1.1_VISTA-VIDEO

March 8, 2018

1 CDFS-SWIRE Master List Creation

1.1 Preparation of VIDEO/VISTA/VIRCAM data

The catalogue comes from `dmu0_VISTA_VIDEO-private`.

There is an old public version of the catalogue but we are using the newer private version in the hope that it will be public by the time we publish the masterlist.

Filters: Z, Y, J, H, Ks

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position (degrees);
- The stellarity;
- The magnitude for each band in apertude 3, which is 2 arcsec (rs548 presumes same for private catalogue).
- The "auto" magnitude is provided, we presume this is standard Sextractor units etc.

Yannick said the dates of observation for VIDEO are from 2009/11 to 2016/12. There is a paper from 2012 (Jarvis et al). So will use 2012.

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
```

```
Out[3]: 'en_GB'
```

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:13:
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:14:
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:15:
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:22:
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:23:
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:24:
```

```
Out[9]: <IPython.core.display.HTML object>
```

1.3 II - Correct z band fluxes and magnitudes

We discovered that the catalogue contains some wrong z magnitudes in the CDFS-SWIRE field. Strangely, Sextractor affected some magnitudes to sources which are not on the z image. Boris found a way to get rid of these magnitudes: all the wrong sources have a Z_MAGERR_AUTO to 0.

But we have to look at these sources in another catalogue because the VIDEO catalogue we use has been processed to correct for wrong error. We use the `video_id` column (which is unique within a field) to find the sources identified in the other catalogue and set their flux, magnitudes, and associated errors to NaN.

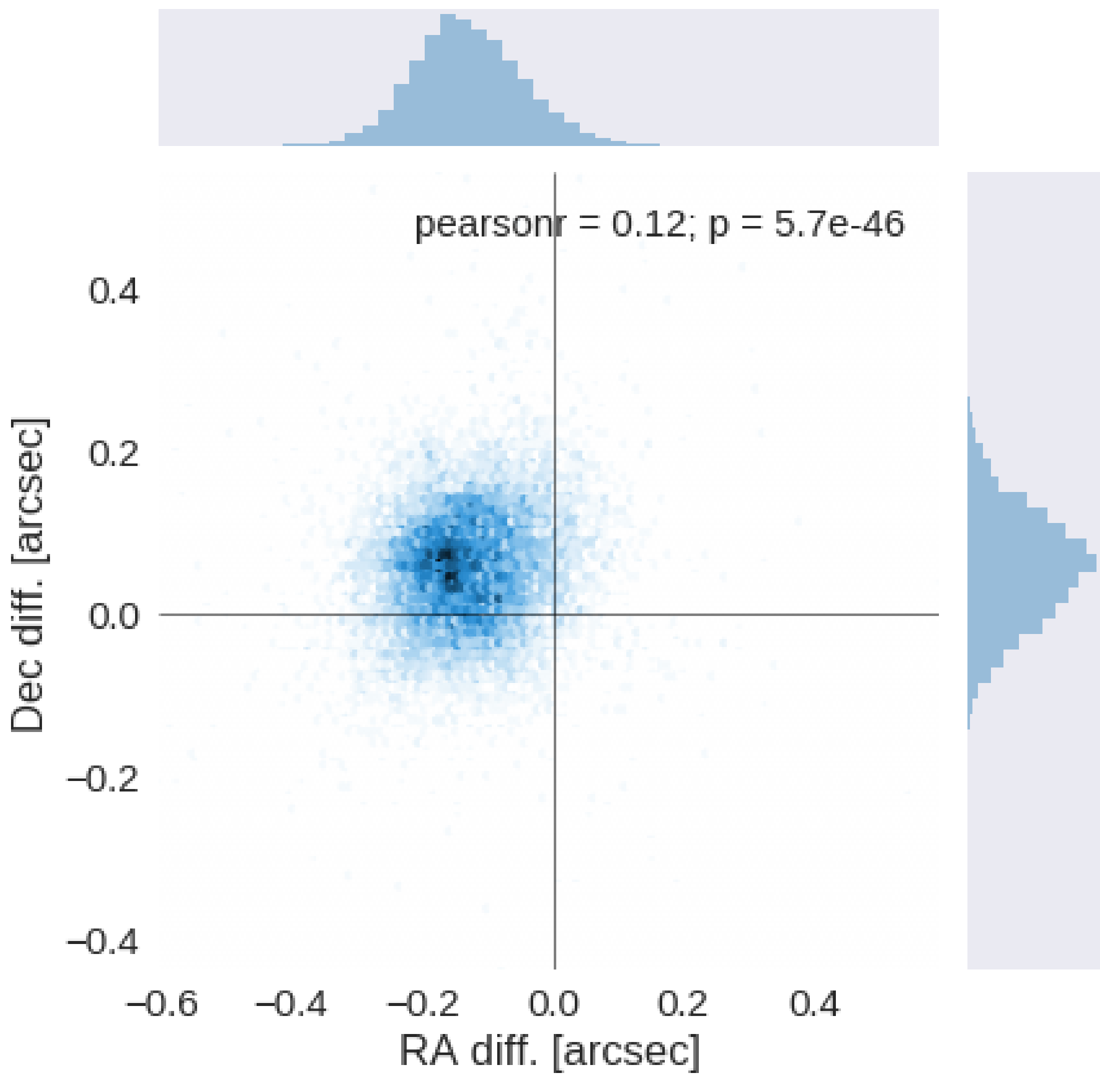
1.4 III - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

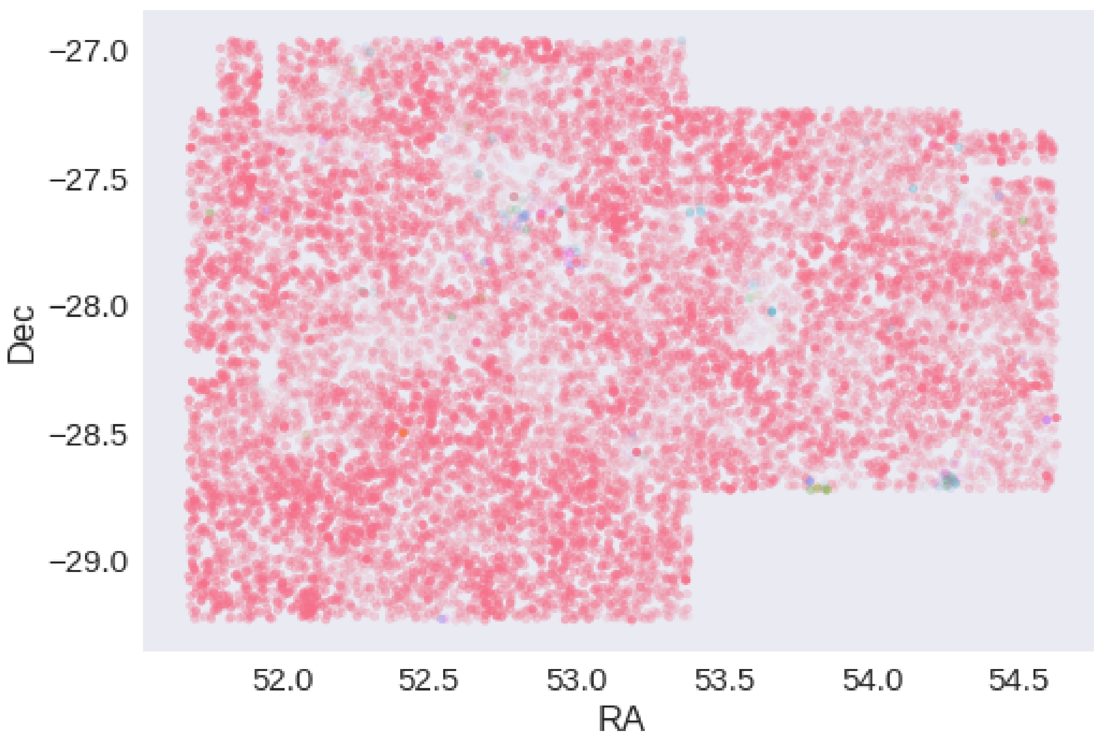
```
The initial catalogue had 1073655 sources.
The cleaned catalogue has 1071323 sources (2332 removed).
The cleaned catalogue has 2319 sources flagged as having been cleaned
```

1.5 IV - Astrometry correction

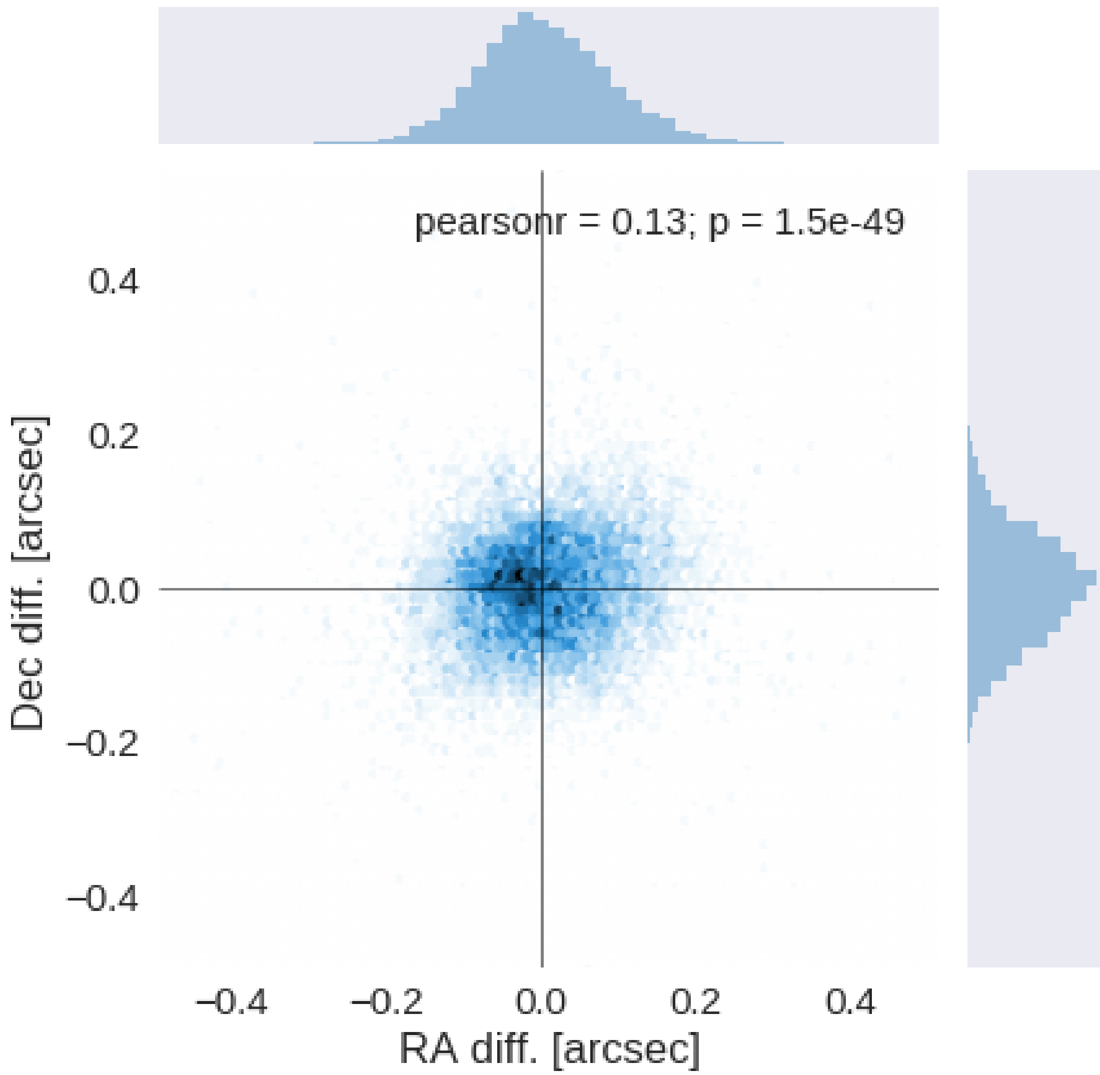
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

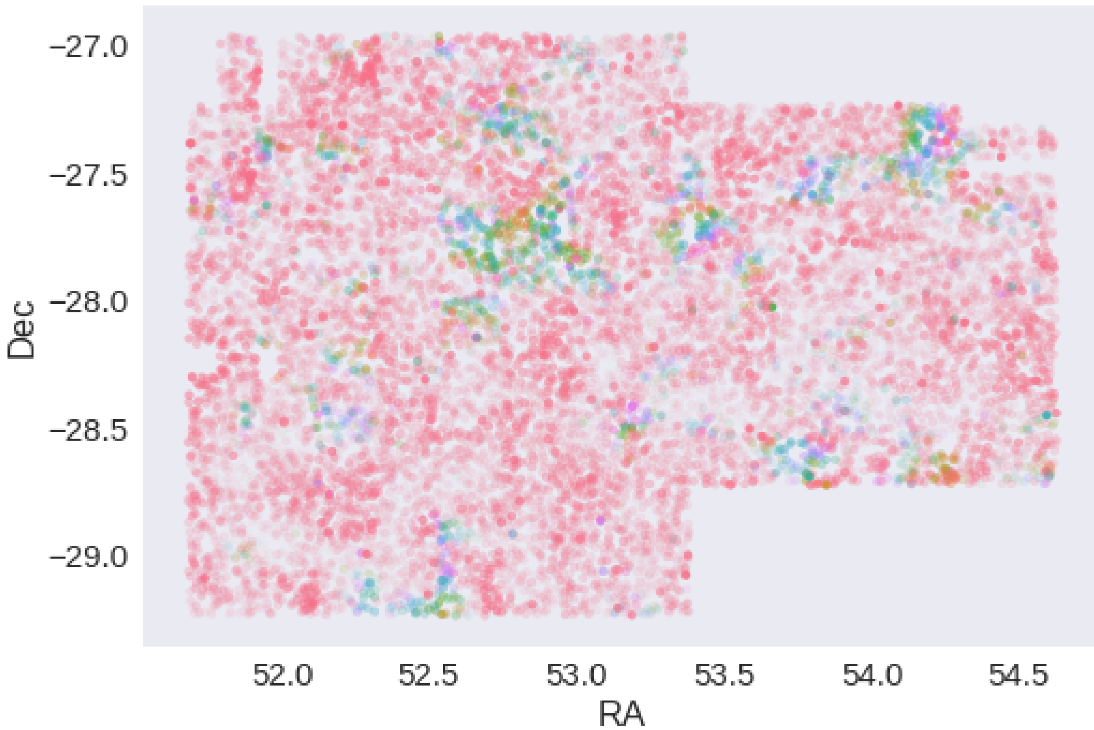


pearsonr = 0.12; p = 5.7e-46
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.6
−0.4
−0.2
0.0
0.2
0.4
RA diff. [arcsec]




```
RA correction: 0.13464397878237833 arcsec
Dec correction: -0.05622936663485234 arcsec
```


pearsonr = 0.13; p = 1.5e-49
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
RA diff. [arcsec]



1.6 V - Flagging Gaia objects

```
13687 sources flagged.
```

1.7 VI - Saving to disk

1.2_SERVS

March 8, 2018

1 CDFS SWIRE master catalogue

1.1 Preparation of Spitzer datafusion SERVS data

The data is in 'dmu0_DataFusion-Spitzer'

The Spitzer catalogues were produced by the datafusion team are available in the HELP virtual observatory server. They are described there: http://vohedamtest.lam.fr/browse/df_spitzer/q.

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

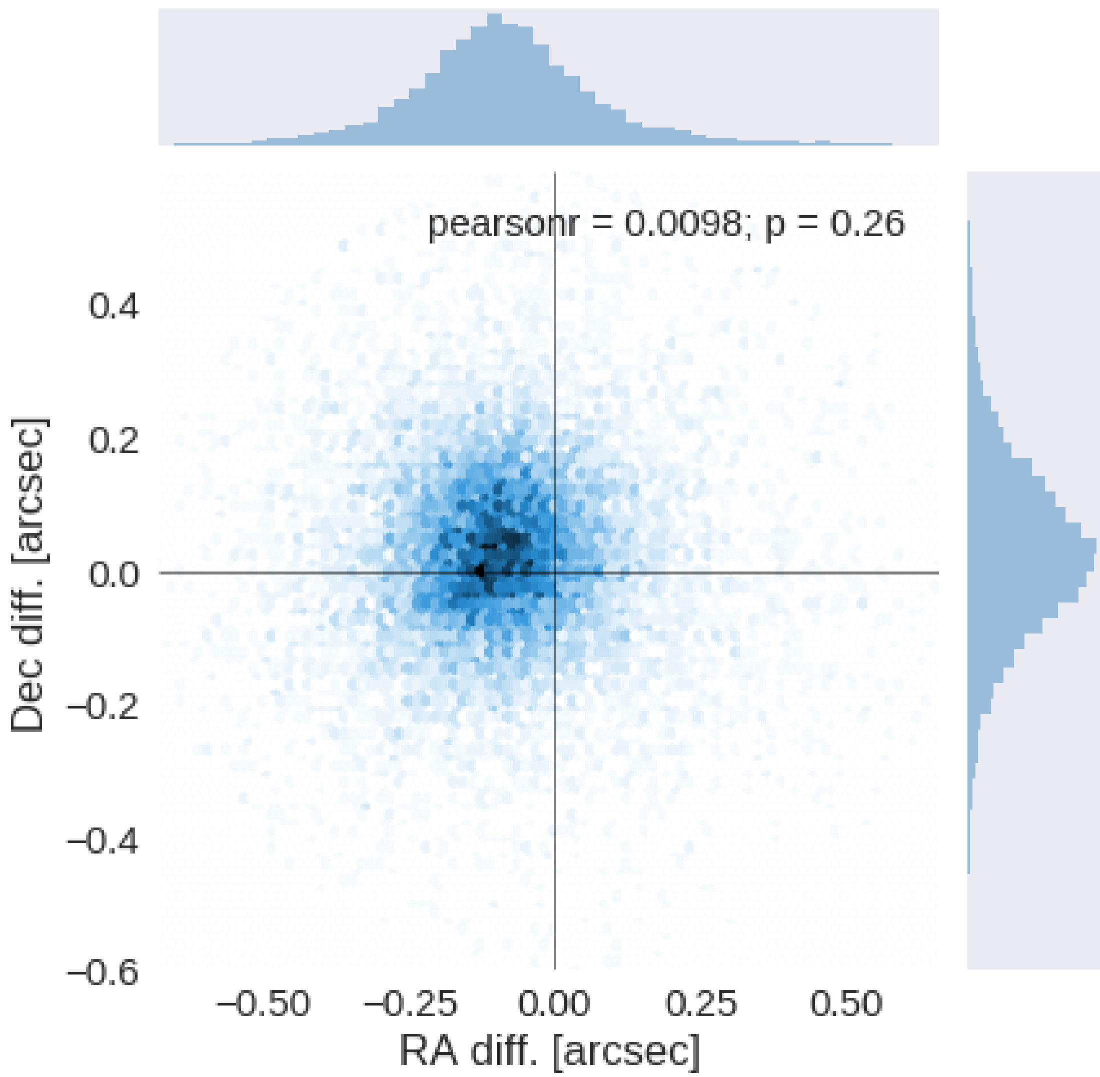
We remove duplicated objects from the input catalogues.

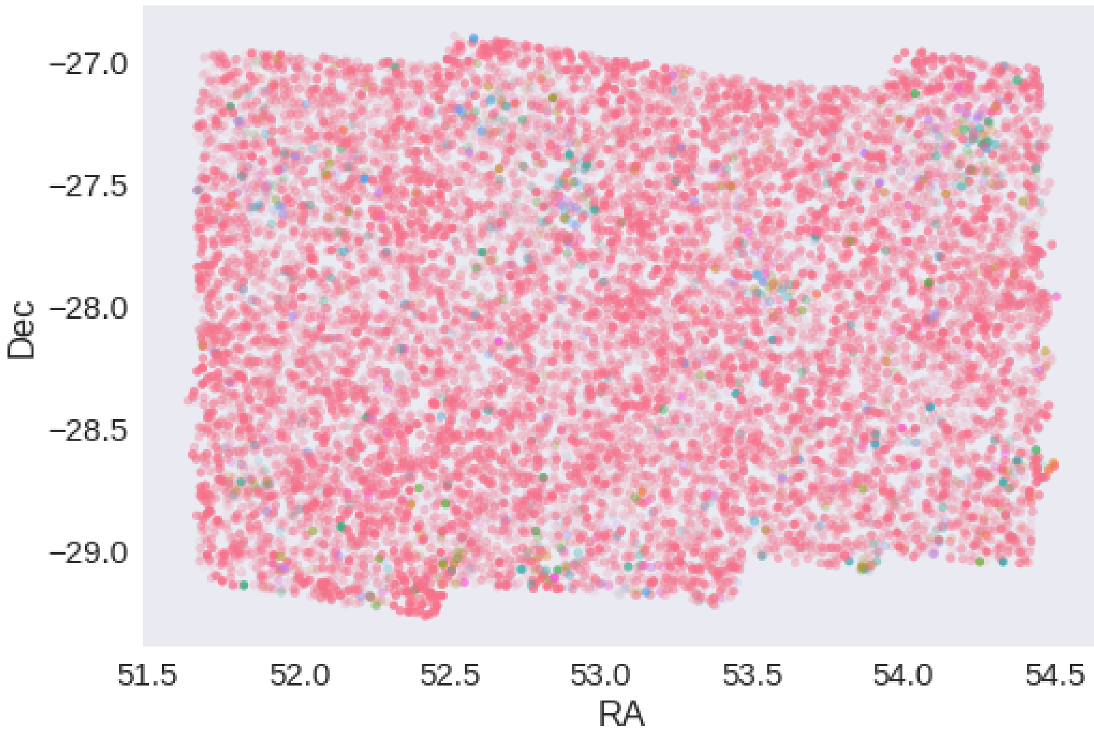
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 829191 sources.
The cleaned catalogue has 829191 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned
```

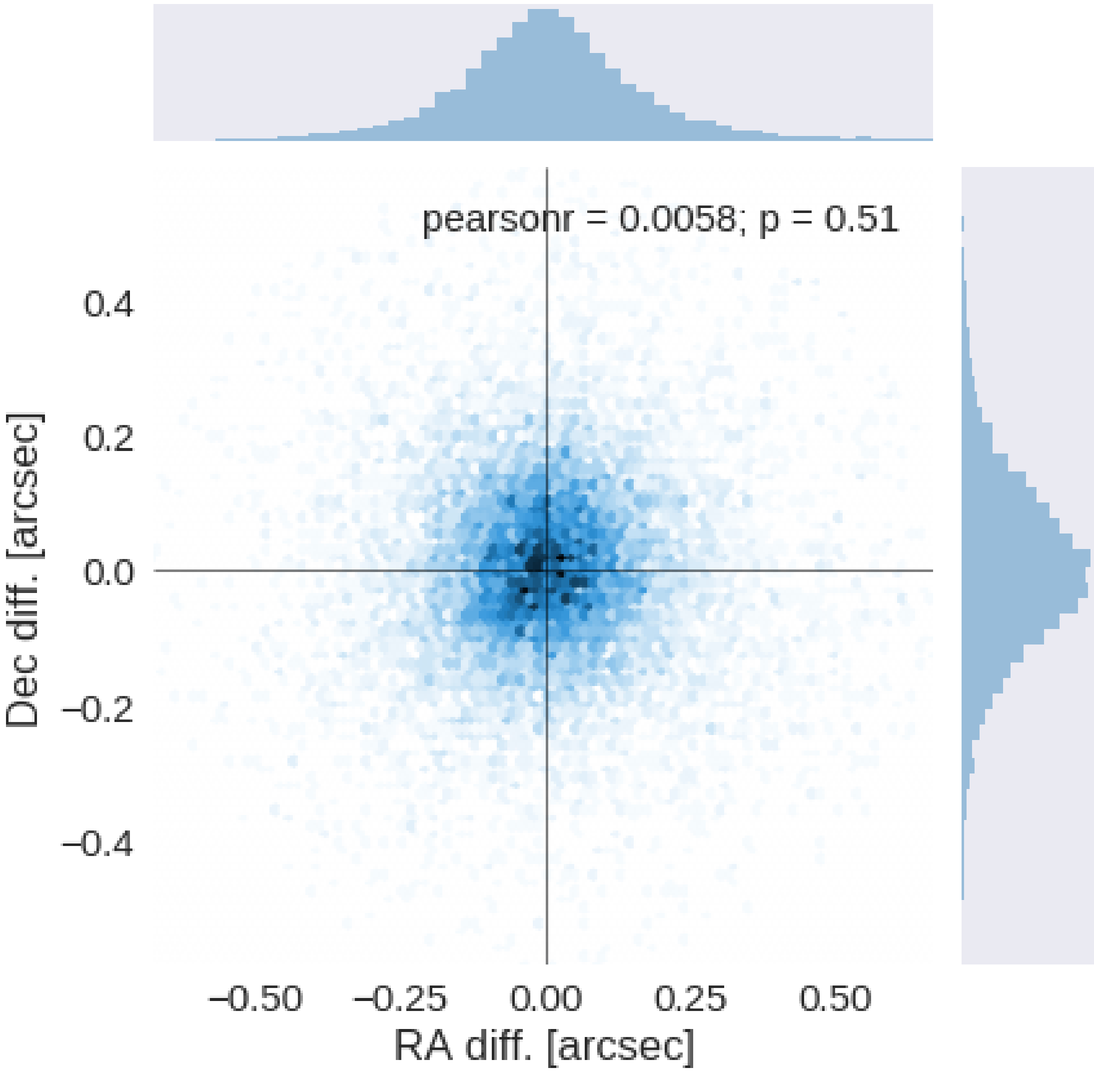
1.4 III - Astrometry correction

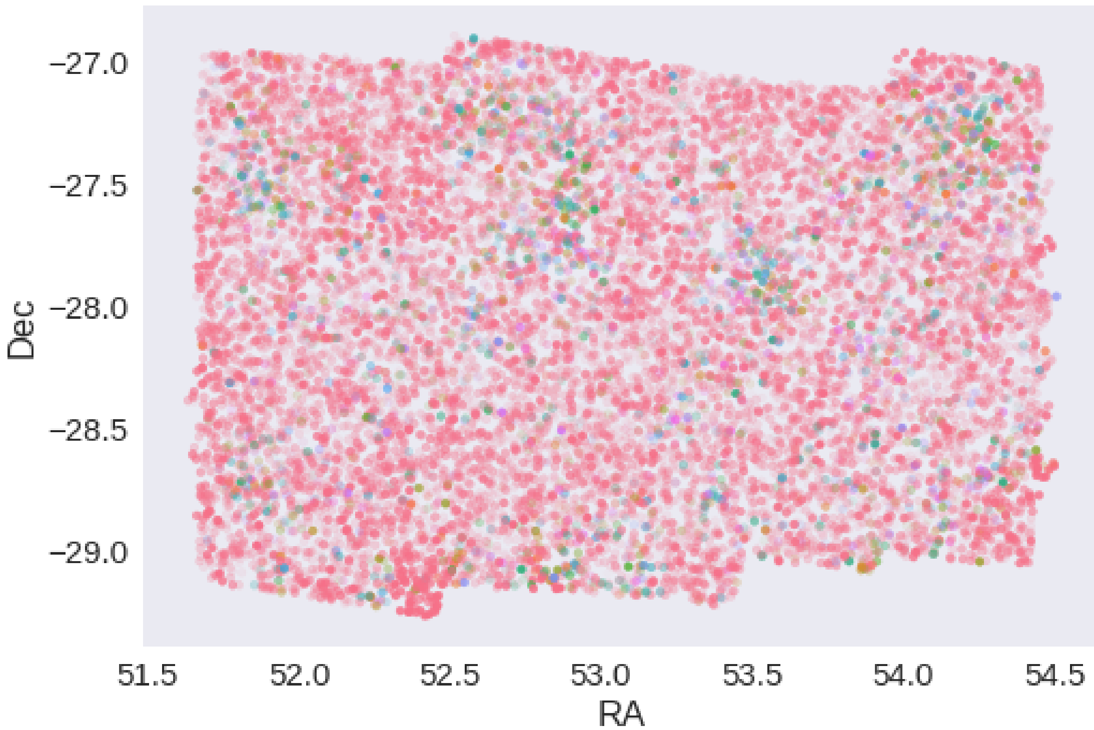
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 0.09465175745901888 arcsec
Dec correction: -0.023302447203832344 arcsec
```


pearsonr = 0.0058; p = 0.51
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
13977 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.3_SWIRE

March 8, 2018

1 CDFS SWIRE master catalogue

1.1 Preparation of Spitzer data fusion/SWIRE data

The data is available at 'dmu0_DataFusion-Spitzer'.

The Spitzer catalogues were produced by the datafusion team are available in the HELP virtual observatory server. They are described there: http://vohedamtest.lam.fr/browse/df_spitzer/q.

Lucia told that the magnitudes are aperture corrected.

In the catalouge, we keep:

We keep: - The internal identifier (this one is only in HeDaM data); - The position; - The fluxes in aperture 2 (1.9 arcsec) for IRAC bands. - The Kron flux; - The stellarity in each band

A query of the position in the Spitzer heritage archive show that the ELAIS-N1 images were observed in 2004. Let's take this as epoch.

We do not use the MIPS fluxes as they will be extracted on MIPS maps using XID+.

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

1.2 I - Column selection

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

1.3 II - Removal of duplicated sources

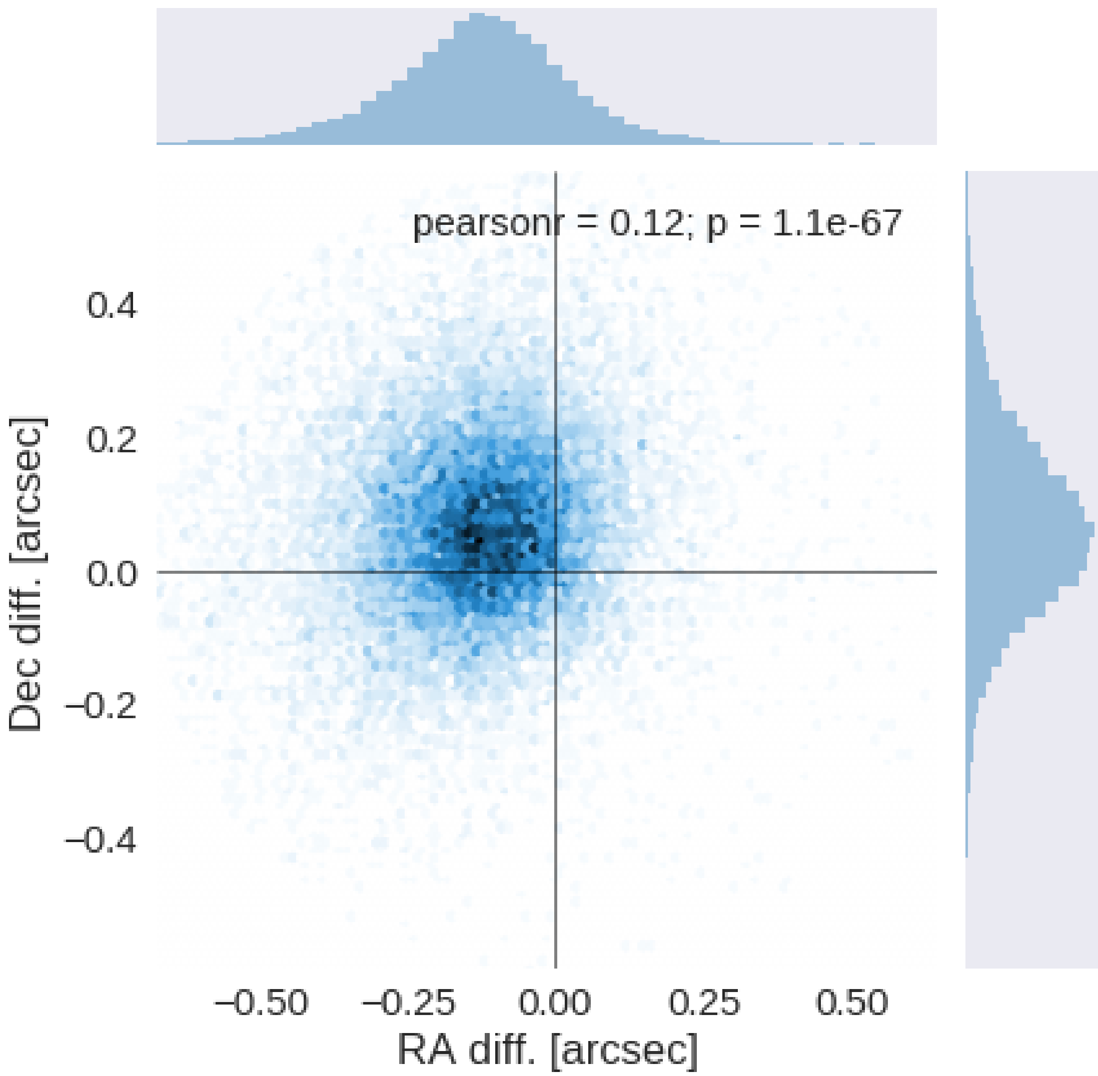
We remove duplicated objects from the input catalogues.

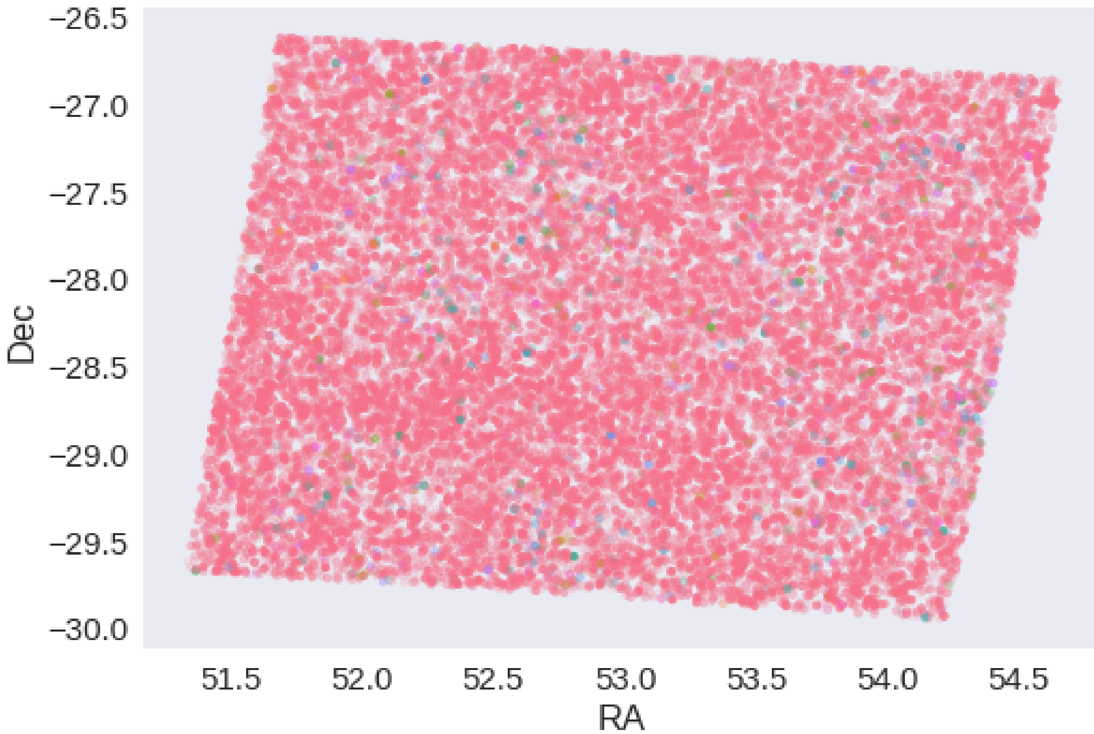
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)


The initial catalogue had 464084 sources.
The cleaned catalogue has 464051 sources (33 removed).
The cleaned catalogue has 33 sources flagged as having been cleaned
```

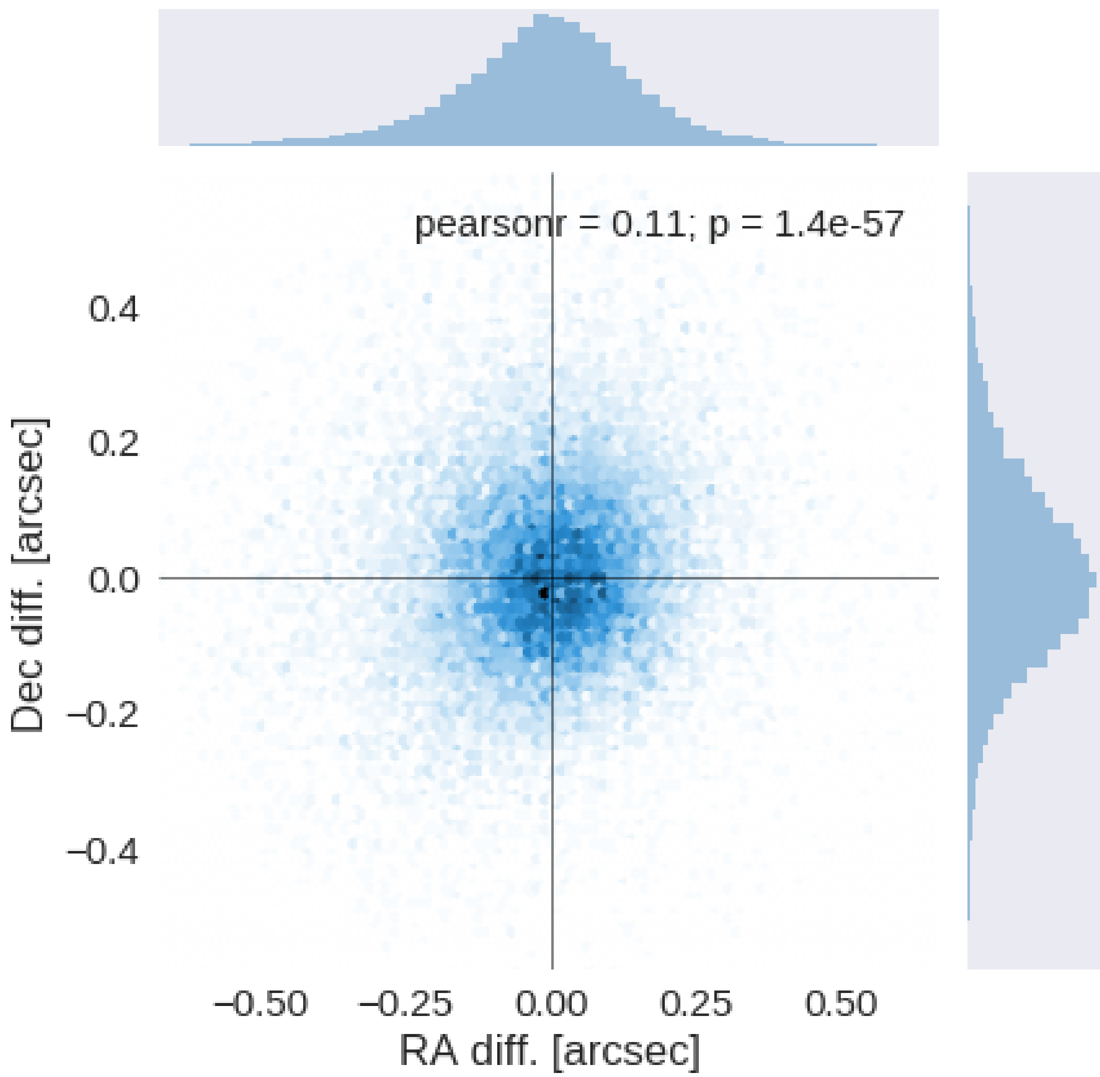
1.4 III - Astrometry correction

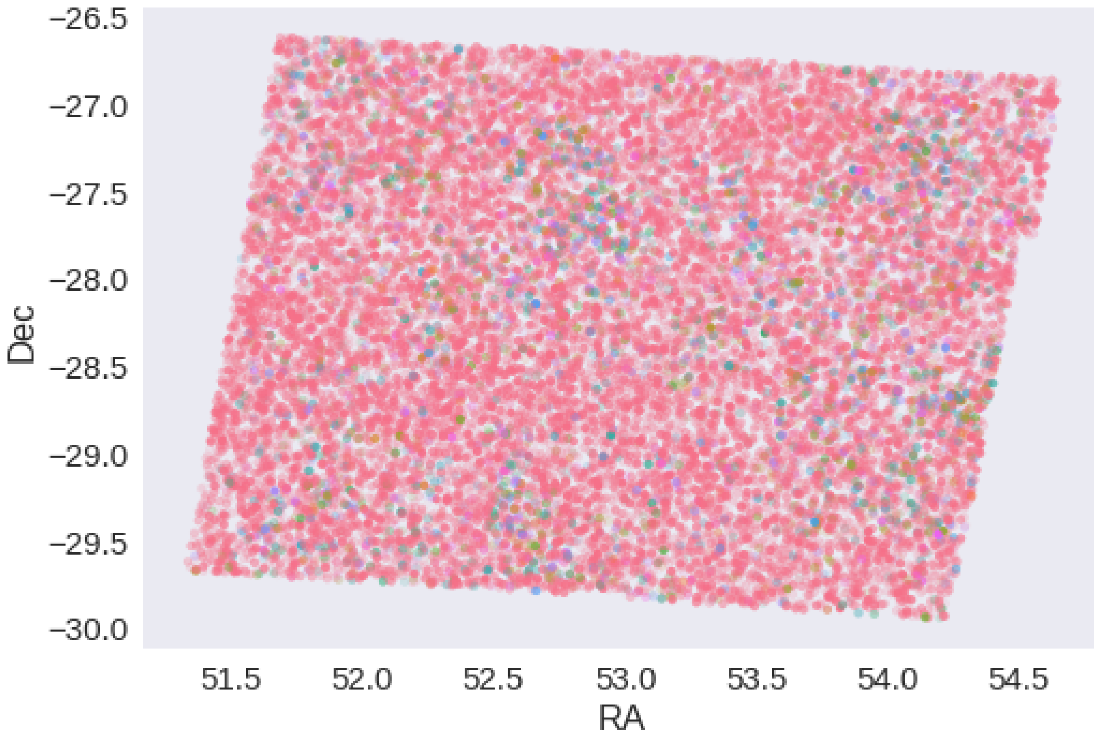
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 0.1236081218308982 arcsec
Dec correction: -0.059570162281374905 arcsec
```


pearsonr = 0.11; p = 1.4e-57
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
21407 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.4_PanSTARRS

March 8, 2018

1 CDFS SWIRE master catalogue

1.1 Preparation of PanSTARRS data

The catalogue comes from `dmu0_PanSTARRS1-3SS`.

