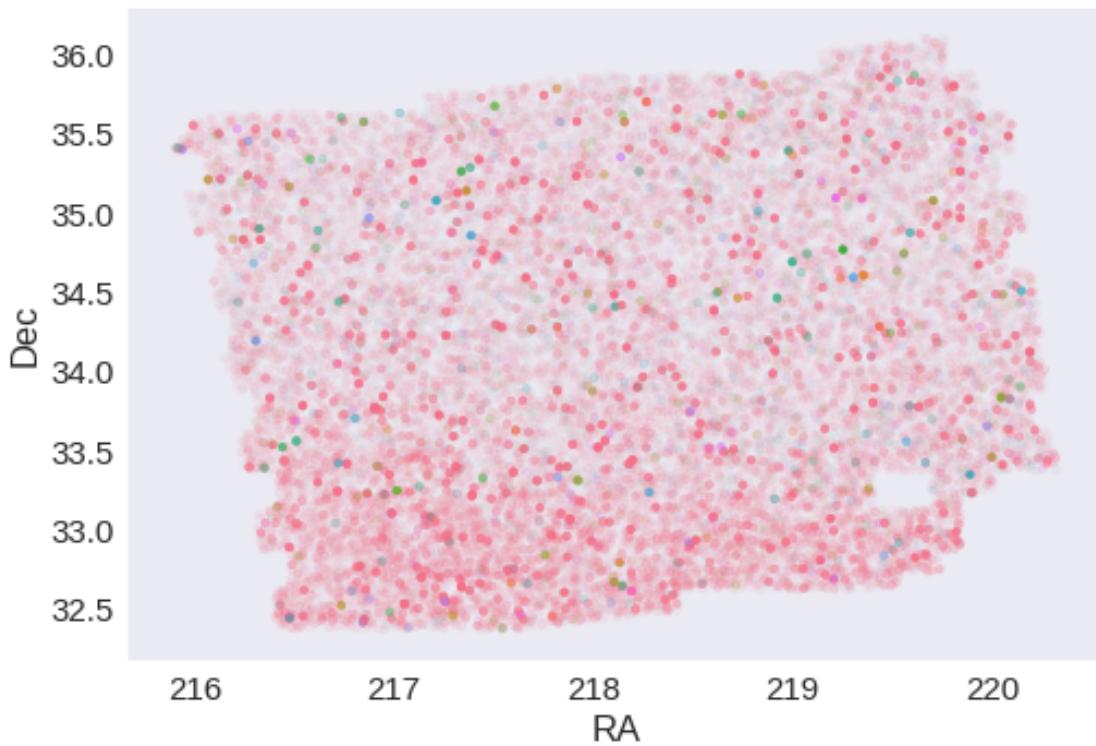
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.





RA correction: -0.0025231083782273345 arcsec
Dec correction: 0.0016053232087642755 arcsec





1.7 IV - Flagging Gaia objects

32886 sources flagged.

2 V - Saving to disk

1.5_NDWFS

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of NDWFS data

The catalogue comes from dmu0_NDWFS.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band in 2 arcsec aperture.
- The kron magnitude to be used as total magnitude (no “auto” magnitude is provided).

We don't know when the maps have been observed. We will use the year of the reference paper.

This notebook was run with herschelhelp_internal version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

1.2 I - Column selection

1.3 1.i - Aperture correction

TODO

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
ma.MaskedArray.__setitem__(self, index, value)
```

Out [6]: <IPython.core.display.HTML object>

1.4 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
ma.MaskedArray.__setitem__(self, index, value)
```

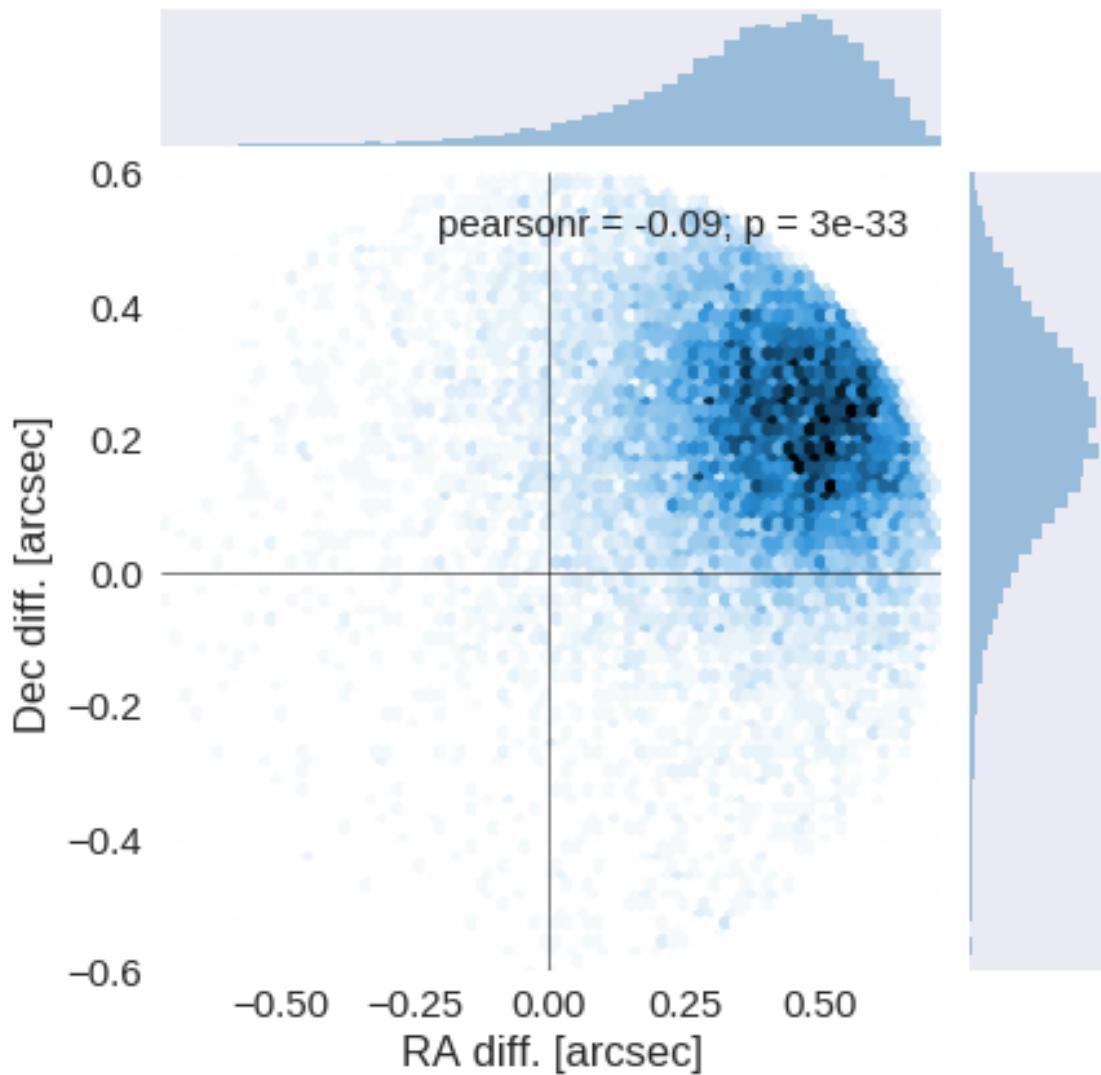
The initial catalogue had 2834130 sources.

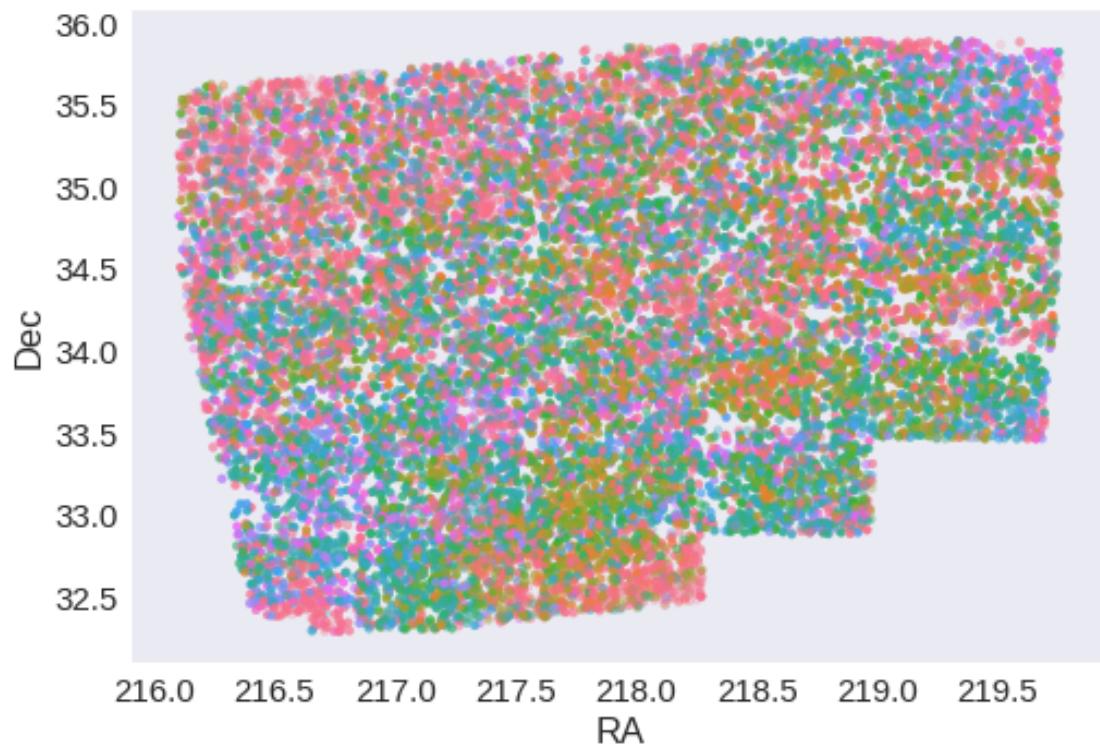
The cleaned catalogue has 2834130 sources (0 removed).

The cleaned catalogue has 0 sources flagged as having been cleaned

1.5 III - Astrometry correction

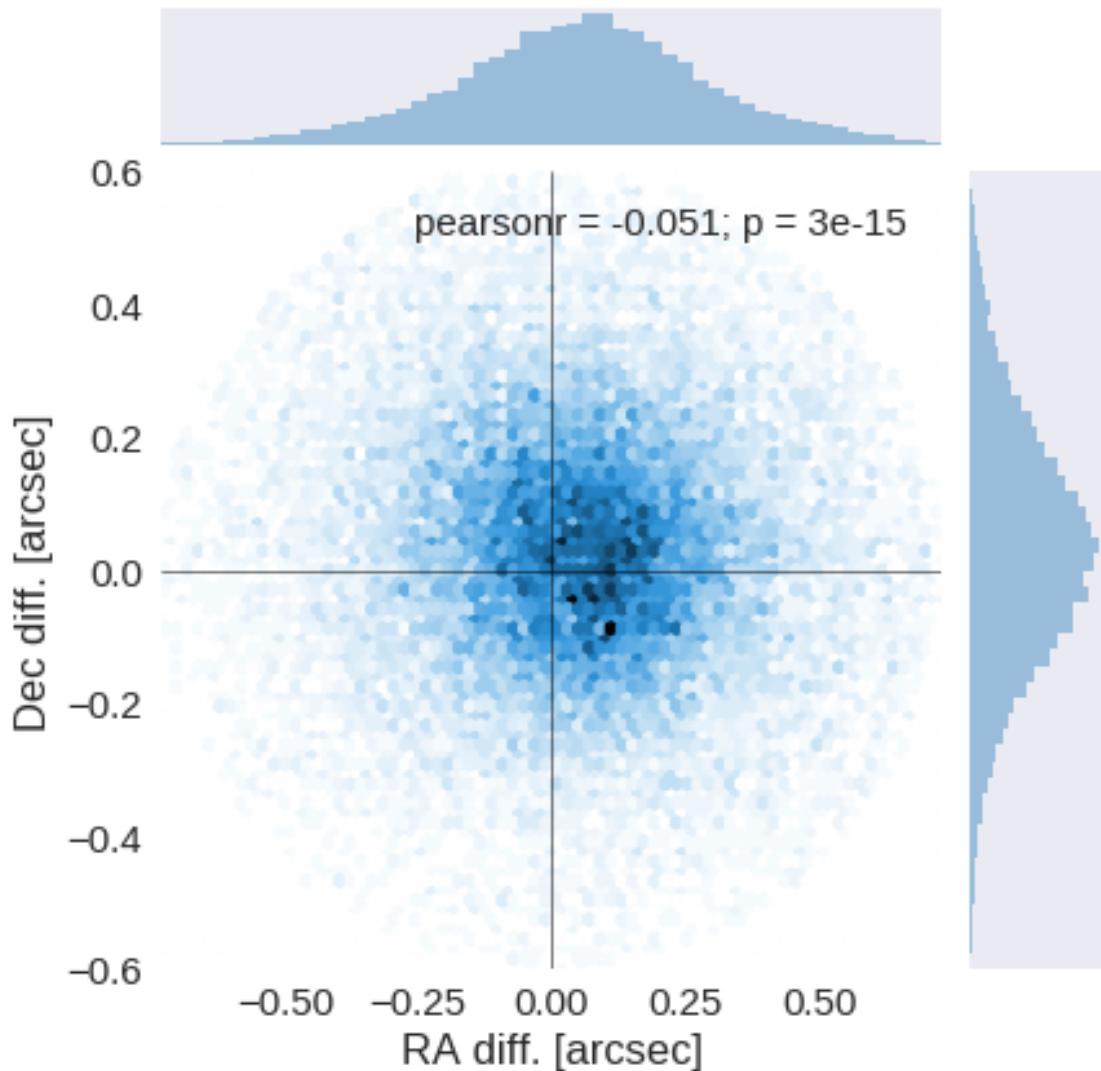
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

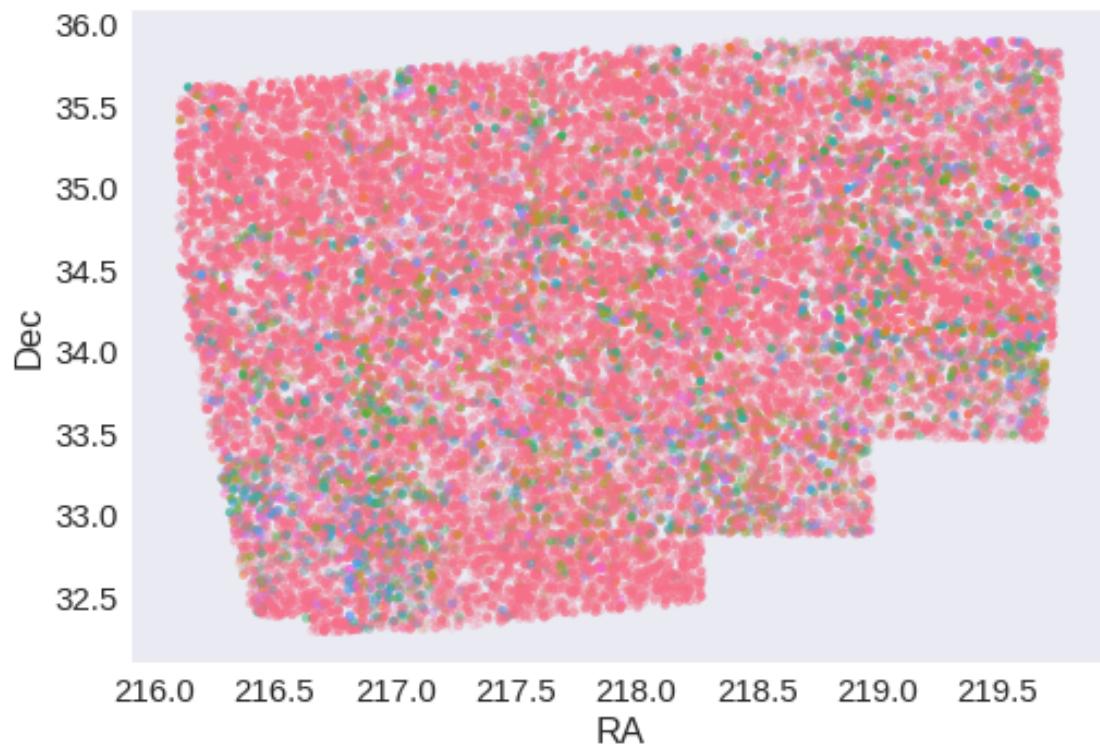




RA correction: -0.40784830923712434 arcsec

Dec correction: -0.2130986199659901 arcsec





1.6 IV - Flagging Gaia objects

30503 sources flagged.

2 V - Saving to disk

1.6_PanSTARRS-3SS

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of Pan-STARRS1 - 3pi Steradian Survey (3SS) data

This catalogue comes from dmu0_PanSTARRS1-3SS.

In the catalogue, we keep:

- The uniquePspssSTid as unique object identifier;
- The r-band position which is given for all the sources;
- The grizy <band>FApMag aperture magnitude (see below);
- The grizy <band>FKronMag as total magnitude.

The Pan-STARRS1-3SS catalogue provides for each band an aperture magnitude defined as “In PS1, an ‘optimal’ aperture radius is determined based on the local PSF. The wings of the same analytic PSF are then used to extrapolate the flux measured inside this aperture to a ‘total’ flux.”

The observations used for the catalogue were done between 2010 and 2015 ([ref](#)).

This notebook was run with `herschelhelp_internal` version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
    ma.MaskedArray.__setitem__(self, index, value)
```

Out [6]: <IPython.core.display.HTML object>

1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
    ma.MaskedArray.__setitem__(self, index, value)
```

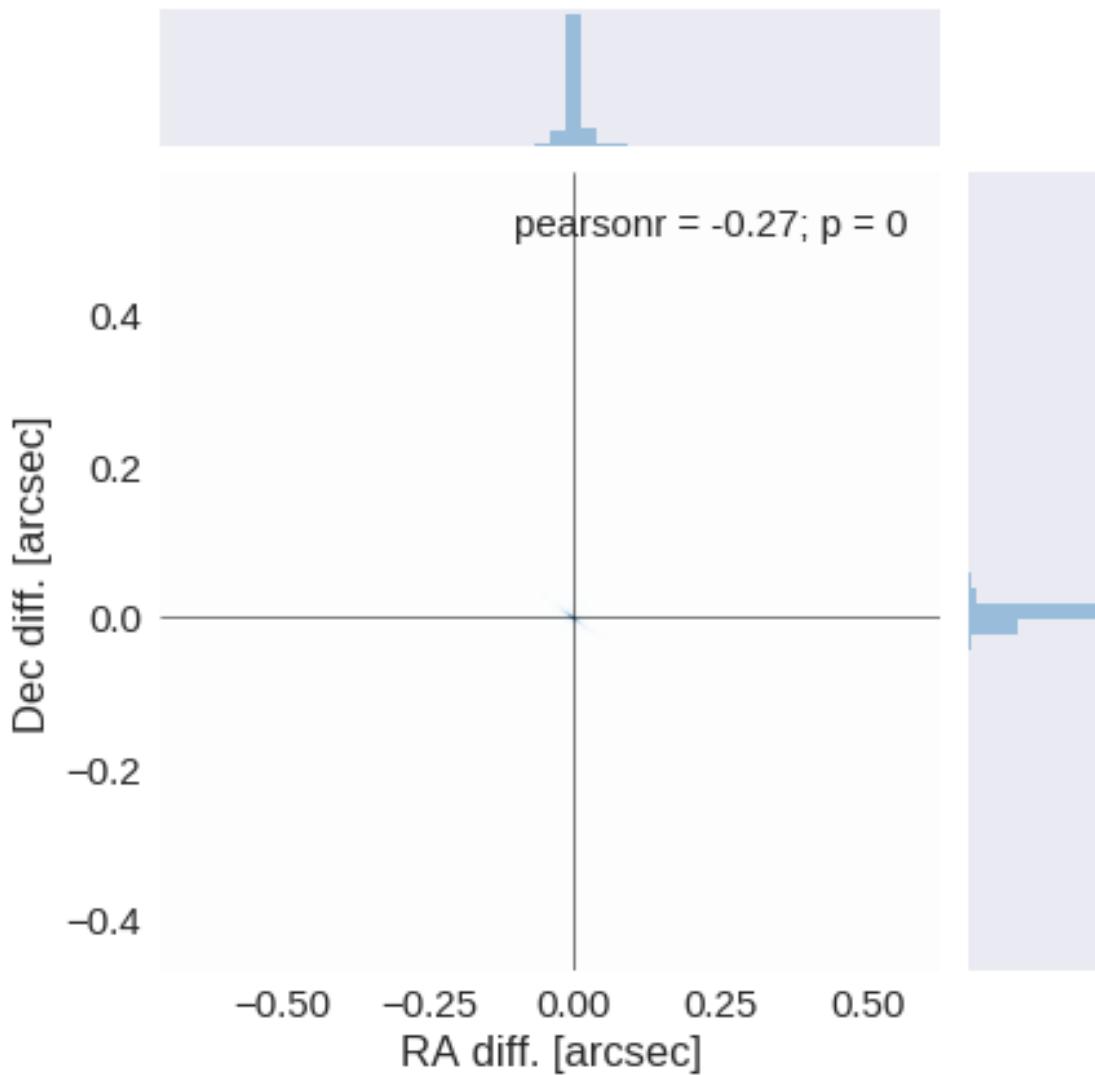
The initial catalogue had 230699 sources.

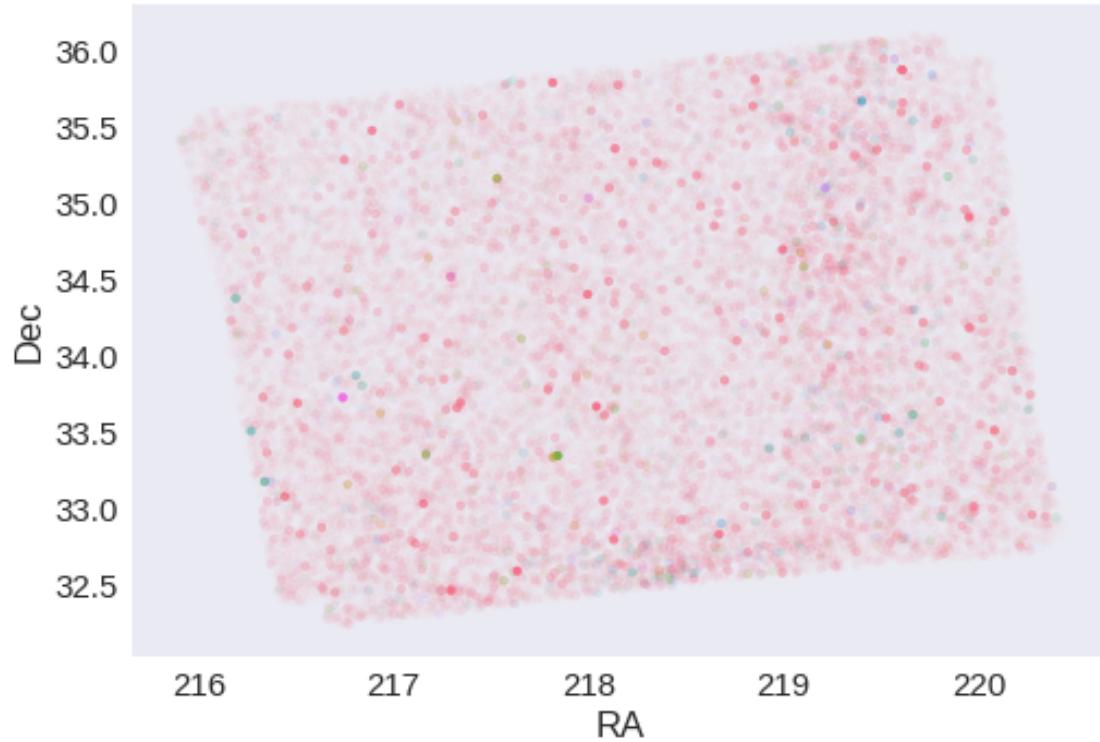
The cleaned catalogue has 230626 sources (73 removed).

The cleaned catalogue has 73 sources flagged as having been cleaned

1.4 III - Astrometry correction

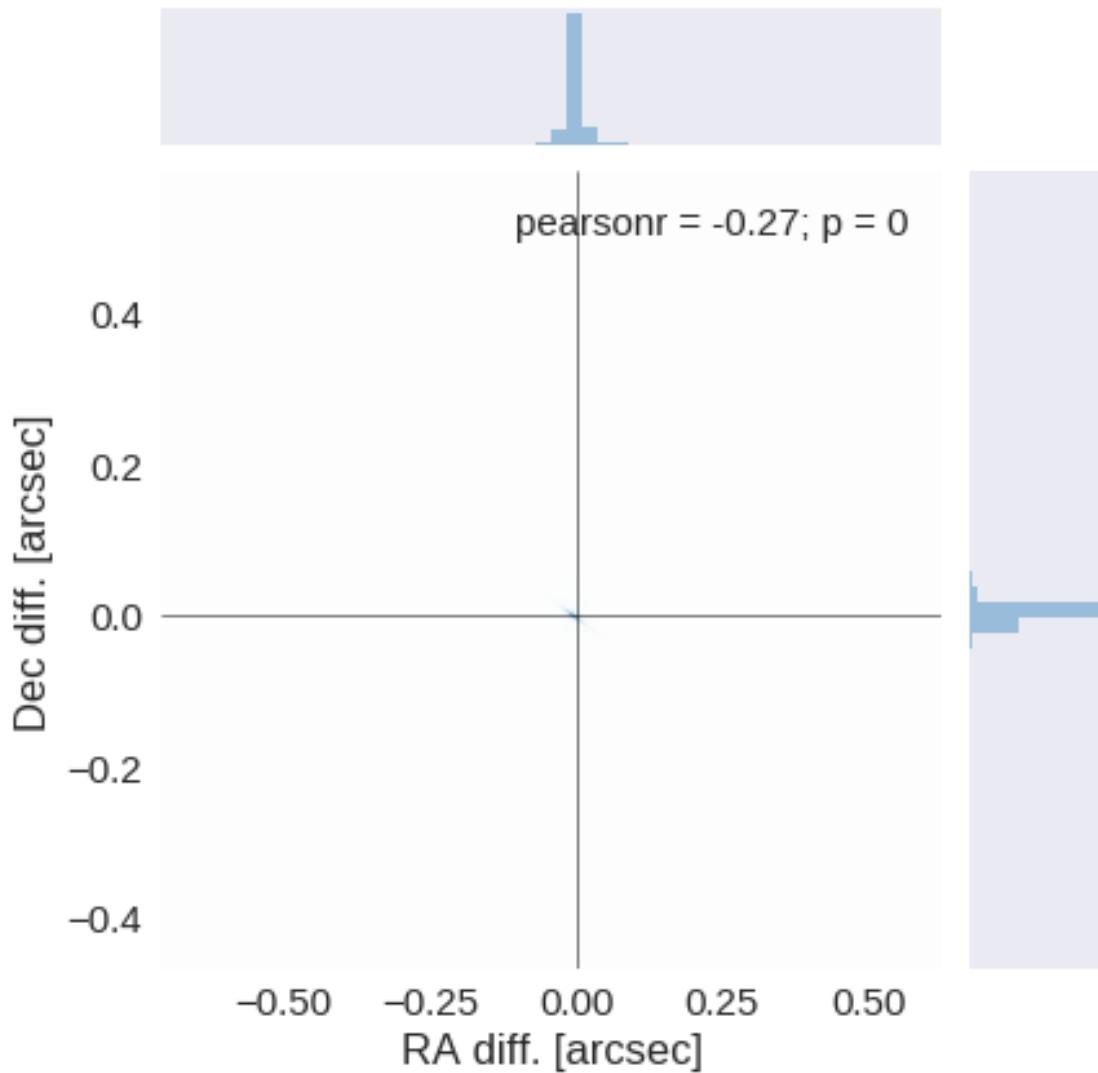
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

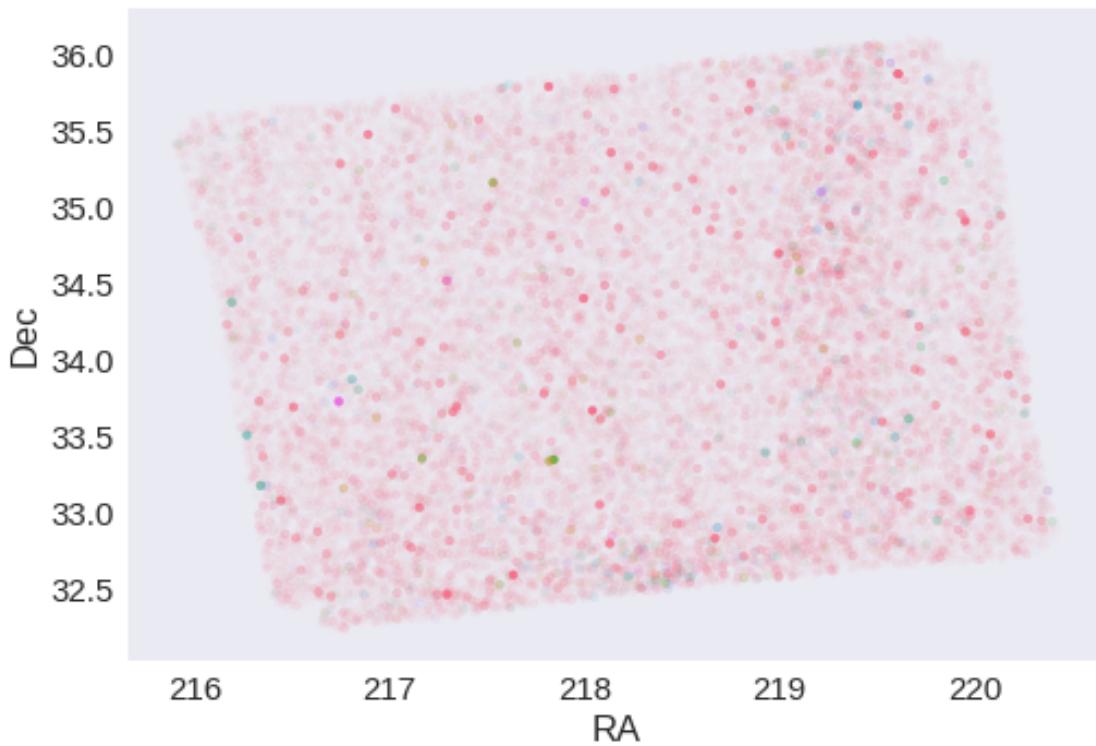




RA correction: -0.00015850442878218018 arcsec

Dec correction: -0.0003453544650255935 arcsec





1.5 IV - Flagging Gaia objects

34850 sources flagged.

