1.1_INT-WFC

March 8, 2018

1 Lockman SWIRE master catalogue

1.1 Preparation of Isaac Newton Telescope / Wide Field Camera (INT/WFC) data

Isaac Newton Telescope / Wide Field Camera (INT/WFC) catalogue: the catalogue comes from `dmu0_INTWFC`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band in apertude 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:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)
```

1.2 I - Column selection

```
/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>
```

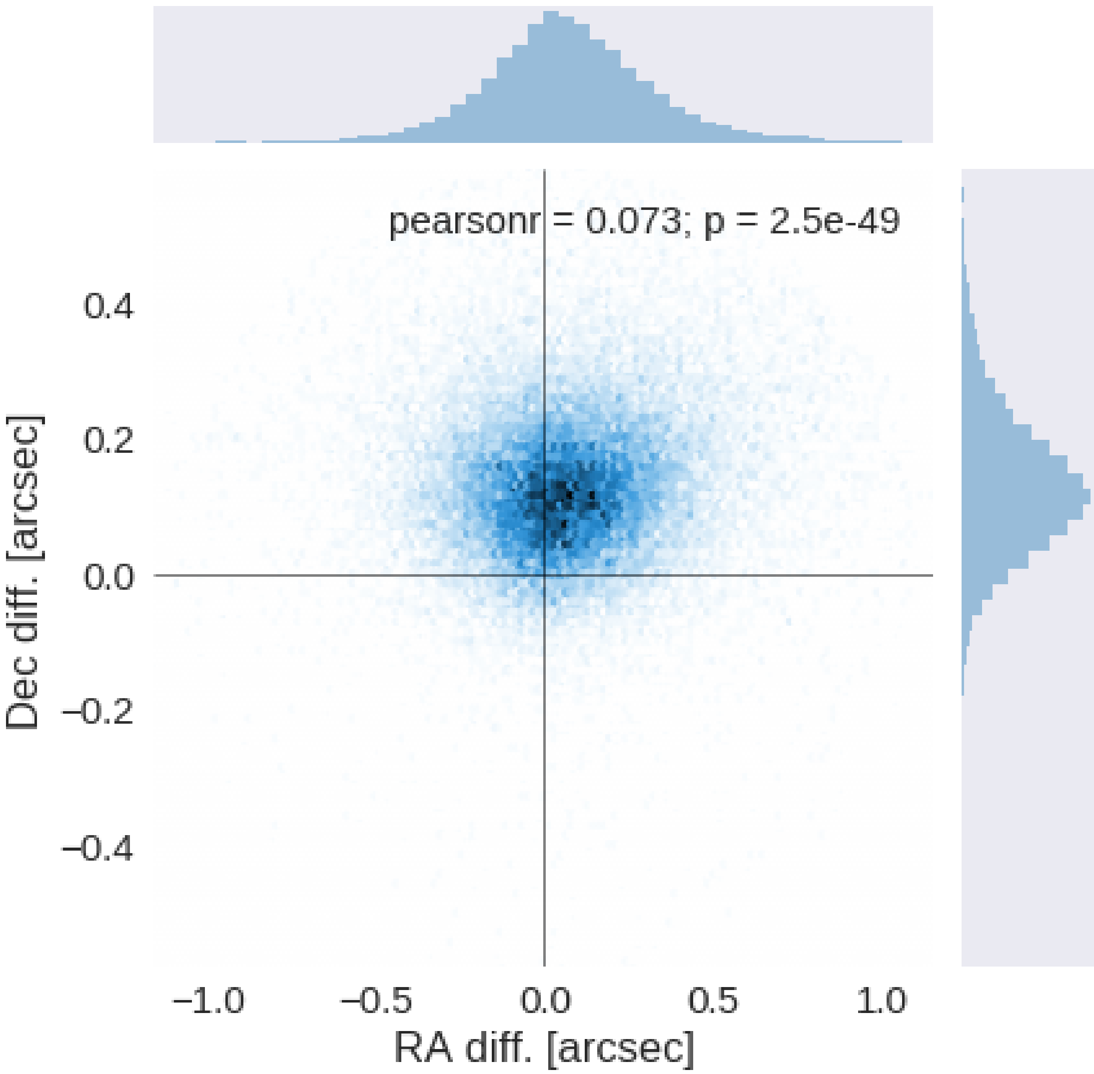
1.3 II - Removal of duplicated sources

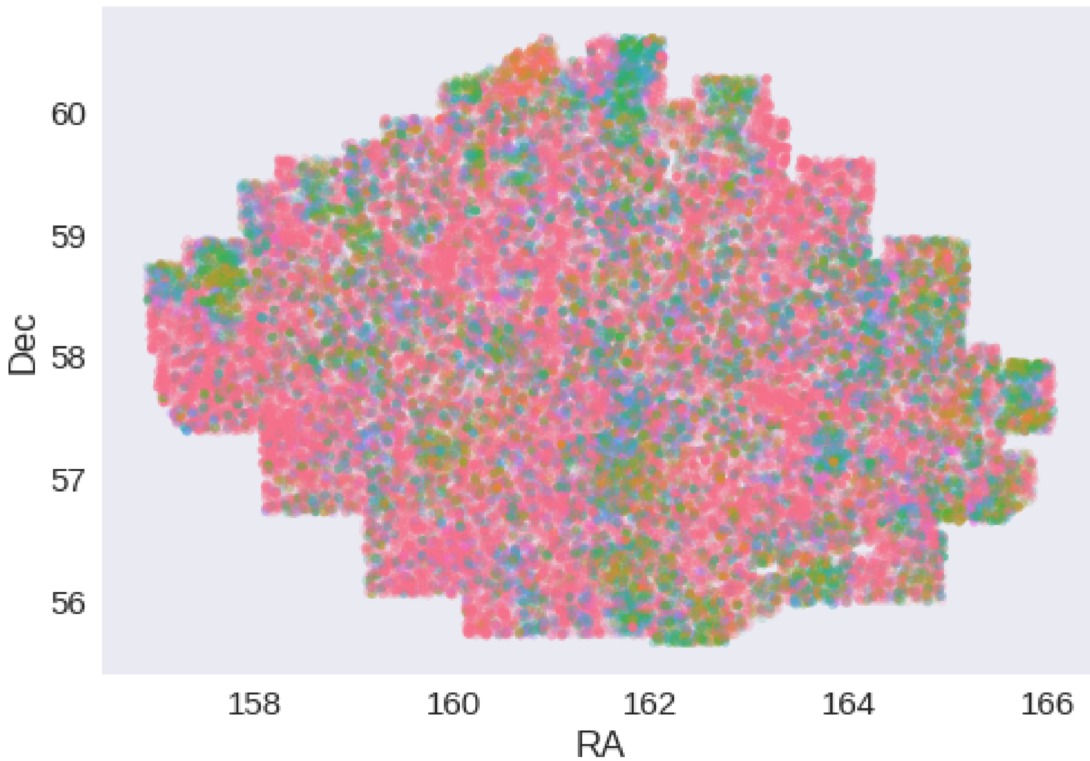
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 949159 sources.
The cleaned catalogue has 948771 sources (388 removed).
The cleaned catalogue has 388 sources flagged as having been cleaned
```

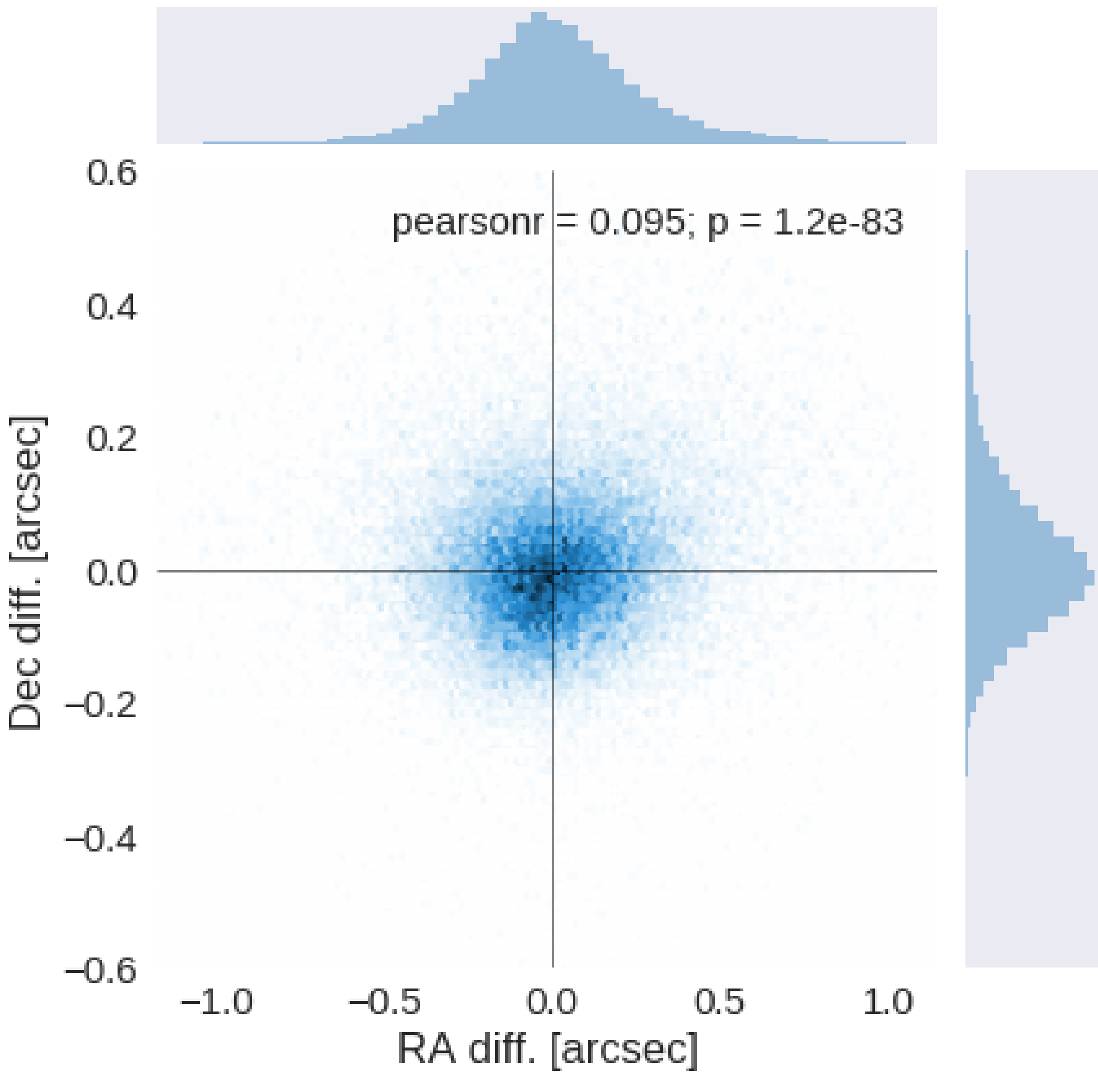
1.4 III - Astrometry correction

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: -0.06007787097246364 arcsec
Dec correction: -0.12125572829972953 arcsec
```


pearsonr = 0.095; p = 1.2e-83
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]

1.5 IV - Flagging Gaia objects

```
43952 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.2_RCSLenS

March 8, 2018

1 Lockman SWIRE master catalogue

1.1 Preparation of Red Cluster Sequence Lensing Survey (RCSLenS) data

This catalogue comes from `dmu0_RCSLenS`.

In the catalogue, we keep:

- The `id` as unique object identifier;
- The position;
- The g, r, i, z, y auto magnitudes.

1.1.1 Strange magnitudes

The missing values seems to be encoded as -99. but there are also quite some 99. magnitudes.

The "sensible" range of magnitudes seems to go from 14 to 37 (depending on the bands and given that 37 is really faint and may not be reliable). In addition to that there are some very low magnitudes under -40. and very high ones above 90. We don't know the meaning of these extreme values so we are removing all the negative magnitudes and and those above 80.

We are also removing the sources for which we have no magnitude information given the modifications above.

```
This notebook was run with herschelhelp_internal version:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)
```

1.2 I - Column selection

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

1.2.1 1.1 Remove all nan rows

```
481360 out of  2607590  objects removed due to all nan magnitudes.
```

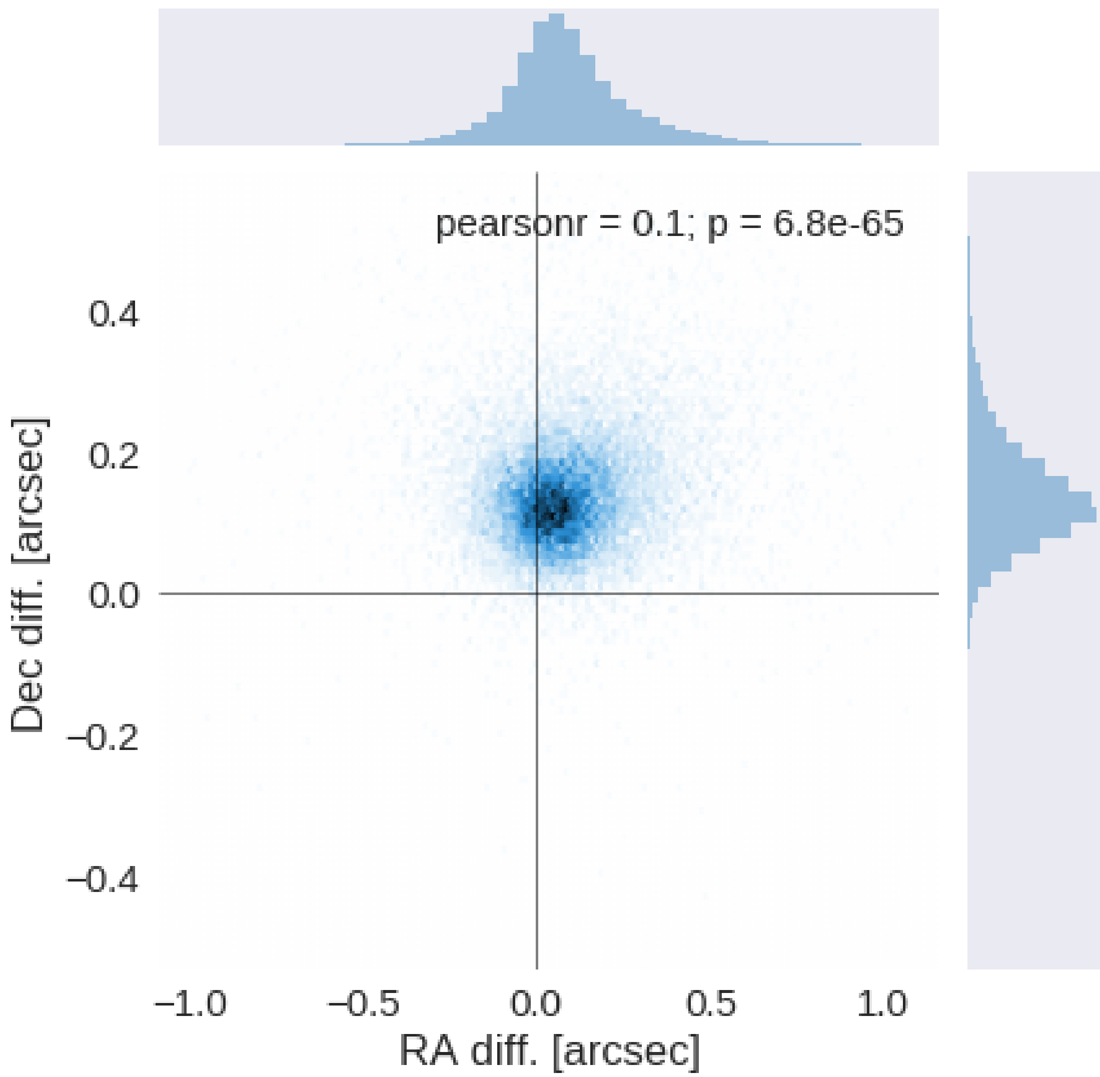
1.3 II - Removal of duplicated sources

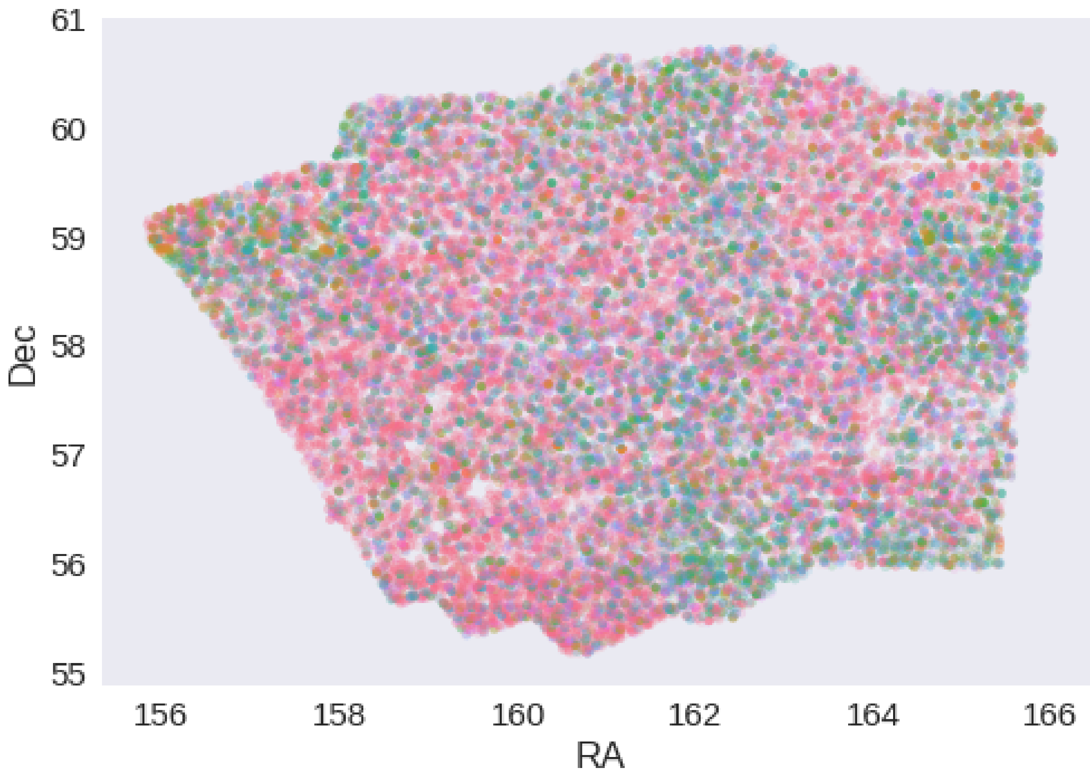
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 2126230 sources.
The cleaned catalogue has 2052639 sources (73591 removed).
The cleaned catalogue has 72807 sources flagged as having been cleaned
```

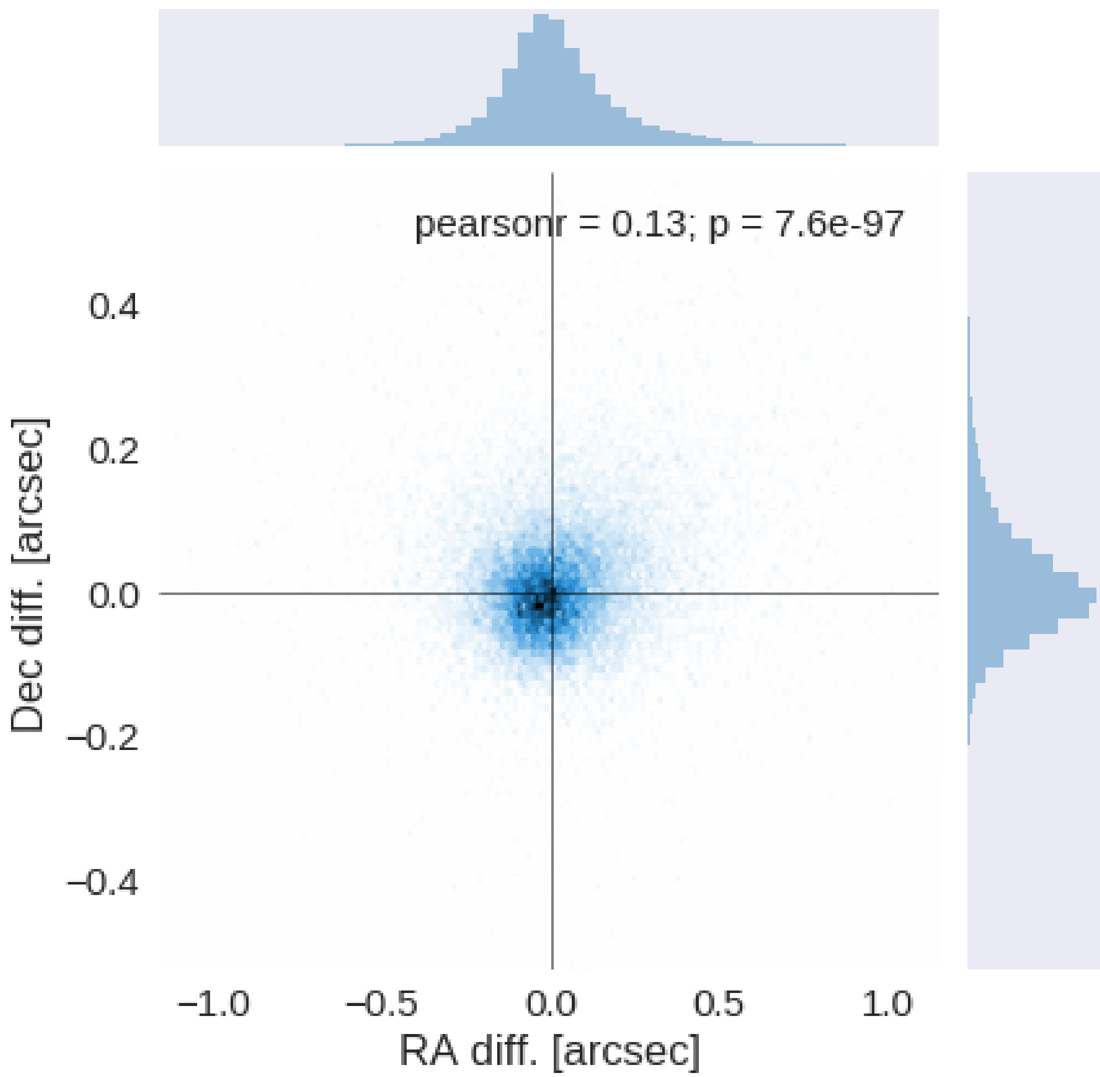
1.4 III - Astrometry correction

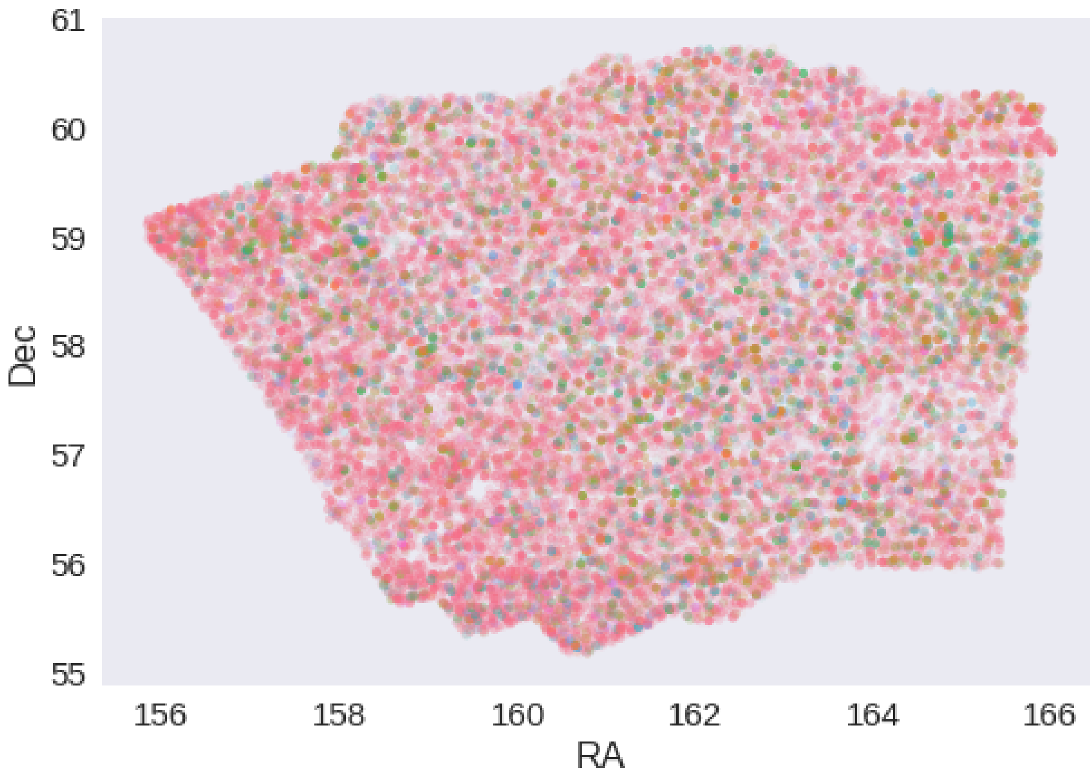
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.07070391181969171 arcsec
Dec correction: -0.1302633008947396 arcsec
```


pearsonr = 0.13; p = 7.6e-97
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
27935 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.3_PanSTARRS-3SS

March 8, 2018

1 Lockman SWIRE 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 `uniquePspsSTid` 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 where done between 2010 and 2015 (ref).

TODO: Check if the detection flag can be used to know in which bands an object was detected to construct the coverage maps.

TODO: Check for stellarity.

```
This notebook was run with herschelhelp_internal version:
44f1ae0 (Thu Nov 30 18:27:54 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

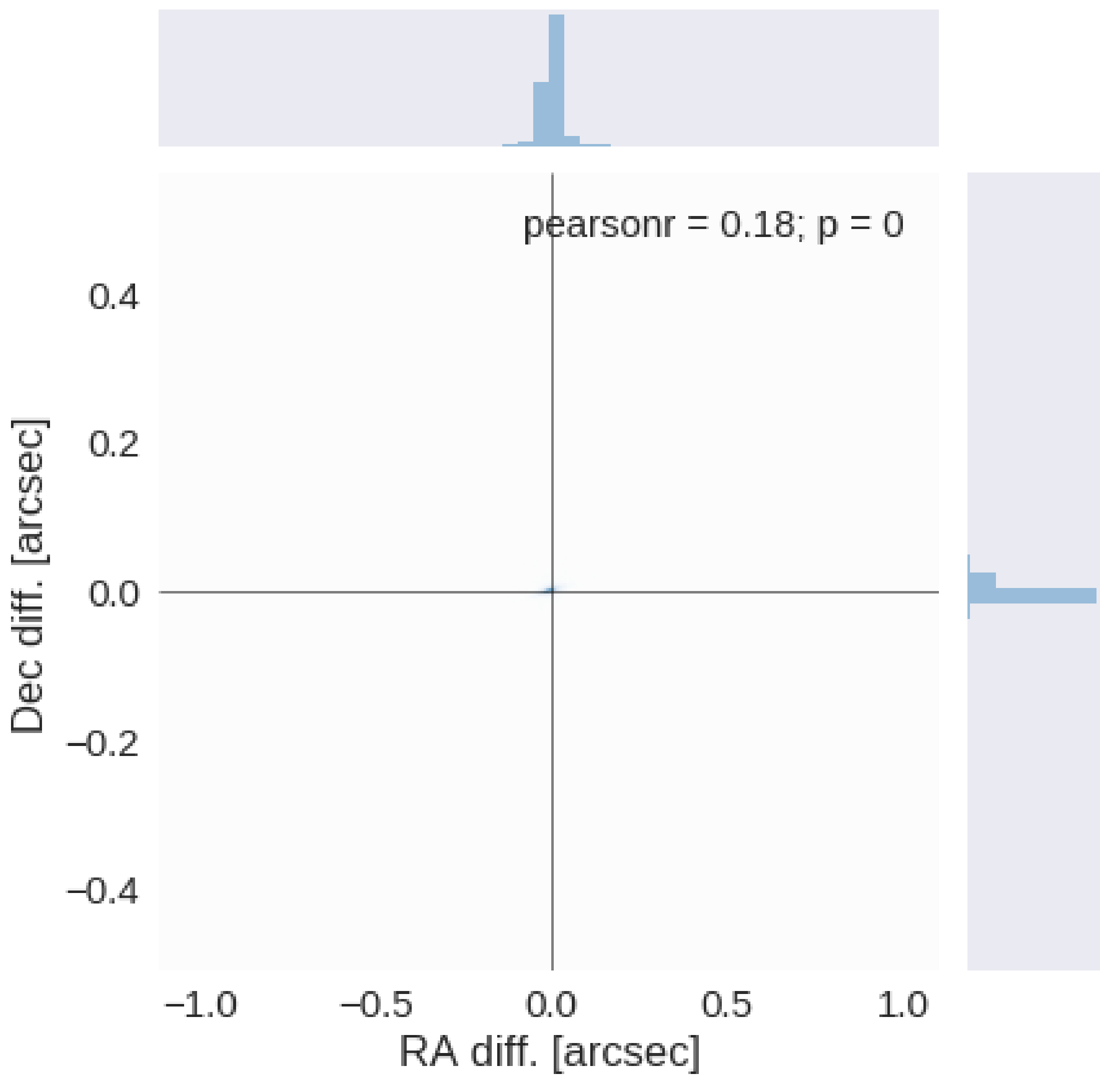
We remove duplicated objects from the input catalogues.

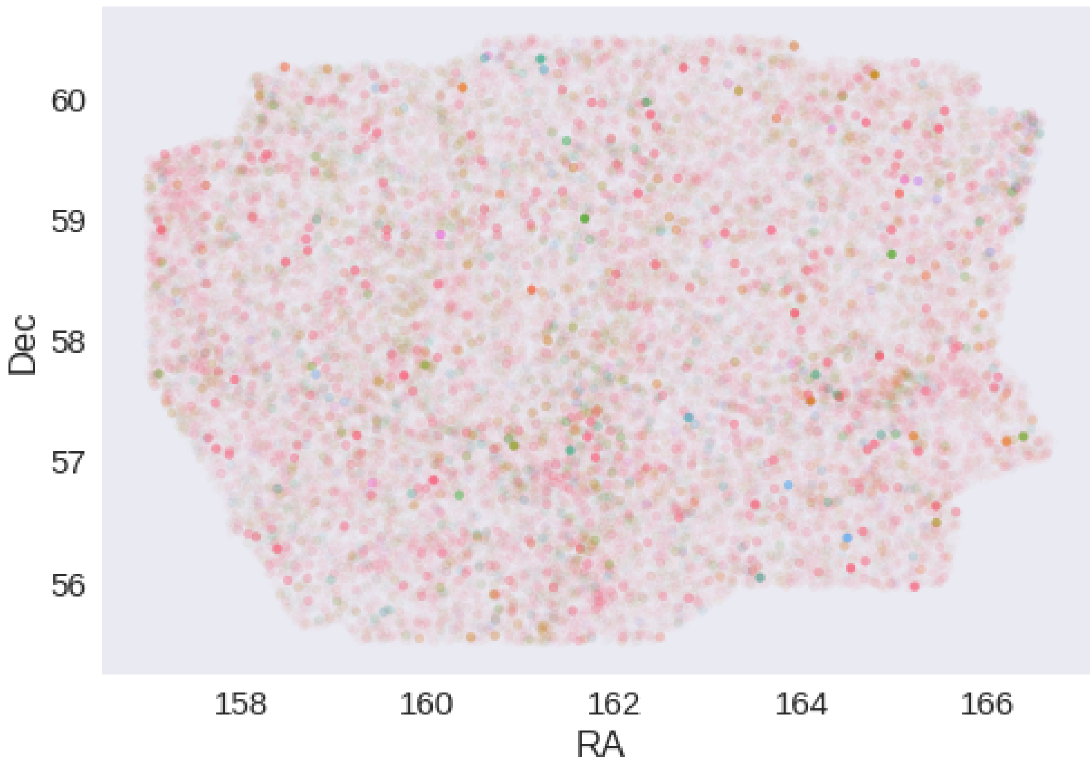
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 435078 sources.
The cleaned catalogue has 434925 sources (153 removed).
The cleaned catalogue has 153 sources flagged as having been cleaned
```

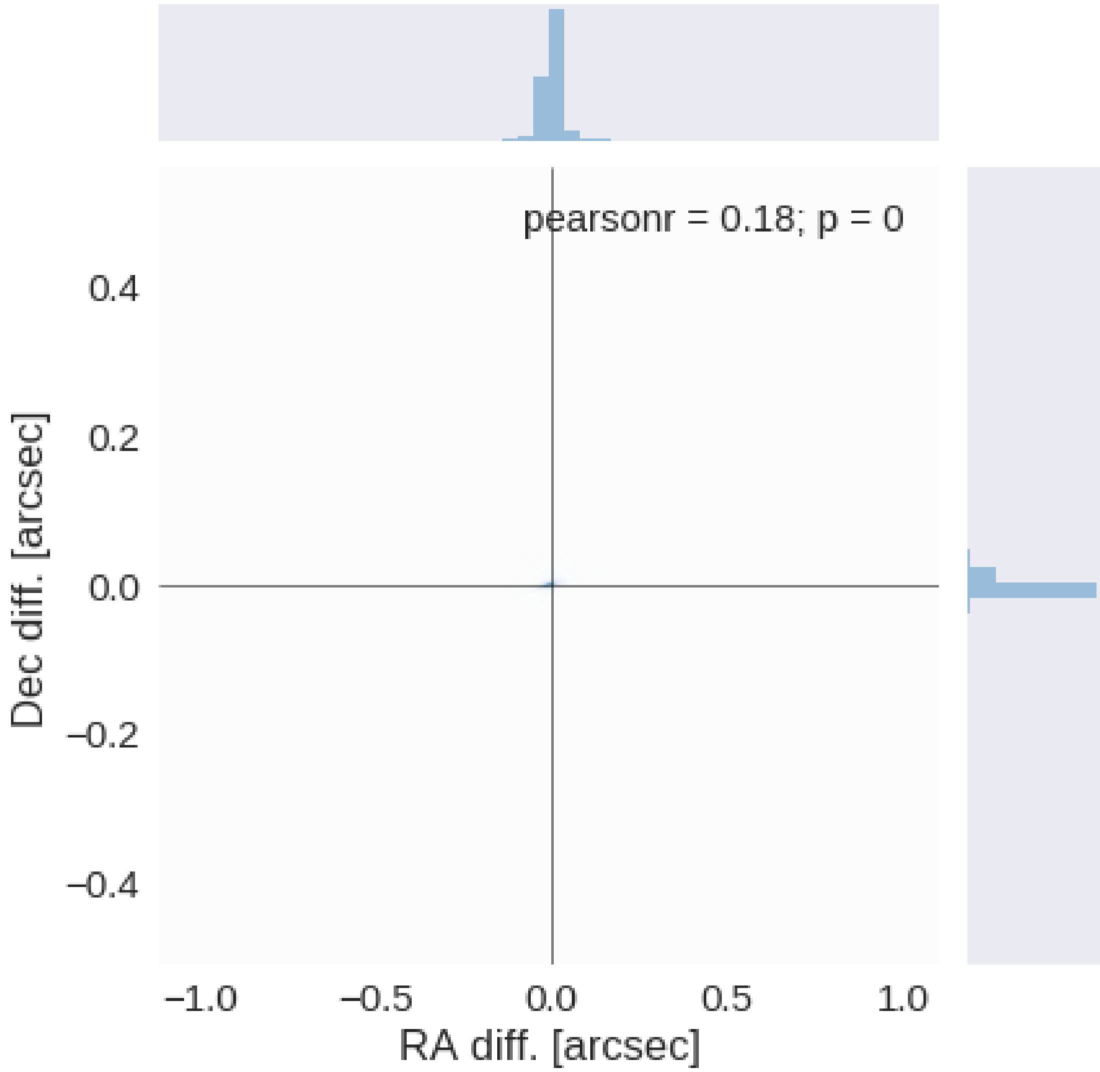
1.4 III - Astrometry correction

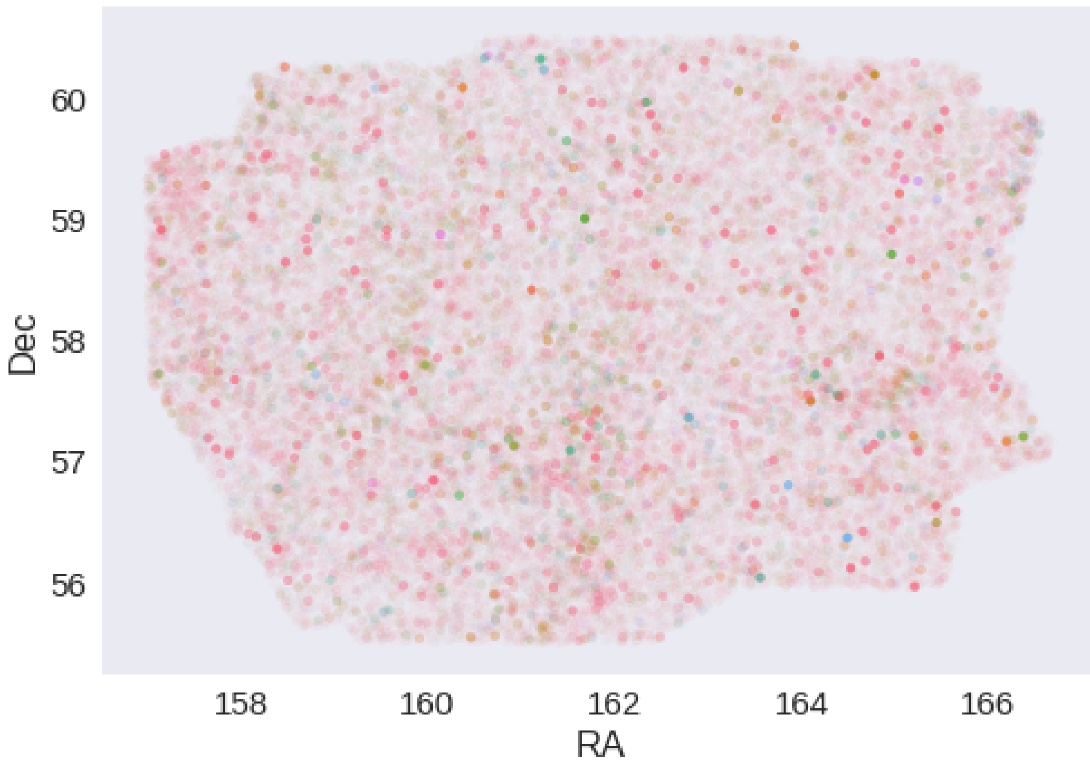
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.0006137910020242998 arcsec
Dec correction: -0.00026867304541156045 arcsec
```


pearsonr = 0.18; p = 0
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
55984 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.4_SpARCS

March 8, 2018

1 Lockman SWIRE master catalogue

1.1 Preparation of Spitzer Adaptation of the Red-sequence Cluster Survey (SpARCS) data

This catalogue comes from `dmu0_SpARCS`. Alexandru Tudorica confirmed that the magnitudes are AB ones and are not aperture corrected.

In the catalogue, we keep:

- The internal identifier (this one is only in HeDaM data);
- The position;
- The ugrz magnitudes in the 8th aperture (11Œ0.186=2.046 arcsec).
- The "auto" magnitudes.

The maps on the web page indicate they were observed in 2012 (or late 2011). Let's use 2012 as epoch.