In the catalogue, we keep:

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

```
This notebook was run with herschelhelp_internal version:
04829ed (Thu Nov 2 16:57:19 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

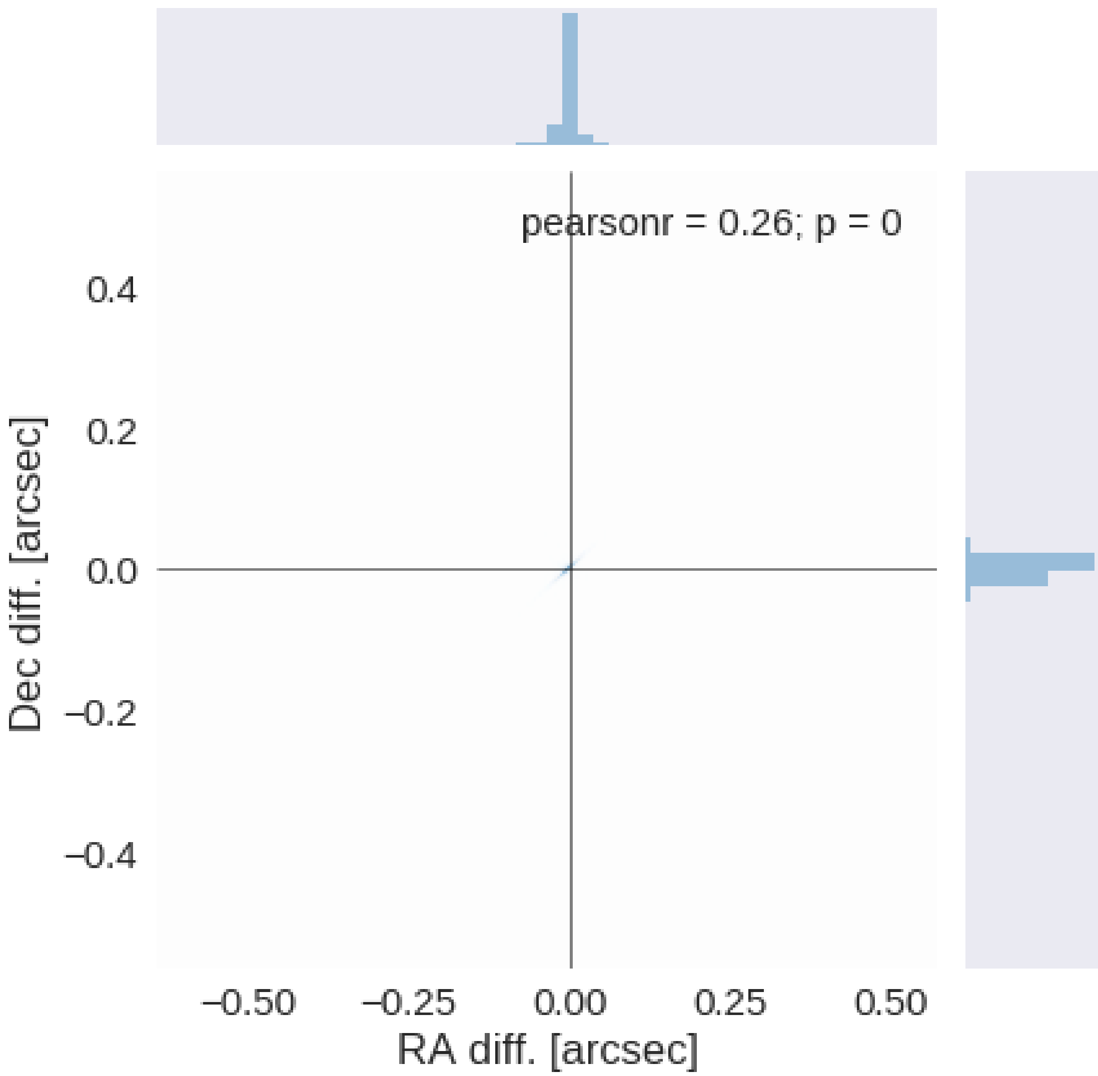
We remove duplicated objects from the input catalogues.

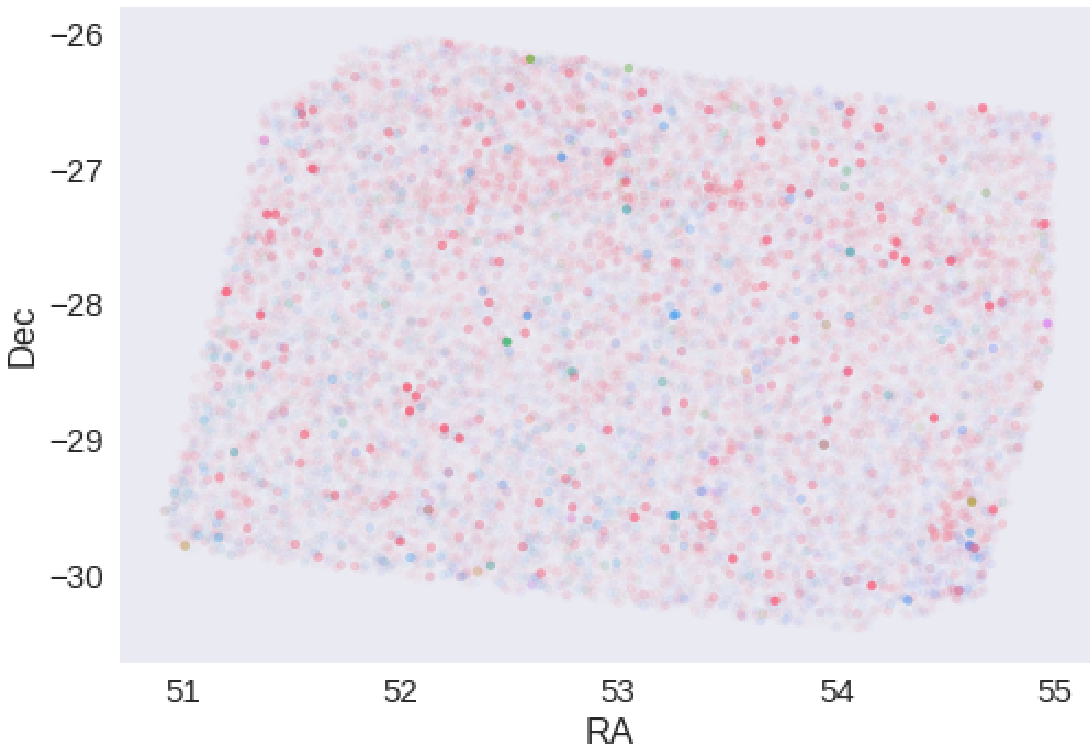
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 216352 sources.
The cleaned catalogue has 179224 sources (37128 removed).
The cleaned catalogue has 32982 sources flagged as having been cleaned
```

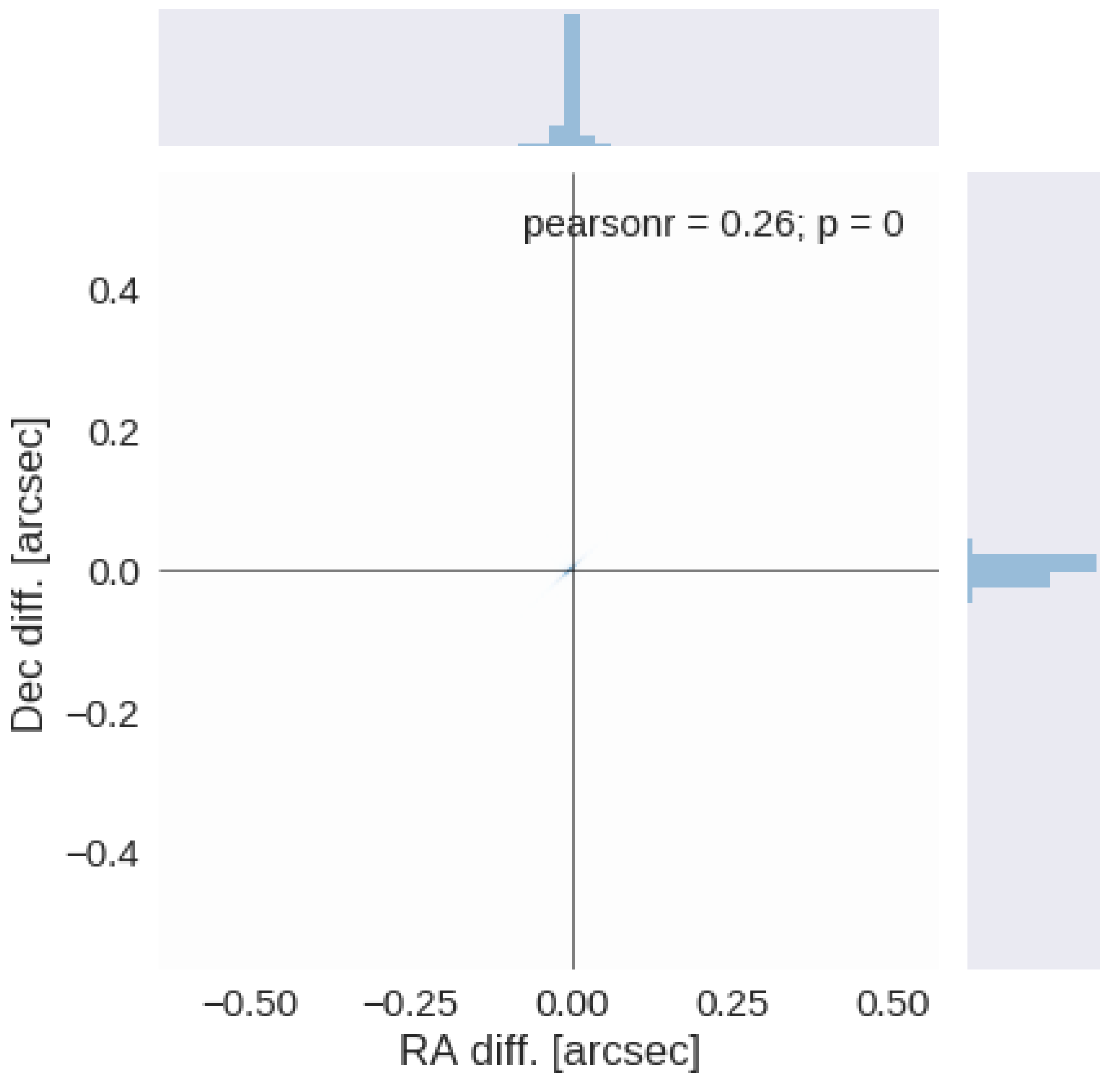
1.4 III - Astrometry correction

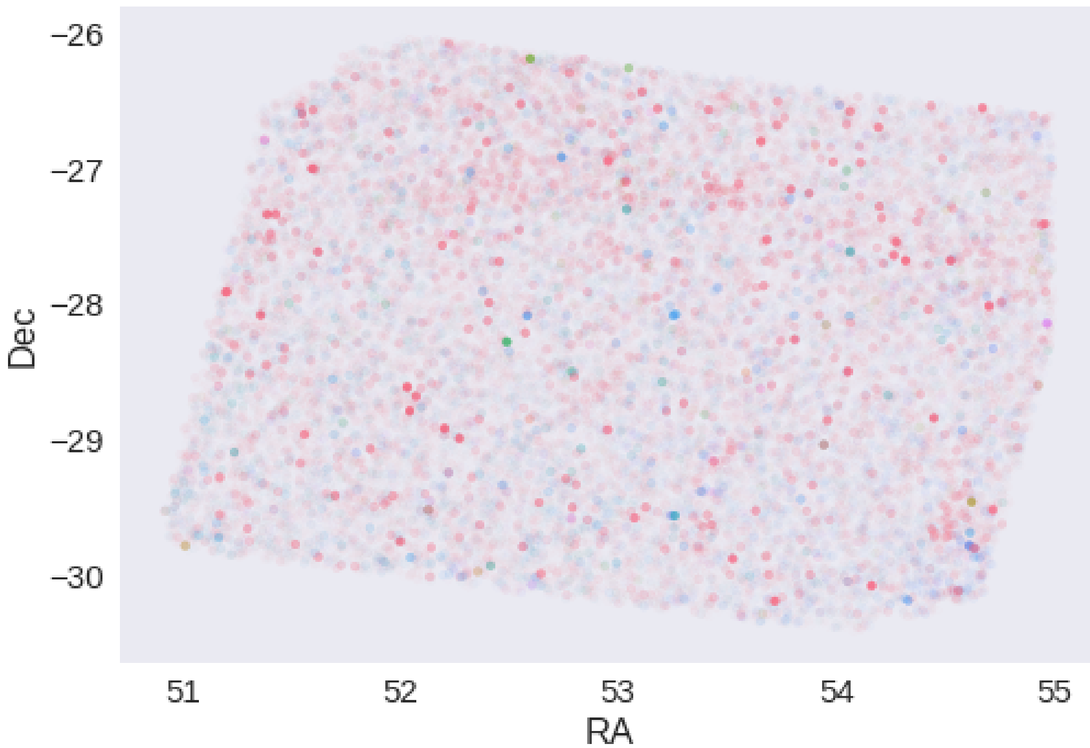
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 0.0001800822658992729 arcsec
Dec correction: -0.0003455704778332347 arcsec
```


pearsonr = 0.26; p = 0
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
34655 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.6_Fireworks

March 8, 2018

1 CDFS SWIRE master catalogue

1.1 Preparation of Fireworks data

FIREWORKS photometry of GOODS CDF-S catalogue: the catalogue comes from `dmu0_Fireworks`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The total magnitude.

```
This notebook was run with herschelhelp_internal version:
04829ed (Thu Nov 2 16:57:19 2017 +0000)
```

1.2 I - Column selection

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

1.3 II - Removal of duplicated sources

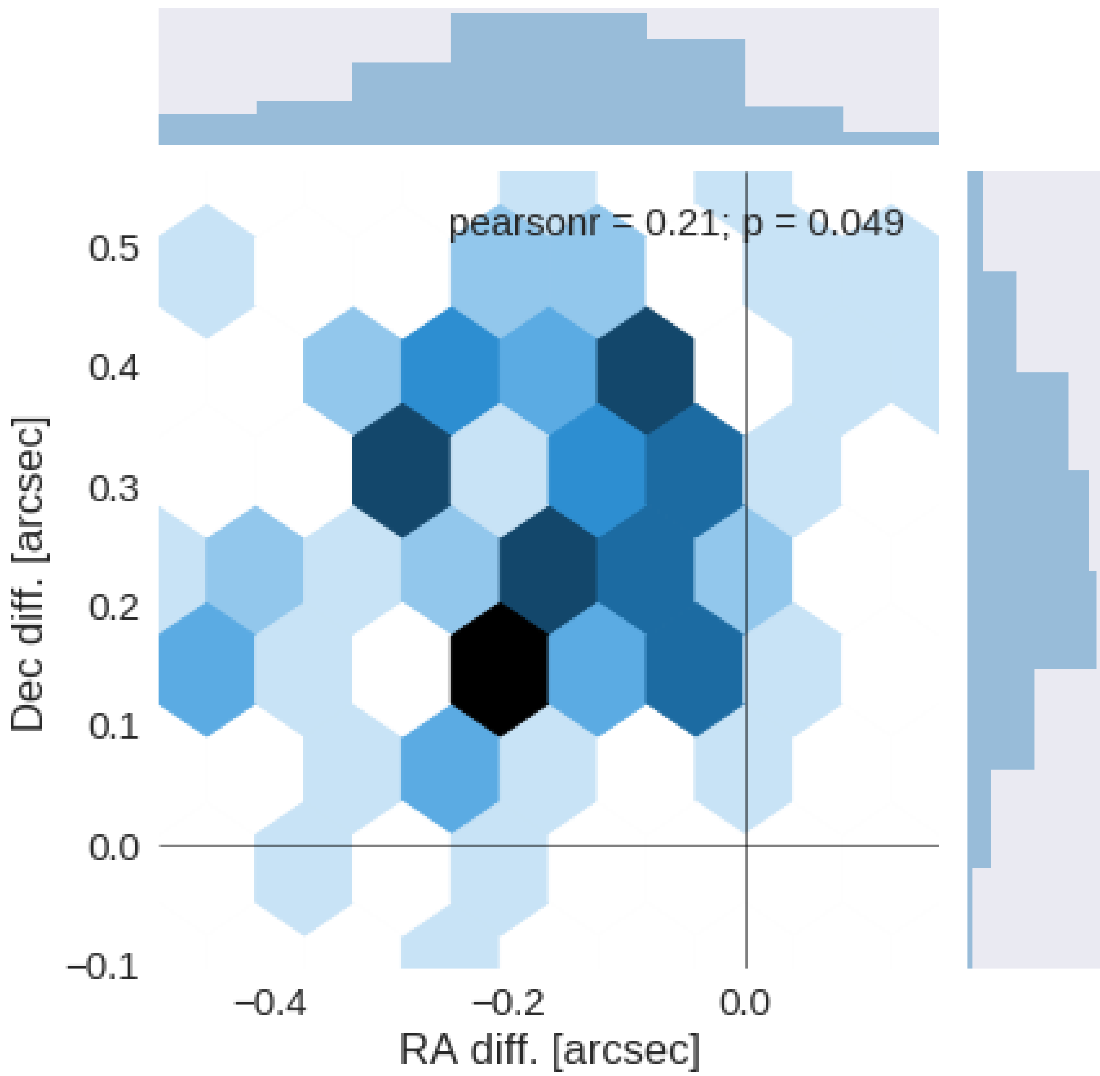
We remove duplicated objects from the input catalogues.

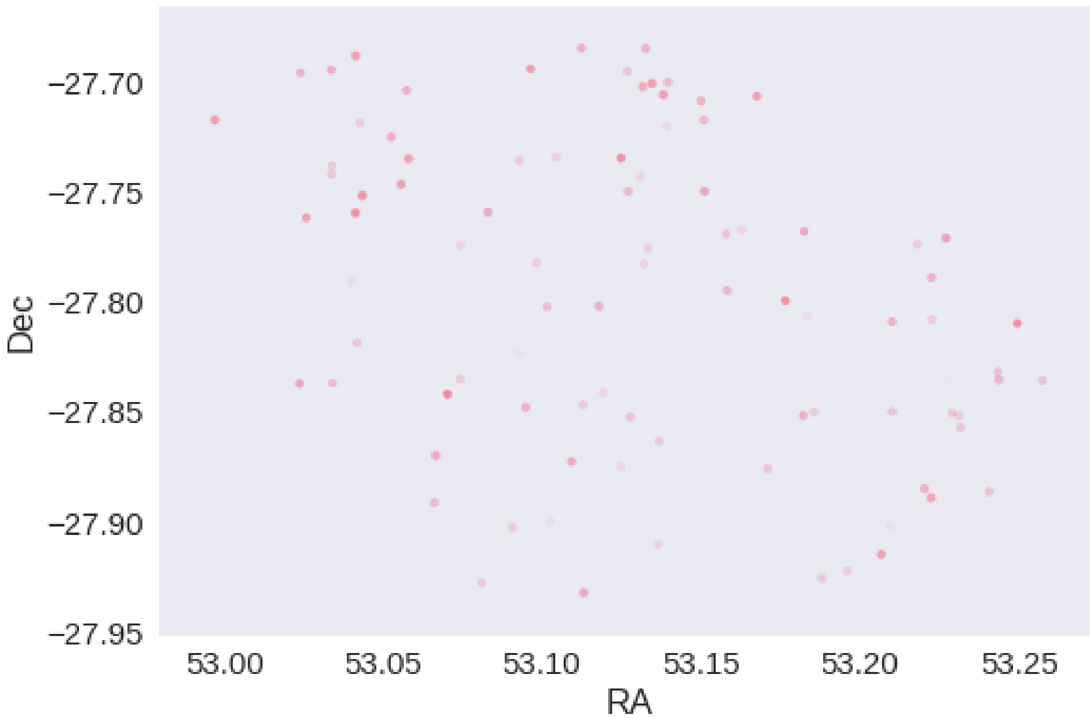
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)


The initial catalogue had 6308 sources.
The cleaned catalogue has 6308 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned
```

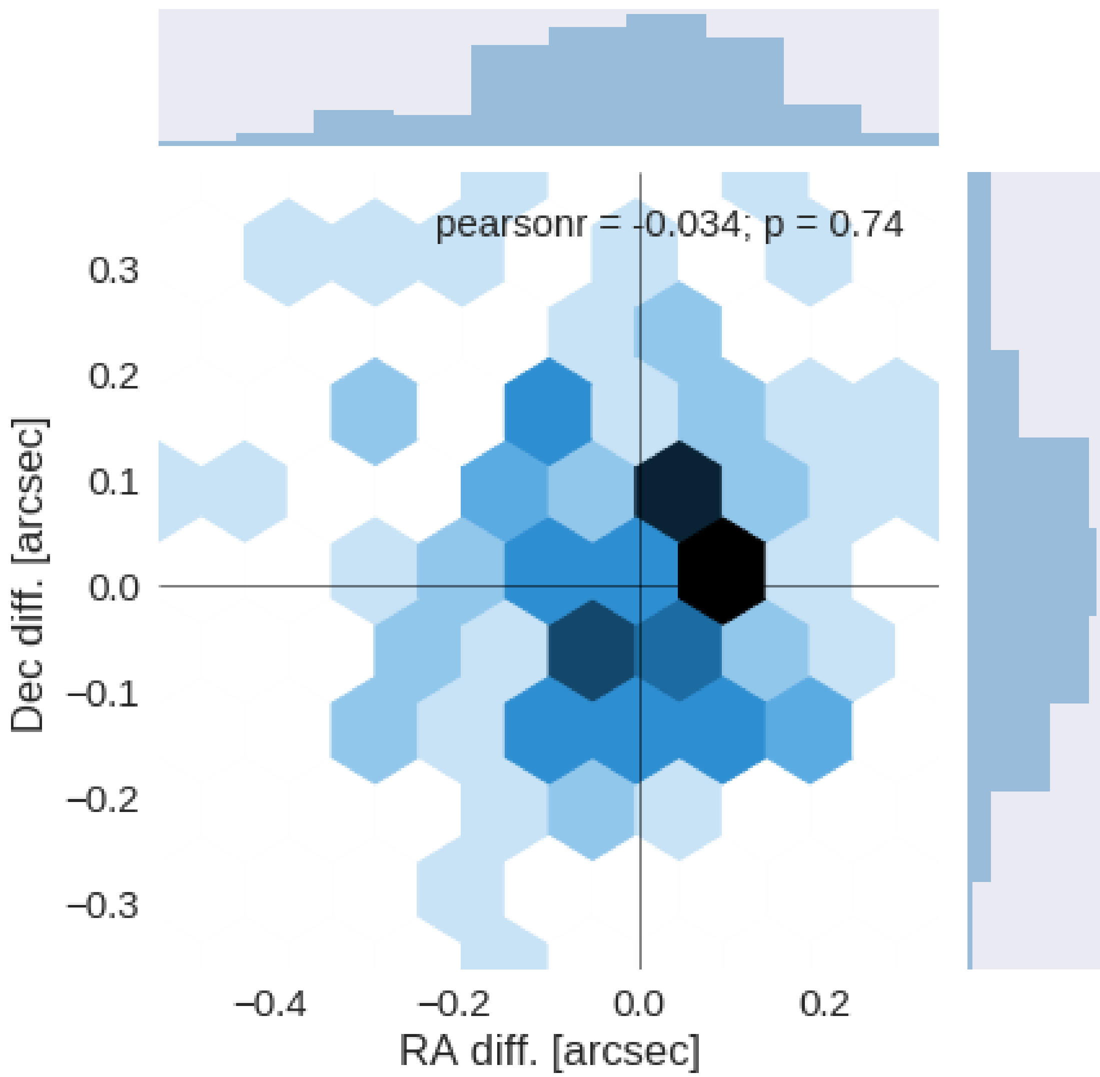
1.4 III - Astrometry correction

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: 0.16079856930133474 arcsec
Dec correction: -0.2589072199192799 arcsec
```



pearsonr = -0.034; p = 0.74
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
RA diff. [arcsec]

1.5 IV - Flagging Gaia objects

```
102 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.7_ATLAS

March 8, 2018

1 CDFS SWIRE master catalogue

1.1 Preparation of ATLAS/VST data

ATLAS/VST catalogue: the catalogue comes from `dmu0_ATLAS`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture corrected aperture magnitude in each band (2")
- The Petrosian 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:
04829ed (Thu Nov 2 16:57:19 2017 +0000)
```

1.2 I - Column selection

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

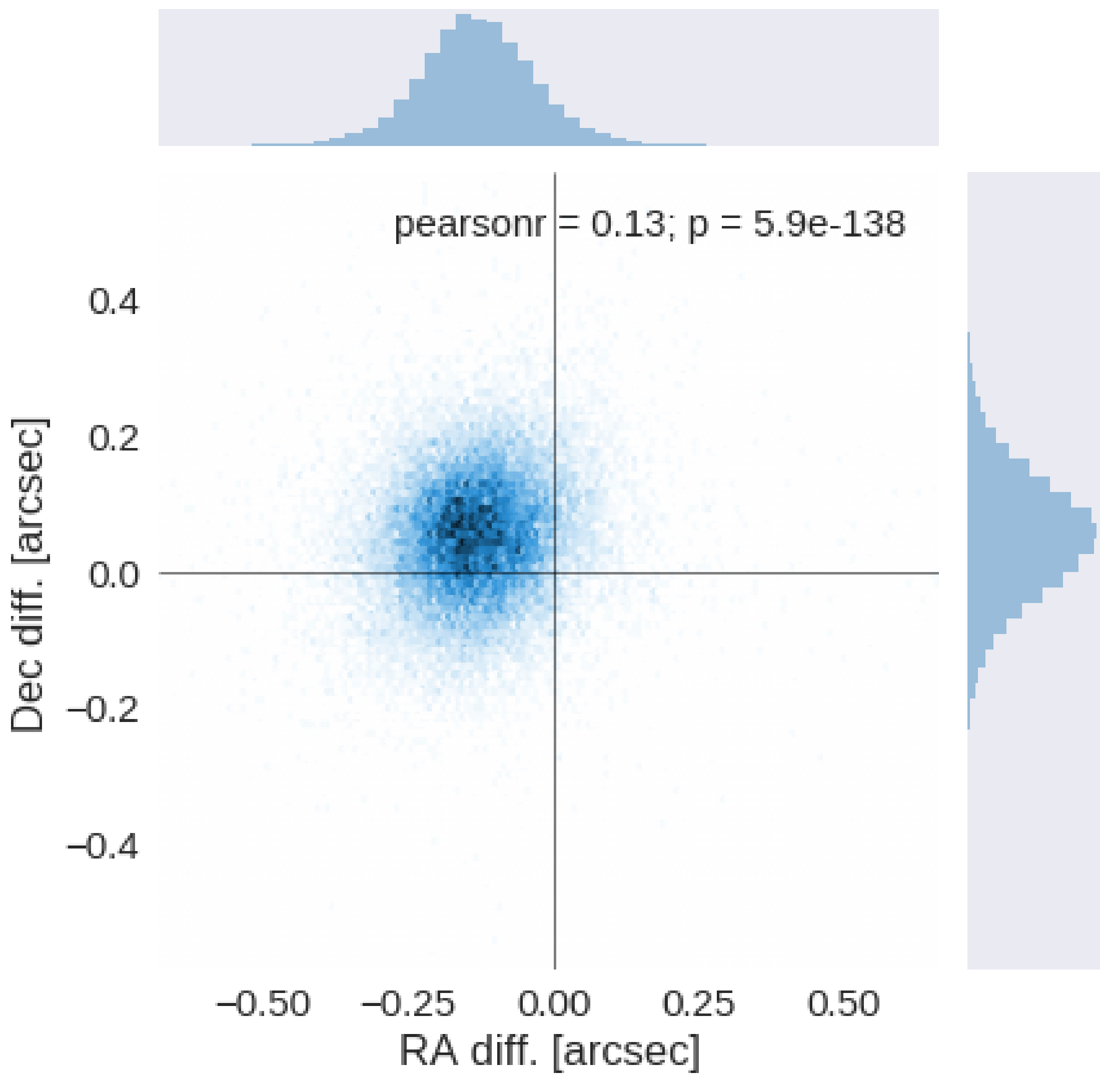
1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

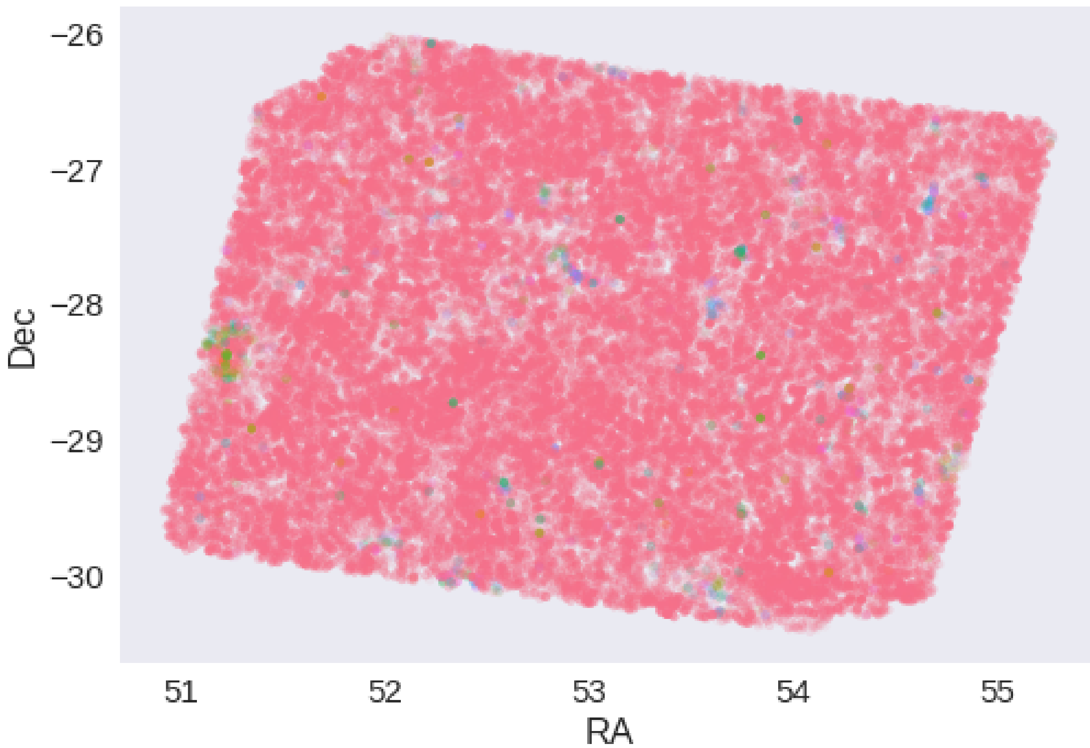
```
The initial catalogue had 316547 sources.
The cleaned catalogue has 301248 sources (15299 removed).
The cleaned catalogue has 14639 sources flagged as having been cleaned
```

1.4 III - Astrometry correction

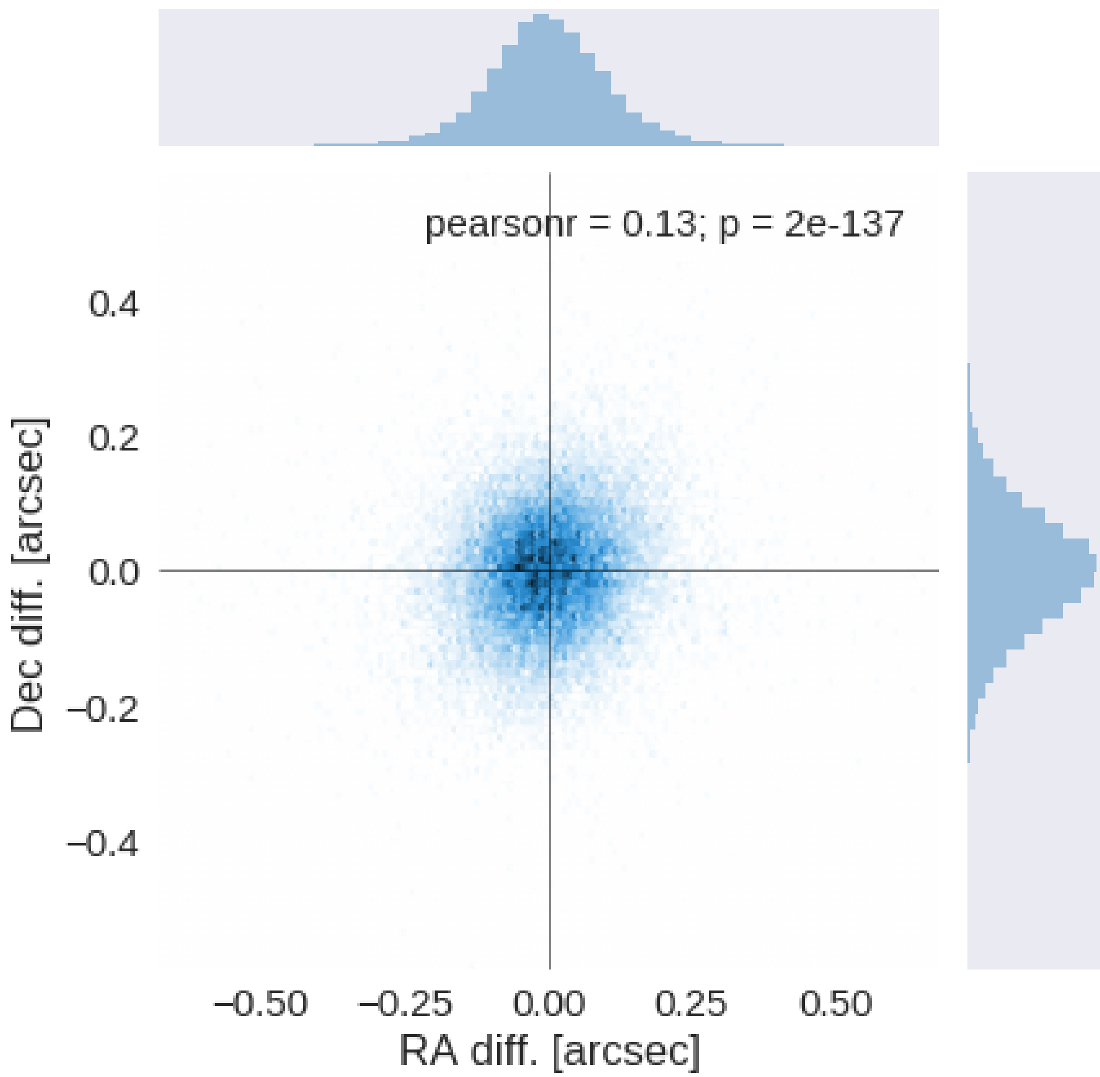
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

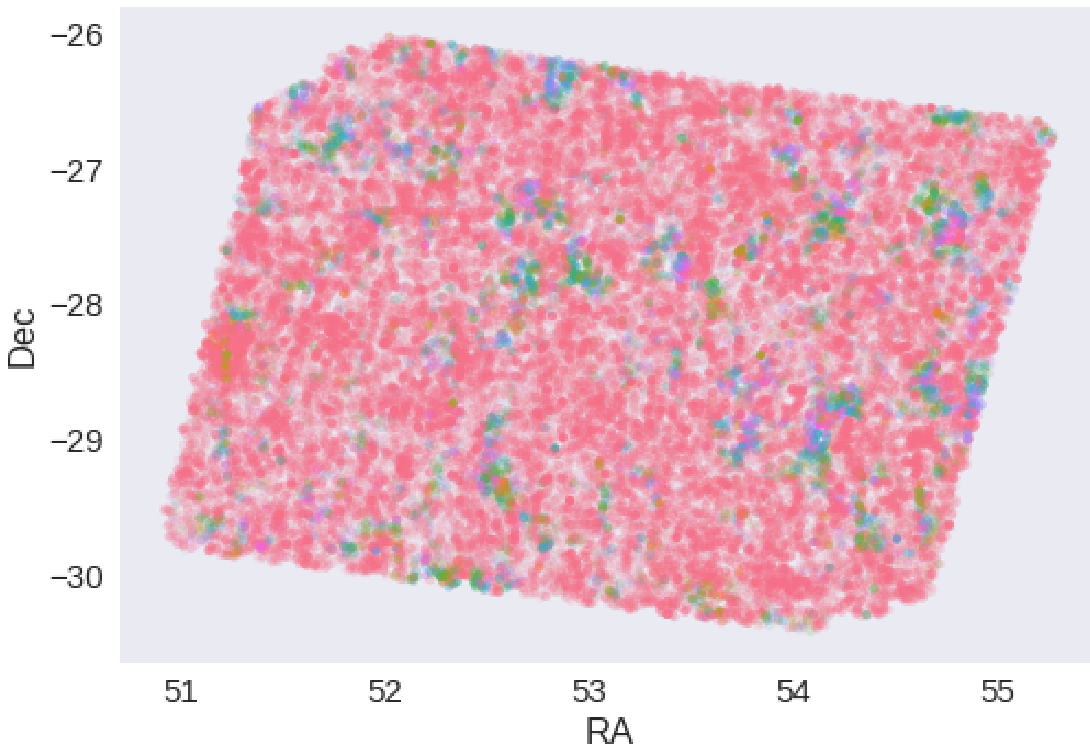


pearsonr = 0.13; p = 5.9e-138
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]




```
RA correction: 0.13242675666447212 arcsec
Dec correction: -0.0507013146410884 arcsec
```


pearsonr = 0.13; p = 2e-137
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
35746 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.8_VISTA-VHS

March 8, 2018

1 CDFS SWIRE master catalogue

1.1 Preparation of VHS data

VISTA telescope/VHS catalogue: the catalogue comes from `dmu0_VHS`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band.
- 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:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
```

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)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:11:
```

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

1.3 II - Removal of duplicated sources

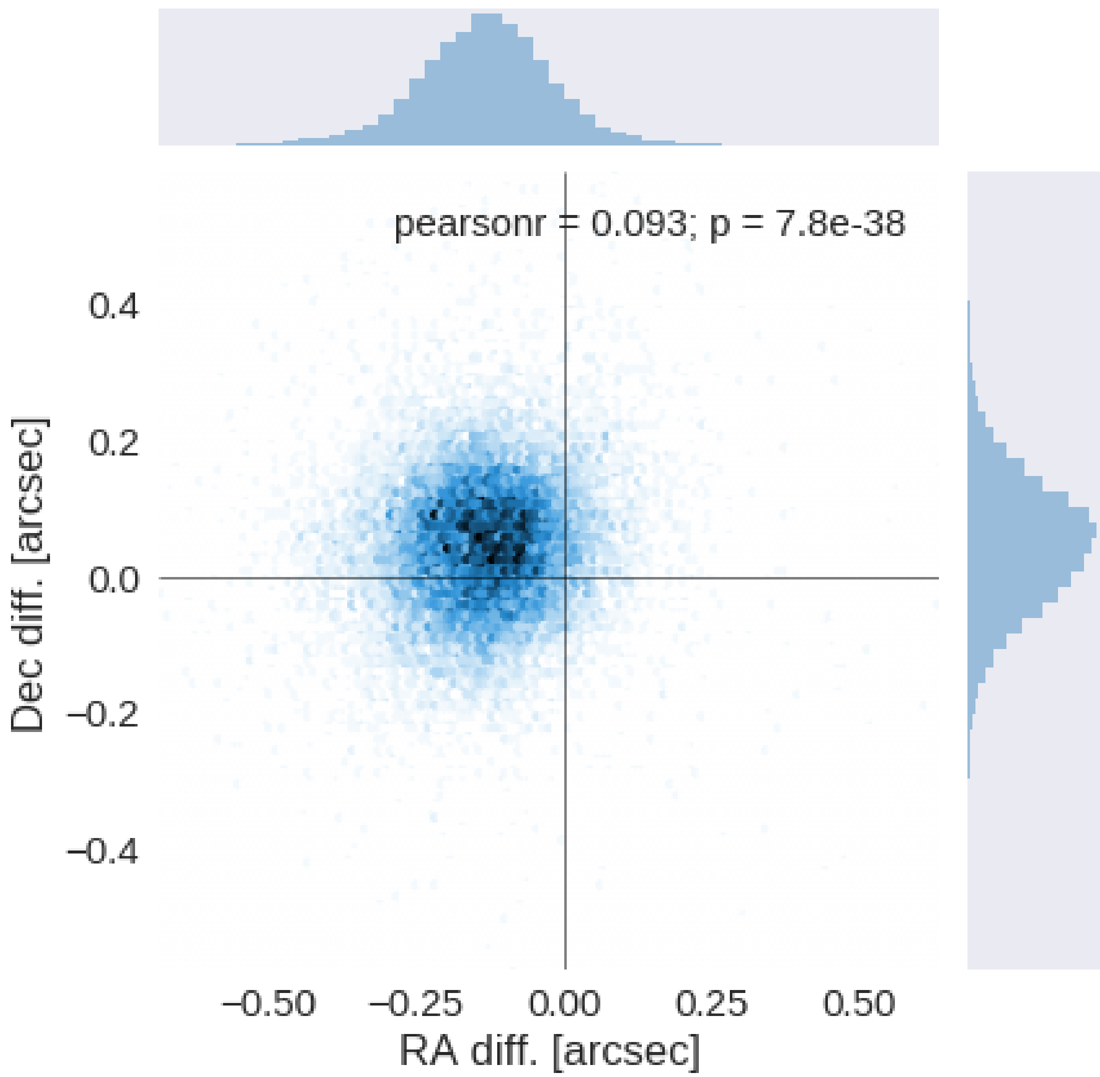
We remove duplicated objects from the input catalogues.

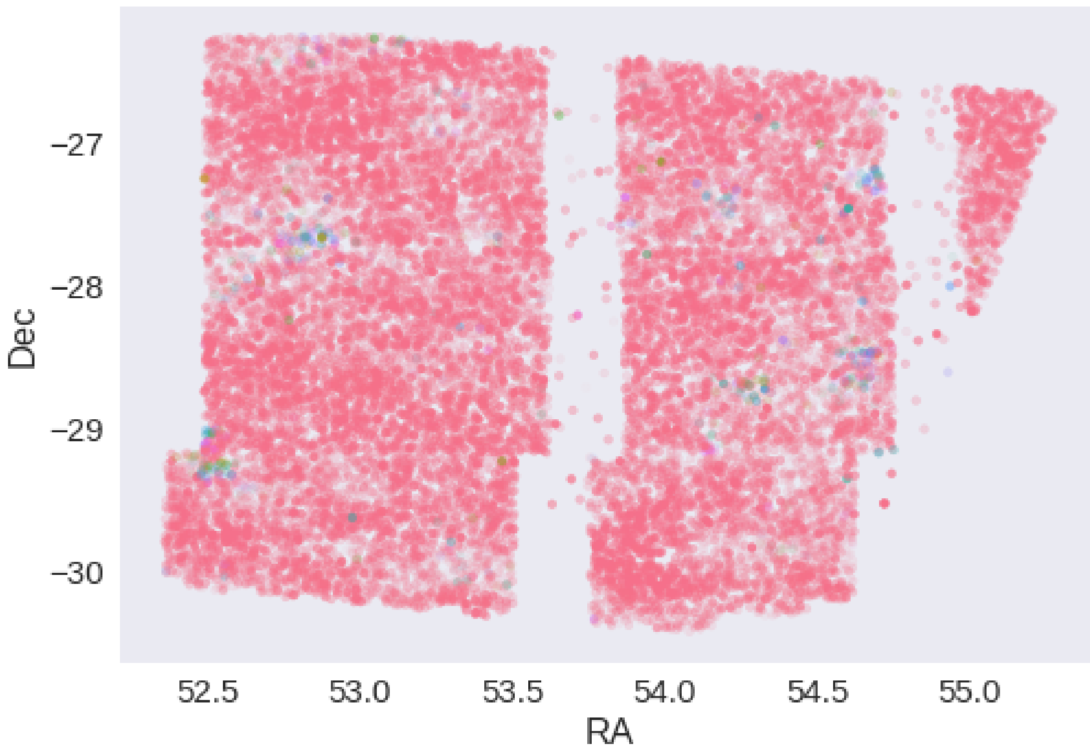
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 130365 sources.
The cleaned catalogue has 130357 sources (8 removed).
The cleaned catalogue has 8 sources flagged as having been cleaned
```

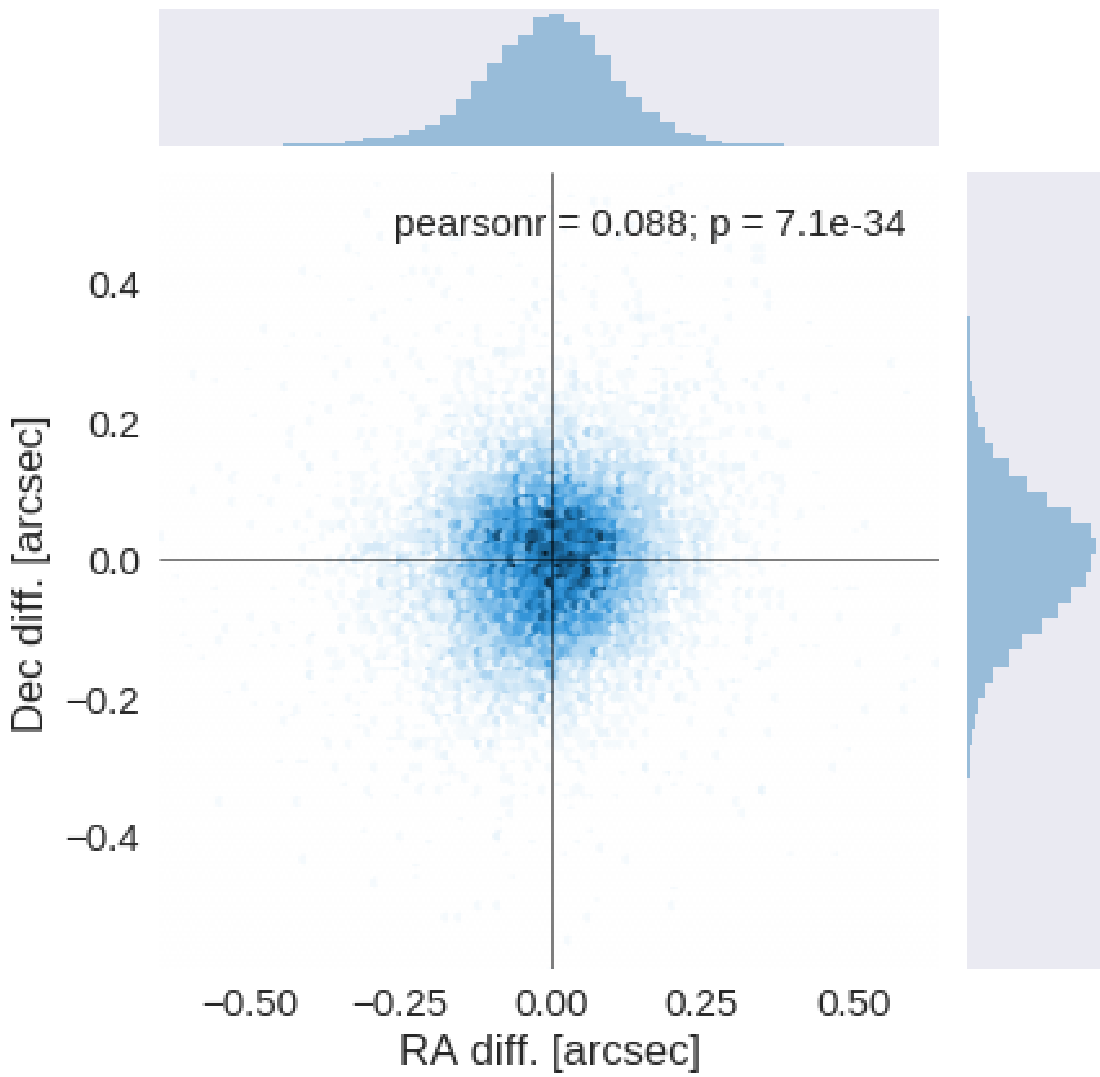
1.4 III - Astrometry correction

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.