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.7_SDWFS

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of SDWFS data

The catalogue comes from dmu0_SDWFS.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- There is no stellarity;
- The magnitude for each band in 2 arcsec aperture.
- The auto magnitude.

We don't know when the maps have been observed. We will use the year of the reference paper.

```
This notebook was run with herschelhelp_internal version:  
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)
```

1.2 I - Column selection

```
WARNING: UnitsWarning: 'vega' did not parse as fits unit: At col 0, Unit 'vega' not supported by
```

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10  
Check the NumPy 1.11 release notes for more information.
```

```
ma.MaskedArray.__setitem__(self, index, value)  
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/_main_.py:8: R  
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/_main_.py:9: R
```

```
Out[6]: <IPython.core.display.HTML object>
```

1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
    ma.MaskedArray.__setitem__(self, index, value)
```

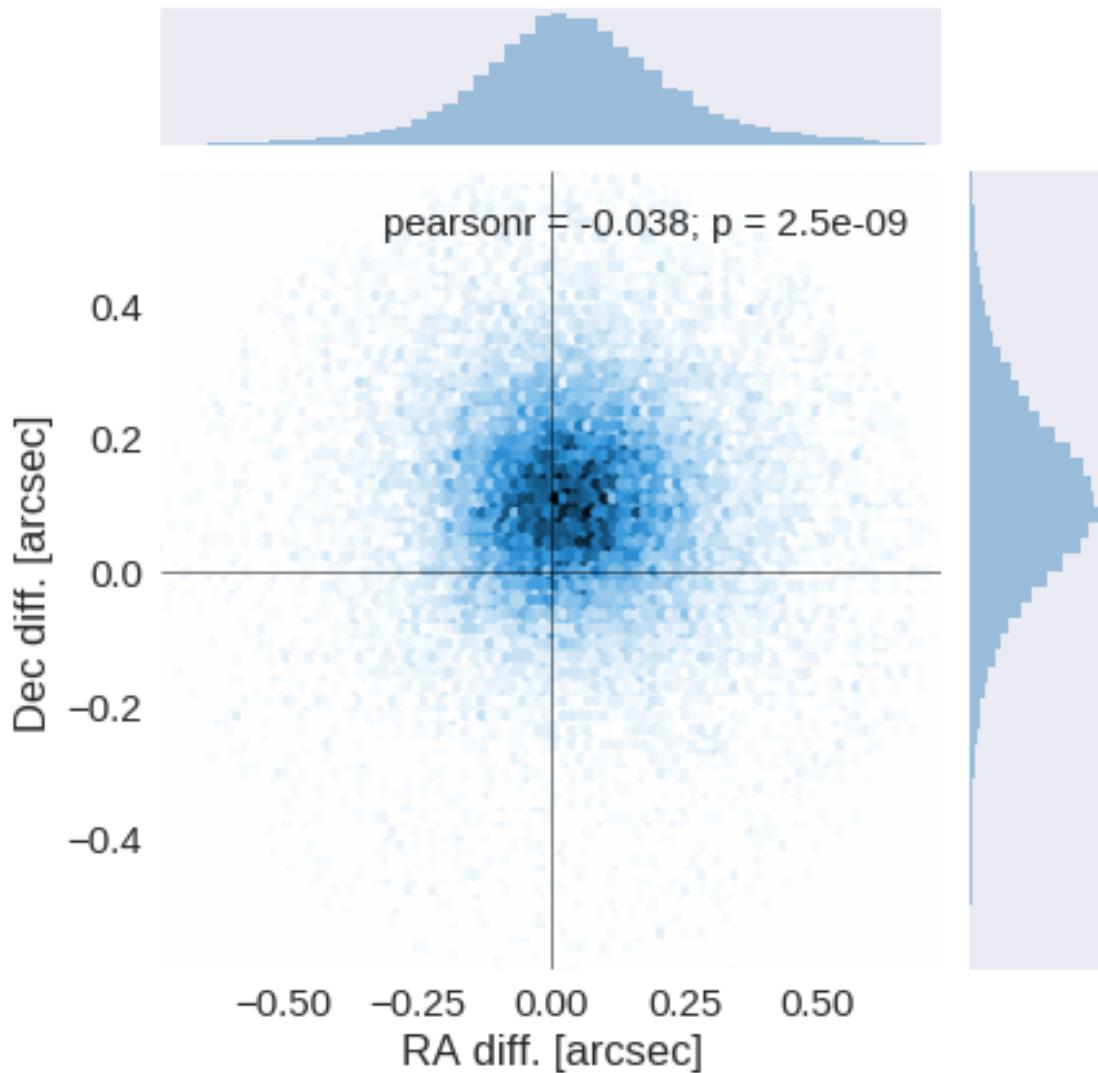
The initial catalogue had 614263 sources.

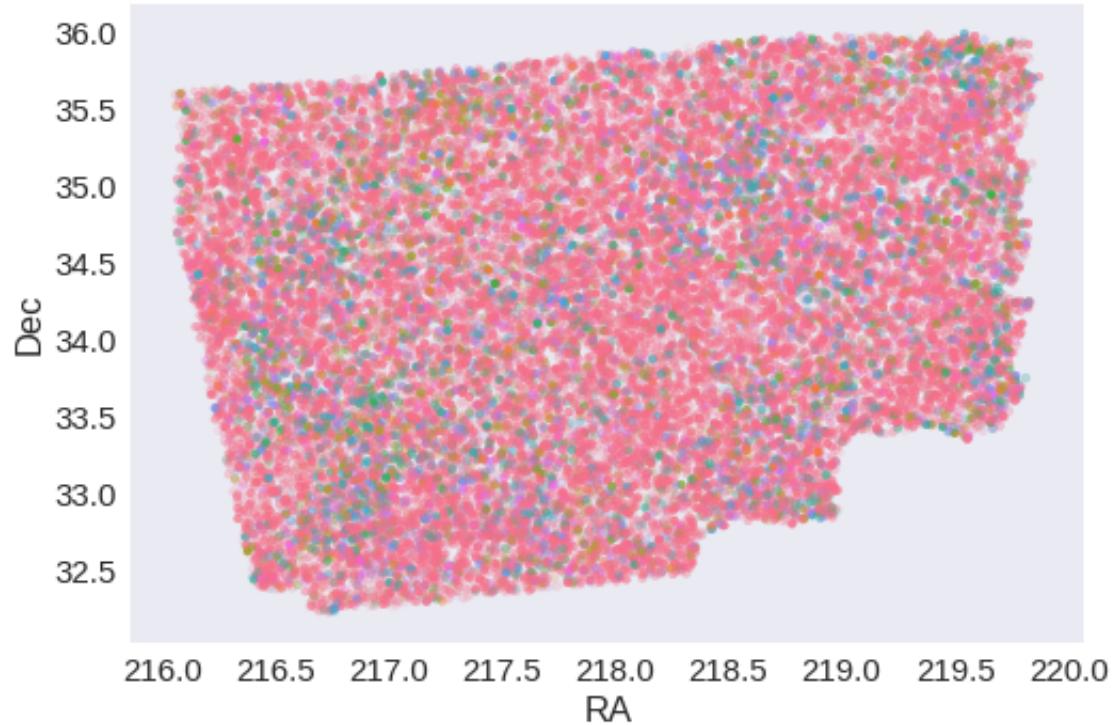
The cleaned catalogue has 614263 sources (0 removed).

The cleaned catalogue has 0 sources flagged as having been cleaned

1.4 III - Astrometry correction

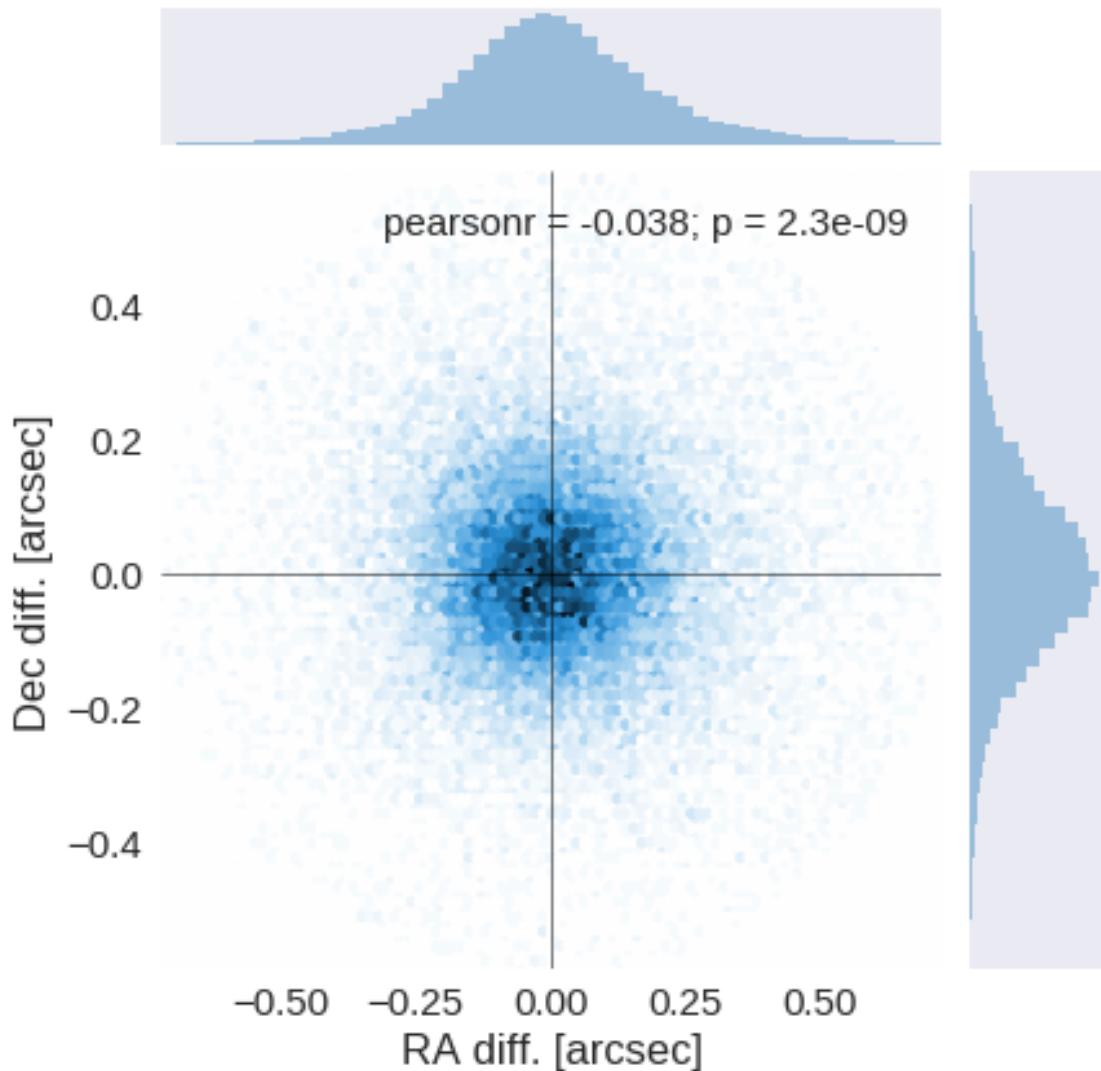
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

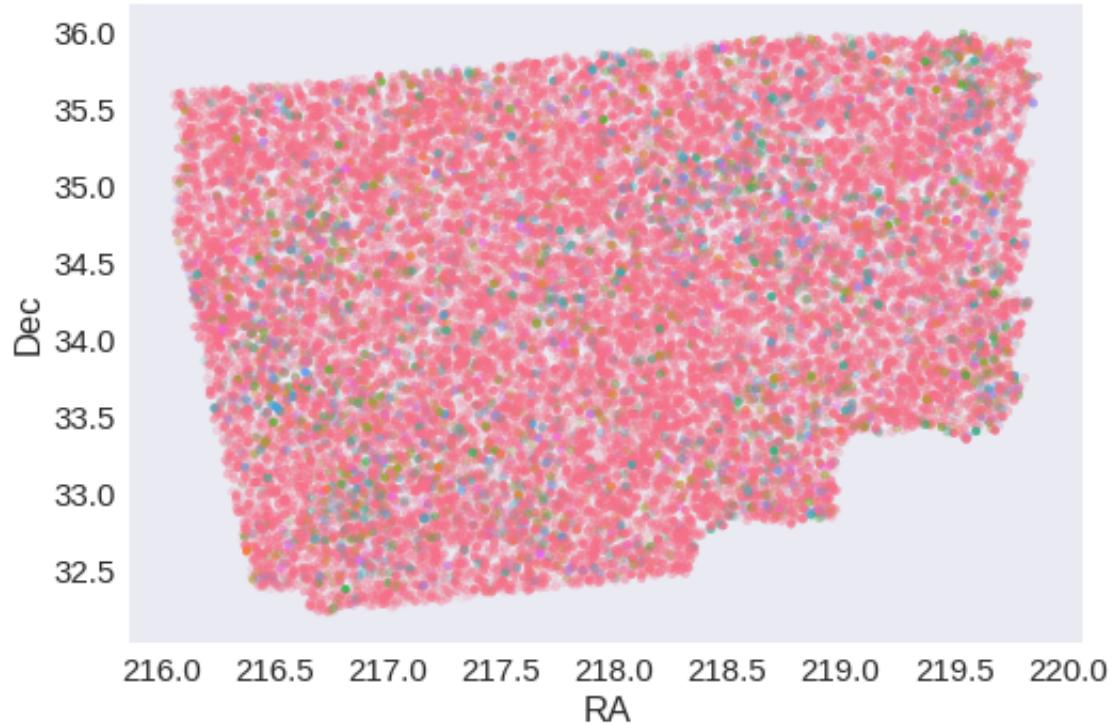




RA correction: -0.03827762104720023 arcsec

Dec correction: -0.10533761135036457 arcsec





1.5 IV - Flagging Gaia objects

27537 sources flagged.

2 V - Saving to disk

1.8_UHS

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of UKIRT Hemisphere Survey (UHS) data

The catalogue comes from `dmu0_UHS`. This is a J band only survey documented in <https://arxiv.org/pdf/1707.09975.pdf>

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band in aperture 4 (2 arcsec aperture corrected).
- The kron magnitude to be used as total magnitude (no "auto" magnitude is provided).

We don't know when the maps have been observed. We will use the year of the reference paper.

This notebook was run with `herschelhelp_internal` version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

1.2 I - Column selection

0.925175419285

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
    ma.MaskedArray.__setitem__(self, index, value)
```

`Out[7]: <IPython.core.display.HTML object>`

1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
    ma.MaskedArray.__setitem__(self, index, value)
```

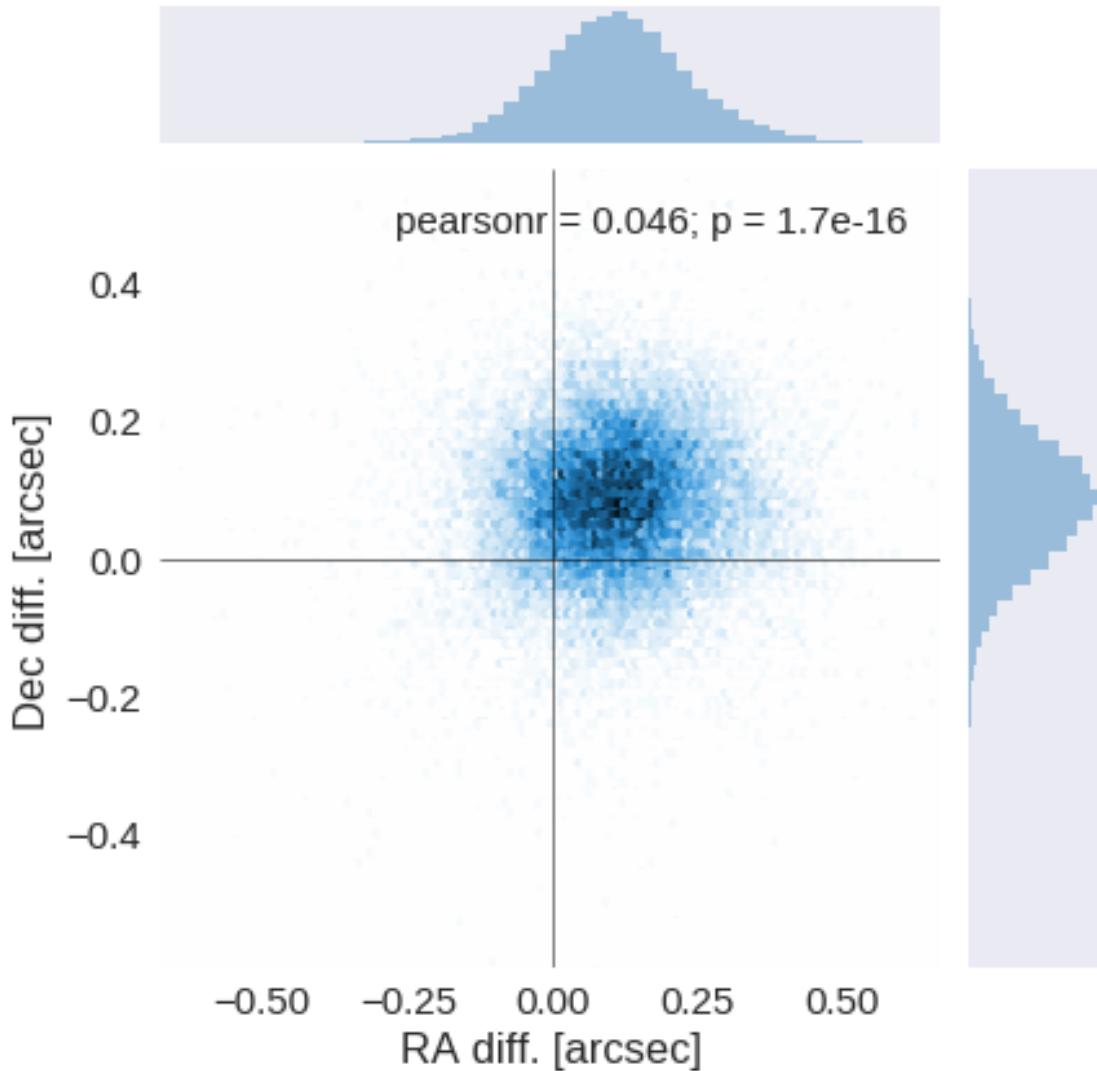
The initial catalogue had 110730 sources.

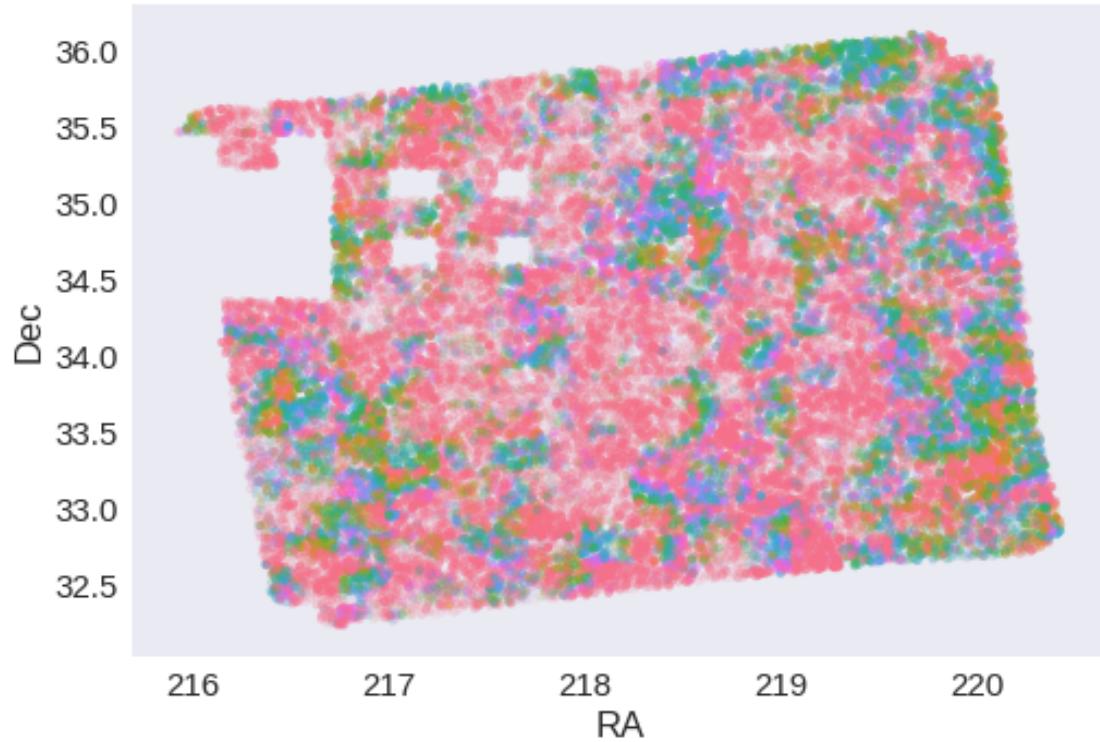
The cleaned catalogue has 102722 sources (8008 removed).

The cleaned catalogue has 7642 sources flagged as having been cleaned

1.4 III - Astrometry correction

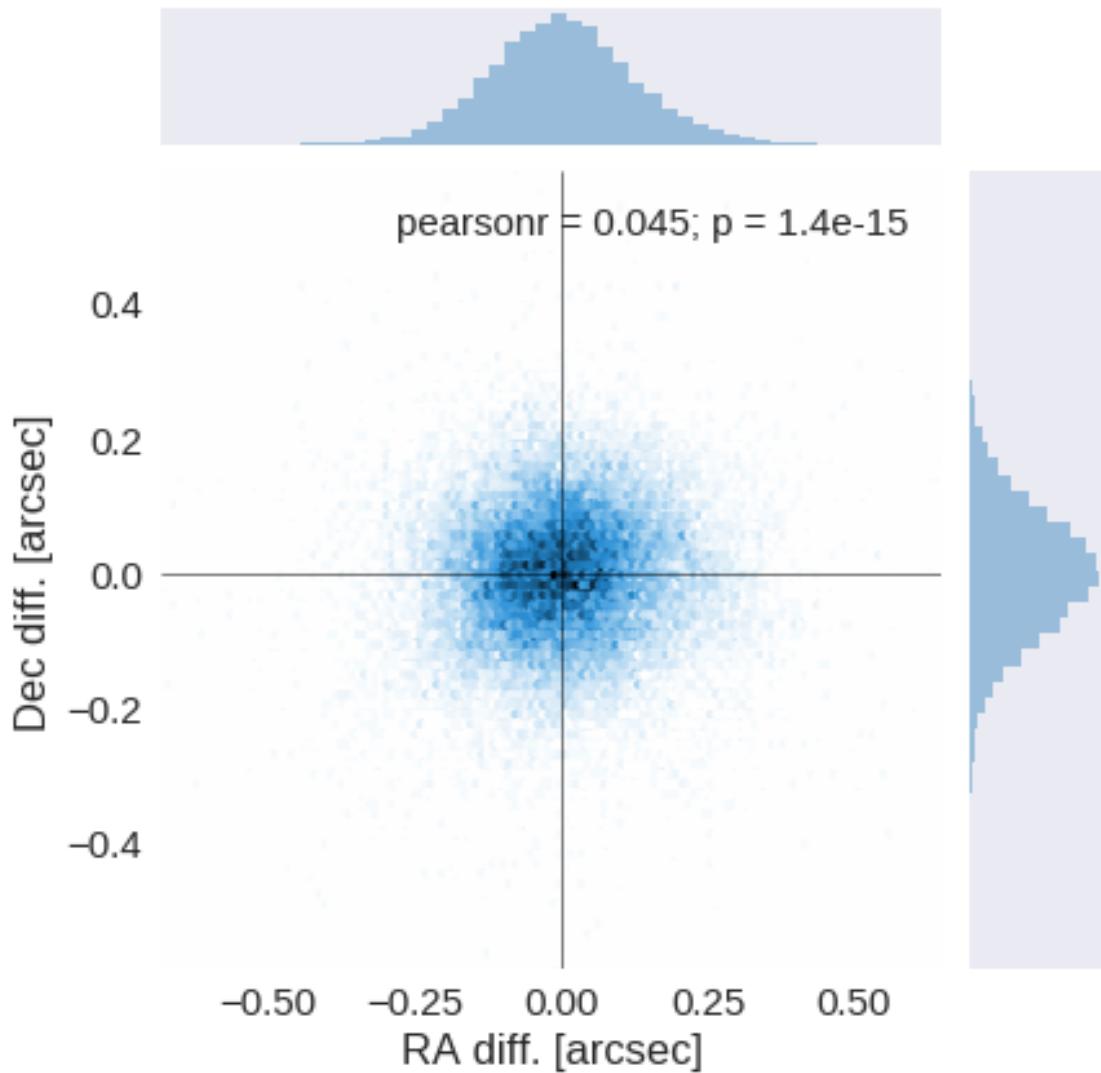
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

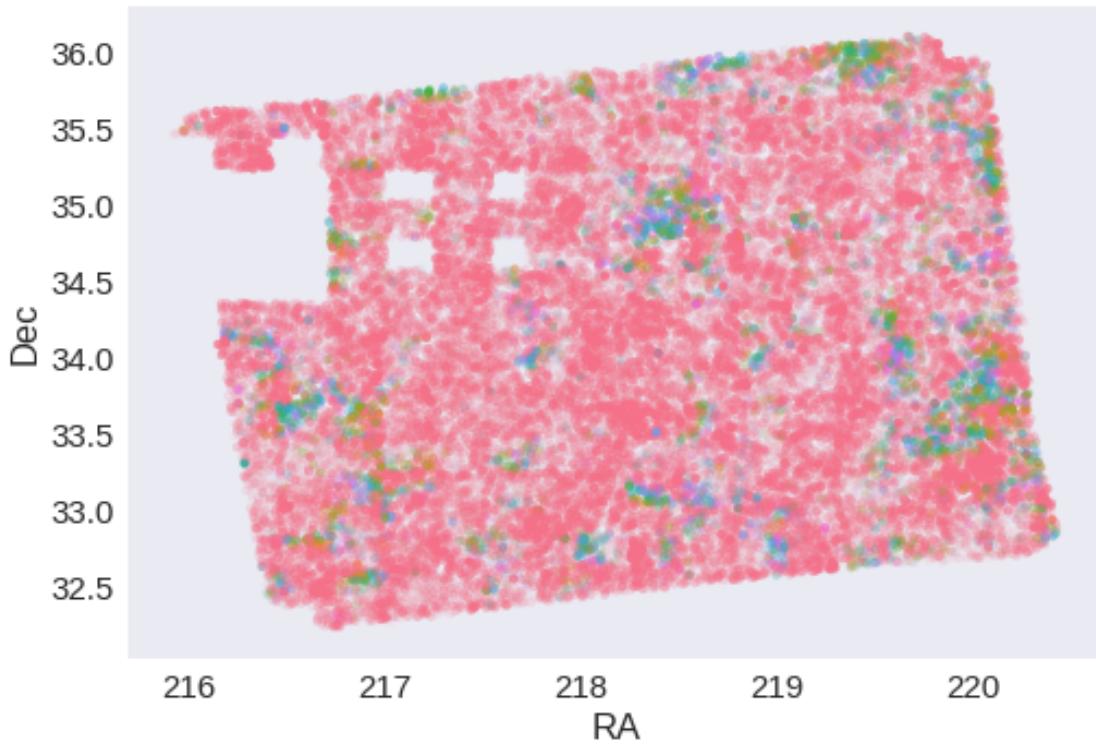




RA correction: -0.10771486696512511 arcsec

Dec correction: -0.08473485251698776 arcsec





1.5 IV - Flagging Gaia objects

31777 sources flagged.

2 V - Saving to disk

1.9_zBootes

January 18, 2018

1 Bootes master catalogue

1.1 Preparation of zBootes data

The catalogue comes from `dmu0_zBootes`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band in 2 arcsec aperture.
- The auto magnitude.

We don't know when the maps have been observed. We will use the year of the reference paper.