```
This notebook was run with herschelhelp_internal version:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)
```

1.2 I - Parametres for 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.

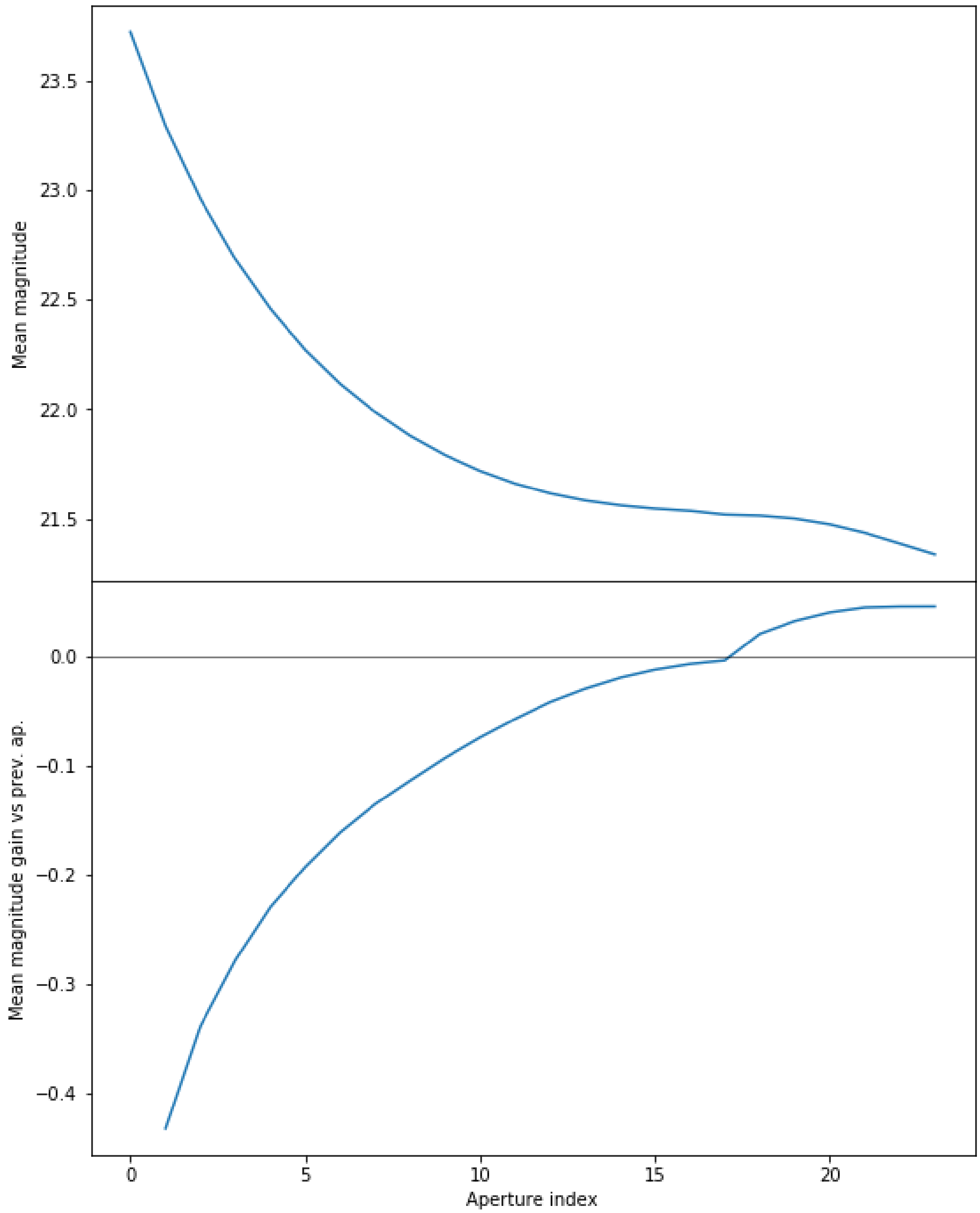
Target aperture: To determine the target aperture, we simulate a curve of growth using the provided apertures and draw two figures: - The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude. - The mean gain (loss when negative) of magnitude is 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.

```
WARNING: UnitsWarning: '""' did not parse as fits unit: Invalid character at col 0 [astropy.unit
```

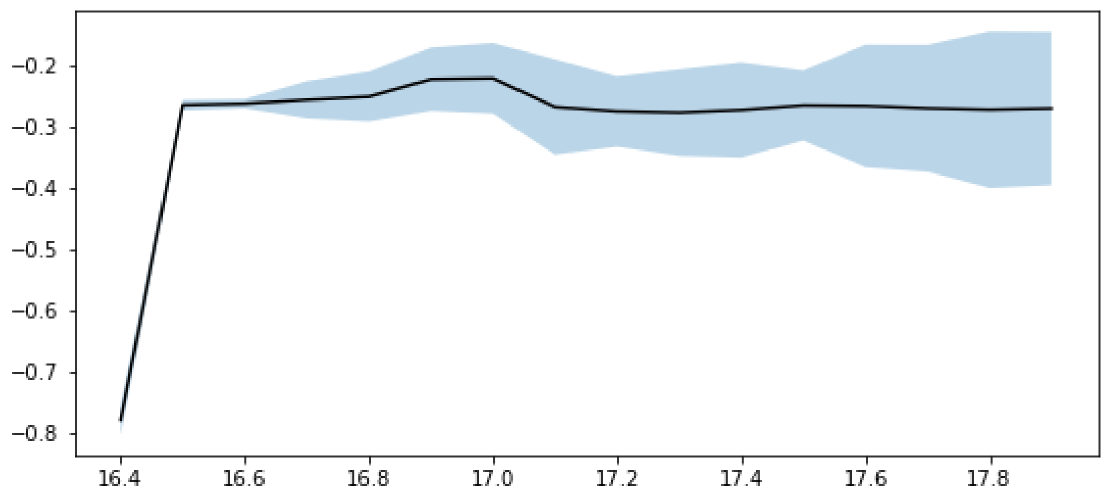
1.2.1 I.a r-band



We will use the 16th (aperture number above begin to 0) aperture as target.

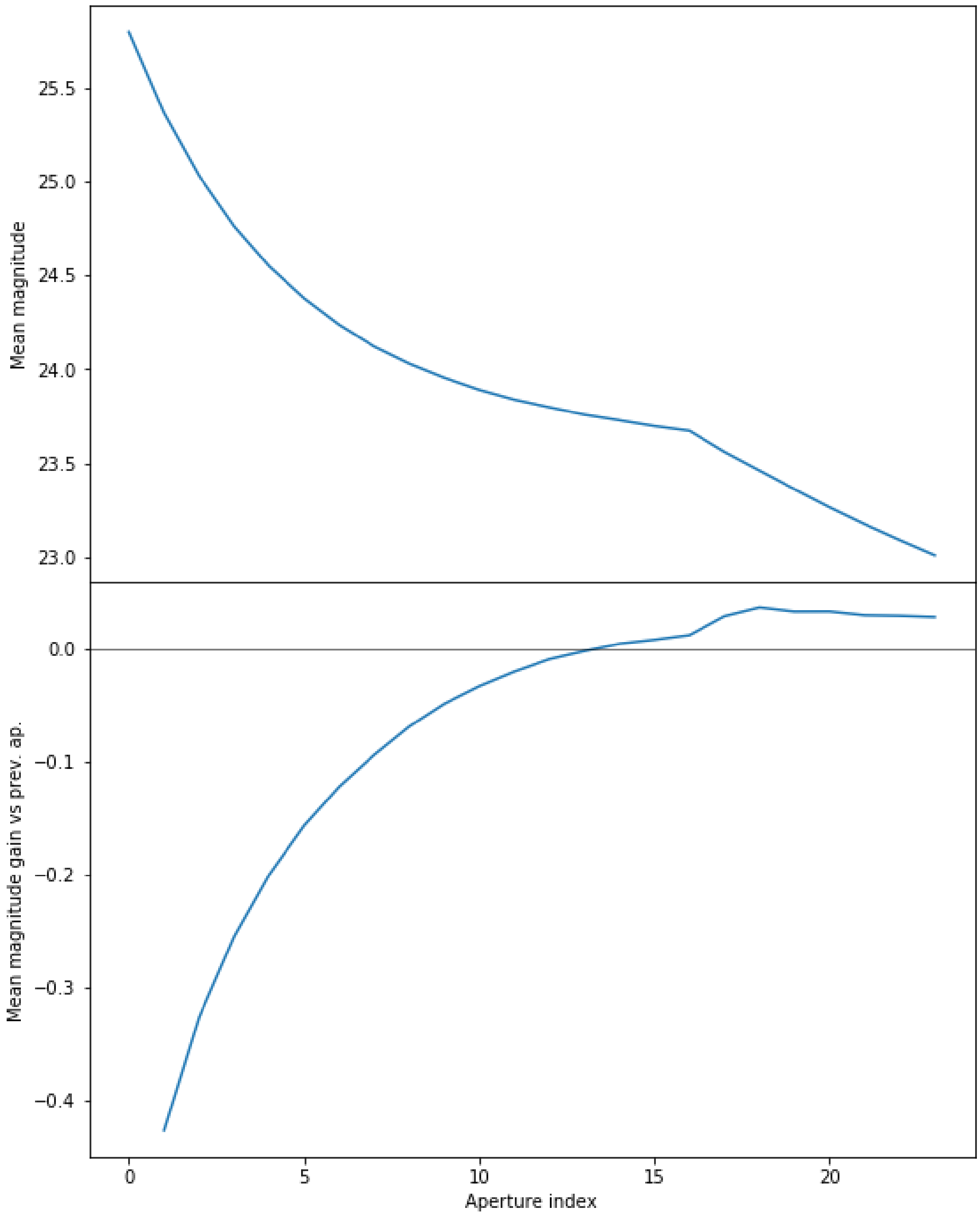
```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid value enc
```

```
mask &= (mag <= mag_max)
```



We use magnitudes between 17 and 17.9.

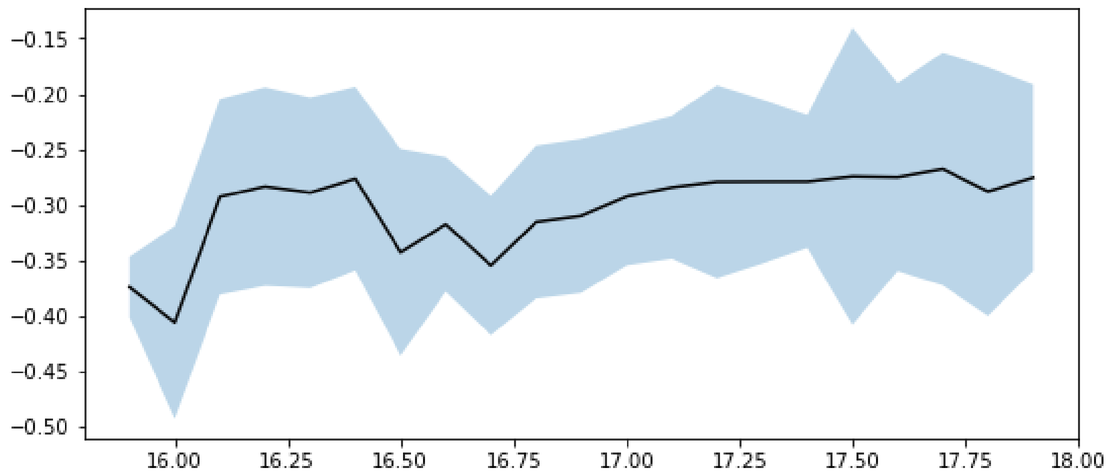
1.2.2 I.b u-band



We will use the 16th (aperture number above begin to 0) aperture as target. Should we use the 12nd because of the increasing magnitude?

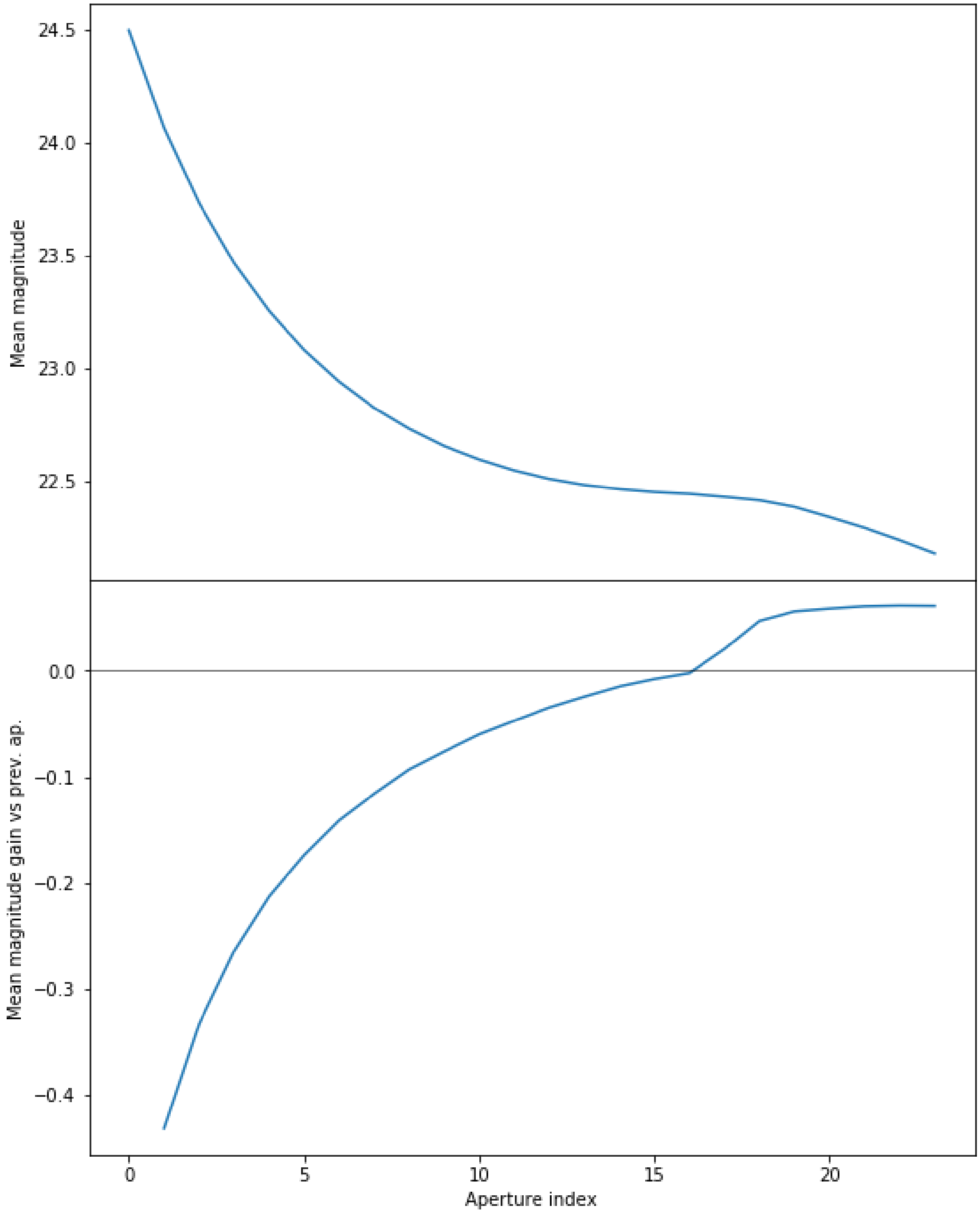
```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid value enc
  mask &= (mag <= mag_max)
```



We use magnitudes between 17 and 17.9.

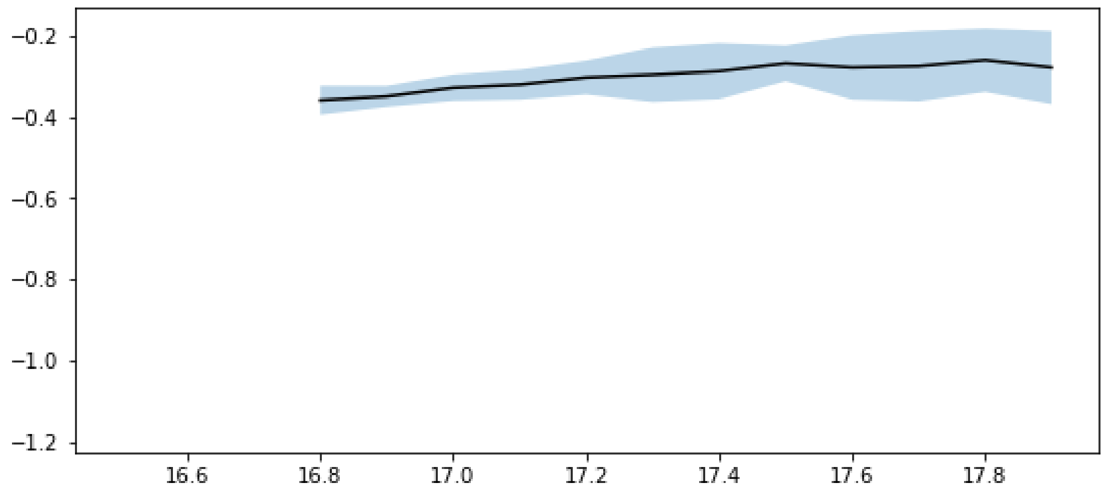
1.2.3 I.c g-band



We will use the 16th (aperture number above begin to 0) aperture as target.

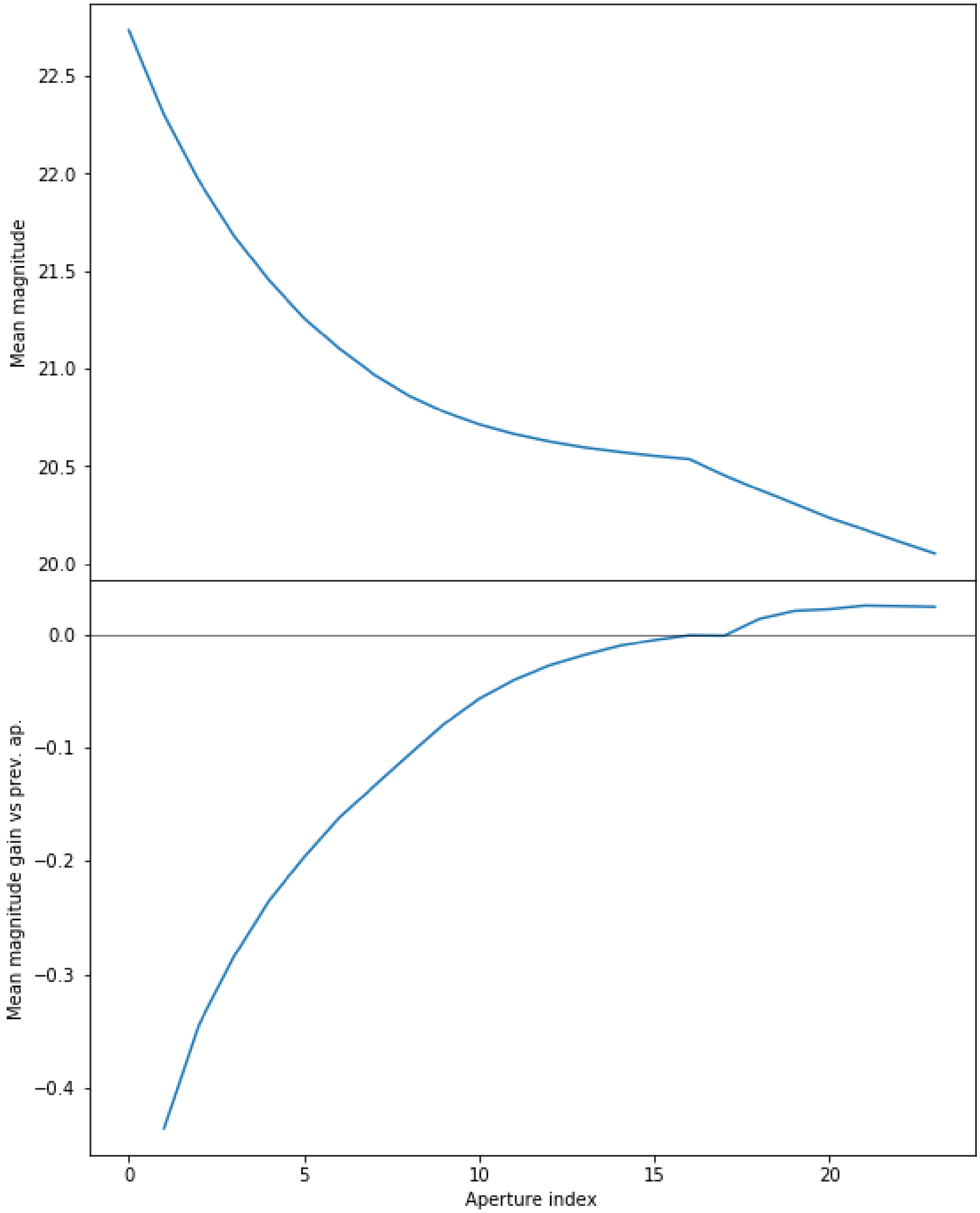
```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid value enc
```

```
mask &= (mag <= mag_max)
```



We use magnitudes between 17.2 and 18.

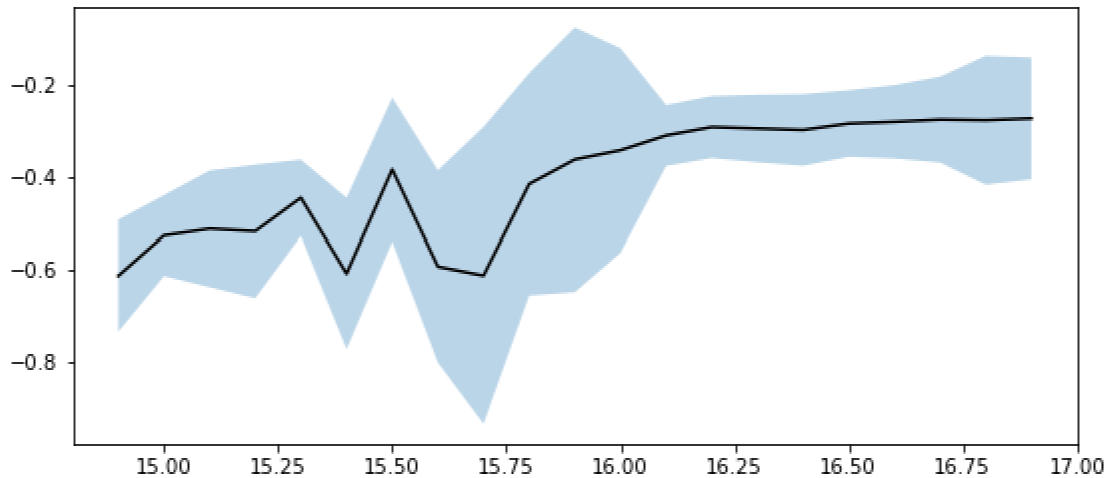
1.2.4 I.d z-band



We will use the 16th (aperture number above begin to 0) aperture as target.

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid value enc
```

```
  mask &= (mag <= mag_max)
```



We use magnitudes between 16 and 17.

1.3 II - Column selection

```
WARNING: UnitsWarning: '""' did not parse as fits unit: Invalid character at col 0 [astropy.unit
/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/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid value enc
  mask &= (mag <= mag_max)


Aperture correction for SpARCS band u:
Correction: -0.27798938751220703
Number of source used: 1660
RMS: 0.08023226255400404

Aperture correction for SpARCS band g:
Correction: -0.2888603210449219
Number of source used: 1841
RMS: 0.06882894024296196

Aperture correction for SpARCS band r:
Correction: -0.2717933654785156
Number of source used: 2856
RMS: 0.0943208091734509
```

```
Aperture correction for SpARCS band z:
Correction: -0.2810707092285156
Number of source used: 2507
RMS: 0.0844786978275072
```

```
Out[15]: <IPython.core.display.HTML object>
```

1.4 II - Removal of duplicated sources

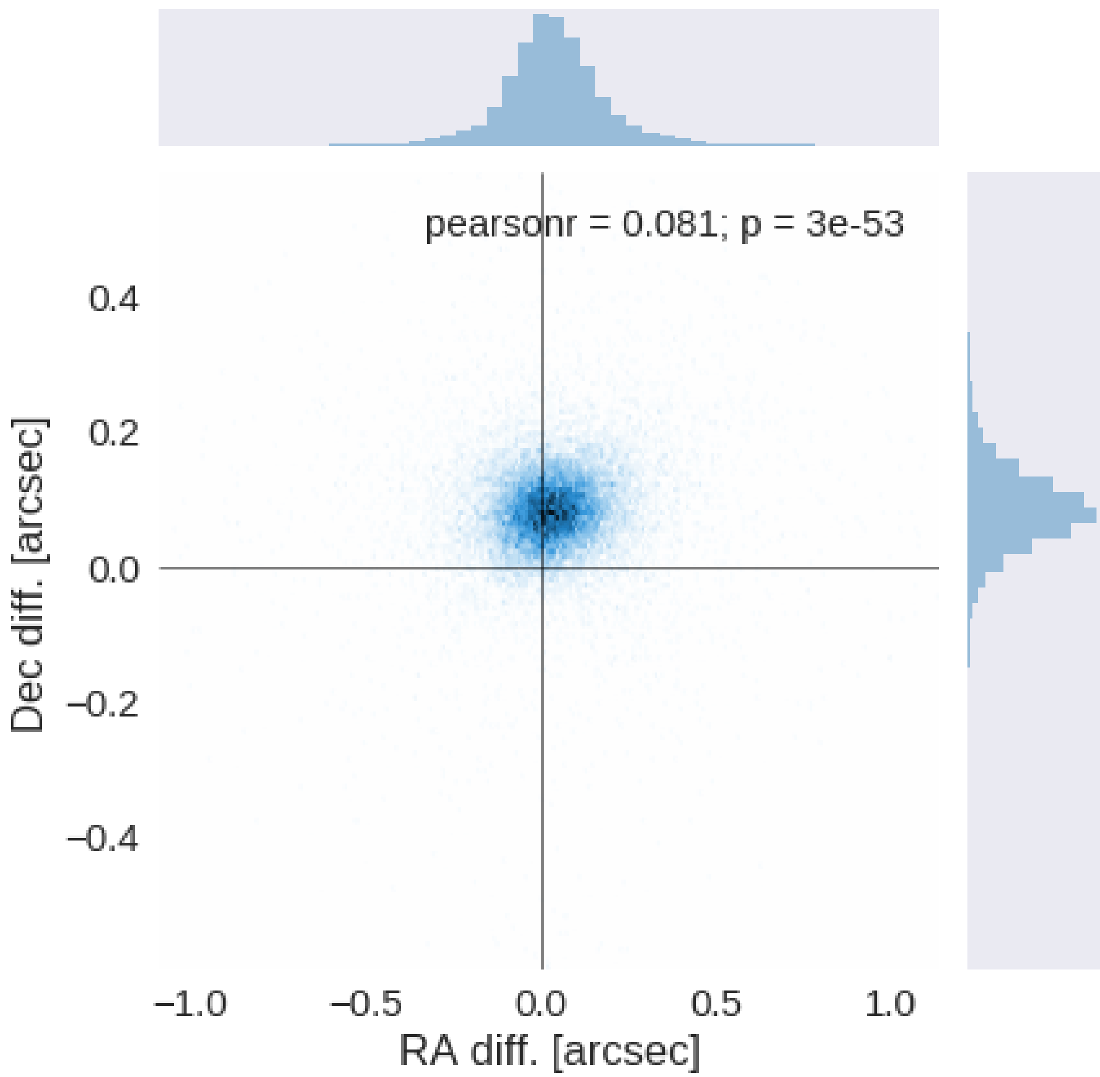
We remove duplicated objects from the input catalogues.