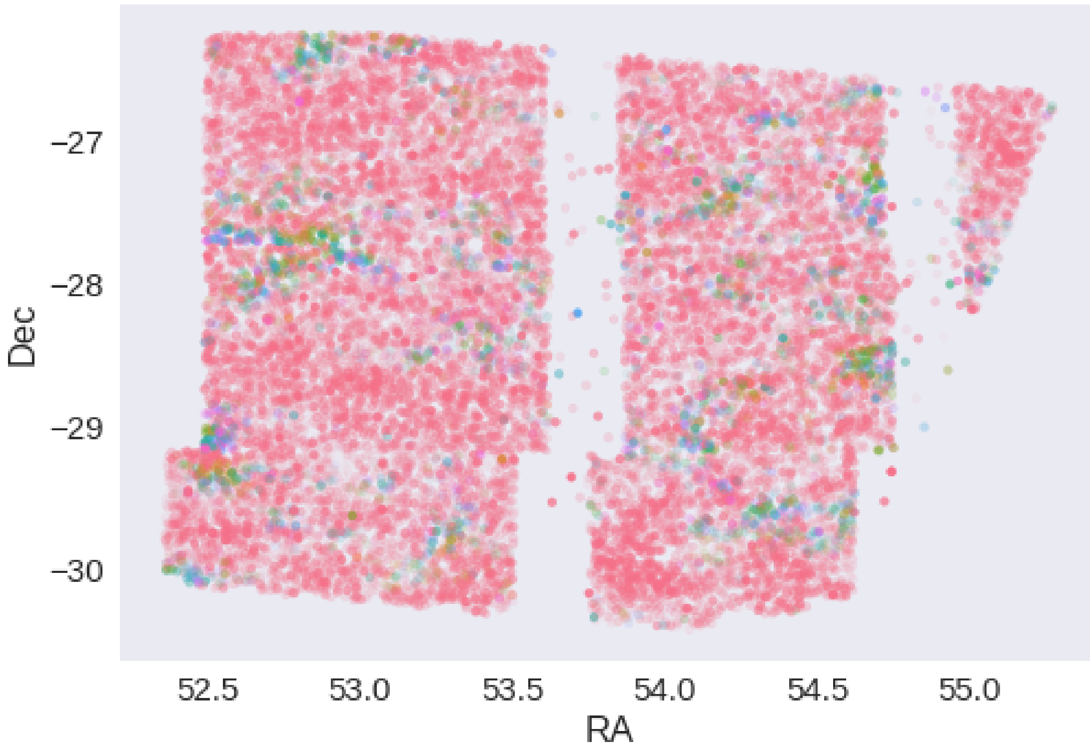





```
RA correction: 0.12950658218784383 arcsec
Dec correction: -0.046652433941574145 arcsec
```



pearsonr = 0.088; p = 7.1e-34
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
19163 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.9_DES

March 8, 2018

1 CDFS SWIRE master catalogue

1.1 Preparation of DES data

Blanco DES catalogue: the catalogue comes from `dmu0_DES`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The G band stellarity;
- The magnitude for each band.
- The auto/kron magnitudes/fluxes to be used as total magnitude.
- The aperture magnitudes, which are used to compute a corrected 2 arcsec aperture magnitude.

We don't know when the maps have been observed. We will take the final observation date as 2017.

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-21 19:05:21.709271
```

1.2 1 - Aperture correction

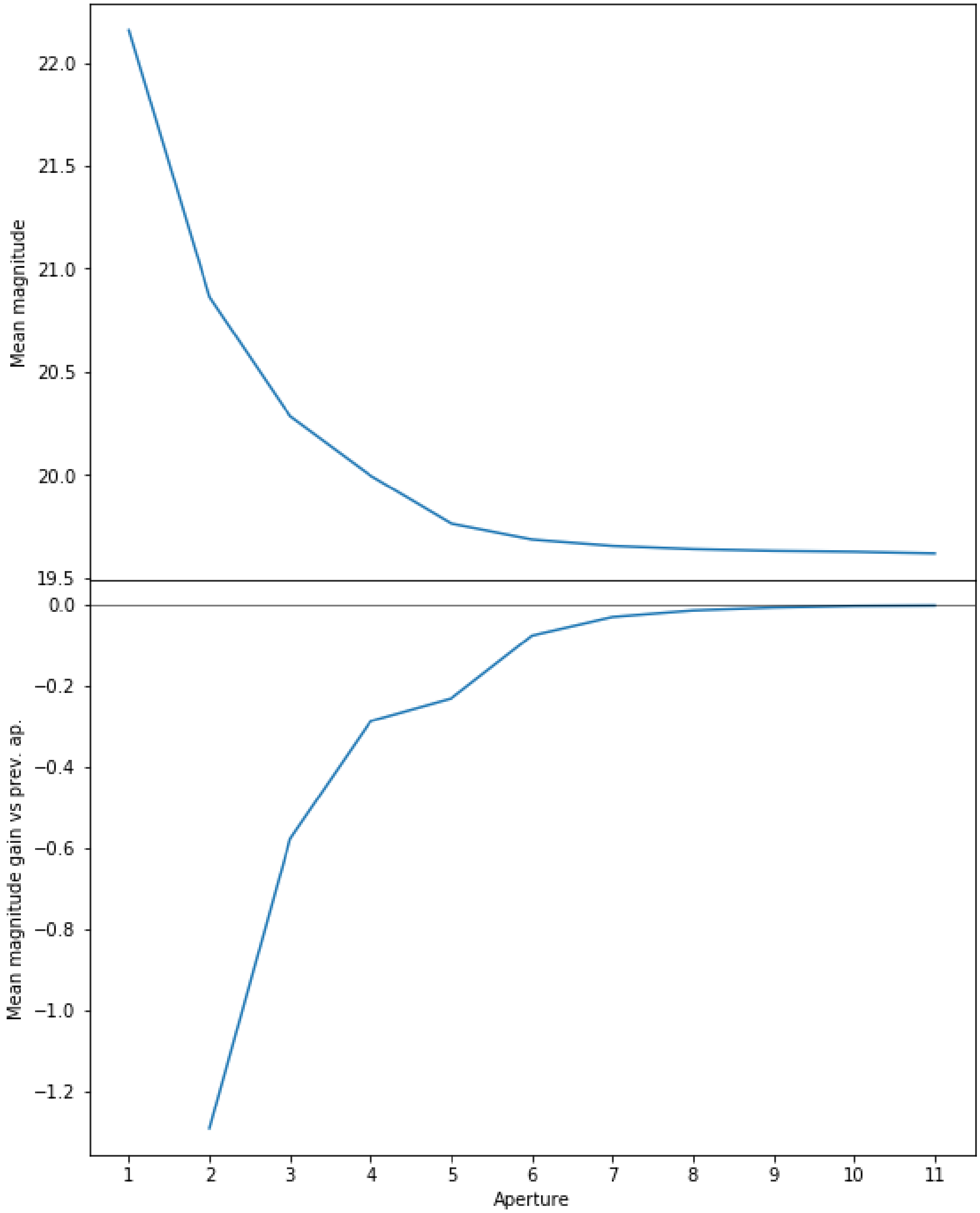
To compute aperture correction we need to dertermine two parametres: the target aperture and the range of magnitudes for the stars that will be used to compute the correction.

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

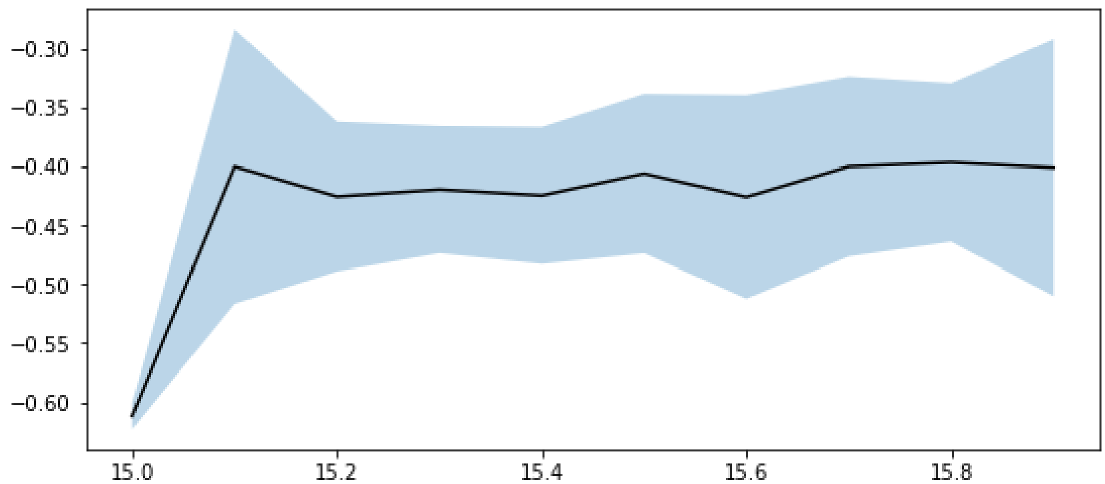
The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude. The mean gain (loss when negative) of magnitude is each aperture compared to the previous (except for the first of course). As target aperture, we should use the smallest (i.e. less noisy) aperture for which most of the flux is captures.

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.

1.2.1 I.a - g band



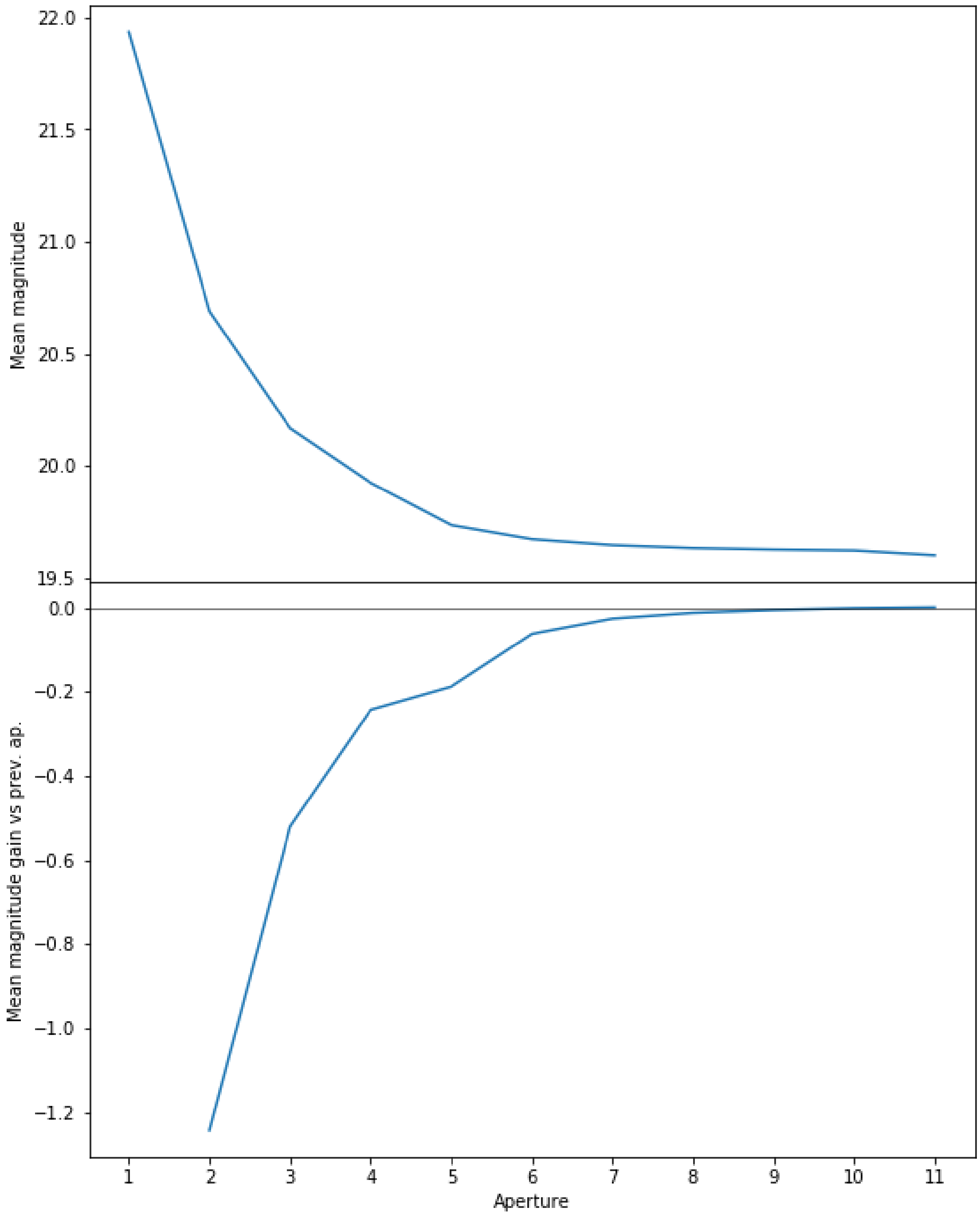
We will use aperture 10 as target.



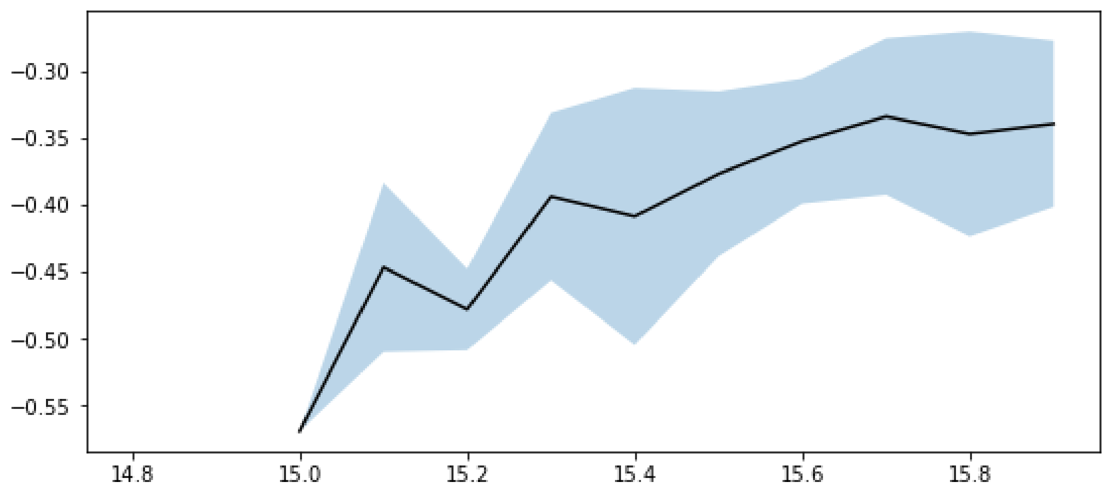
We will use magnitudes between 15.0 and 16.0

```
Aperture correction for g band:
Correction: -0.40595245361328125
Number of source used: 1048
RMS: 0.0773379441038148
```

1.2.2 I.b - r band



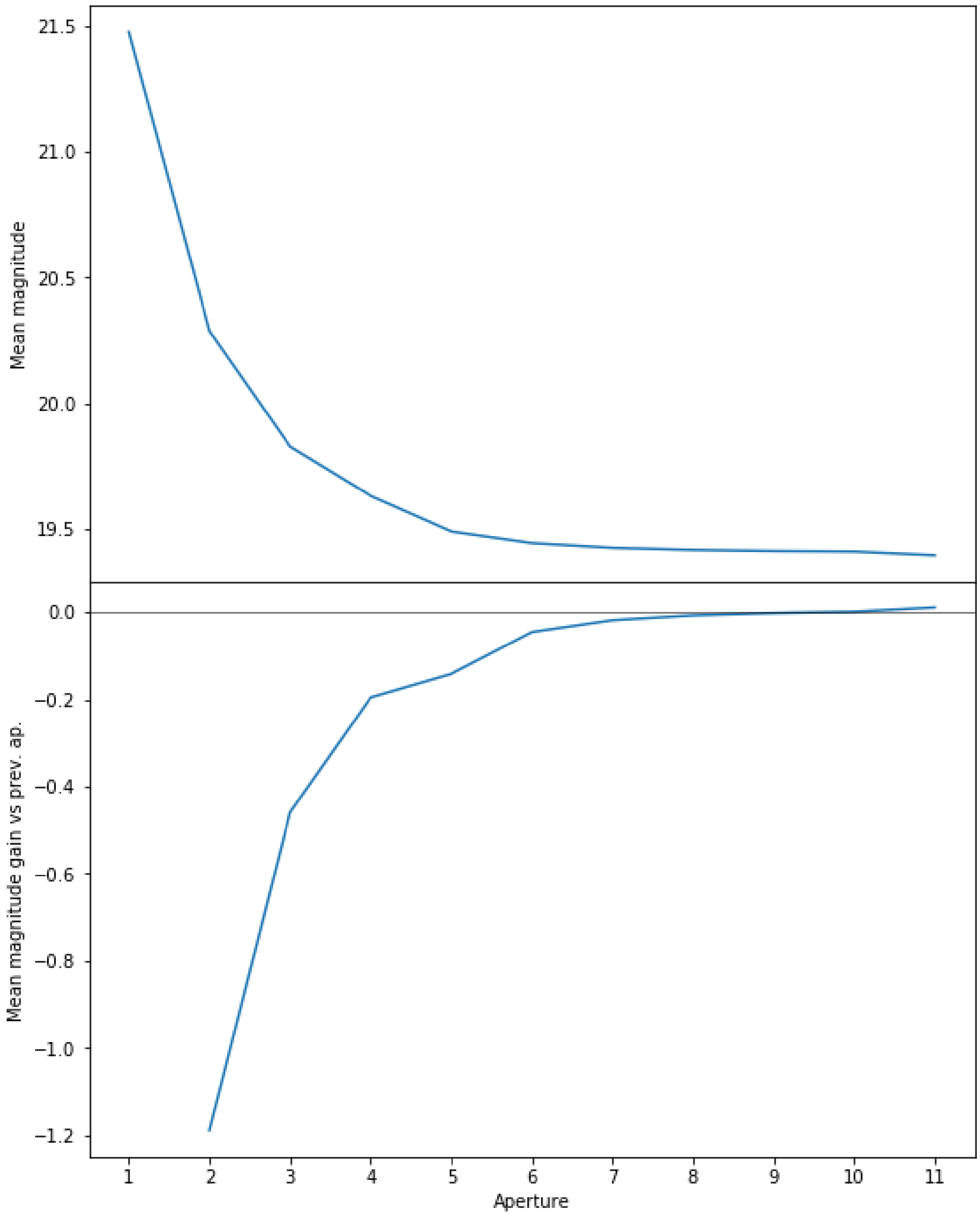
We will use aperture 10 as target.



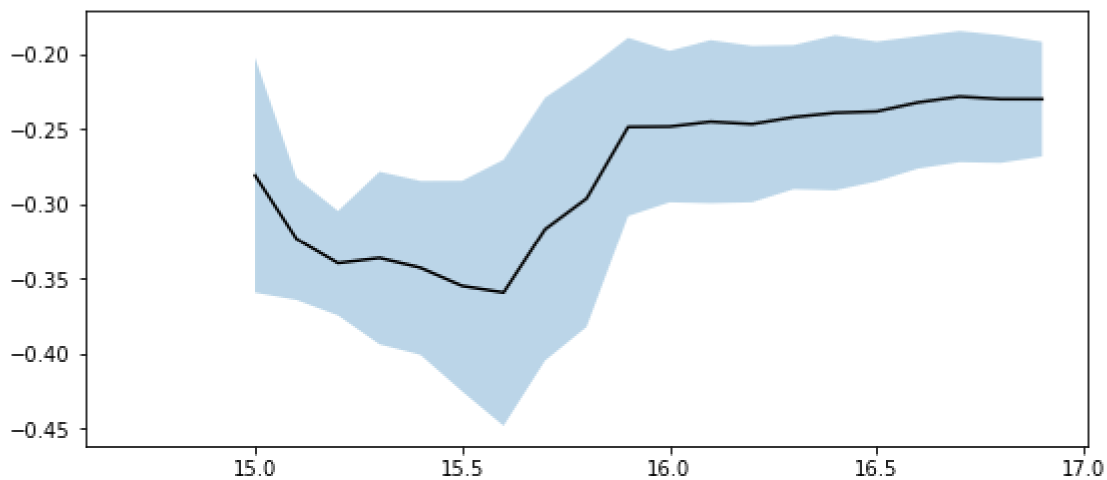
We use magnitudes between 15.0 and 16.0.

```
Aperture correction for r band:
Correction: -0.34665727615356445
Number of source used: 601
RMS: 0.06991605935786925
```

1.2.3 I.b - i band



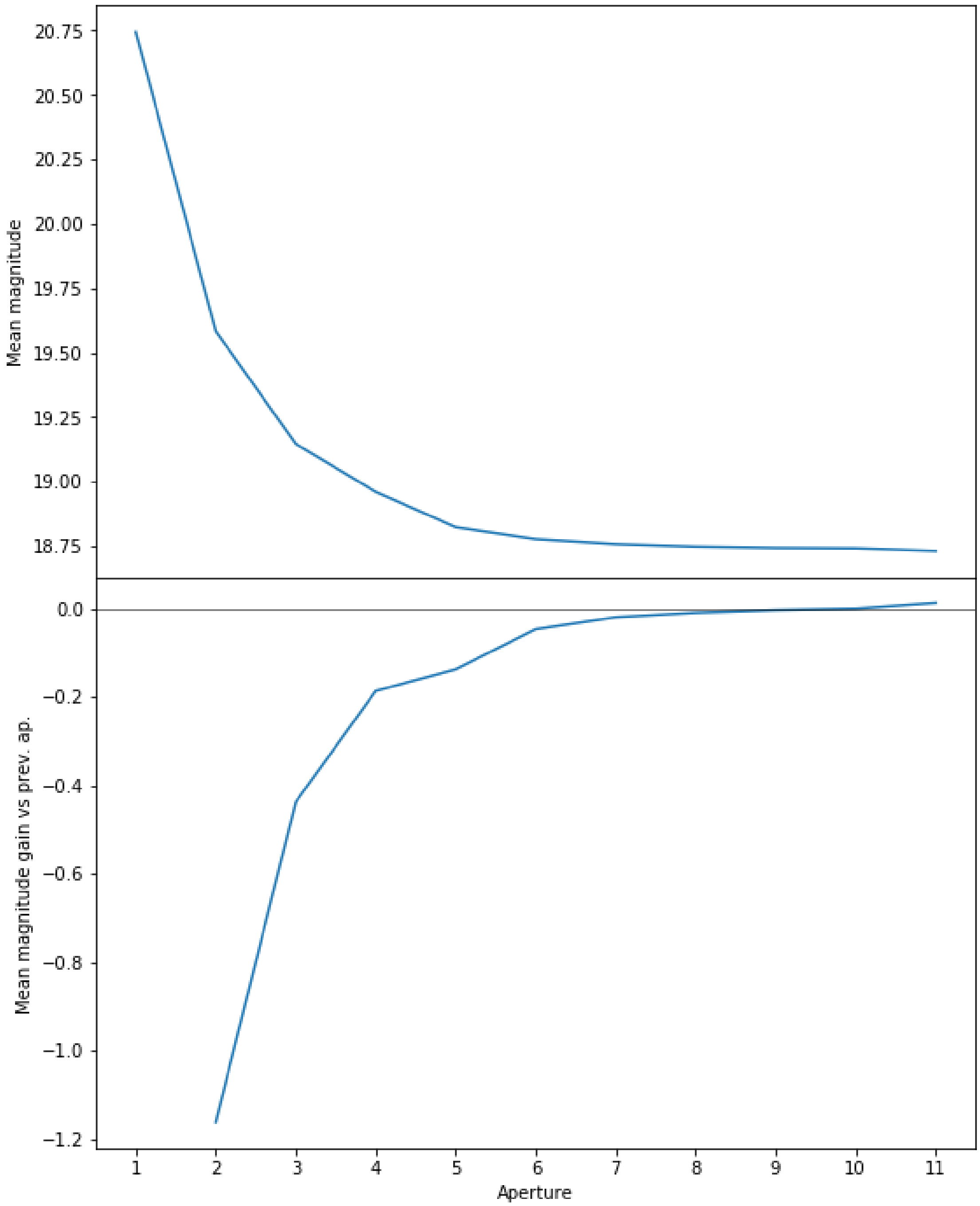
We will use aperture 10 as target.



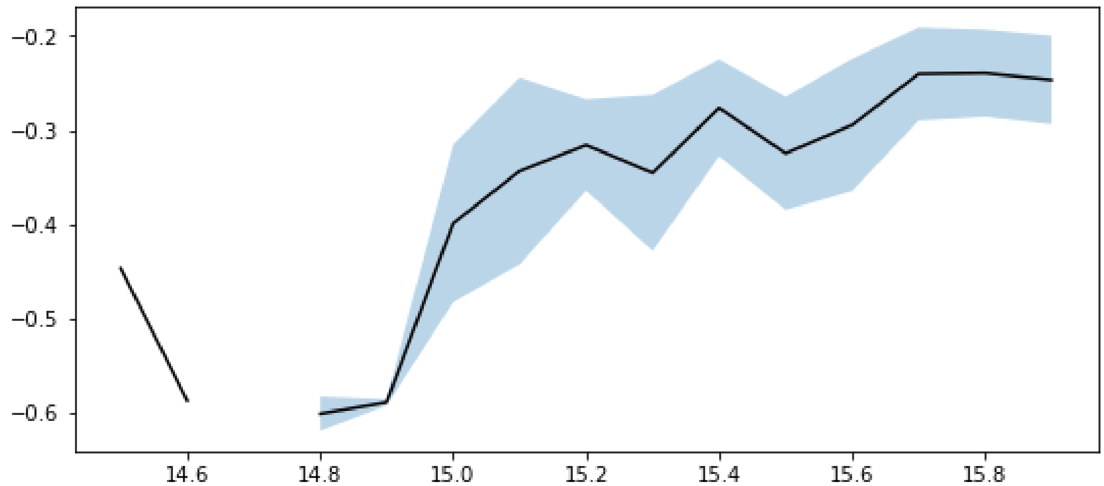
We use magnitudes between 15.0 and 16.0.

```
Aperture correction for i band:
Correction: -0.2888193130493164
Number of source used: 392
RMS: 0.08284547063194449
```

1.2.4 I.b - z band



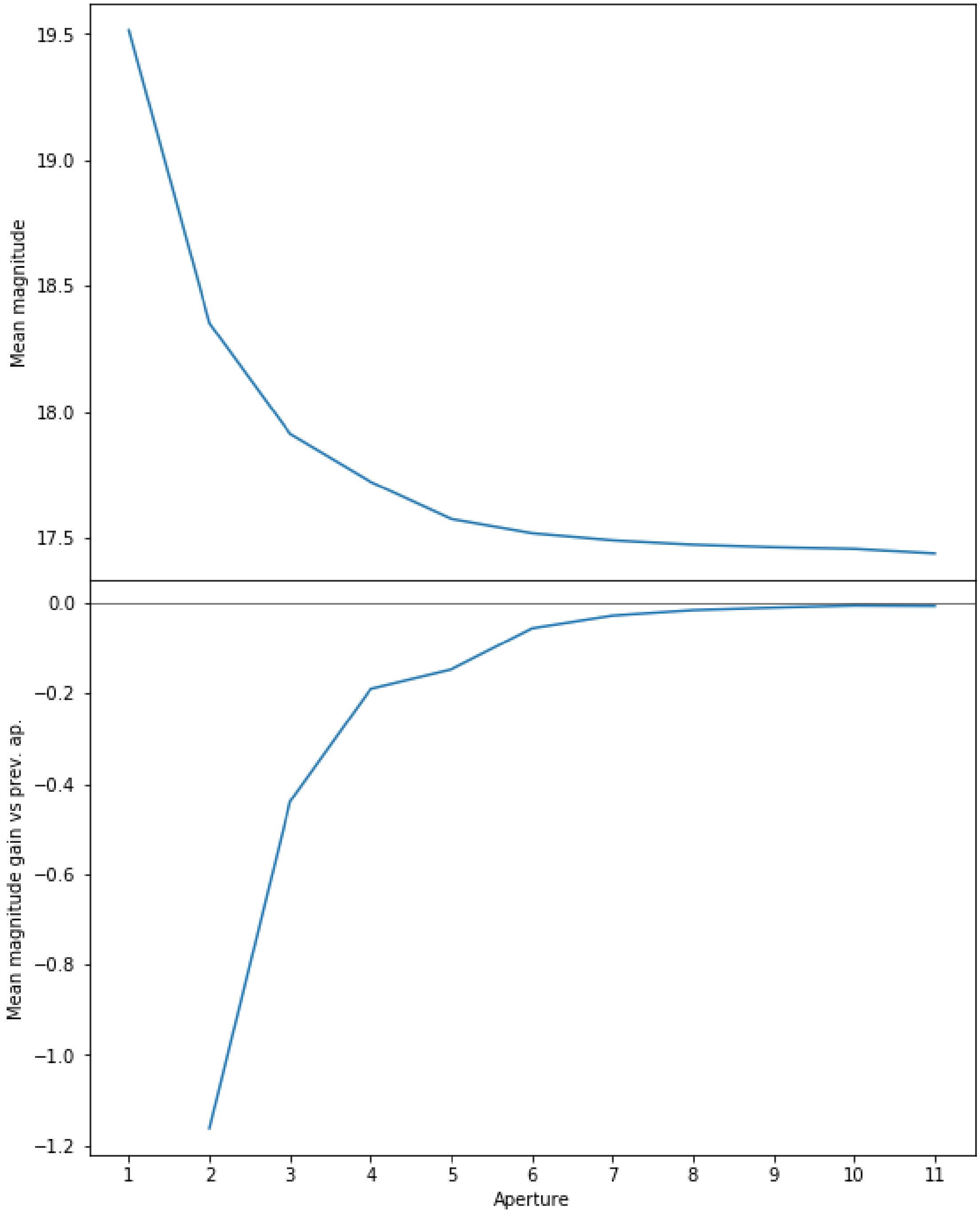
We will use aperture 57 as target.



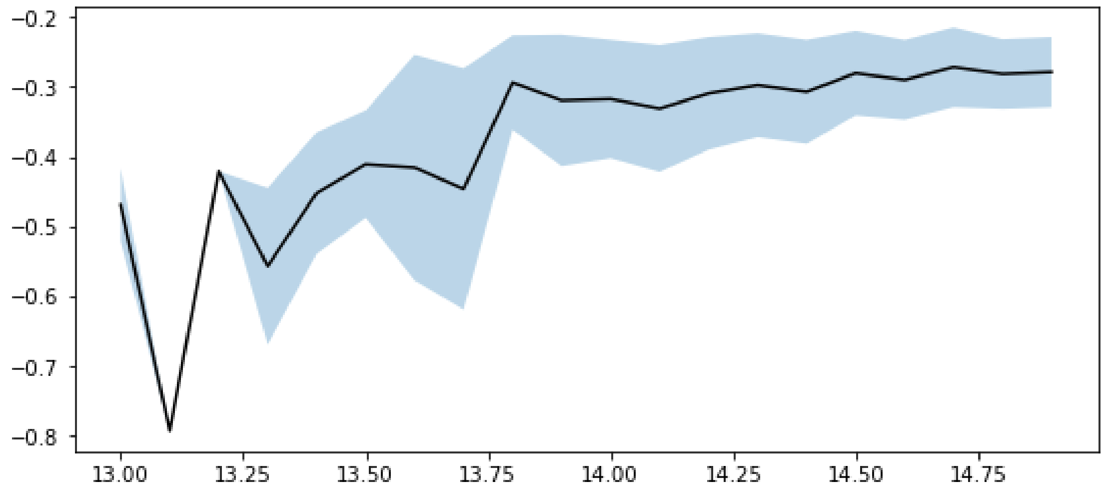
We use magnitudes between 15. and 16.

```
Aperture correction for z band:
Correction: -0.24968433380126953
Number of source used: 879
RMS: 0.054259308128121096
```

1.2.5 I.b - y band



We will use aperture 10 as target.



We use magnitudes between 15.0 and 16.0.

```
Aperture correction for y band:
Correction: -0.2601947784423828
Number of source used: 1262
RMS: 0.04467325882172178
```

1.3 2 - 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[24]: <IPython.core.display.HTML object>
```

1.4 II - Removal of duplicated sources

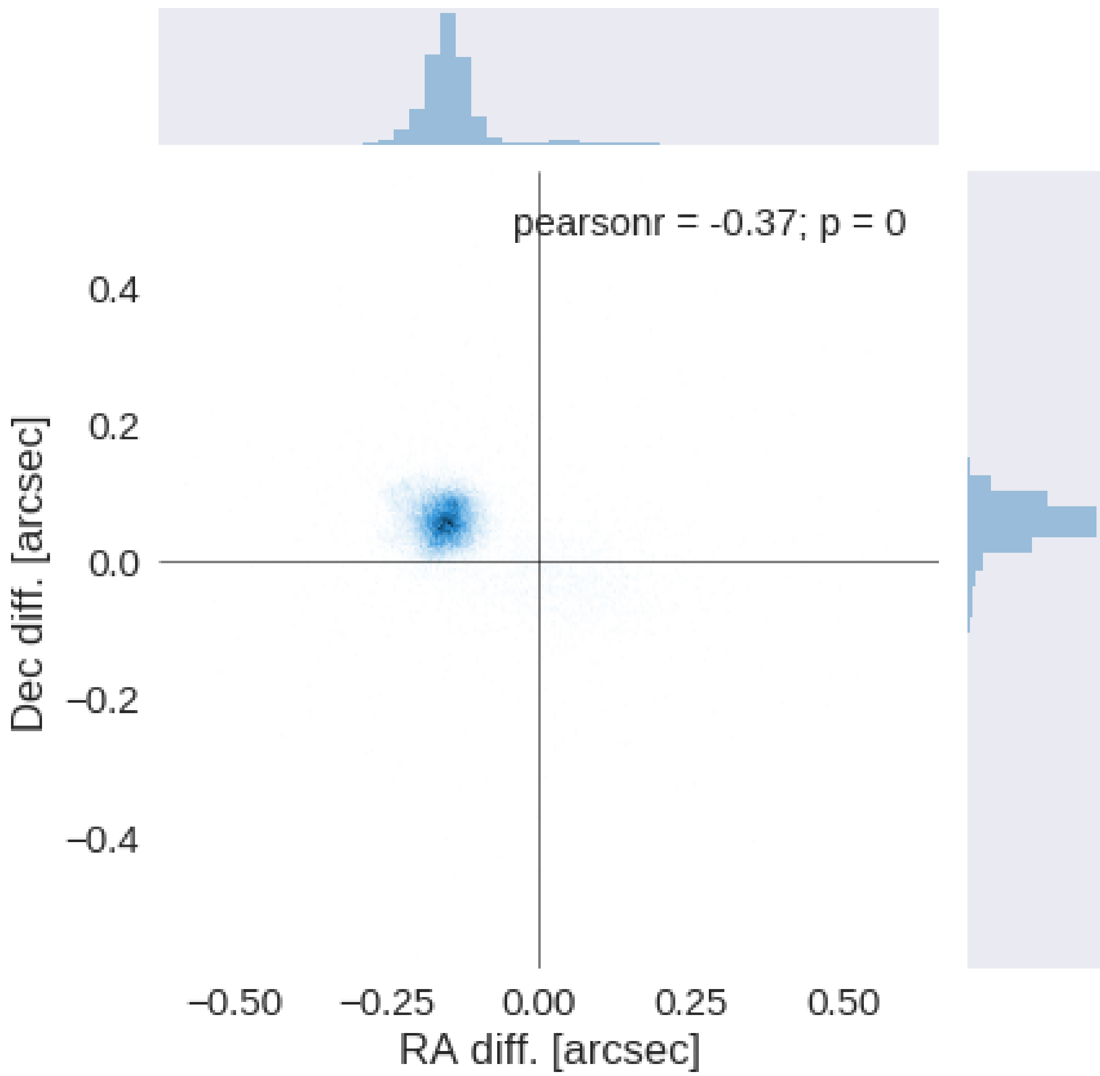
We remove duplicated objects from the input catalogues.