This notebook was run with `herschelhelp_internal` version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

1.2 I - Column selection

1.3 1.i Aperture correction]

TODO

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
    ma.MaskedArray.__setitem__(self, index, value)
```

Out [6]: <IPython.core.display.HTML object>

1.4 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
    ma.MaskedArray.__setitem__(self, index, value)
```

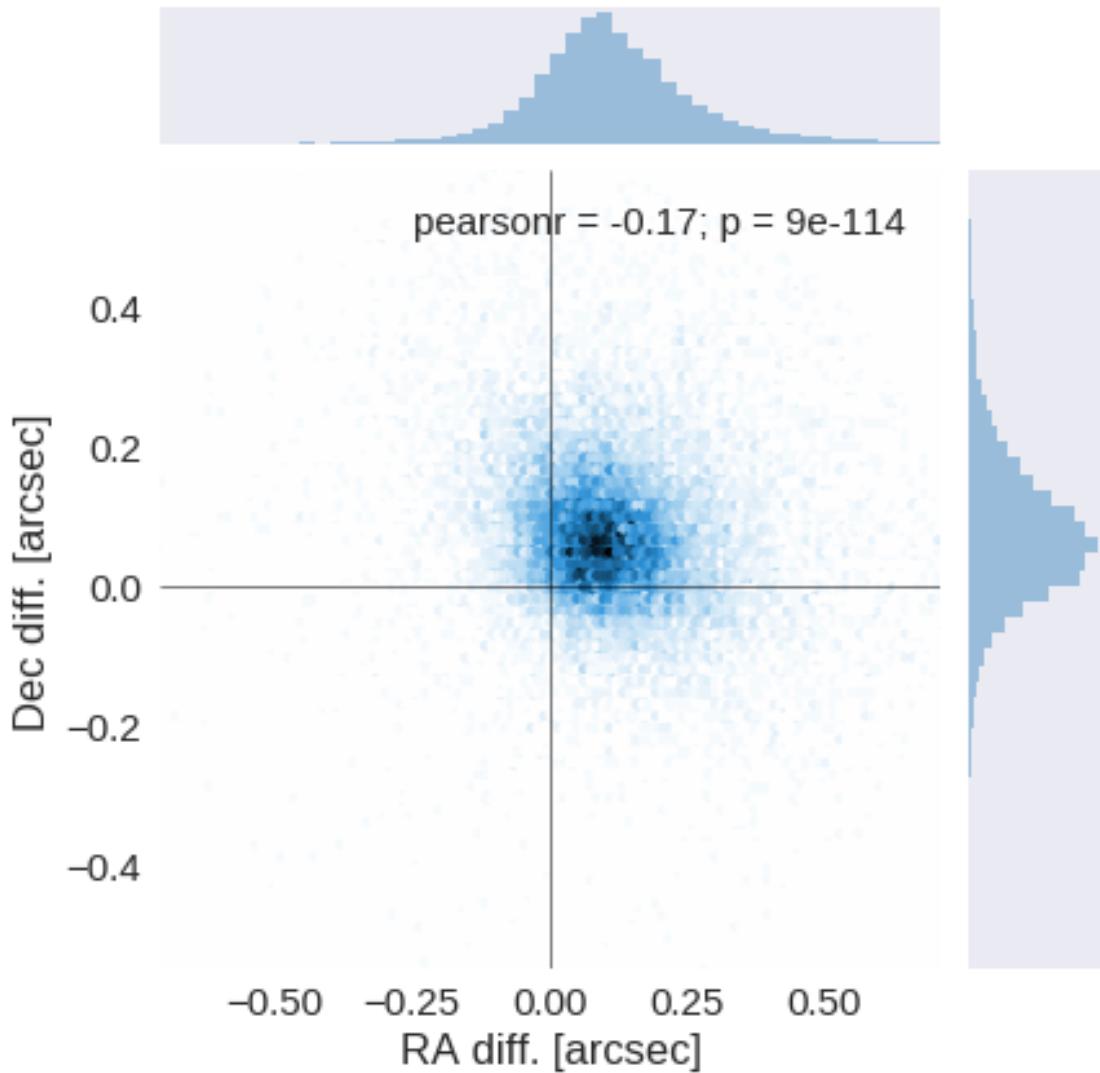
The initial catalogue had 187628 sources.

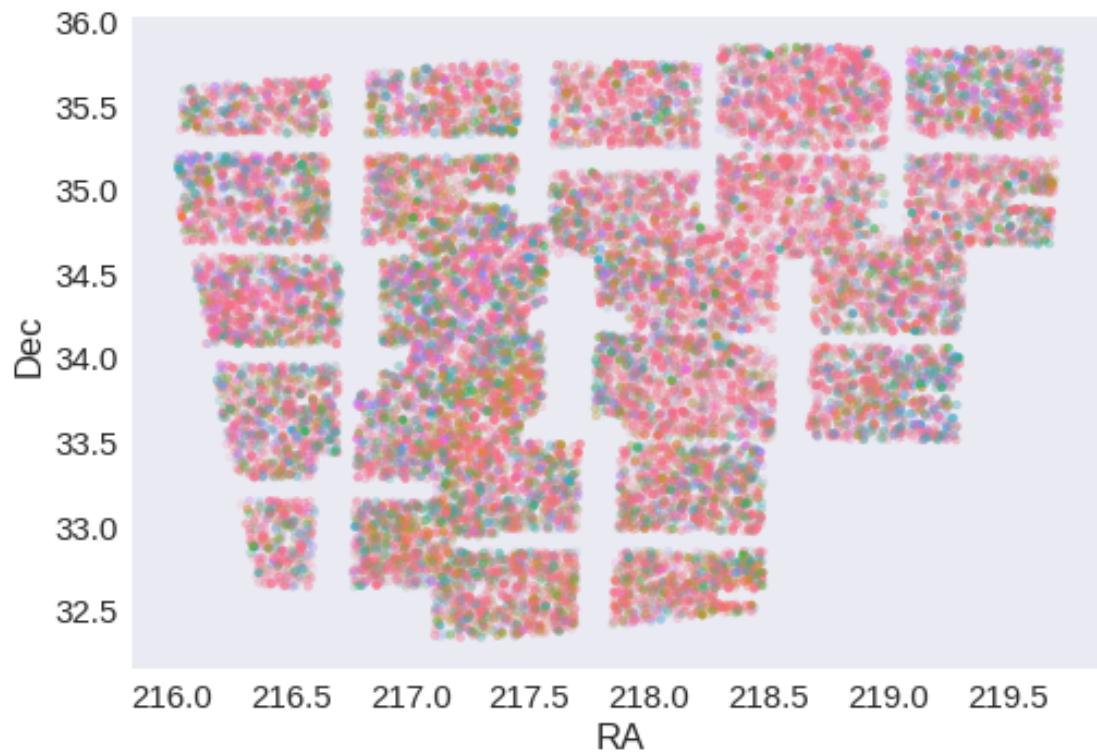
The cleaned catalogue has 187628 sources (0 removed).

The cleaned catalogue has 0 sources flagged as having been cleaned

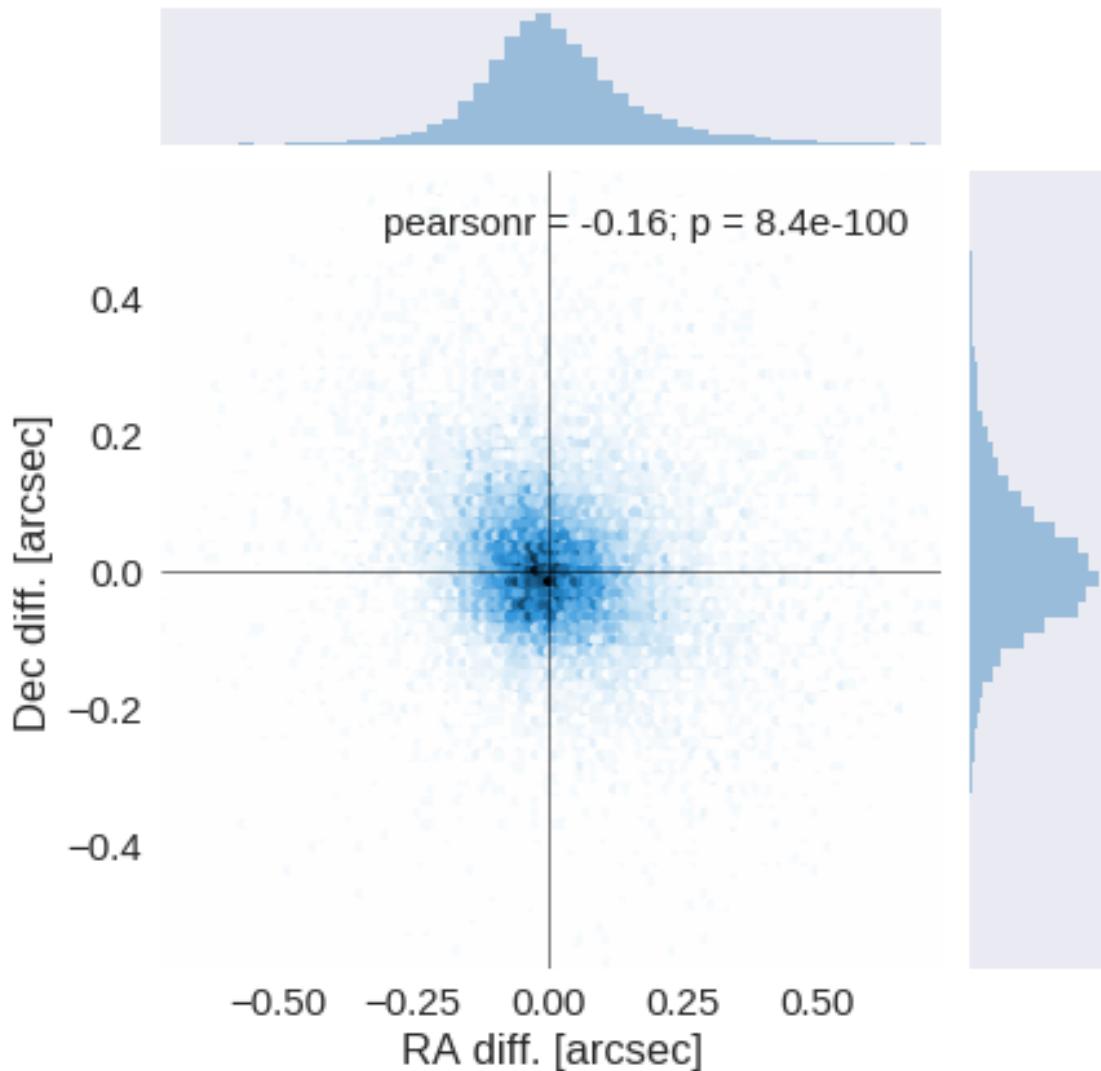
1.5 III - Astrometry correction

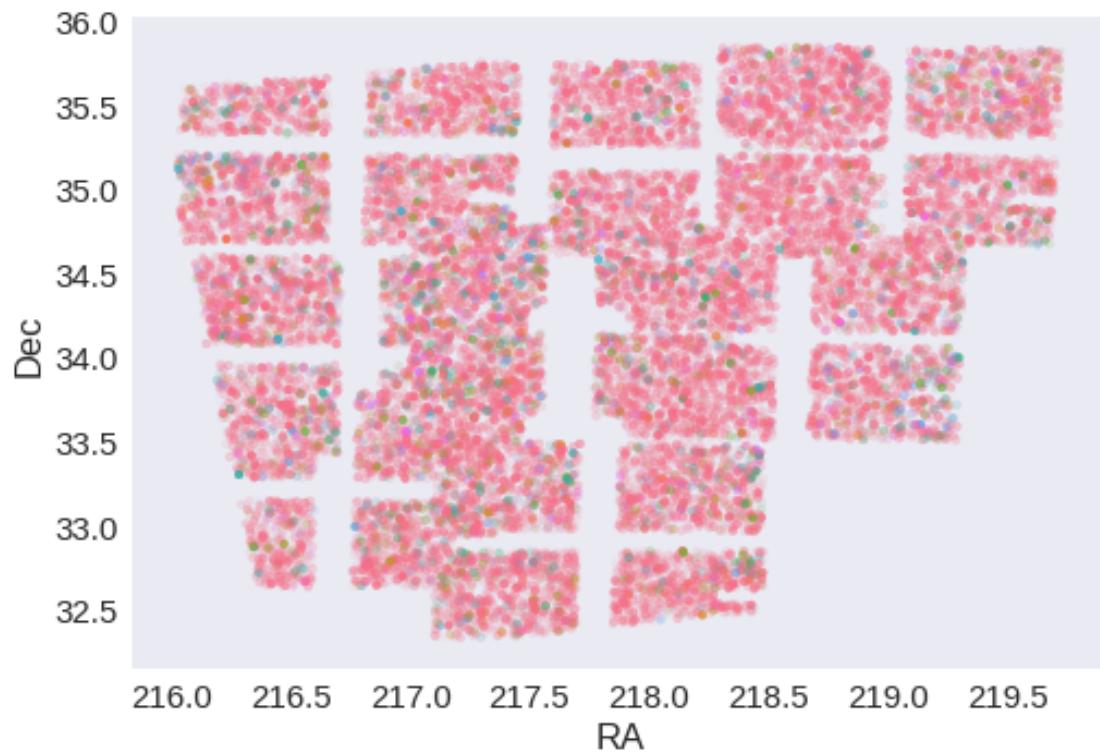
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.





RA correction: -0.10194170581598883 arcsec
Dec correction: -0.06714873594120263 arcsec





1.6 IV - Flagging Gaia objects

18176 sources flagged.

2 V - Saving to disk

2_HELP_Merging

January 18, 2018

1 Bootes master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on ELAIS-N1.

This notebook was run with herschelhelp_internal version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

1.1 I - Reading the prepared pristine catalogues

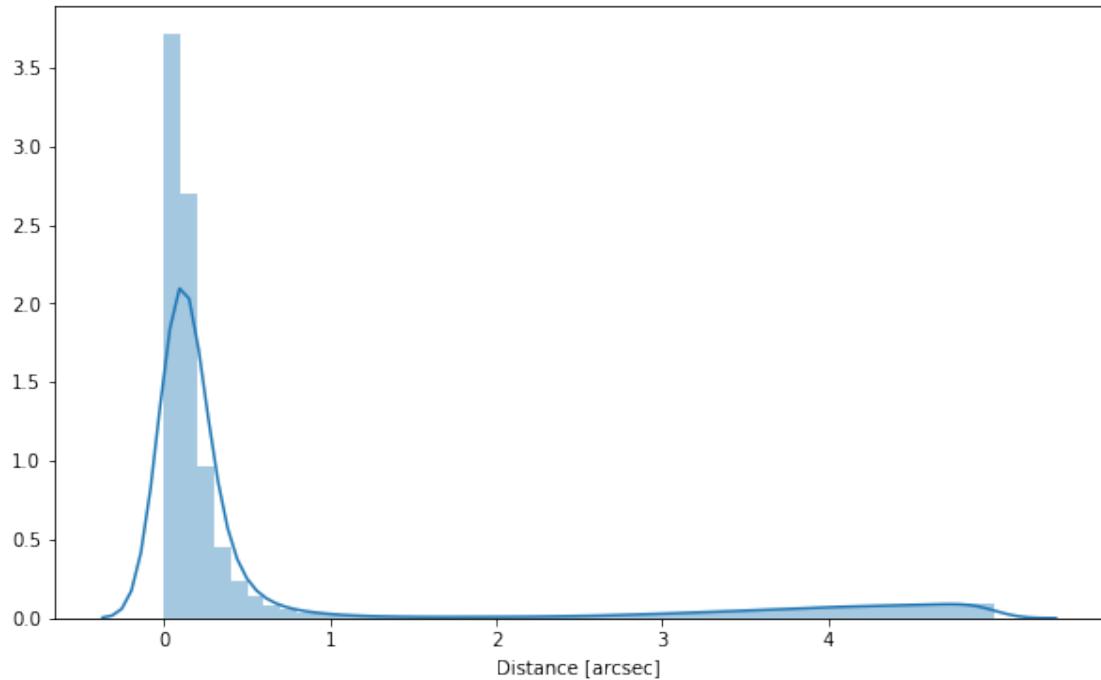
1.2 II - Merging tables

We first merge the optical catalogues and then add the infrared ones.

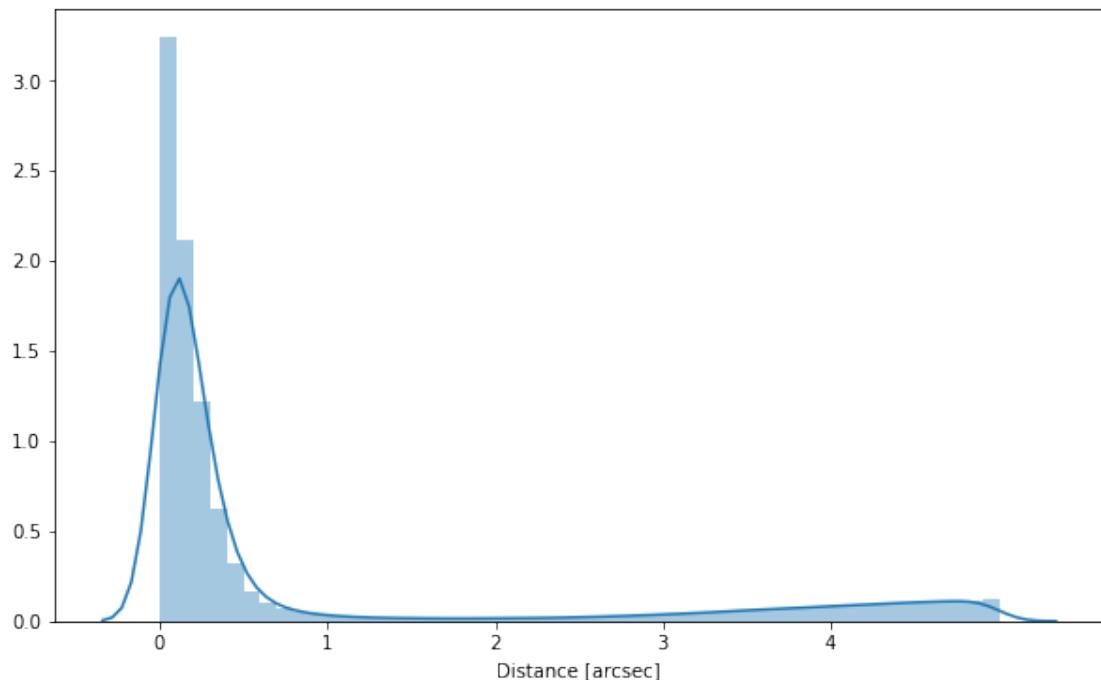
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 PanSTARRS

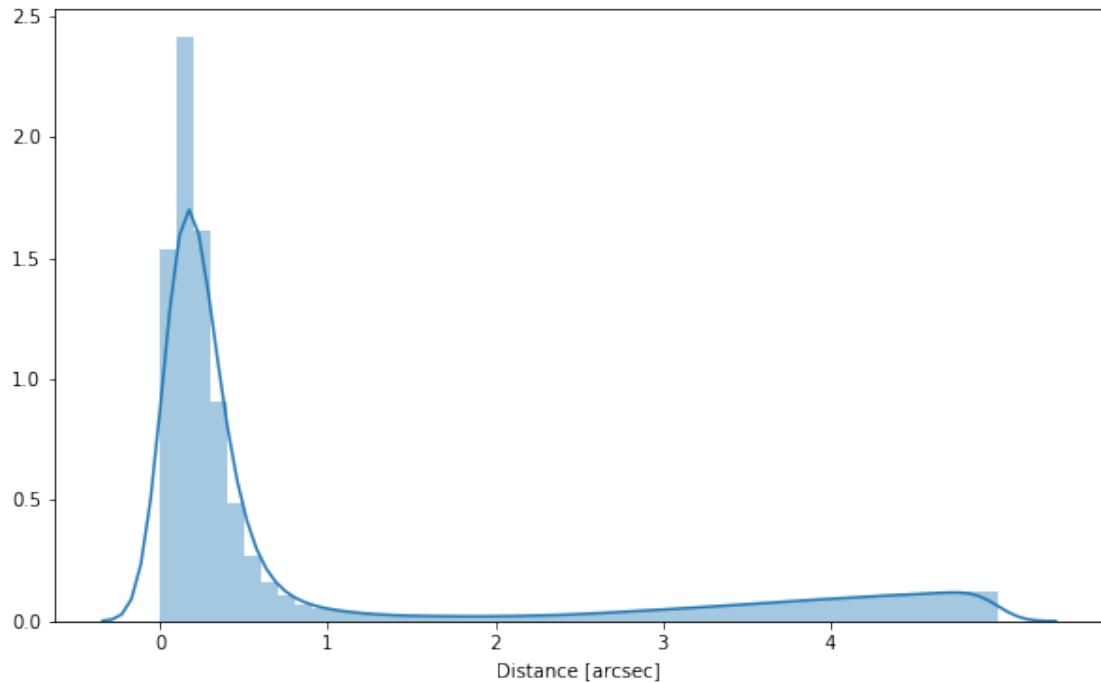
1.2.2 Add DECaLS



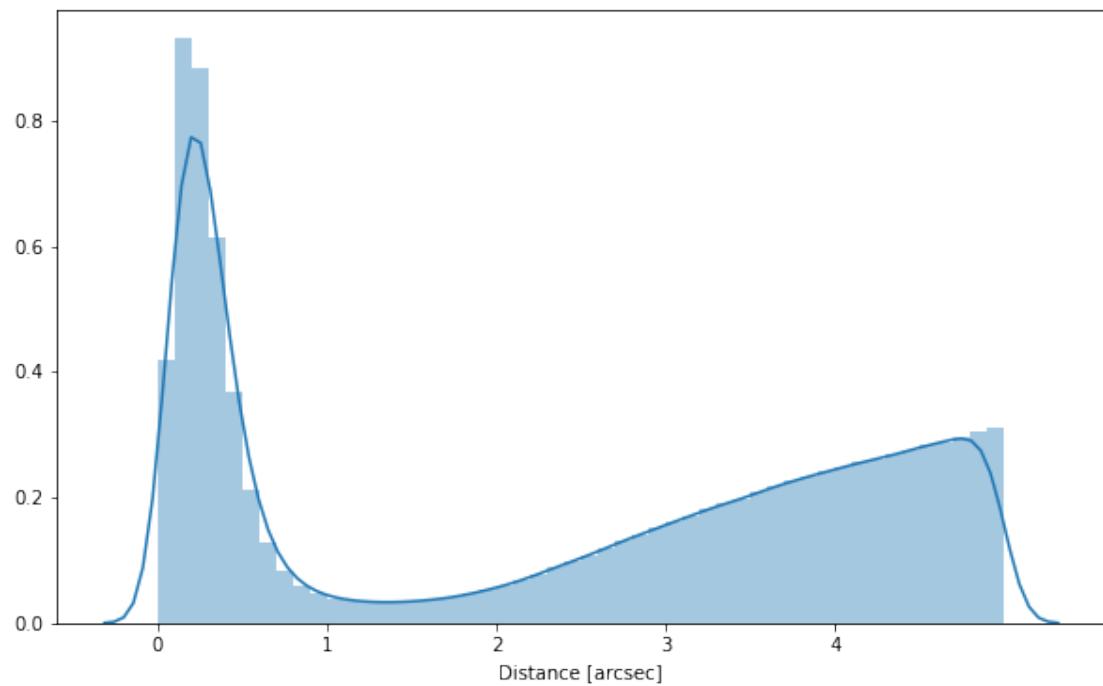
1.2.3 Add Legacy Survey



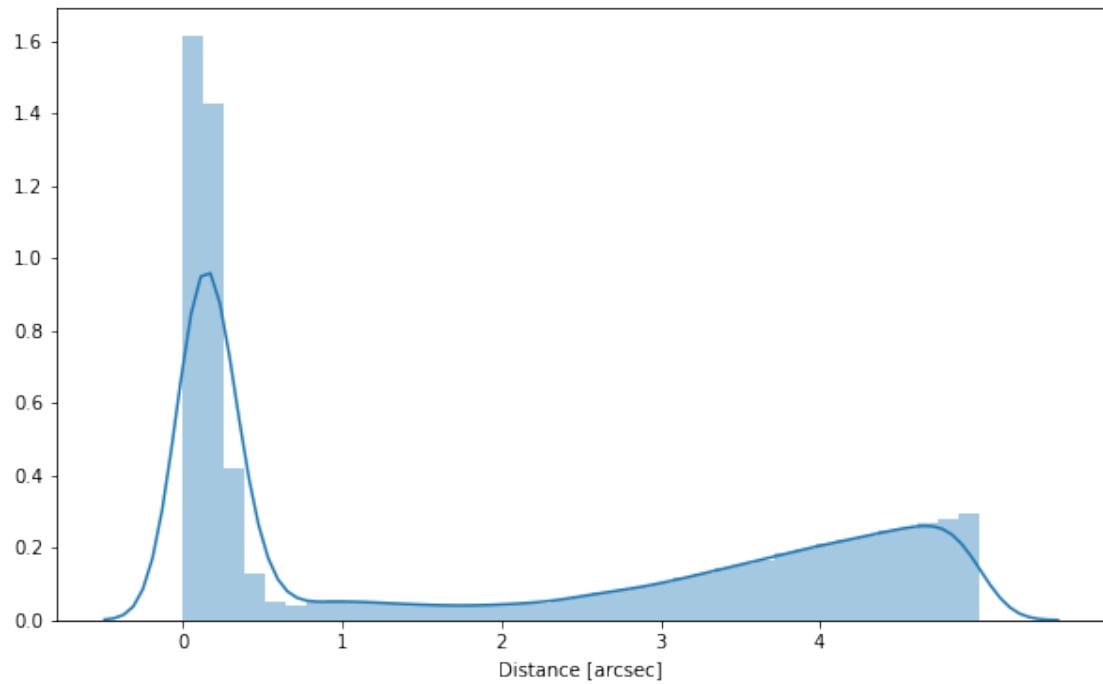
1.2.4 Add IBIS



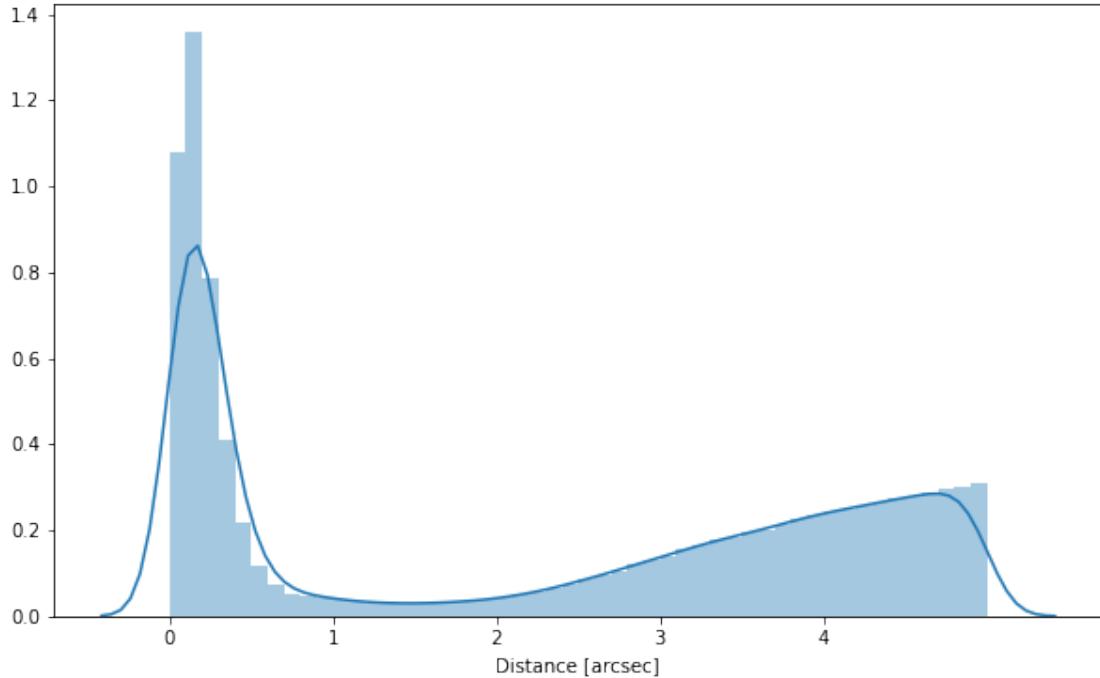
1.2.5 Add NDWFS



1.2.6 Add UHS



1.2.7 Add zBootes

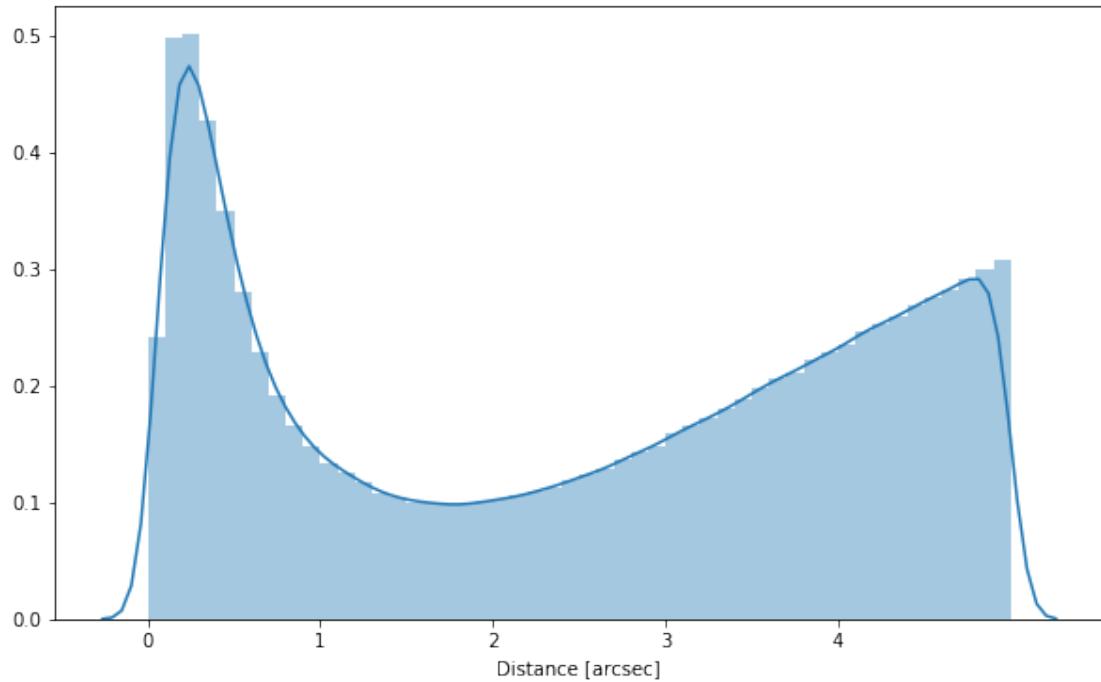


1.2.8 Add SDWFS

```
nb_merge_dist_plot( SkyCoord(master_catalogue['ra'], master_catalogue['dec']), SkyCoord(sdwfs['sdwfs_ra'], sdwfs['sdwfs_dec']) )
```

```
#Given the graph above, we use 1 arc-second radius
master_catalogue = merge_catalogues(master_catalogue, sdwfs, "sdwfs_ra", "sdwfs_dec", radius=1.*u.arcsec)
```

1.2.9 Add Datafusion



1.2.10 Cleaning

When we merge the catalogues, astropy masks the non-existent values (e.g. when a row comes only from a catalogue and has no counterparts in the other, the columns from the latest are masked for that row). We indicate to use NaN for masked values for floats columns, False for flag columns and -1 for ID columns.