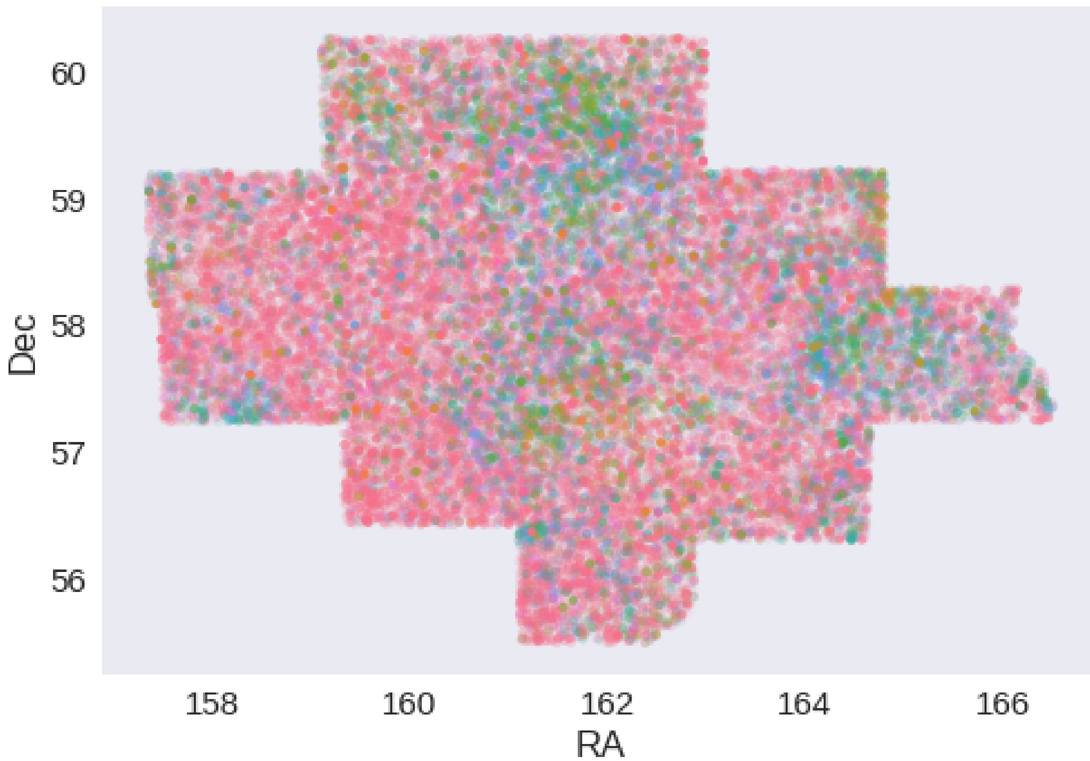
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 2518326 sources.
The cleaned catalogue has 2518326 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned
```

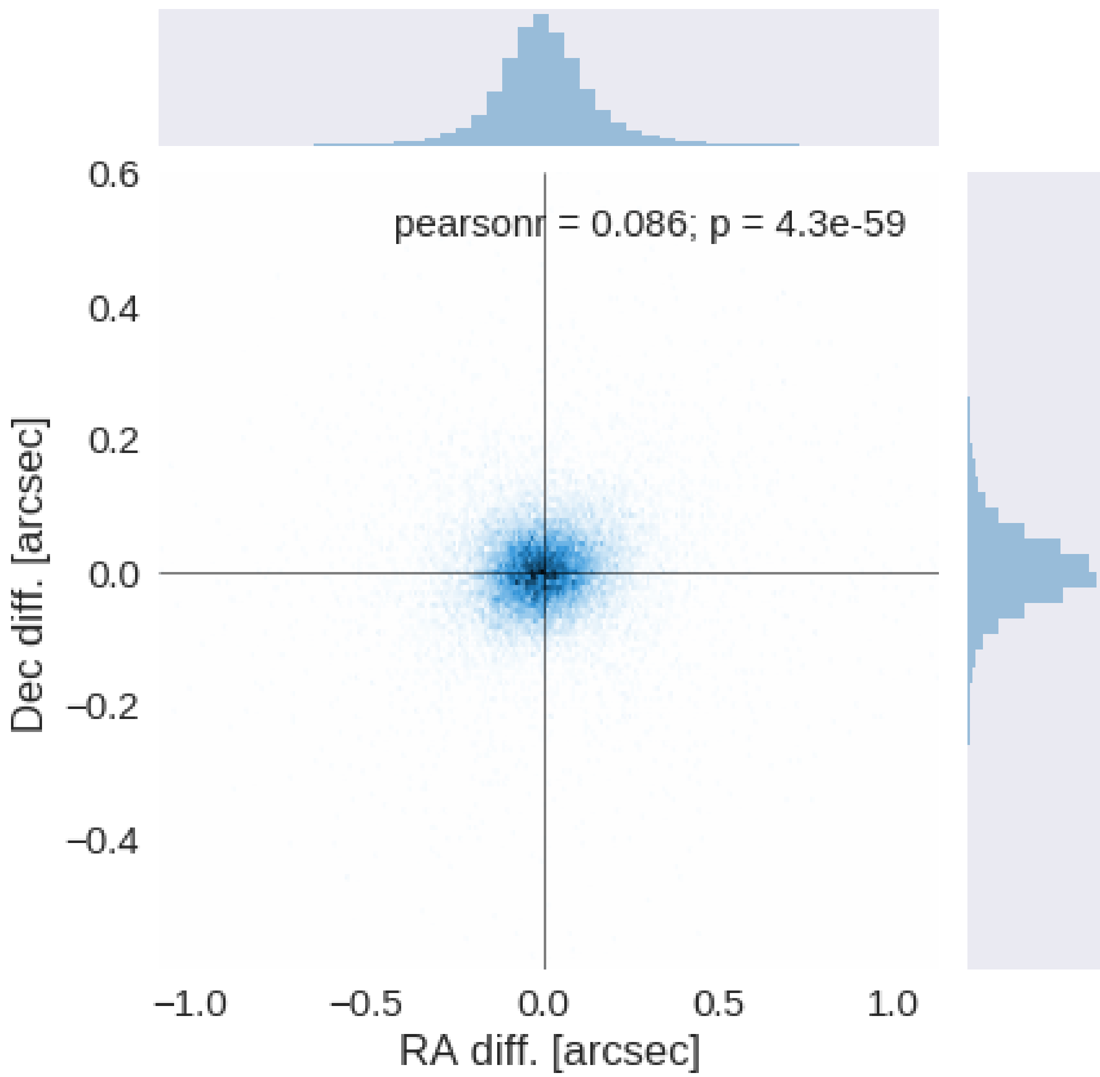
1.5 III - Astrometry correction

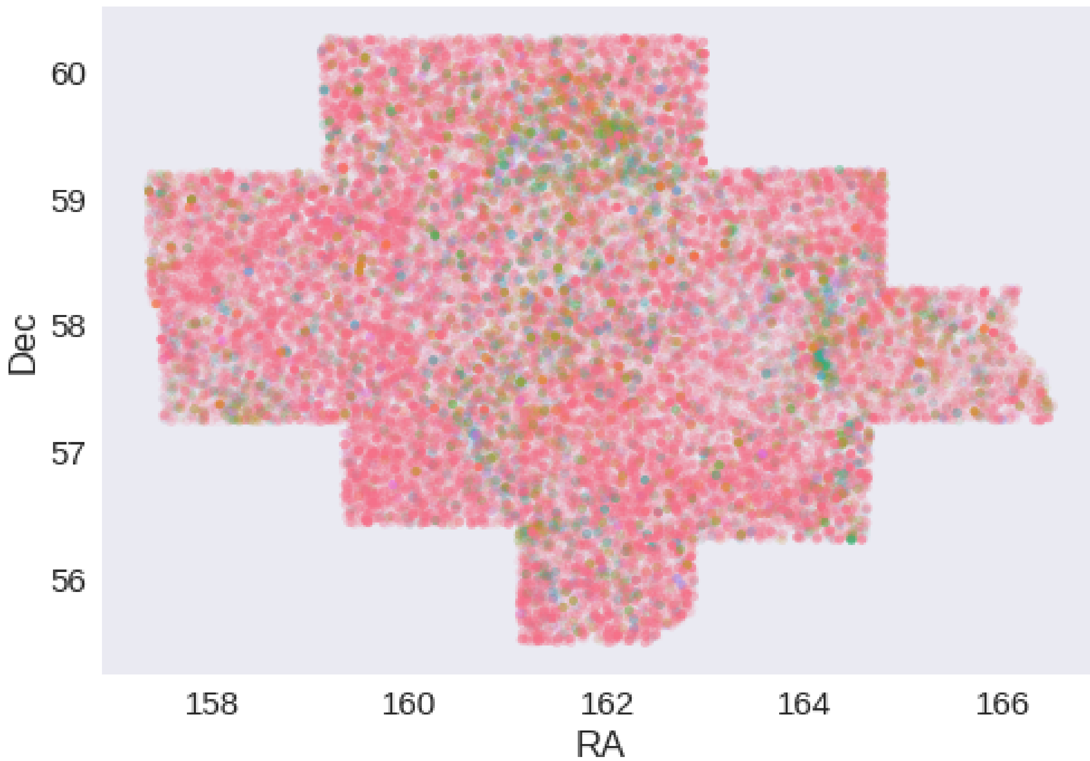
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = 0.081; p = 3e-53
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]




```
RA correction: -0.03440895461039872 arcsec
Dec correction: -0.0818096918720812 arcsec
```


pearsonr = 0.086; p = 4.3e-59
0.6
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.6 IV - Flagging Gaia objects

```
37513 sources flagged.
```

1.7 V - Flagging objects near bright stars

1.8 VI - Saving to disk

1.5_UKIDSS-DXS

March 8, 2018

1 Lockman SWIRE master catalogue

1.1 Preparation of UKIRT Infrared Deep Sky Survey / Deep Extragalactic Survey (UKIDSS/DXS)

The catalogue comes from `dmu0_UKIDSS-DXS_DR10plus`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band in apertude 3 (2 arcsec).
- The kron magnitude to be used as total magnitude (no "auto" magnitude is provided).

The magnitudes are "*Vega like*". The AB offsets are given by Hewett *et al.* (2016):

Band	AB offset
J	0.938
H	1.379
K	1.900

A query to the UKIDSS database with 242.9+55.071 position returns a list of images taken between 2007 and 2009. Let's take 2008 for the epoch.

```
This notebook was run with herschelhelp_internal version:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)
```

1.2 I - Column selection

```
WARNING: UnitsWarning: 'degrees' did not parse as fits unit: At col 0, Unit 'degrees' not suppor
```

```
/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>
```

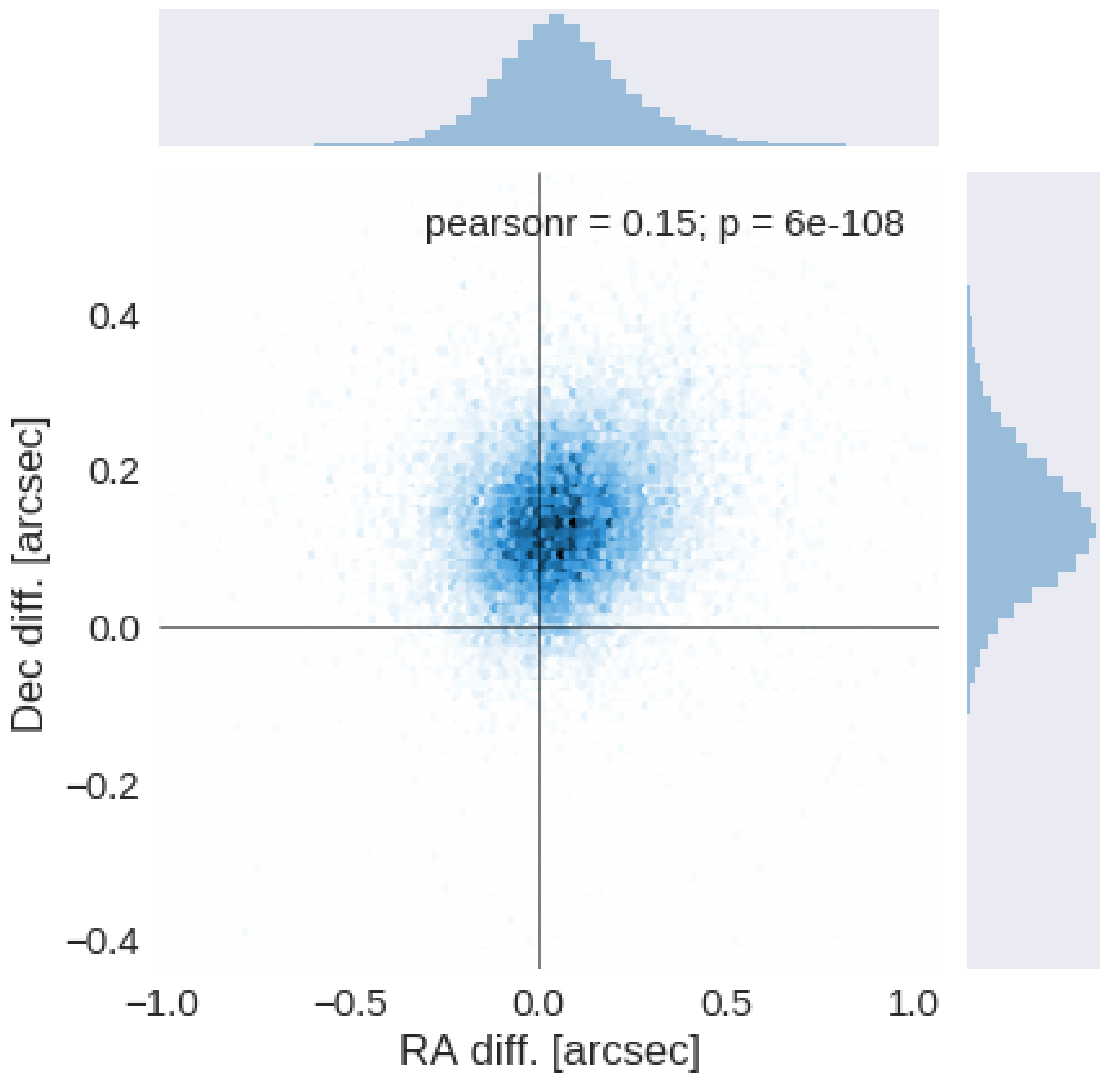
1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

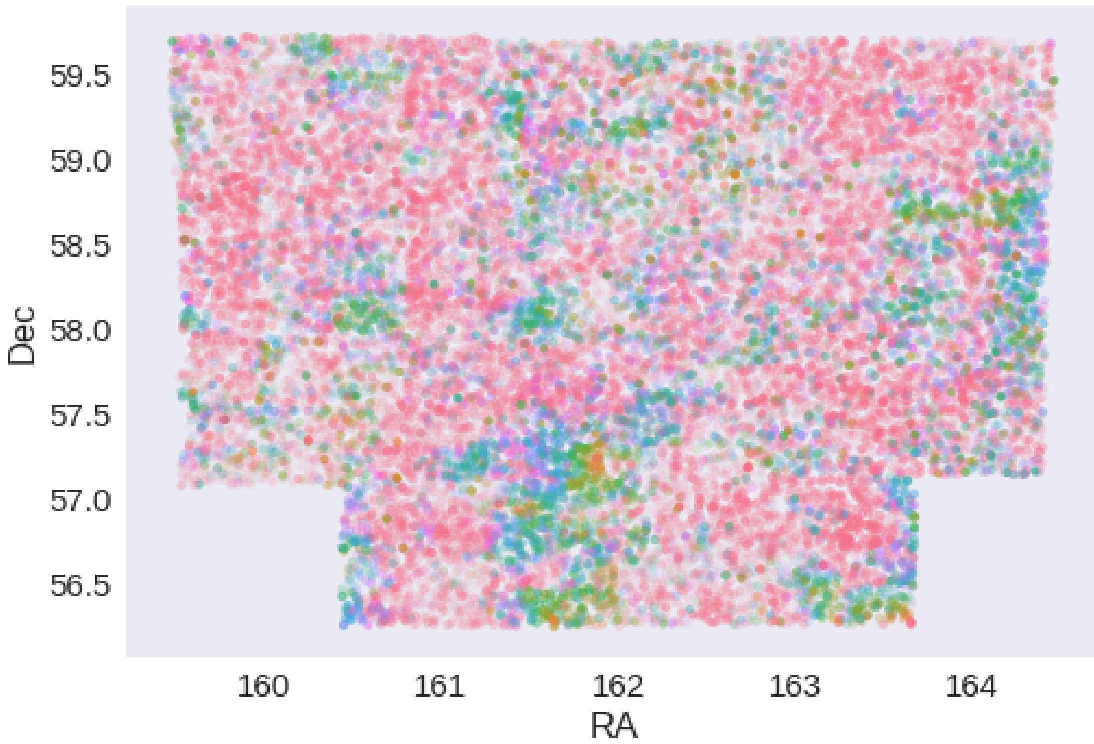
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)


The initial catalogue had 697325 sources.
The cleaned catalogue has 696542 sources (783 removed).
The cleaned catalogue has 781 sources flagged as having been cleaned
```

1.4 III - Astrometry correction

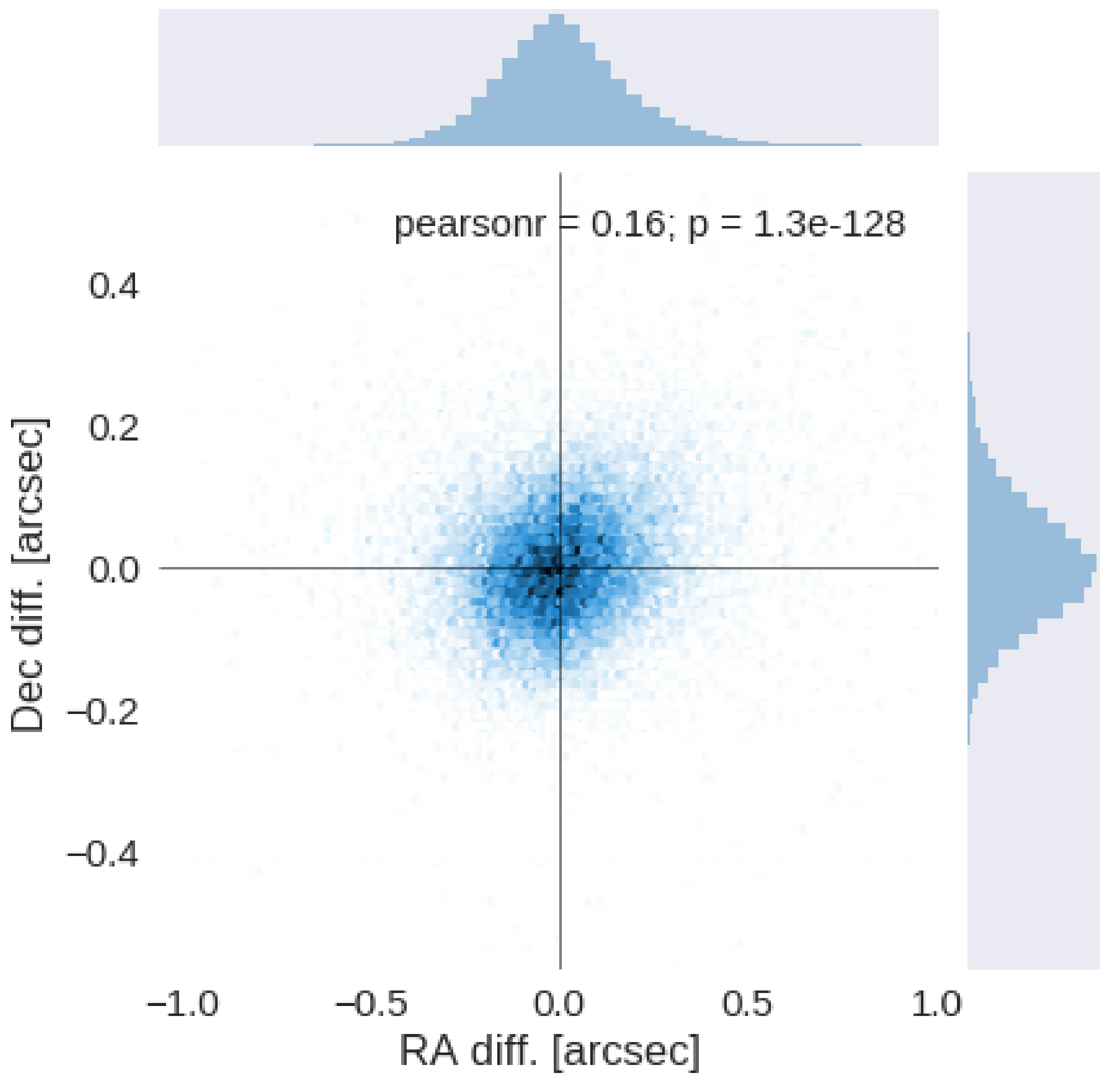
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.



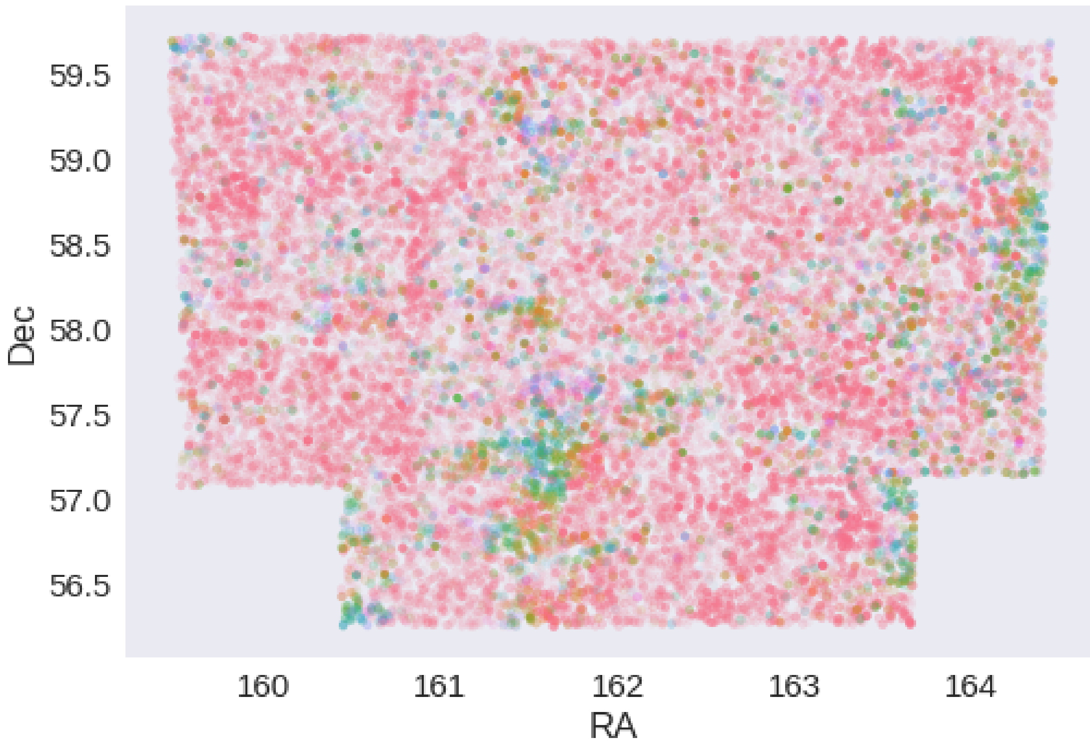
pearsonr = 0.15; p = 6e-108
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]




```
RA correction: -0.056558793744444339 arcsec
Dec correction: -0.12994021536201217 arcsec
```



pearsonr = 0.16; p = 1.3e-128
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
21766 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.6_SWIRE

March 8, 2018

1 Lockman SWIRE master catalogue

1.1 Preparation of Spitzer datafusion SWIRE 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:

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:
44f1ae0 (Thu Nov 30 18:27:54 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

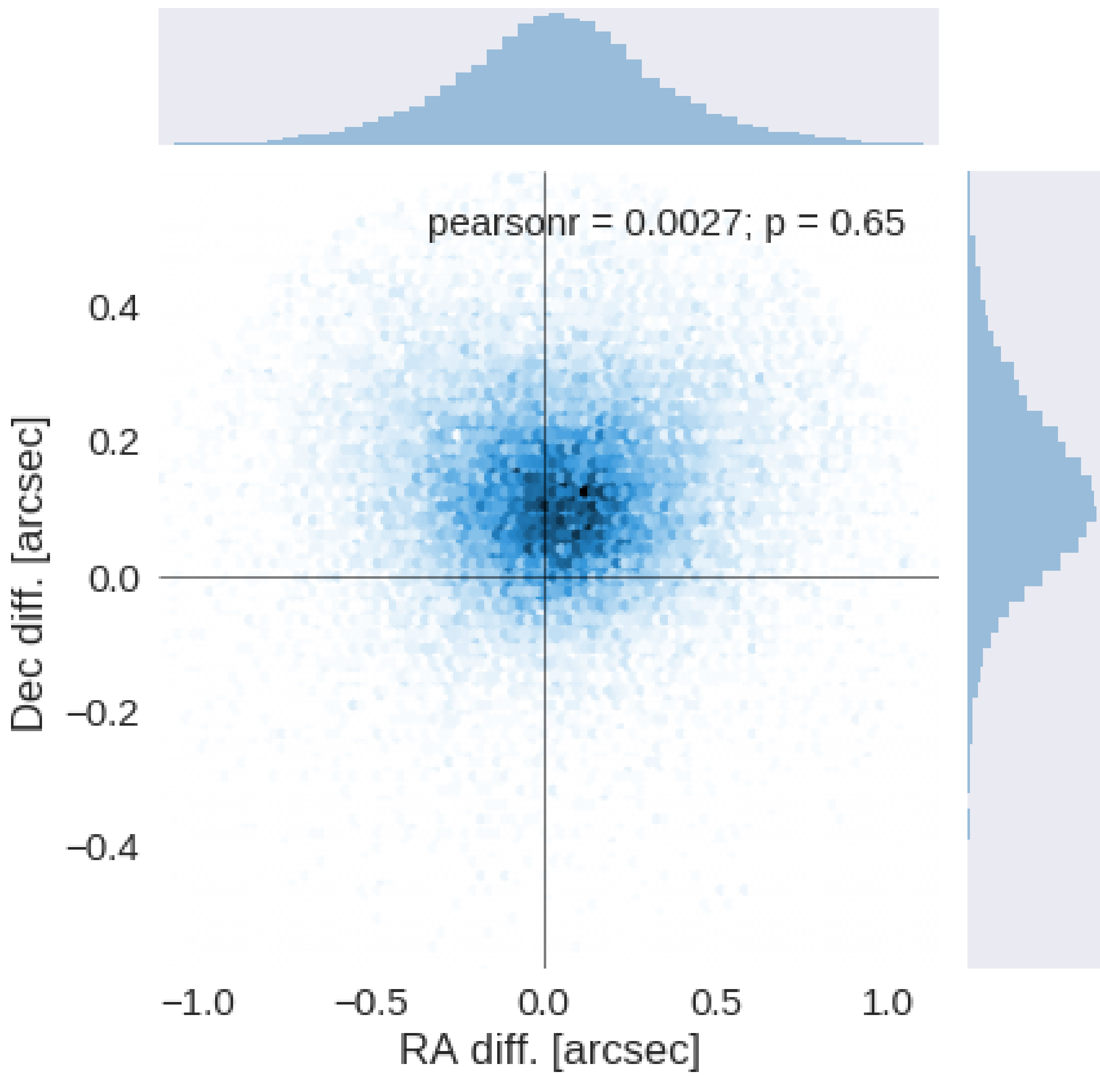
We remove duplicated objects from the input catalogues.

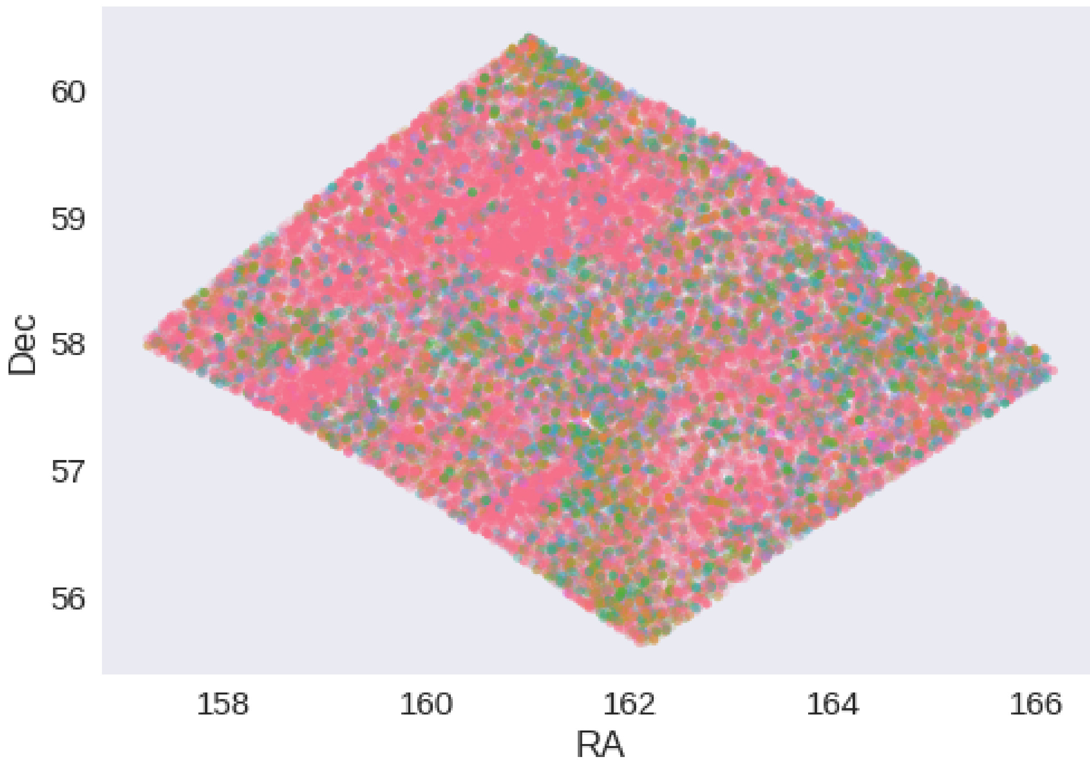
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 659974 sources.
The cleaned catalogue has 659925 sources (49 removed).
The cleaned catalogue has 49 sources flagged as having been cleaned
```

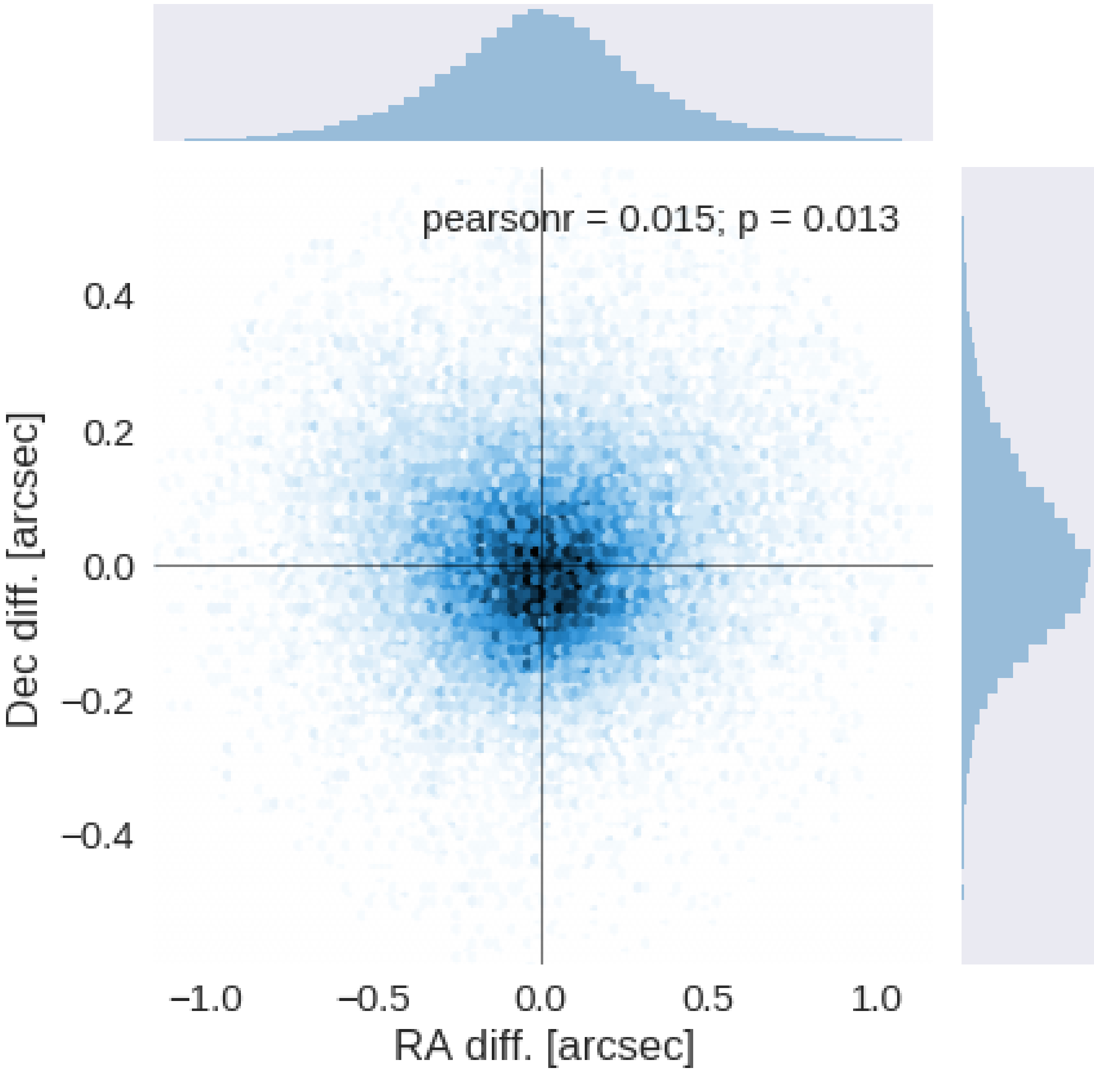
1.4 III - Astrometry correction

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.

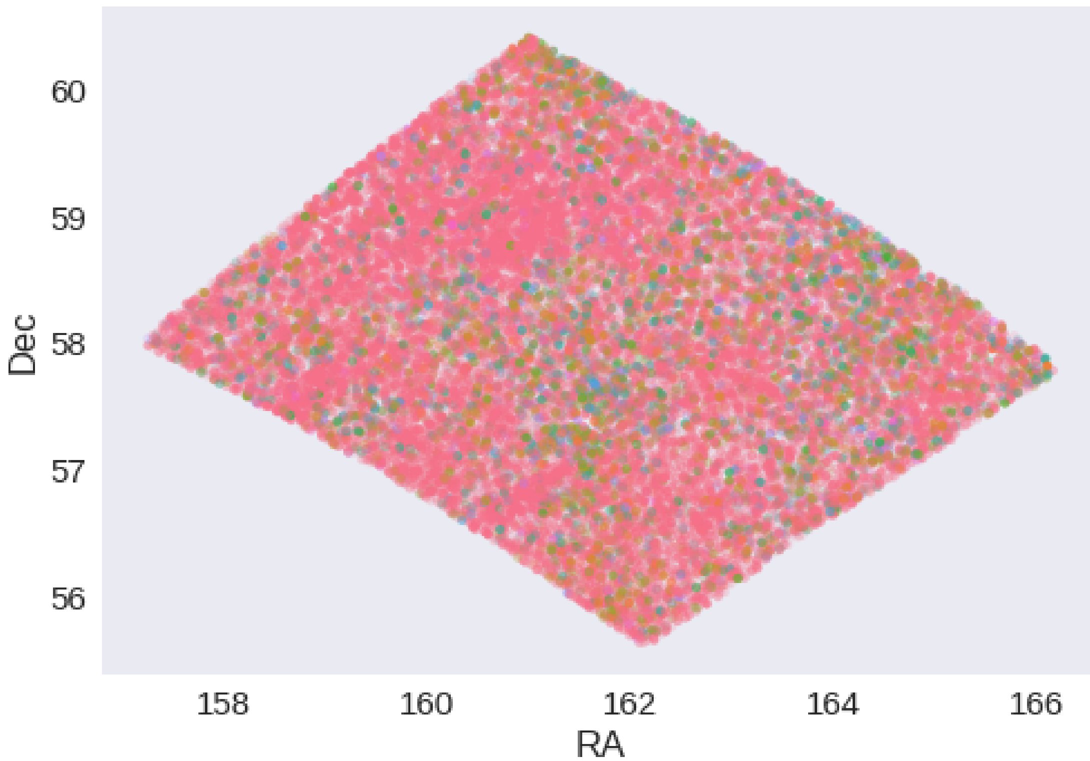





```
RA correction: -0.04179821406751216 arcsec
Dec correction: -0.11961620856055788 arcsec
```



pearsonr = 0.015; p = 0.013
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
29668 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.7_SERVS

March 8, 2018

1 Lockman SWIRE master catalogue

1.1 Preparation of Spitzer datafusion SERVS 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:
44f1ae0 (Thu Nov 30 18:27:54 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>
```