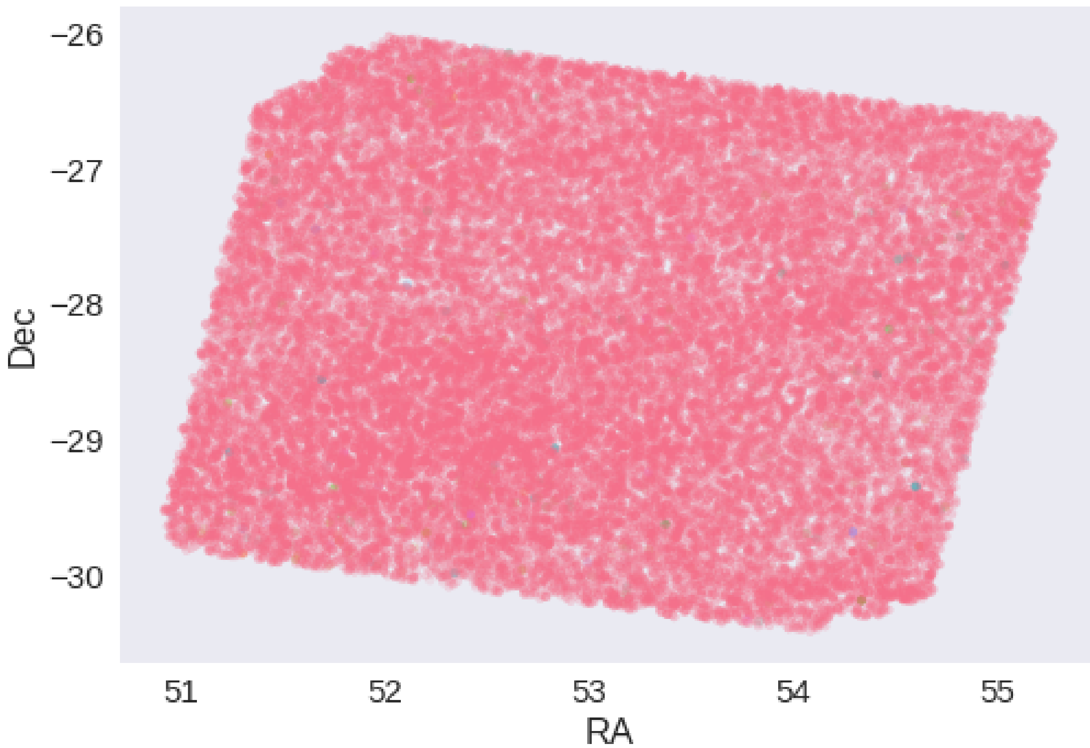
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 999553 sources.
The cleaned catalogue has 999544 sources (9 removed).
The cleaned catalogue has 9 sources flagged as having been cleaned
```

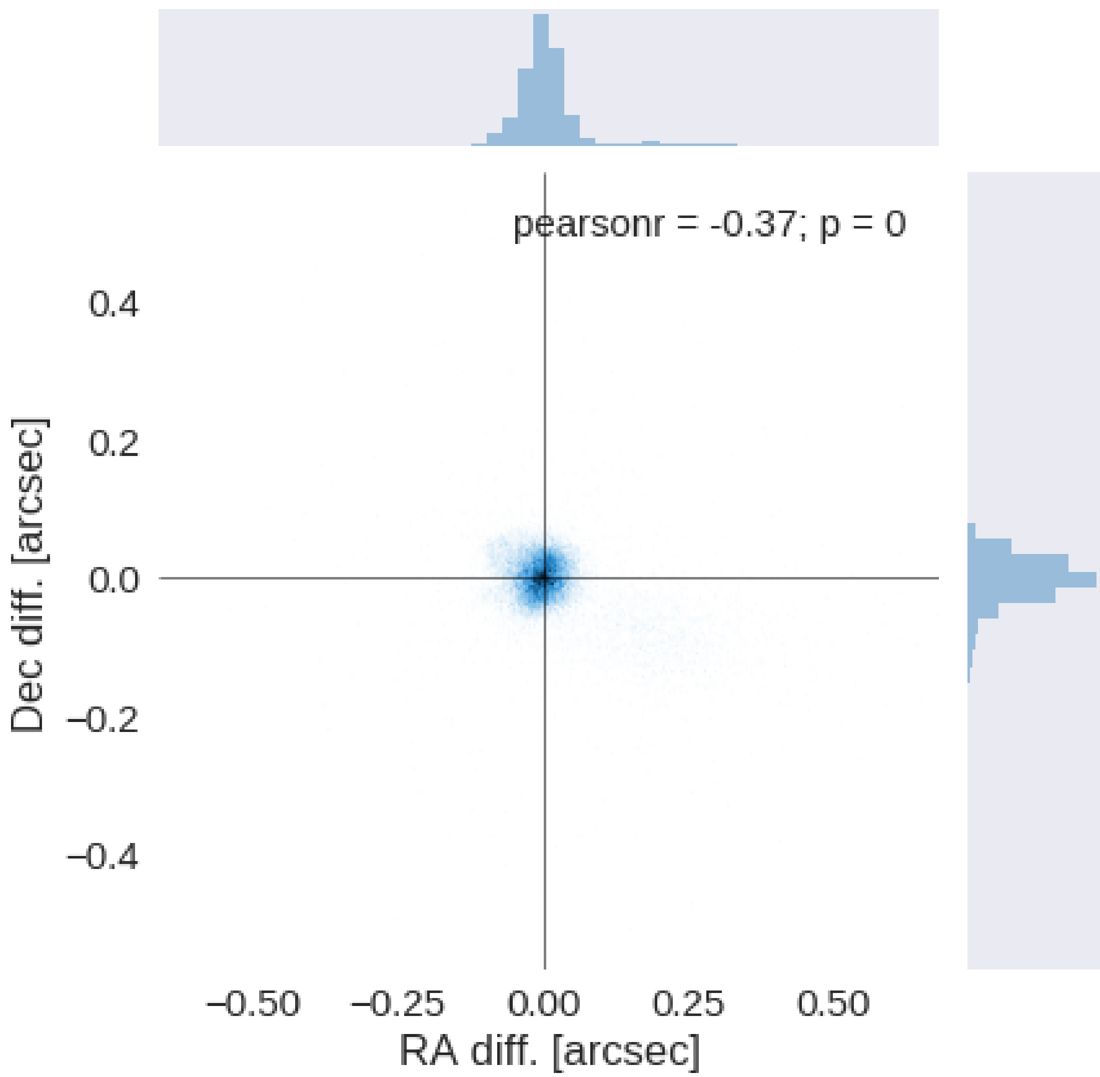
1.5 III - Astrometry correction

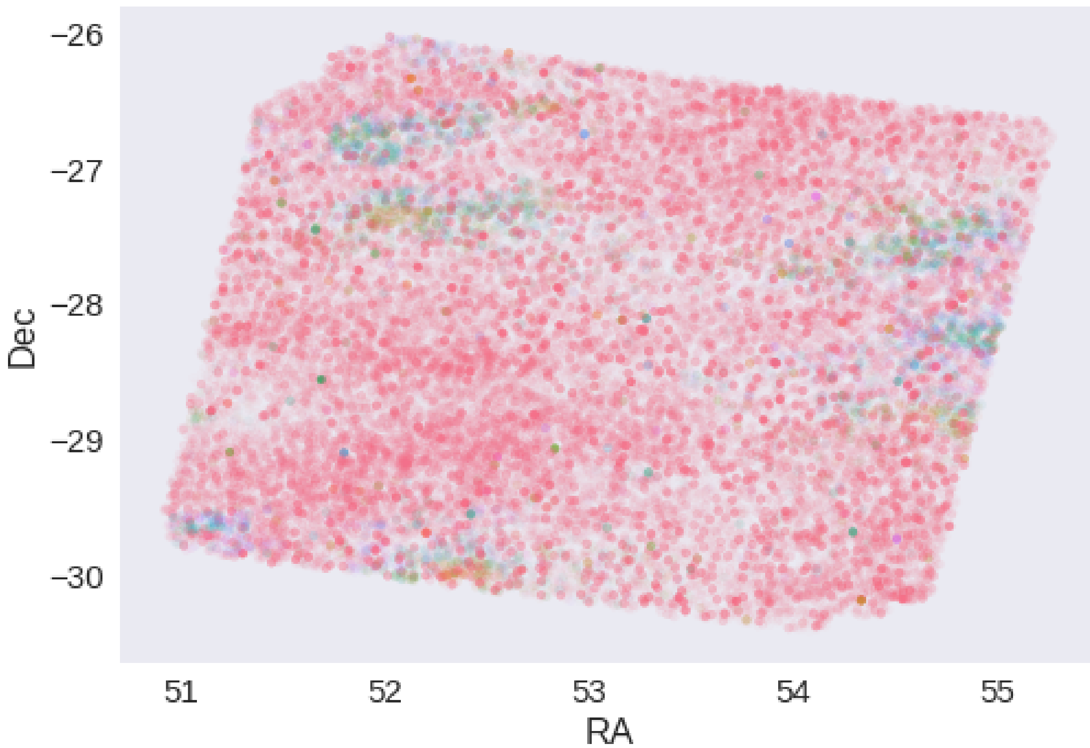
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 0.15149059884294047 arcsec
Dec correction: -0.057696934679540846 arcsec
```


pearsonr = -0.37; p = 0
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.50
−0.25
0.00
0.25
0.50
RA diff. [arcsec]



1.6 IV - Flagging Gaia objects

```
35223 sources flagged.
```

1.7 V - Flagging objects near bright stars

2 VI - Saving to disk

1.10_CANDELS-GOODS-S

March 8, 2018

1 CDFS-SWIRE master catalogue

1.1 Preparation of CANDELS-GOODS-S data

CANDELS-GOODS-N catalogue: the catalogue comes from `dmu0_CANDELS-GOODS-S`.
In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The total 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

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

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

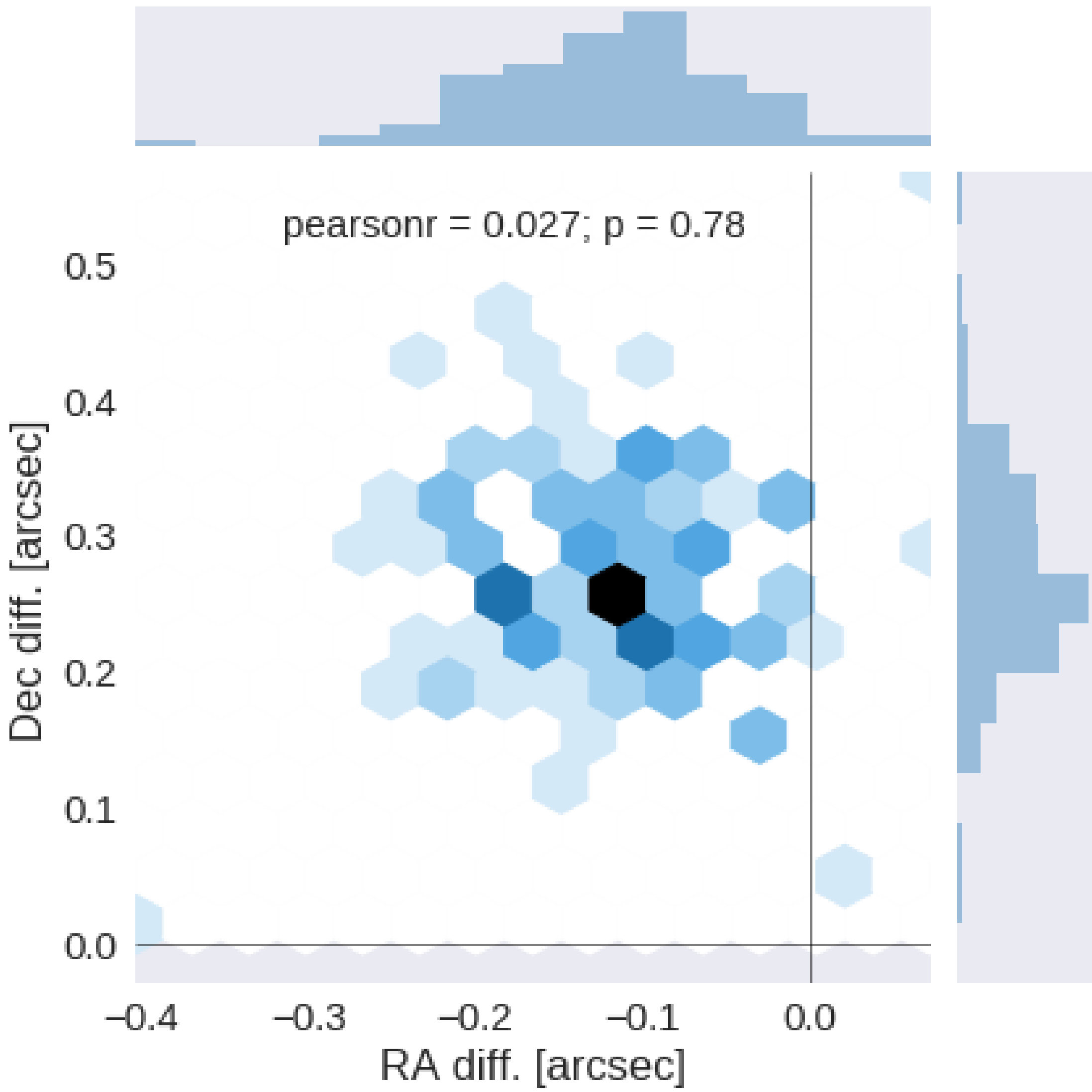
1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

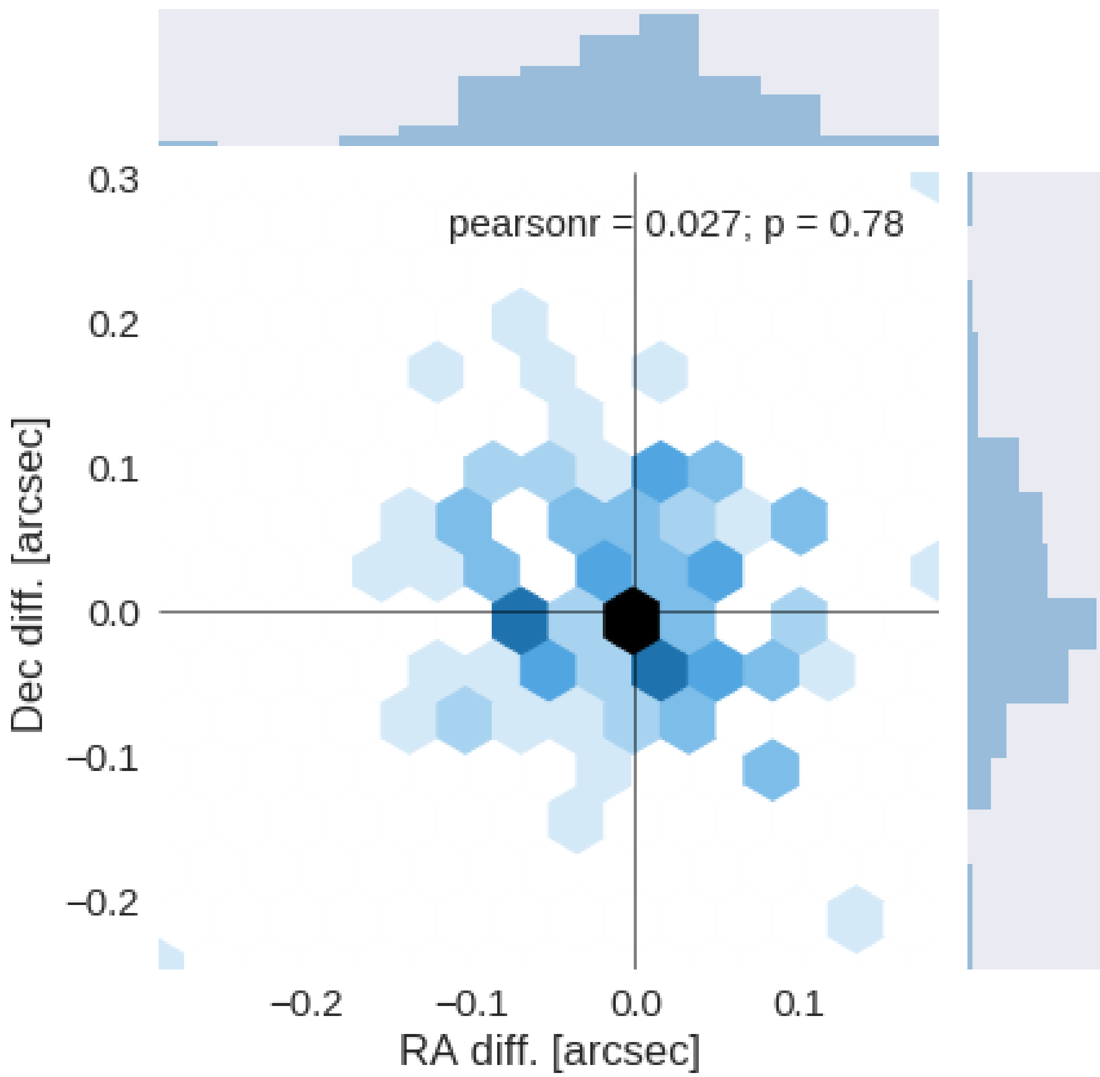
```
The initial catalogue had 34930 sources.
The cleaned catalogue has 34926 sources (4 removed).
The cleaned catalogue has 4 sources flagged as having been cleaned
```

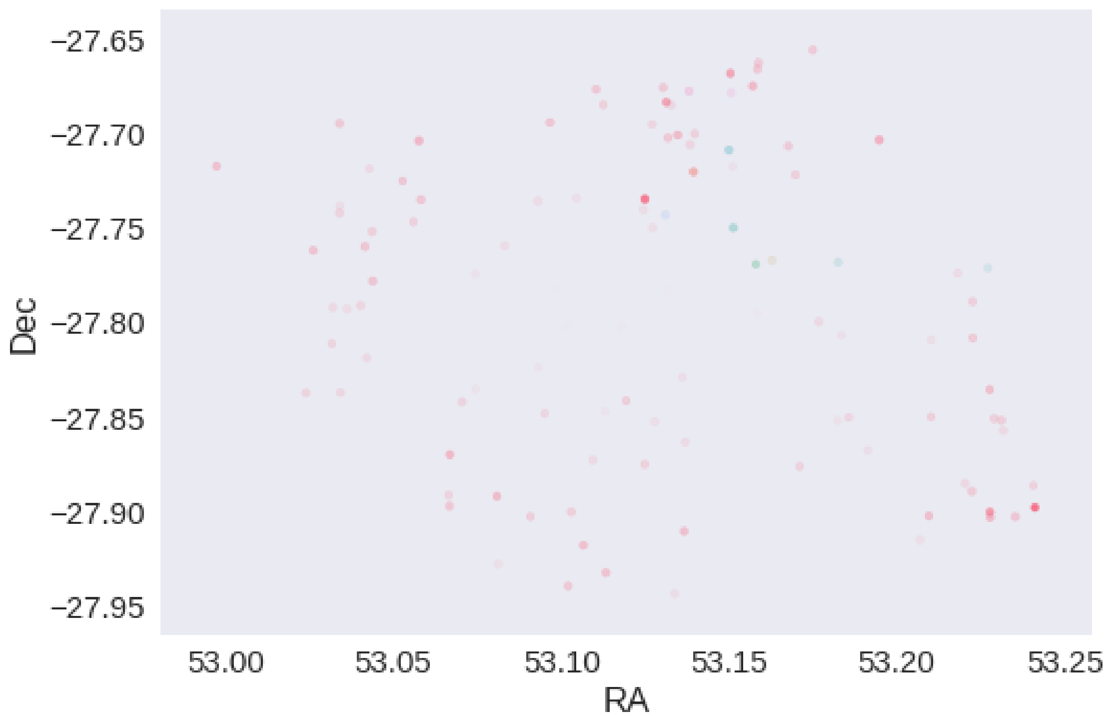
1.4 III - Astrometry correction

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: 0.11352528611894286 arcsec
Dec correction: -0.2639050027212875 arcsec
```


pearsonr = 0.027; p = 0.78
0.3
0.2
0.1
0.0
−0.1
−0.2
Dec diff. [arcsec]
−0.2
−0.1
0.0
0.1
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
123 sources flagged.
```

2 V - Saving to disk

2_Merging

March 8, 2018

1 CDFS SWIRE master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP master catalogue on CDFS SWIRE.

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
```

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: PS1, COMBO, ATLAS, VIDEO, VHS, SERVS, SWIRE. Fireworks is no longer included.

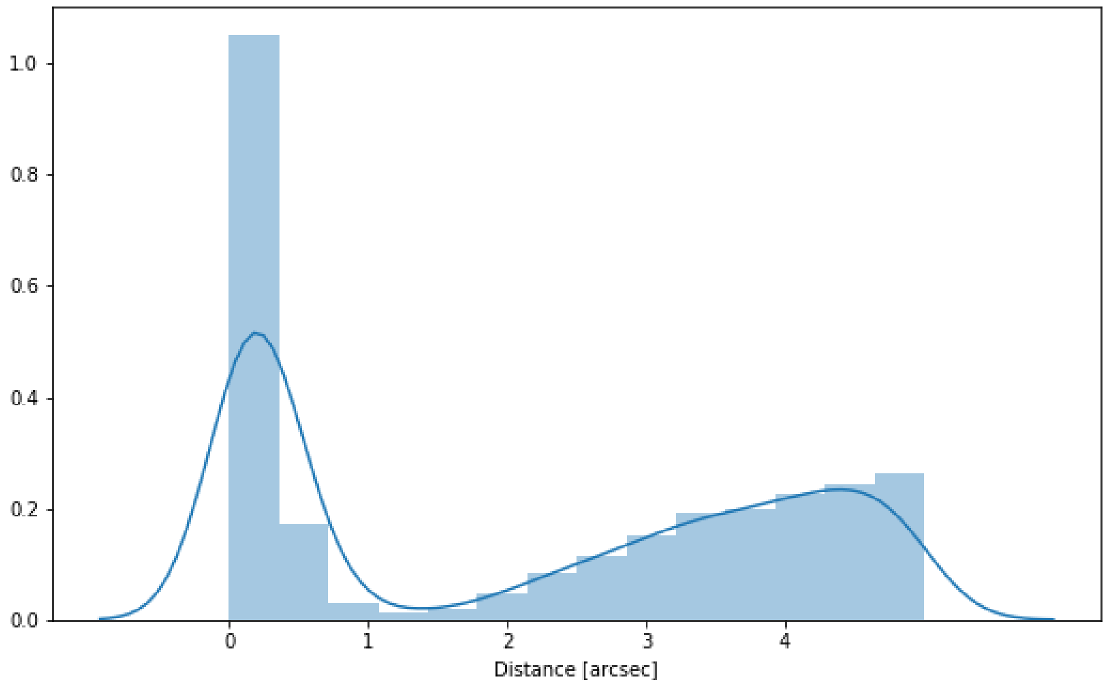
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 PanSTARRS

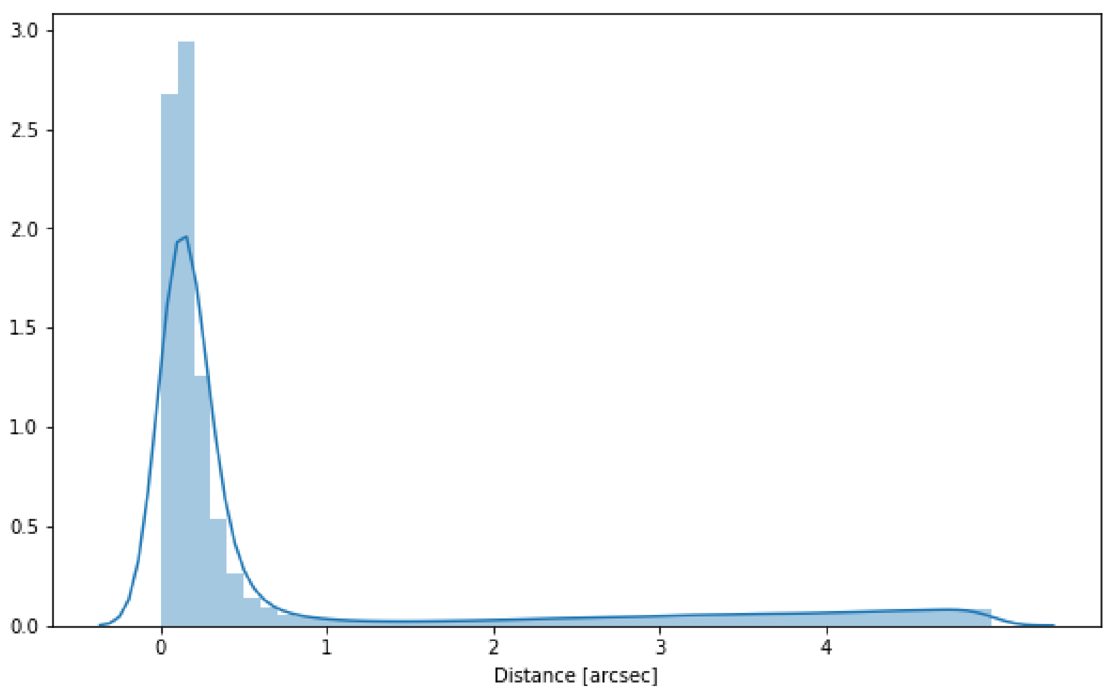
1.2.2 Add Fireworks

We are no longer including Fireworks under Mattia's advice. I leave the code in the notebook commented out in case the user wishes to include it.

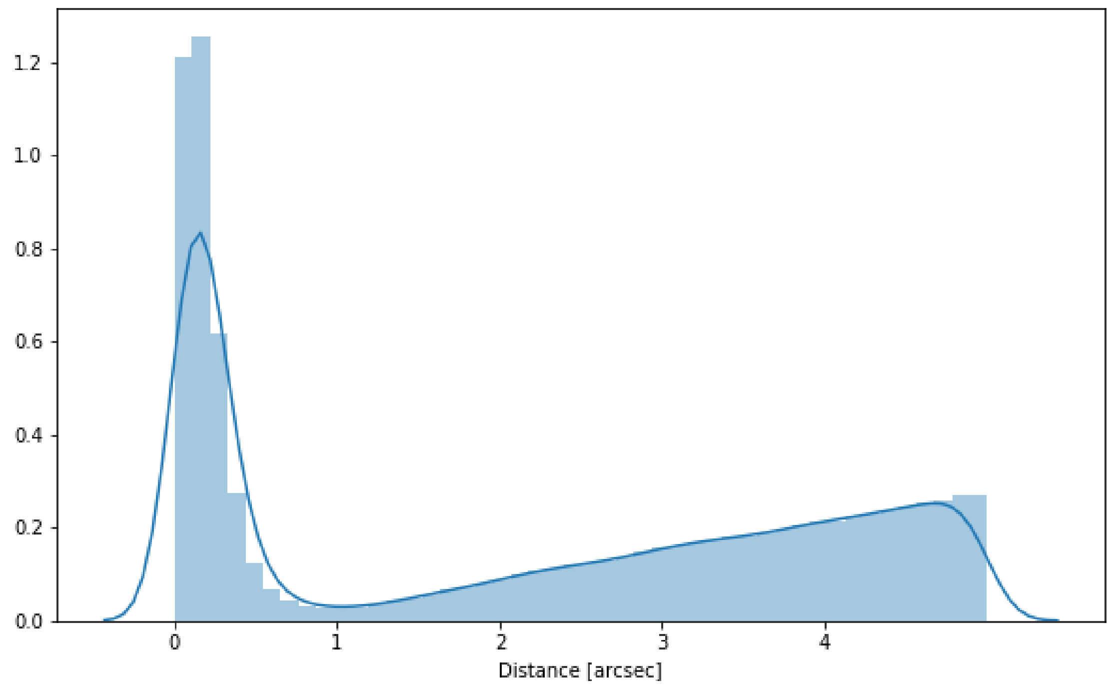
1.2.3 Add COMBO



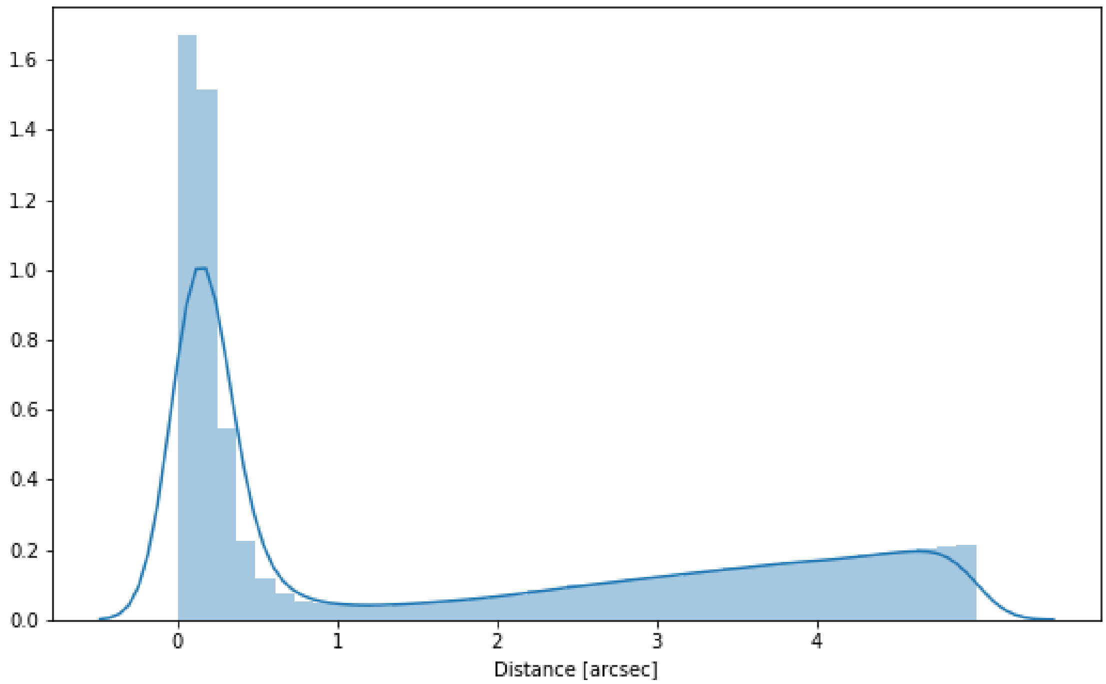
1.2.4 Add ATLAS



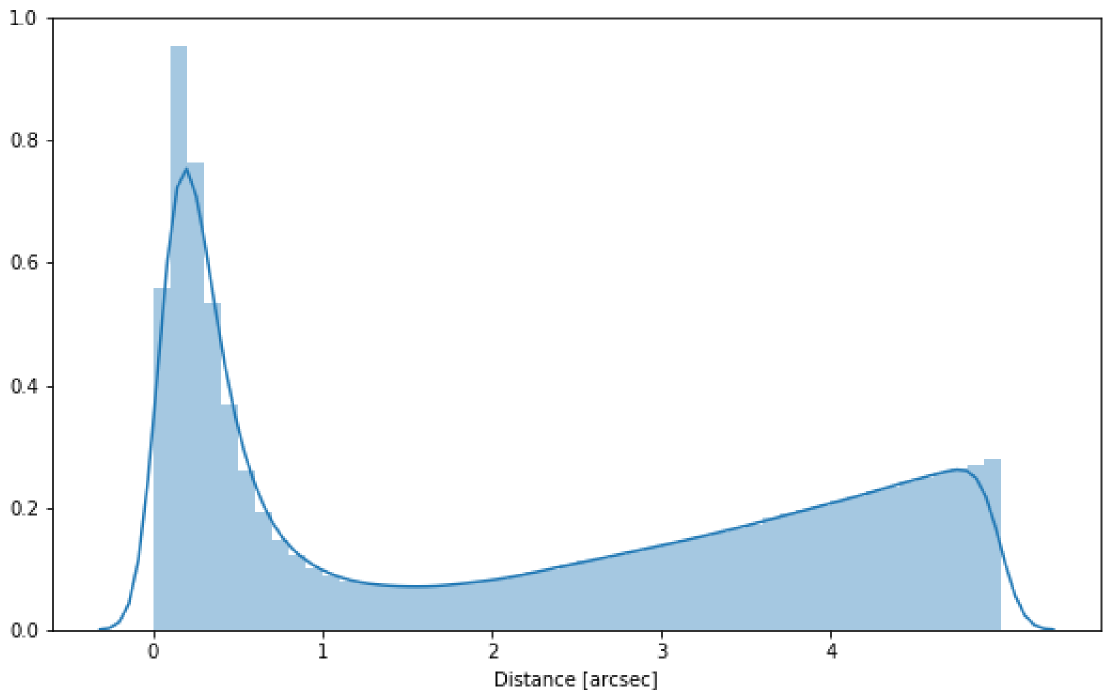
1.2.5 Add VIDEO



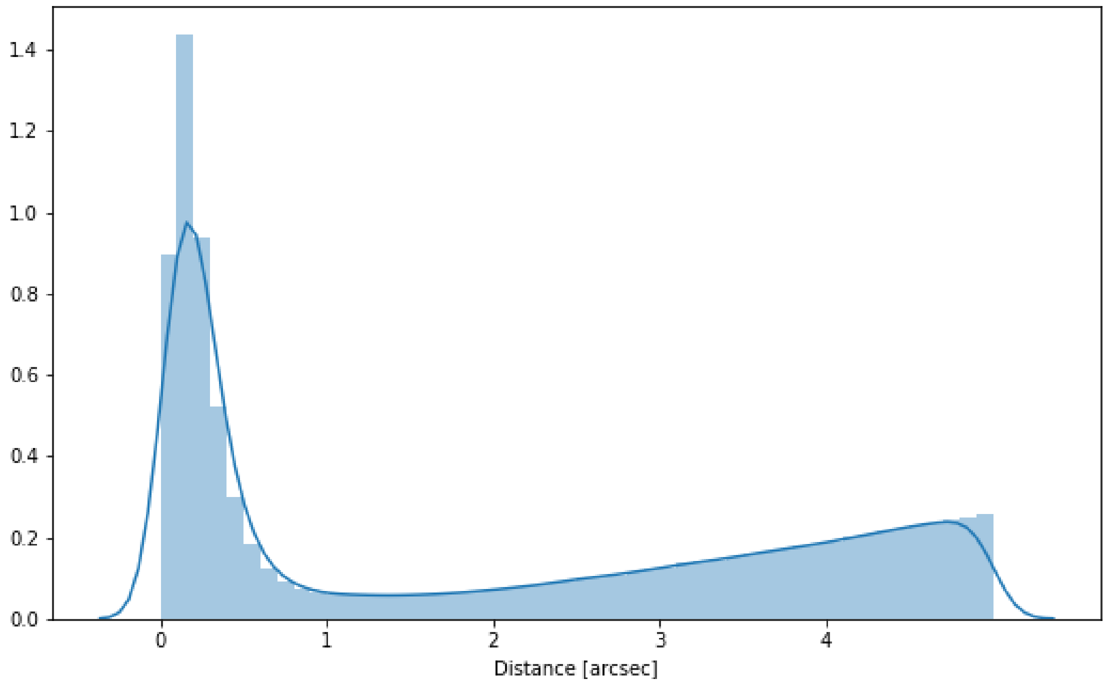
1.2.6 Add VHS



1.2.7 Add SERVS

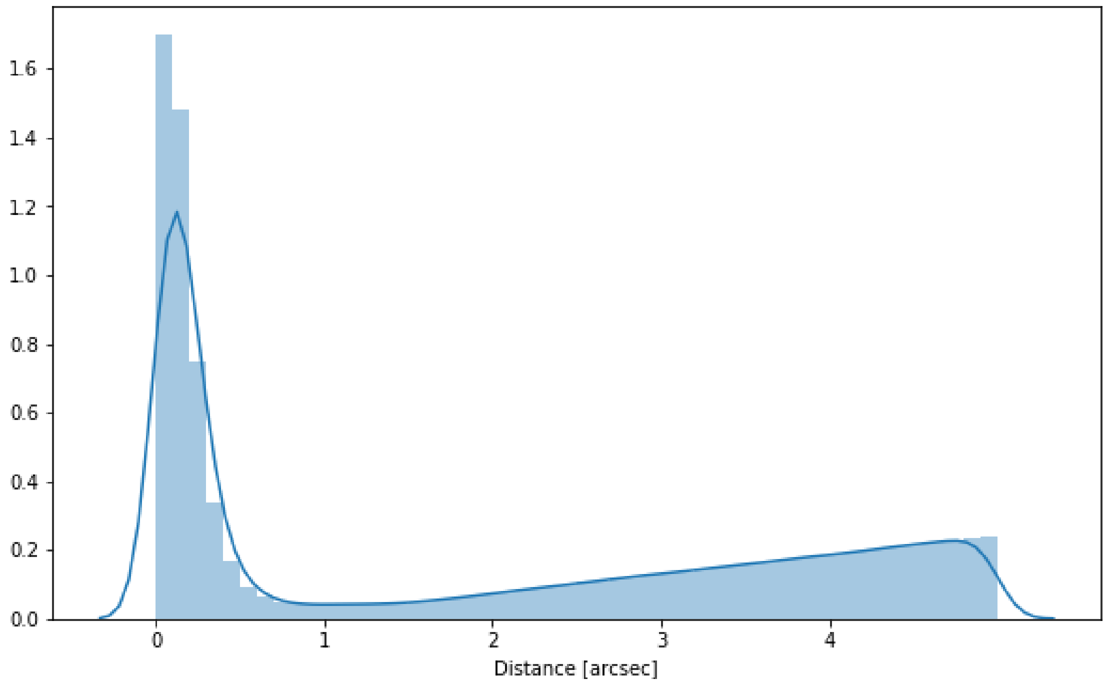


1.2.8 Add SWIRE

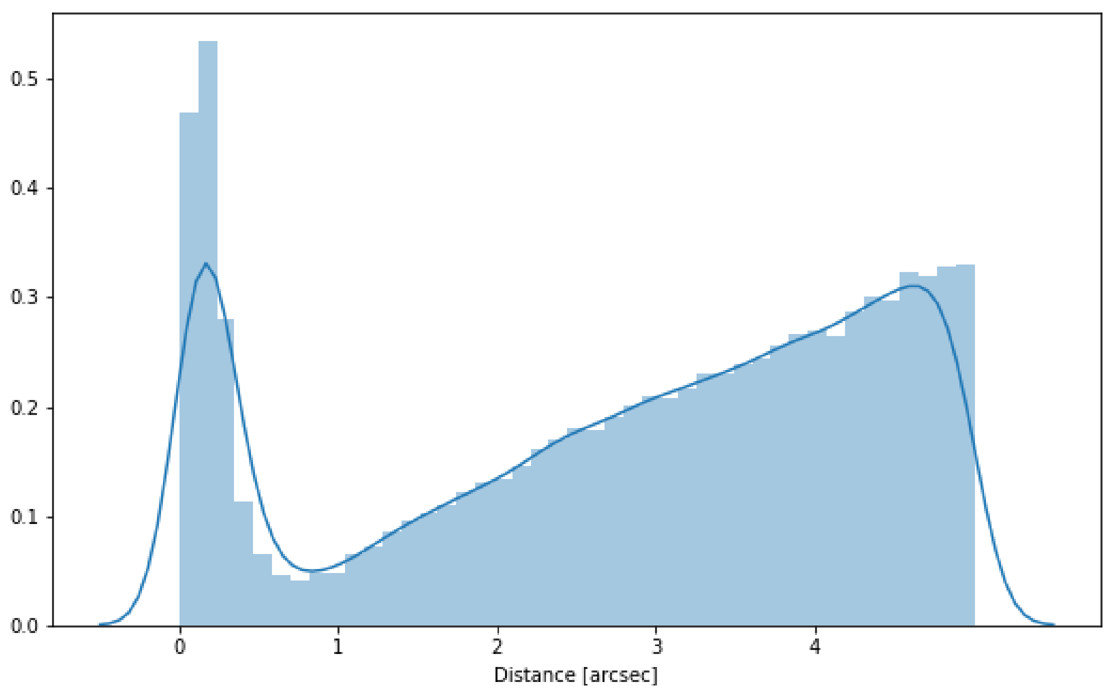


1.2.9 Add DES

DES and CANDELS are added at the end because they were not in teh original masterlist. By adding them at the end we ensure that the original HELP ids are maintained.



1.2.10 Add CANDELS



1.2.11 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[25]: <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 prisitine 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.

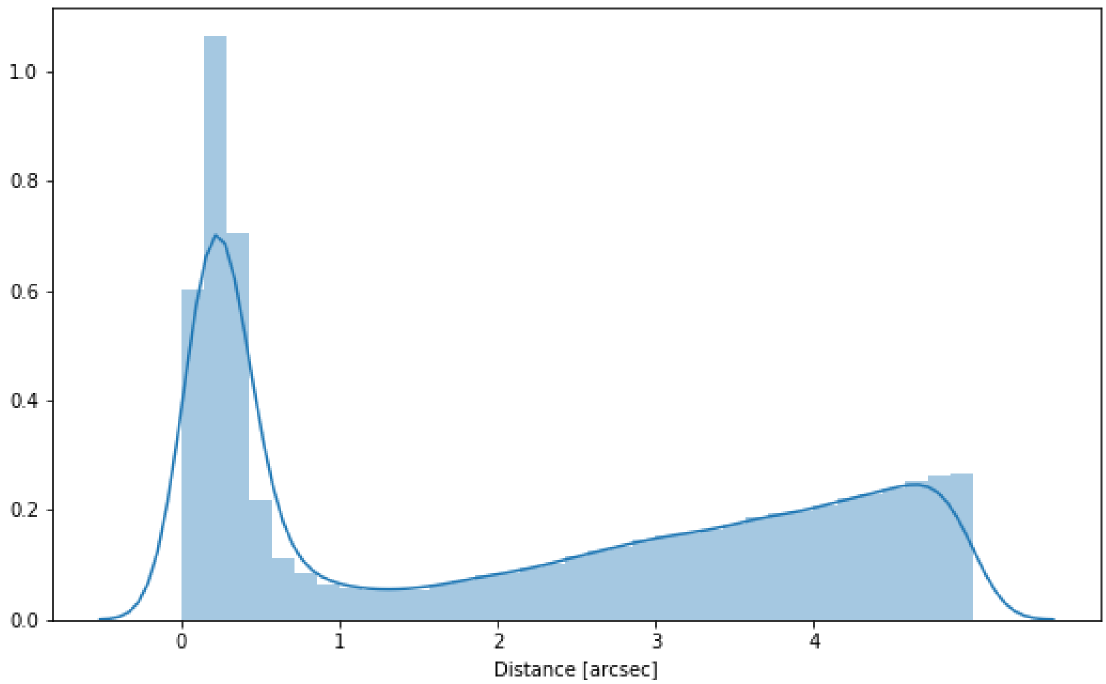
```
combo_stellarity, atlas_stellarity, video_stellarity, vhs_stellarity, servs_stellarity_irac1, se
```

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

```
OK!
```

2 VI - Cross-matching with the spec-z catalogue

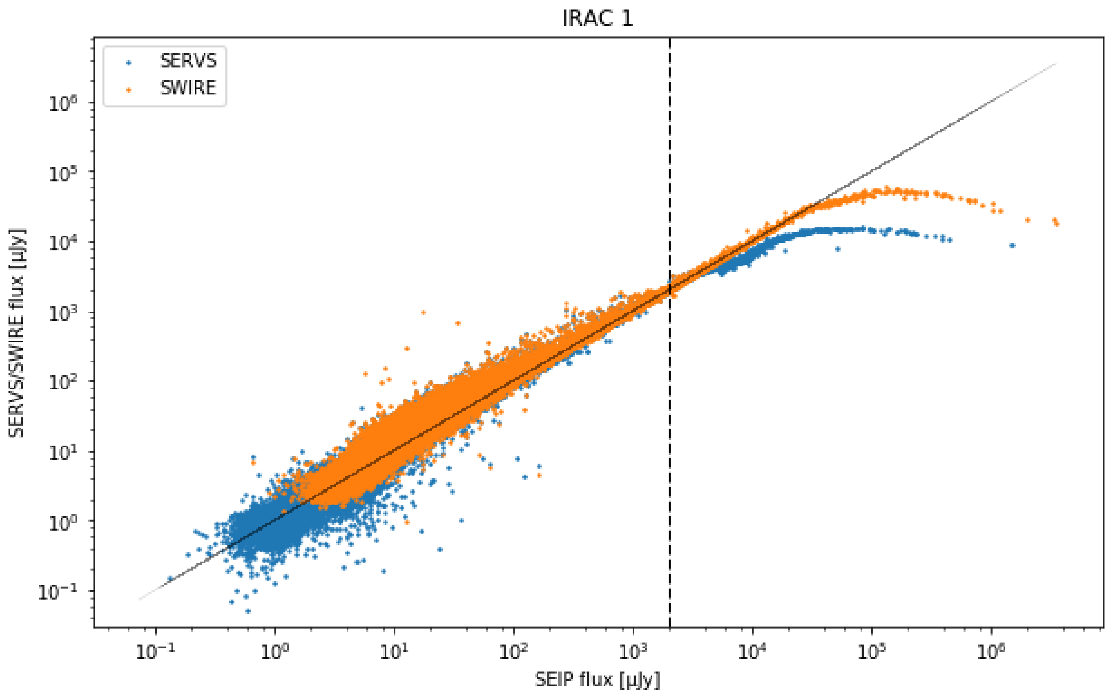


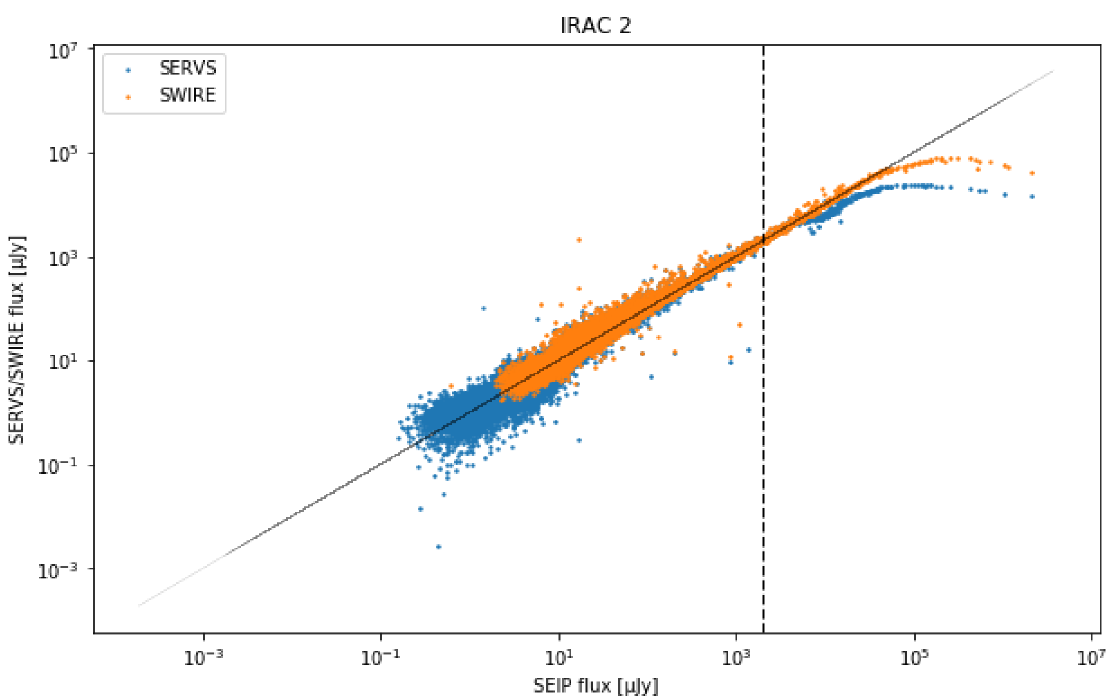
2.1 VII - Choosing between multiple values for the same filter

2.1.1 VII.a SERVS vs SWIRE vs CANDELS

Both SERVS and SWIRE provide IRAC1 and IRAC2 fluxes. SERVS is deeper but tends to underestimate flux of bright sources (Mattia said over 2000 ţJy) as illustrated by this comparison of SWIRE, SERVS, and Spitzer-EIP fluxes. On a small section there are also CANDELS forced irac fluxes which since thay are very deep we always take preferentially.