Out[21]: <IPython.core.display.HTML object>

1.3 III - Merging flags and stellarity

Each pristine catalogue contains a flag indicating if the source was associated to a another nearby source that was removed during the cleaning process. We merge these flags in a single one.

Each pristine catalogue contains a flag indicating the probability of a source being a Gaia object (0: not a Gaia object, 1: possibly, 2: probably, 3: definitely). We merge these flags taking the highest value.

Each pristin catalogue may contain one or several stellarity columns indicating the probability (0 to 1) of each source being a star. We merge these columns taking the highest value. We keep trace of the origin of the stellarity.

```
decals_stellarity, legacy_stellarity, ibis_stellarity, ndwfs_stellarity, uhs_stellarity, zbootes
```

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:  
    warnings.warn("All-NaN slice encountered", RuntimeWarning)
```

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

OK!

1.6 VI - Cross-matching with spec-z catalogue

```
specz = Table.read("../dmu23/dmu23_Bootes/data/Bootes-specz-v2.1.fits")  
nb_merge_dist_plot( SkyCoord(master_catalogue['ra'], master_catalogue['dec']), SkyCoord(specz['ra'] * u.deg, specz['dec'] * u.deg) )  
master_catalogue = specz.merge(master_catalogue, specz, radius=1. * u.arcsec)
```

1.7 VII - Choosing between multiple values for the same filter

We take DataFusion Spitzer instead of SDWFS which is shallower.

1.8 VIII.a Wavelength domain coverage

We add a binary `flag_optnir_obs` indicating that a source was observed in a given wavelength domain:

- 1 for observation in optical;
- 2 for observation in near-infrared;
- 4 for observation in mid-infrared (IRAC).

It's an integer binary flag, so a source observed both in optical and near-infrared by not in mid-infrared would have this flag at $1 + 2 = 3$.

Note 1: The observation flag is based on the creation of multi-order coverage maps from the catalogues, this may not be accurate, especially on the edges of the coverage.

Note 2: Being on the observation coverage does not mean having fluxes in that wavelength domain. For sources observed in one domain but having no flux in it, one must take into consideration de different depths in the catalogue we are using.

1.9 VIII.b Wavelength domain detection

We add a binary `flag_optnir_det` indicating that a source was detected in a given wavelength domain:

- 1 for detection in optical;
- 2 for detection in near-infrared;
- 4 for detection in mid-infrared (IRAC).

It's an integer binary flag, so a source detected both in optical and near-infrared by not in mid-infrared would have this flag at $1 + 2 = 3$.

Note 1: We use the total flux columns to know if the source has flux, in some catalogues, we may have aperture flux and no total flux.

To get rid of artefacts (chip edges, star flares, etc.) we consider that a source is detected in one wavelength domain when it has a flux value in **at least two bands**. That means that good sources will be excluded from this flag when they are on the coverage of only one band.

1.10 IX - Cross-identification table

We are producing a table associating to each HELP identifier, the identifiers of the sources in the pristine catalogues. This can be used to easily get additional information from them.

For convenience, we also cross-match the master list with the SDSS catalogue and add the objID associated with each source, if any. **TODO: should we correct the astrometry with respect to Gaia positions?**

235 master list rows had multiple associations.

```
['ps1_id', 'decals_id', 'legacy_id', 'ibis_id', 'ndwfs_id', 'uhs_id', 'zbootes_id', 'datafusion_id']
```

1.11 X - Adding HEALPix index

We are adding a column with a HEALPix index at order 13 associated with each source.

1.12 XI - Saving the catalogue

Missing columns: {'flag_bass_z', 'flag_gpc1_i', 'flag_irac_i3', 'flag_90prime_z', 'flag_decam_r'}

3.0_Brown_Checks_and_diagnostics

January 18, 2018

1 Bootes master catalogue

1.1 Checks and diagnostics

This notebook was run with herschelhelp_internal version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

Diagnostics done using: master_catalogue_bootes_20171212.fits

1.2 0 - Quick checks

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
    format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
    format(shape, fill_value, array(fill_value).dtype), FutureWarning)
```

Table shows only problematic columns.

Out[4]: <IPython.core.display.HTML object>

1.3 I - Summary of wavelength domains

1.4 II - Comparing magnitudes in similar filters

The master list is composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

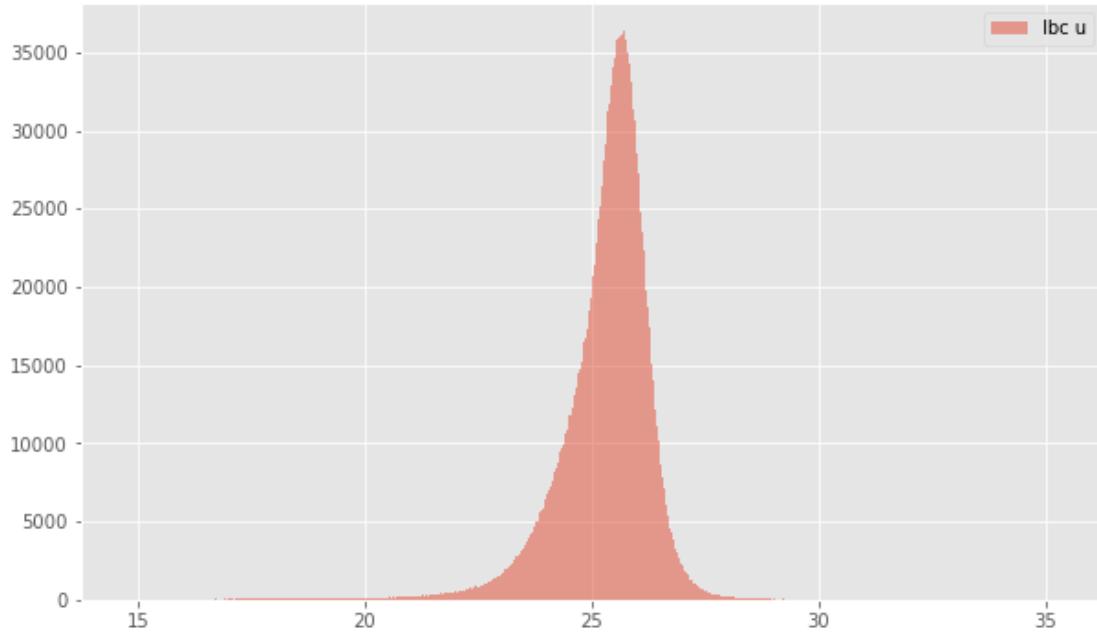
```
Out[8]: ['ra',
          'dec',
          'stellarity',
          'm_ap_lbc_u',
          'merr_ap_lbc_u',
          'f_ap_lbc_u',
          'ferr_ap_lbc_u',
```

```
'm_ap_mosaic_bw',
'merr_ap_mosaic_bw',
'f_ap_mosaic_bw',
'ferr_ap_mosaic_bw',
'm_ap_mosaic_r',
'merr_ap_mosaic_r',
'f_ap_mosaic_r',
'ferr_ap_mosaic_r',
'm_ap_mosaic_i',
'merr_ap_mosaic_i',
'f_ap_mosaic_i',
'ferr_ap_mosaic_i',
'm_ap_prime90_z',
'merr_ap_prime90_z',
'f_ap_prime90_z',
'ferr_ap_prime90_z',
'm_ap_suprime_z',
'merr_ap_suprime_z',
'f_ap_suprime_z',
'ferr_ap_suprime_z',
'm_ap_lbc_y',
'merr_ap_lbc_y',
'f_ap_lbc_y',
'ferr_ap_lbc_y',
'm_ap_newfirm_j',
'merr_ap_newfirm_j',
'f_ap_newfirm_j',
'ferr_ap_newfirm_j',
'm_ap_newfirm_h',
'merr_ap_newfirm_h',
'f_ap_newfirm_h',
'ferr_ap_newfirm_h',
'm_ap_onis_k',
'merr_ap_onis_k',
'f_ap_onis_k',
'ferr_ap_onis_k',
'm_ap_newfirm_k',
'merr_ap_newfirm_k',
'f_ap_newfirm_k',
'ferr_ap_newfirm_k',
'm_ap_irac_ch1',
'merr_ap_irac_ch1',
'f_ap_irac_ch1',
'ferr_ap_irac_ch1',
'm_ap_irac_ch2',
'merr_ap_irac_ch2',
'f_ap_irac_ch2',
'ferr_ap_irac_ch2',
```

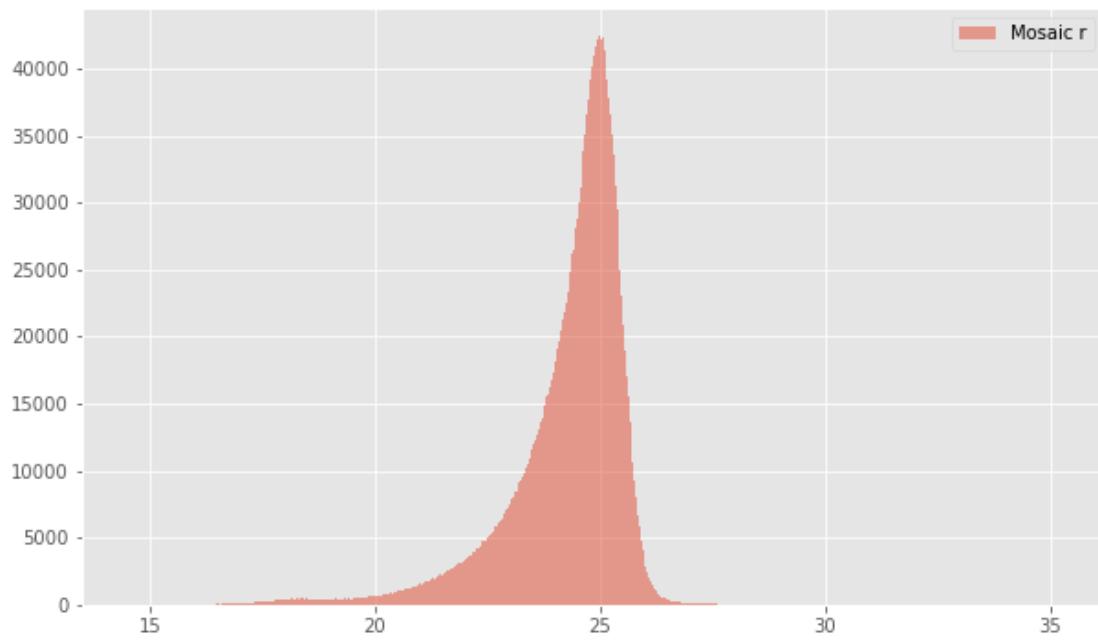
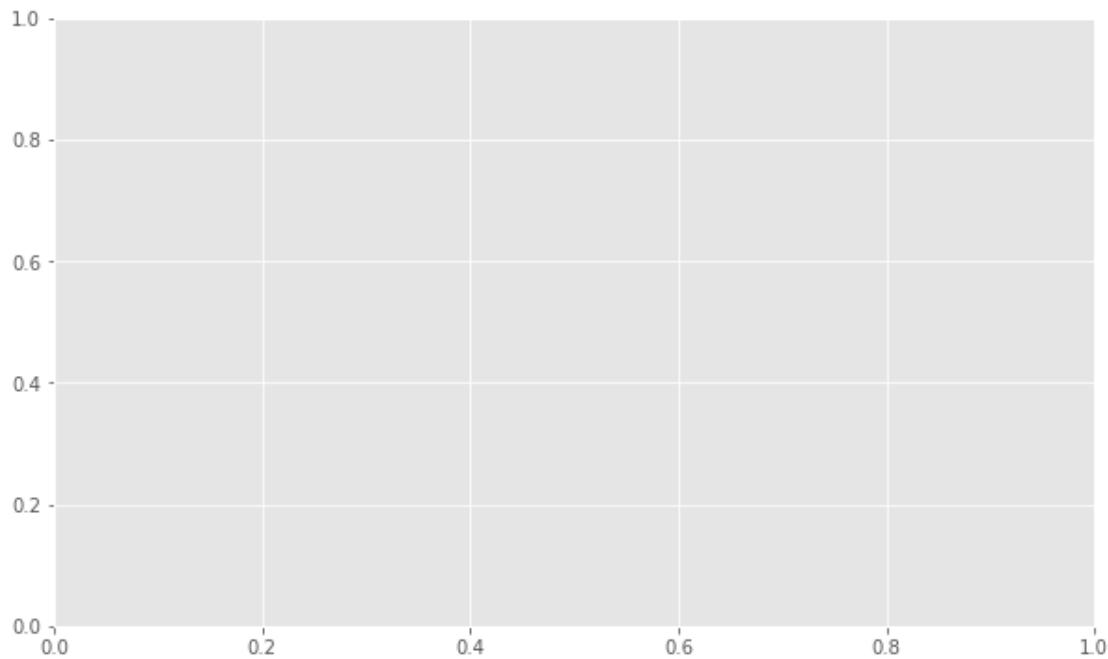
```
'm_ap_irac_ch3',
'merr_ap_irac_ch3',
'f_ap_irac_ch3',
'ferr_ap_irac_ch3',
'm_ap_irac_ch4',
'merr_ap_irac_ch4',
'f_ap_irac_ch4',
'ferr_ap_irac_ch4',
'flag_merged',
'bootes_flag_gaia',
'help_id',
'field']
```

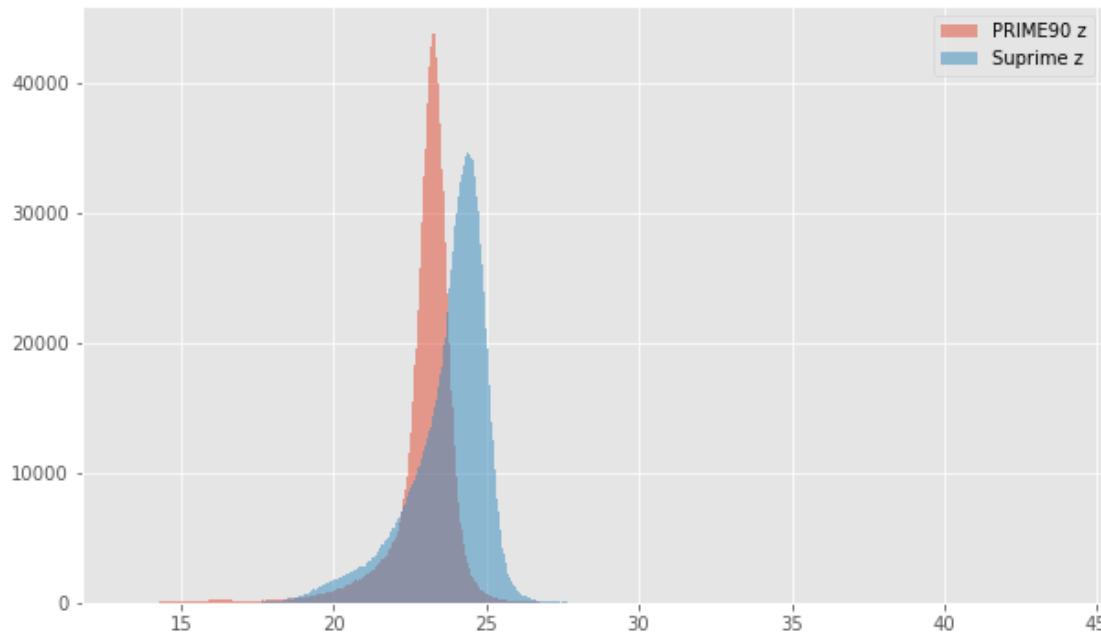
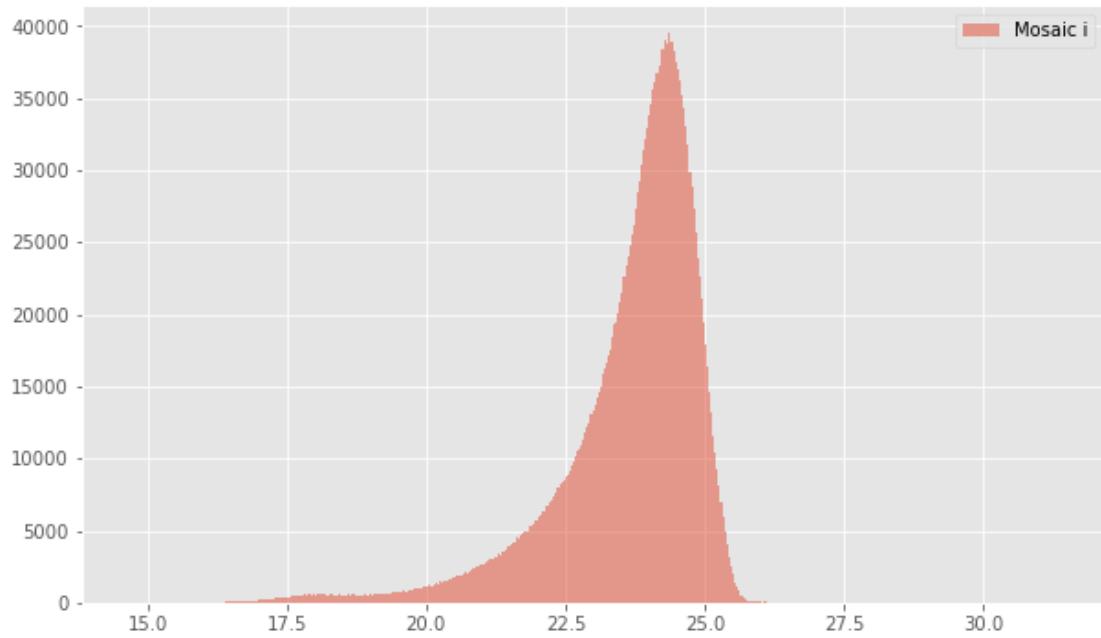
1.4.1 II.a - Comparing depths

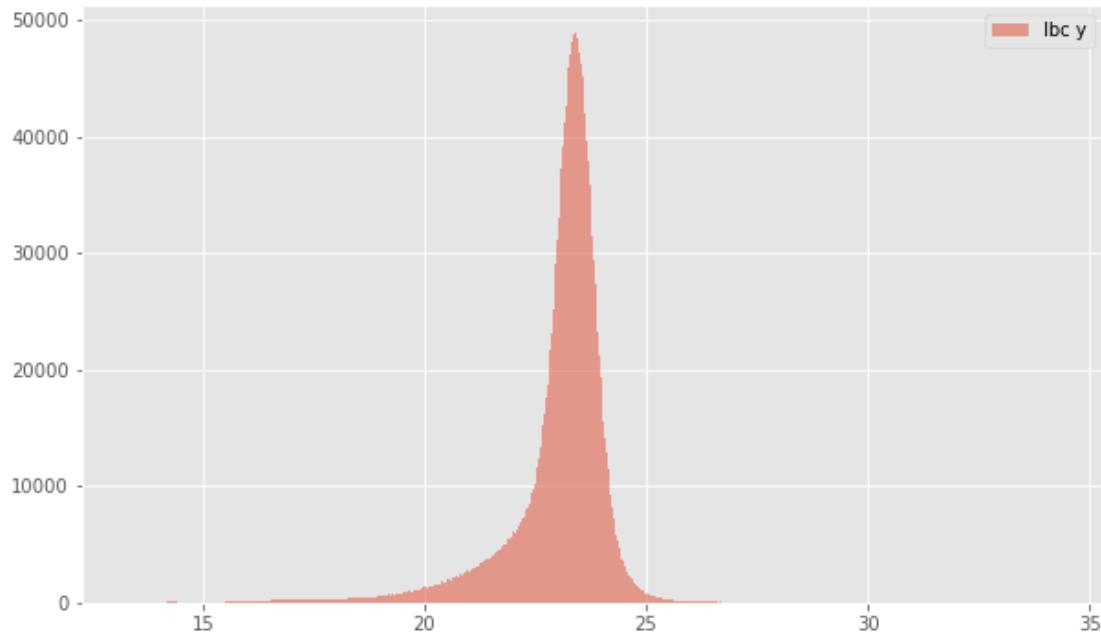
We compare the histograms of the total aperture magnitudes of similar bands.