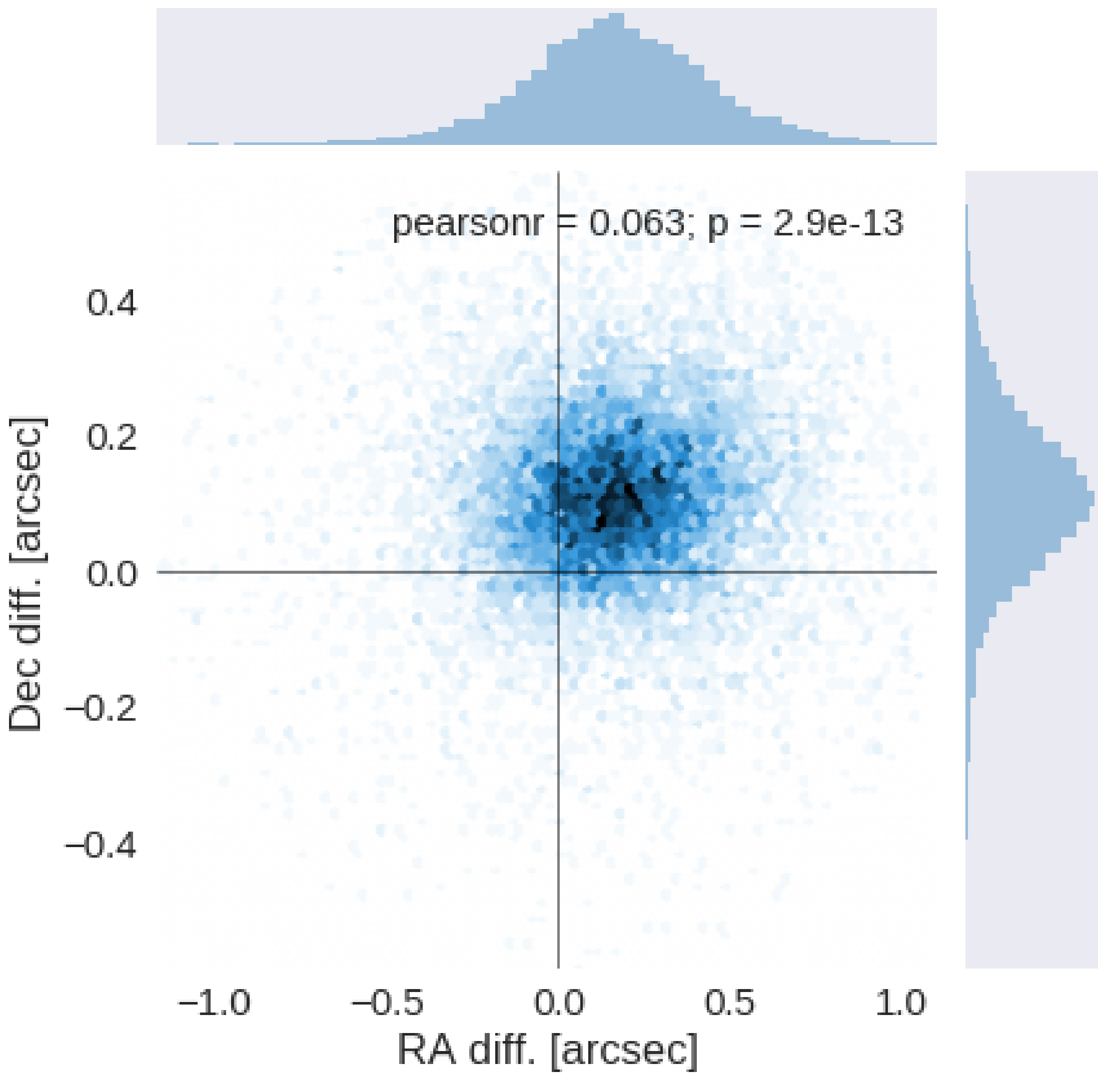
1.3 II - Removal of duplicated sources

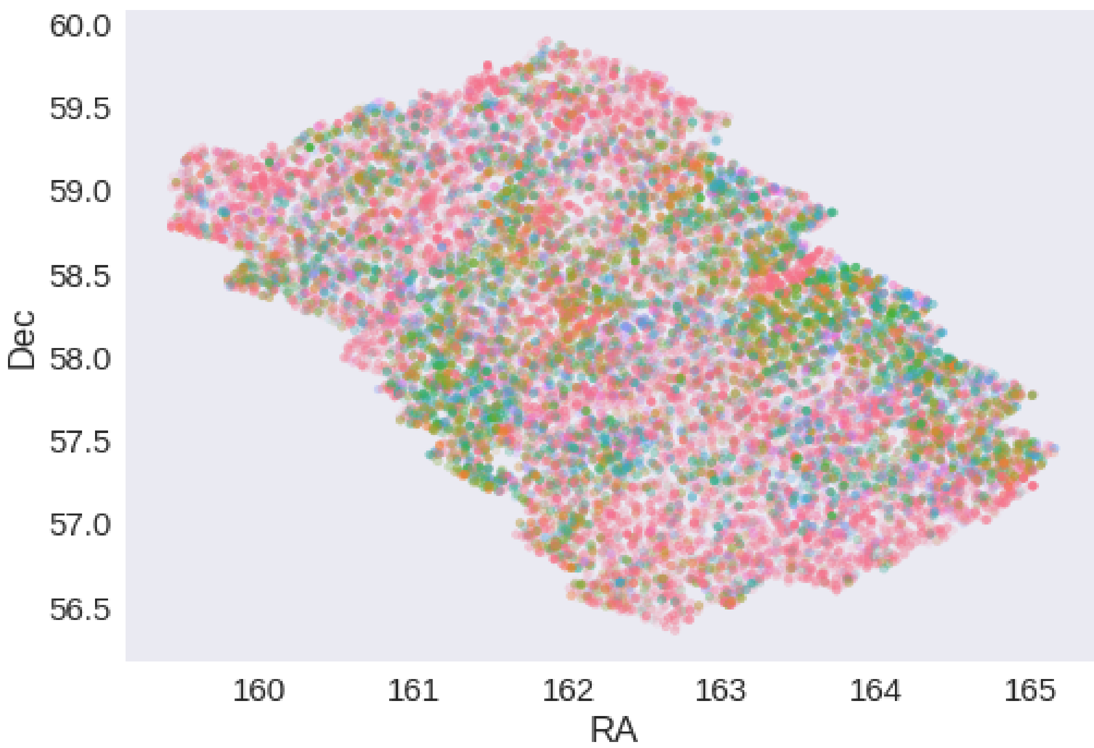
We remove duplicated objects from the input catalogues.

```
/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 951102 sources.
The cleaned catalogue has 951102 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned
```

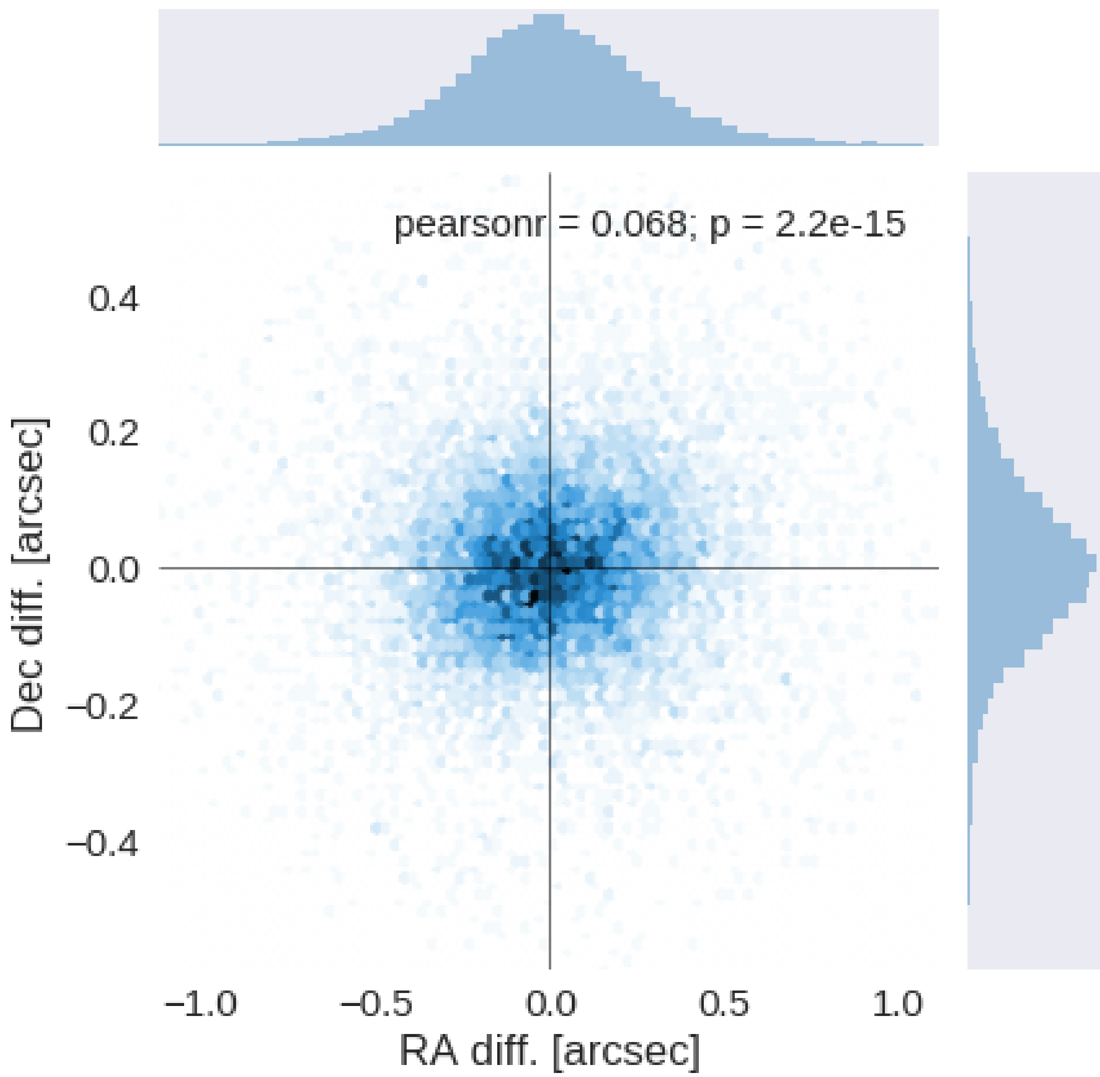
1.4 III - Astrometry correction

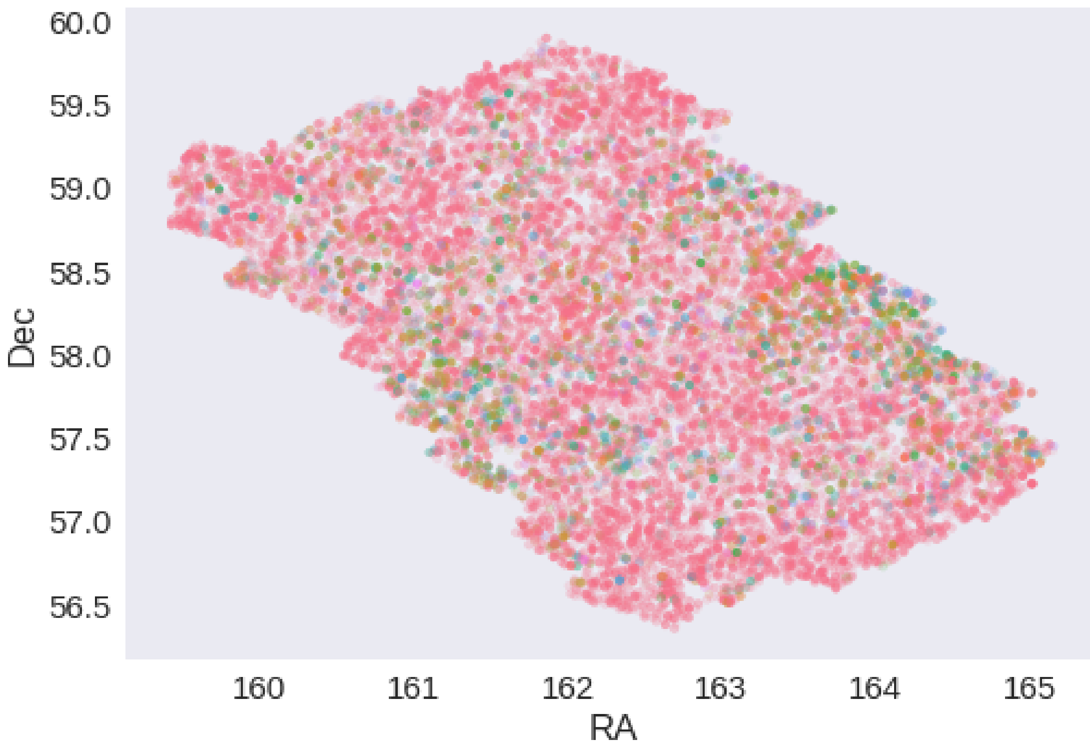
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.16942944777724733 arcsec
Dec correction: -0.10899877246544065 arcsec
```


pearsonr = 0.068; p = 2.2e-15
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
14350 sources flagged.
```

1.6 V - Flagging objects near bright stars

1.7 VI - Saving to disk

1.8_UHS

March 8, 2018

1 Lockman-SWIRE 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:
44f1ae0 (Thu Nov 30 18:27:54 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

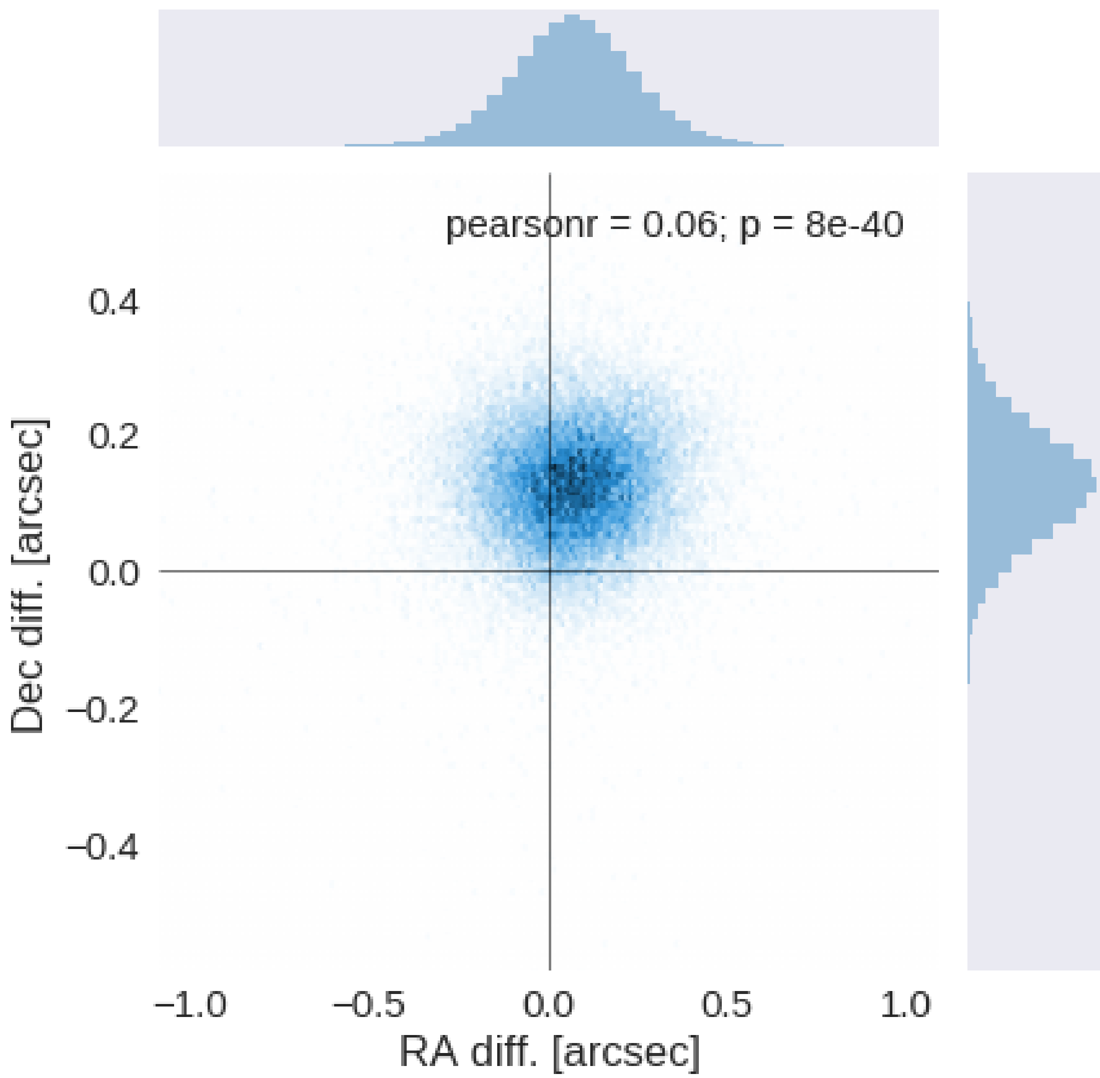
We remove duplicated objects from the input catalogues.

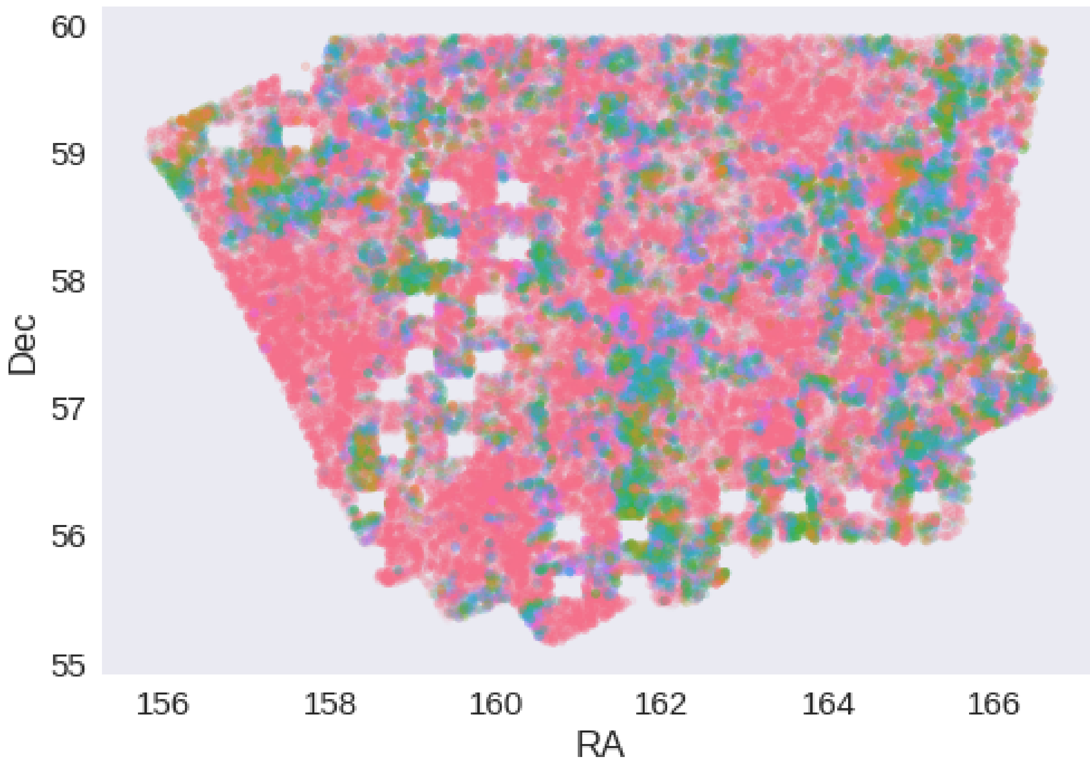
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 195229 sources.
The cleaned catalogue has 182619 sources (12610 removed).
The cleaned catalogue has 12112 sources flagged as having been cleaned
```

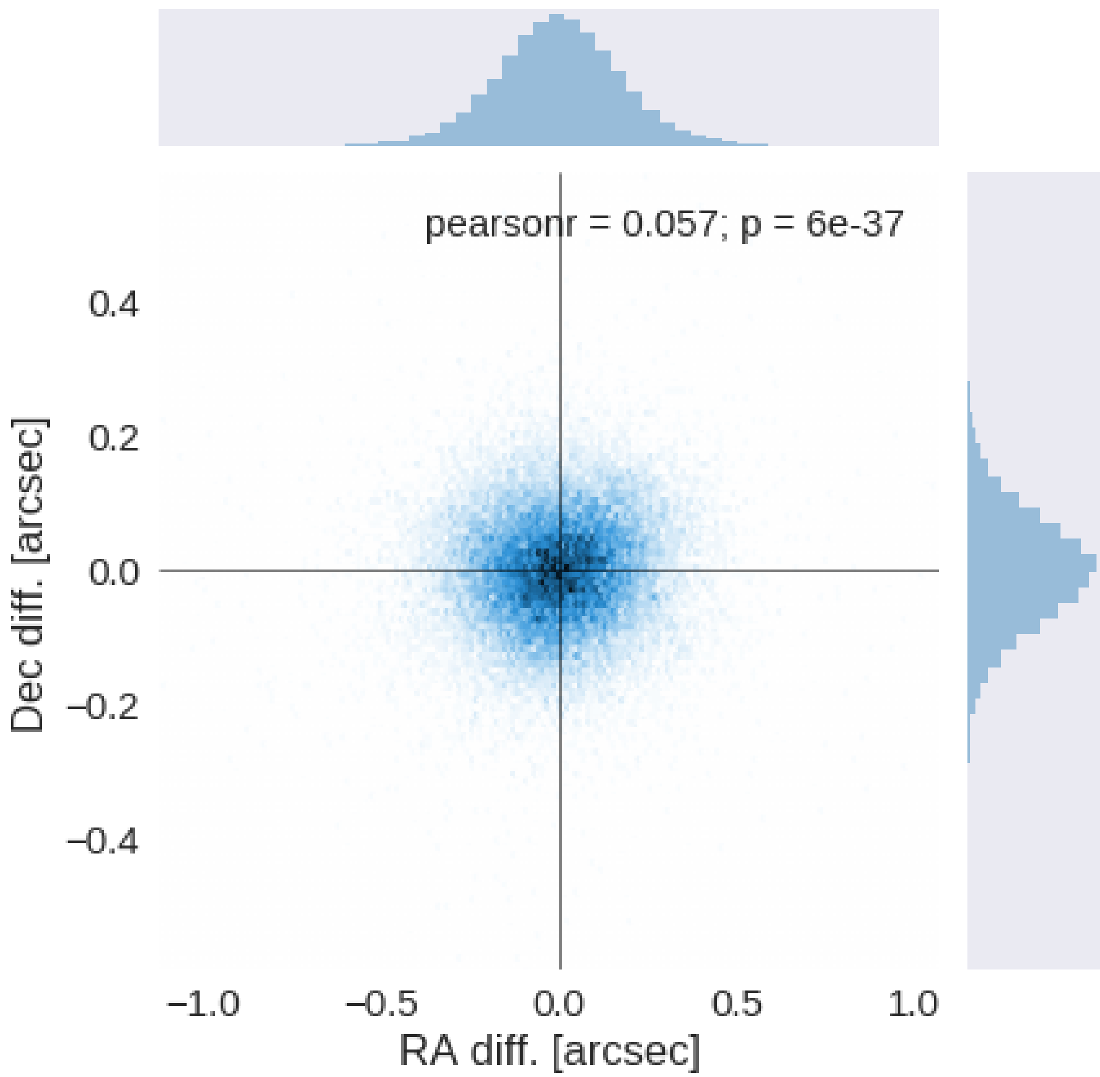
1.4 III - Astrometry correction

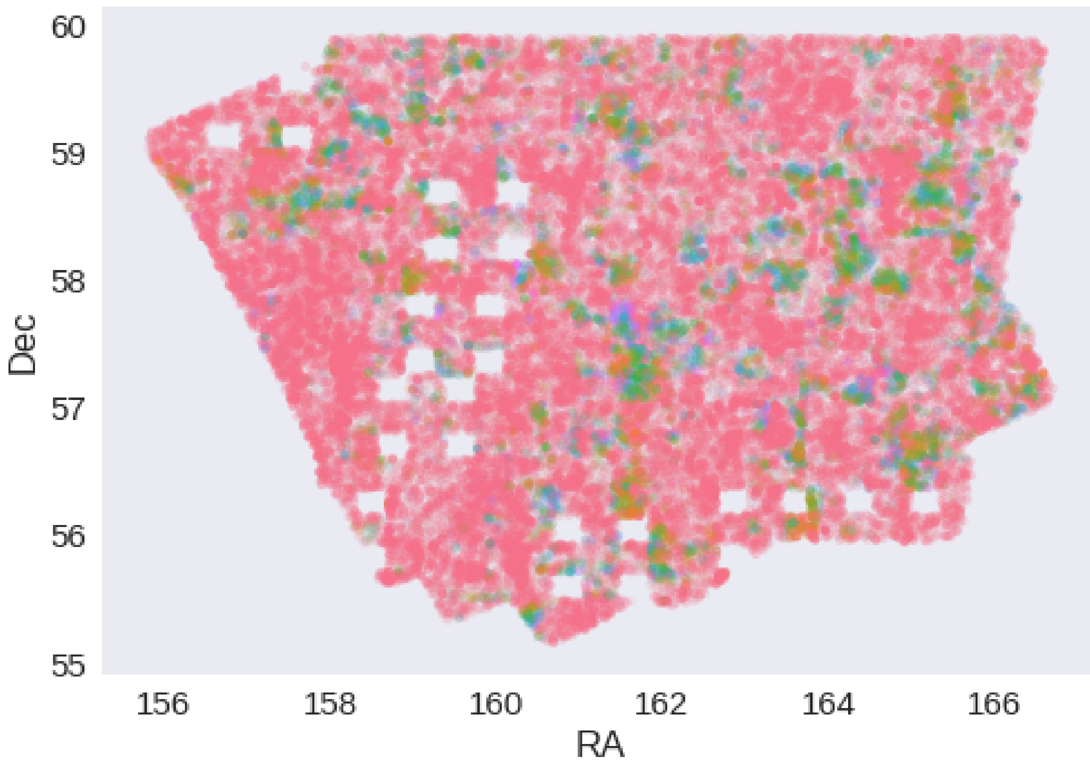
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.07215760333565413 arcsec
Dec correction: -0.12638207908679533 arcsec
```