```
WARNING: UnitsWarning: 'e/count' did not parse as fits unit: At col 0, Unit 'e' not supported by
WARNING: UnitsWarning: 'image' did not parse as fits unit: At col 0, Unit 'image' not supported
```





When both SWIRE and SERVS fluxes are provided, we use the SERVS flux below 2000 Jy and the SWIRE flux over.

We create a table indicating for each source the origin on the IRAC1 and IRAC2 fluxes that will be saved separately.

```
620841 sources with SERVS flux
433129 sources with SWIRE flux
247077 sources with SERVS and SWIRE flux
619863 sources for which we use SERVS
187030 sources for which we use SWIRE


620841 sources with SERVS flux
433097 sources with SWIRE flux
247077 sources with SERVS and SWIRE flux
34926 sources with CANDELS flux
614662 sources for which we use SERVS
186876 sources for which we use SWIRE
34926 sources for which we use CANDELS


634320 sources with SERVS flux
318895 sources with SWIRE flux
186454 sources with SERVS and SWIRE flux
633670 sources for which we use SERVS
133091 sources for which we use SWIRE


634320 sources with SERVS flux
318886 sources with SWIRE flux
186454 sources with SERVS and SWIRE flux
34926 sources with CANDELS flux
628496 sources for which we use SERVS
133020 sources for which we use SWIRE
34926 sources for which we use CANDELS
```

2.2 VII.b VIDEO vs VHS

VIDEO is deeper than VHS so we take VIDEO flux for any source that has both.

```
For VISTA band y:
1063464 sources with VIDEO flux
14179 sources with VHS flux
10792 sources with VIDEO and VHS flux
1063464 sources for which we use VIDEO
3387 sources for which we use VHS
1061411 sources with VIDEO aperture flux
14179 sources with VHS aperture flux
10791 sources with VIDEO and VHS aperture flux
1061411 sources for which we use VIDEO aperture fluxes
```

```
3388 sources for which we use VHS aperture fluxes
For VISTA band j:
1061794 sources with VIDEO flux
105677 sources with VHS flux
31304 sources with VIDEO and VHS flux
1061794 sources for which we use VIDEO
74373 sources for which we use VHS
1058115 sources with VIDEO aperture flux
105674 sources with VHS aperture flux
31305 sources with VIDEO and VHS aperture flux
1058115 sources for which we use VIDEO aperture fluxes
74369 sources for which we use VHS aperture fluxes
For VISTA band h:
1051715 sources with VIDEO flux
82037 sources with VHS flux
25260 sources with VIDEO and VHS flux
1051715 sources for which we use VIDEO
56777 sources for which we use VHS
1039701 sources with VIDEO aperture flux
82025 sources with VHS aperture flux
25256 sources with VIDEO and VHS aperture flux
1039701 sources for which we use VIDEO aperture fluxes
56769 sources for which we use VHS aperture fluxes
For VISTA band k:
1040547 sources with VIDEO flux
73765 sources with VHS flux
24516 sources with VIDEO and VHS flux
1040547 sources for which we use VIDEO
49249 sources for which we use VHS
1024472 sources with VIDEO aperture flux
73760 sources with VHS aperture flux
24518 sources with VIDEO and VHS aperture flux
1024472 sources for which we use VIDEO aperture fluxes
49242 sources for which we use VHS aperture fluxes
```

2.3 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.

2.4 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.

2.5 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.

```
['ps1_id', 'combo_id', 'atlas_id', 'video_id', 'vhs_id', 'servs_intid', 'swire_intid', 'des_id',
```

2.6 X - Adding HEALPix index

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

2.7 XI - Renaming columns

We rename some columns to follow the intrument_filter standard.

2.8 XII - Saving the catalogue

```
Missing columns: {'flag_wfi_571nm', 'flag_vista_h', 'flag_acs_f775w', 'flag_omegacam_i', 'flag_d
```

3_Checks_and_diagnostics

March 8, 2018

1 CDFS SWIRE master catalogue

1.1 Checks and diagnostics

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
```

```
Using masterlist ./data/master_catalogue_cdfs-swire_20180221.fits
```

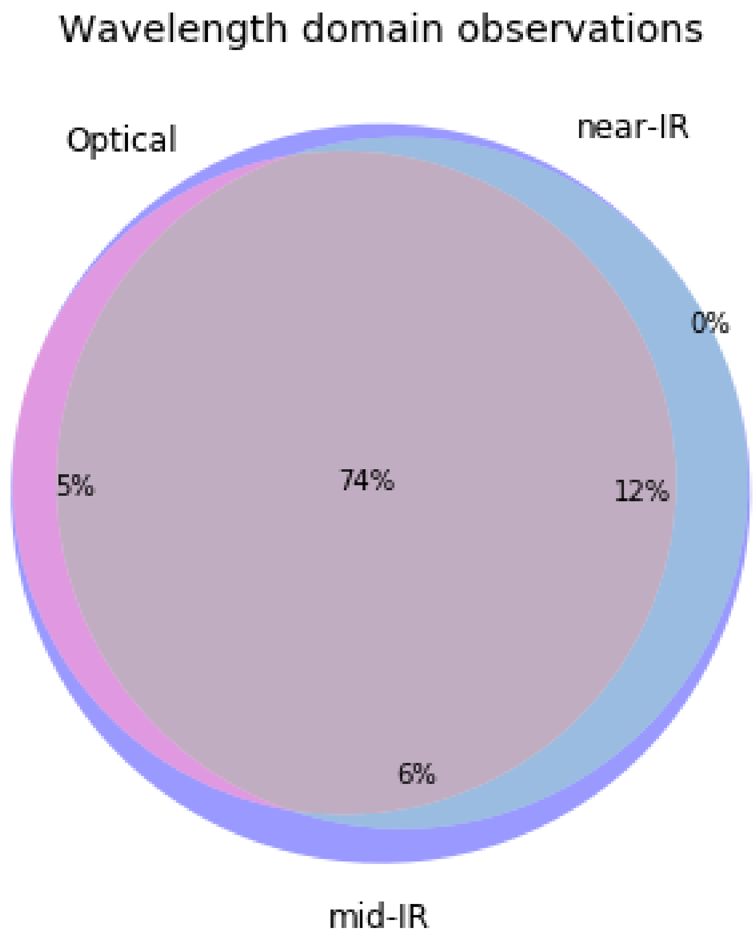
1.2 0 - Quick checks

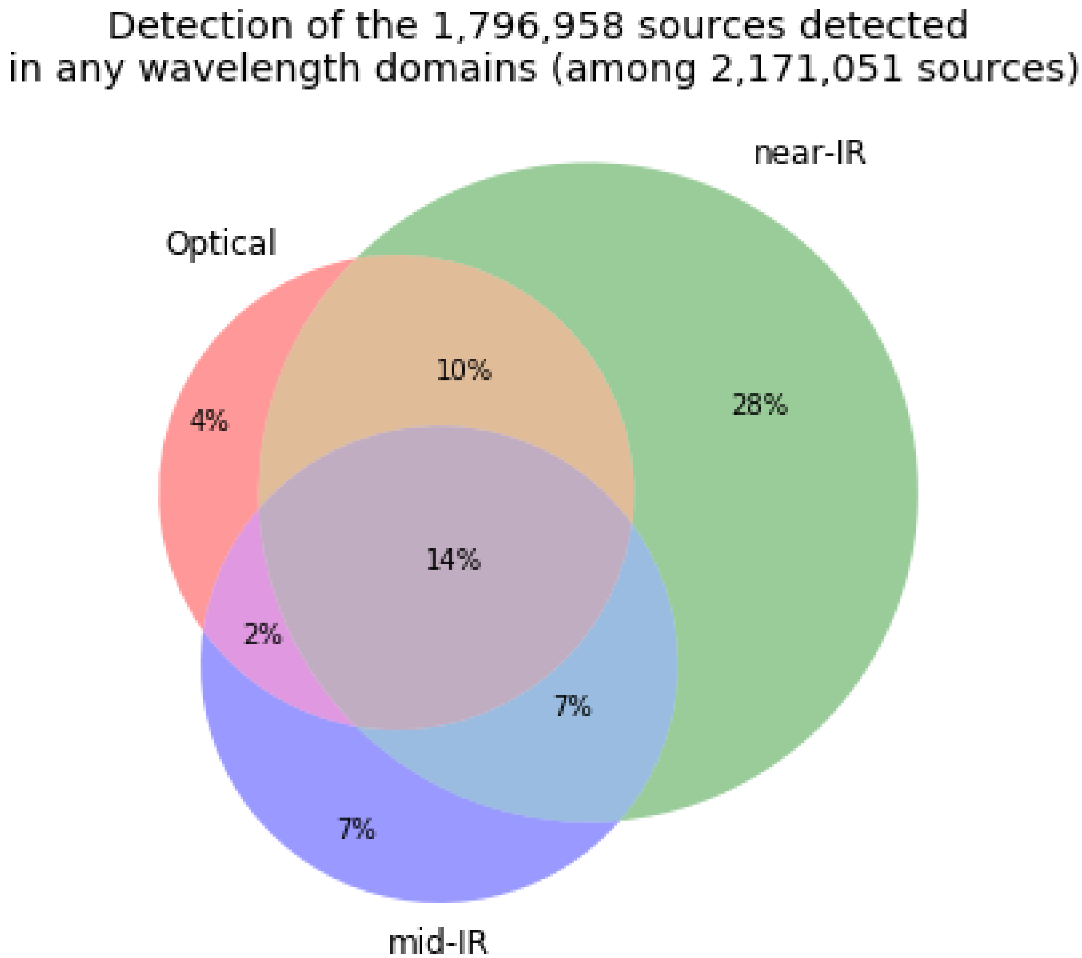
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype),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

```
Table shows only problematic columns.
```

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

1.3 I - Summary of wavelength domains





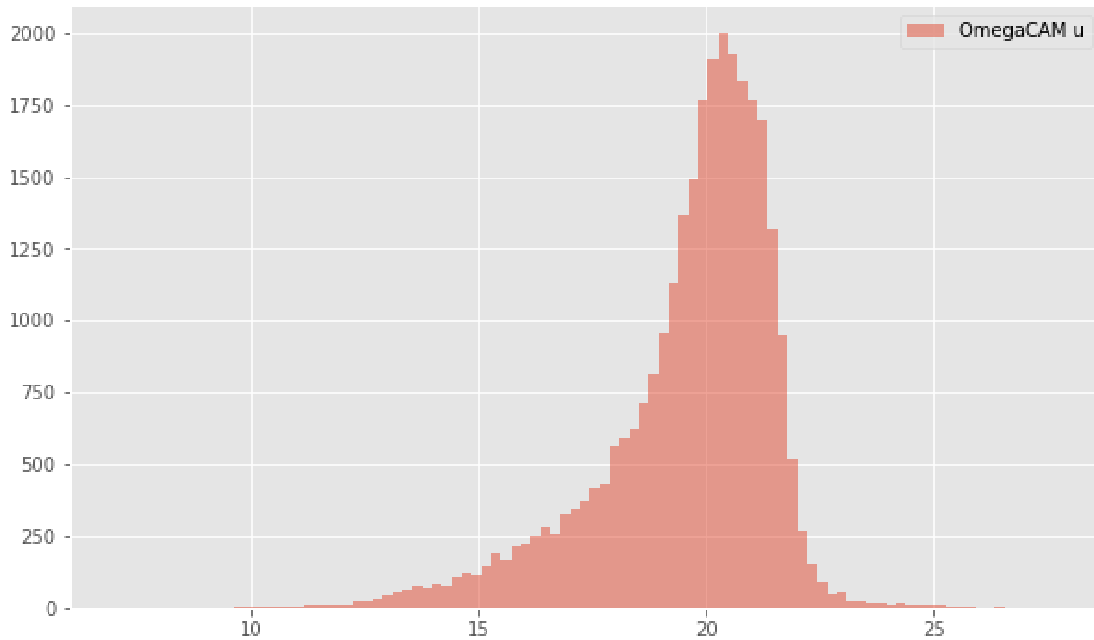
1.4 II - Comparing magnitudes in similar filters

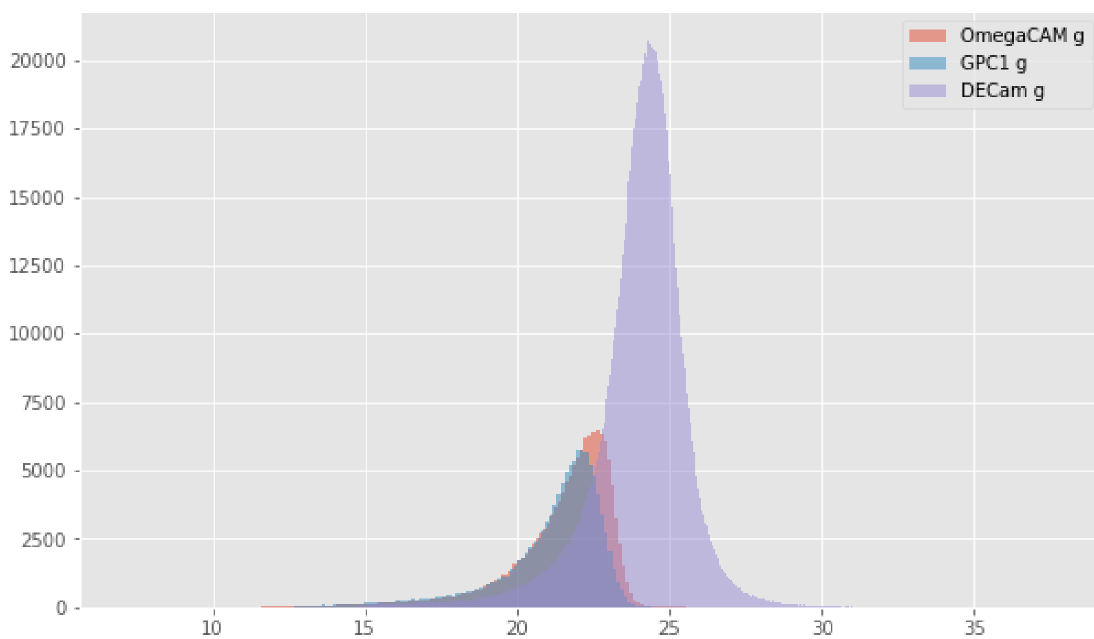
The master list if composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

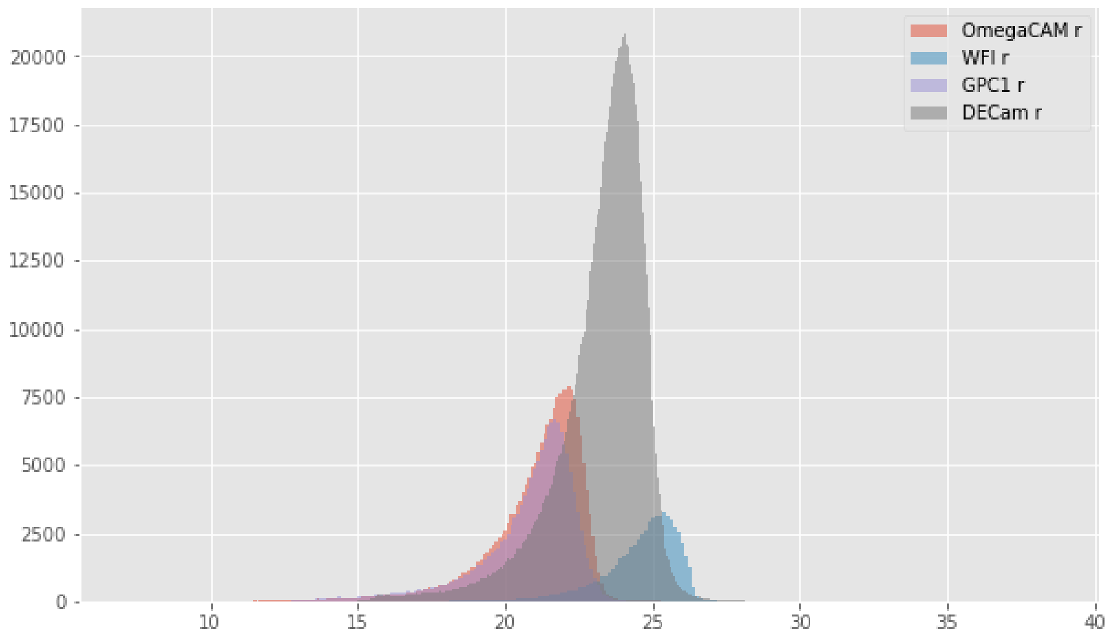
1.4.1 II.a - Comparing depths

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

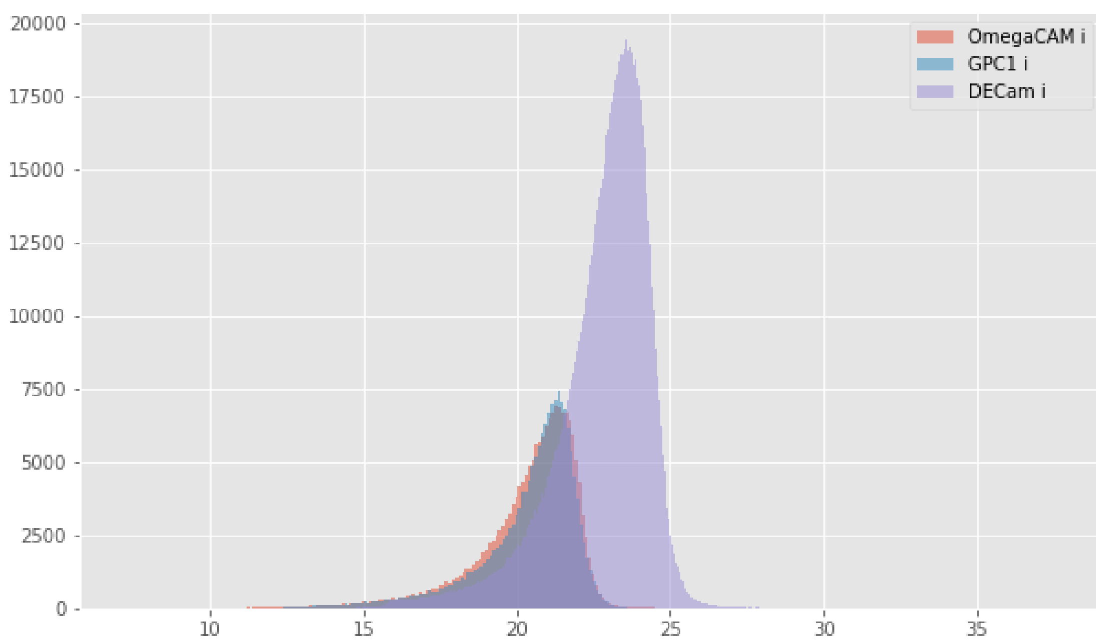
```
HELP warning: the column m_wfi_u (WFI u) is empty.
```

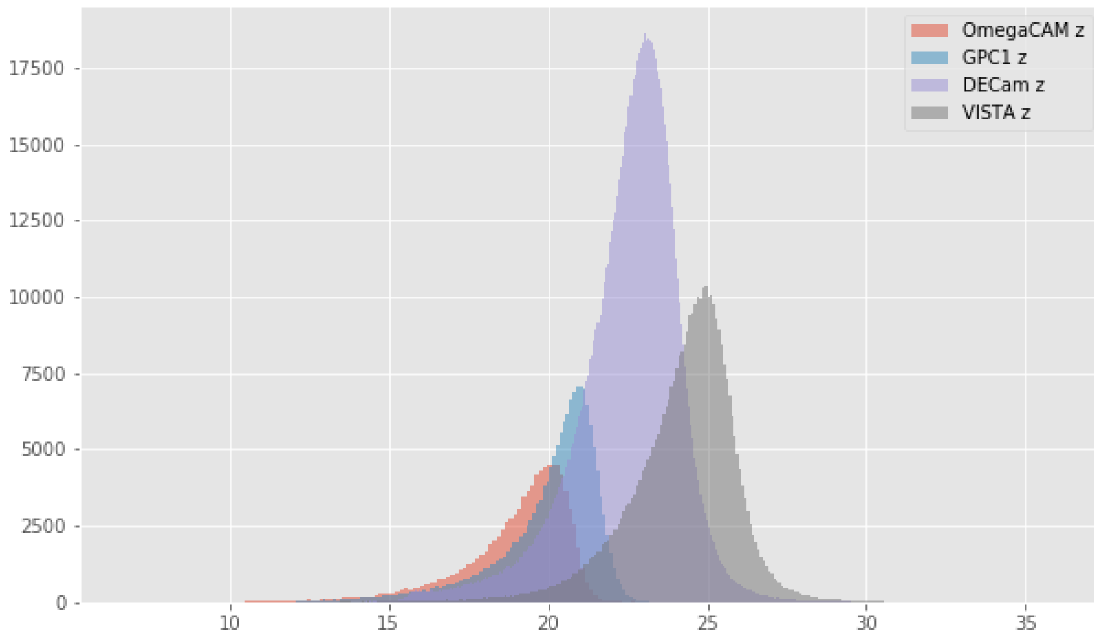

OmegaCAM u
2000
1750
1500
1250
1000
750
500
250
0
10
15
20
25

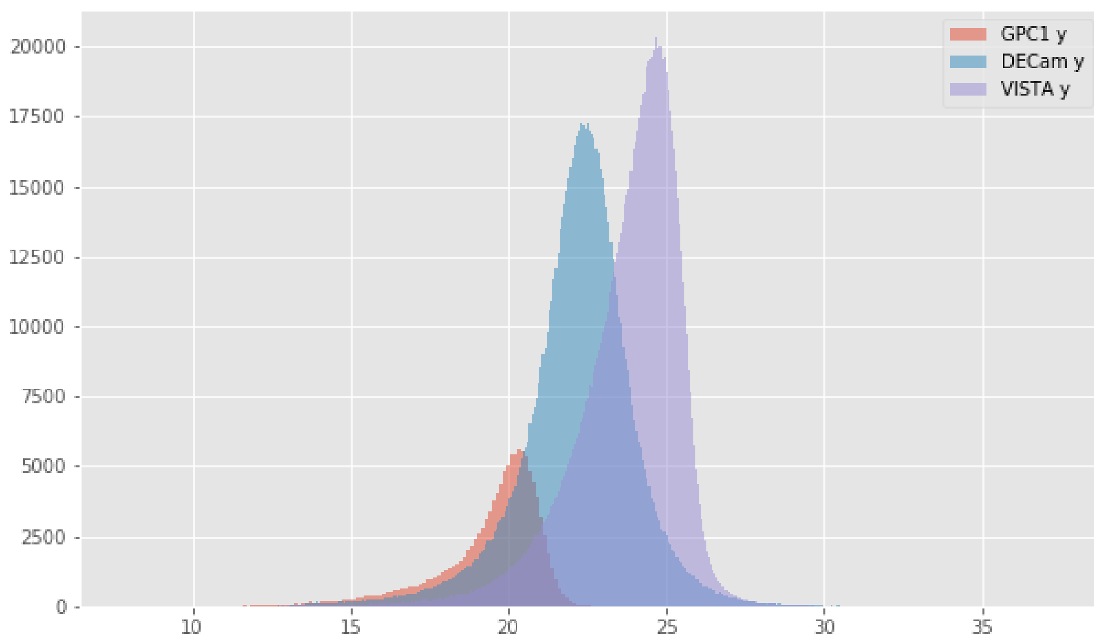

OmegaCAM g
GPC1 g
DECam g
20000
17500
15000
12500
10000
7500
5000
2500
0
10
15
20
25
30
35



HELP warning: the column m_wfi_i (WFI i) is empty.



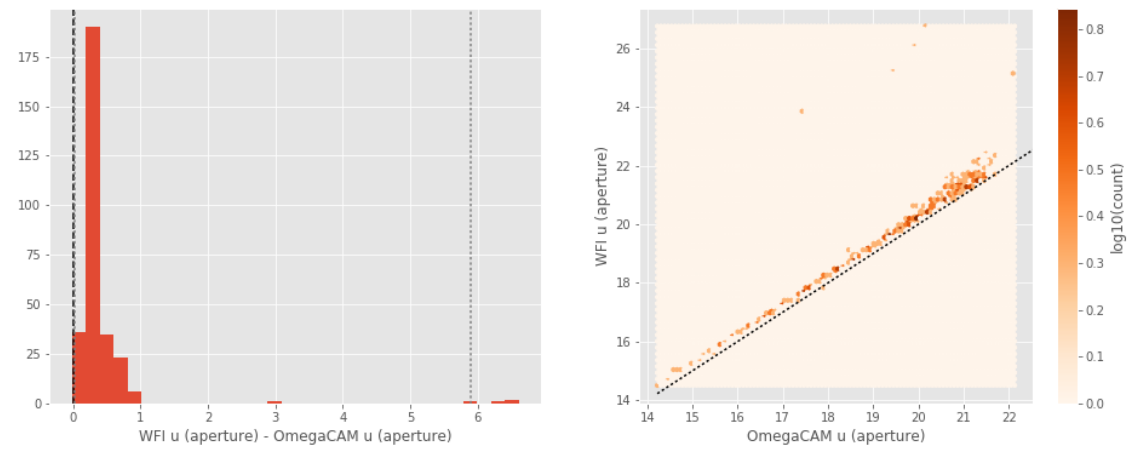




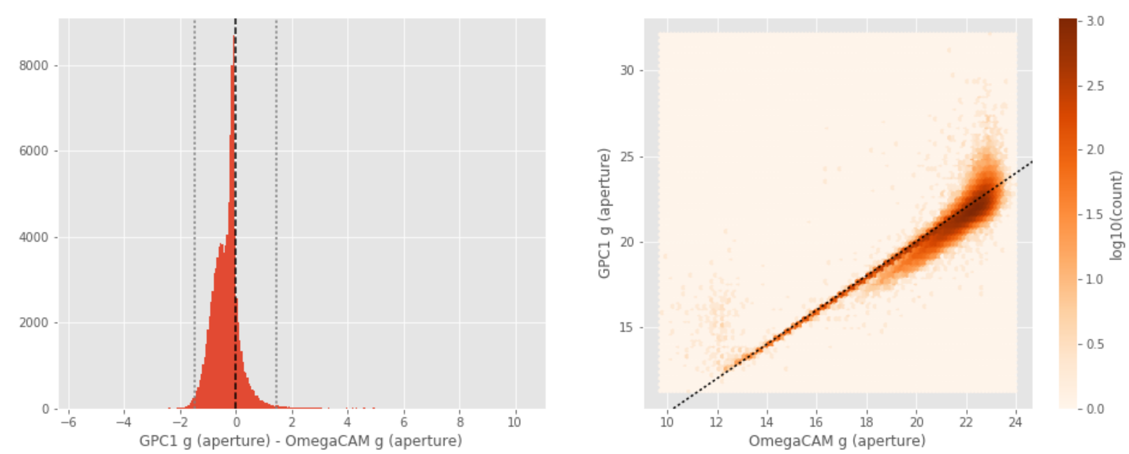
1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

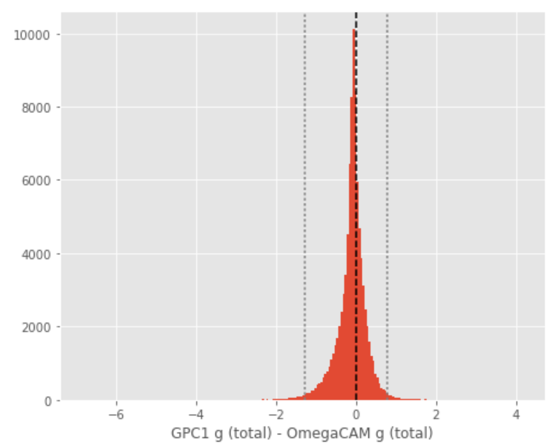
WFI u (aperture) - OmegaCAM u (aperture):
- Median: 0.30
- Median Absolute Deviation: 0.07
- 1% percentile: 0.026031494140625
- 99% percentile: 5.898116226196289

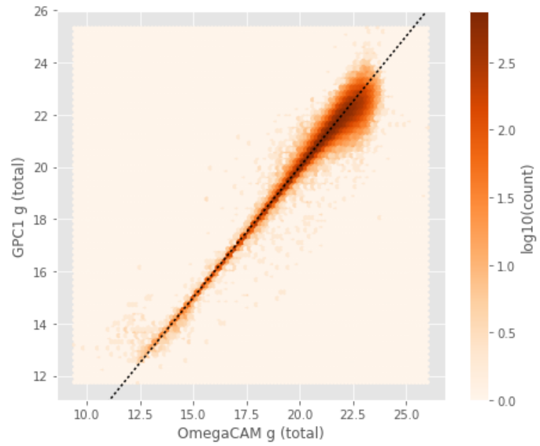


No sources have both OmegaCAM u (total) and WFI u (total) values.
GPC1 g (aperture) - OmegaCAM g (aperture):
- Median: -0.30
- Median Absolute Deviation: 0.27
- 1% percentile: -1.477933654785156
- 99% percentile: 1.4628313636779788

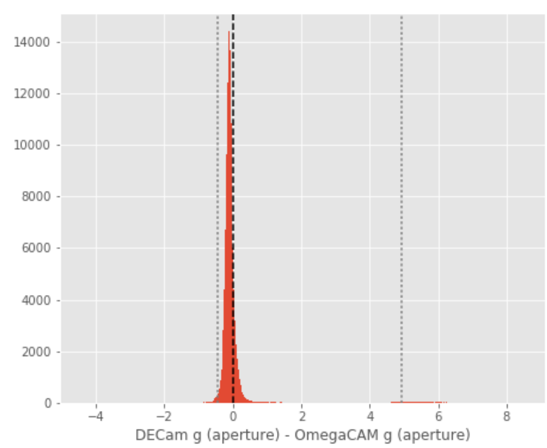


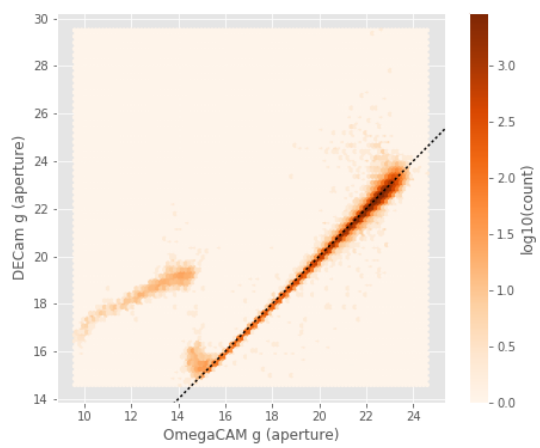
GPC1 g (total) - OmegaCAM g (total):
- Median: -0.07
- Median Absolute Deviation: 0.16
- 1% percentile: -1.296688632965088
- 99% percentile: 0.7950097846984904





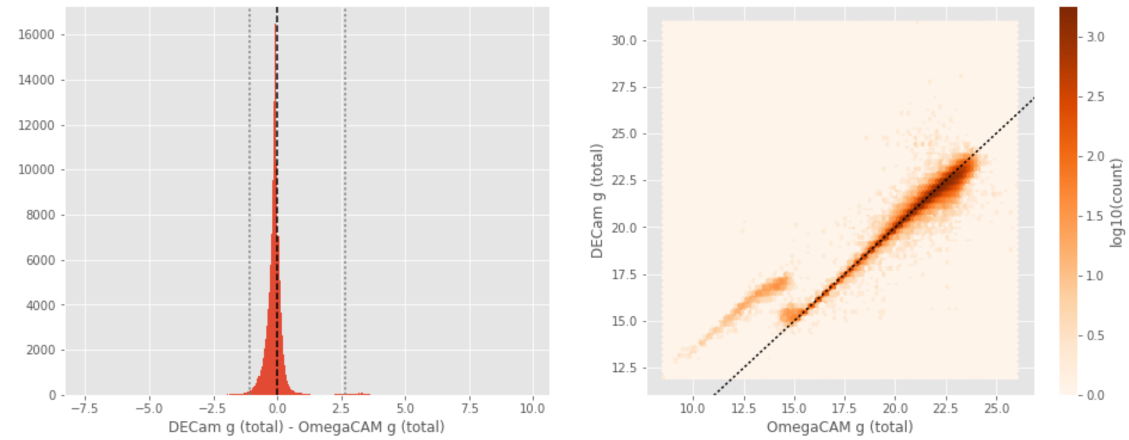
DECam g (aperture) - OmegaCAM g (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.07
- 1% percentile: -0.44108596801757816
- 99% percentile: 4.917257547378539



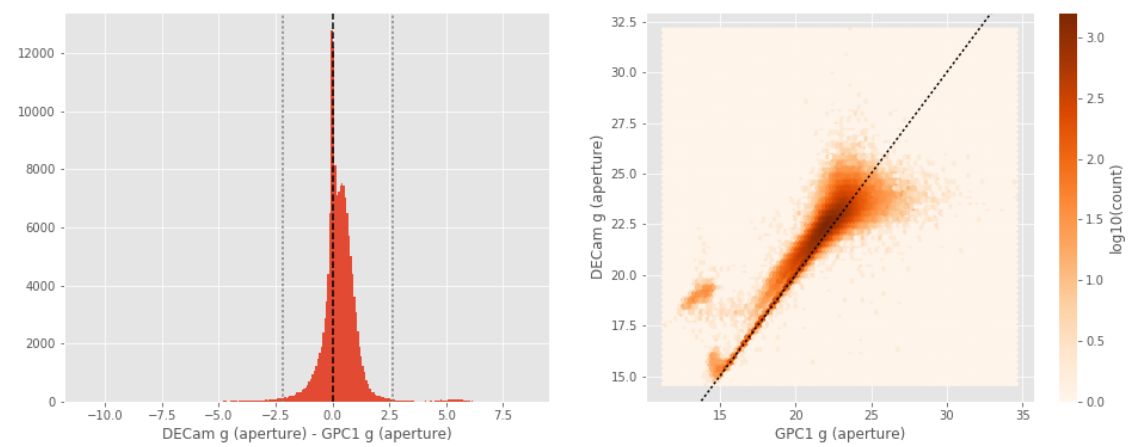


DECam g (total) - OmegaCAM g (total):
- Median: -0.10

- Median Absolute Deviation: 0.13
- 1% percentile: -1.0877220535278318
- 99% percentile: 2.6718725776672354

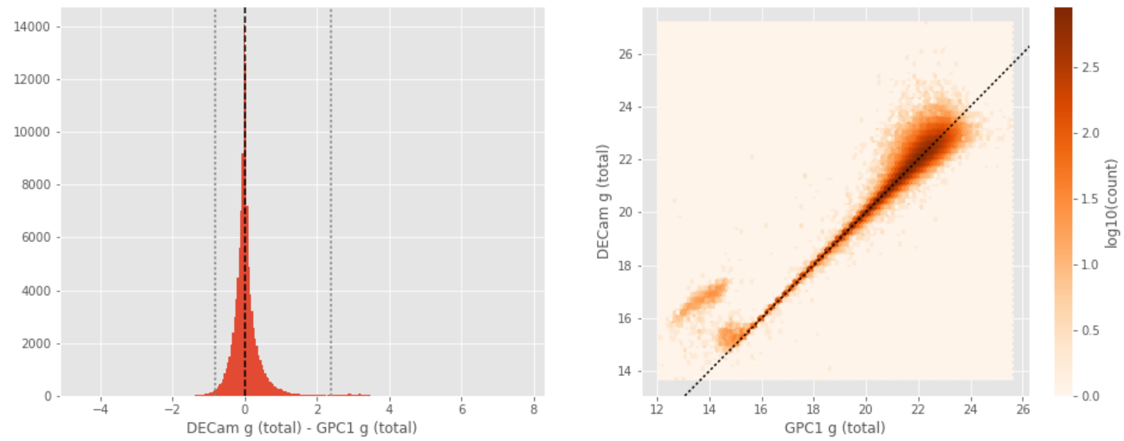


DECam g (aperture) - GPC1 g (aperture):
- Median: 0.26
- Median Absolute Deviation: 0.34
- 1% percentile: -2.2031451225280763
- 99% percentile: 2.6706849861145043

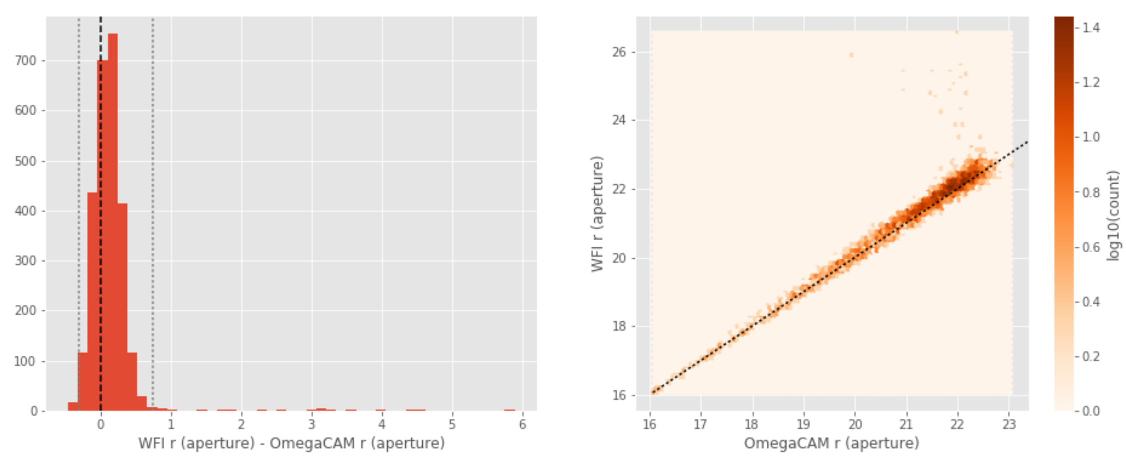


DECam g (total) - GPC1 g (total):
- Median: -0.00
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8024979782104492