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/matplotlib/axes/_axes.py:5
    warnings.warn("No labelled objects found. "
```





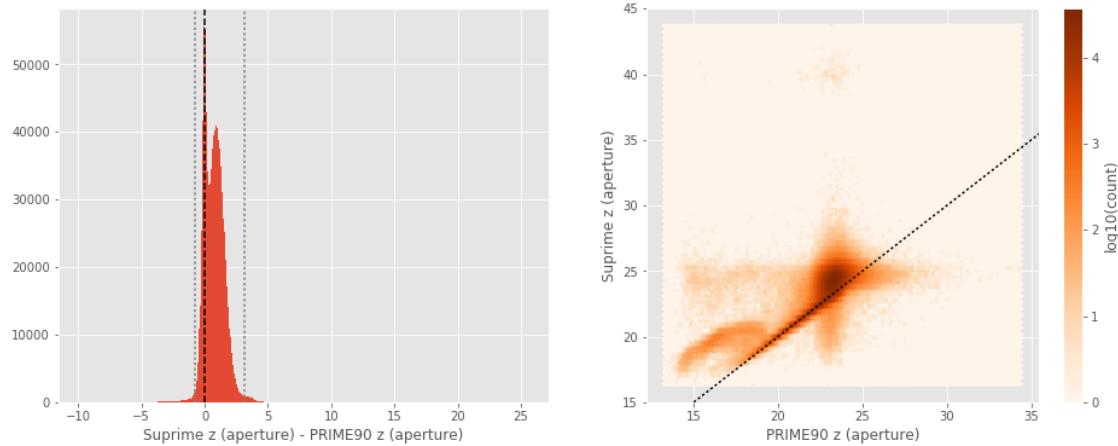


1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

Suprime z (aperture) - PRIME90 z (aperture):

- Median: 0.70
- Median Absolute Deviation: 0.58
- 1% percentile: -0.7906162536703729
- 99% percentile: 3.127203865051266



One of `m_prime90_z` and `m_suprime_z` does not exist.

1.5 III - Comparing magnitudes to reference bands

Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

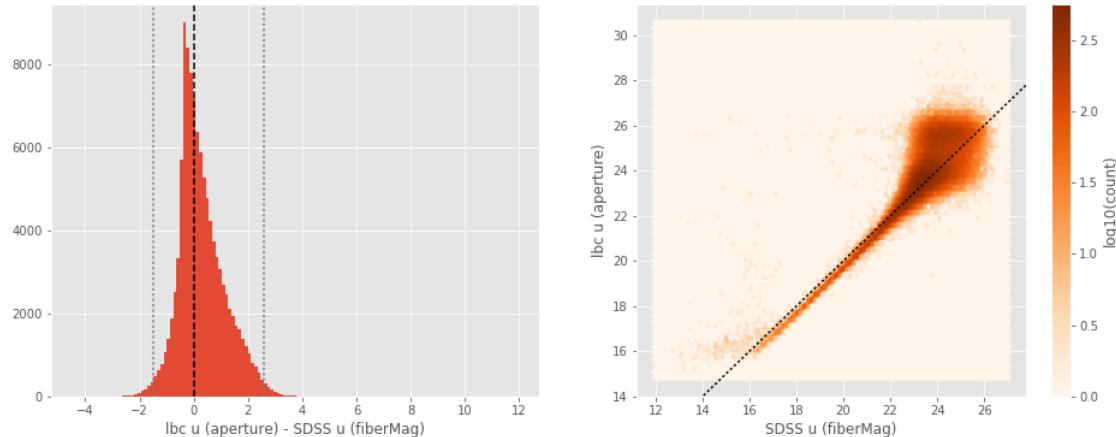
1.5.1 III.a - Comparing u, g, r, i, and z bands to SDSS

The catalogue is cross-matched to SDSS-DR13 withing 0.2 arcsecond.

We compare the u, g, r, i, and z magnitudes to those from SDSS using `fiberMag` for the aperture magnitude and `petroMag` for the total magnitude.

`lbc u (aperture) - SDSS u (fiberMag)`:

- Median: 0.13
- Median Absolute Deviation: 0.48
- 1% percentile: -1.4935266494750976
- 99% percentile: 2.5912899017333997

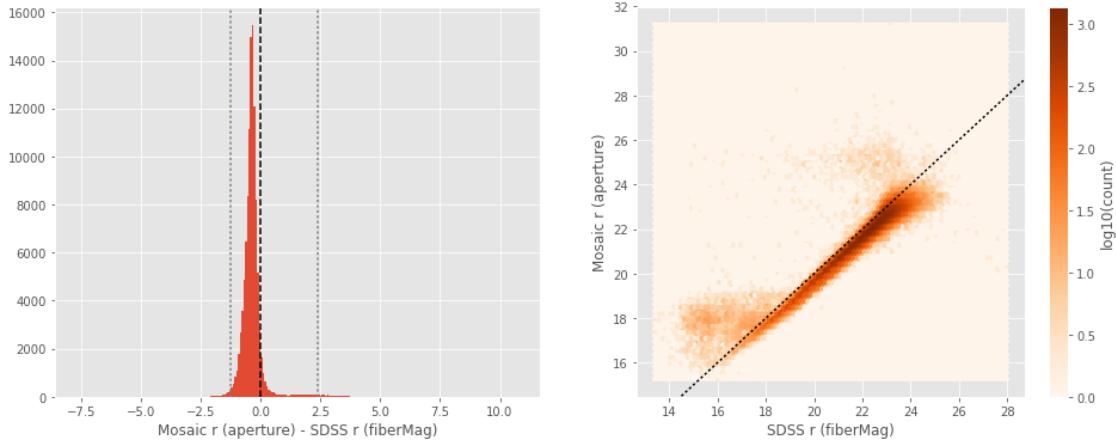


No `m_lbc_u`

No sources have both SDSS u (petroMag) and lbc u (total) values.

Mosaic r (aperture) - SDSS r (fiberMag):

- Median: -0.38
- Median Absolute Deviation: 0.15
- 1% percentile: -1.2427162170410158
- 99% percentile: 2.388106526517424

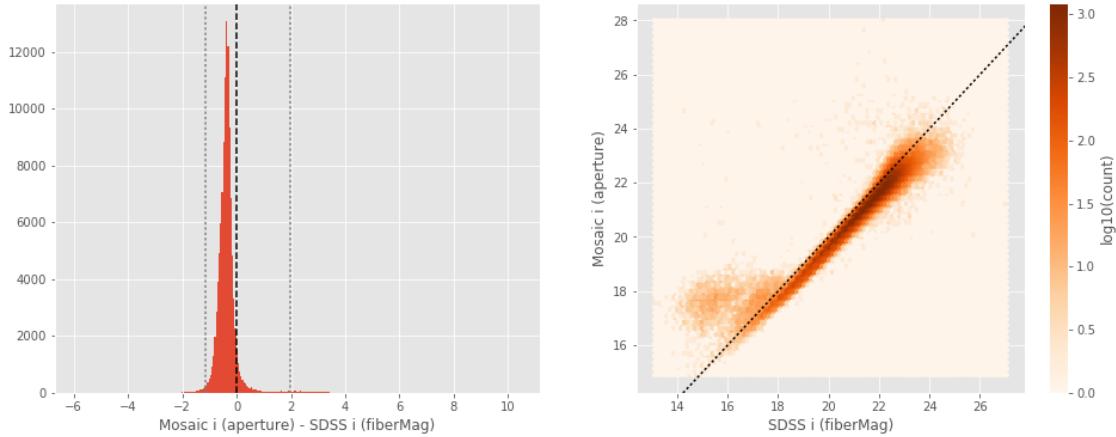


No m_mosaic_r

No sources have both SDSS r (petroMag) and Mosaic r (total) values.

Mosaic i (aperture) - SDSS i (fiberMag):

- Median: -0.38
- Median Absolute Deviation: 0.14
- 1% percentile: -1.1454618072509766
- 99% percentile: 1.975587410362594

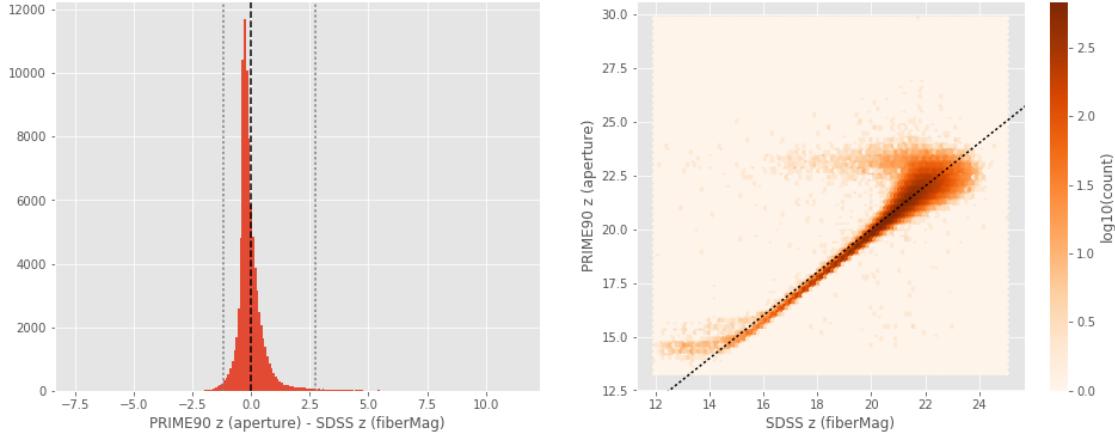


No m_mosaic_i

No sources have both SDSS i (petroMag) and Mosaic i (total) values.

PRIME90 z (aperture) - SDSS z (fiberMag):

- Median: -0.17
- Median Absolute Deviation: 0.21
- 1% percentile: -1.2076813316345214
- 99% percentile: 2.707011108398442

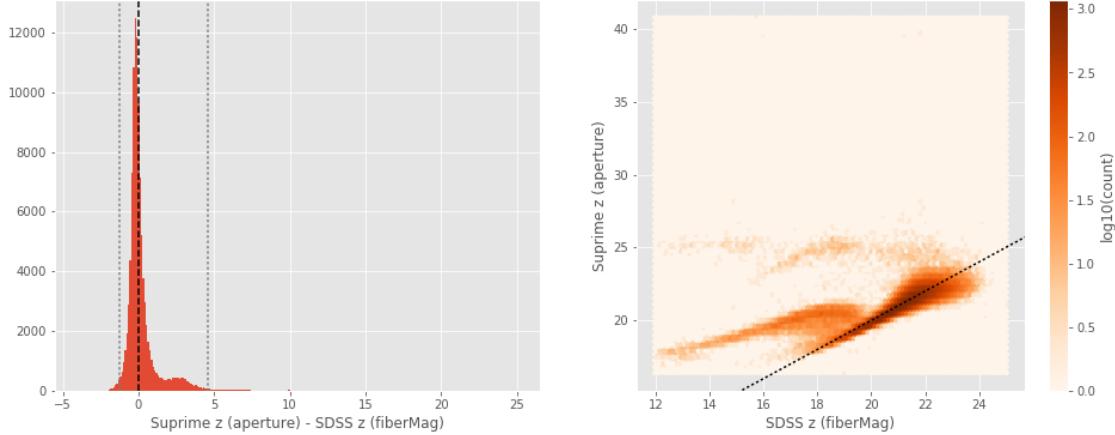


No `m_prime90_z`

No sources have both SDSS z (petroMag) and PRIME90 z (total) values.

Suprime z (aperture) - SDSS z (fiberMag):

- Median: -0.09
- Median Absolute Deviation: 0.27
- 1% percentile: -1.2514193153381348
- 99% percentile: 4.580278812588574



No `m_suprime_z`

No sources have both SDSS z (petroMag) and Suprime z (total) values.

1.5.2 III.b - Comparing J and K bands to 2MASS

The catalogue is cross-matched to 2MASS-PSC withing 0.2 arcsecond. We compare the UKIDSS total J and K magnitudes to those from 2MASS.

The 2MASS magnitudes are “*Vega-like*” and we have to convert them to AB magnitudes using the zero points provided on [this page](#):

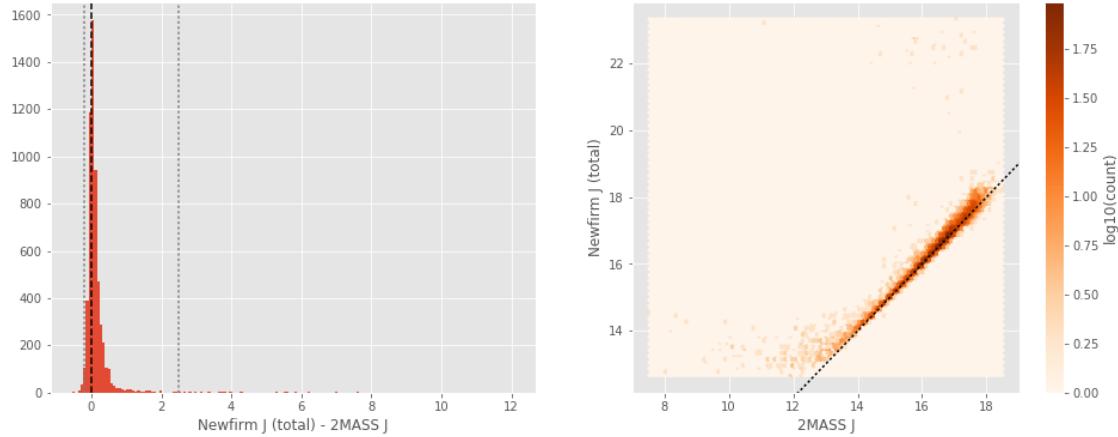
Band	F - 0 mag (Jy)
J	1594
H	1024
Ks	666.7

In addition, UKIDSS uses a K band whereas 2MASS uses a Ks (“short”) band, [this page](#) give a correction to convert the K band in a Ks band with the formula:

$$K_{s(2MASS)} = K_{UKIRT} + 0.003 + 0.004 * (JK)_{UKIRT}$$

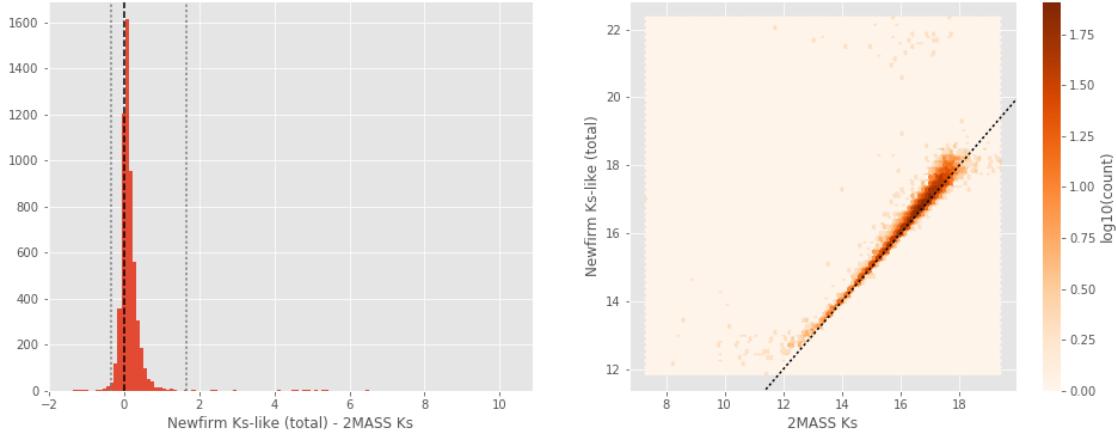
Newfirm J (total) - 2MASS J:

- Median: 0.06
- Median Absolute Deviation: 0.08
- 1% percentile: -0.20999463988321493
- 99% percentile: 2.499920256823075



Newfirm Ks-like (total) - 2MASS Ks:

- Median: 0.09
- Median Absolute Deviation: 0.10
- 1% percentile: -0.36023741652093016
- 99% percentile: 1.6431110585128939



1.6 Keeping only sources with good signal to noise ratio

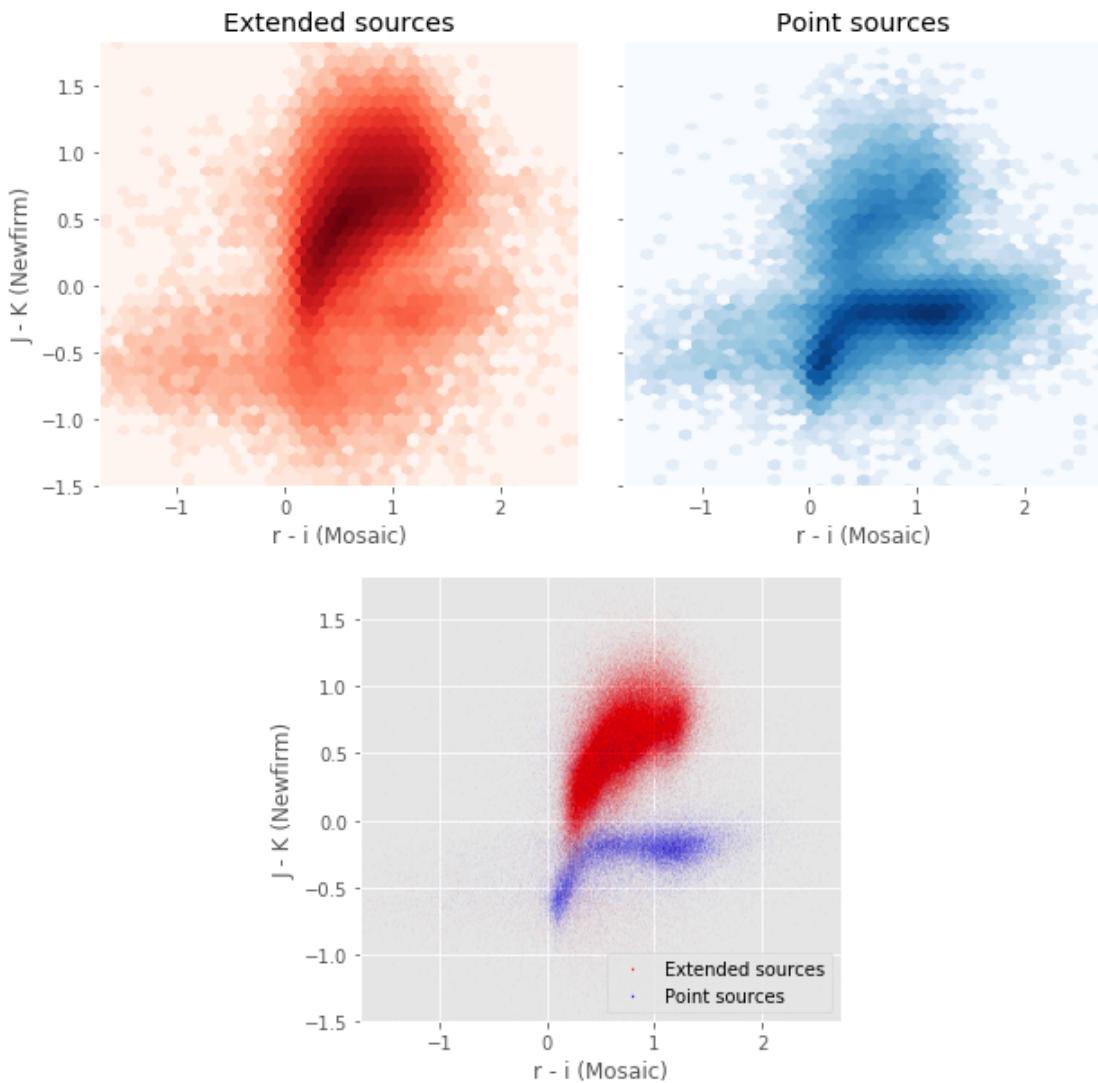
From here, we are only comparing sources with a signal to noise ratio above 3, i.e. roughly we a magnitude error below 0.3.

To make it easier, we are setting to NaN in the catalogue the magnitudes associated with an error above 0.3 so we can't use these magnitudes after the next cell.

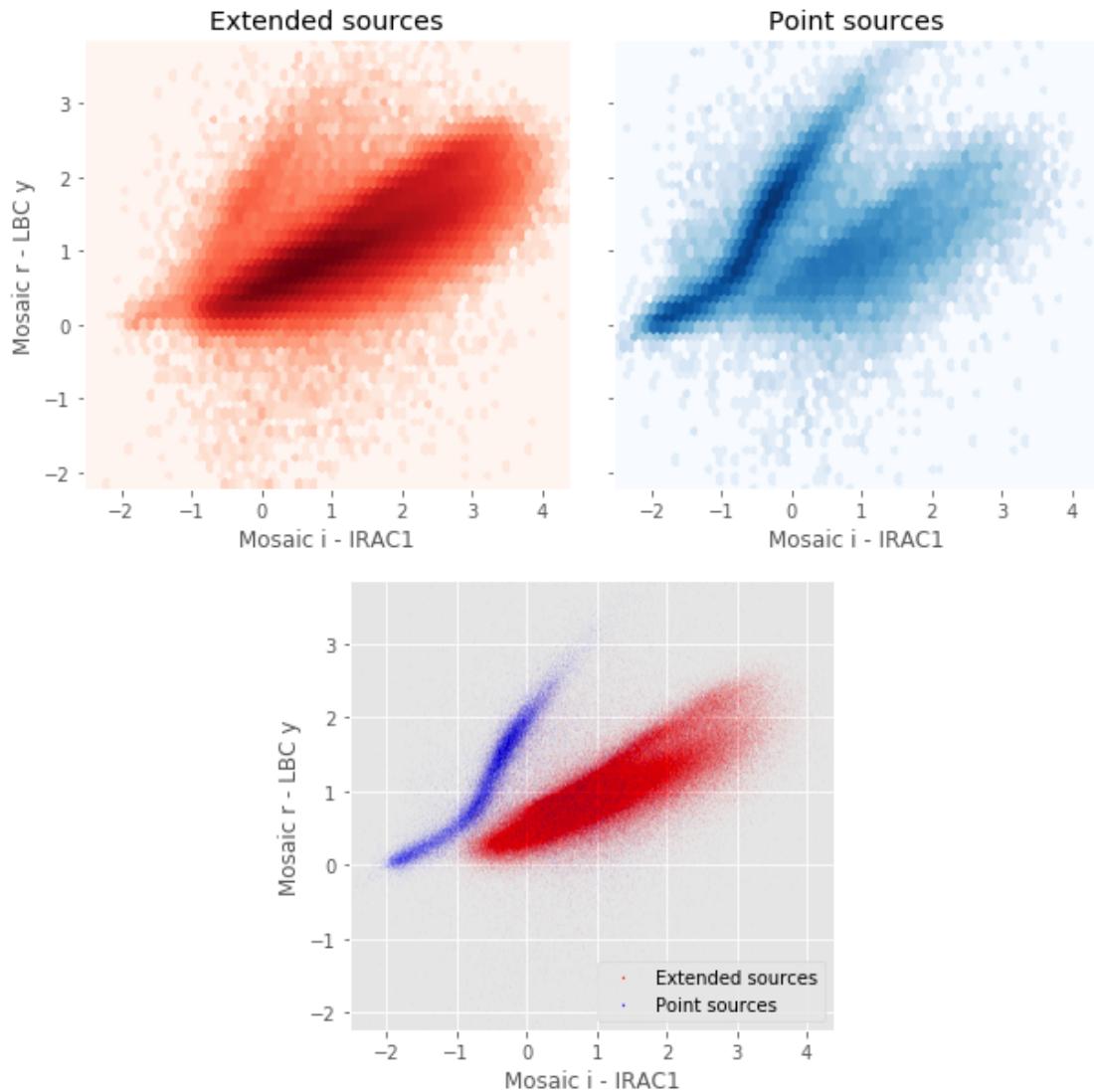
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/_main_.py:4: M
Check the NumPy 1.11 release notes for more information.
```

1.7 V - Color-color and magnitude-color plots

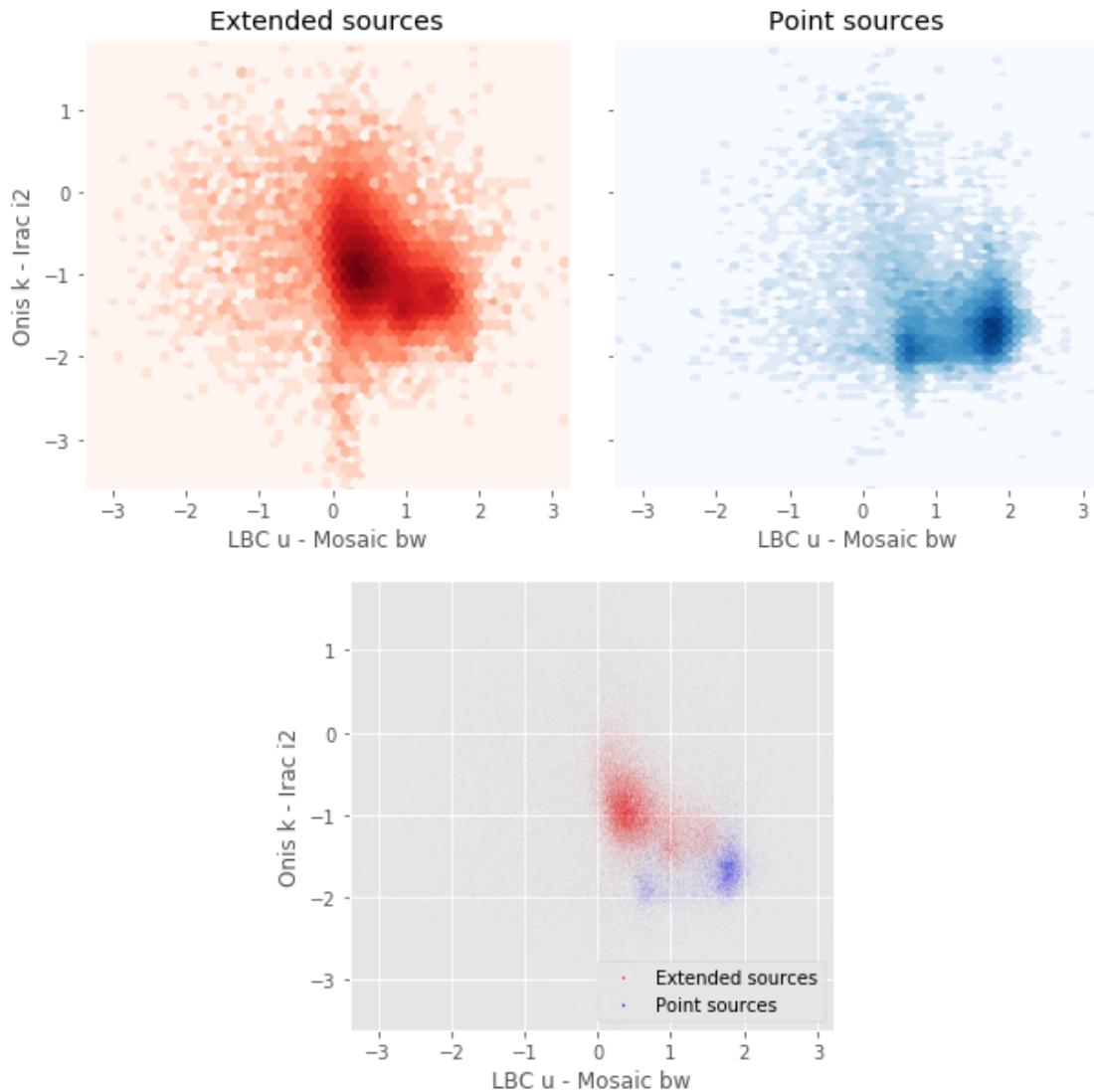
Number of source used: 275707 / 2252093 (12.24%)



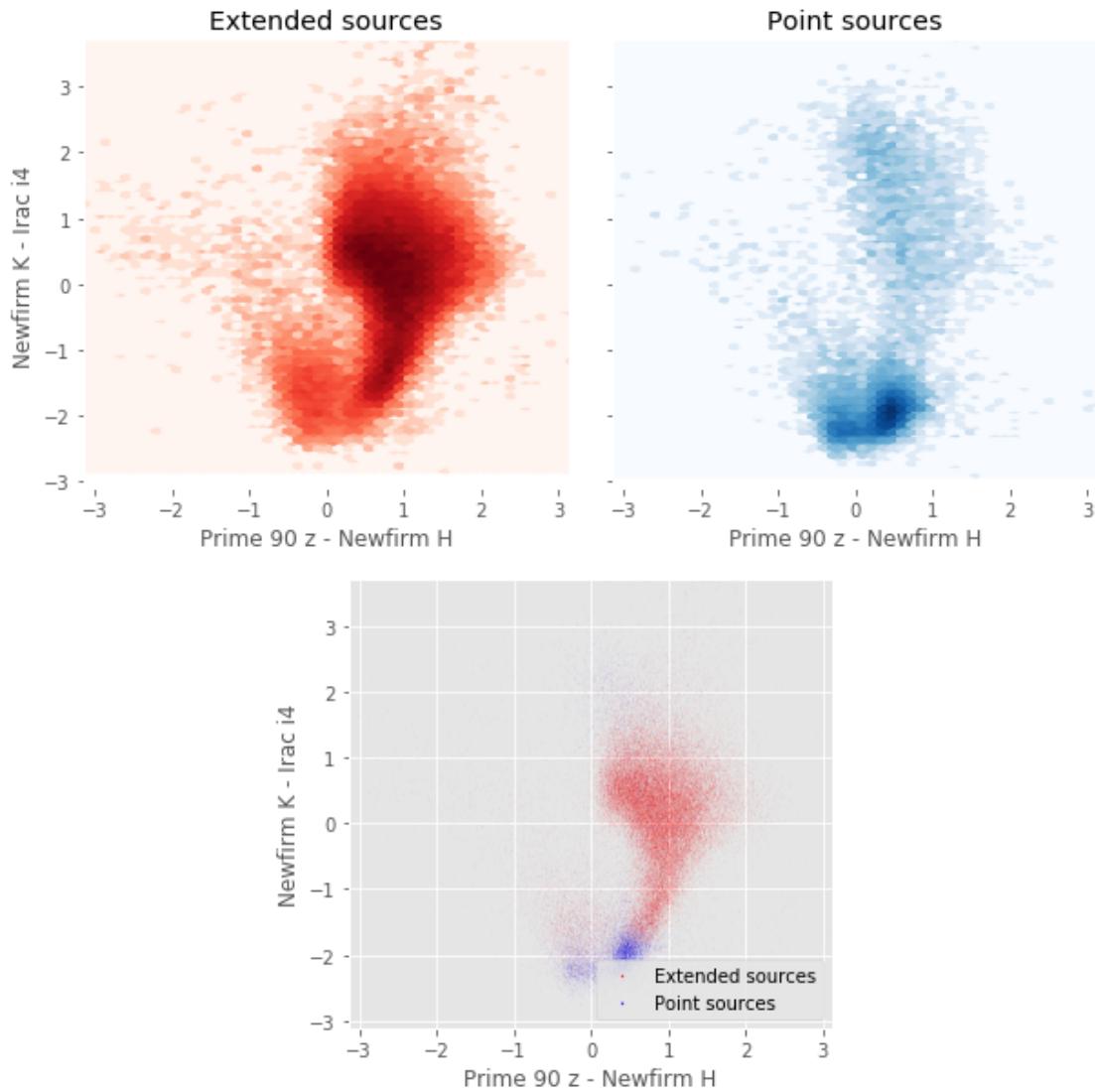
Number of source used: 406736 / 2252093 (18.06%)



Number of source used: 41857 / 2252093 (1.86%)



Number of source used: 74417 / 2252093 (3.30%)



3.1_HELP_Checks_and_diagnostics

January 18, 2018

1 Bootes master catalogue

1.1 Checks and diagnostics

This notebook was run with herschelhelp_internal version:
33f5ec7 (Wed Dec 6 16:56:17 2017 +0000)

Diagnostics done using: master_catalogue_bootes_HELP_20180111.fits

1.2 0 - Quick checks

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
    format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
    format(shape, fill_value, array(fill_value).dtype), FutureWarning)
```

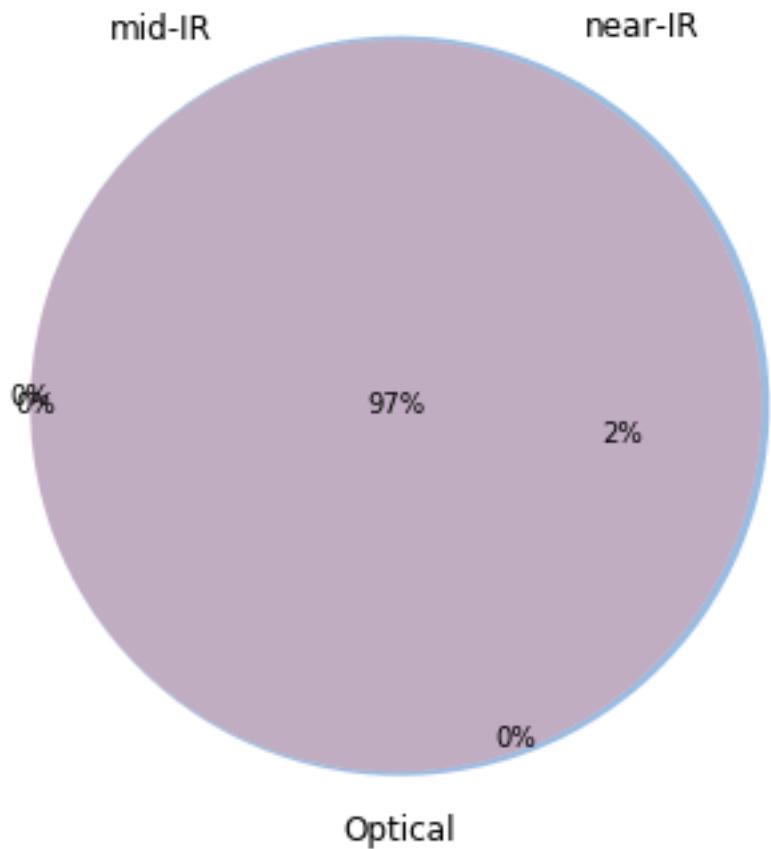
Table shows only problematic columns.

Out [4]: <IPython.core.display.HTML object>

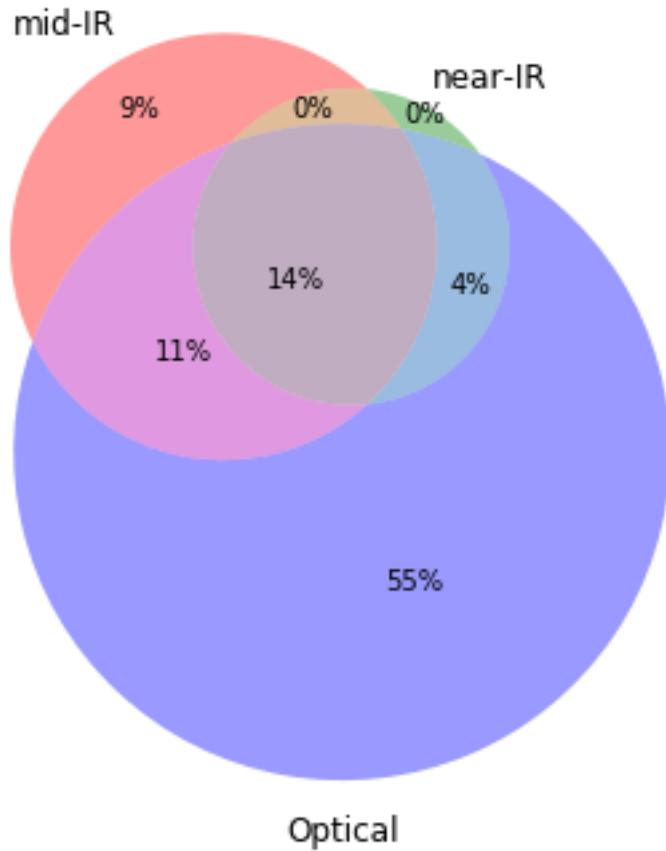
1.3 I - Summary of wavelength domains

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/matplotlib_venn/_venn3.py:
    warnings.warn("Bad circle positioning")
```

Wavelength domain observations



Detection of the 1,926,373 sources detected
in any wavelength domains (among 3,388,482 sources)



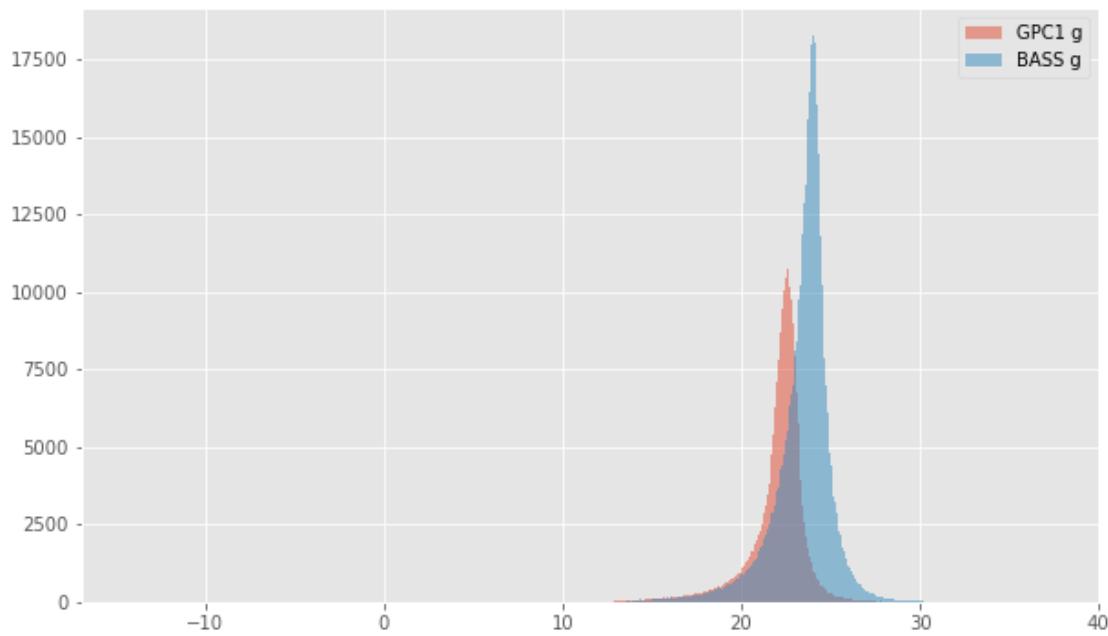
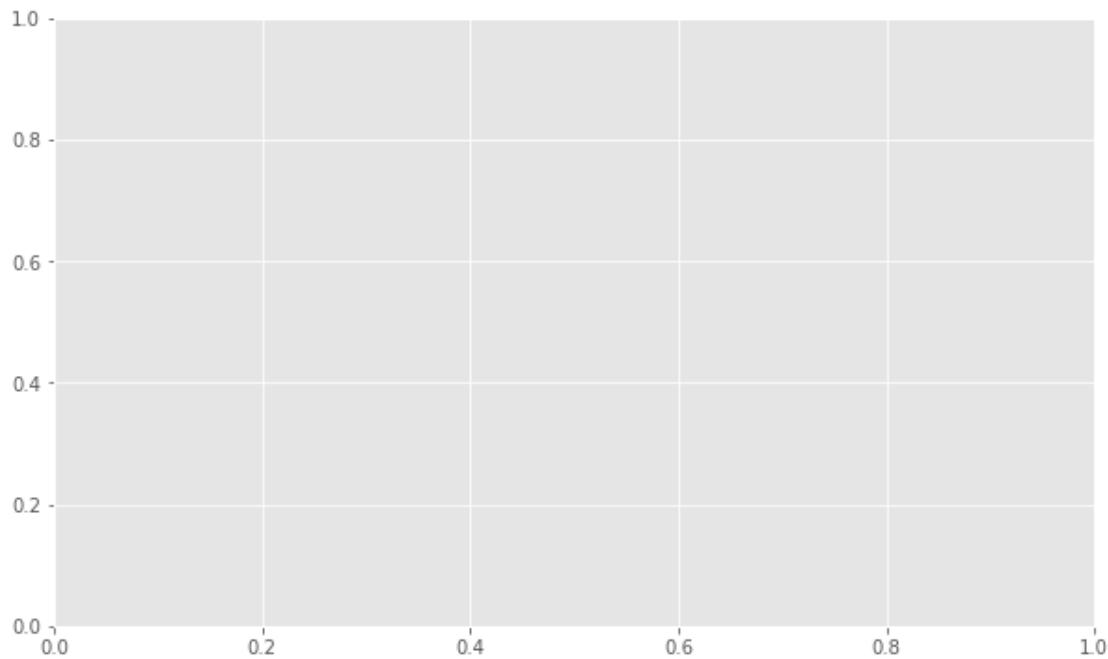
1.4 II - Comparing magnitudes in similar filters