pearsonr = 0.057; p = 6e-37
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−1.0
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
49470 sources flagged.
```

2 V - Saving to disk

2_Merging

March 8, 2018

1 Lockman SWIRE master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on Lockman 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

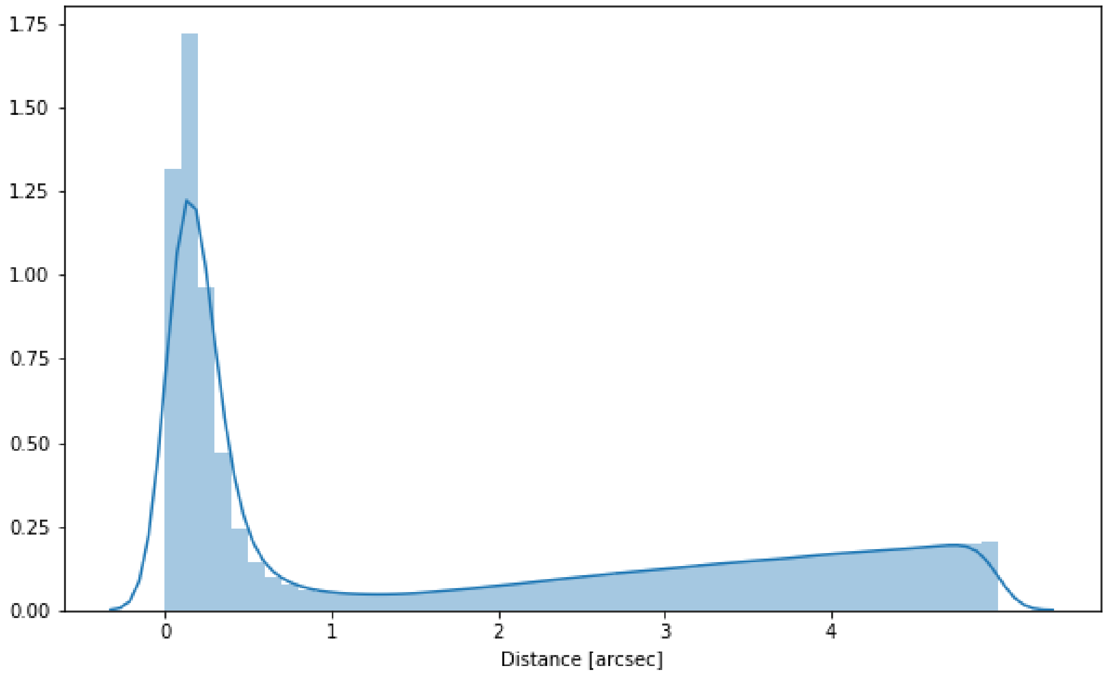
1.2 II - Merging tables

We first merge the optical catalogues and then add the infrared ones: WFC, DXS, SpARCS, HSC, PS1, SERVS, SWIRE.

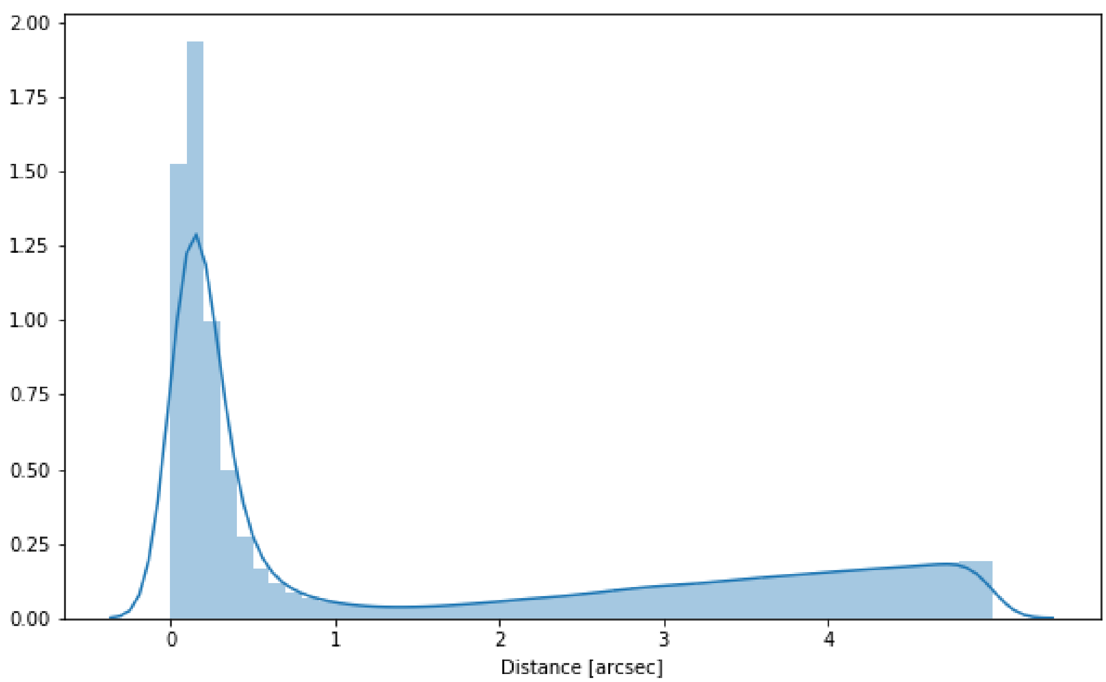
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 WFC

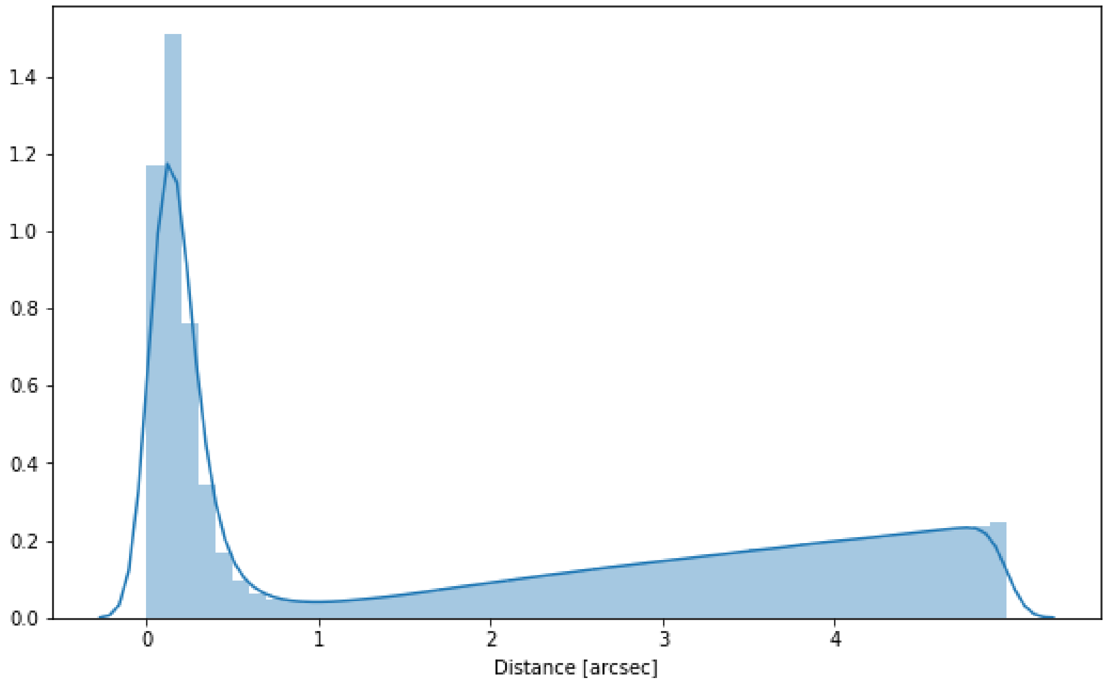
1.2.2 Add RCSLenS



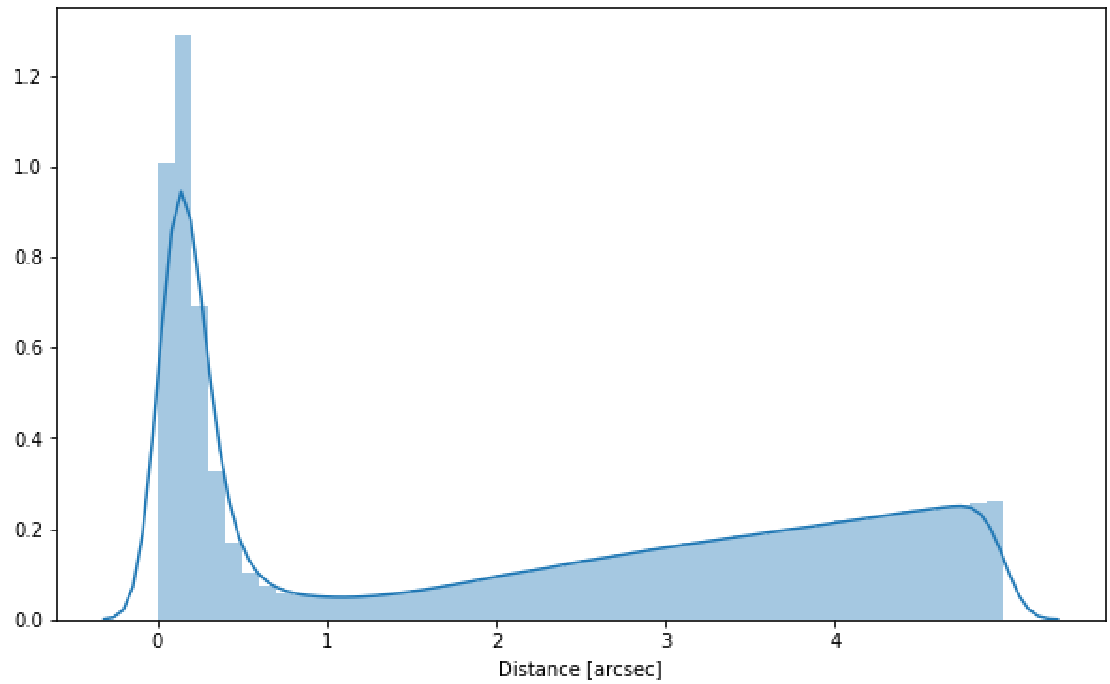
1.2.3 Add PanSTARRS



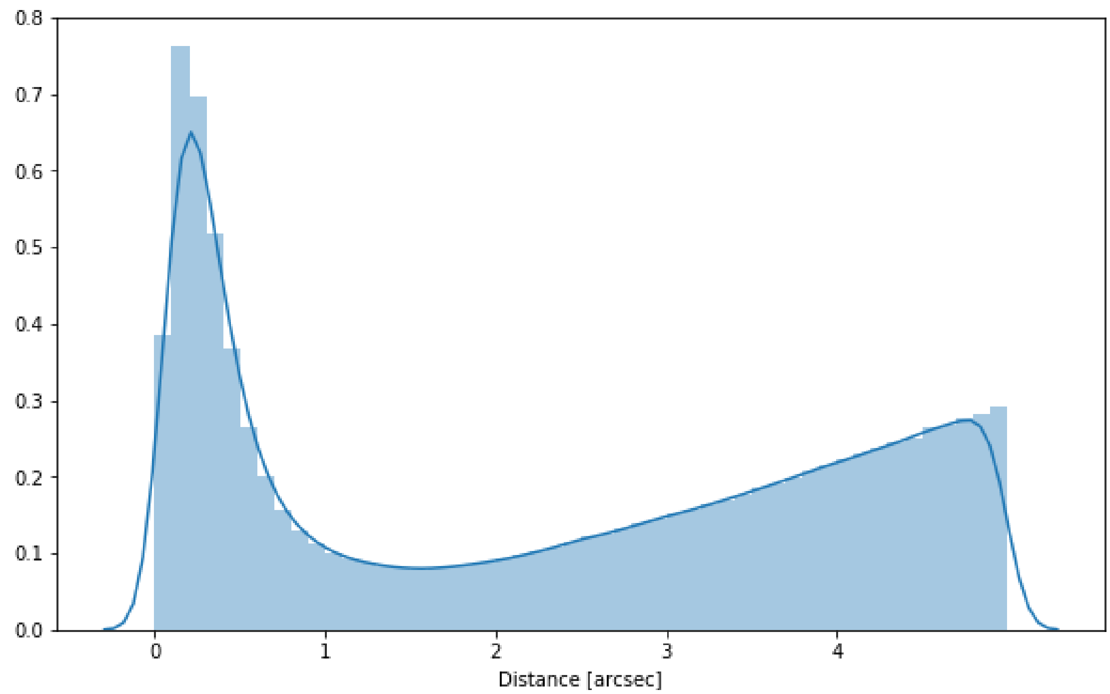
1.2.4 Add SpARCS



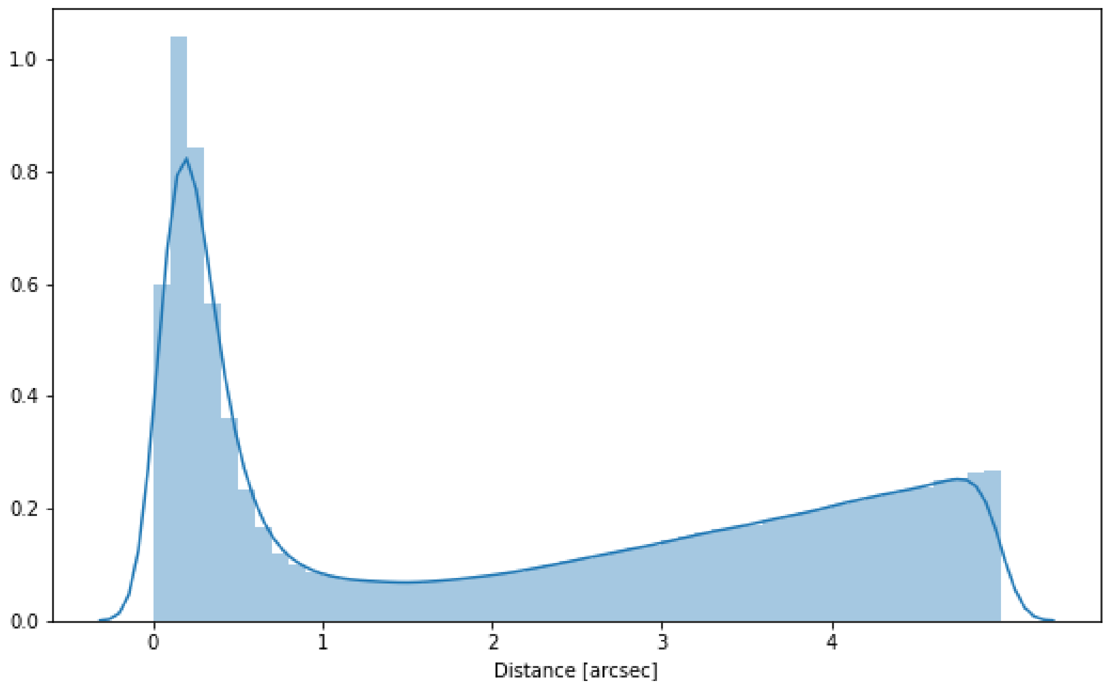
1.2.5 Add DXS



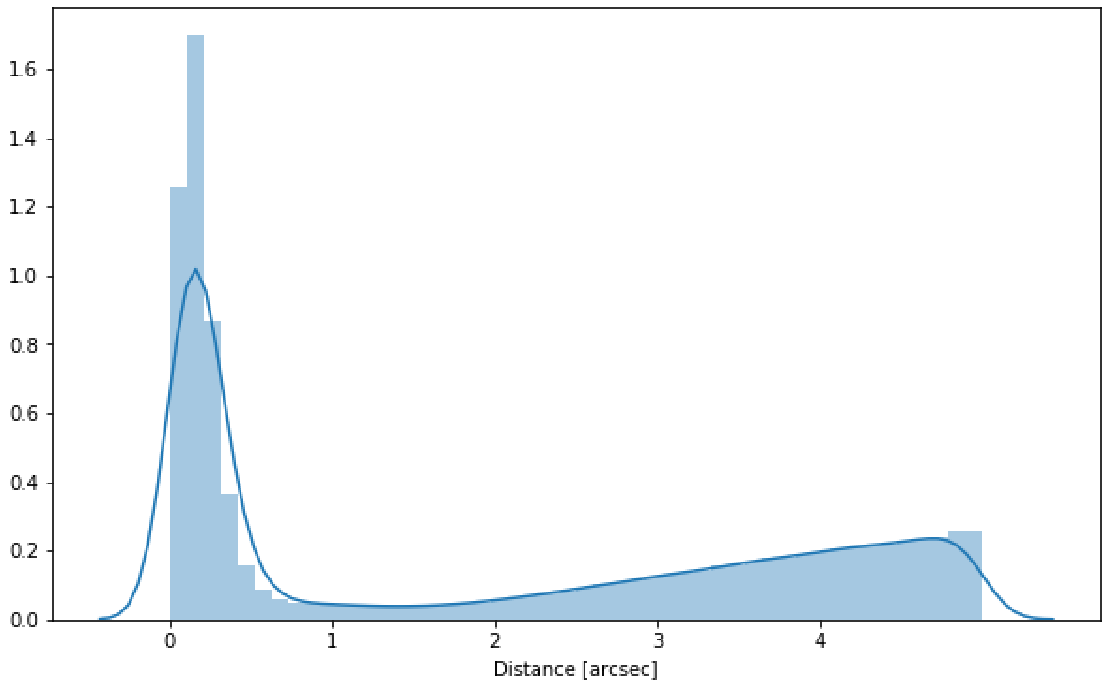
1.2.6 Add SERVS



1.2.7 Add SWIRE



1.2.8 Add UHS



1.2.9 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 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.

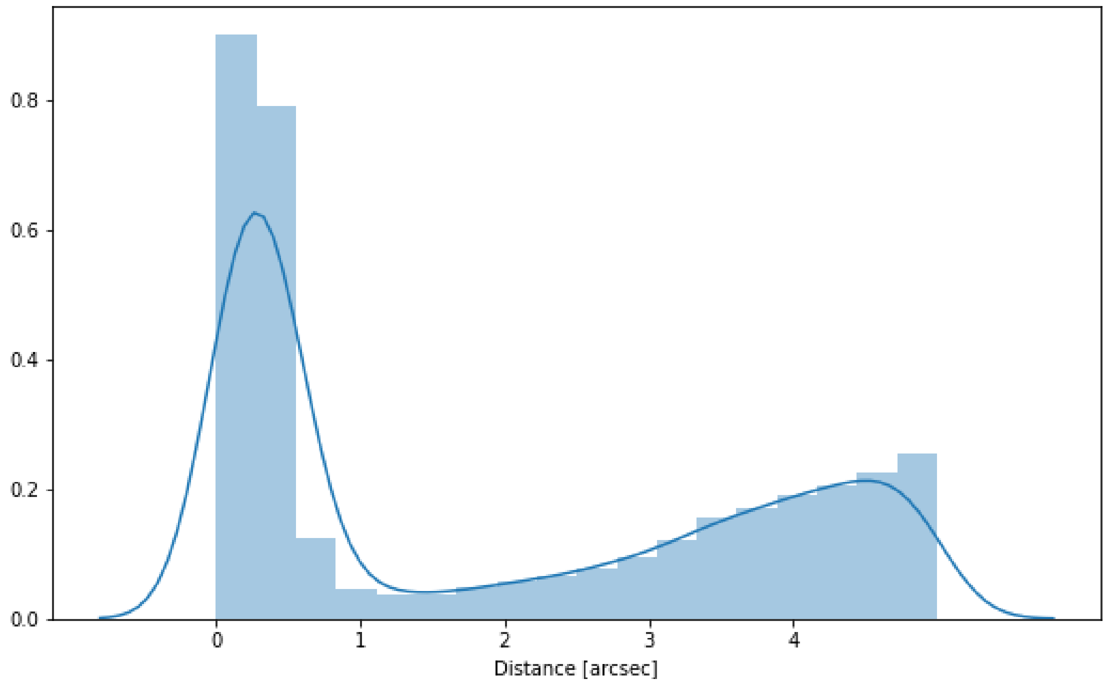
```
wfc_stellarity, rcs_stellarity, sparcs_stellarity, dxs_stellarity, servs_stellarity_irac1, servs
```

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

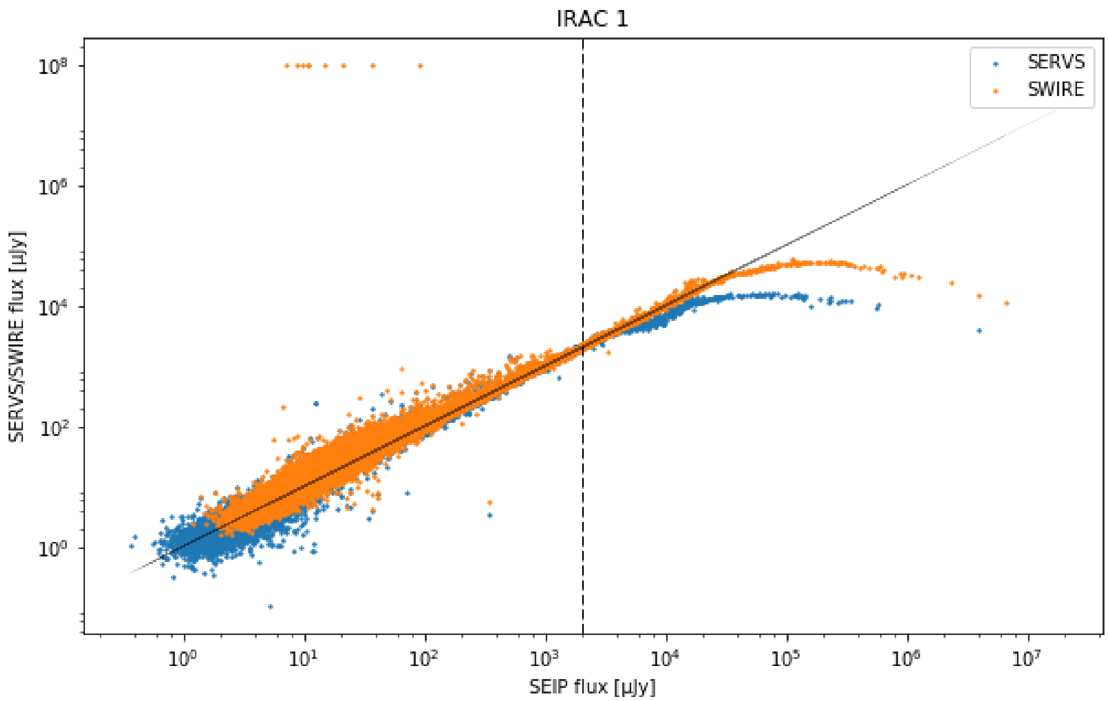


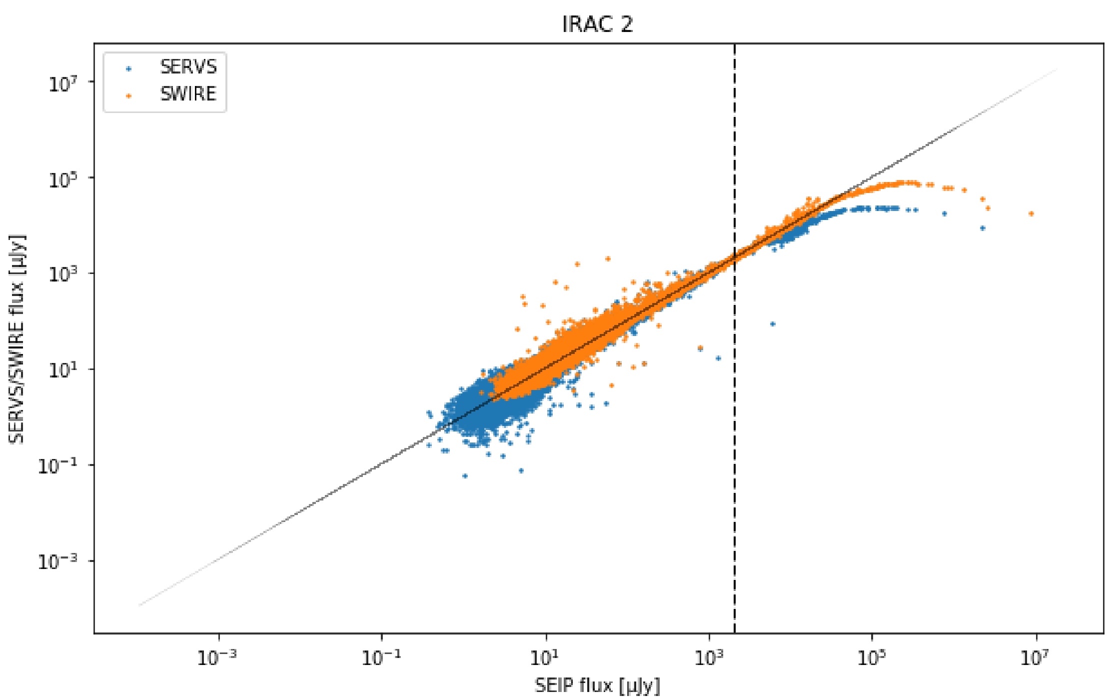
1.7 VII - Choosing between multiple values for the same filter

1.7.1 VII.1 - SERVS vs SWIRE

Both SERVS and SWIRE provide IRAC1 and IRAC2 fluxes. SERVS is deeper but tends to under-estimate flux of bright sources (Mattia said over 2000 ţJy) as illustrated by this comparison of SWIRE, SERVS, and Spitzer-EIP fluxes.

```
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.

```
684599 sources with SERVS flux
617006 sources with SWIRE flux
280721 sources with SERVS and SWIRE flux
683634 sources for which we use SERVS
337250 sources for which we use SWIRE


684599 sources with SERVS flux
616836 sources with SWIRE flux
280717 sources with SERVS and SWIRE flux
683570 sources for which we use SERVS
337148 sources for which we use SWIRE


732936 sources with SERVS flux
441887 sources with SWIRE flux
197895 sources with SERVS and SWIRE flux
732316 sources for which we use SERVS
244612 sources for which we use SWIRE


732936 sources with SERVS flux
441831 sources with SWIRE flux
197895 sources with SERVS and SWIRE flux
732273 sources for which we use SERVS
244599 sources for which we use SWIRE
```

1.7.2 UHS WFCAM J vs DXS WFCAM J

These both come from wfcam. If UHS is to be included (it currently is not) we will have to decide between the two. DXS is deeper so it would probably be a case of preferentially taking DXS J fluxes.

1.7.3 CFHT Megacam SpARCS vs RCSLenS

SpARCS apears to be significantly deeper and contains both total and aperture magnitudes so we take SpARCS over RCSLenS if both are available

Survey	Bands
SpARCS	ugrz
RCSLenS	grizy

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

Out[49]: <IPython.core.display.HTML object>

1.8 VIII.a Wavelenght domain coverage

We add a binary `flag_optnir_obs` indicating that a source was observed in a given wavelenght 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 Wavelenght domain detection

We add a binary `flag_optnir_det` indicating that a source was detected in a given wavelenght 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 catalogue. This can be used to easily get additional information from them.

```
['wfc_id', 'rcs_id', 'ps1_id', 'sparcs_intid', 'dxs_id', 'servs_intid', 'swire_intid', 'uhs_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_megacam_u', 'flag_gpc1_z', 'flag_irac_i3', 'flag_irac_i1', 'flag_gpc1_y'
```

3_Checks_and_diagnostics

March 8, 2018

1 Lockman SWIRE master catalogue

1.1 Checks and diagnostics

```
This notebook was run with herschelhelp_internal version:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)
```

```
Diagnostics done using: master_catalogue_lockman-swire_20171201.fits
```

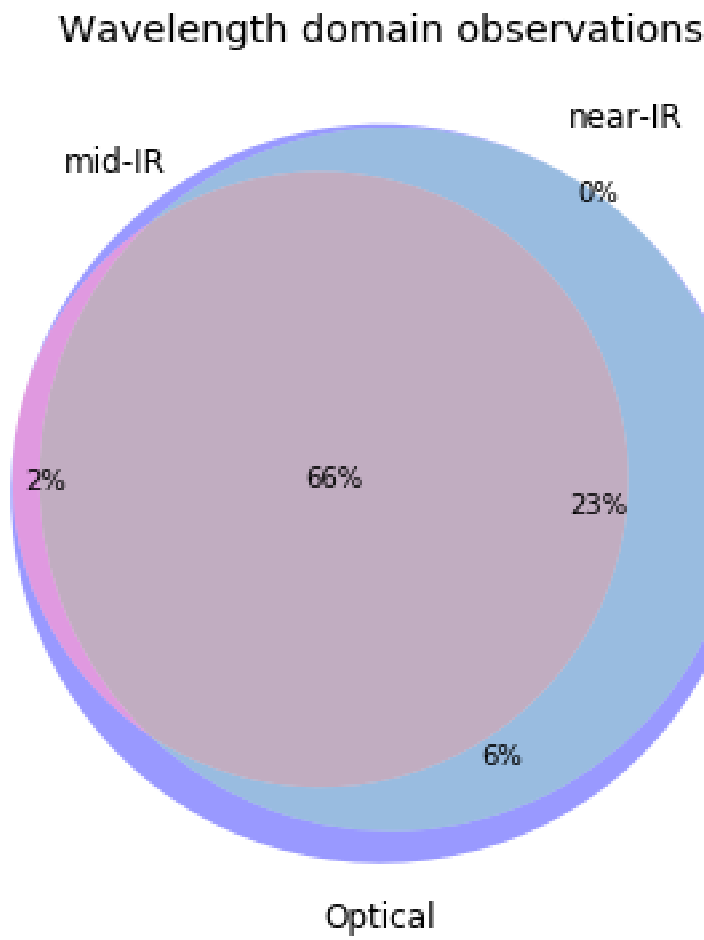
1.2 0 - Quick checks

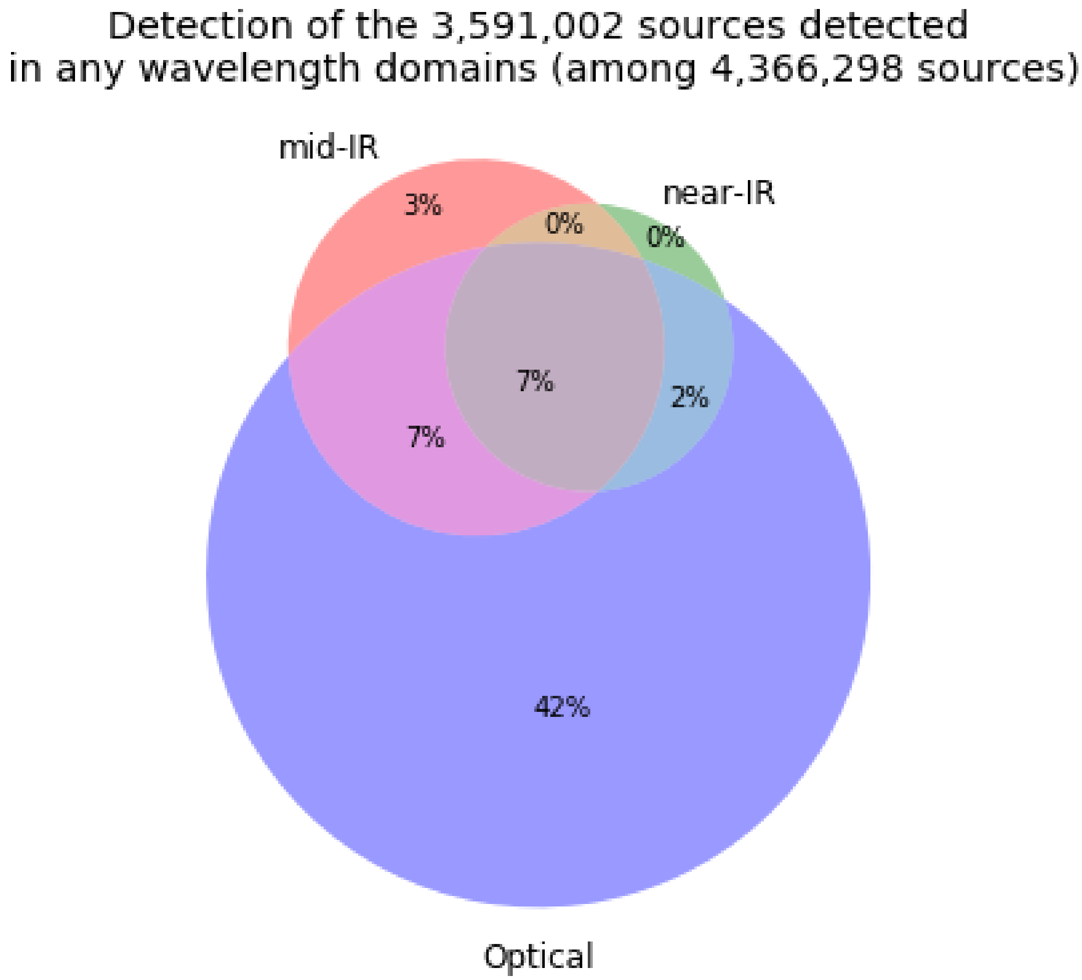
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype),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

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

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

1.3 I - Summary of wavelength domains



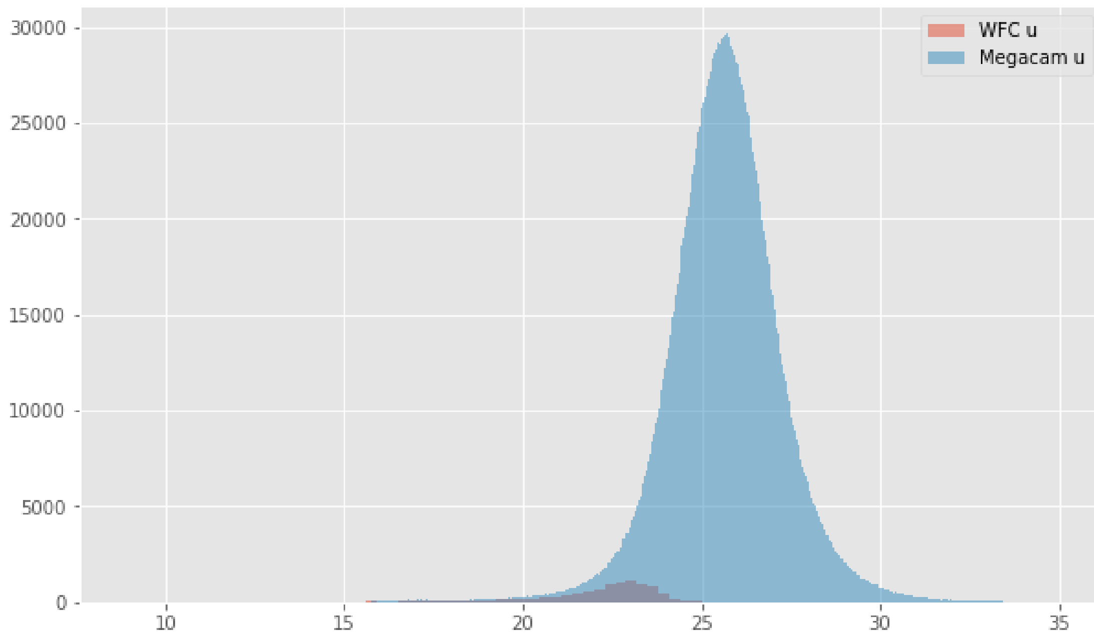


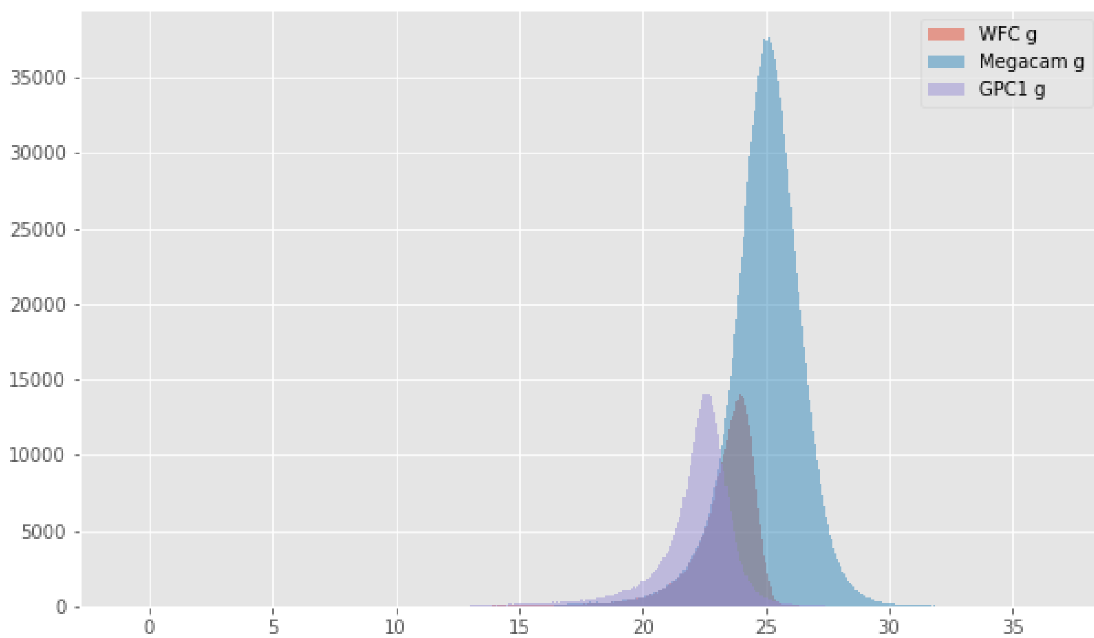
1.4 II - Comparing magnitudes in similar filters

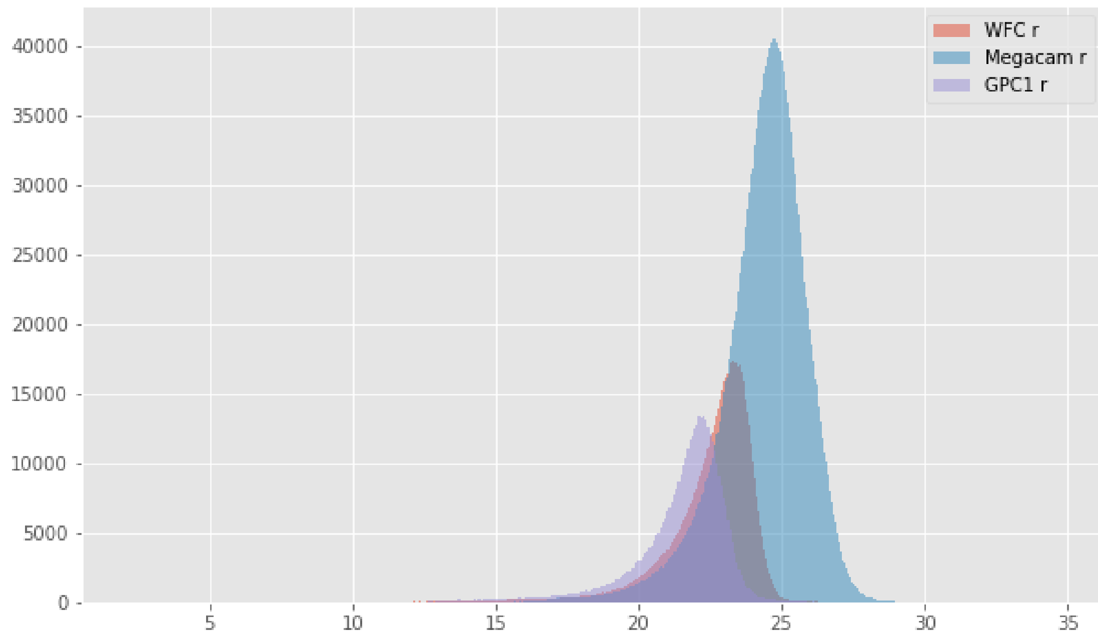
The master list if composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

1.4.1 II.a - Comparing depths

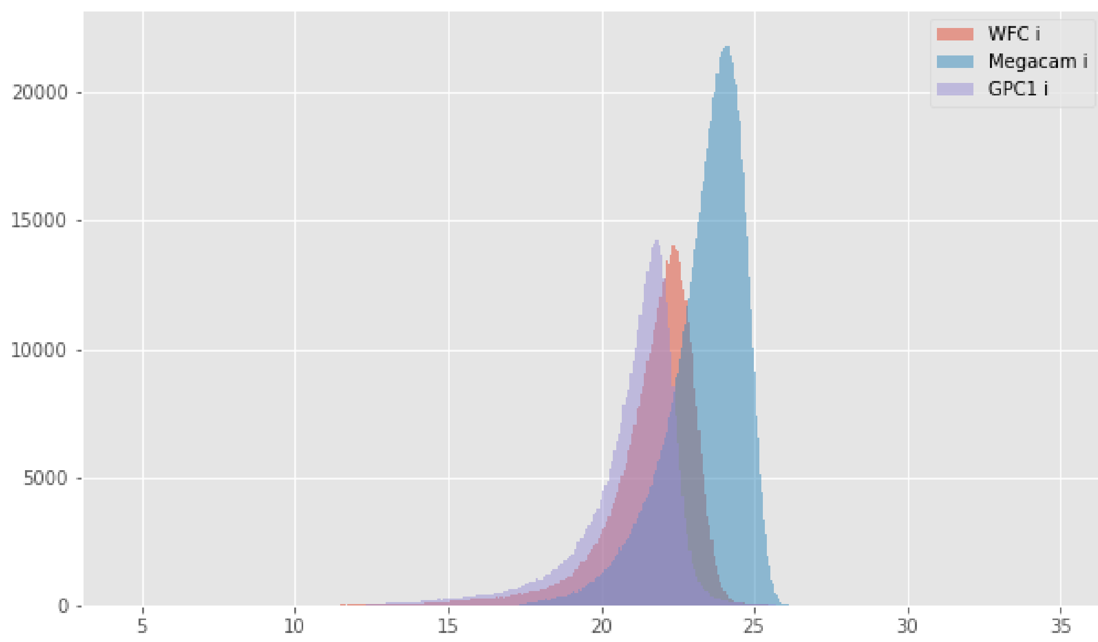
We compare the histograms of the total aperture magnitudes of similar bands.