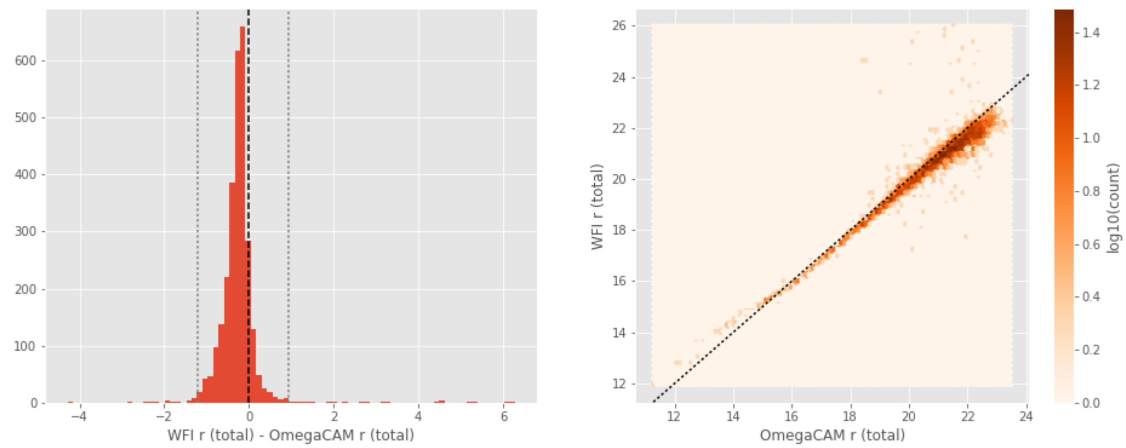
- 99% percentile: 2.3768721008300764



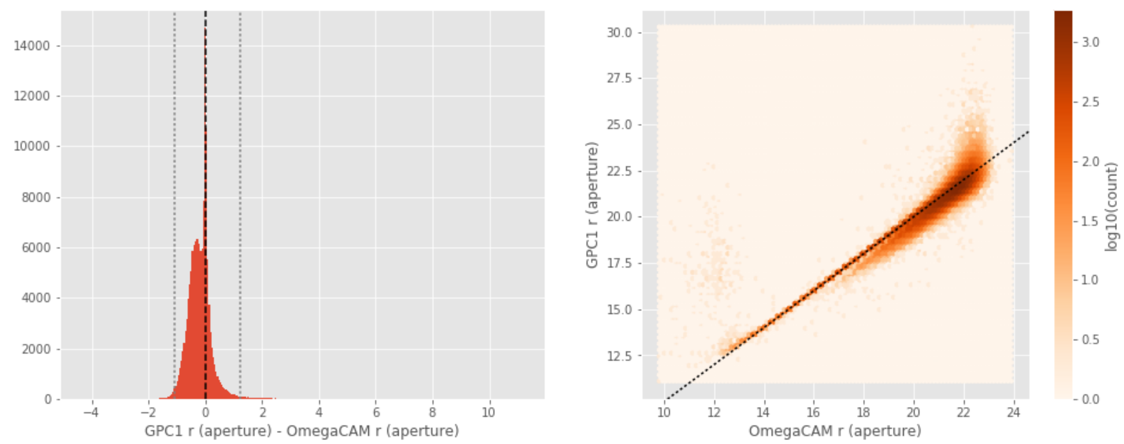
WFI r (aperture) - OmegaCAM r (aperture):
- Median: 0.10
- Median Absolute Deviation: 0.13
- 1% percentile: -0.3106356048583985
- 99% percentile: 0.7375316619873049



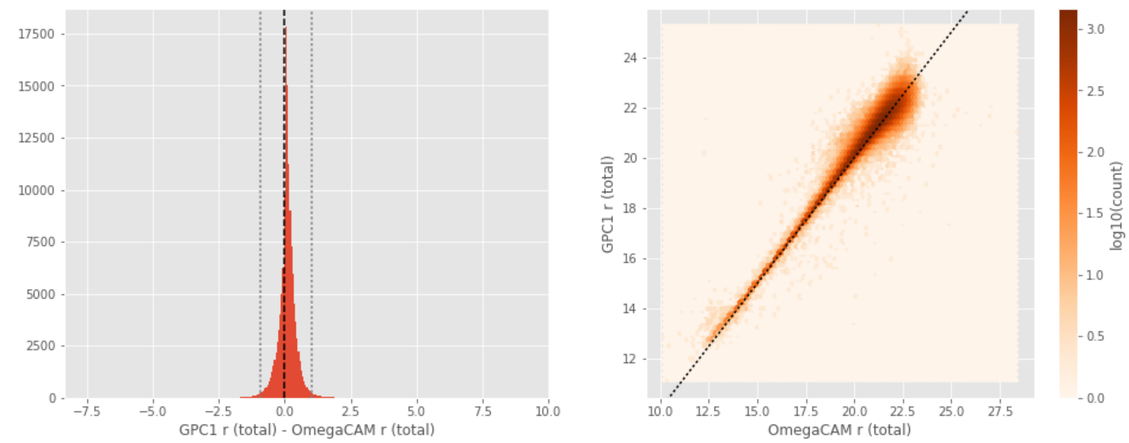
WFI r (total) - OmegaCAM r (total):
- Median: -0.25
- Median Absolute Deviation: 0.15
- 1% percentile: -1.2209947586059569
- 99% percentile: 0.9199421310424809



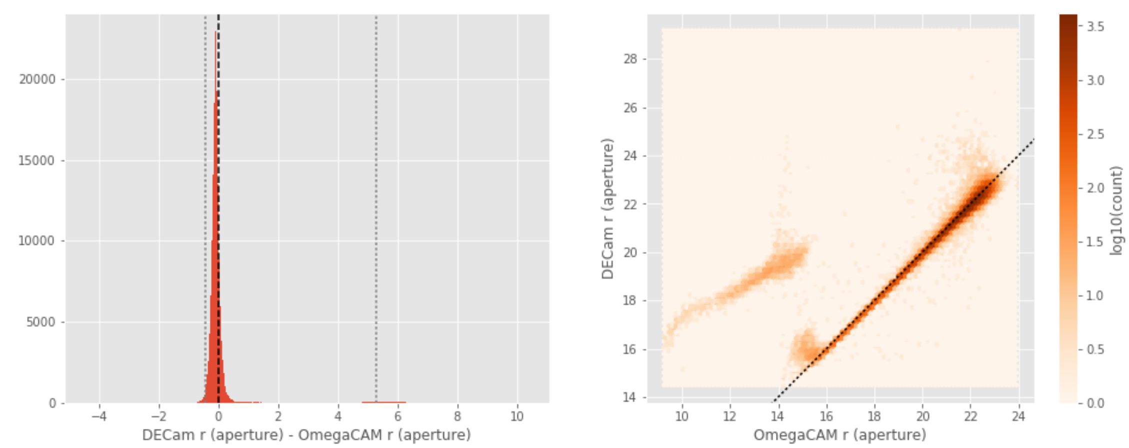
GPC1 r (aperture) - OmegaCAM r (aperture):
- Median: -0.16
- Median Absolute Deviation: 0.22
- 1% percentile: -1.072125778198242
- 99% percentile: 1.2293571472167972



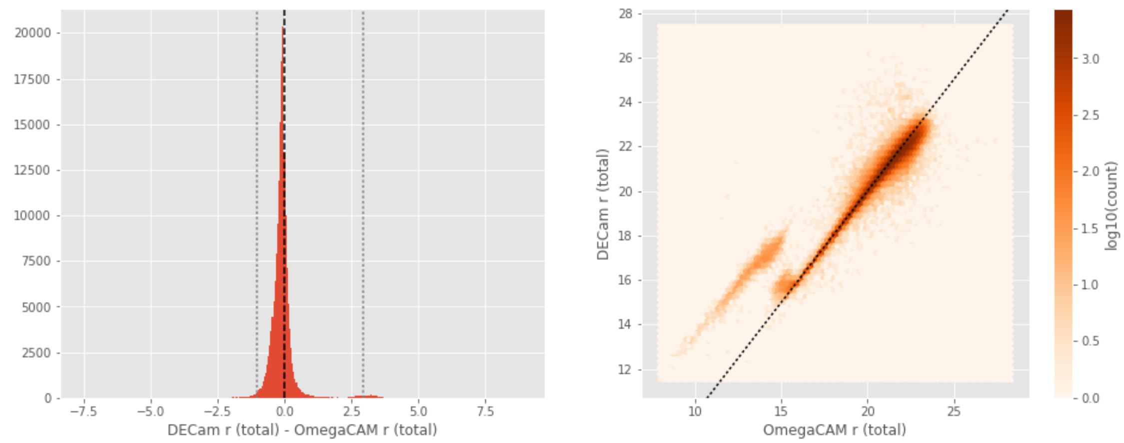
GPC1 r (total) - OmegaCAM r (total):
- Median: 0.08
- Median Absolute Deviation: 0.14
- 1% percentile: -0.922282371520996
- 99% percentile: 1.0283002471923828



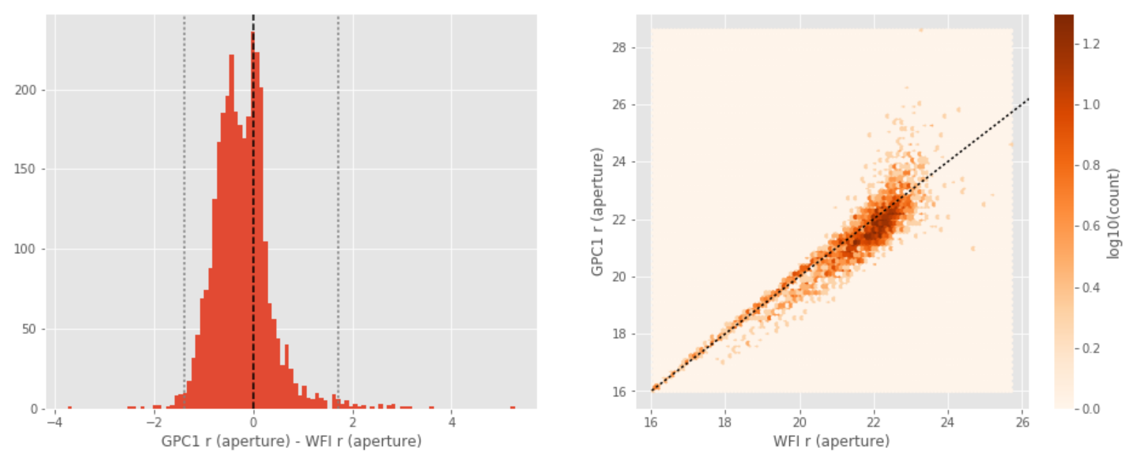
DECam r (aperture) - OmegaCAM r (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.07
- 1% percentile: -0.4484758949279785
- 99% percentile: 5.2776344108581545



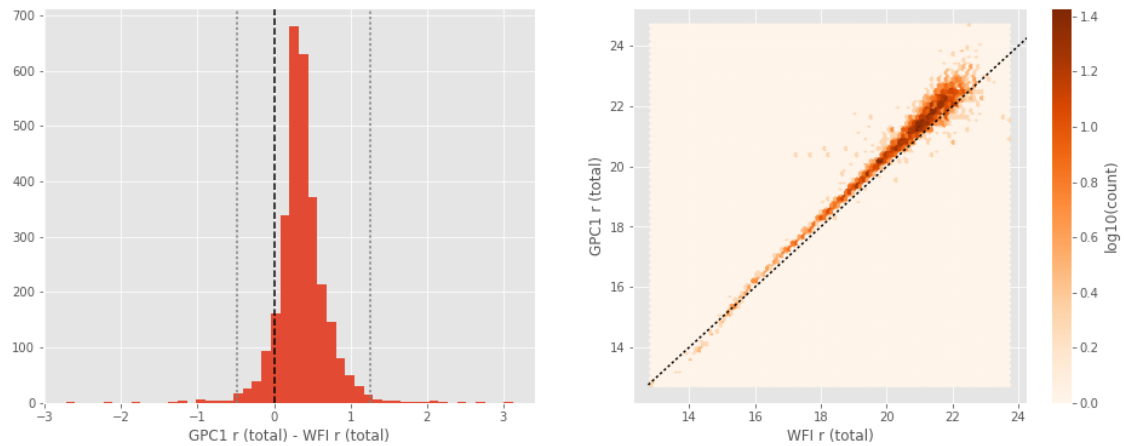
DECam r (total) - OmegaCAM r (total):
- Median: -0.10
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0036057472229005
- 99% percentile: 2.9234039497375495



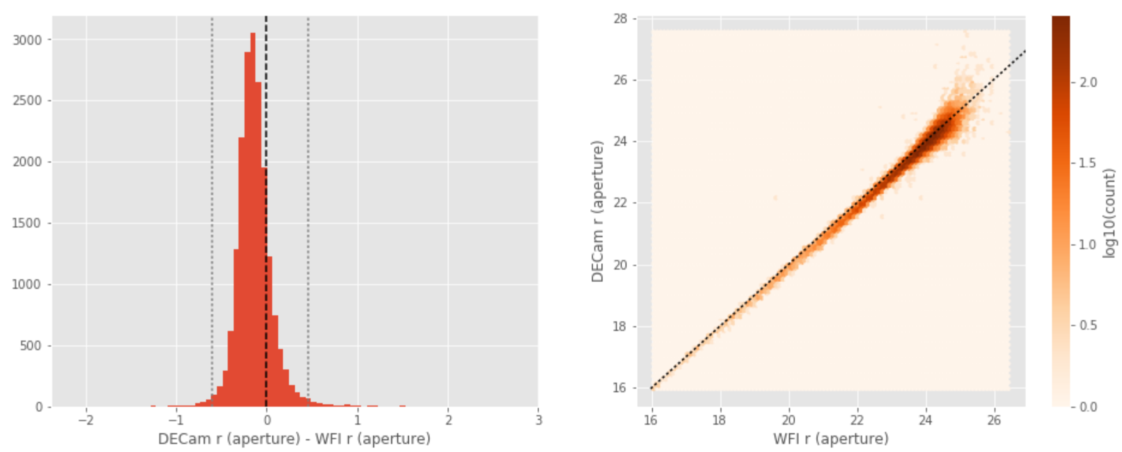
GPC1 r (aperture) - WFI r (aperture):
- Median: -0.25
- Median Absolute Deviation: 0.34
- 1% percentile: -1.379720687866211
- 99% percentile: 1.7204780578613306



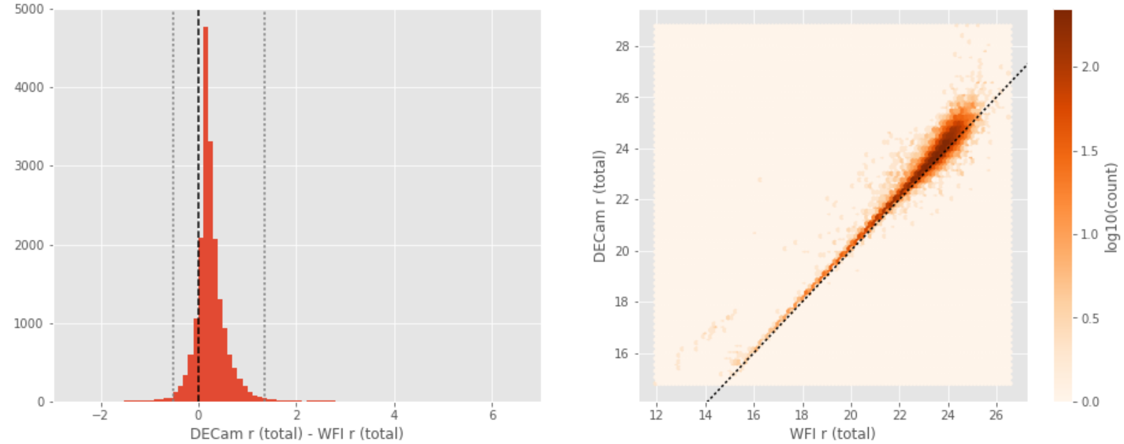
GPC1 r (total) - WFI r (total):
- Median: 0.34
- Median Absolute Deviation: 0.14
- 1% percentile: -0.486072883605957
- 99% percentile: 1.257844467163085



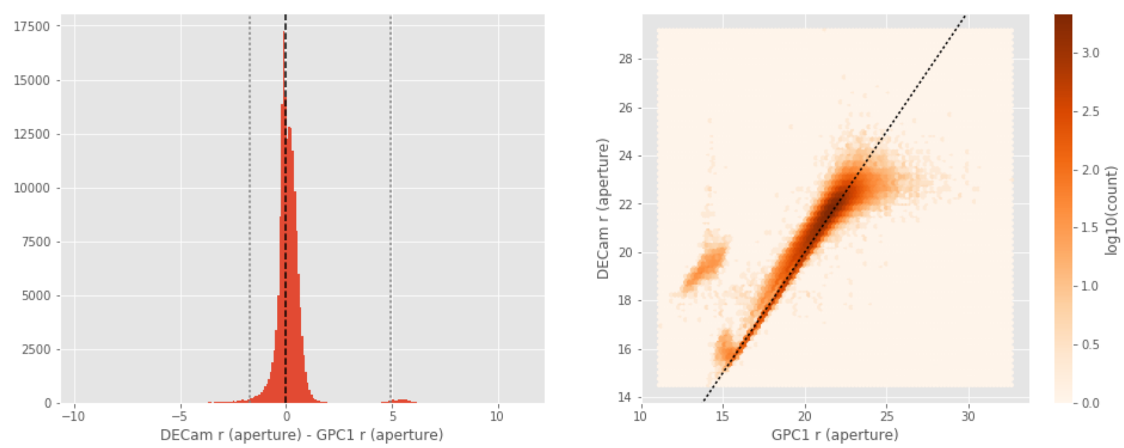
DECam r (aperture) - WFI r (aperture):
- Median: -0.15
- Median Absolute Deviation: 0.10
- 1% percentile: -0.5979123115539551
- 99% percentile: 0.4599405479431148



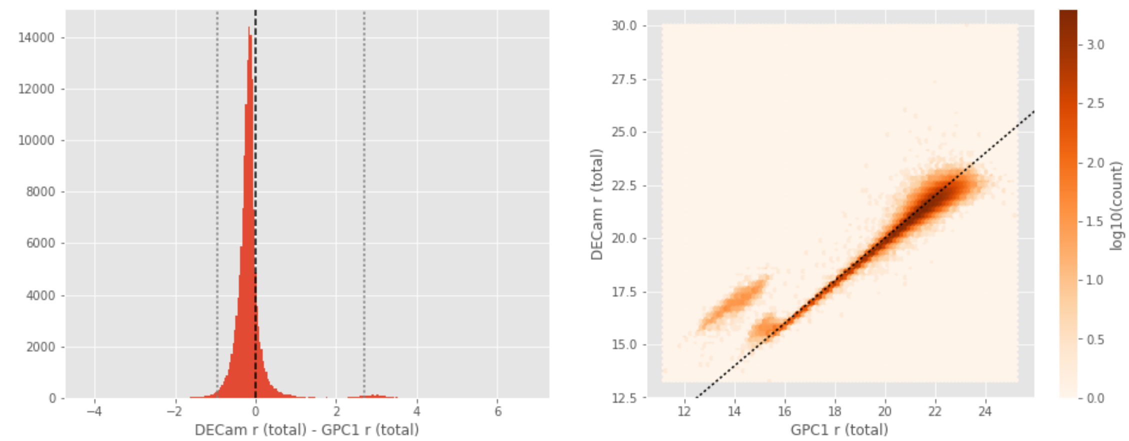
DECam r (total) - WFI r (total):
- Median: 0.20
- Median Absolute Deviation: 0.13
- 1% percentile: -0.5269406700134277
- 99% percentile: 1.3608647155761737



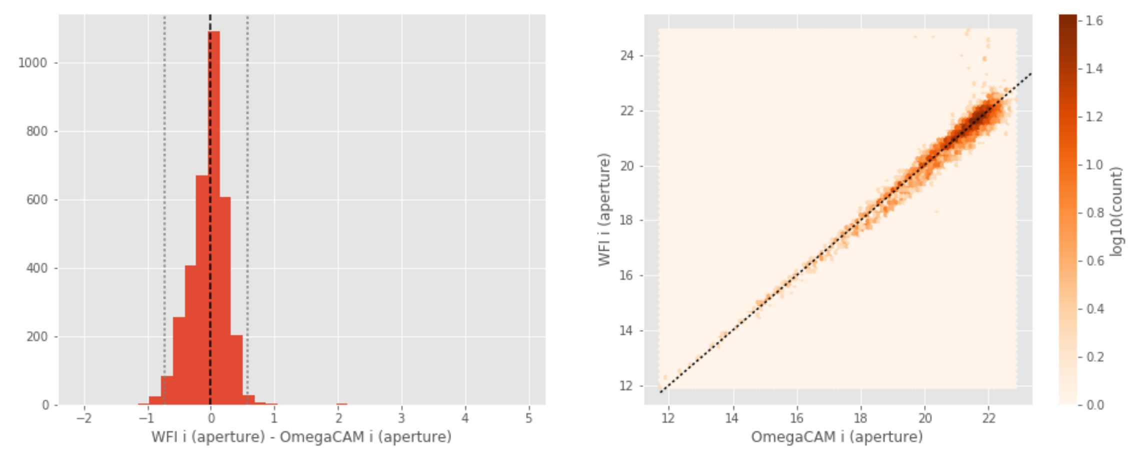
DECam r (aperture) - GPC1 r (aperture):
- Median: 0.08
- Median Absolute Deviation: 0.26
- 1% percentile: -1.6942697525024415
- 99% percentile: 4.972725324630737



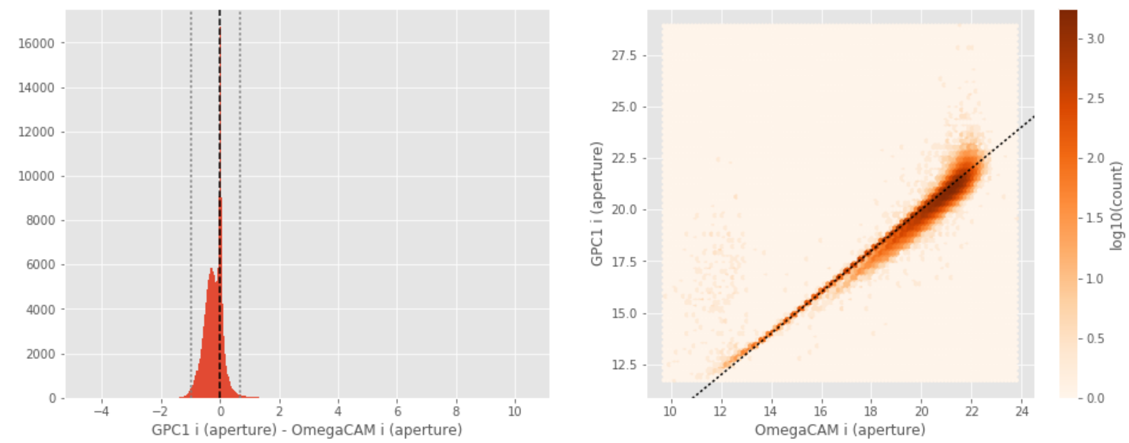
DECam r (total) - GPC1 r (total):
- Median: -0.18
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9400119018554687
- 99% percentile: 2.7042432403564445



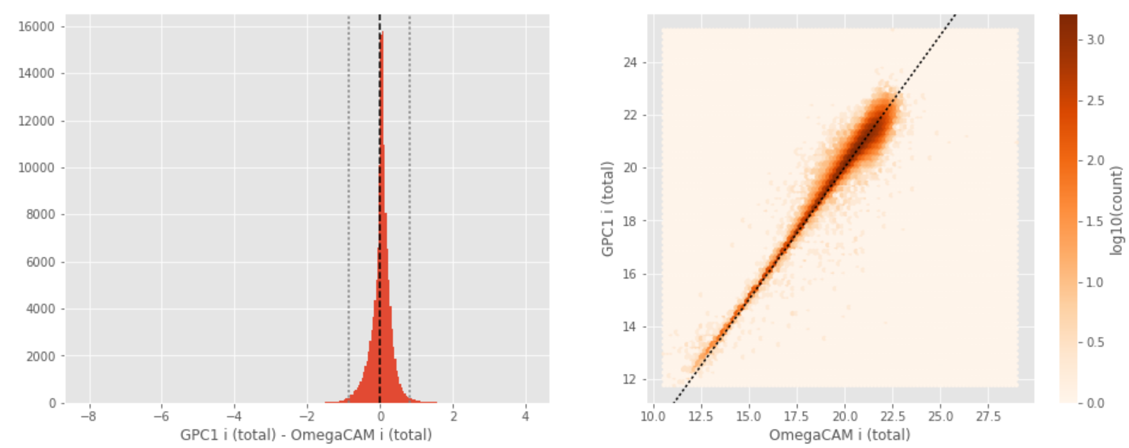
WFI i (aperture) - OmegaCAM i (aperture):
- Median: -0.00
- Median Absolute Deviation: 0.16
- 1% percentile: -0.7342316436767578
- 99% percentile: 0.5792187499999985



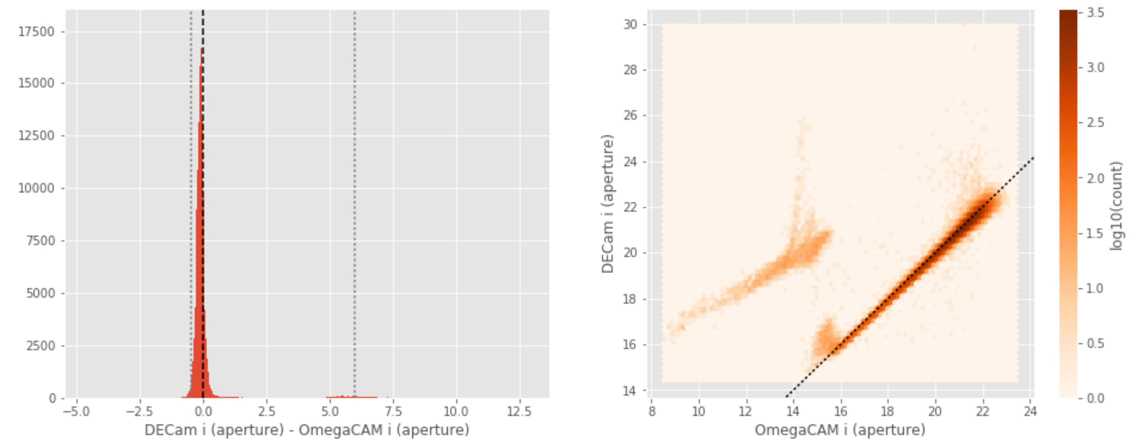
No sources have both OmegaCAM i (total) and WFI i (total) values.
GPC1 i (aperture) - OmegaCAM i (aperture):
- Median: -0.17
- Median Absolute Deviation: 0.19
- 1% percentile: -0.9848984146118165
- 99% percentile: 0.6653031349182128



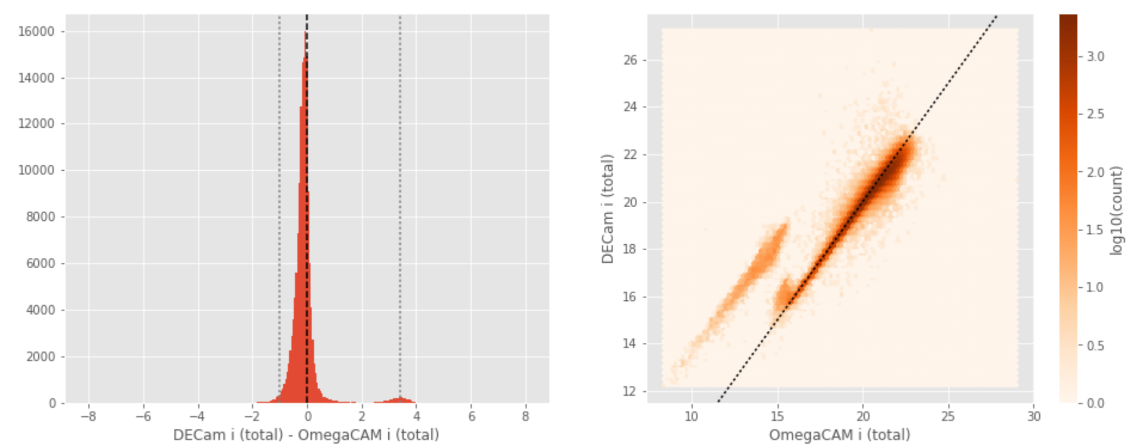
GPC1 i (total) - OmegaCAM i (total):
- Median: 0.05
- Median Absolute Deviation: 0.12
- 1% percentile: -0.8688420867919922
- 99% percentile: 0.8083547973632813



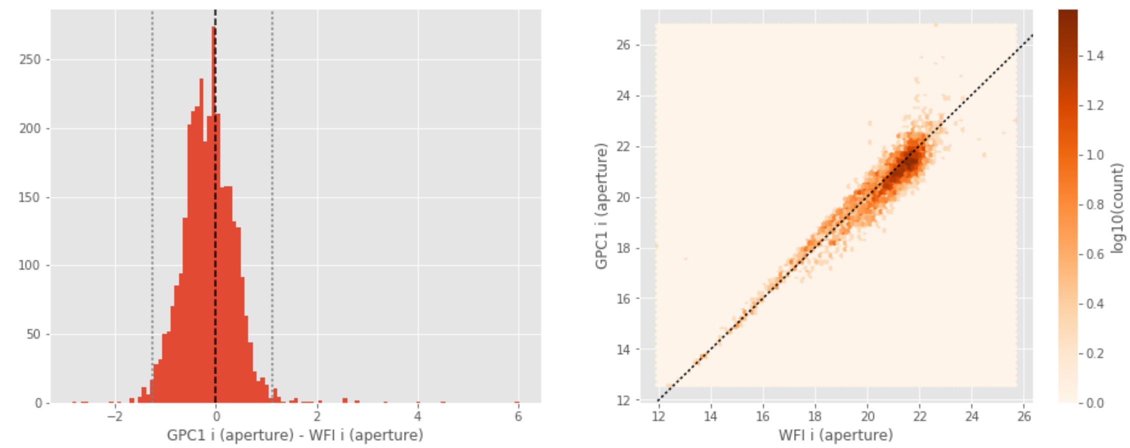
DECam i (aperture) - OmegaCAM i (aperture):
- Median: -0.11
- Median Absolute Deviation: 0.09
- 1% percentile: -0.4917967414855957
- 99% percentile: 5.982972488403316



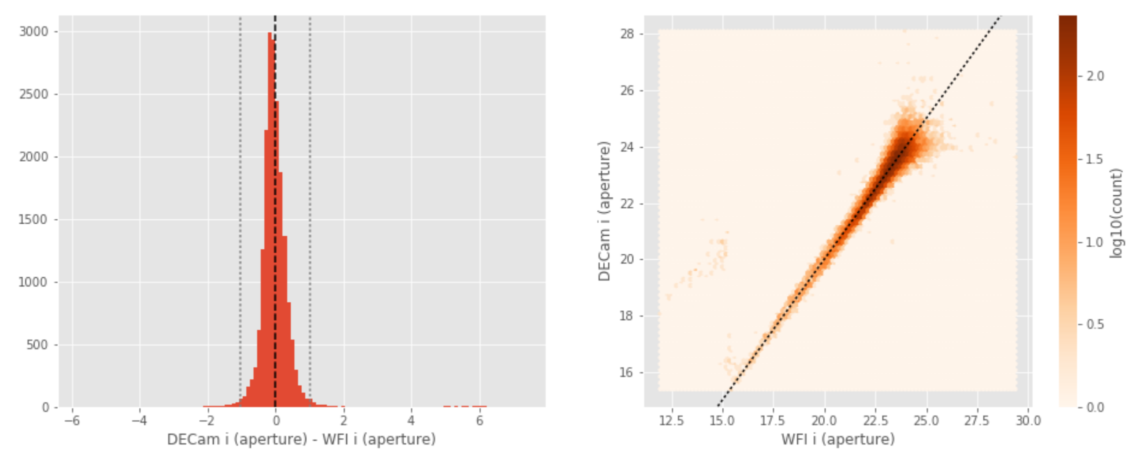
DECam i (total) - OmegaCAM i (total):
- Median: -0.13
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0200267028808594
- 99% percentile: 3.4285067367553728



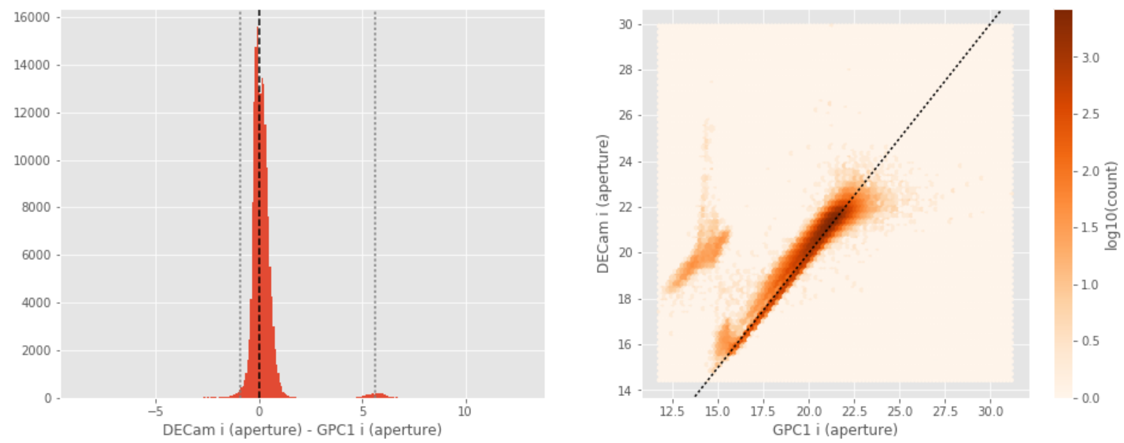
GPC1 i (aperture) - WFI i (aperture):
- Median: -0.15
- Median Absolute Deviation: 0.32
- 1% percentile: -1.2702113151550294
- 99% percentile: 1.1307513236999518



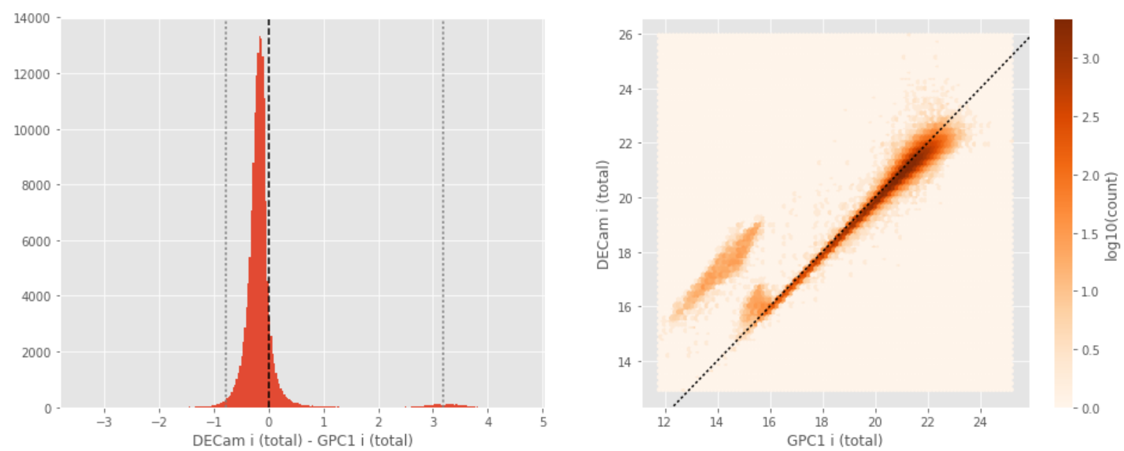
No sources have both WFI i (total) and GPC1 i (total) values.
DECam i (aperture) - WFI i (aperture):
- Median: -0.05
- Median Absolute Deviation: 0.19
- 1% percentile: -1.0325747299194337
- 99% percentile: 1.0265789794921876



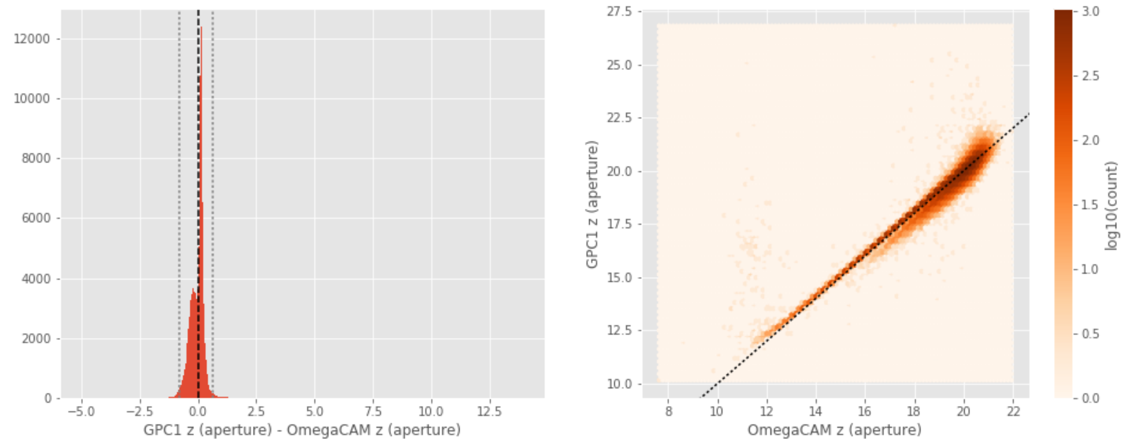
No sources have both WFI i (total) and DECam i (total) values.
DECam i (aperture) - GPC1 i (aperture):
- Median: 0.08
- Median Absolute Deviation: 0.24
- 1% percentile: -0.9106433296203613
- 99% percentile: 5.6198643112182625



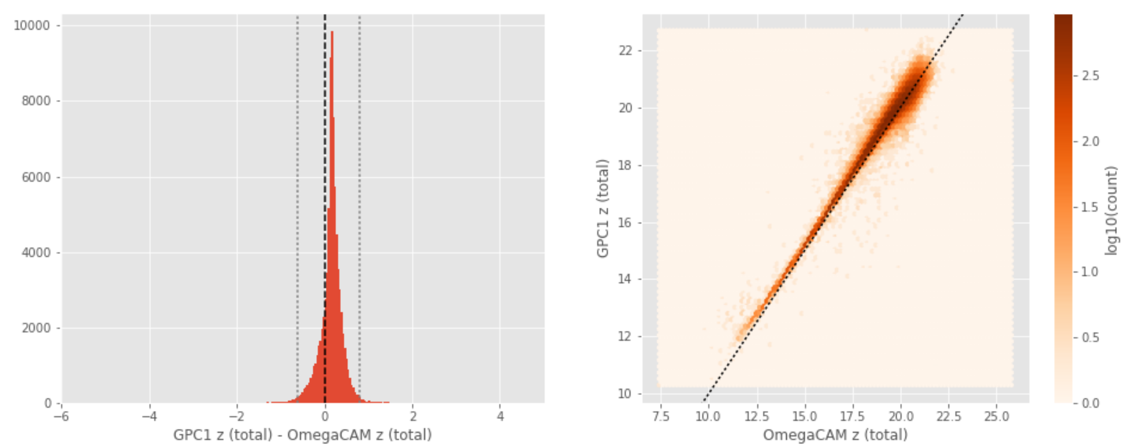
DECam i (total) - GPC1 i (total):
- Median: -0.17
- Median Absolute Deviation: 0.10
- 1% percentile: -0.7831951522827149
- 99% percentile: 3.1839627075195307



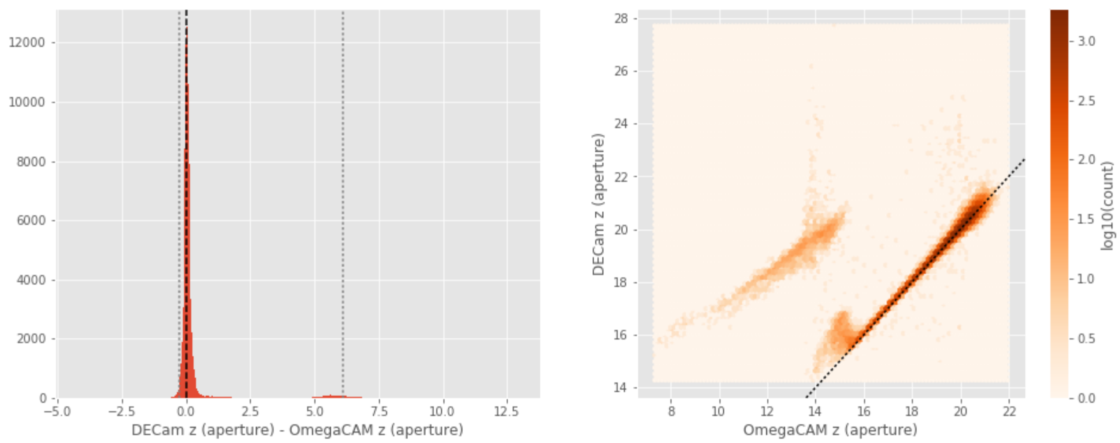
GPC1 z (aperture) - OmegaCAM z (aperture):
- Median: 0.05
- Median Absolute Deviation: 0.14
- 1% percentile: -0.806519775390625
- 99% percentile: 0.6441340255737295



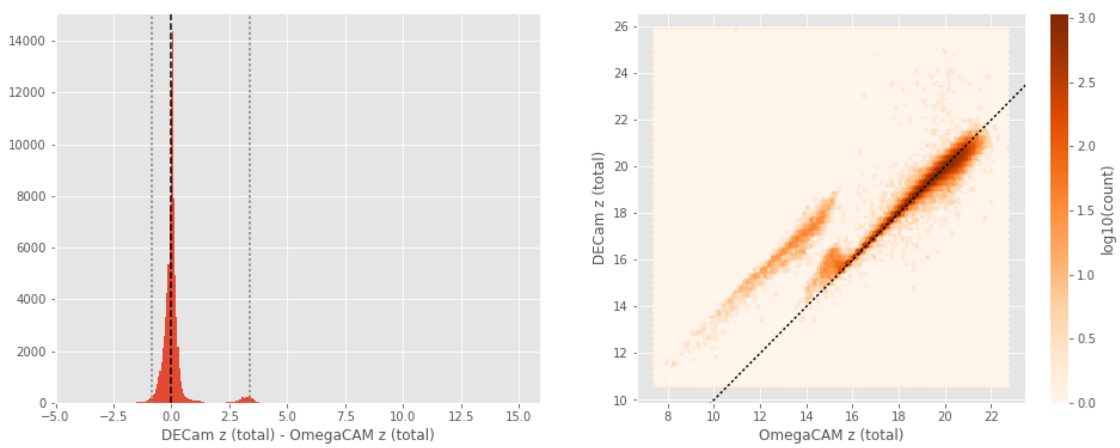
GPC1 z (total) - OmegaCAM z (total):
- Median: 0.17
- Median Absolute Deviation: 0.11
- 1% percentile: -0.6282771301269532
- 99% percentile: 0.7950209236145019