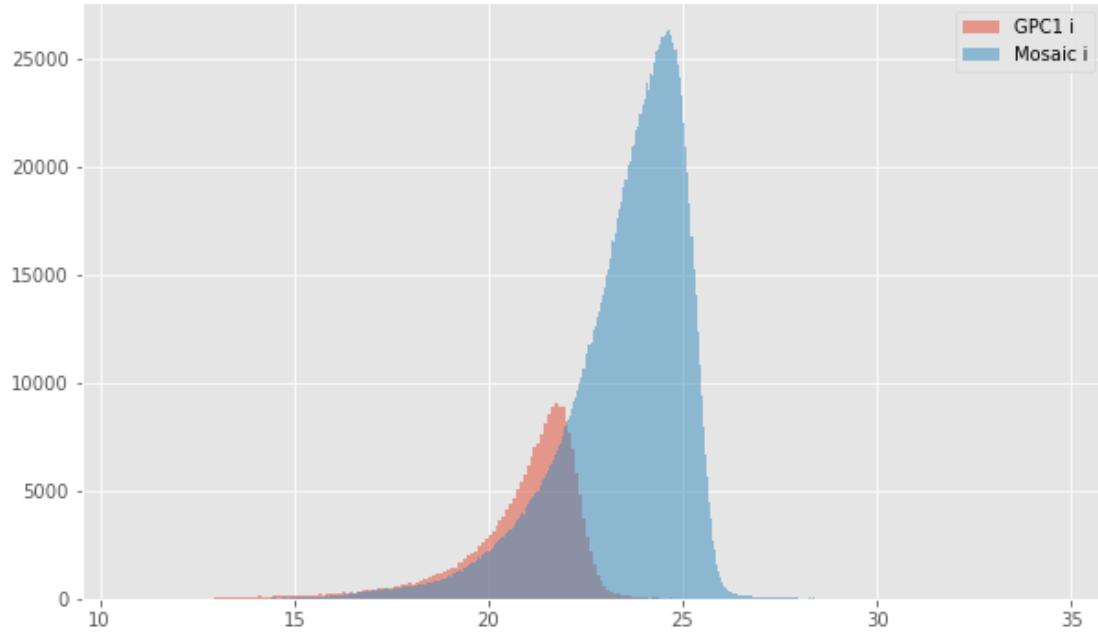
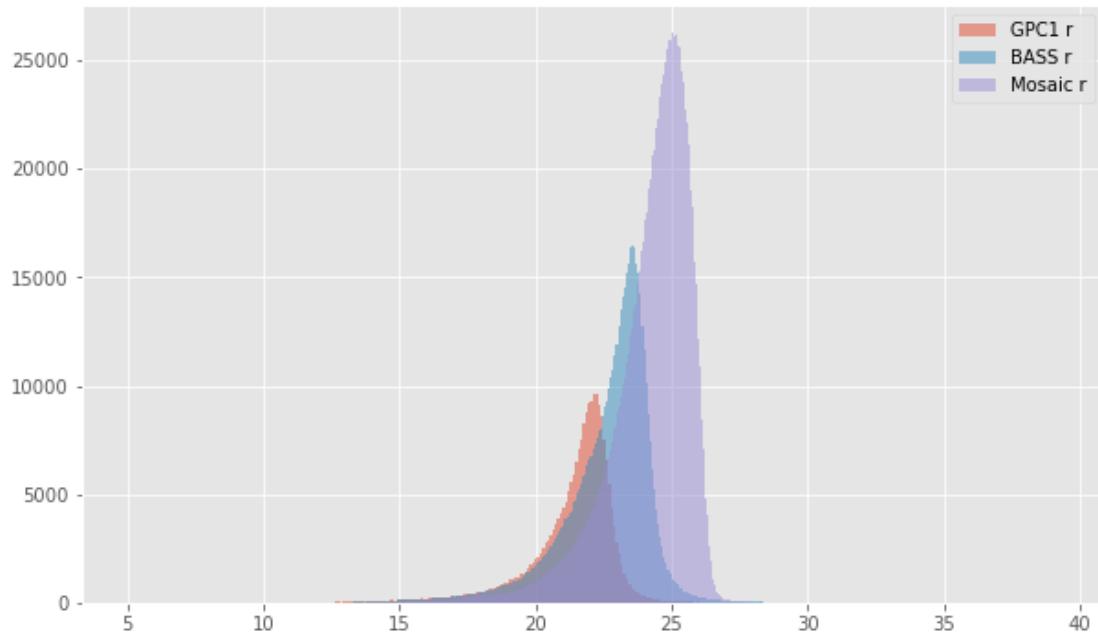
The master list is composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

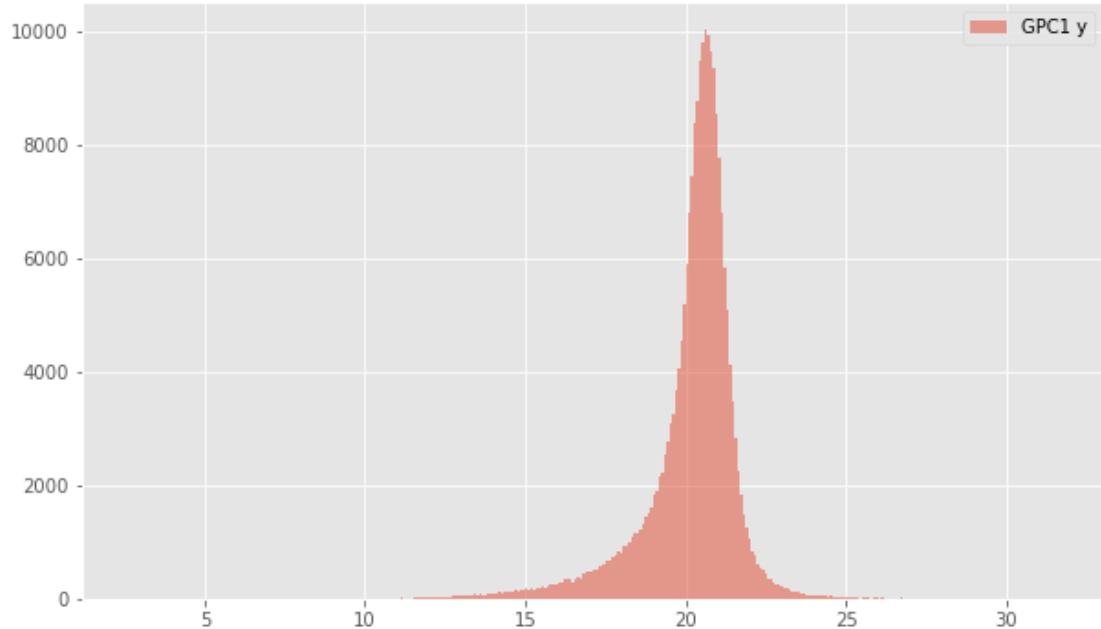
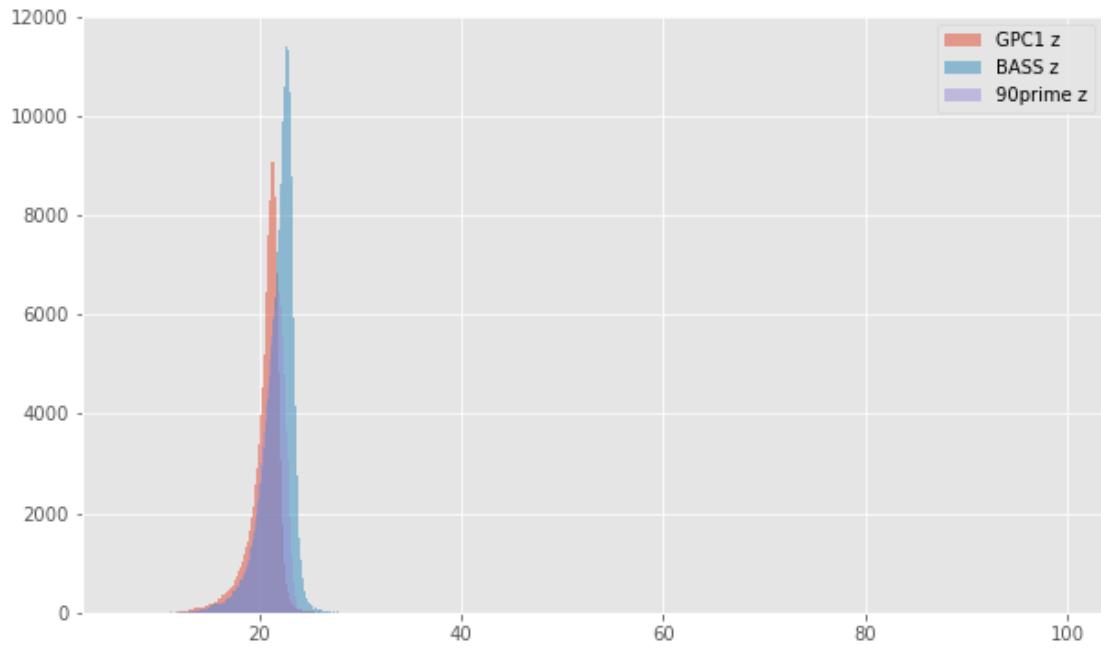
1.4.1 II.a - Comparing depths