WFC u
Megacam u
30000
25000
20000
15000
10000
5000
0
10
15
20
25
30
35

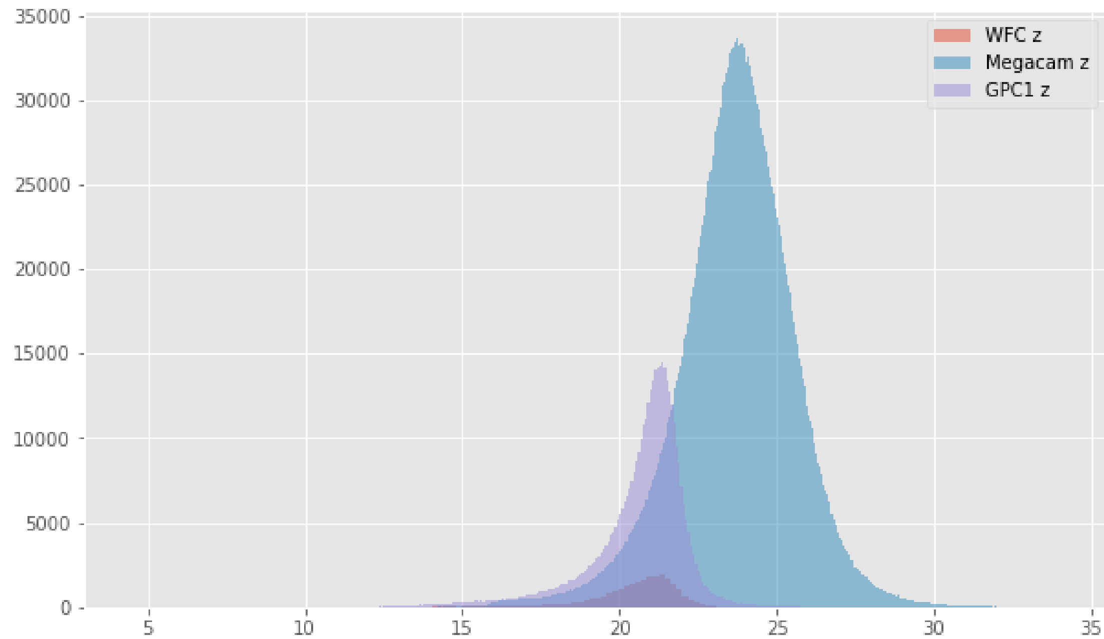

WFC g
Megacam g
GPC1 g
35000
30000
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
35

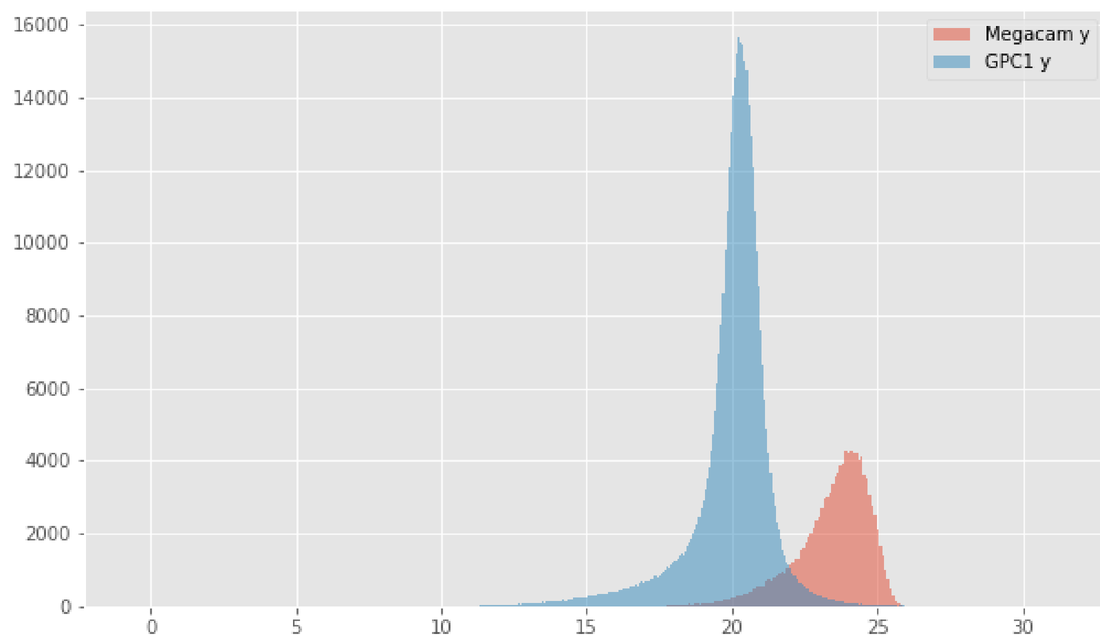


WFC r
Megacam r
GPC1 r
0
5000
10000
15000
20000
25000
30000
35000
40000
5
10
15
20
25
30
35



WFC i
Megacam i
GPC1 i
0
5000
10000
15000
20000
5
10
15
20
25
30
35

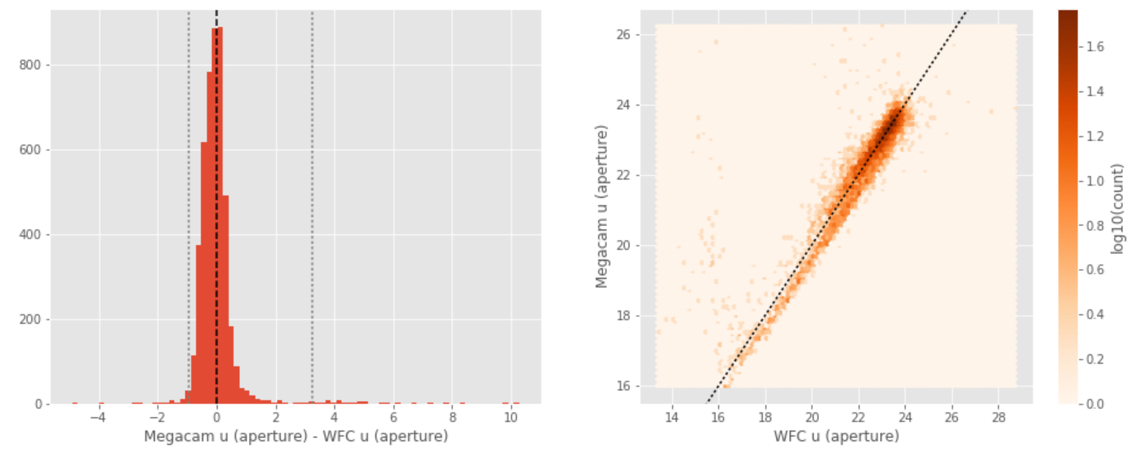




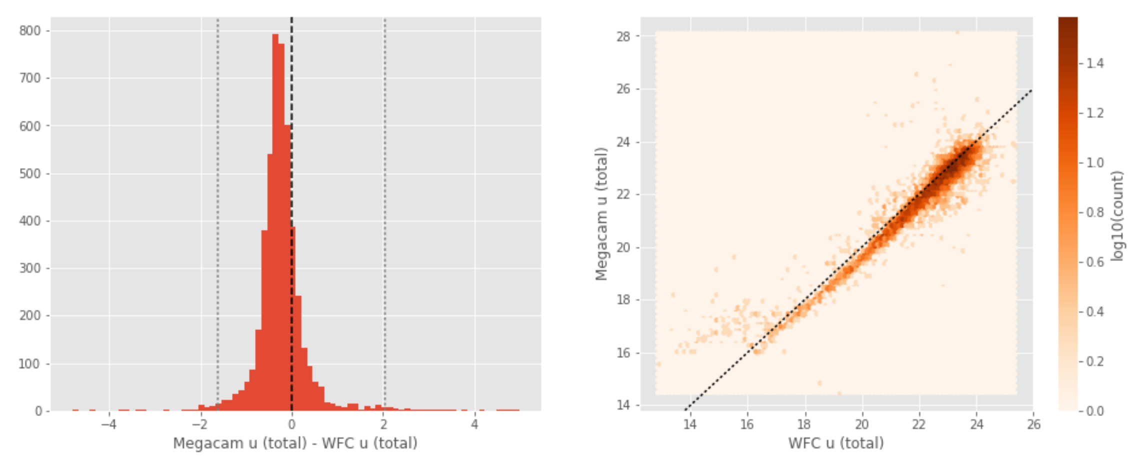
1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

```
Megacam u (aperture) - WFC u (aperture):
- Median: -0.06
- Median Absolute Deviation: 0.25
- 1% percentile: -0.9491949844360351
- 99% percentile: 3.2663552665710673
```

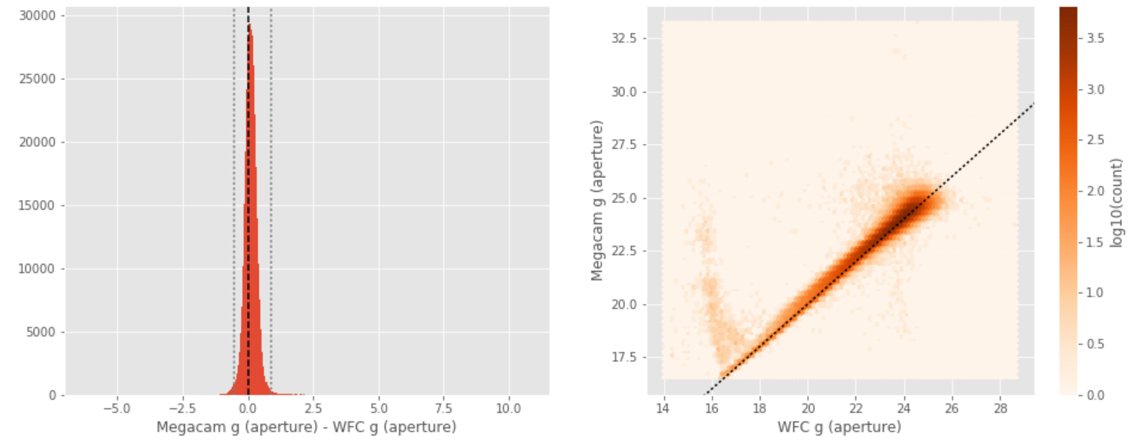



```
Megacam u (total) - WFC u (total):
- Median: -0.27
- Median Absolute Deviation: 0.21
- 1% percentile: -1.6218692207336425
- 99% percentile: 2.0539311504363935
```

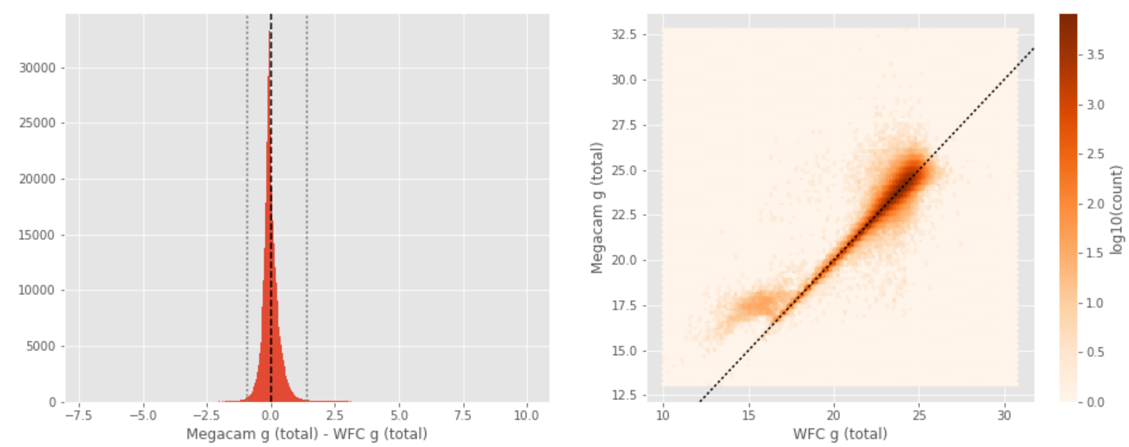



```
Megacam g (aperture) - WFC g (aperture):
- Median: 0.11
```

- Median Absolute Deviation: 0.14
- 1% percentile: -0.5078629302978516
- 99% percentile: 0.8724484062194824

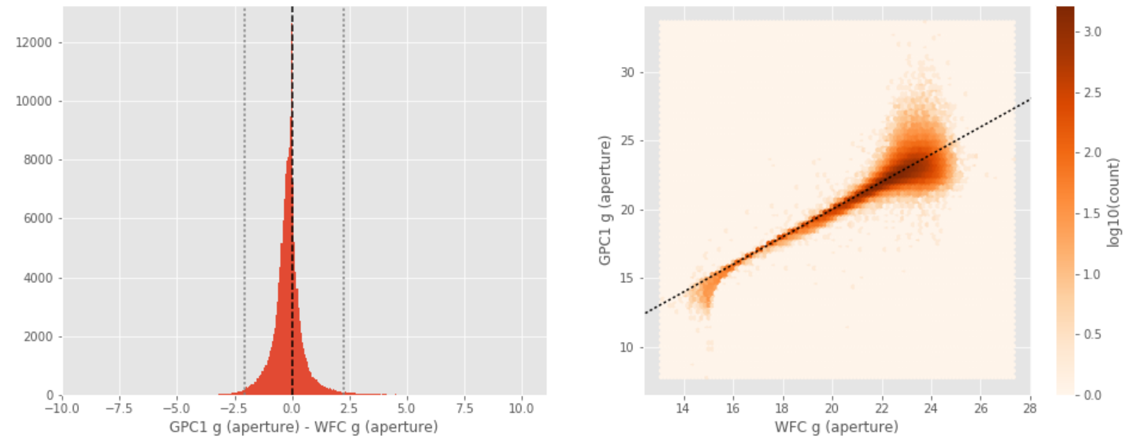


Megacam g (total) - WFC g (total):
- Median: -0.05
- Median Absolute Deviation: 0.15
- 1% percentile: -0.9023867797851562
- 99% percentile: 1.4200260162353513

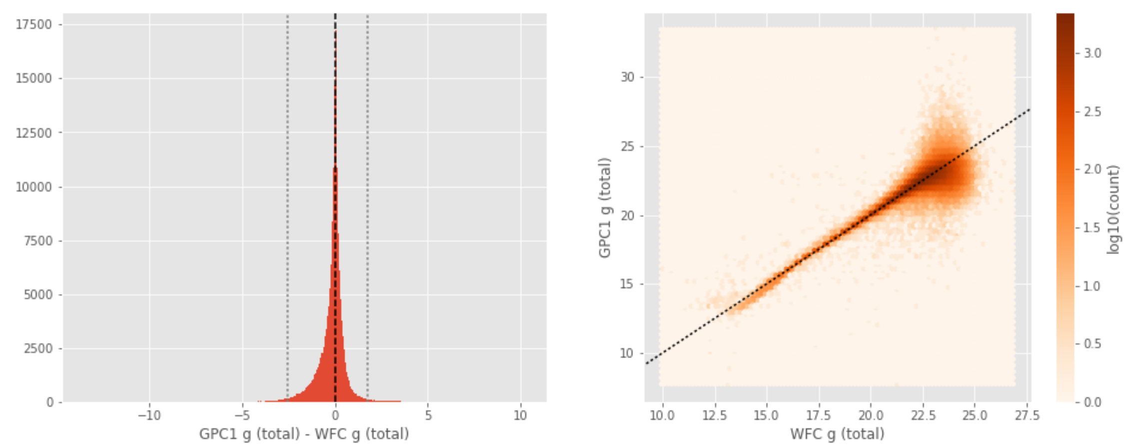


GPC1 g (aperture) - WFC g (aperture):
- Median: -0.14
- Median Absolute Deviation: 0.27
- 1% percentile: -2.033579864501953

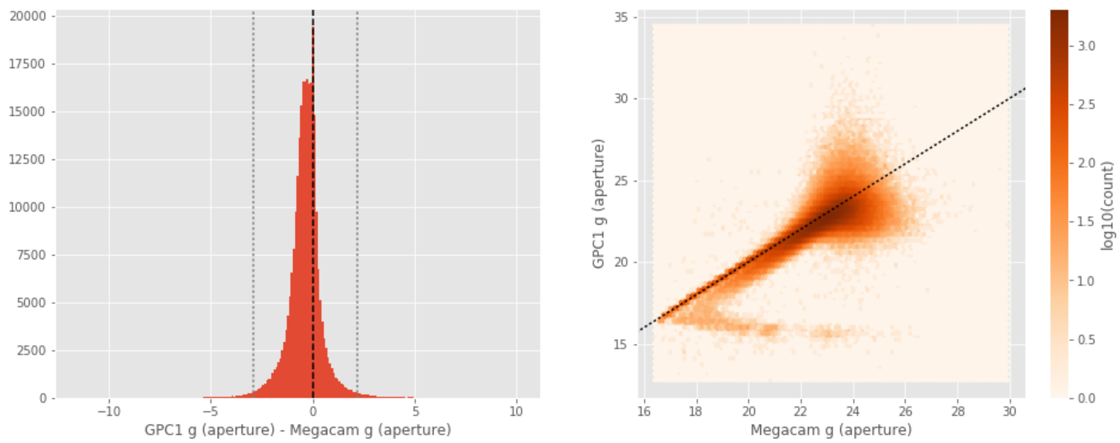
- 99% percentile: 2.2427005767822266



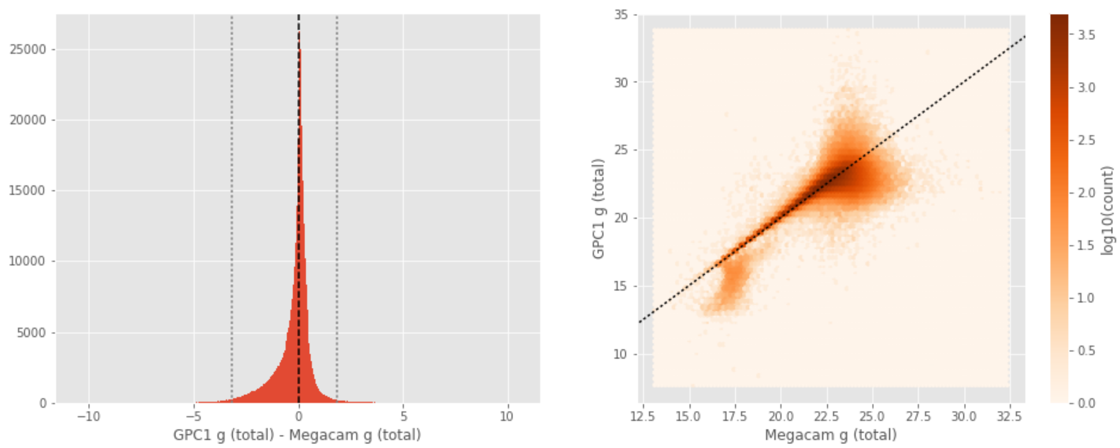
GPC1 g (total) - WFC g (total):
- Median: -0.03
- Median Absolute Deviation: 0.24
- 1% percentile: -2.5378850173950194
- 99% percentile: 1.7712992477417002



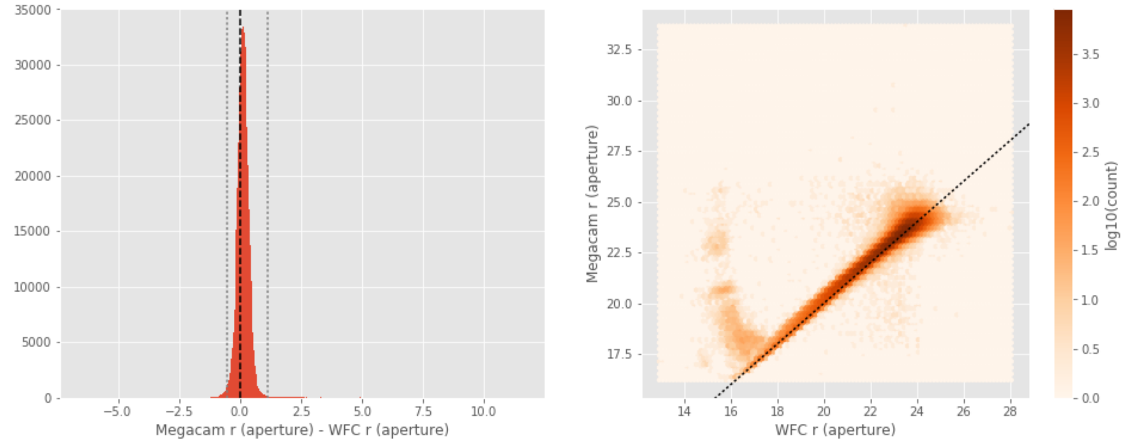
GPC1 g (aperture) - Megacam g (aperture):
- Median: -0.33
- Median Absolute Deviation: 0.38
- 1% percentile: -2.9429248237609866
- 99% percentile: 2.1852089309692397



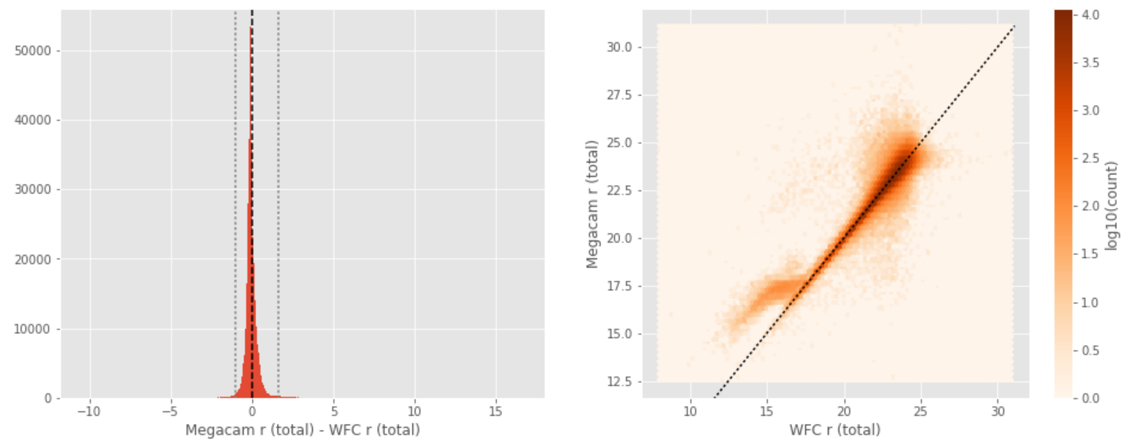
GPC1 g (total) - Megacam g (total):
- Median: 0.02
- Median Absolute Deviation: 0.28
- 1% percentile: -3.185884475708008
- 99% percentile: 1.8667194366455089



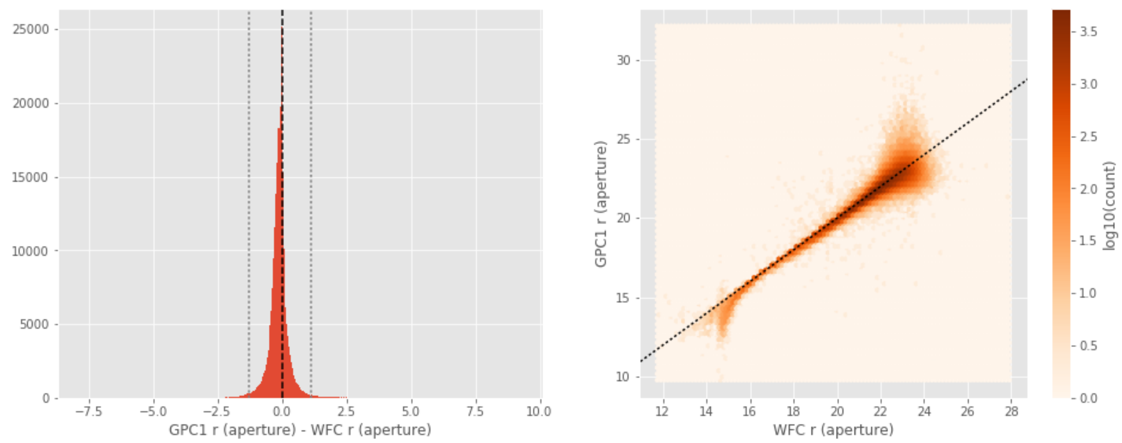
Megacam r (aperture) - WFC r (aperture):
- Median: 0.13
- Median Absolute Deviation: 0.15
- 1% percentile: -0.545387954711914
- 99% percentile: 1.148755531311045



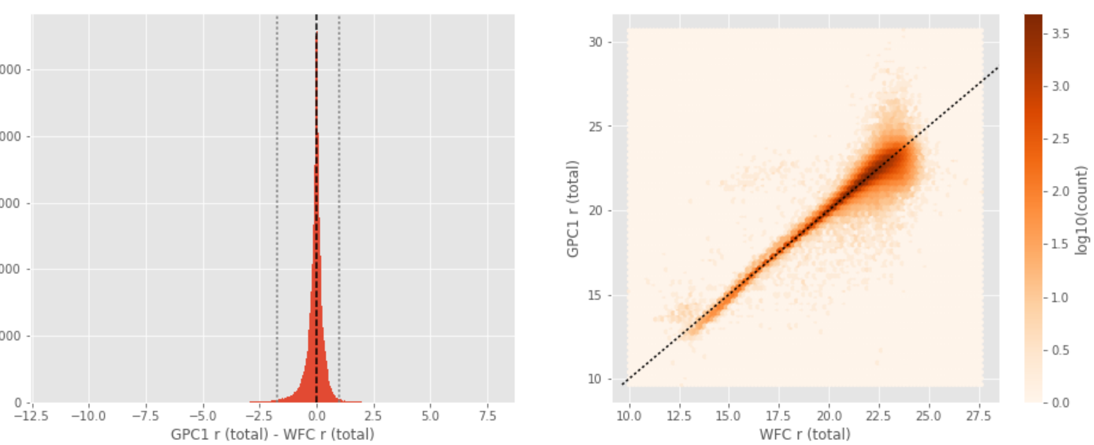
Megacam r (total) - WFC r (total):
- Median: -0.08
- Median Absolute Deviation: 0.14
- 1% percentile: -0.9950507736206055
- 99% percentile: 1.6092028617858827



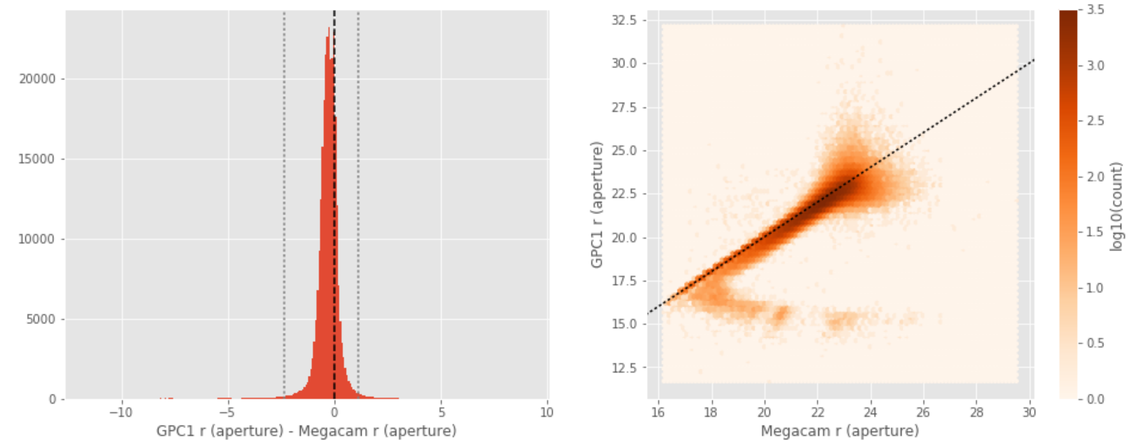
GPC1 r (aperture) - WFC r (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.15
- 1% percentile: -1.2963315582275392
- 99% percentile: 1.1390761566162118



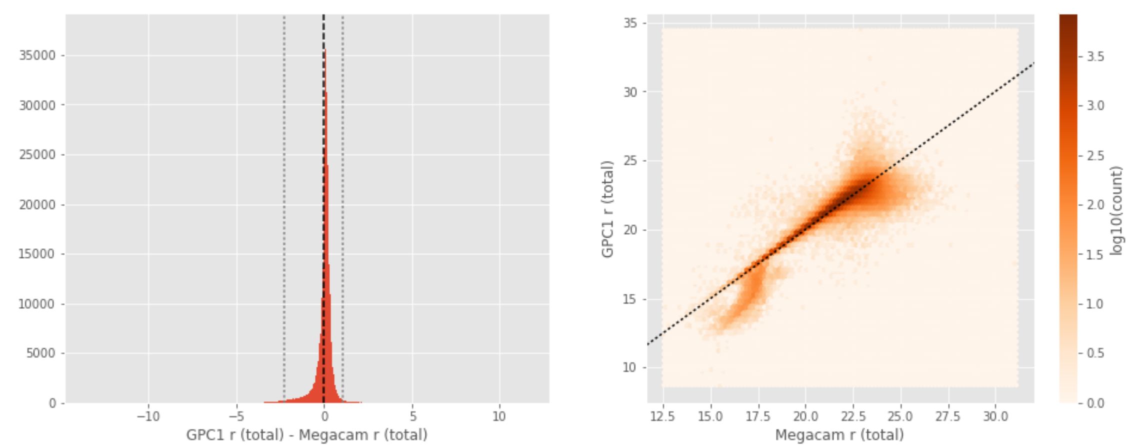

```
GPC1 r (total) - WFC r (total):
- Median: -0.01
- Median Absolute Deviation: 0.14
- 1% percentile: -1.7165836334228515
- 99% percentile: 0.9766998291015625
```



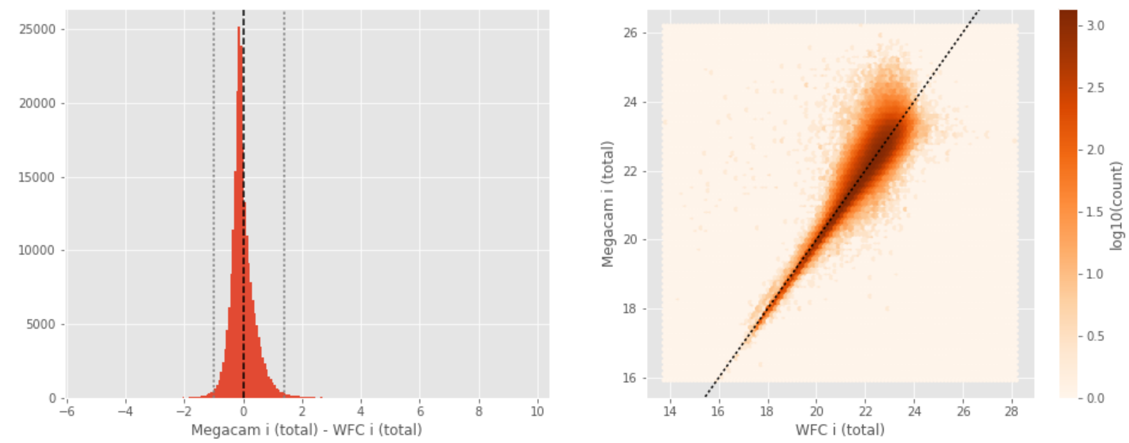

```
GPC1 r (aperture) - Megacam r (aperture):
- Median: -0.26
- Median Absolute Deviation: 0.25
- 1% percentile: -2.3193286895751952
- 99% percentile: 1.125625000000003
```



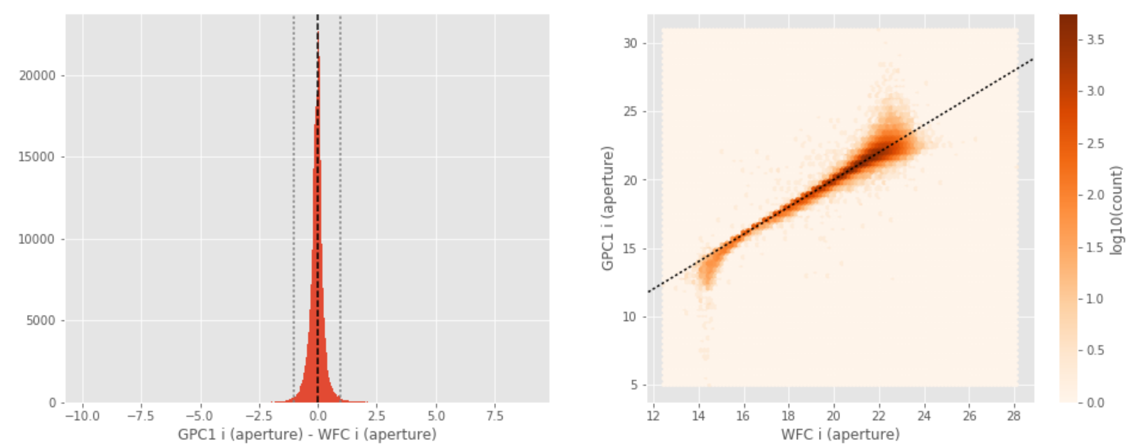
GPC1 r (total) - Megacam r (total):
- Median: 0.08
- Median Absolute Deviation: 0.14
- 1% percentile: -2.285899467468262
- 99% percentile: 1.0307445526123051



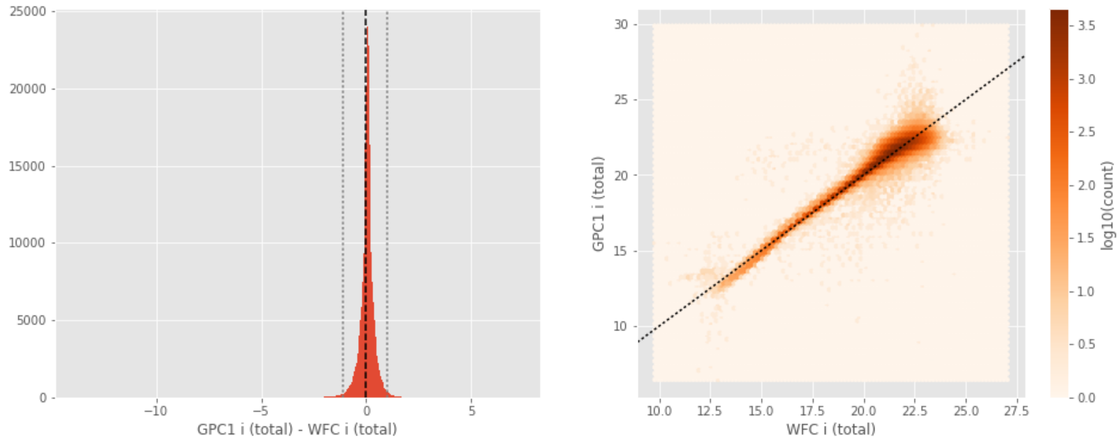
Megacam i (total) - WFC i (total):
- Median: -0.08
- Median Absolute Deviation: 0.20
- 1% percentile: -0.9779530334472656
- 99% percentile: 1.4092513275146472



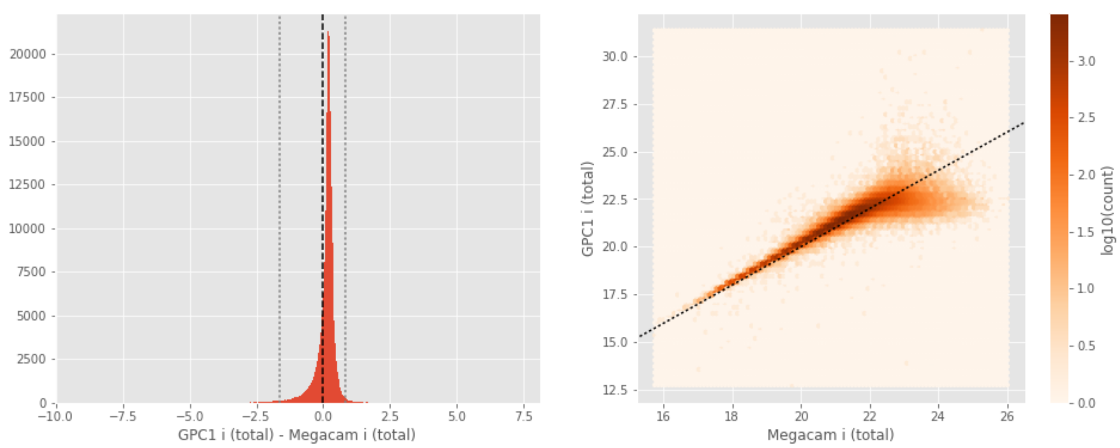
GPC1 i (aperture) - WFC i (aperture):
- Median: -0.03
- Median Absolute Deviation: 0.14
- 1% percentile: -1.025598430633545
- 99% percentile: 0.9575976371765118



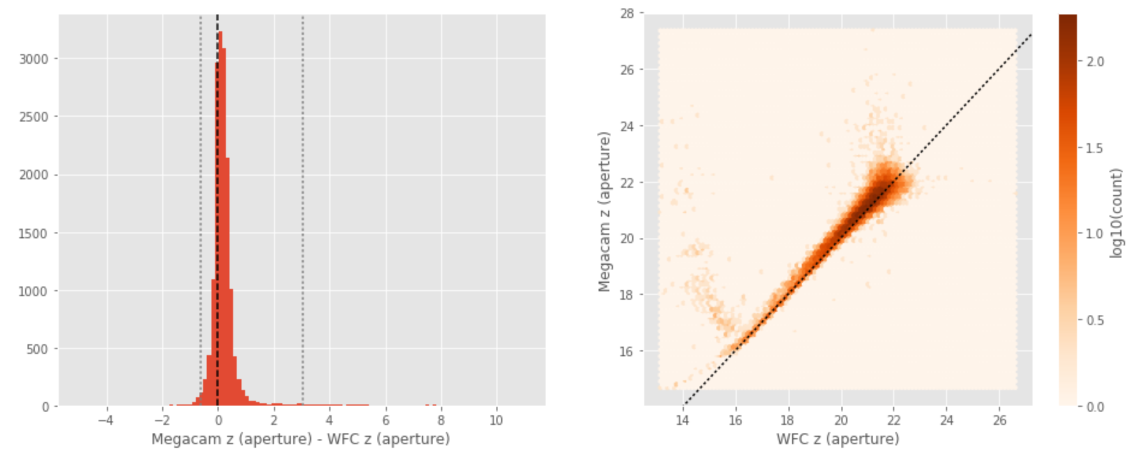
GPC1 i (total) - WFC i (total):
- Median: 0.06
- Median Absolute Deviation: 0.15
- 1% percentile: -1.102666082382202
- 99% percentile: 0.9996103668212877



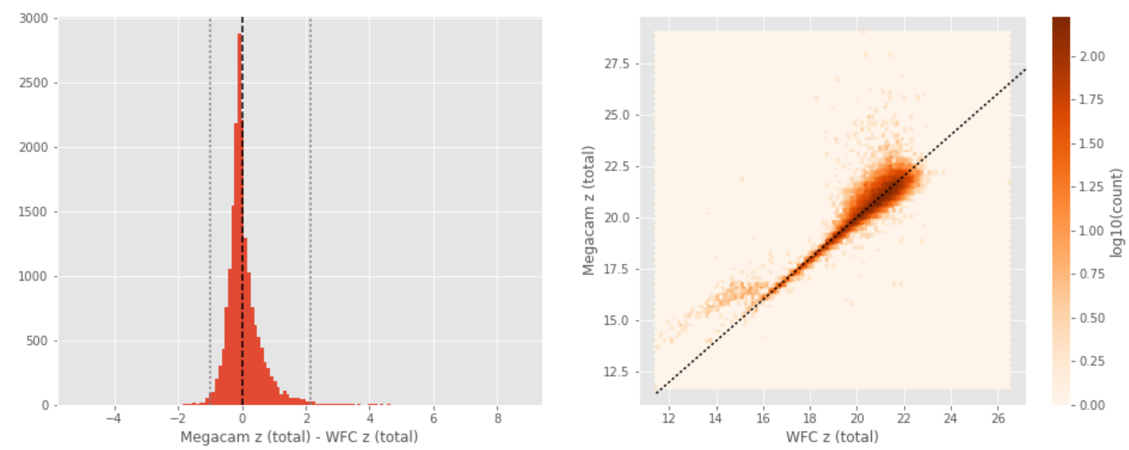
GPC1 i (total) - Megacam i (total):
- Median: 0.17
- Median Absolute Deviation: 0.12
- 1% percentile: -1.6147754669189454
- 99% percentile: 0.8306443786621096