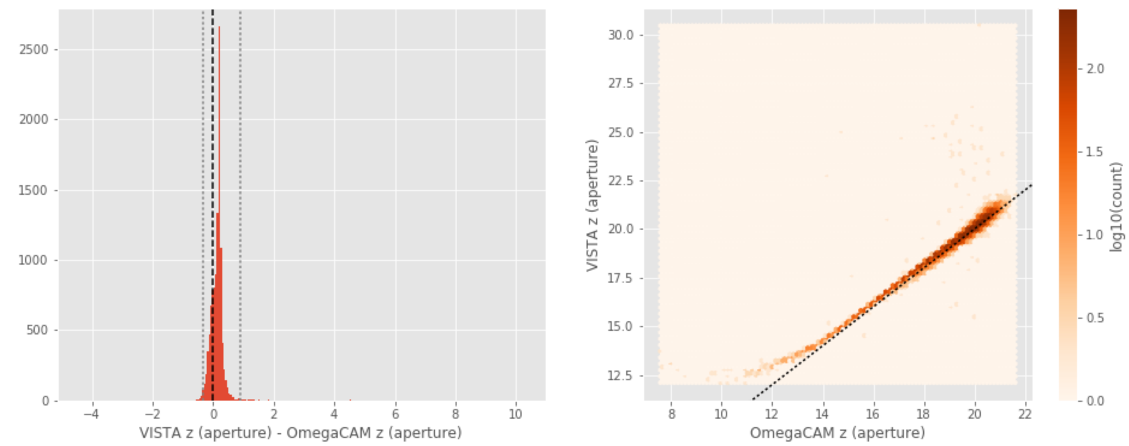
DECam z (aperture) - OmegaCAM z (aperture):
- Median: 0.04
- Median Absolute Deviation: 0.07
- 1% percentile: -0.2861647605895996
- 99% percentile: 6.120206441879276



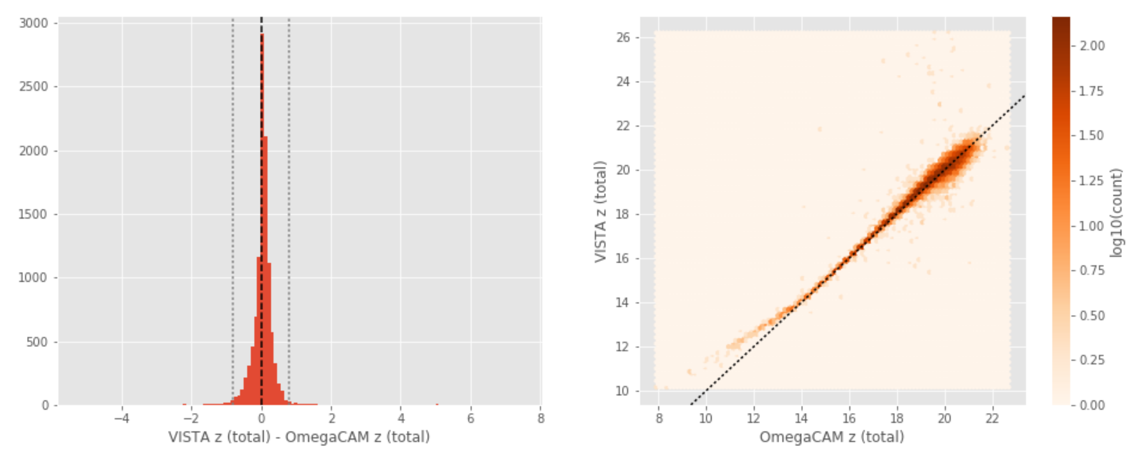
DECam z (total) - OmegaCAM z (total):
- Median: 0.01
- Median Absolute Deviation: 0.12
- 1% percentile: -0.828127956390381
- 99% percentile: 3.3931367397308363



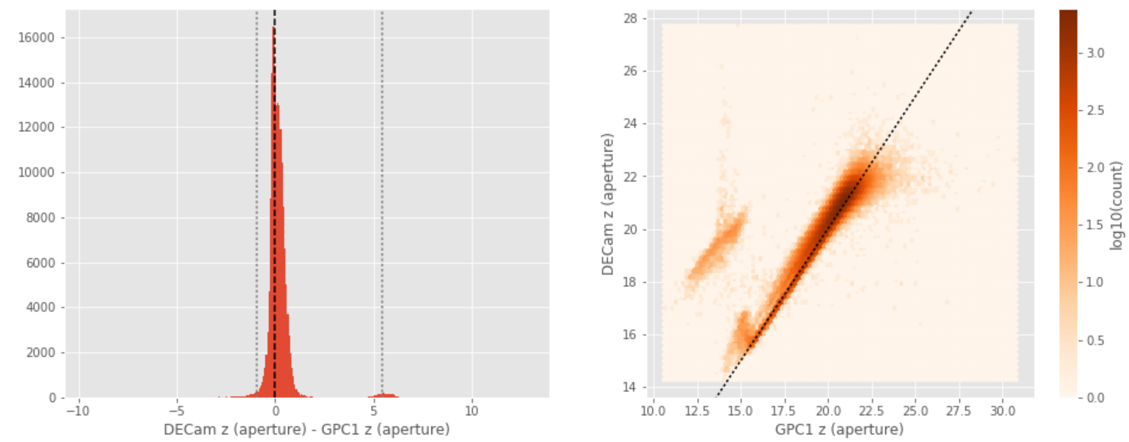
VISTA z (aperture) - OmegaCAM z (aperture):
- Median: 0.16
- Median Absolute Deviation: 0.09
- 1% percentile: -0.33622013092041014
- 99% percentile: 0.8982582283020007



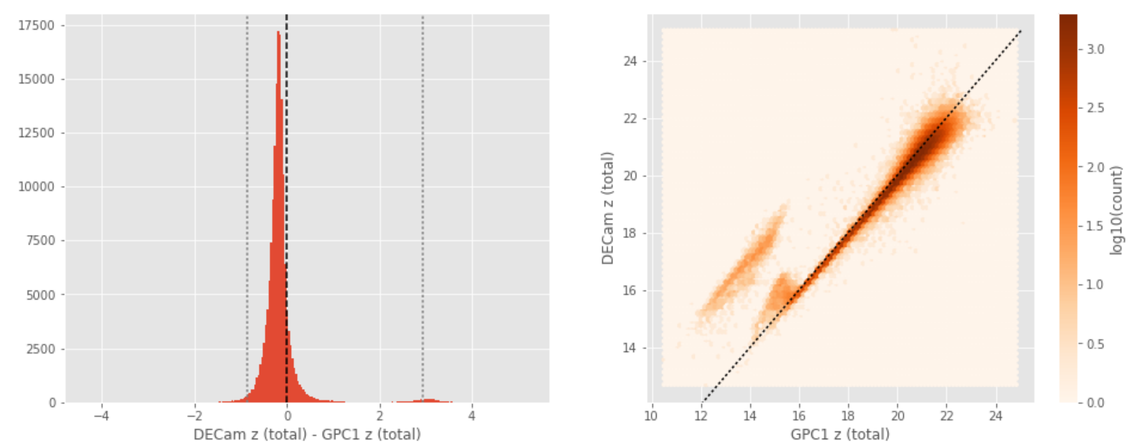
VISTA z (total) - OmegaCAM z (total):
- Median: 0.05
- Median Absolute Deviation: 0.11
- 1% percentile: -0.8182351684570313
- 99% percentile: 0.7913664817810039



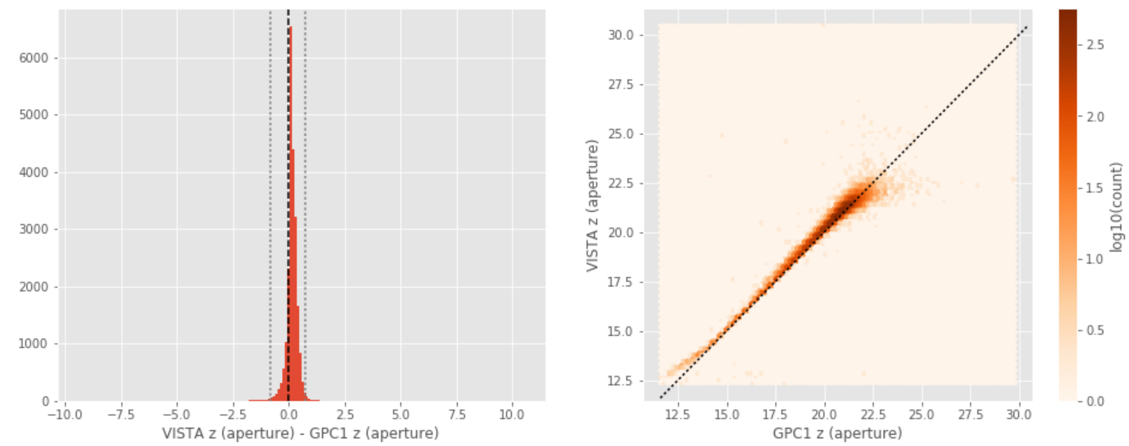
DECam z (aperture) - GPC1 z (aperture):
- Median: 0.10
- Median Absolute Deviation: 0.22
- 1% percentile: -0.9308026123046874
- 99% percentile: 5.422517871856689



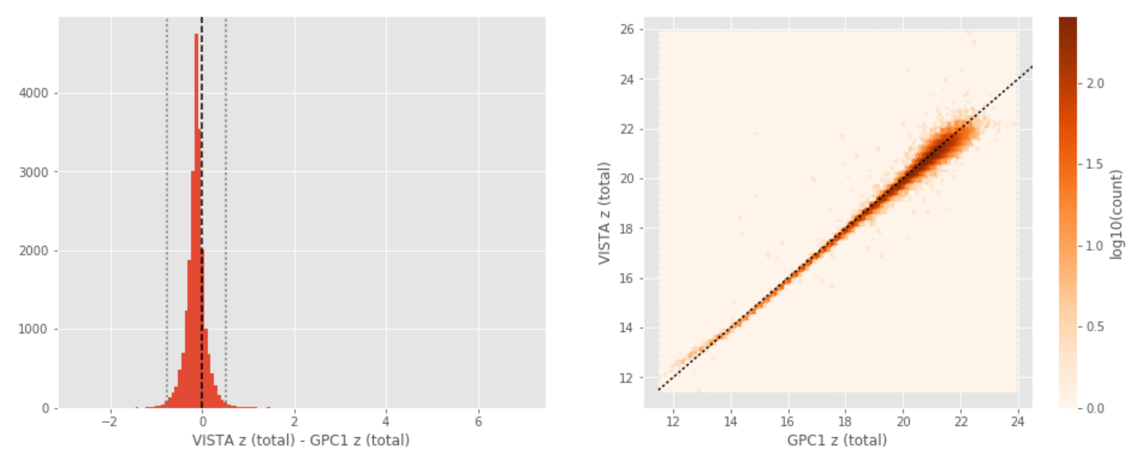
DECam z (total) - GPC1 z (total):
- Median: -0.18
- Median Absolute Deviation: 0.10
- 1% percentile: -0.8586163139343262
- 99% percentile: 2.947213668823245



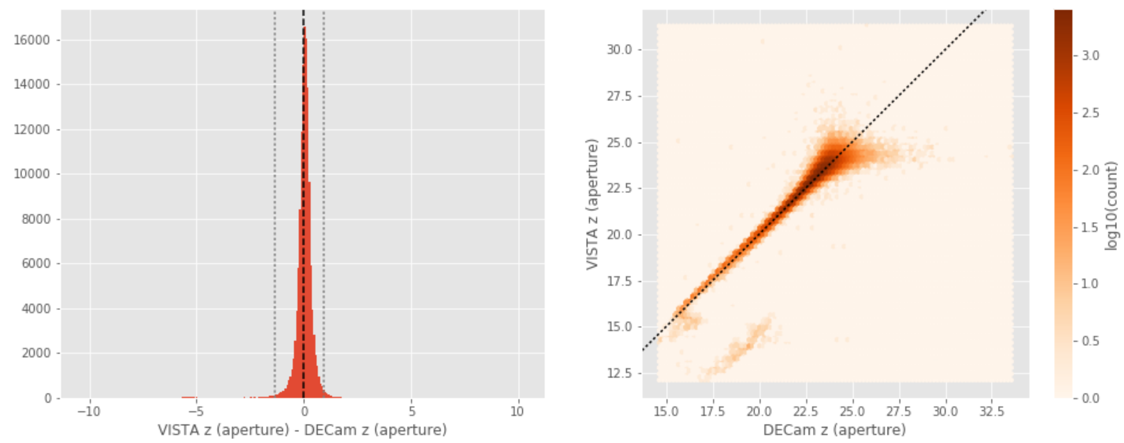
VISTA z (aperture) - GPC1 z (aperture):
- Median: 0.12
- Median Absolute Deviation: 0.11
- 1% percentile: -0.8292744445800782
- 99% percentile: 0.7439142608642577



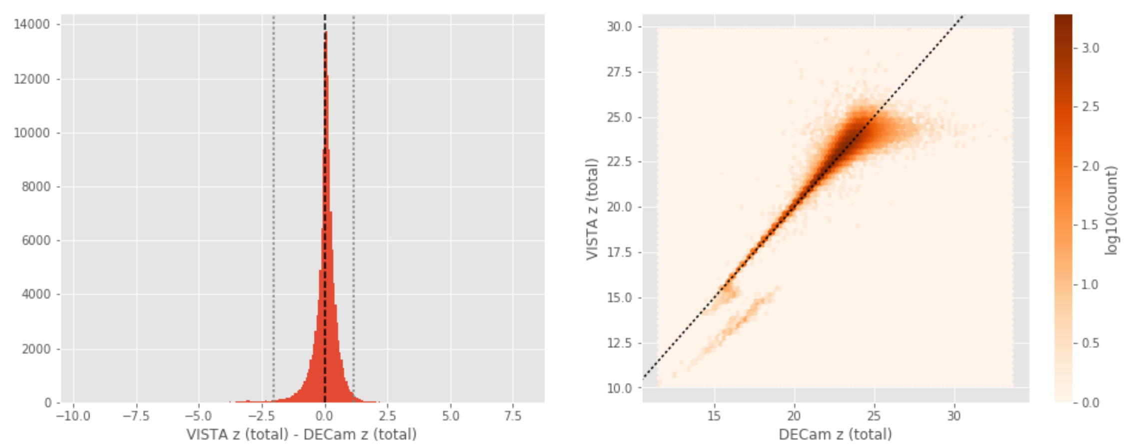
VISTA z (total) - GPC1 z (total):
- Median: -0.13
- Median Absolute Deviation: 0.10
- 1% percentile: -0.7600824356079102
- 99% percentile: 0.5232796287536614



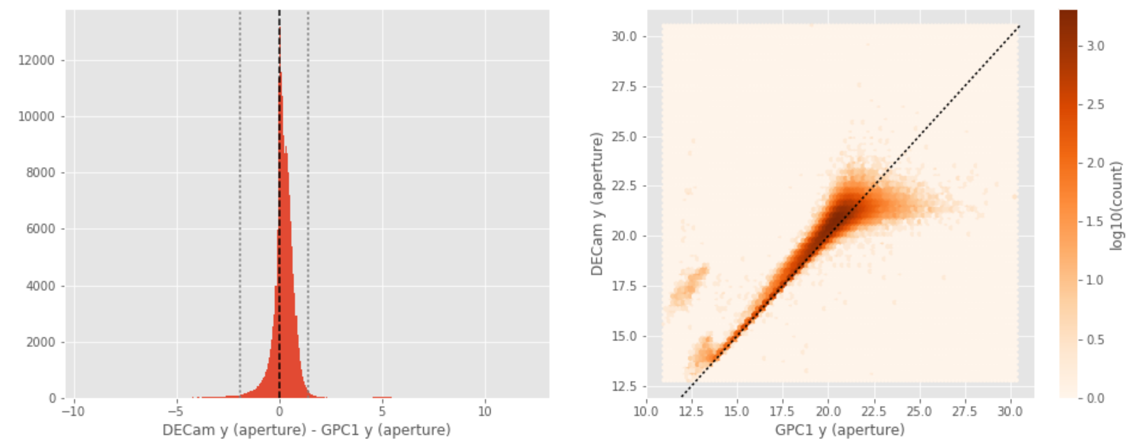
VISTA z (aperture) - DECam z (aperture):
- Median: 0.06
- Median Absolute Deviation: 0.16
- 1% percentile: -1.331837320327759
- 99% percentile: 0.9218461990356448



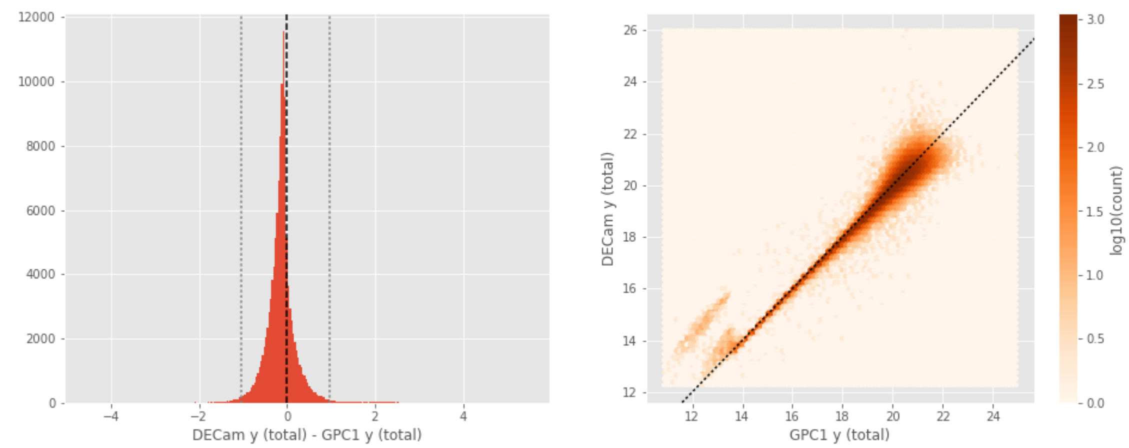
VISTA z (total) - DECam z (total):
- Median: 0.07
- Median Absolute Deviation: 0.19
- 1% percentile: -2.0062858581542966
- 99% percentile: 1.170430679321289



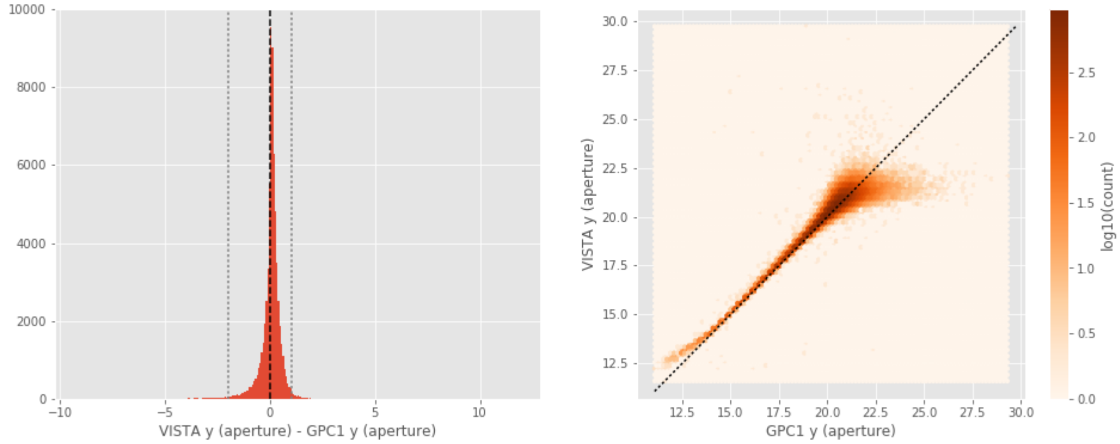
DECam y (aperture) - GPC1 y (aperture):
- Median: 0.20
- Median Absolute Deviation: 0.24
- 1% percentile: -1.8964884185791016
- 99% percentile: 1.423168087005615



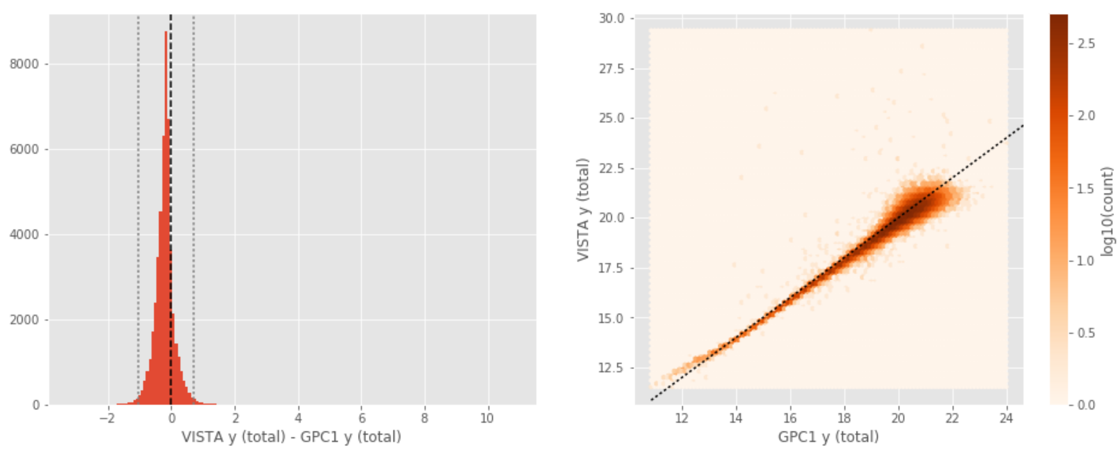
DECam y (total) - GPC1 y (total):
- Median: -0.12
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0283802032470704
- 99% percentile: 0.9840372848510729



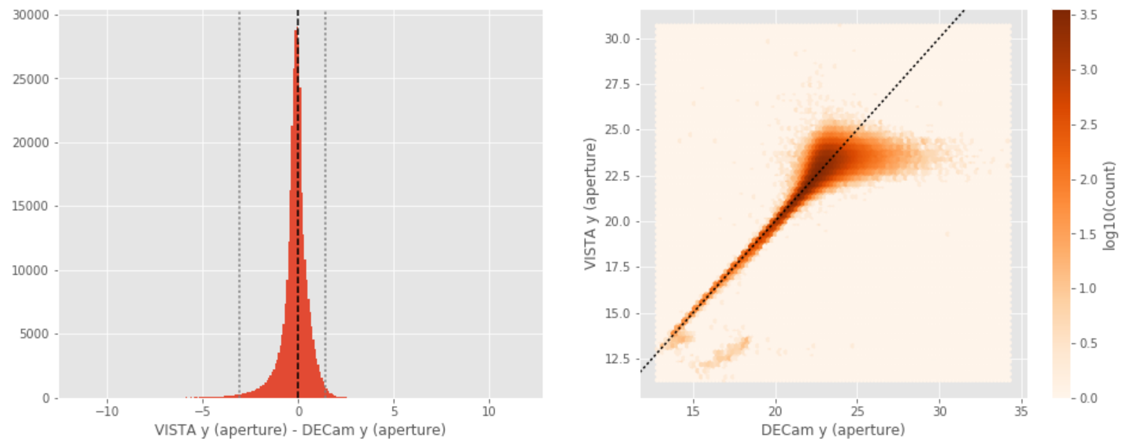
VISTA y (aperture) - GPC1 y (aperture):
- Median: 0.09
- Median Absolute Deviation: 0.16
- 1% percentile: -1.9527296447753906
- 99% percentile: 1.0630077362060548



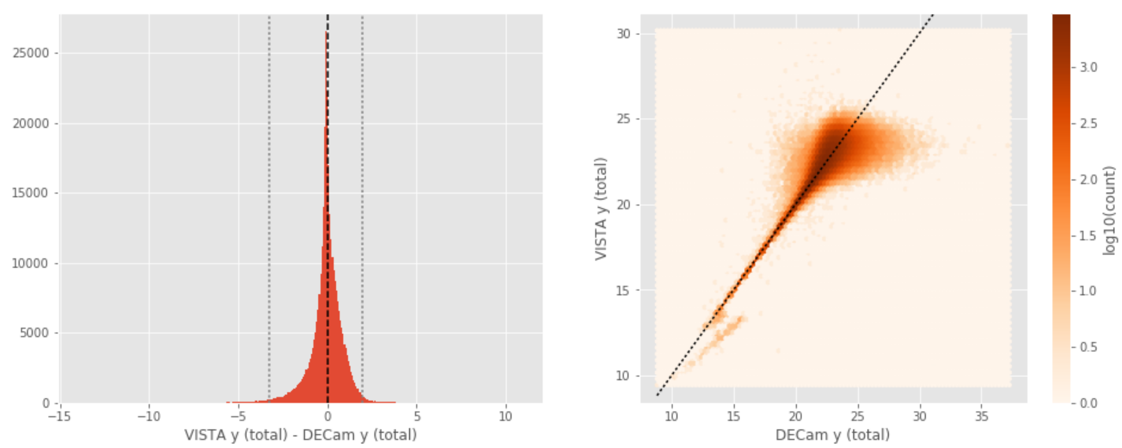
VISTA y (total) - GPC1 y (total):
- Median: -0.19
- Median Absolute Deviation: 0.15
- 1% percentile: -1.0352452850341796
- 99% percentile: 0.7106719207763674



VISTA y (aperture) - DECam y (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.29
- 1% percentile: -3.0841085243225095
- 99% percentile: 1.4085693359375




```
VISTA y (total) - DECam y (total):
- Median: -0.04
- Median Absolute Deviation: 0.38
- 1% percentile: -3.278031234741211
- 99% percentile: 1.9568926239013726
```



1.5 III - Comparing magnitudes to reference bands

Cross-match the master list to 2MASS to compare magnitudes.

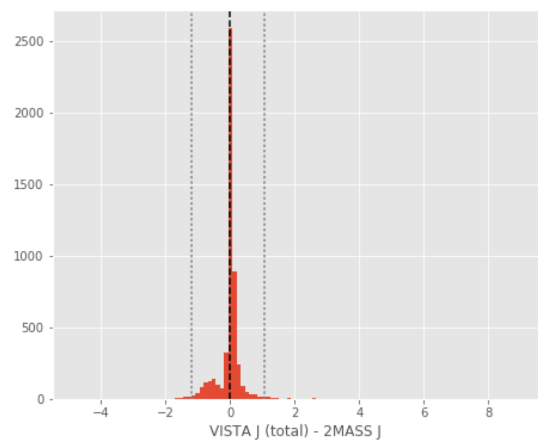
1.5.1 III.b - Comparing J and K bands to 2MASS

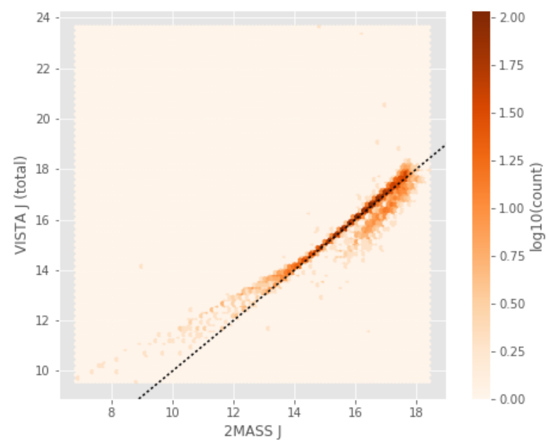
The catalogue is cross-matched to 2MASS-PSC withing 0.2 arcsecond. We compare the UKIDSS total J and K magnitudes to those from 2MASS.

The 2MASS magnitudes are "*Vega-like*" and we have to convert them to AB magnitudes using the zero points provided on this page:

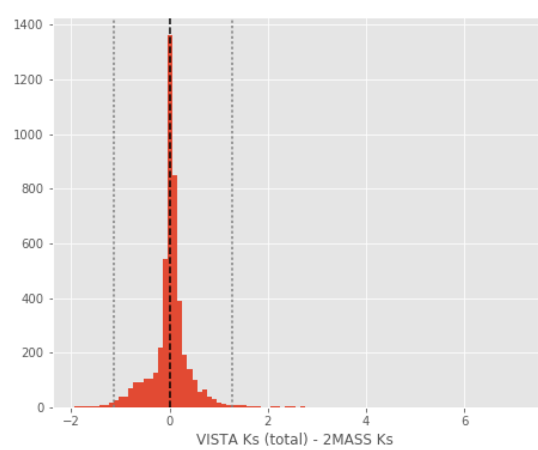
Band	F - 0 mag (Jy)
J	1594
H	1024
Ks	666.7

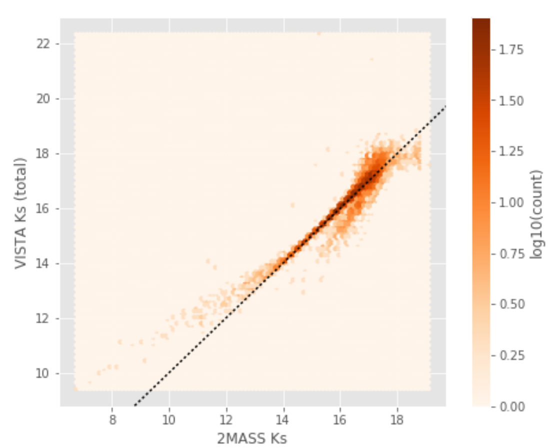
```
VISTA J (total) - 2MASS J:
- Median: 0.03
- Median Absolute Deviation: 0.06
- 1% percentile: -1.2033101961423698
- 99% percentile: 1.0771015779970339
```





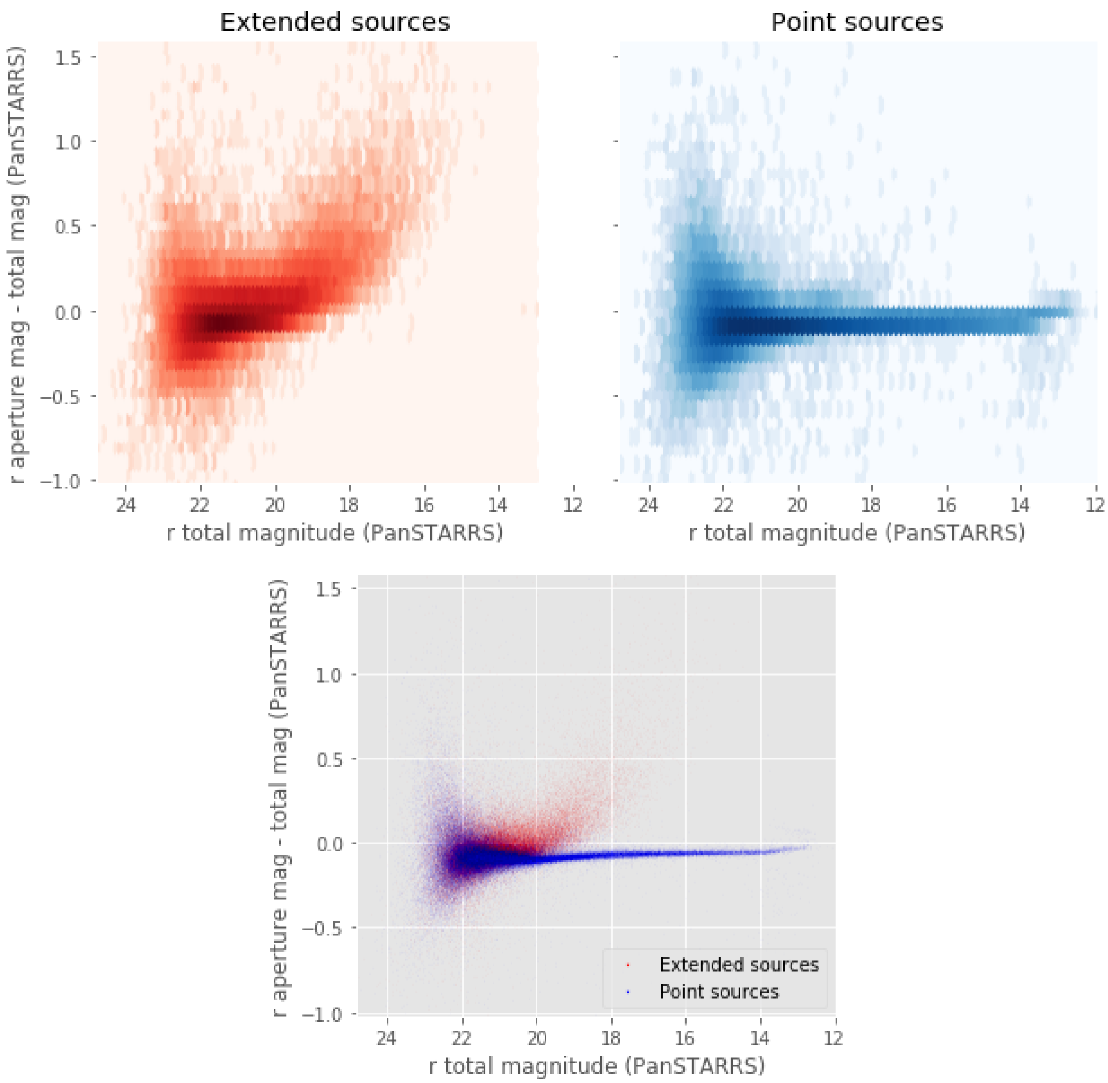

```
VISTA Ks (total) - 2MASS Ks:
- Median: 0.03
- Median Absolute Deviation: 0.11
- 1% percentile: -1.1203042906816978
- 99% percentile: 1.2803789119092368
```





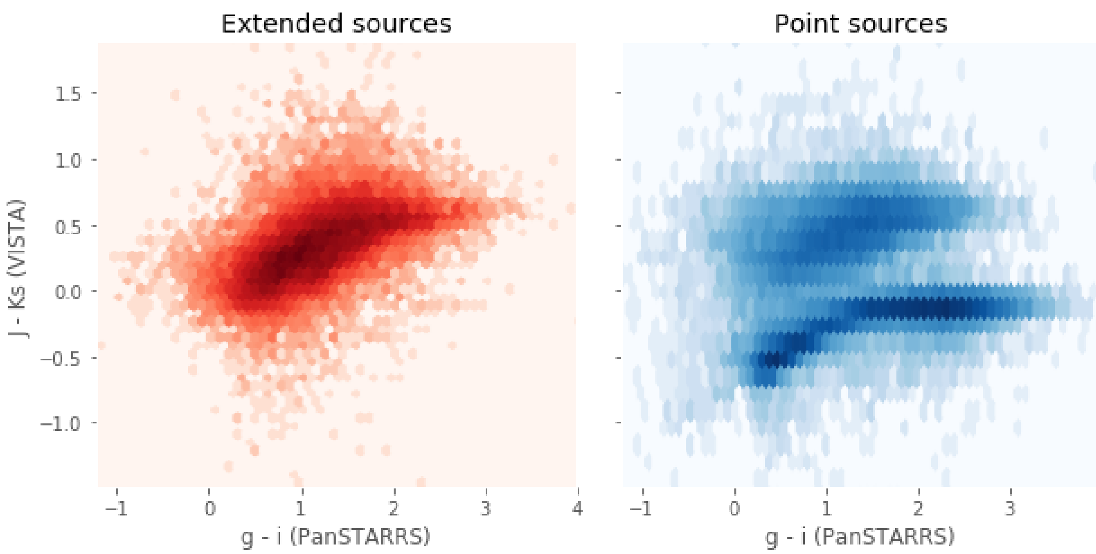
1.6 IV - Comparing aperture magnitudes to total ones.

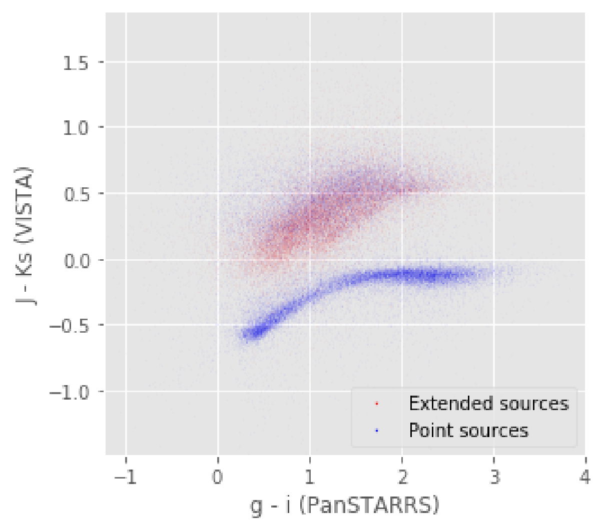
```
Number of source used: 148302 / 2171051 (6.83%)
```



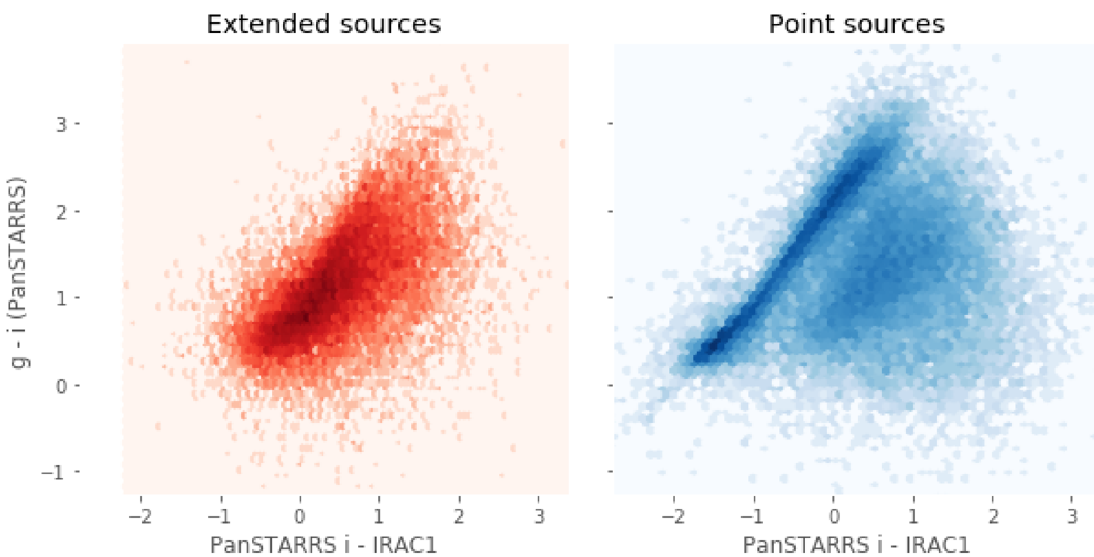
1.7 V - Color-color and magnitude-color plots

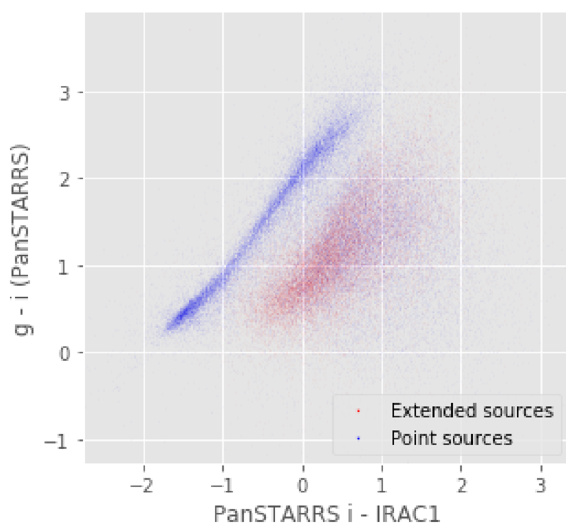
```
Number of source used: 63057 / 2171051 (2.90%)
```



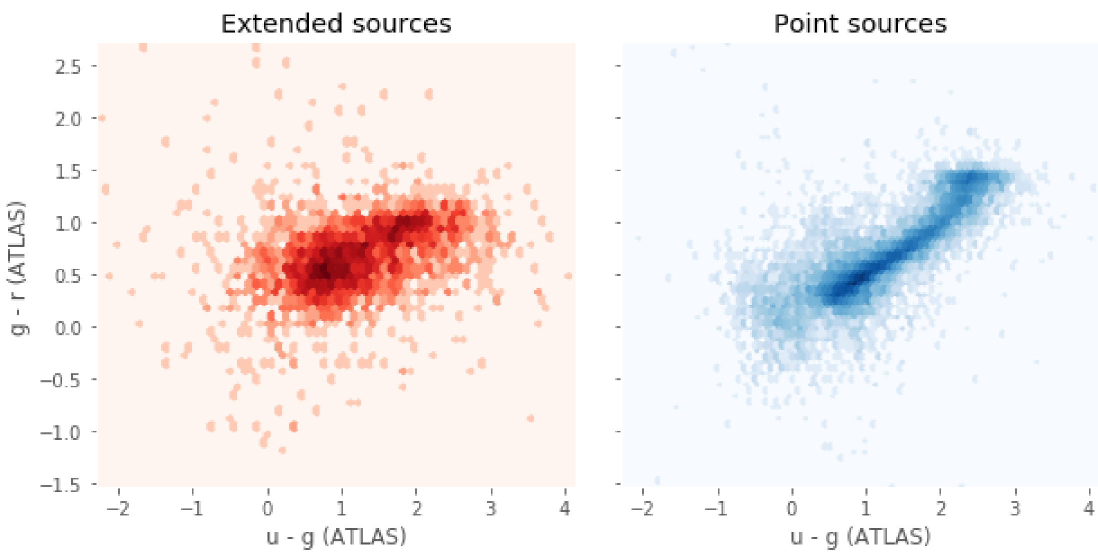


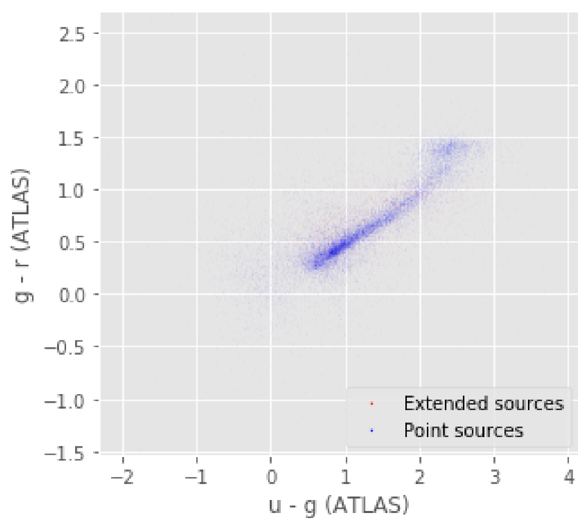

```
Number of source used: 64750 / 2171051 (2.98%)
```