We compare the histograms of the total aperture magnitudes of similar bands.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/matplotlib/axes/_axes.py:5
    warnings.warn("No labelled objects found. "
```





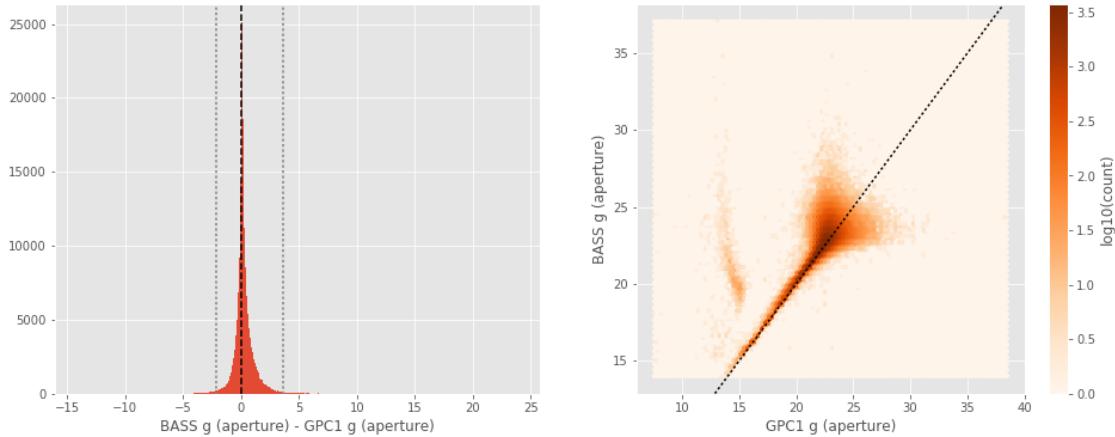


1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

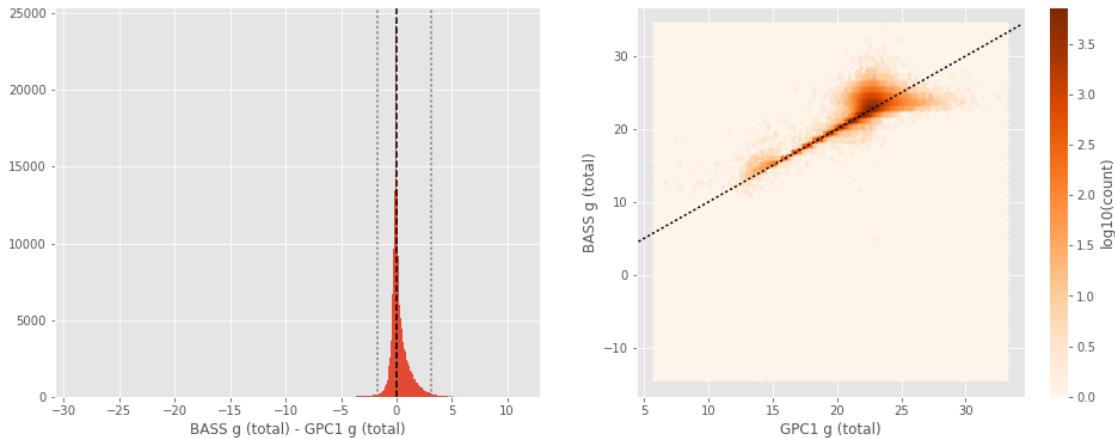
BASS g (aperture) - GPC1 g (aperture):

- Median: 0.13
- Median Absolute Deviation: 0.27
- 1% percentile: -2.1558848571777345
- 99% percentile: 3.624149322509765



BASS g (total) - GPC1 g (total):

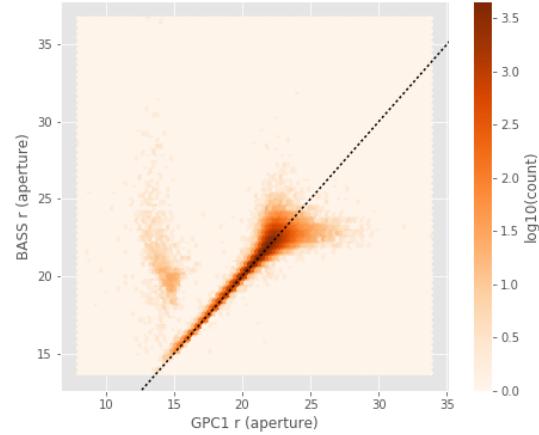
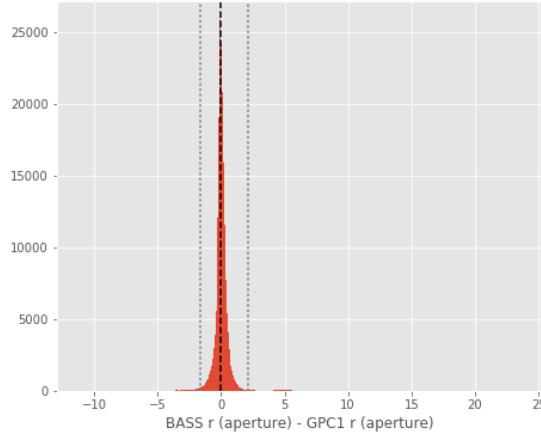
- Median: 0.01
- Median Absolute Deviation: 0.27
- 1% percentile: -1.7584948539733887
- 99% percentile: 3.16856803894043



BASS r (aperture) - GPC1 r (aperture):

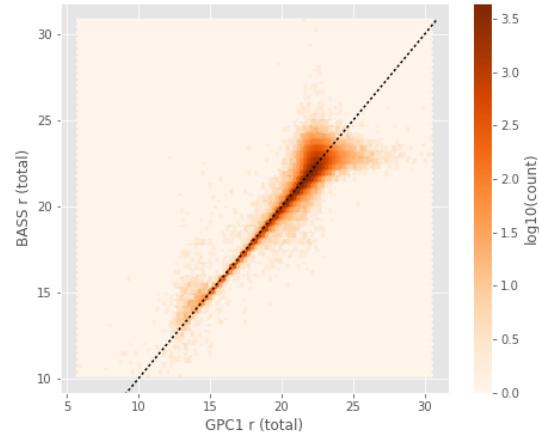
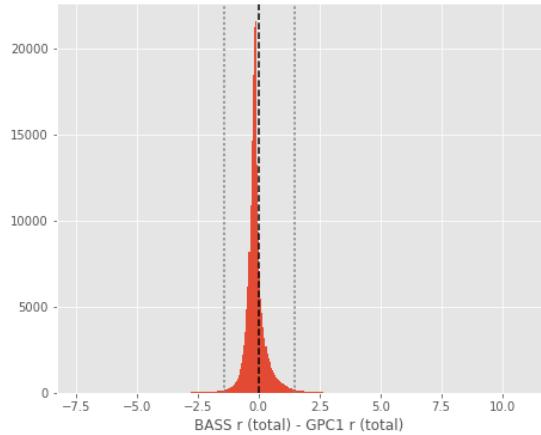
- Median: 0.01

- Median Absolute Deviation: 0.19
- 1% percentile: -1.6478734016418457
- 99% percentile: 2.0846044635772616



BASS r (total) - GPC1 r (total):

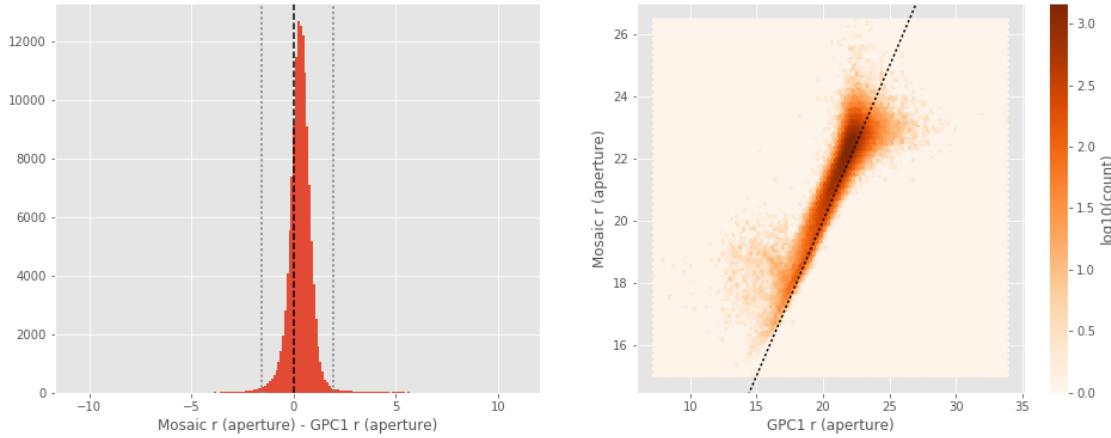
- Median: -0.16
- Median Absolute Deviation: 0.15
- 1% percentile: -1.4110986709594726
- 99% percentile: 1.466648483276367



Mosaic r (aperture) - GPC1 r (aperture):

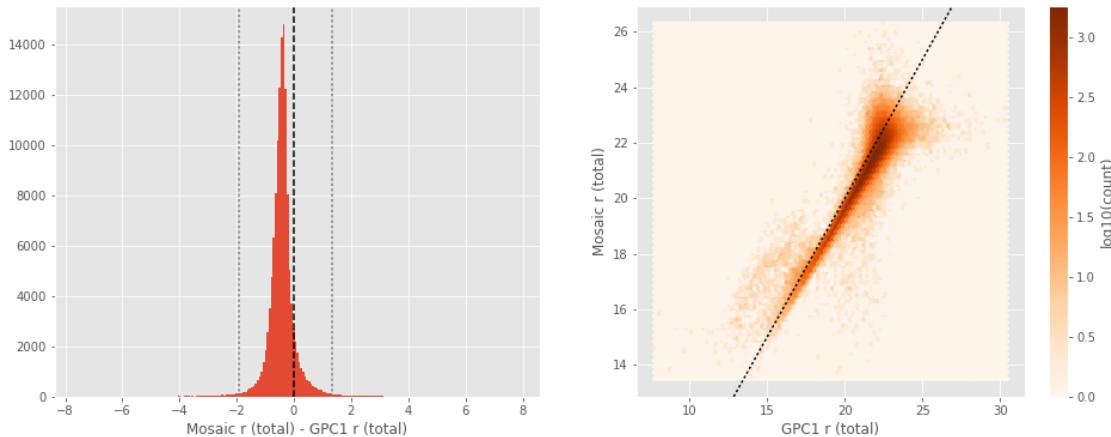
- Median: 0.32
- Median Absolute Deviation: 0.30
- 1% percentile: -1.5543725476989732

- 99% percentile: 1.9533455380248914



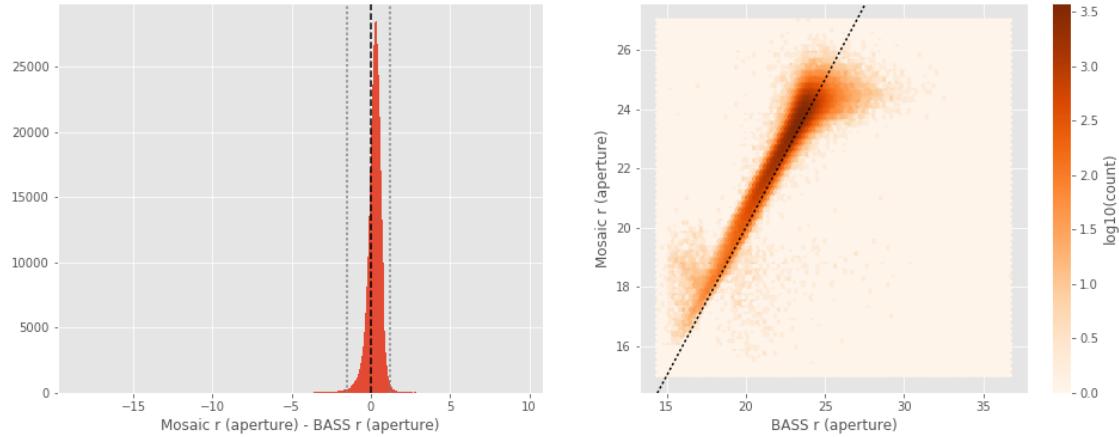
Mosaic r (total) - GPC1 r (total):

- Median: -0.42
- Median Absolute Deviation: 0.18
- 1% percentile: -1.9438456686096197
- 99% percentile: 1.3285997677612298



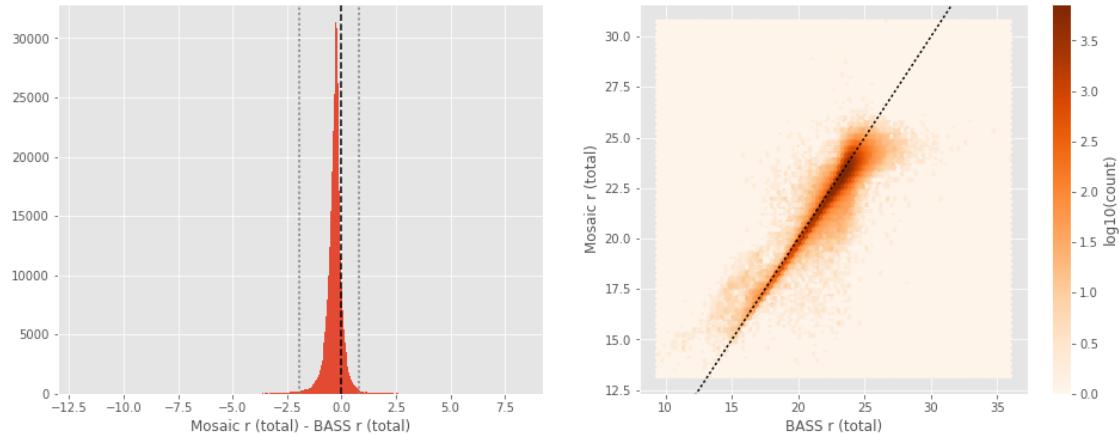
Mosaic r (aperture) - BASS r (aperture):

- Median: 0.26
- Median Absolute Deviation: 0.24
- 1% percentile: -1.5048314084472654
- 99% percentile: 1.1905264020996087



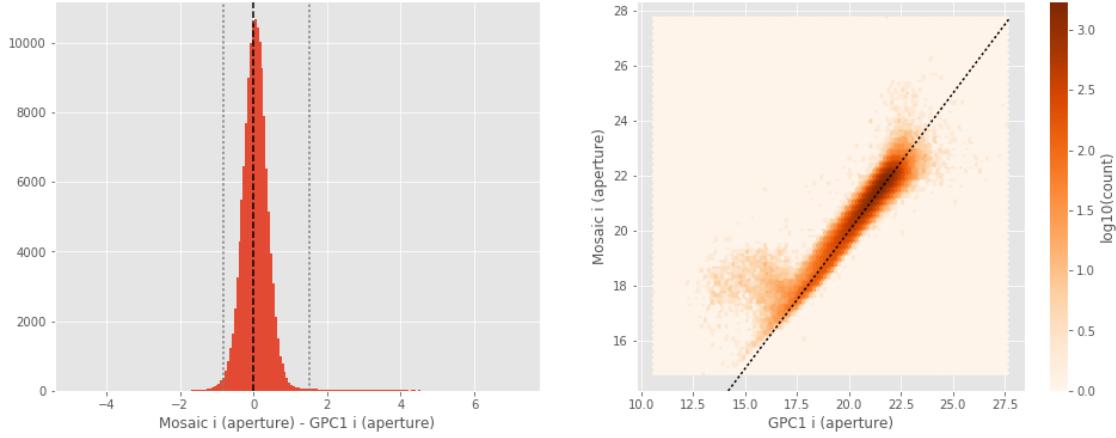
Mosaic r (total) - BASS r (total):

- Median: -0.29
- Median Absolute Deviation: 0.16
- 1% percentile: -1.9414329913330073
- 99% percentile: 0.7985939500732392



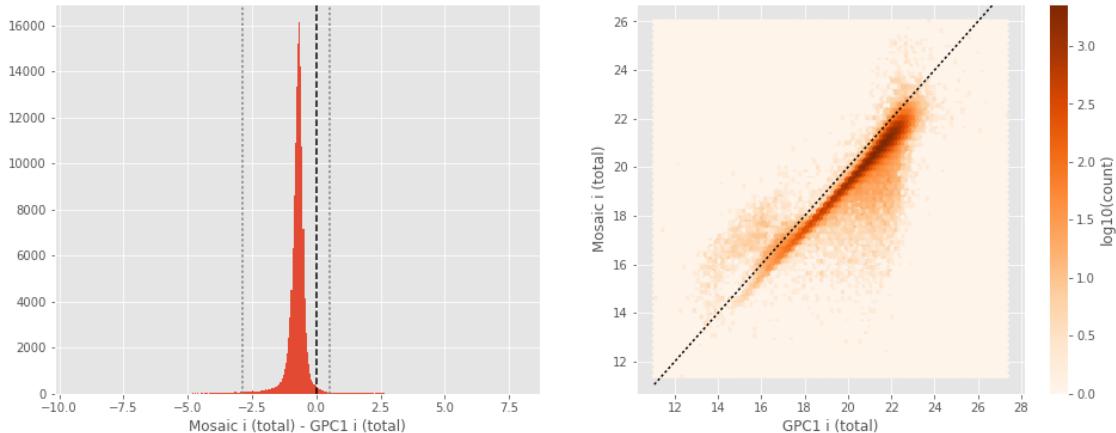
Mosaic i (aperture) - GPC1 i (aperture):

- Median: 0.05
- Median Absolute Deviation: 0.22
- 1% percentile: -0.8175293390808115
- 99% percentile: 1.5236310905456432



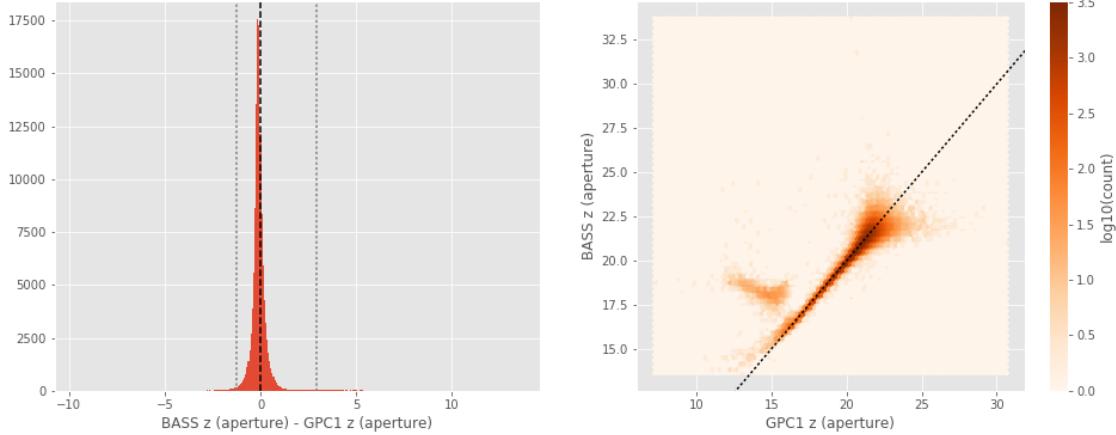
Mosaic i (total) - GPC1 i (total):

- Median: -0.70
- Median Absolute Deviation: 0.13
- 1% percentile: -2.8845257424011237
- 99% percentile: 0.5245688302917544



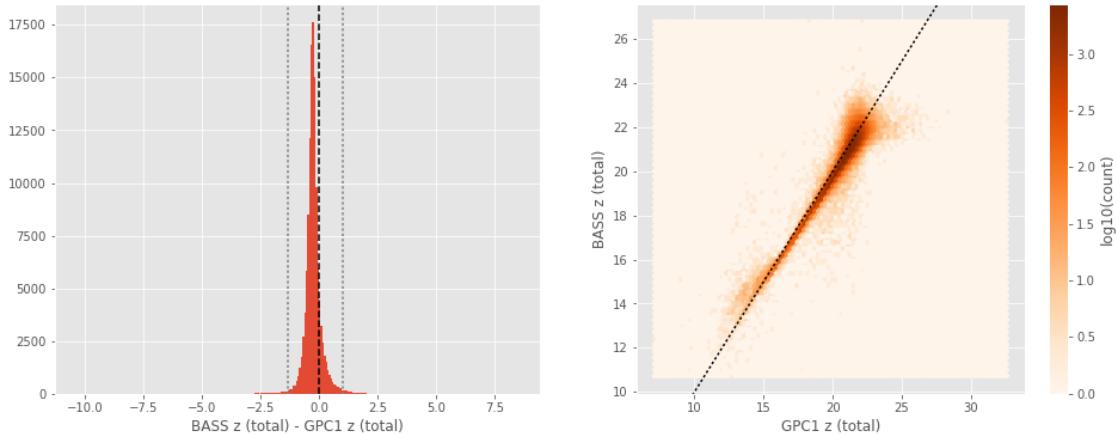
BASS z (aperture) - GPC1 z (aperture):

- Median: -0.10
- Median Absolute Deviation: 0.14
- 1% percentile: -1.2721107482910157
- 99% percentile: 2.941773223876948



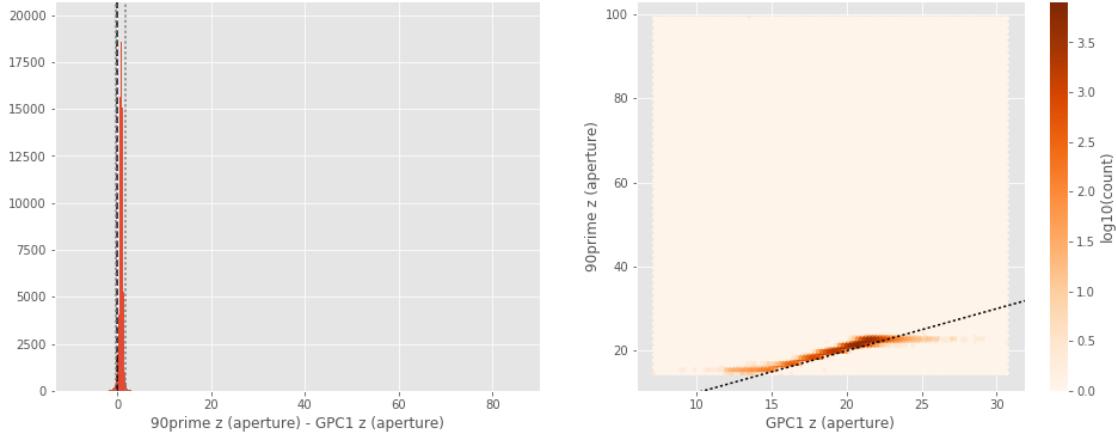
BASS z (total) - GPC1 z (total):

- Median: -0.28
- Median Absolute Deviation: 0.14
- 1% percentile: -1.3286592864990234
- 99% percentile: 0.979087142944336



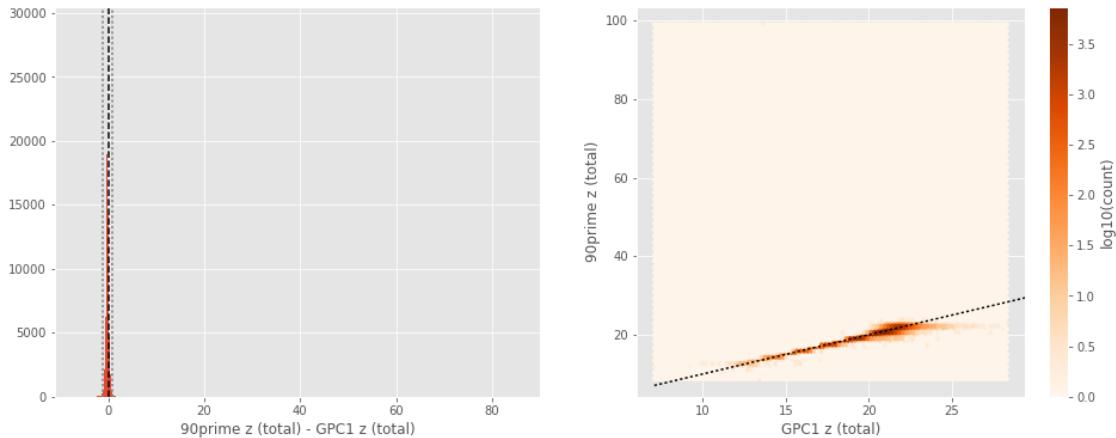
90prime z (aperture) - GPC1 z (aperture):

- Median: 0.80
- Median Absolute Deviation: 0.23
- 1% percentile: -0.43189697265624993
- 99% percentile: 1.6813874053955074



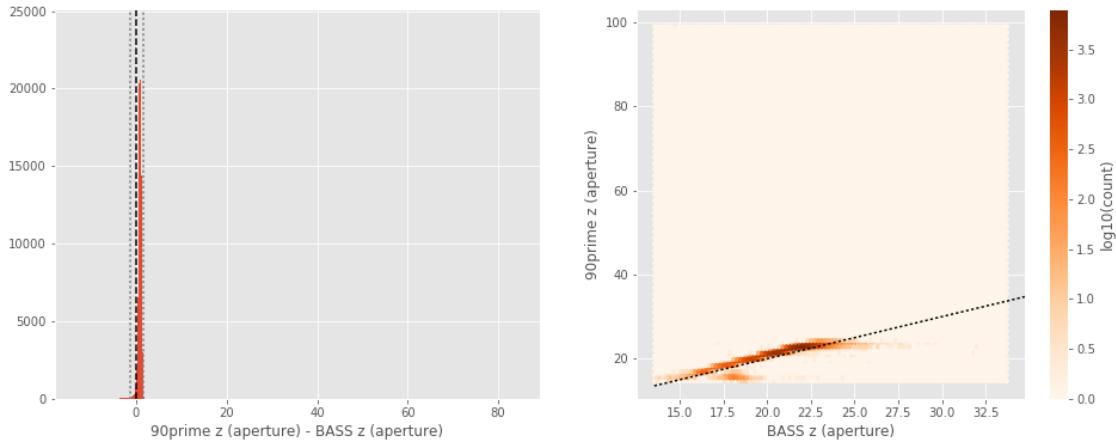
90prime z (total) - GPC1 z (total):

- Median: -0.20
- Median Absolute Deviation: 0.13
- 1% percentile: -1.2456600189208984
- 99% percentile: 0.7505413055419916



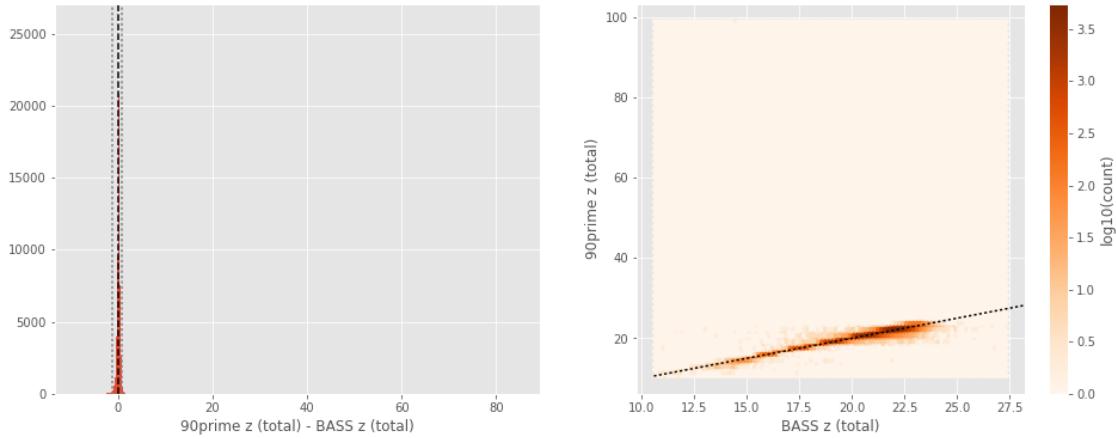
90prime z (aperture) - BASS z (aperture):

- Median: 0.85
- Median Absolute Deviation: 0.20
- 1% percentile: -1.3515640258789061
- 99% percentile: 1.4728759765625004



90prime z (total) - BASS z (total):

- Median: 0.09
- Median Absolute Deviation: 0.15
- 1% percentile: -1.181374053955078
- 99% percentile: 0.8647583007812494



1.5 III - Comparing magnitudes to reference bands

Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

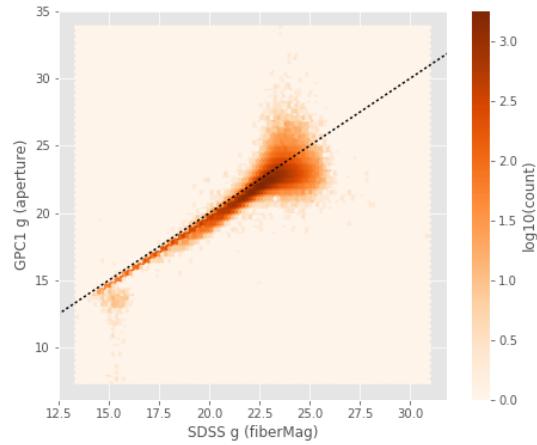
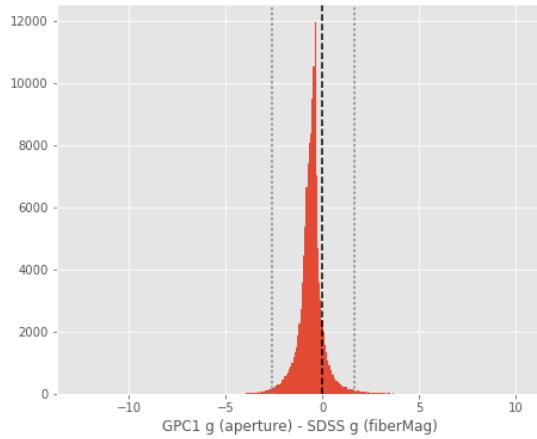
1.5.1 III.a - Comparing u, g, r, i, and z bands to SDSS

The catalogue is cross-matched to SDSS-DR13 withing 0.2 arcsecond.

We compare the u, g, r, i, and z magnitudes to those from SDSS using `fiberMag` for the aperture magnitude and `petroMag` for the total magnitude.

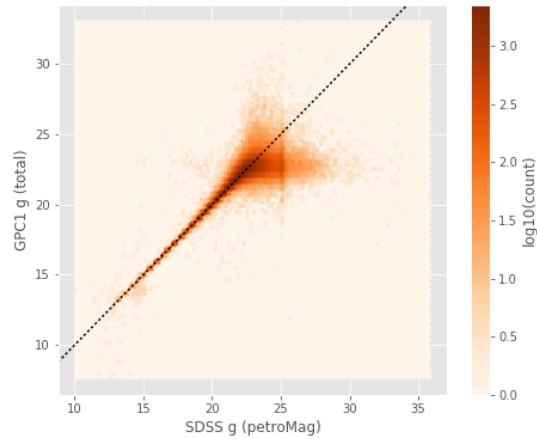
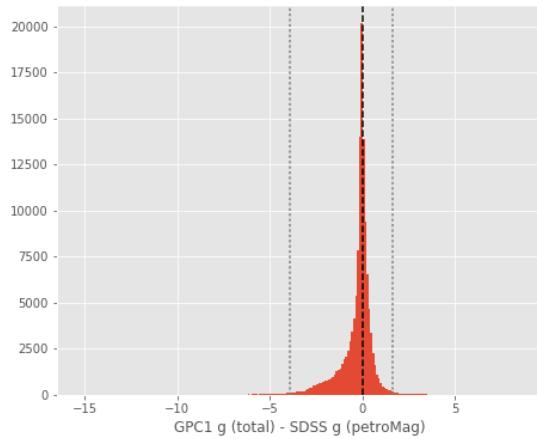
GPC1 g (aperture) - SDSS g (fiberMag):

- Median: -0.55
- Median Absolute Deviation: 0.27
- 1% percentile: -2.6034235382080078
- 99% percentile: 1.6591714096069339



GPC1 g (total) - SDSS g (petroMag):

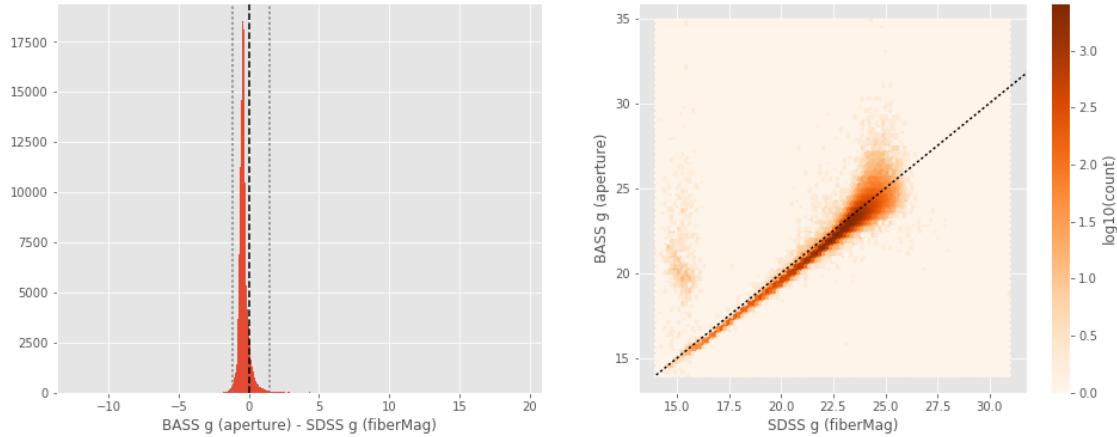
- Median: -0.07
- Median Absolute Deviation: 0.26
- 1% percentile: -3.896455383300781
- 99% percentile: 1.6326969146728527



BASS g (aperture) - SDSS g (fiberMag):

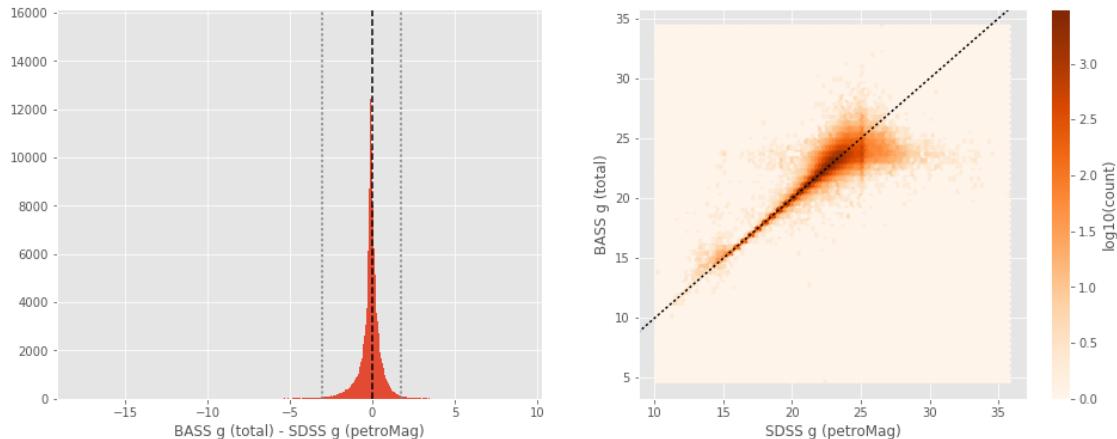
- Median: -0.41

- Median Absolute Deviation: 0.15
- 1% percentile: -1.1409005737304687
- 99% percentile: 1.4991419219971012



BASS g (total) - SDSS g (petroMag):

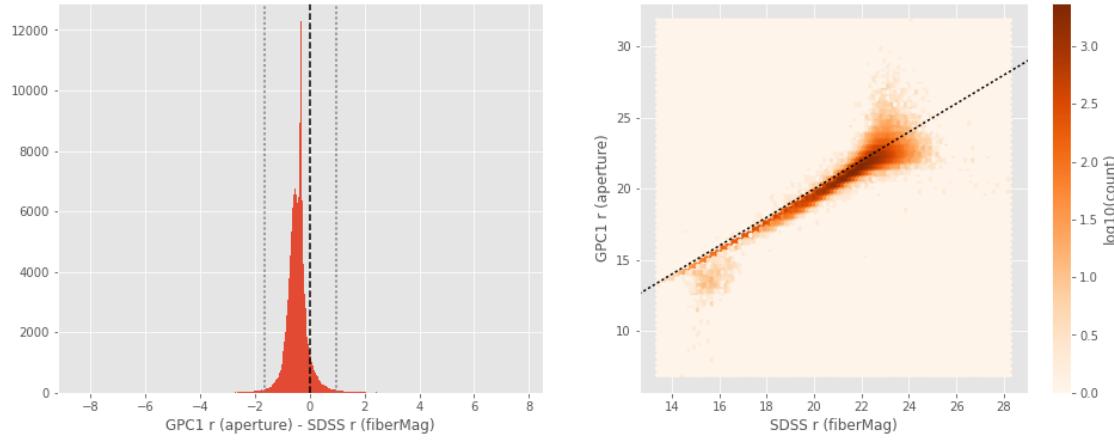
- Median: -0.08
- Median Absolute Deviation: 0.22