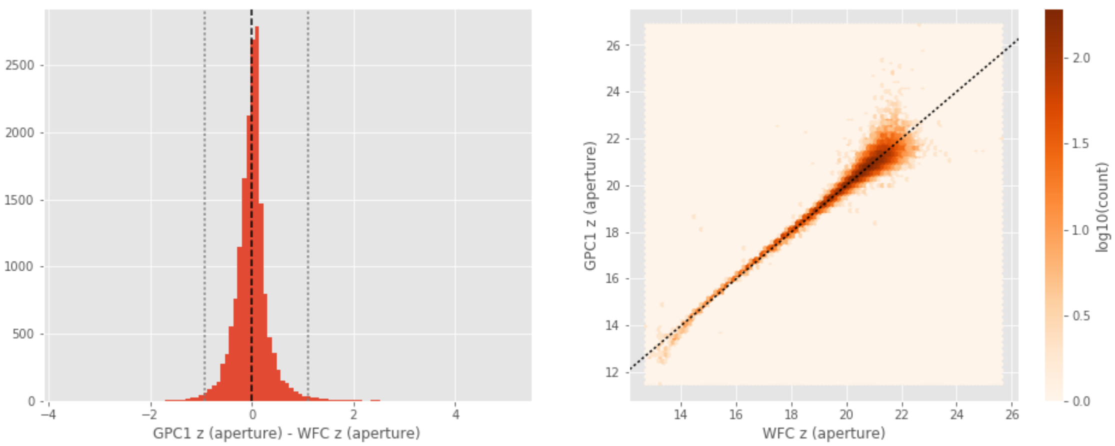
Megacam z (aperture) - WFC z (aperture):
- Median: 0.14
- Median Absolute Deviation: 0.17
- 1% percentile: -0.6397380828857422
- 99% percentile: 3.043675384521484



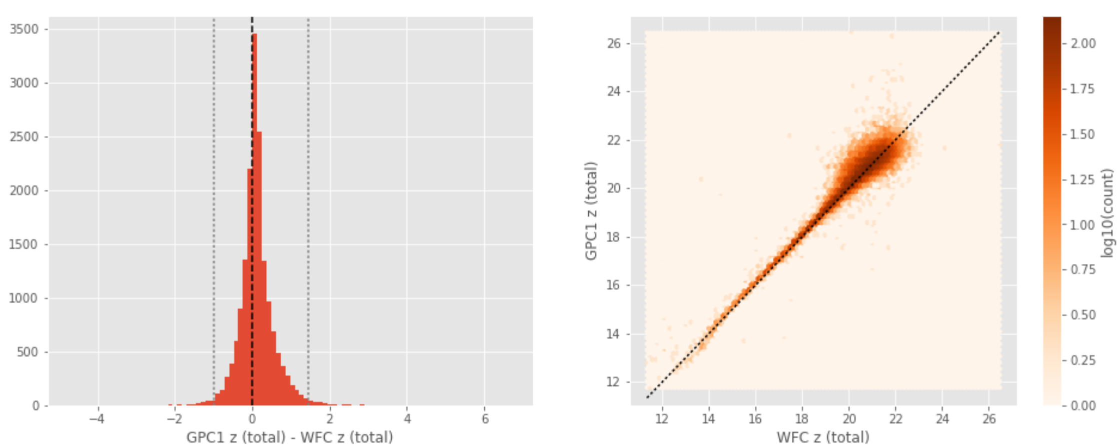
Megacam z (total) - WFC z (total):
- Median: -0.04
- Median Absolute Deviation: 0.22
- 1% percentile: -0.9952455520629883
- 99% percentile: 2.1356584072113094



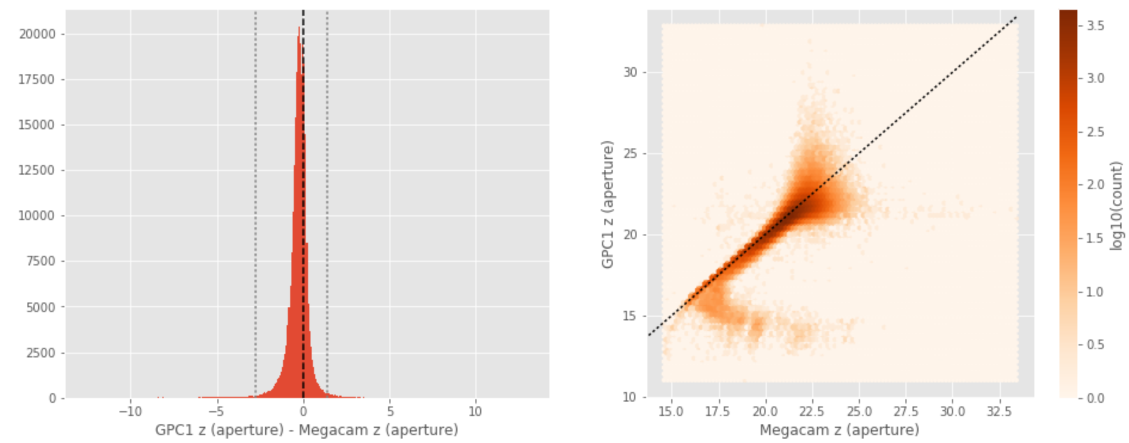
GPC1 z (aperture) - WFC z (aperture):
- Median: 0.01
- Median Absolute Deviation: 0.15
- 1% percentile: -0.9230419921874999
- 99% percentile: 1.1071548843383785



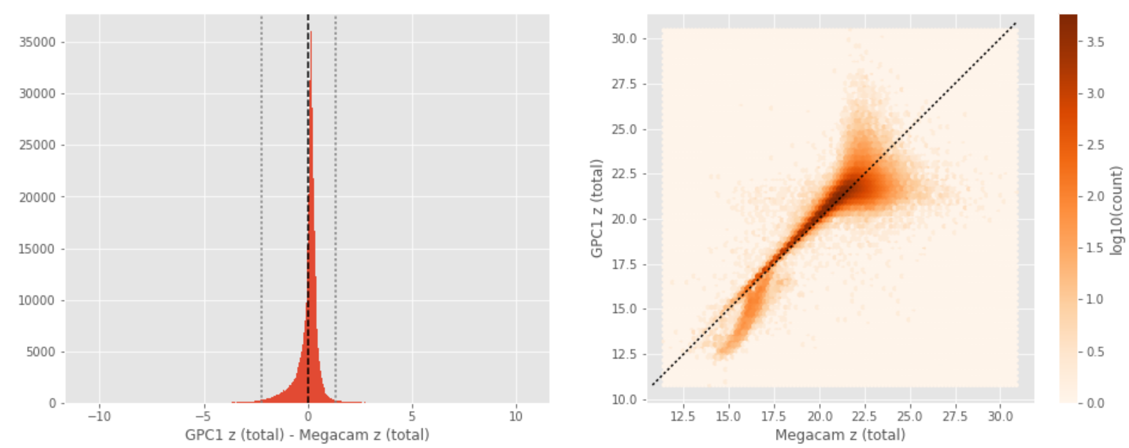
GPC1 z (total) - WFC z (total):
- Median: 0.09
- Median Absolute Deviation: 0.19
- 1% percentile: -0.9829817771911621
- 99% percentile: 1.4533742713928244



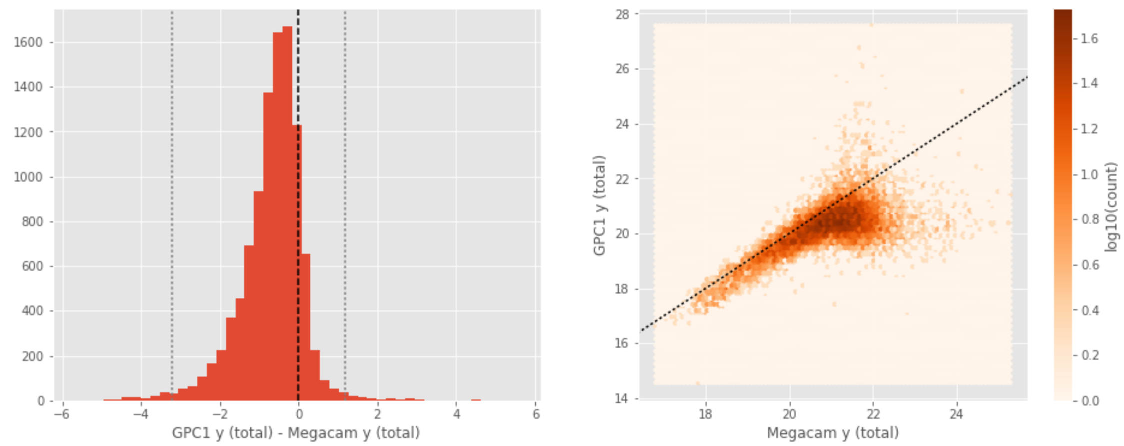
GPC1 z (aperture) - Megacam z (aperture):
- Median: -0.22
- Median Absolute Deviation: 0.26
- 1% percentile: -2.777841310501098
- 99% percentile: 1.4052535629272451



GPC1 z (total) - Megacam z (total):
- Median: 0.13
- Median Absolute Deviation: 0.17
- 1% percentile: -2.225839080810547
- 99% percentile: 1.3188536834716849



GPC1 y (total) - Megacam y (total):
- Median: -0.57
- Median Absolute Deviation: 0.41
- 1% percentile: -3.220444412231445
- 99% percentile: 1.1729692840576167



1.5 III - Comparing magnitudes to reference bands

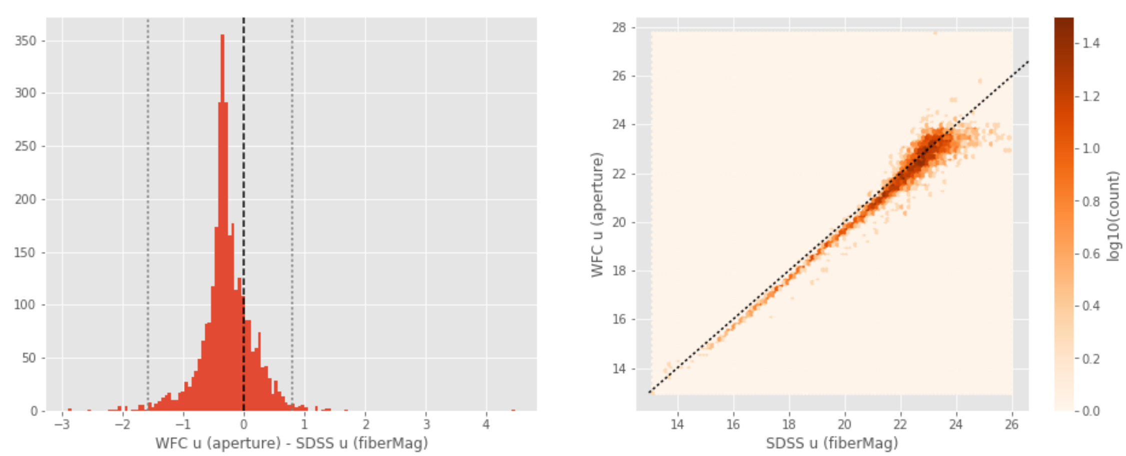
Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

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

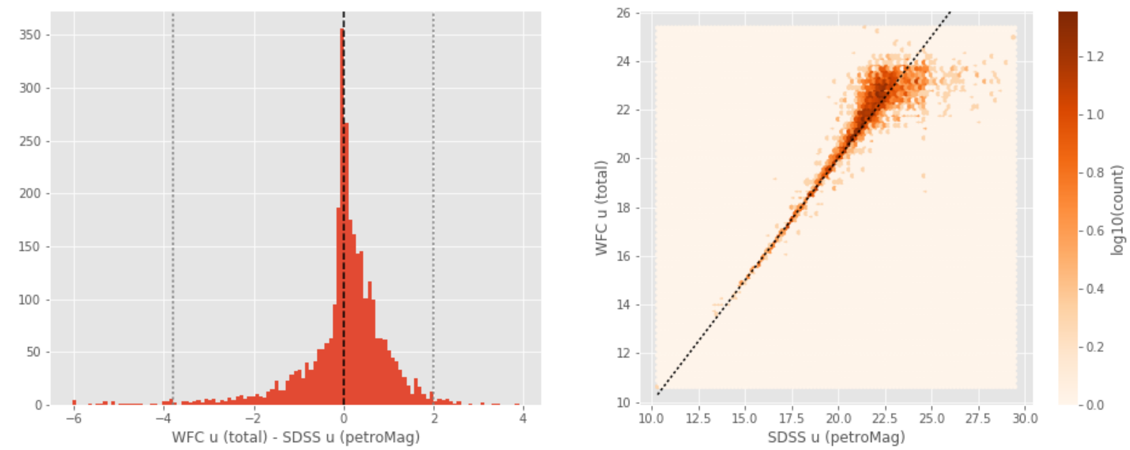
The catalogue is cross-matched to SDSS-DR13 withing 0.2 arcsecond.

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.

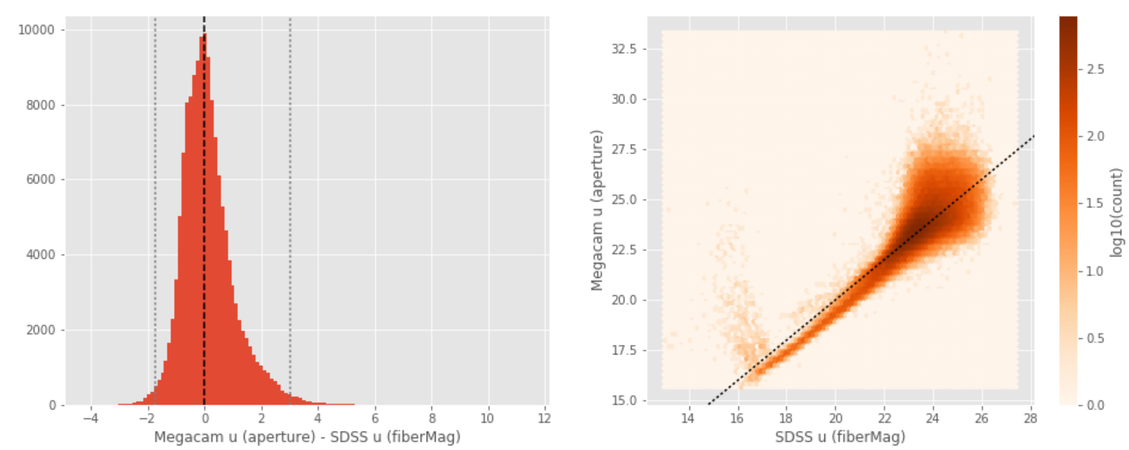
```
WFC u (aperture) - SDSS u (fiberMag):
- Median: -0.31
- Median Absolute Deviation: 0.18
- 1% percentile: -1.5710824012756348
- 99% percentile: 0.7945964813232422
```



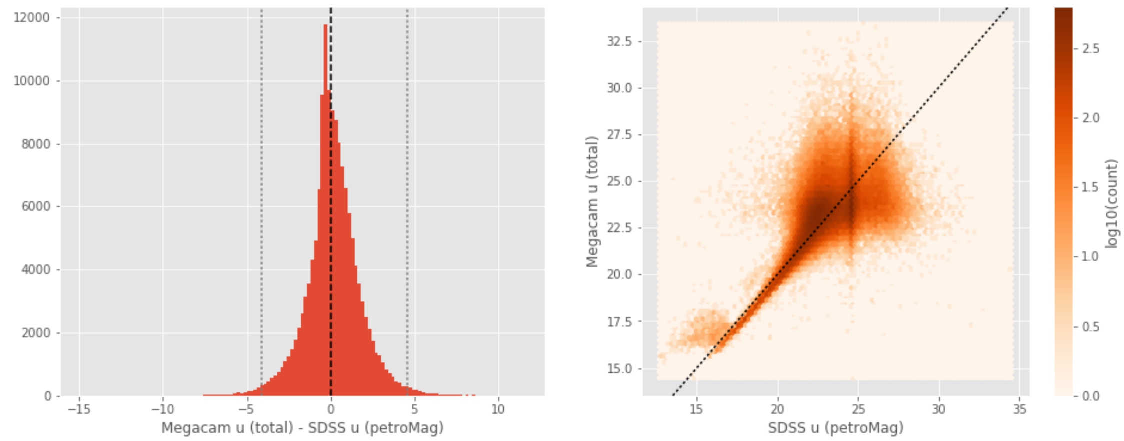
WFC u (total) - SDSS u (petroMag):
- Median: 0.07
- Median Absolute Deviation: 0.36
- 1% percentile: -3.809451866149902
- 99% percentile: 1.9933301925659166



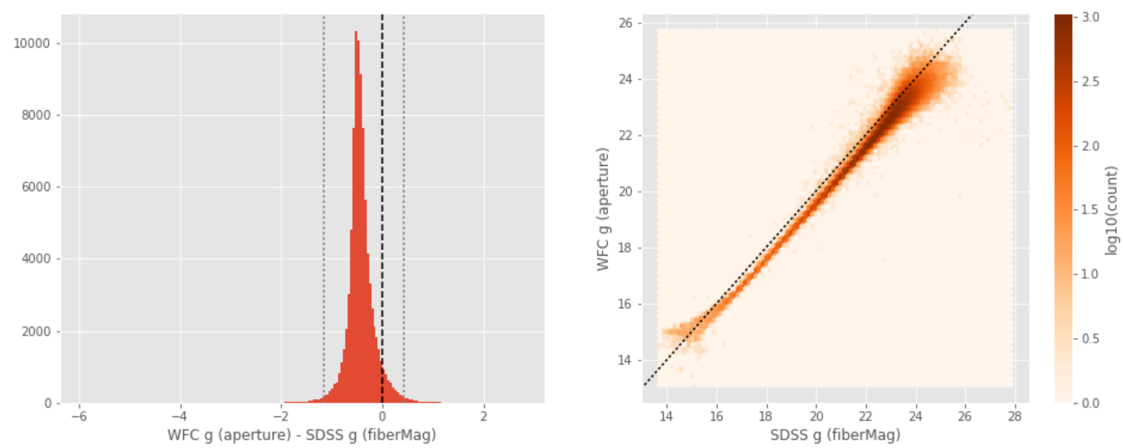
Megacam u (aperture) - SDSS u (fiberMag):
- Median: 0.01
- Median Absolute Deviation: 0.52
- 1% percentile: -1.7239515686035158
- 99% percentile: 3.037174682617188



Megacam u (total) - SDSS u (petroMag):
- Median: 0.09
- Median Absolute Deviation: 0.83
- 1% percentile: -4.138626194000244
- 99% percentile: 4.583783168792724

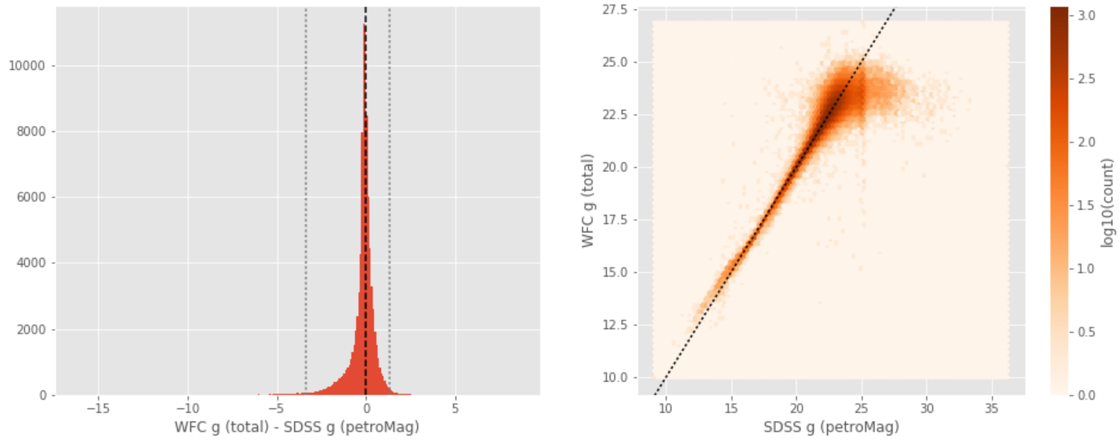


WFC g (aperture) - SDSS g (fiberMag):
- Median: -0.45
- Median Absolute Deviation: 0.12
- 1% percentile: -1.153176498413086
- 99% percentile: 0.4261890411376952

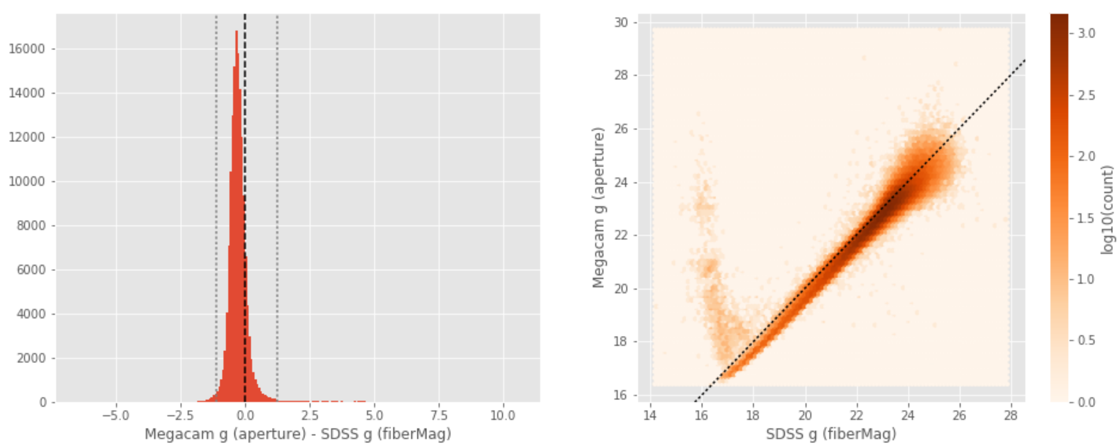


WFC g (total) - SDSS g (petroMag):
- Median: -0.08

- Median Absolute Deviation: 0.23
- 1% percentile: -3.3376033782958983
- 99% percentile: 1.32151603698731

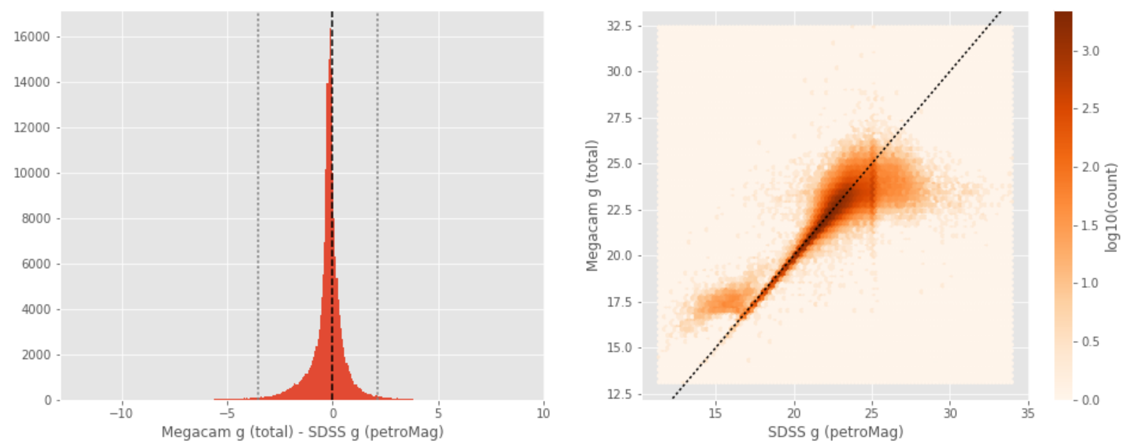


Megacam g (aperture) - SDSS g (fiberMag):
- Median: -0.29
- Median Absolute Deviation: 0.18
- 1% percentile: -1.0998111724853517
- 99% percentile: 1.262142181396477

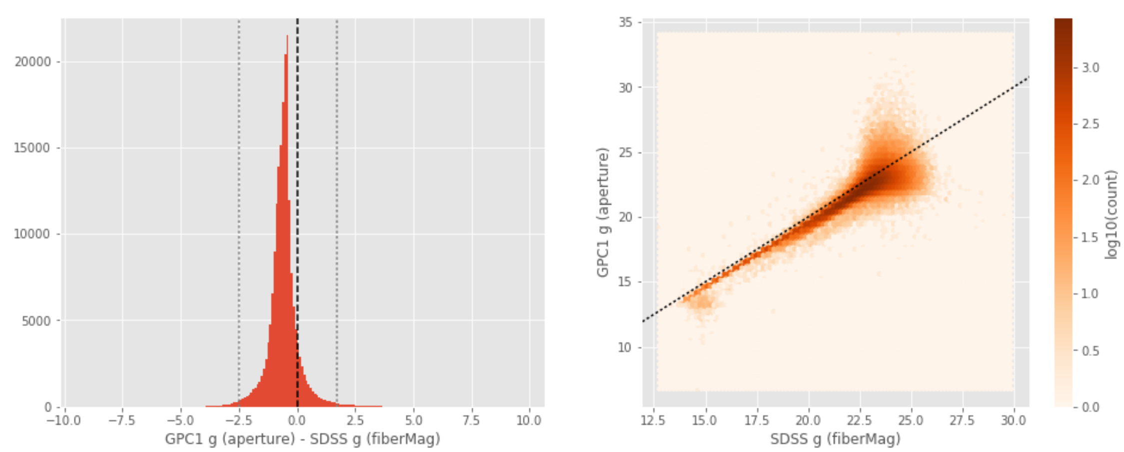


Megacam g (total) - SDSS g (petroMag):
- Median: -0.15
- Median Absolute Deviation: 0.26
- 1% percentile: -3.540327453613281

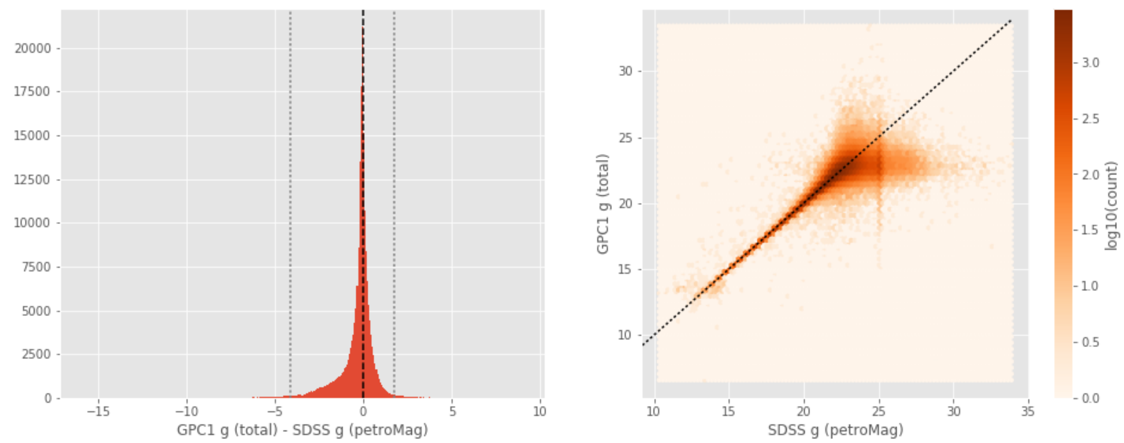
- 99% percentile: 2.118810653686525



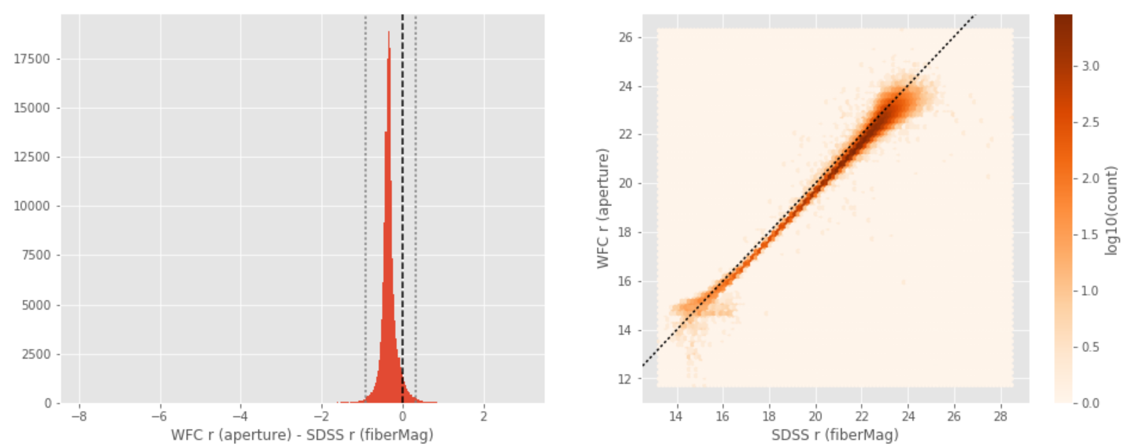
GPC1 g (aperture) - SDSS g (fiberMag):
- Median: -0.56
- Median Absolute Deviation: 0.26
- 1% percentile: -2.496891307830811
- 99% percentile: 1.7368188095092725



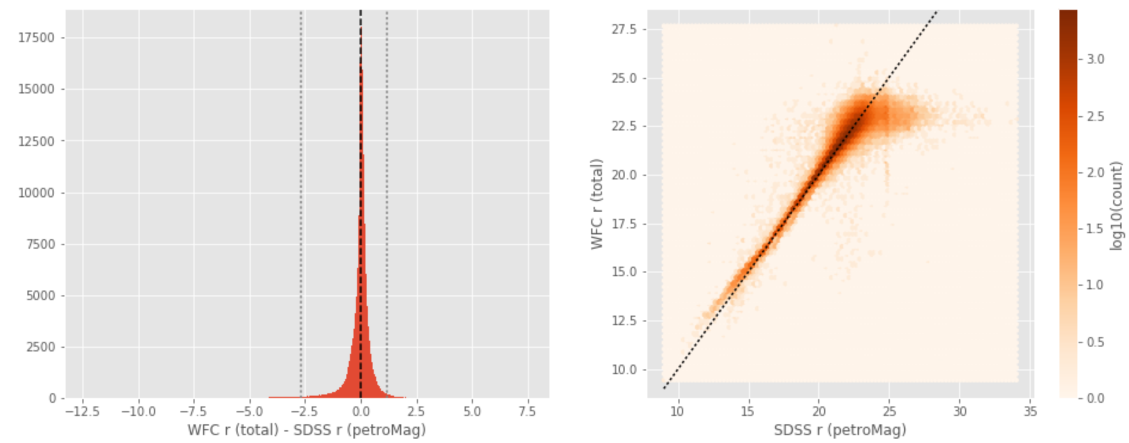
GPC1 g (total) - SDSS g (petroMag):
- Median: -0.10
- Median Absolute Deviation: 0.27
- 1% percentile: -4.111917877197266
- 99% percentile: 1.7278203964233376



WFC r (aperture) - SDSS r (fiberMag):
- Median: -0.35
- Median Absolute Deviation: 0.07
- 1% percentile: -0.9245659255981445
- 99% percentile: 0.3214846229553226

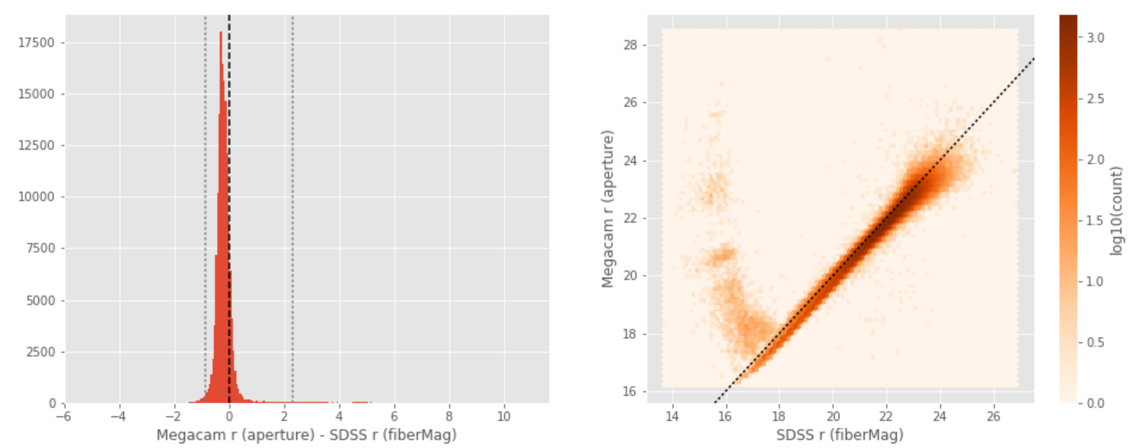


WFC r (total) - SDSS r (petroMag):
- Median: 0.04
- Median Absolute Deviation: 0.15
- 1% percentile: -2.676791229248047
- 99% percentile: 1.1676996612548833

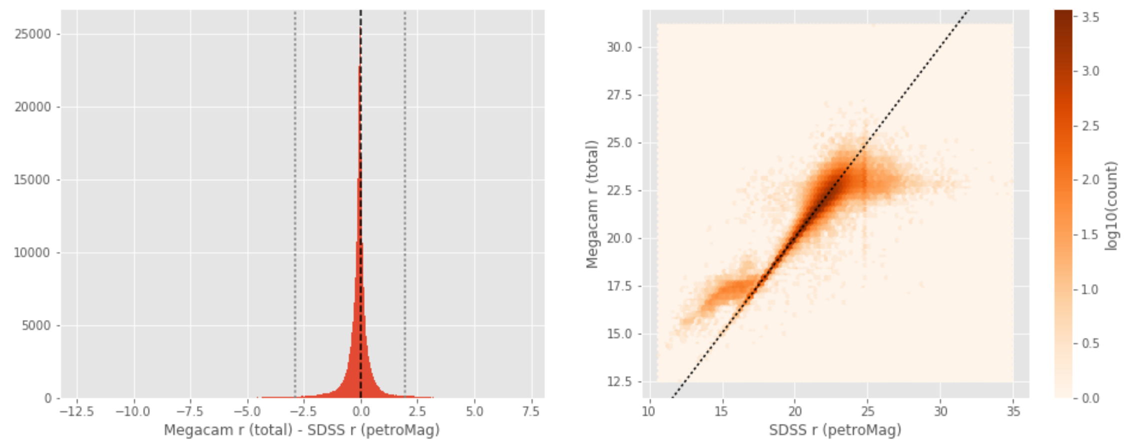



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:11:
```

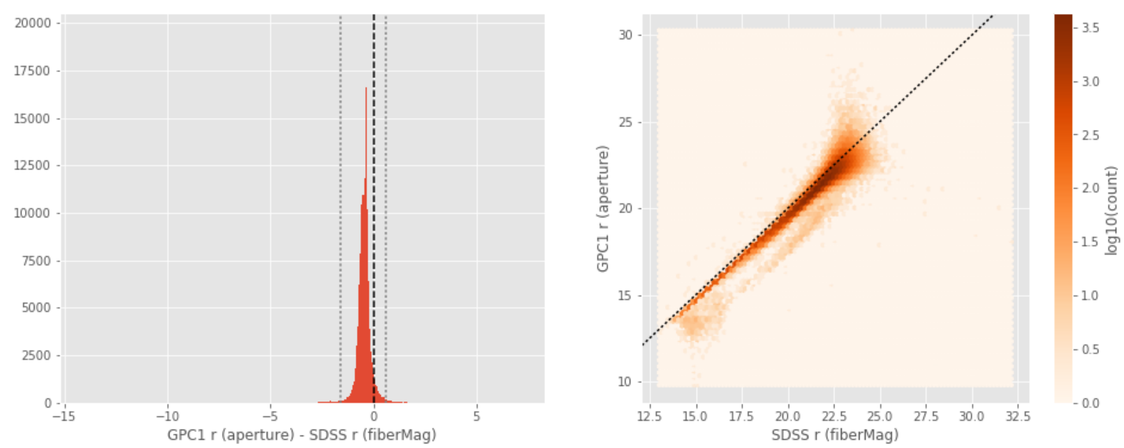
```
Megacam r (aperture) - SDSS r (fiberMag):
- Median: -0.21
- Median Absolute Deviation: 0.14
- 1% percentile: -0.8575413894653321
- 99% percentile: 2.322139625549326
```



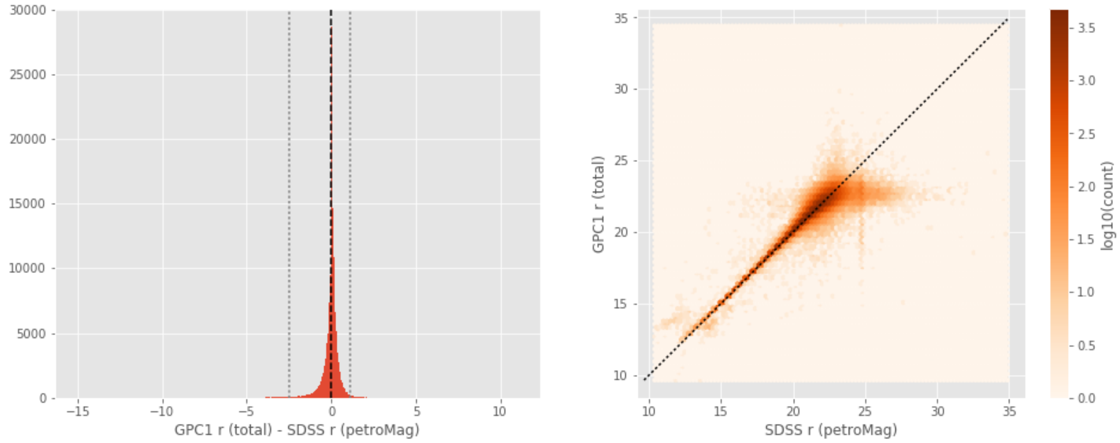