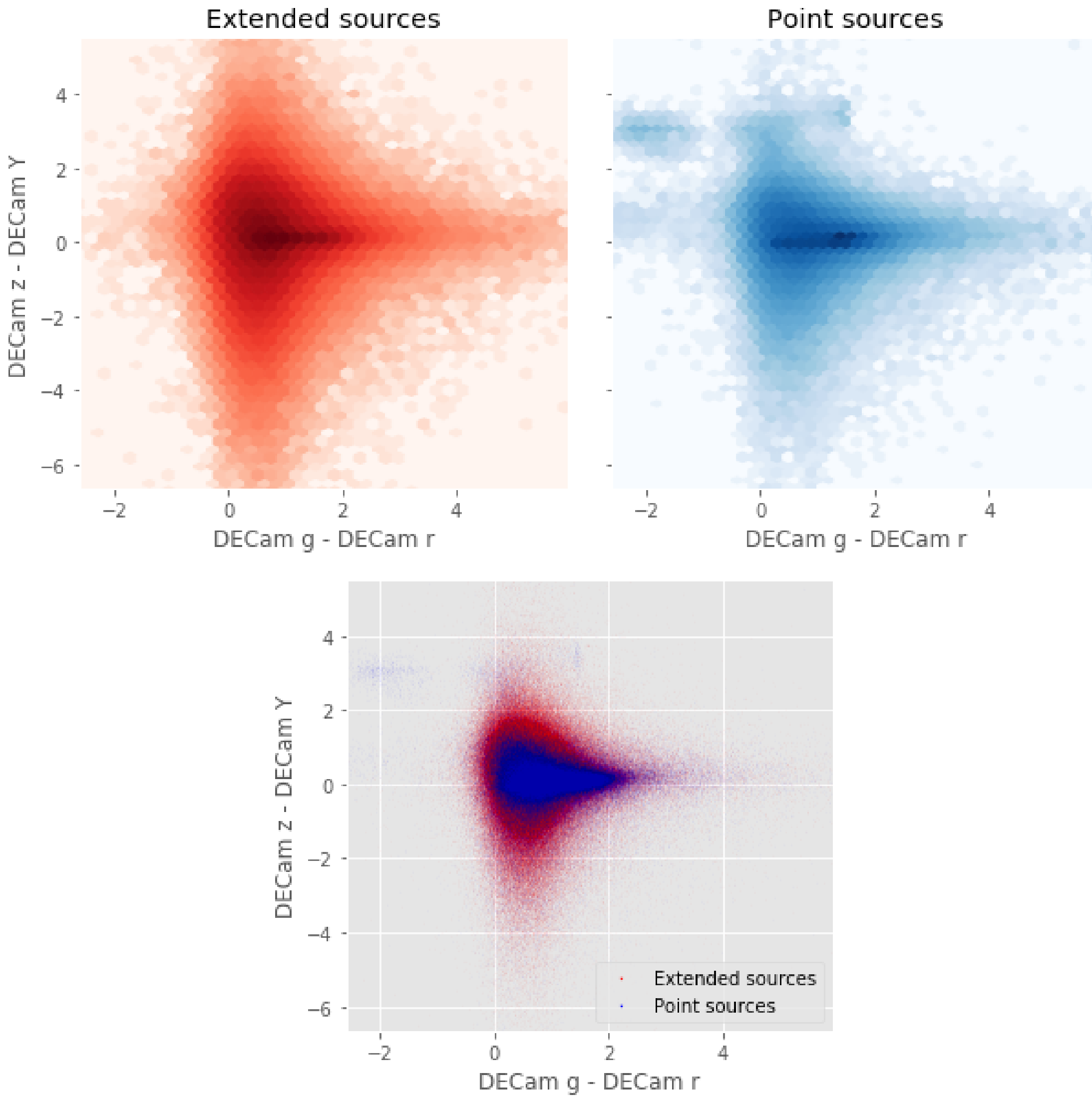



```
Number of source used: 18258 / 2171051 (0.84%)
```

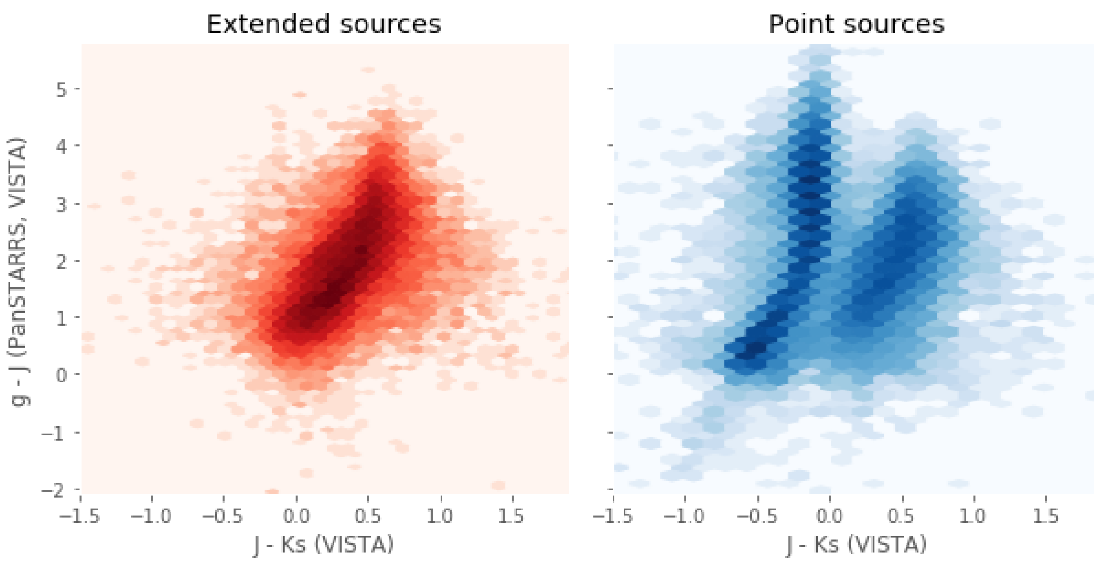


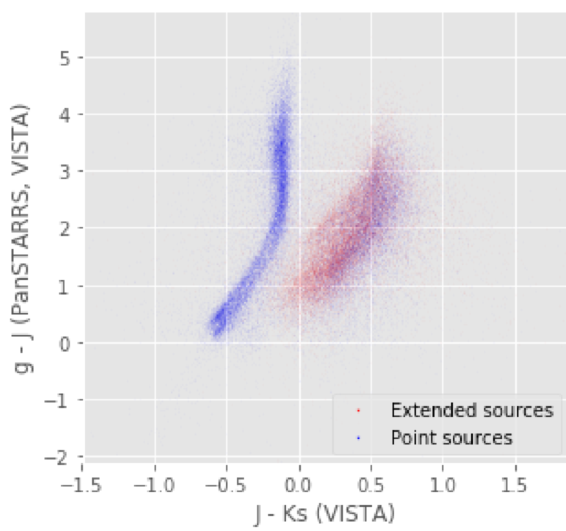


Number of source used: 826224 / 2171051 (38.06%)

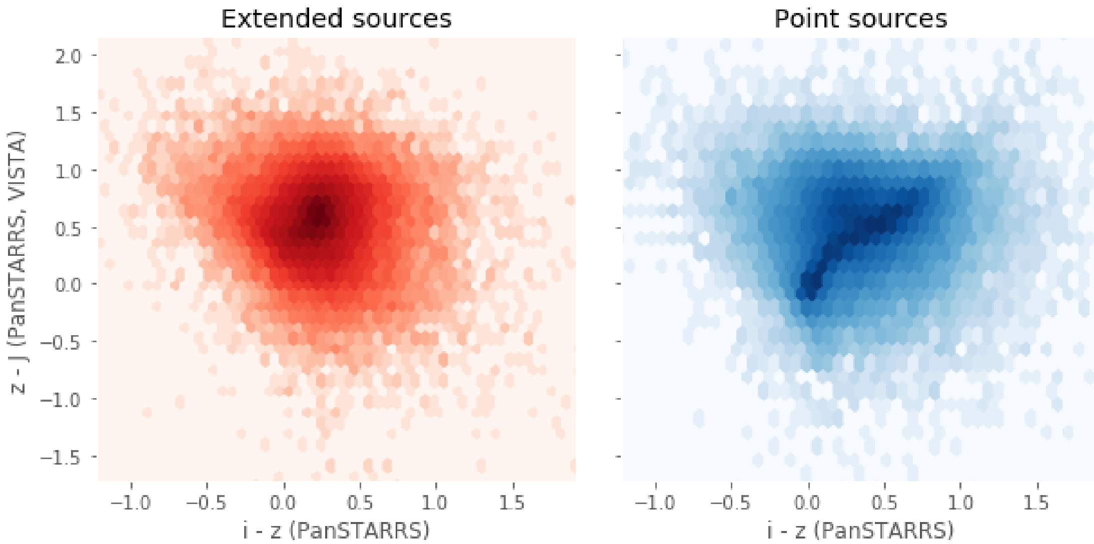


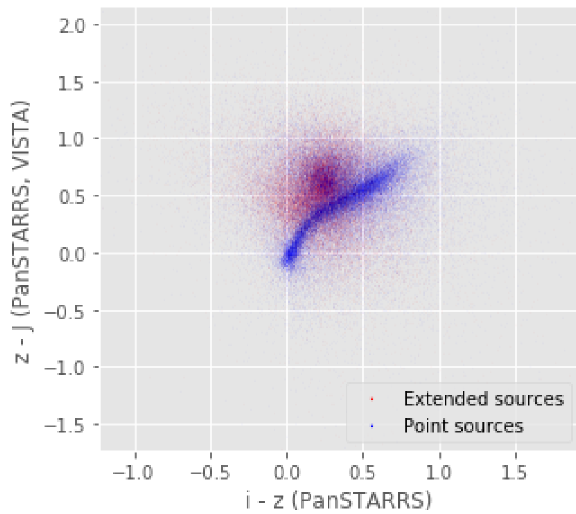
Number of source used: 64049 / 2171051 (2.95%)



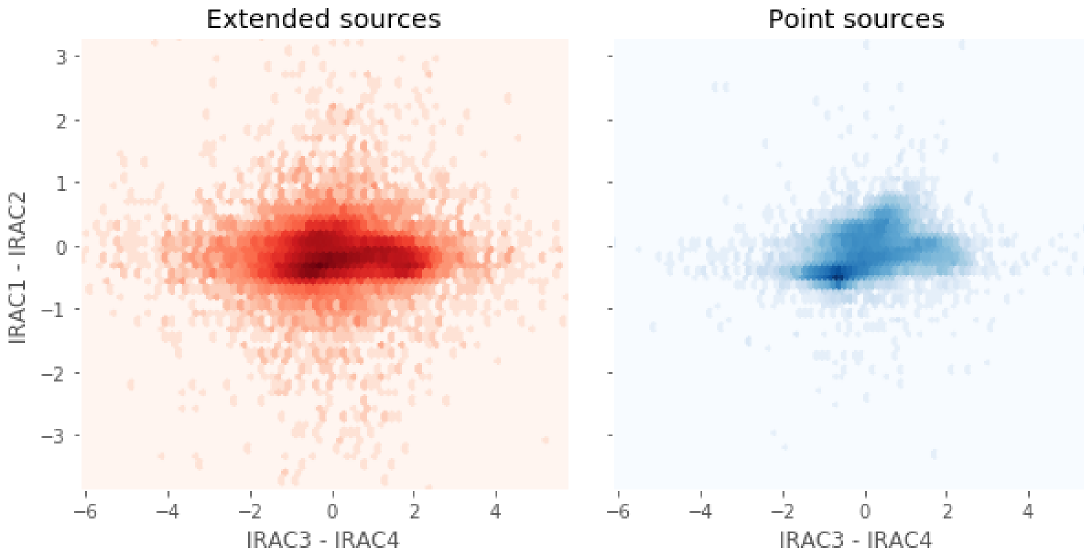



```
Number of source used: 101174 / 2171051 (4.66%)
```

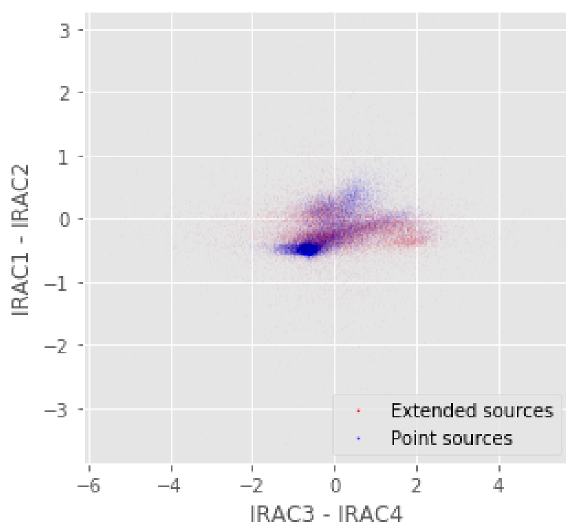





```
Number of source used: 44692 / 2171051 (2.06%)
```



Extended sources
Point sources
IRAC1 - IRAC2
IRAC3 - IRAC4
IRAC3 - IRAC4



IRAC1 - IRAC2
IRAC3 - IRAC4
Extended sources
Point sources

4_Selection_function

March 8, 2018

1 CDFS-SWIRE Selection Functions

1.1 Depth maps and selection functions

The simplest selection function available is the field MOC which specifies the area for which there is Herschel data. Each pristine catalogue also has a MOC defining the area for which that data is available.

The next stage is to provide mean flux standard deviations which act as a proxy for the catalogue's 5σ depth

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-27 18:15:44.654183
```

```
Depth maps produced using: master_catalogue_cdfs-swire_20180221.fits
```

1.2 I - Group masterlist objects by healpix cell and calculate depths

We add a column to the masterlist catalogue for the target order healpix cell per object.

1.3 II Create a table of all Order=13 healpix cells in the field and populate it

We create a table with every order=13 healpix cell in the field MOC. We then calculate the healpix cell at lower order that the order=13 cell is in. We then fill in the depth at every order=13 cell as calculated for the lower order cell that that the order=13 cell is inside.

```
Out[9]: <IPython.core.display.HTML object>
```

```
Out[11]: <IPython.core.display.HTML object>
```

```
Out[12]: <IPython.core.display.HTML object>
```

1.4 III - Save the depth map table

1.5 IV - Overview plots

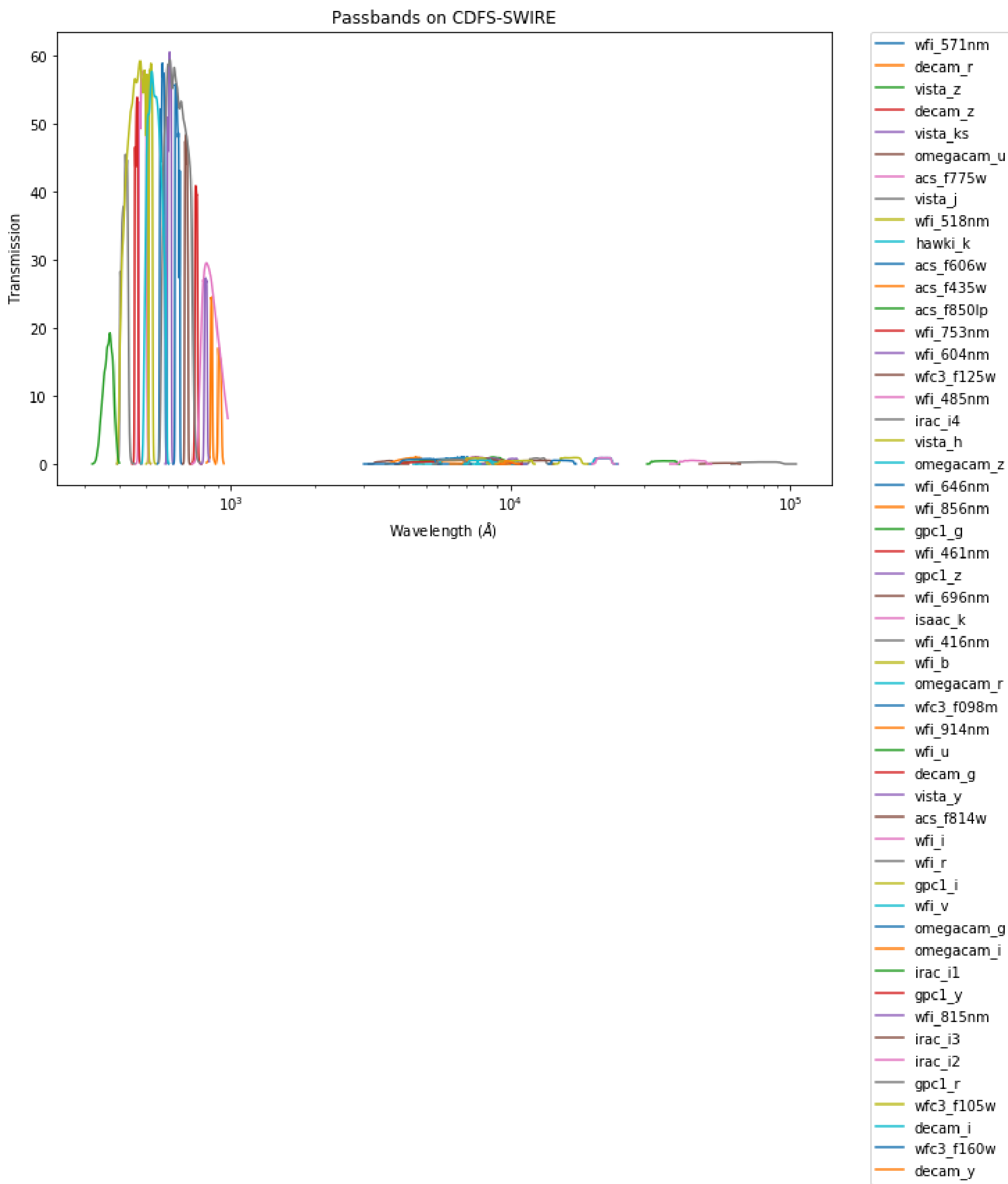
1.5.1 IV.a - Filters

First we simply plot all the filters available on this field to give an overview of coverage.

```
Out[14]: {'acs_f435w',
          'acs_f606w',
          'acs_f775w',
          'acs_f814w',
          'acs_f850lp',
          'decam_g',
          'decam_i',
          'decam_r',
          'decam_y',
          'decam_z',
          'gpc1_g',
          'gpc1_i',
          'gpc1_r',
          'gpc1_y',
          'gpc1_z',
          'hawki_k',
          'irac_i1',
          'irac_i2',
          'irac_i3',
          'irac_i4',
          'isaac_k',
          'omegacam_g',
          'omegacam_i',
          'omegacam_r',
          'omegacam_u',
          'omegacam_z',
          'vista_h',
          'vista_j',
          'vista_ks',
          'vista_y',
          'vista_z',
          'wfc3_f098m',
          'wfc3_f105w',
          'wfc3_f125w',
          'wfc3_f160w',
          'wfi_416nm',
          'wfi_461nm',
          'wfi_485nm',
          'wfi_518nm',
          'wfi_571nm',
          'wfi_604nm',
```

```
         'wfi_646nm',
         'wfi_696nm',
         'wfi_753nm',
         'wfi_815nm',
         'wfi_856nm',
         'wfi_914nm',
         'wfi_b',
         'wfi_i',
         'wfi_r',
         'wfi_u',
         'wfi_v'}
```

```
Out[15]: <matplotlib.text.Text at 0x7fb9f4053b70>
```



1.5.2 IV.a - Depth overview

Then we plot the mean depths available across the area a given band is available

```
gpc1_g: mean flux error: 0.7572806506669679, 3sigma in AB mag (Aperture): 23.009054712509702
gpc1_r: mean flux error: 0.9357328002738964, 3sigma in AB mag (Aperture): 22.77931723049341
gpc1_i: mean flux error: 0.8475967345877123, 3sigma in AB mag (Aperture): 22.88672367595337
gpc1_z: mean flux error: 1.0879093278563152, 3sigma in AB mag (Aperture): 22.61571511204871
```

gpc1_y: mean flux error: 1.0816128086109469, 3sigma in AB mag (Aperture): 22.622017309190035
wfi_416nm: mean flux error: 0.11377613246440887, 3sigma in AB mag (Aperture): 25.067068945886028
wfi_461nm: mean flux error: 0.12192642688751221, 3sigma in AB mag (Aperture): 24.991952246252175
wfi_485nm: mean flux error: 0.17386078834533691, 3sigma in AB mag (Aperture): 24.606692751860884
wfi_518nm: mean flux error: 0.19460389018058777, 3sigma in AB mag (Aperture): 24.484318069013945
wfi_571nm: mean flux error: 0.1675543487071991, 3sigma in AB mag (Aperture): 24.6468076031989
wfi_604nm: mean flux error: 0.20636124908924103, 3sigma in AB mag (Aperture): 24.420626493297554
wfi_646nm: mean flux error: 0.3961279094219208, 3sigma in AB mag (Aperture): 23.712608258320323
wfi_696nm: mean flux error: 0.19594746828079224, 3sigma in AB mag (Aperture): 24.47684772171842
wfi_753nm: mean flux error: 0.33146166801452637, 3sigma in AB mag (Aperture): 23.90611358438303
wfi_815nm: mean flux error: 0.21977104246616364, 3sigma in AB mag (Aperture): 24.352270692636914
wfi_856nm: mean flux error: 0.4343852698802948, 3sigma in AB mag (Aperture): 23.612509138727283
wfi_914nm: mean flux error: 0.5239728689193726, 3sigma in AB mag (Aperture): 23.408924863220797
wfi_u: mean flux error: 0.059950005263090134, 3sigma in AB mag (Aperture): 25.76272379929545
wfi_b: mean flux error: 0.040135063230991364, 3sigma in AB mag (Aperture): 26.19838698438884
wfi_v: mean flux error: 0.07349023967981339, 3sigma in AB mag (Aperture): 25.541622703744416
wfi_r: mean flux error: 0.0226069875061512, 3sigma in AB mag (Aperture): 26.821590127463587
wfi_i: mean flux error: 0.31333398818969727, 3sigma in AB mag (Aperture): 23.967178096850155
omegacam_u: mean flux error: 2.511311591330948, 3sigma in AB mag (Aperture): 21.70744536019172
omegacam_g: mean flux error: 0.5734693326568753, 3sigma in AB mag (Aperture): 23.310921367825607
omegacam_r: mean flux error: 0.7922872670537008, 3sigma in AB mag (Aperture): 22.95999017224451
omegacam_i: mean flux error: 1.4834320806357262, 3sigma in AB mag (Aperture): 22.279027696174985
omegacam_z: mean flux error: 4.476022309071788, 3sigma in AB mag (Aperture): 21.07996625709746
vista_z: mean flux error: 0.1722133904695511, 3sigma in AB mag (Aperture): 24.617029570596337
irac_i3: mean flux error: 4.909256210210634, 3sigma in AB mag (Aperture): 20.979657617756082
irac_i4: mean flux error: 4.948720801050288, 3sigma in AB mag (Aperture): 20.970964482453333
decam_g: mean flux error: 0.1027993557719444, 3sigma in AB mag (Aperture): 25.177220880676394
decam_r: mean flux error: 0.12160599388444042, 3sigma in AB mag (Aperture): 24.994809409272214
decam_i: mean flux error: 0.21936818291882237, 3sigma in AB mag (Aperture): 24.354262768467997
decam_z: mean flux error: 0.4117865109851437, 3sigma in AB mag (Aperture): 23.67051657270141
decam_y: mean flux error: 1.4066419345344106, 3sigma in AB mag (Aperture): 22.336737962269375
irac_i1: mean flux error: 0.7205447532326866, 3sigma in AB mag (Aperture): 23.063044462857384
irac_i2: mean flux error: 0.95774766129445, 3sigma in AB mag (Aperture): 22.754069112798128
vista_y: mean flux error: 0.31191600656000723, 3sigma in AB mag (Aperture): 23.972102708270818
vista_j: mean flux error: 1.7632260469553904, 3sigma in AB mag (Aperture): 22.091426881300656
vista_h: mean flux error: 2.1970480867209172, 3sigma in AB mag (Aperture): 21.85259795716606
vista_ks: mean flux error: 3.0590415111454736, 3sigma in AB mag (Aperture): 21.493233437215856
gpc1_g: mean flux error: 0.828766000556715, 3sigma in AB mag (Total): 22.91111704771881
gpc1_r: mean flux error: 0.9765442831086122, 3sigma in AB mag (Total): 22.732967008417525
gpc1_i: mean flux error: 1.0484007092807812, 3sigma in AB mag (Total): 22.6558785979746
gpc1_z: mean flux error: 1.740987053810125, 3sigma in AB mag (Total): 22.10520800904296
gpc1_y: mean flux error: 4.284603139860406, 3sigma in AB mag (Total): 21.12742035890087
wfi_416nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_461nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_485nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_518nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_571nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_604nm: mean flux error: nan, 3sigma in AB mag (Total): nan

```
wfi_646nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_696nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_753nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_815nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_856nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_914nm: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_u: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_b: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_v: mean flux error: nan, 3sigma in AB mag (Total): nan
wfi_r: mean flux error: 5.9475272706777105e-08, 3sigma in AB mag (Total): 40.7713557580847
wfi_i: mean flux error: nan, 3sigma in AB mag (Total): nan
omegacam_u: mean flux error: 3.4125962153959533, 3sigma in AB mag (Total): 21.37448460119129
omegacam_g: mean flux error: 0.9078894099593301, 3sigma in AB mag (Total): 22.812114487408813
omegacam_r: mean flux error: 1.38562435536946, 3sigma in AB mag (Total): 22.35308309216864
omegacam_i: mean flux error: 2.550607022160237, 3sigma in AB mag (Total): 21.690587985643695
omegacam_z: mean flux error: 7.663351499054843, 3sigma in AB mag (Total): 20.496149998121943
vista_z: mean flux error: 0.31961238384246826, 3sigma in AB mag (Total): 23.94563786736682
irac_i3: mean flux error: 6.590304219636124, 3sigma in AB mag (Total): 20.659933206131704
irac_i4: mean flux error: 5.47373294027701, 3sigma in AB mag (Total): 20.861487851557477
decam_g: mean flux error: 0.1484273113361329, 3sigma in AB mag (Total): 24.778412311799293
decam_r: mean flux error: 0.18530145150554156, 3sigma in AB mag (Total): 24.53749981006849
decam_i: mean flux error: 0.3587508654894544, 3sigma in AB mag (Total): 23.82021446949492
decam_z: mean flux error: 0.7061953216049718, 3sigma in AB mag (Total): 23.08488477288264
decam_y: mean flux error: 2.4407179464311746, 3sigma in AB mag (Total): 21.738402876954147
irac_i1: mean flux error: 1.1372236735974461, 3sigma in AB mag (Total): 22.567582133637323
irac_i2: mean flux error: 1.2450085999860945, 3sigma in AB mag (Total): 22.469265984794937
vista_y: mean flux error: 0.5453642483808308, 3sigma in AB mag (Total): 23.36548020282013
vista_j: mean flux error: 3.4274921072826166, 3sigma in AB mag (Total): 21.36975570474211
vista_h: mean flux error: 4.7847759818817535, 3sigma in AB mag (Total): 21.007542839742122
vista_ks: mean flux error: 6.818018036034584, 3sigma in AB mag (Total): 20.6230514988141
isaac_k: mean flux error: 0.10790348798036575, 3sigma in AB mag (Total): 25.12460815450232
acs_f850lp: mean flux error: 0.03505978360772133, 3sigma in AB mag (Total): 26.345173785051593
wfc3_f125w: mean flux error: 0.023850014433264732, 3sigma in AB mag (Total): 26.76347524770754
hawki_k: mean flux error: 0.04855722934007645, 3sigma in AB mag (Total): 25.991562118024852
acs_f775w: mean flux error: 0.024519704282283783, 3sigma in AB mag (Total): 26.733408792931037
acs_f435w: mean flux error: 0.01684591919183731, 3sigma in AB mag (Total): 27.14096008046581
acs_f814w: mean flux error: 0.02730550989508629, 3sigma in AB mag (Total): 26.61657113611306
acs_f606w: mean flux error: 0.013298597186803818, 3sigma in AB mag (Total): 27.39768228449777
wfc3_f098m: mean flux error: 0.028698811307549477, 3sigma in AB mag (Total): 26.56253709116229
wfc3_f160w: mean flux error: 0.02874237298965454, 3sigma in AB mag (Total): 26.560890310893136
wfc3_f105w: mean flux error: 0.019424518570303917, 3sigma in AB mag (Total): 26.986321203765748


ap_gpc1_g (4260.0, 5500.0, 1240.0)
ap_gpc1_r (5500.0, 6900.0, 1400.0)
ap_gpc1_i (6910.0, 8190.0, 1280.0)
ap_gpc1_z (8190.0, 9210.0, 1020.0)
ap_gpc1_y (9200.0, 9820.0, 620.0)
```

```
ap_wfi_416nm (402.0, 431.5, 29.5)
ap_wfi_461nm (455.0, 468.0, 13.0)
ap_wfi_485nm (470.5, 501.5, 31.0)
ap_wfi_518nm (511.0, 527.0, 16.0)
ap_wfi_571nm (558.80701, 584.0, 25.192993)
ap_wfi_604nm (594.0, 614.5, 20.5)
ap_wfi_646nm (632.5, 660.0, 27.5)
ap_wfi_696nm (686.0, 706.5, 20.5)
ap_wfi_753nm (744.5, 762.0, 17.5)
ap_wfi_815nm (805.49988, 825.90002, 20.400146)
ap_wfi_856nm (848.99988, 863.09998, 14.100098)
ap_wfi_914nm (900.90002, 927.11401, 26.213989)
ap_wfi_u (348.3334, 384.16669, 35.833282)
ap_wfi_b (408.5, 505.5, 97.0)
ap_wfi_v (495.0, 583.5, 88.5)
ap_wfi_r (570.5, 729.0, 158.5)
ap_wfi_i (779.0, 923.0, 144.0)
ap_omegacam_u (3296.7, 3807.8999, 511.19995)
ap_omegacam_g (4077.8999, 5369.7002, 1291.8003)
ap_omegacam_r (5640.7002, 6962.7998, 1322.0996)
ap_omegacam_i (6841.5, 8373.7998, 1532.2998)
ap_omegacam_z (8433.9004, 9274.5996, 840.69922)
ap_vista_z (8300.0, 9260.0, 960.0)
ap_irac_i3 (50246.301, 64096.699, 13850.398)
ap_irac_i4 (64415.199, 92596.797, 28181.598)
ap_decam_g (4180.0, 5470.0, 1290.0)
ap_decam_r (5680.0, 7150.0, 1470.0)
ap_decam_i (7090.0, 8560.0, 1470.0)
ap_decam_z (8490.0, 9960.0, 1470.0)
ap_decam_y (9510.0, 10170.0, 660.0)
ap_irac_i1 (31754.0, 39164.801, 7410.8008)
ap_irac_i2 (39980.102, 50052.301, 10072.199)
ap_vista_y (9740.0, 10660.0, 920.0)
ap_vista_j (11670.0, 13380.0, 1710.0)
ap_vista_h (15000.0, 17900.0, 2900.0)
ap_vista_ks (19930.0, 23010.0, 3080.0)
gpc1_g (4260.0, 5500.0, 1240.0)
gpc1_r (5500.0, 6900.0, 1400.0)
gpc1_i (6910.0, 8190.0, 1280.0)
gpc1_z (8190.0, 9210.0, 1020.0)
gpc1_y (9200.0, 9820.0, 620.0)
wfi_416nm (402.0, 431.5, 29.5)
wfi_461nm (455.0, 468.0, 13.0)
wfi_485nm (470.5, 501.5, 31.0)
wfi_518nm (511.0, 527.0, 16.0)
wfi_571nm (558.80701, 584.0, 25.192993)
wfi_604nm (594.0, 614.5, 20.5)
wfi_646nm (632.5, 660.0, 27.5)
```

```
wfi_696nm (686.0, 706.5, 20.5)
wfi_753nm (744.5, 762.0, 17.5)
wfi_815nm (805.49988, 825.90002, 20.400146)
wfi_856nm (848.99988, 863.09998, 14.100098)
wfi_914nm (900.90002, 927.11401, 26.213989)
wfi_u (348.3334, 384.16669, 35.833282)
wfi_b (408.5, 505.5, 97.0)
wfi_v (495.0, 583.5, 88.5)
wfi_r (570.5, 729.0, 158.5)
wfi_i (779.0, 923.0, 144.0)
omegacam_u (3296.7, 3807.8999, 511.19995)
omegacam_g (4077.8999, 5369.7002, 1291.8003)
omegacam_r (5640.7002, 6962.7998, 1322.0996)
omegacam_i (6841.5, 8373.7998, 1532.2998)
omegacam_z (8433.9004, 9274.5996, 840.69922)
vista_z (8300.0, 9260.0, 960.0)
irac_i3 (50246.301, 64096.699, 13850.398)
irac_i4 (64415.199, 92596.797, 28181.598)
decam_g (4180.0, 5470.0, 1290.0)
decam_r (5680.0, 7150.0, 1470.0)
decam_i (7090.0, 8560.0, 1470.0)
decam_z (8490.0, 9960.0, 1470.0)
decam_y (9510.0, 10170.0, 660.0)
irac_i1 (31754.0, 39164.801, 7410.8008)
irac_i2 (39980.102, 50052.301, 10072.199)
vista_y (9740.0, 10660.0, 920.0)
vista_j (11670.0, 13380.0, 1710.0)
vista_h (15000.0, 17900.0, 2900.0)
vista_ks (19930.0, 23010.0, 3080.0)
isaac_k (20251.0, 22994.0, 2743.0)
acs_f850lp (8308.9297, 9584.25, 1275.3203)
wfc3_f125w (10993.5, 13997.47, 3003.9697)
hawki_k (19820.0, 23061.0, 3241.0)
acs_f775w (7004.5098, 8521.3799, 1516.8701)
acs_f435w (3919.51, 4798.7798, 879.26978)
acs_f814w (7069.6699, 9138.1104, 2068.4404)
acs_f606w (4835.3999, 7088.4702, 2253.0703)
wfc3_f098m (9009.1182, 10701.37, 1692.252)
wfc3_f160w (13996.34, 16869.92, 2873.5801)
wfc3_f105w (9072.9238, 11989.37, 2916.4463)
```

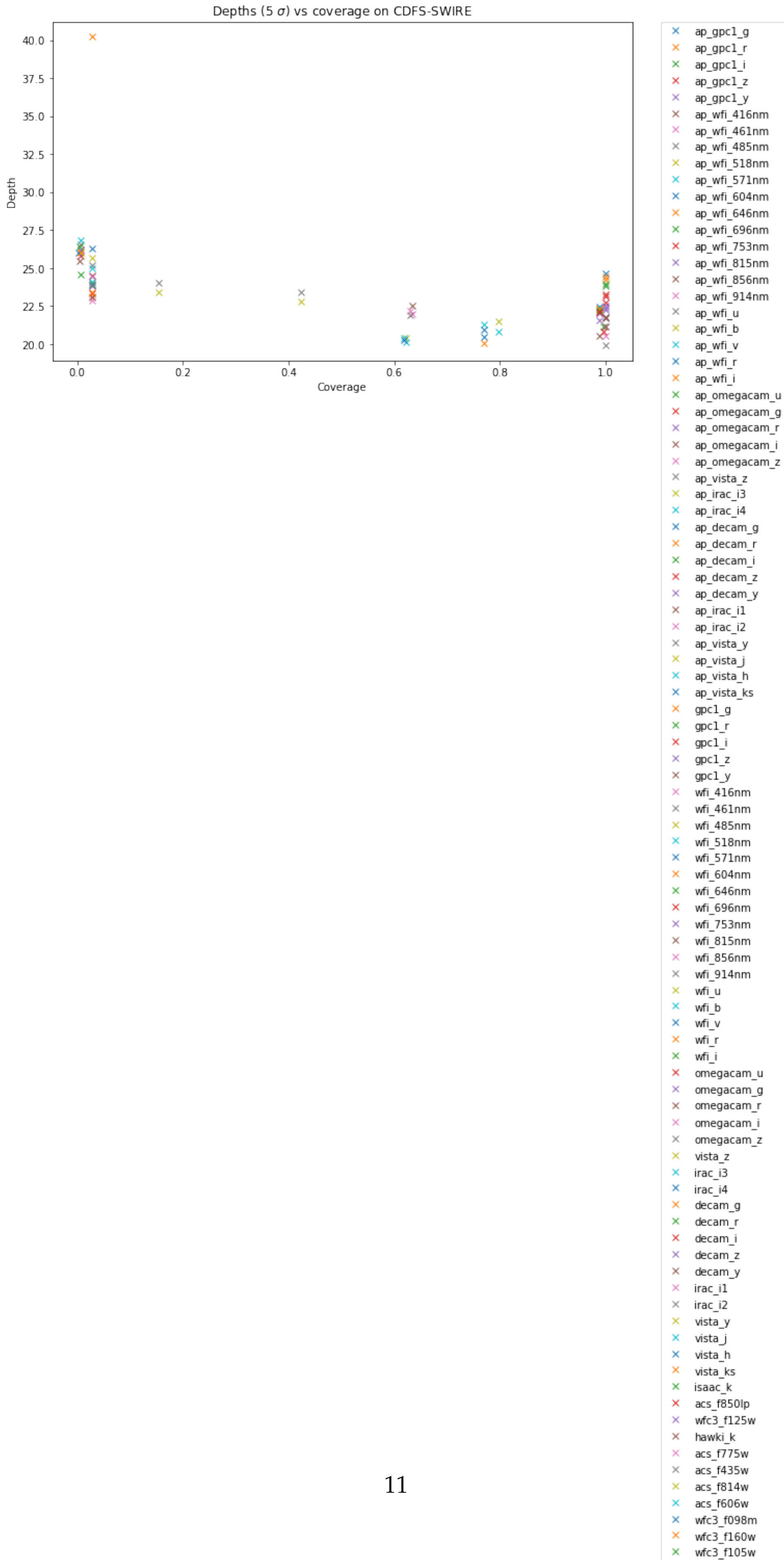
```
Out[20]: <matplotlib.text.Text at 0x7fb9f3b7c5f8>
```


Depths on CDFS-SWIRE
Depth
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
10^3
10^4
10^5
Wavelength (Å)
ap_gpc1_g
ap_gpc1_r
ap_gpc1_i
ap_gpc1_z
ap_gpc1_y
ap_wfi_416nm
ap_wfi_461nm
ap_wfi_485nm
ap_wfi_518nm
ap_wfi_571nm
ap_wfi_604nm
ap_wfi_646nm
ap_wfi_696nm
ap_wfi_753nm
ap_wfi_815nm
ap_wfi_856nm
ap_wfi_914nm
ap_wfi_u
ap_wfi_b
ap_wfi_v
ap_wfi_r
ap_wfi_i
ap_omegacam_u
ap_omegacam_g
ap_omegacam_r
ap_omegacam_i
ap_omegacam_z
ap_vista_z
ap_irac_i3
ap_irac_i4
ap_decam_g
ap_decam_r
ap_decam_i
ap_decam_z
ap_decam_y
ap_irac_i1
ap_irac_i2
ap_vista_y
ap_vista_j
ap_vista_h
ap_vista_ks
gpc1_g
gpc1_r
gpc1_i
gpc1_z
gpc1_y
wfi_416nm
wfi_461nm
wfi_485nm
wfi_518nm
wfi_571nm
wfi_604nm
wfi_646nm
wfi_696nm
wfi_753nm
wfi_815nm
wfi_856nm
wfi_914nm
wfi_u
wfi_b
wfi_v
wfi_r
wfi_i
omegacam_u
omegacam_g
omegacam_r
omegacam_i
omegacam_z
vista_z
irac_i3
irac_i4
decam_g
decam_r
decam_i
decam_z
decam_y
irac_i1
irac_i2
vista_y
vista_j
vista_h
vista_ks
isaac_k
acs_f850lp
wfc3_f125w
hawki_k
acs_f775w
acs_f435w
acs_f814w
acs_f606w
wfc3_f098m
wfc3_f160w
wfc3_f105w

1.5.3 IV.c - Depth vs coverage comparison

How best to do this? Colour/intensity plot over area? Percentage coverage vs mean depth?

```
Out[21]: <matplotlib.text.Text at 0x7fb9f1bfc668>
```


Depths (5 σ) vs coverage on CDFS-SWIRE
Depth
Coverage
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
0.0
0.2
0.4
0.6
0.8
1.0
ap_gpc1_g
ap_gpc1_r
ap_gpc1_i
ap_gpc1_z
ap_gpc1_y
ap_wfi_416nm
ap_wfi_461nm
ap_wfi_485nm
ap_wfi_518nm
ap_wfi_571nm
ap_wfi_604nm
ap_wfi_646nm
ap_wfi_696nm
ap_wfi_753nm
ap_wfi_815nm
ap_wfi_856nm
ap_wfi_914nm
ap_wfi_u
ap_wfi_b
ap_wfi_v
ap_wfi_r
ap_wfi_i
ap_omegacam_u
ap_omegacam_g
ap_omegacam_r
ap_omegacam_i
ap_omegacam_z
ap_vista_z
ap_irac_i3
ap_irac_i4
ap_decam_g
ap_decam_r
ap_decam_i
ap_decam_z
ap_decam_y
ap_irac_i1
ap_irac_i2
ap_vista_y
ap_vista_j
ap_vista_h
ap_vista_ks
gpc1_g
gpc1_r
gpc1_i
gpc1_z
gpc1_y
wfi_416nm
wfi_461nm
wfi_485nm
wfi_518nm
wfi_571nm
wfi_604nm
wfi_646nm
wfi_696nm
wfi_753nm
wfi_815nm
wfi_856nm
wfi_914nm
wfi_u
wfi_b
wfi_v
wfi_r
wfi_i
omegacam_u
omegacam_g
omegacam_r
omegacam_i
omegacam_z
vista_z
irac_i3
irac_i4
decam_g
decam_r
decam_i
decam_z
decam_y
irac_i1
irac_i2
vista_y
vista_j
vista_h
vista_ks
isaac_k
acs_f850lp
wfc3_f125w
hawki_k
acs_f775w
acs_f435w
acs_f814w
acs_f606w
wfc3_f098m
wfc3_f160w
wfc3_f105w