- 1% percentile: -3.024509620666504
- 99% percentile: 1.7733711624145534



GPC1 r (aperture) - SDSS r (fiberMag):

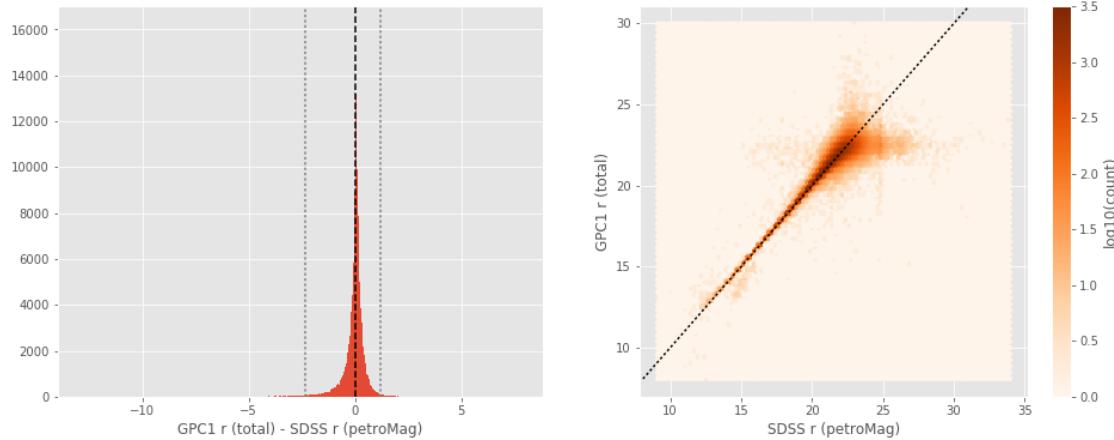
- Median: -0.45
- Median Absolute Deviation: 0.18
- 1% percentile: -1.6361807250976563

- 99% percentile: 0.9835488510131456



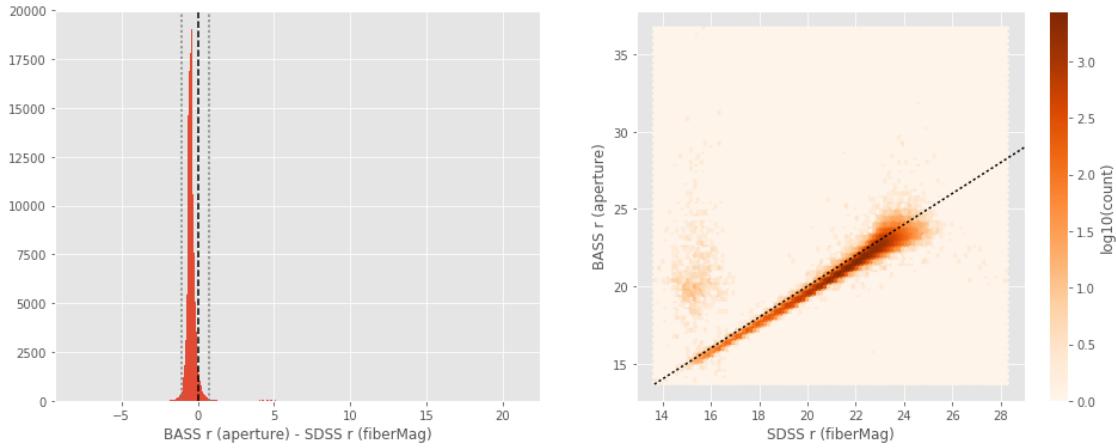
GPC1 r (total) - SDSS r (petroMag):

- Median: 0.03
- Median Absolute Deviation: 0.15
- 1% percentile: -2.361153564453125
- 99% percentile: 1.1698699951171851



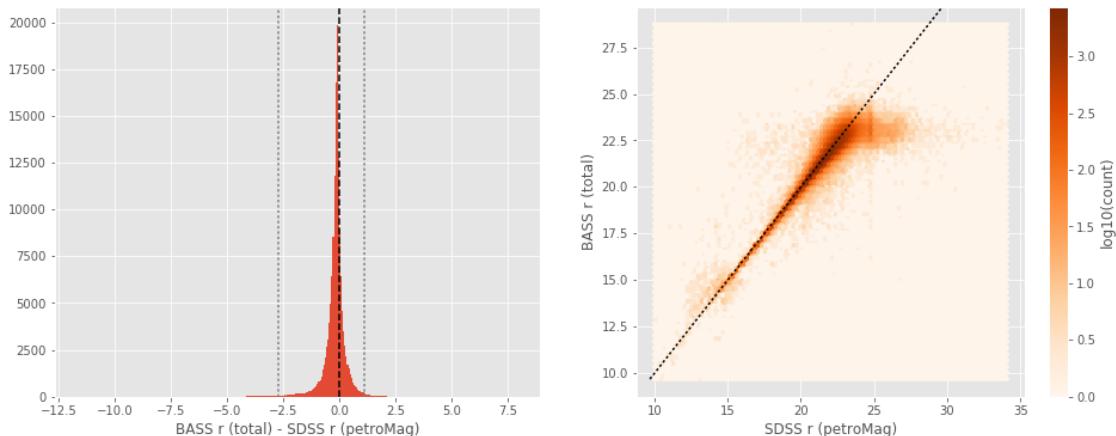
BASS r (aperture) - SDSS r (fiberMag):

- Median: -0.45
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0858132362365722
- 99% percentile: 0.7321663665771609



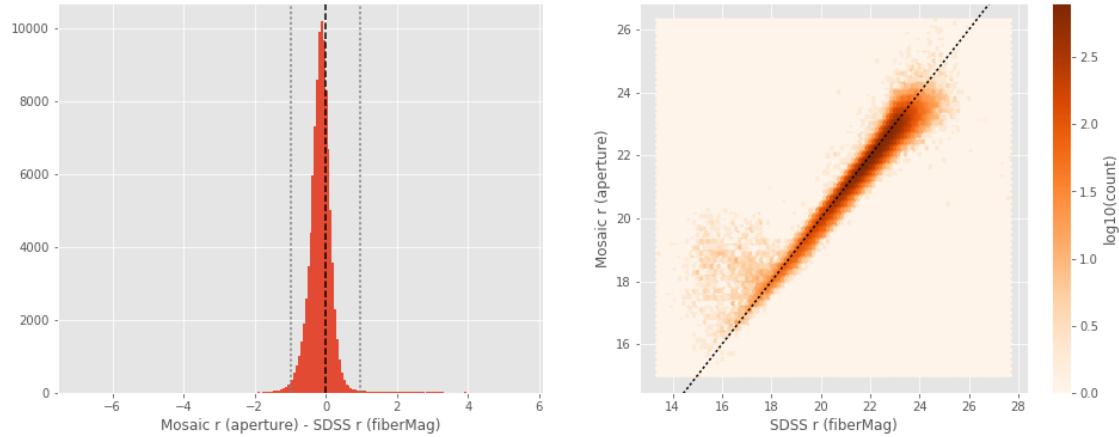
BASS r (total) - SDSS r (petroMag):

- Median: -0.14
- Median Absolute Deviation: 0.15
- 1% percentile: -2.7322116088867188
- 99% percentile: 1.1080004882812462



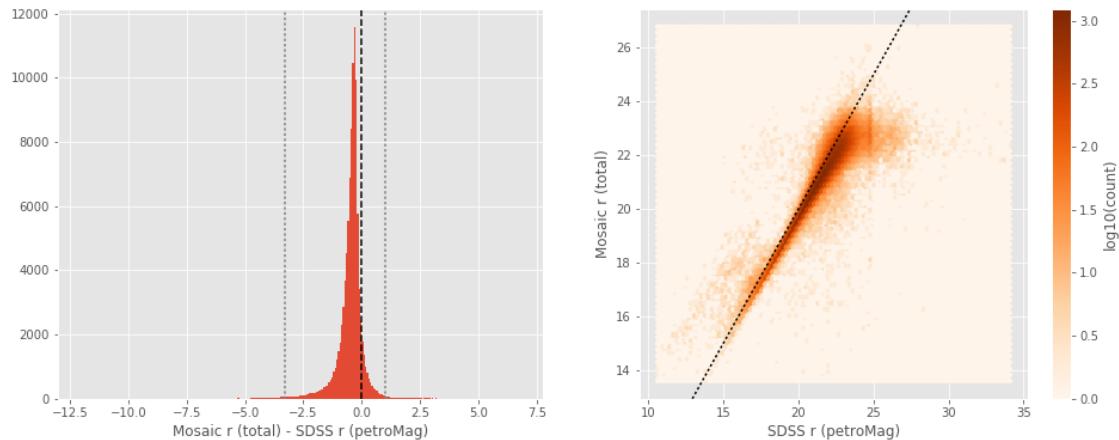
Mosaic r (aperture) - SDSS r (fiberMag):

- Median: -0.14
- Median Absolute Deviation: 0.17
- 1% percentile: -0.9998389564514172
- 99% percentile: 0.9589054608154217



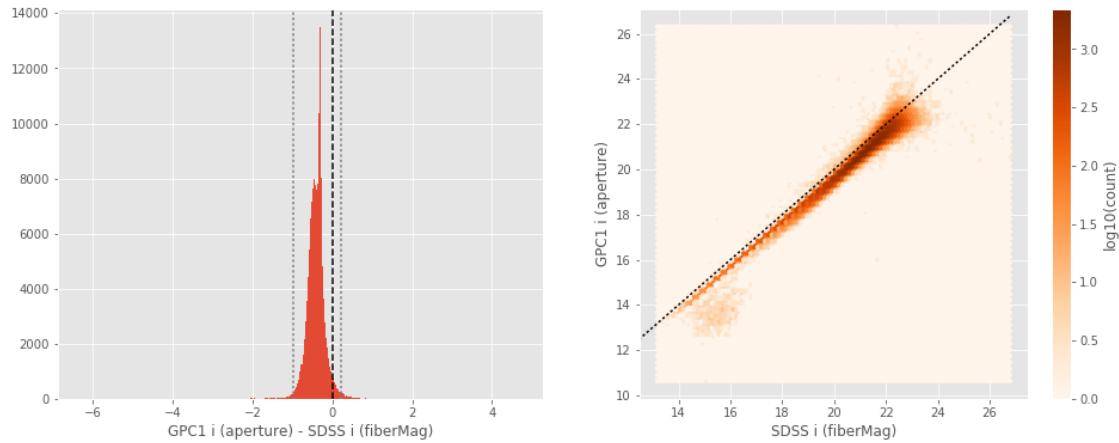
Mosaic r (total) - SDSS r (petroMag):

- Median: -0.39
- Median Absolute Deviation: 0.19
- 1% percentile: -3.2797517349243166
- 99% percentile: 1.0121476103210338



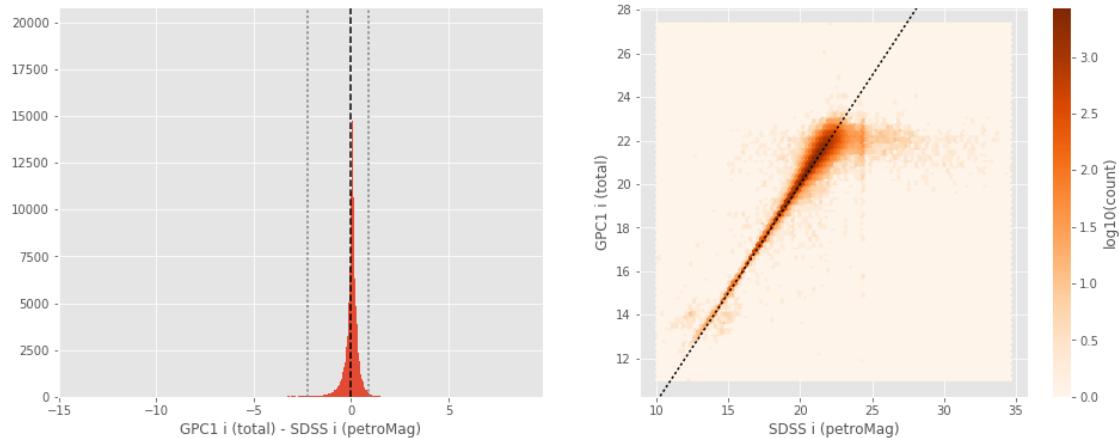
GPC1 i (aperture) - SDSS i (fiberMag):

- Median: -0.41
- Median Absolute Deviation: 0.11
- 1% percentile: -0.9914297962188721
- 99% percentile: 0.2297468376159671



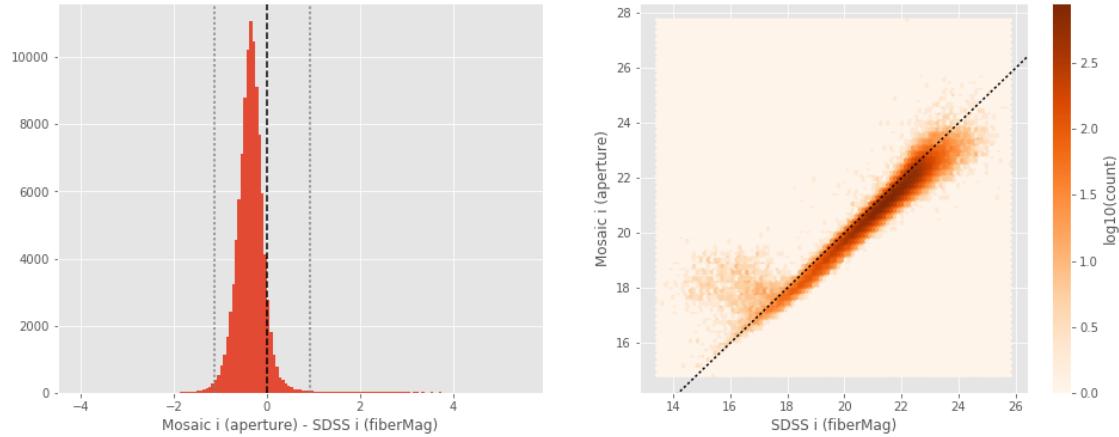
GPC1 i (total) - SDSS i (petroMag):

- Median: 0.05
- Median Absolute Deviation: 0.12
- 1% percentile: -2.2184738159179687
- 99% percentile: 0.8837654113769535



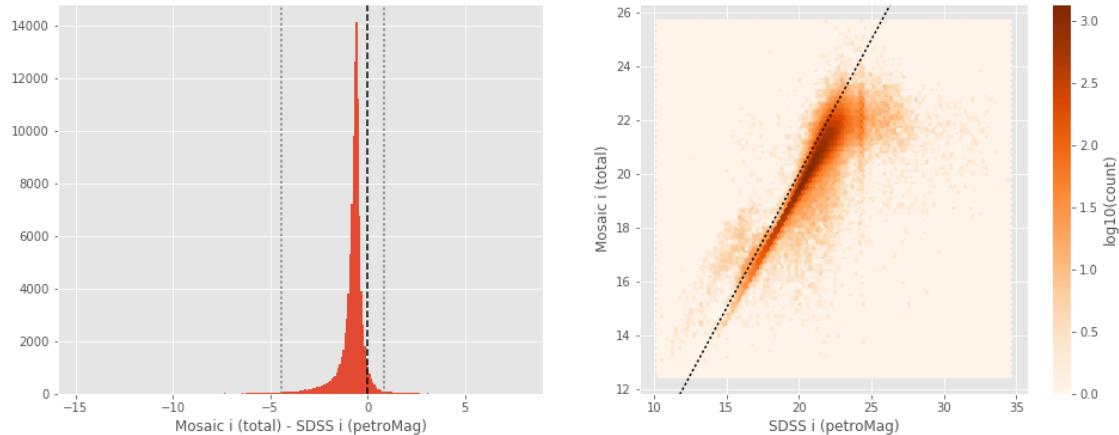
Mosaic i (aperture) - SDSS i (fiberMag):

- Median: -0.35
- Median Absolute Deviation: 0.17
- 1% percentile: -1.124779717590332
- 99% percentile: 0.9277369622192353



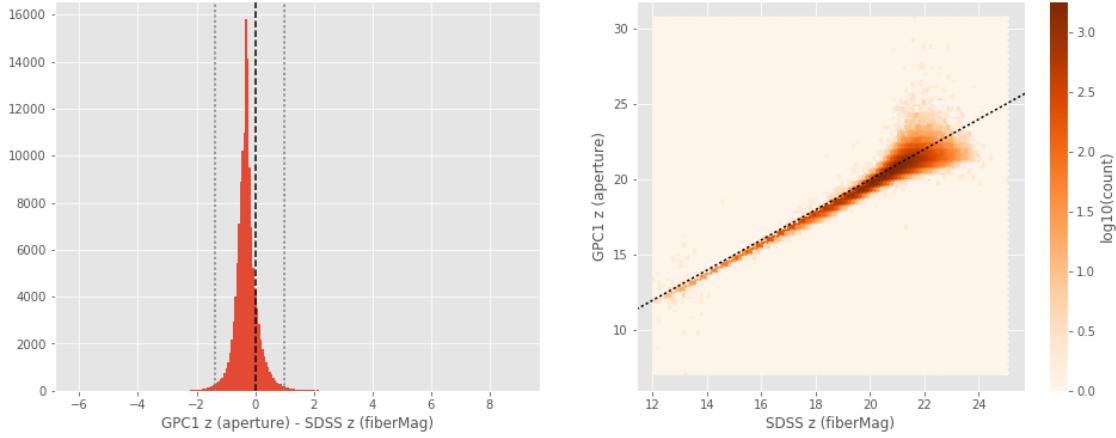
Mosaic i (total) - SDSS i (petroMag):

- Median: -0.64
- Median Absolute Deviation: 0.20
- 1% percentile: -4.404036397033691
- 99% percentile: 0.8486794779052738



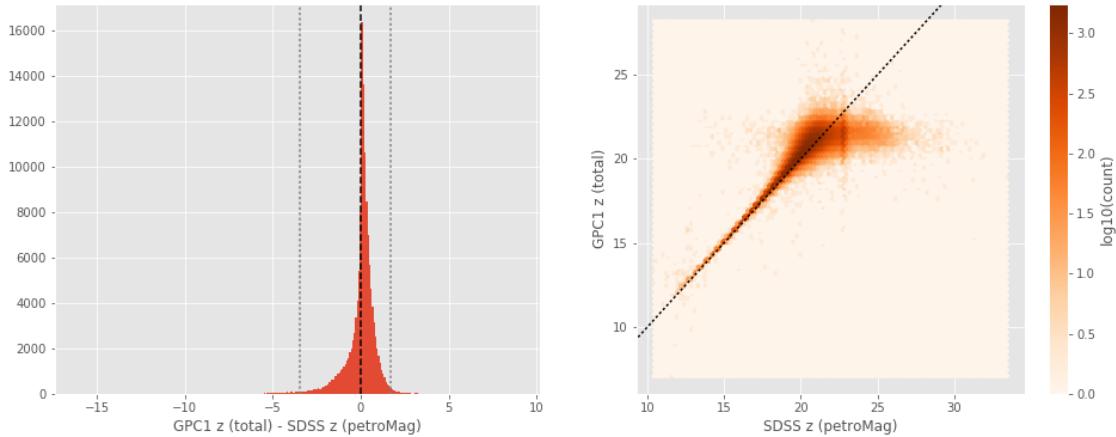
GPC1 z (aperture) - SDSS z (fiberMag):

- Median: -0.30
- Median Absolute Deviation: 0.18
- 1% percentile: -1.356192569732666
- 99% percentile: 0.9832890510559065



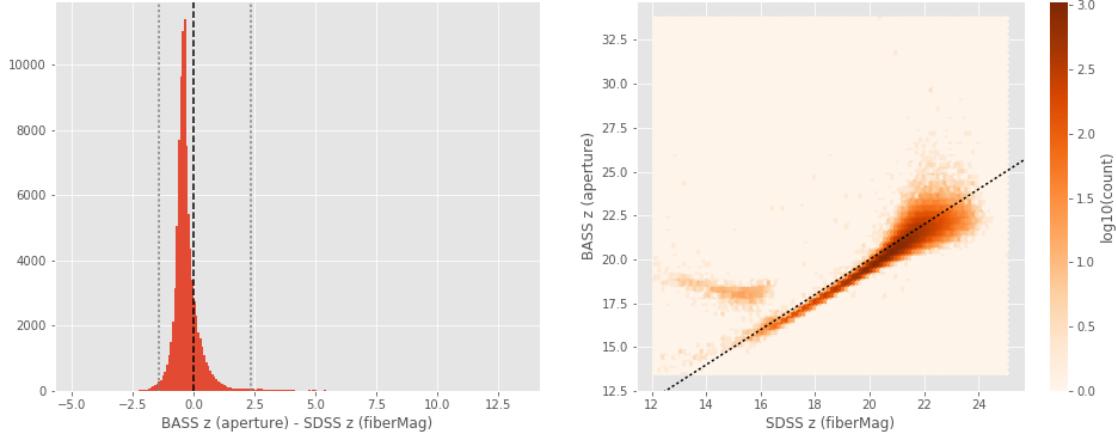
GPC1 z (total) - SDSS z (petroMag):

- Median: 0.13
- Median Absolute Deviation: 0.29
- 1% percentile: -3.4653361892700194
- 99% percentile: 1.7037193870544391



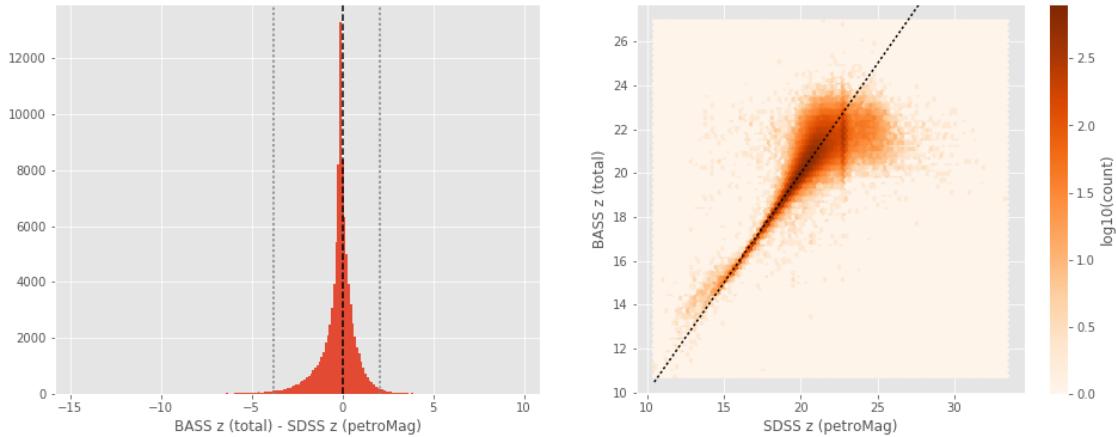
BASS z (aperture) - SDSS z (fiberMag):

- Median: -0.38
- Median Absolute Deviation: 0.21
- 1% percentile: -1.4236827850341798
- 99% percentile: 2.3649870300292894



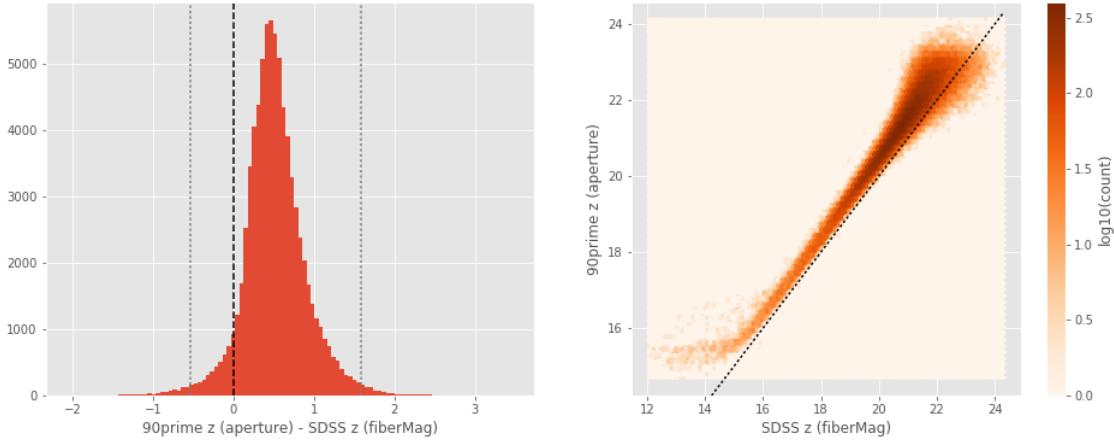
BASS z (total) - SDSS z (petroMag) :

- Median: -0.11
- Median Absolute Deviation: 0.36
- 1% percentile: -3.8109129333496092
- 99% percentile: 2.0887960815429665



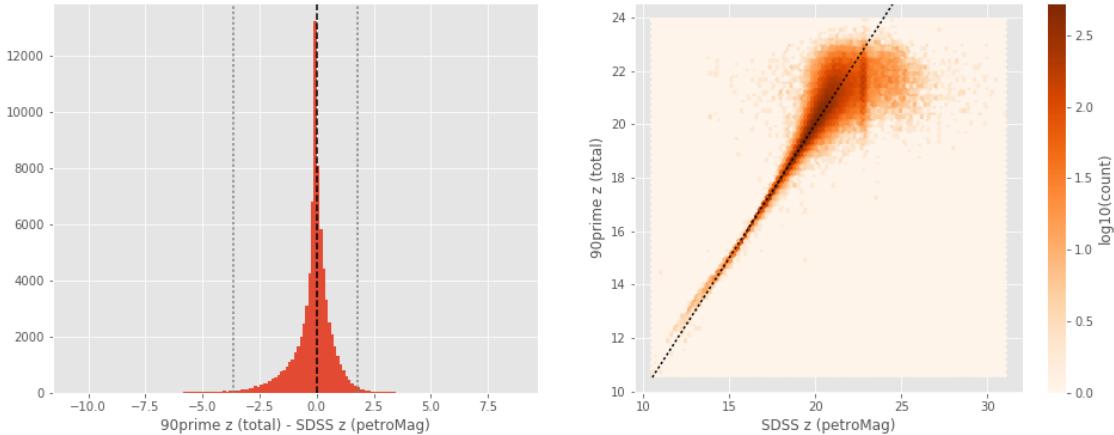
90prime z (aperture) - SDSS z (fiberMag) :

- Median: 0.49
- Median Absolute Deviation: 0.21
- 1% percentile: -0.5331401062011718
- 99% percentile: 1.5899079895019539



90prime z (total) - SDSS z (petroMag):

- Median: -0.05
- Median Absolute Deviation: 0.33
- 1% percentile: -3.625672569274902
- 99% percentile: 1.8136268615722657



1.5.2 III.b - Comparing J and K bands to 2MASS

The catalogue is cross-matched to 2MASS-PSC within 0.2 arcsecond. We compare the UKIDSS total J and K magnitudes to those from 2MASS.

The 2MASS magnitudes are “Vega-like” and we have to convert them to AB magnitudes using the zero points provided on [this page](#):

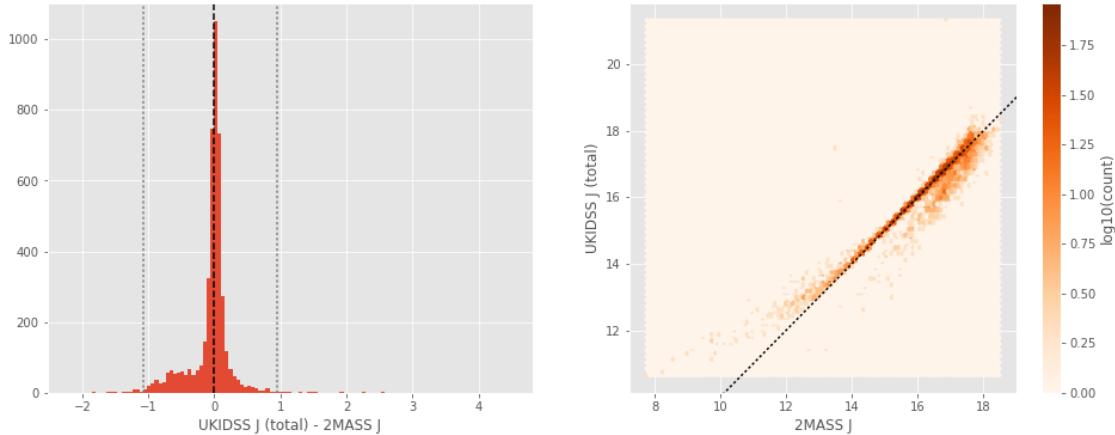
Band	F - 0 mag (Jy)
J	1594
H	1024
Ks	666.7

In addition, UKIDSS uses a K band whereas 2MASS uses a Ks (“short”) band, this page give a correction to convert the K band in a Ks band with the formula:

$$K_{s(2MASS)} = K_{UKIRT} + 0.003 + 0.004 * (JK)_{UKIRT}$$

UKIDSS J (total) - 2MASS J:

- Median: 0.01
- Median Absolute Deviation: 0.07
- 1% percentile: -1.0741193592740834
- 99% percentile: 0.9443260482118769



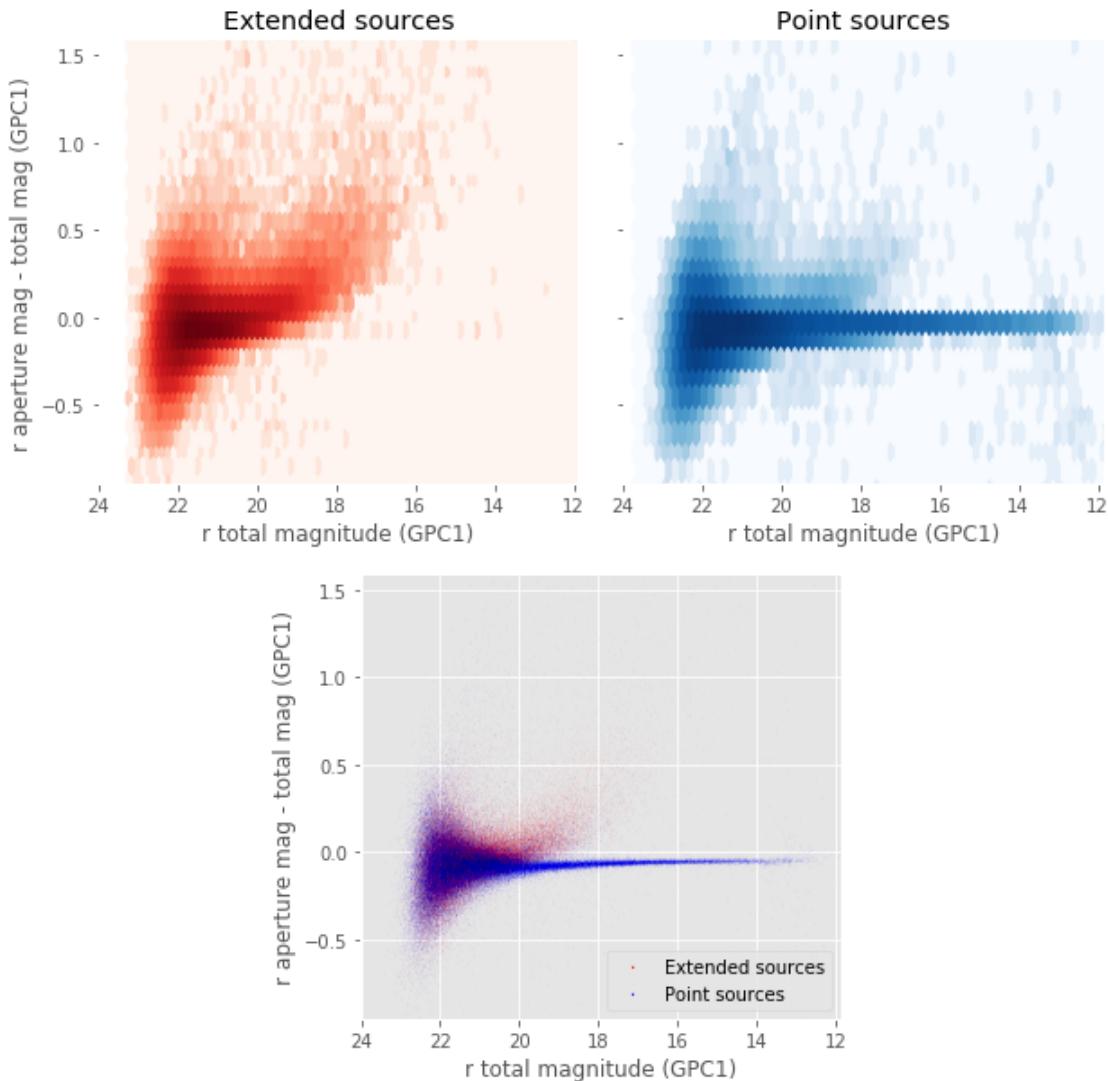
1.6 Keeping only sources with good signal to noise ratio

From here, we are only comparing sources with a signal to noise ratio above 3, i.e. roughly we a magnitude error below 0.3.

To make it easier, we are setting to NaN in the catalogue the magnitudes associated with an error above 0.3 so we can't use these magnitudes after the next cell.

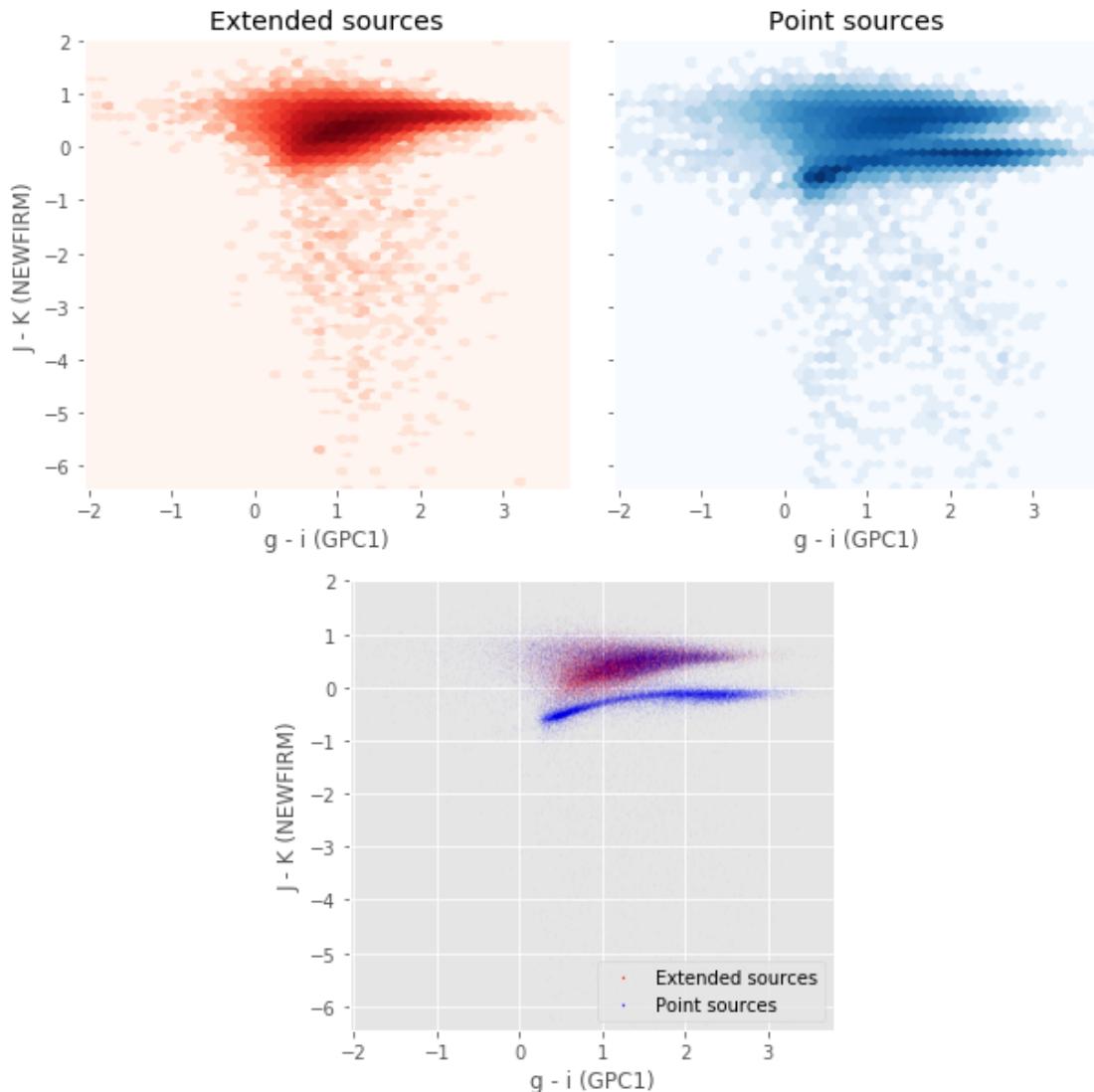
1.7 IV - Comparing aperture magnitudes to total ones.

Number of source used: 166865 / 3388482 (4.92%)

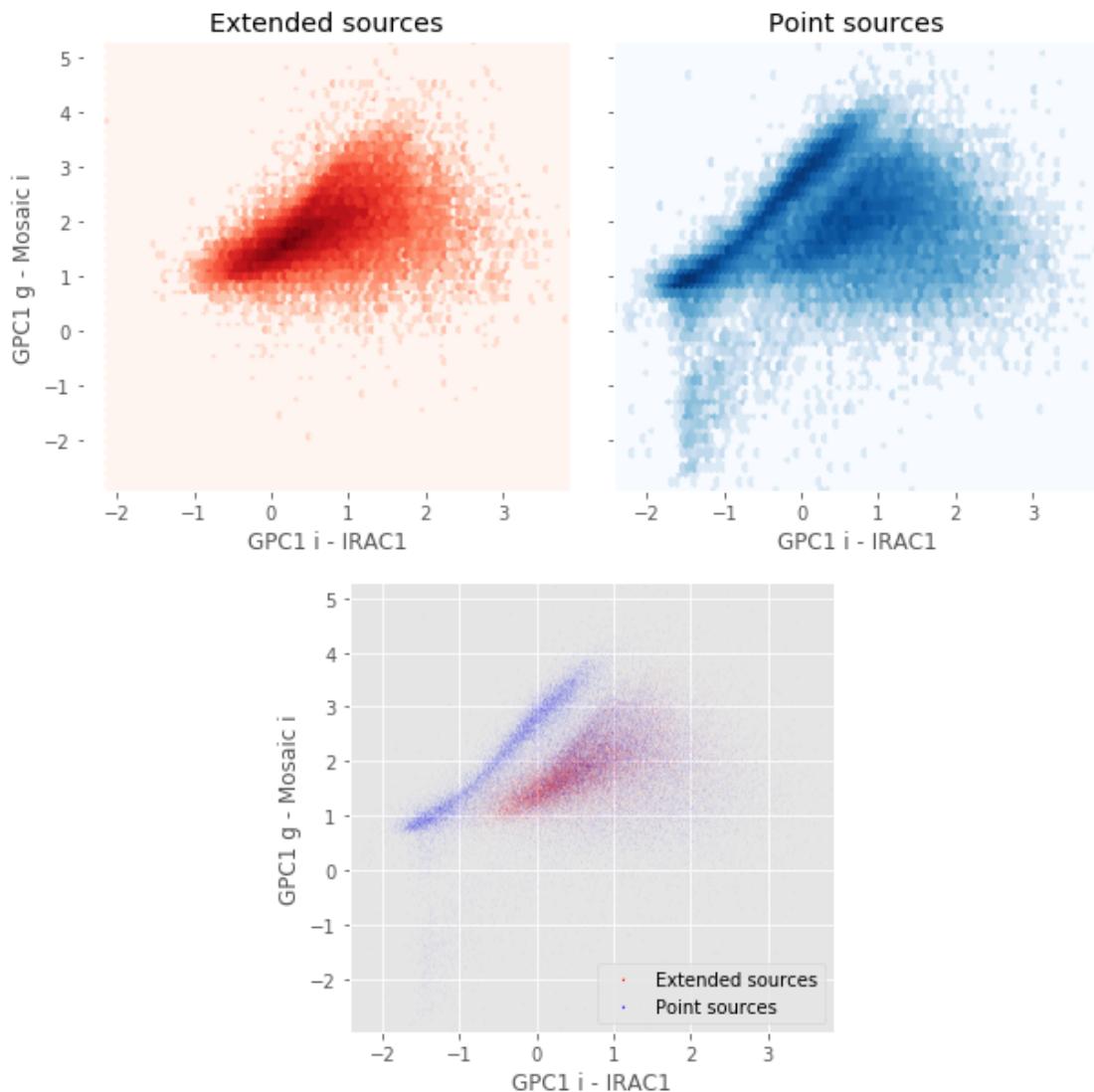


1.8 V - Color-color and magnitude-color plots

Number of source used: 91646 / 3388482 (2.70%)



Number of source used: 67924 / 3388482 (2.00%)



Number of source used: 175725 / 3388482 (5.19%)