```
Megacam r (total) - SDSS r (petroMag):
- Median: -0.06
- Median Absolute Deviation: 0.15
- 1% percentile: -2.867800807952881
- 99% percentile: 1.969779825210568
```



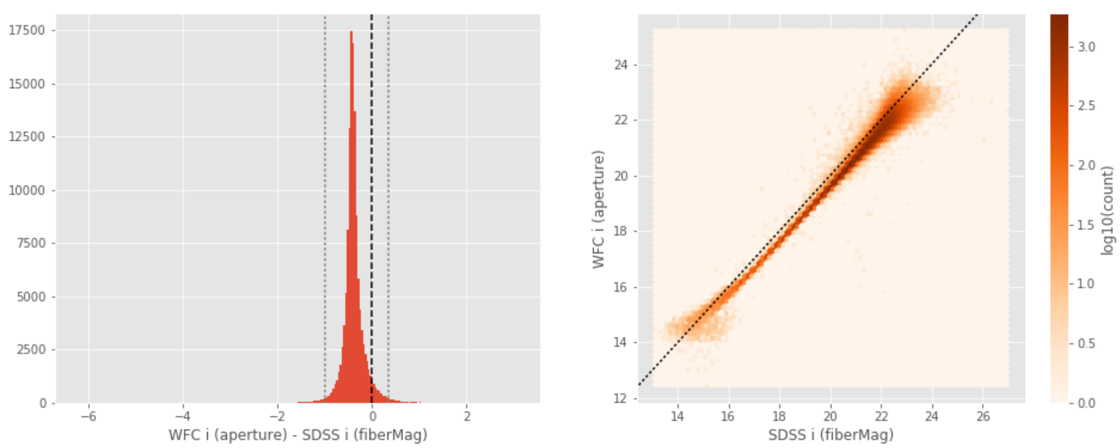
GPC1 r (aperture) - SDSS r (fiberMag):
- Median: -0.43
- Median Absolute Deviation: 0.14
- 1% percentile: -1.5779515075683594
- 99% percentile: 0.6068578338623037



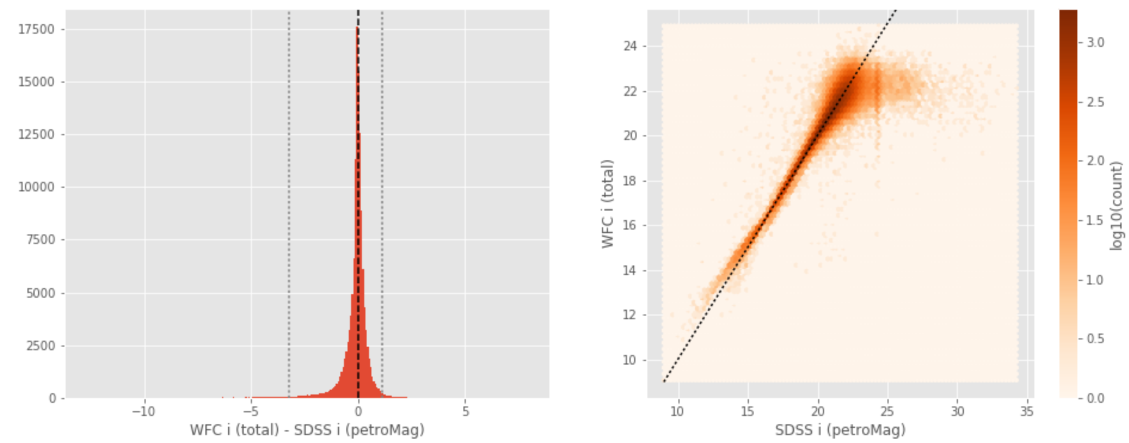
GPC1 r (total) - SDSS r (petroMag):
- Median: 0.04
- Median Absolute Deviation: 0.14
- 1% percentile: -2.5192892456054685
- 99% percentile: 1.1319837570190423



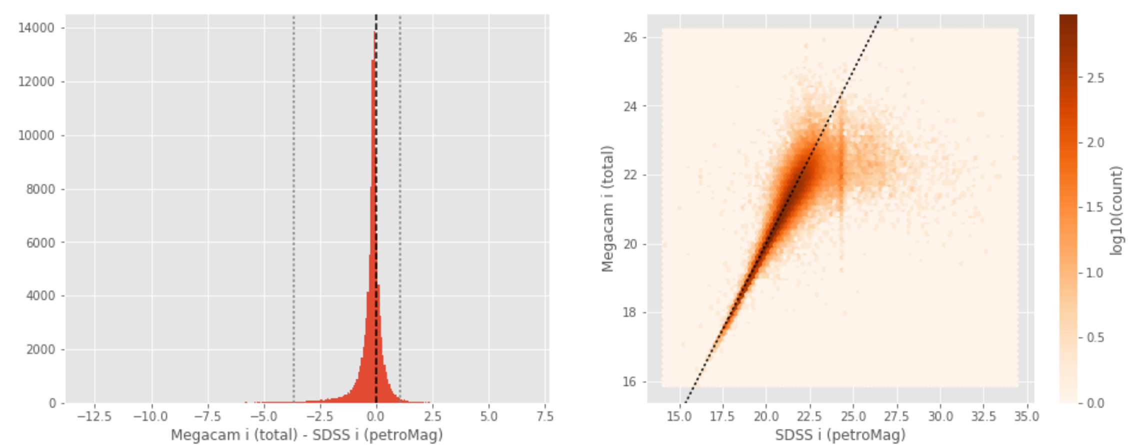
WFC i (aperture) - SDSS i (fiberMag):
- Median: -0.41
- Median Absolute Deviation: 0.08
- 1% percentile: -0.9962218856811523
- 99% percentile: 0.35475969314575084



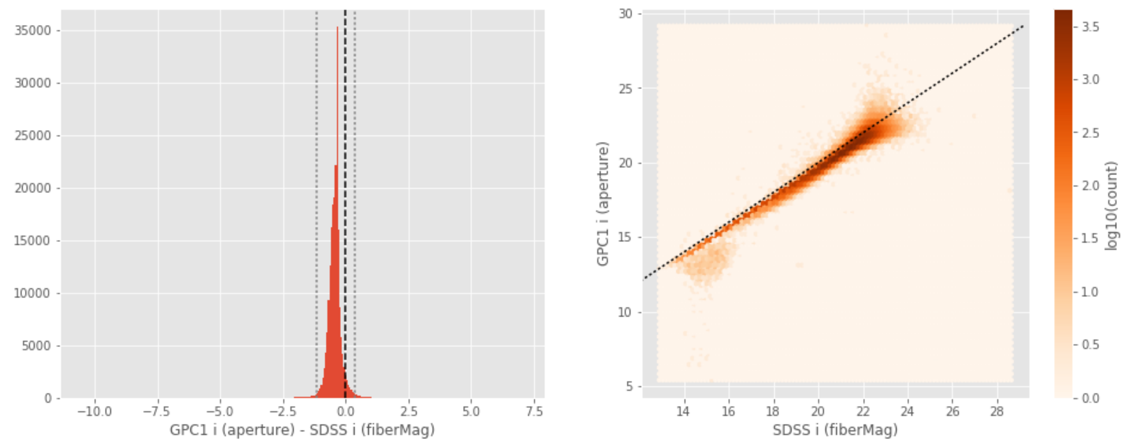
WFC i (total) - SDSS i (petroMag):
- Median: -0.02
- Median Absolute Deviation: 0.18
- 1% percentile: -3.216203365325928
- 99% percentile: 1.130485744476317



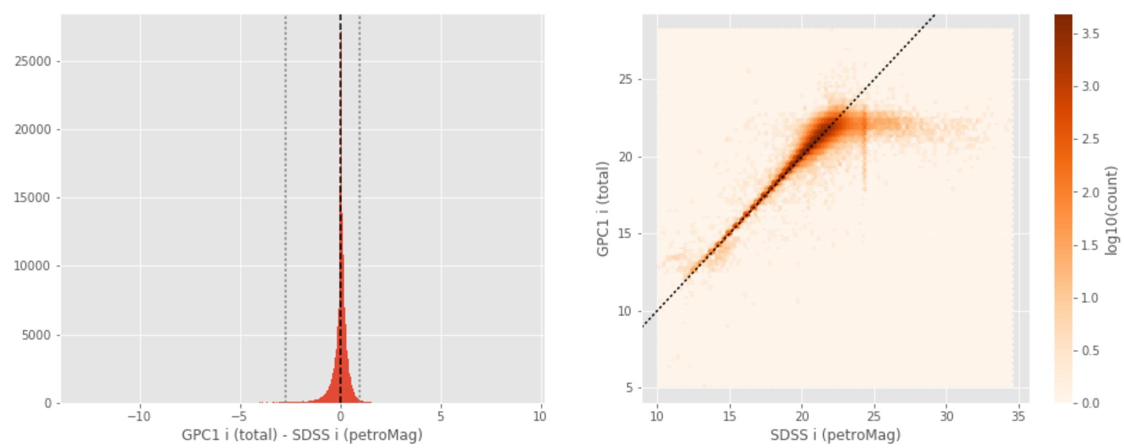
Megacam i (total) - SDSS i (petroMag):
- Median: -0.13
- Median Absolute Deviation: 0.17
- 1% percentile: -3.6602382850646973
- 99% percentile: 1.091551609039307



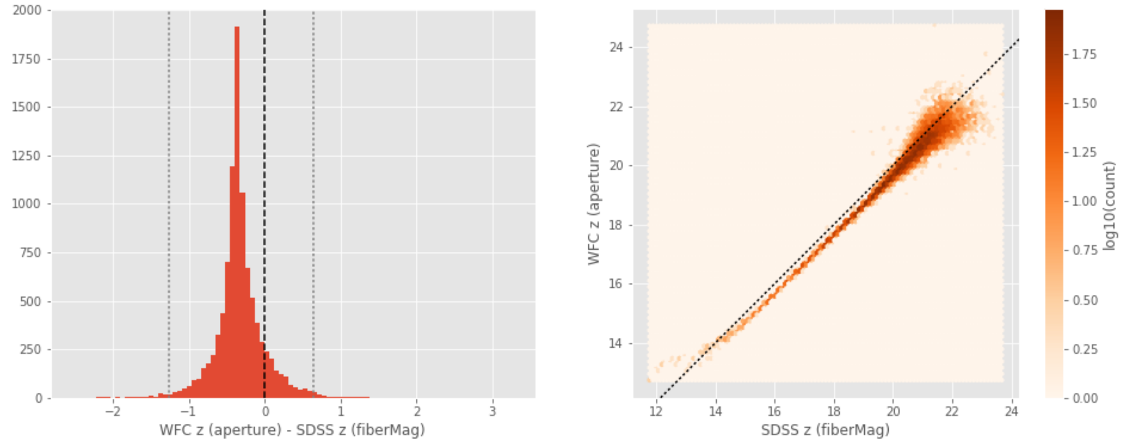
GPC1 i (aperture) - SDSS i (fiberMag):
- Median: -0.41
- Median Absolute Deviation: 0.12
- 1% percentile: -1.1483927154541016
- 99% percentile: 0.3729707336425758



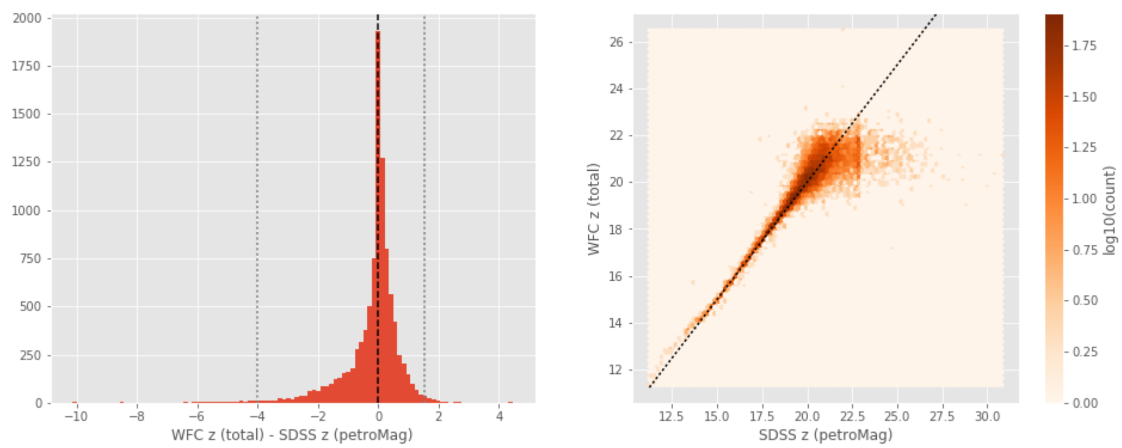
GPC1 i (total) - SDSS i (petroMag):
- Median: 0.05
- Median Absolute Deviation: 0.13
- 1% percentile: -2.7237721443176266
- 99% percentile: 0.9462432289123528



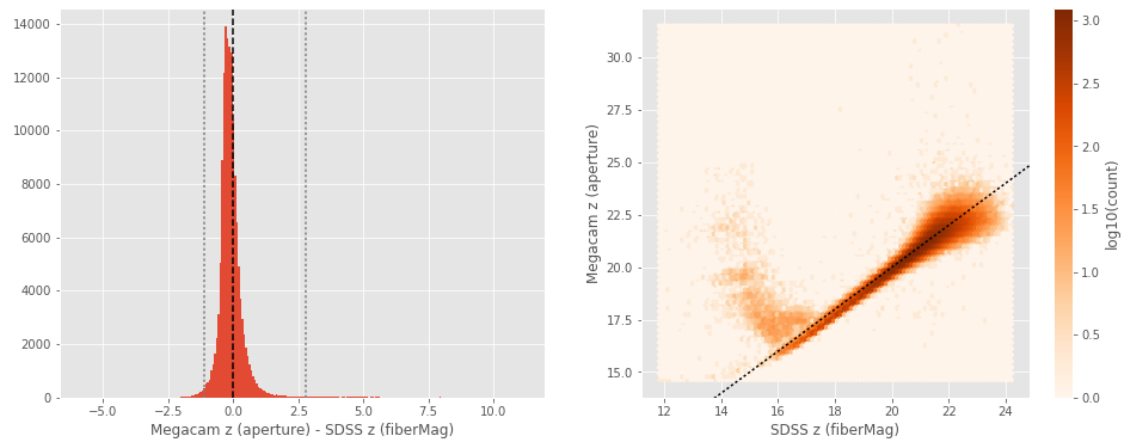
WFC z (aperture) - SDSS z (fiberMag):
- Median: -0.35
- Median Absolute Deviation: 0.12
- 1% percentile: -1.2592236328125
- 99% percentile: 0.6335509490966799



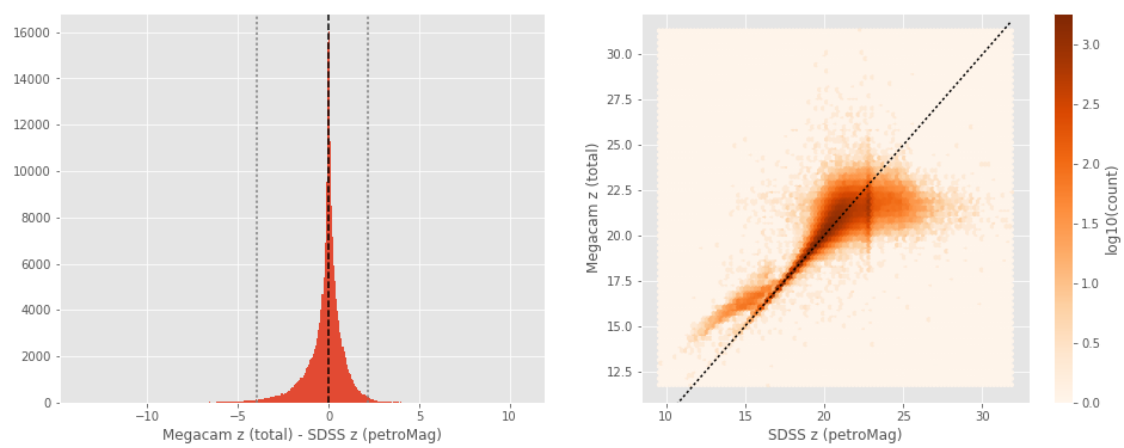
WFC z (total) - SDSS z (petroMag):
- Median: 0.00
- Median Absolute Deviation: 0.30
- 1% percentile: -4.017242908477783
- 99% percentile: 1.5223383903503418



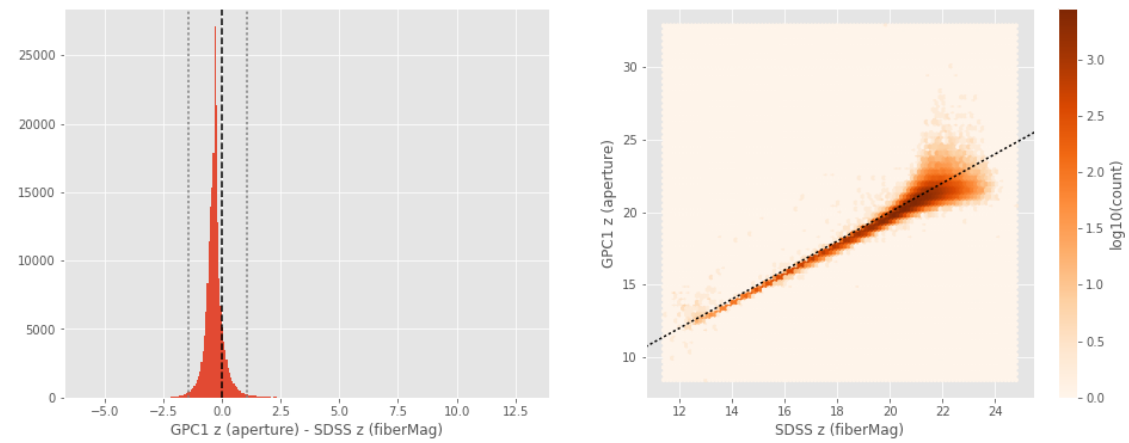
Megacam z (aperture) - SDSS z (fiberMag):
- Median: -0.14
- Median Absolute Deviation: 0.20
- 1% percentile: -1.1127138900756837
- 99% percentile: 2.7650779533386163



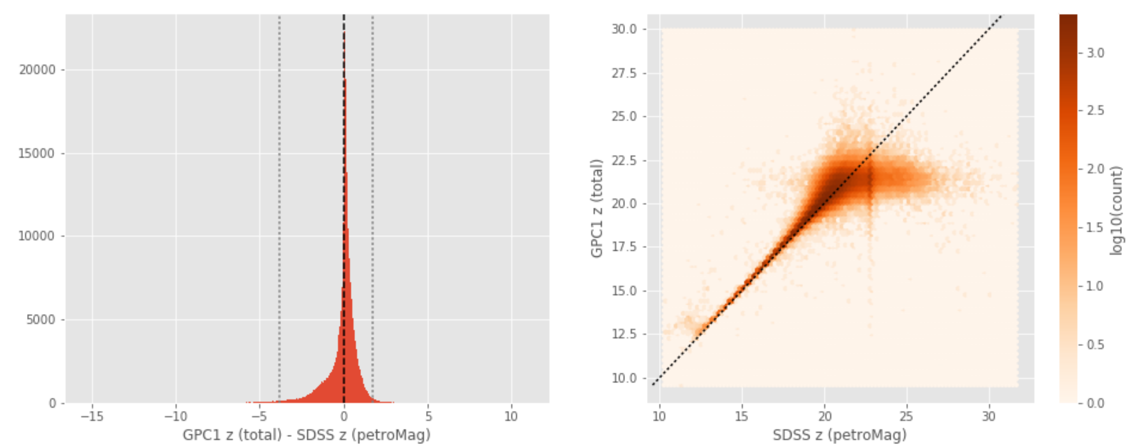
Megacam z (total) - SDSS z (petroMag):
- Median: -0.02
- Median Absolute Deviation: 0.37
- 1% percentile: -3.9964558029174806
- 99% percentile: 2.1697754859924325



GPC1 z (aperture) - SDSS z (fiberMag):
- Median: -0.32
- Median Absolute Deviation: 0.17
- 1% percentile: -1.417550163269043
- 99% percentile: 1.0491362571716336



GPC1 z (total) - SDSS z (petroMag):
- Median: 0.11
- Median Absolute Deviation: 0.29
- 1% percentile: -3.821057033538818
- 99% percentile: 1.7081263542175282



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.

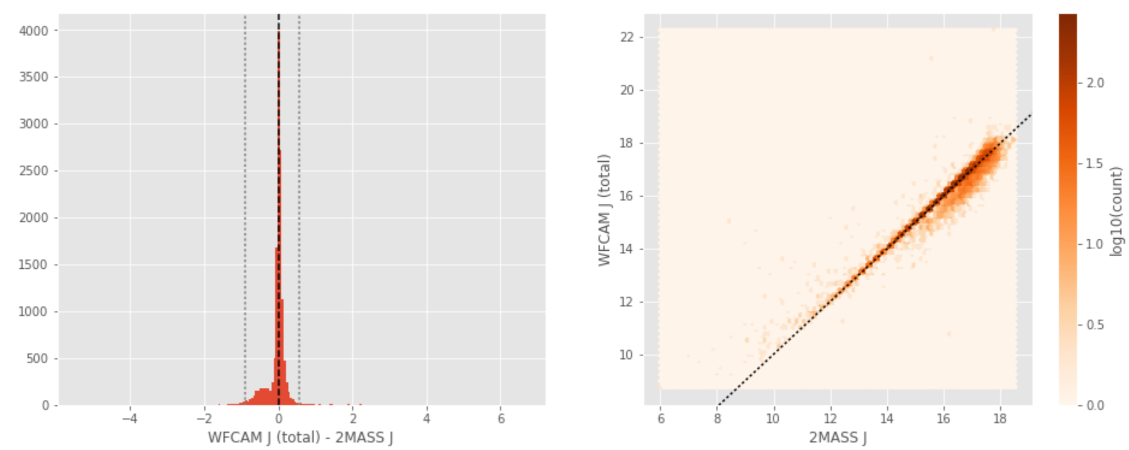
The 2MASS magnitudes are "*Vega-like*" and we have to convert them to AB magnitudes using the zero points provided on this page:

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

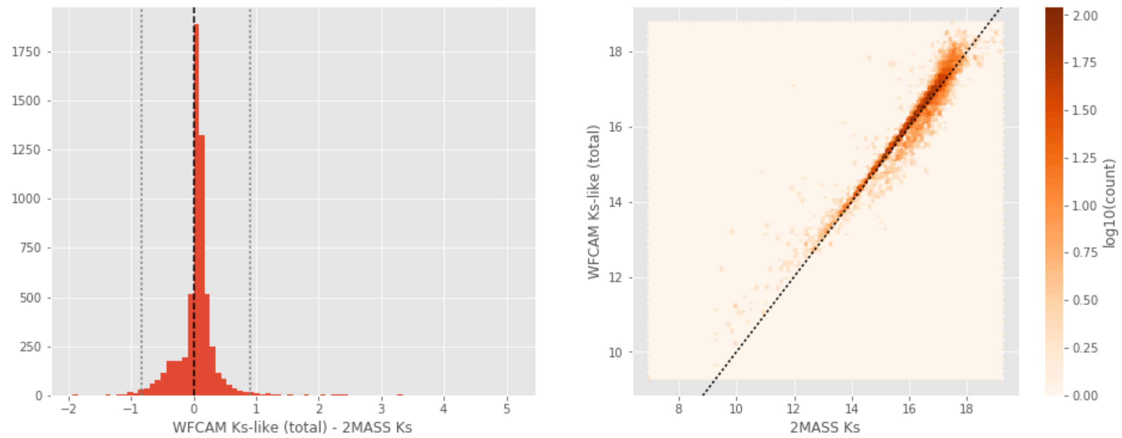
In addition, UKIDSS uses a K band whereas 2MASS uses a Ks ("short") band, this page give a correction to convert the K band in a Ks band with the formula:

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

```
WFCAM J (total) - 2MASS J:
- Median: 0.02
- Median Absolute Deviation: 0.05
- 1% percentile: -0.9130657836820437
- 99% percentile: 0.575751805124098
```




```
WFCAM Ks-like (total) - 2MASS Ks:
- Median: 0.07
- Median Absolute Deviation: 0.08
- 1% percentile: -0.8240238957842398
- 99% percentile: 0.9100533730451055
```



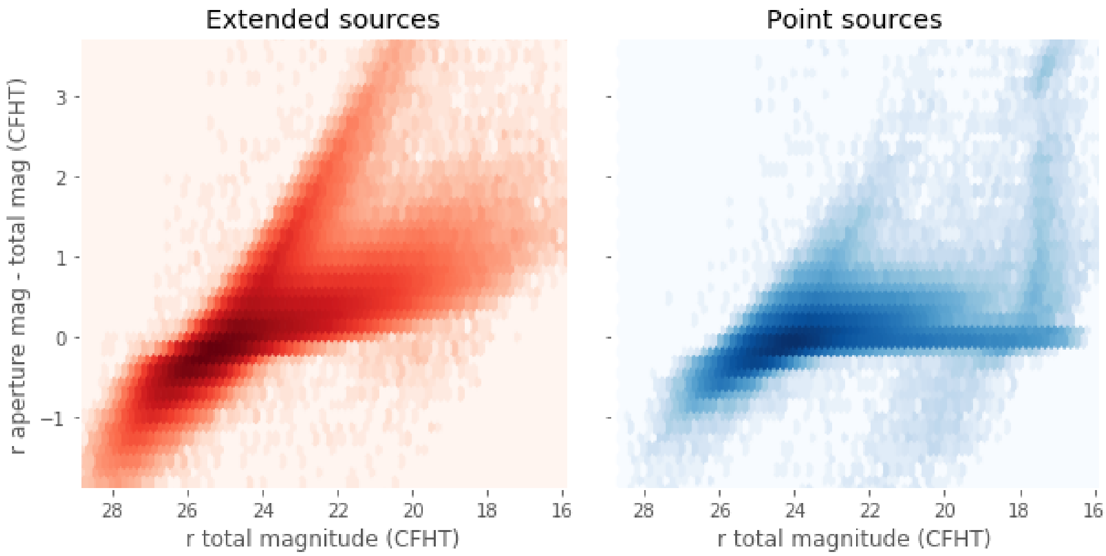
1.6 Keeping only sources with good signal to noise ratio

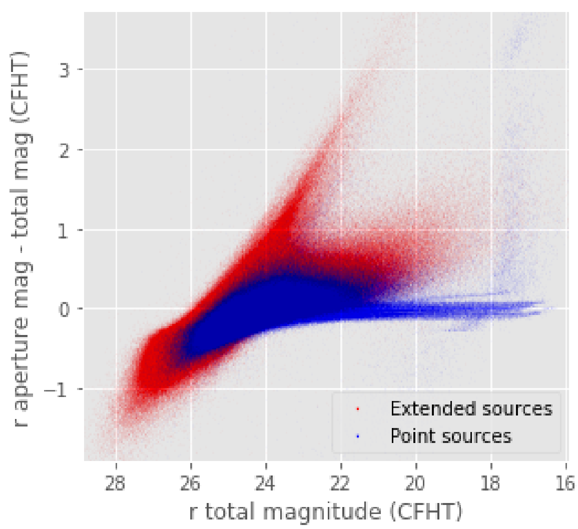
From here, we are only comparing sources with a signal to noise ratio above 3, i.e. roughly we a magnitude error below 0.3.

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.

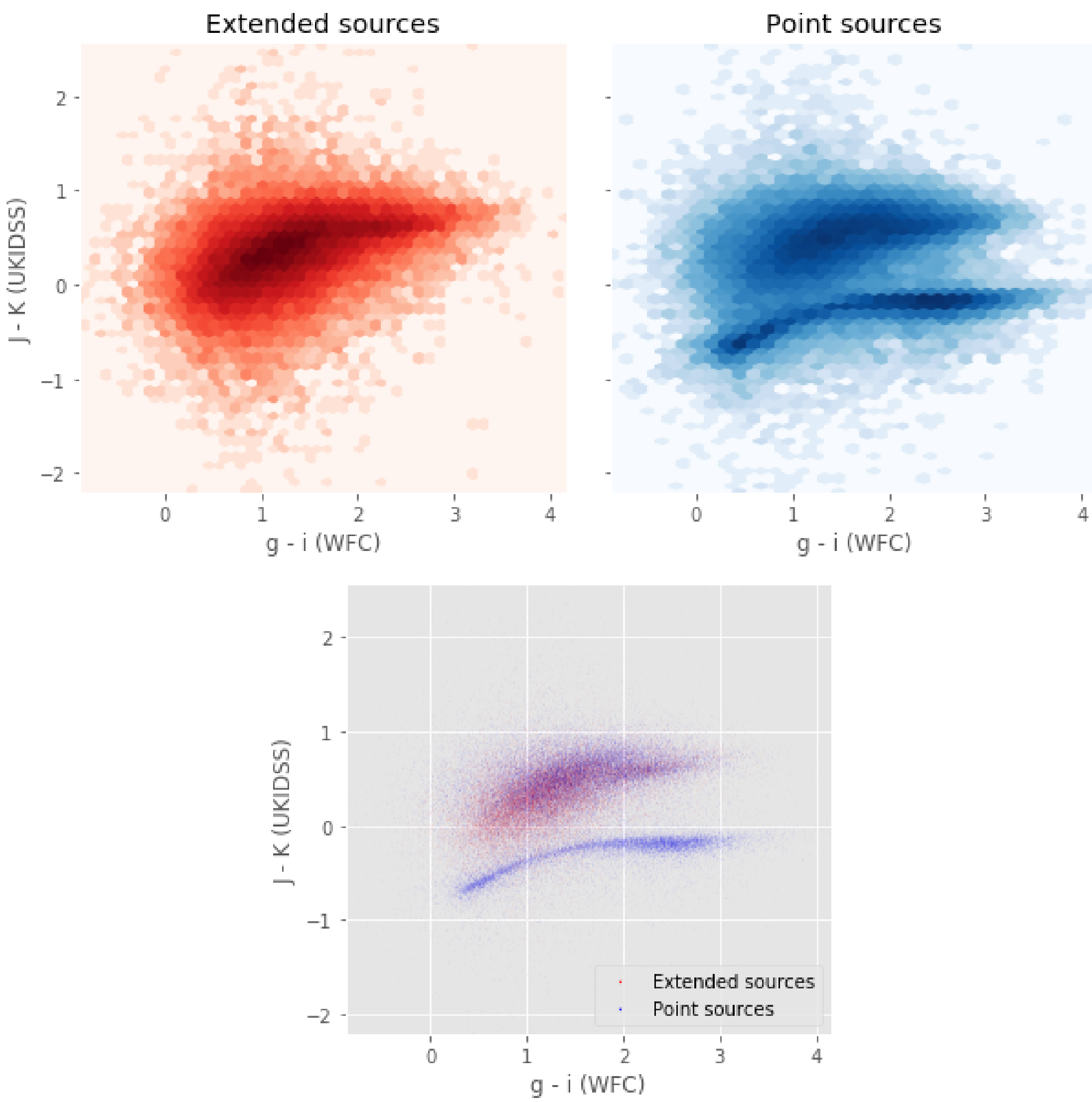
```
Number of source used: 2456999 / 4366298 (56.27%)
```



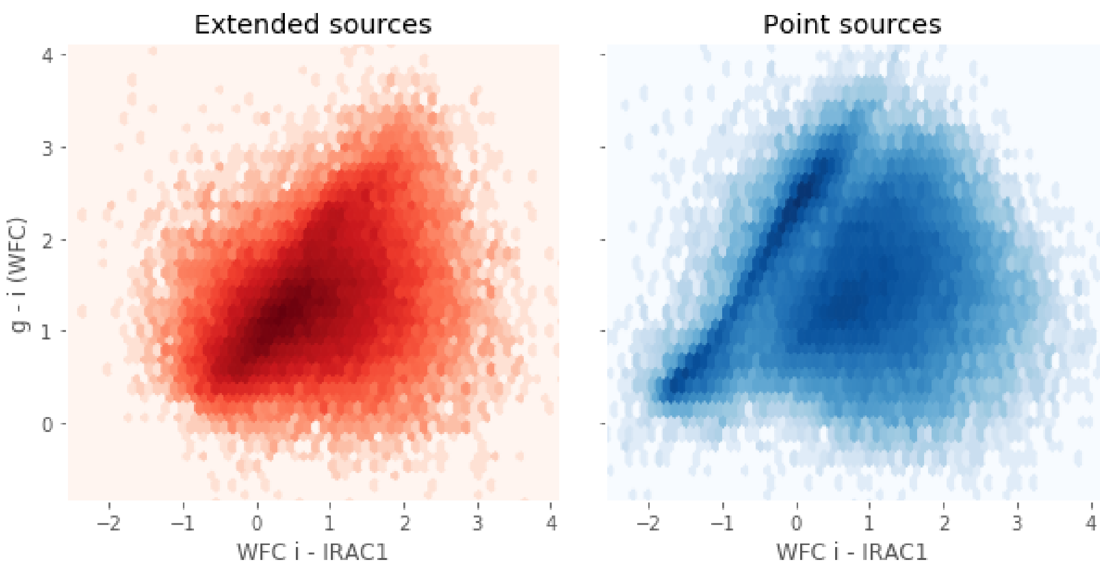


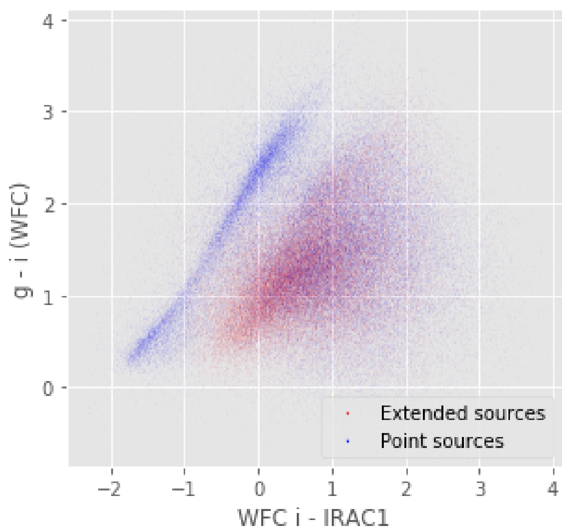
1.8 V - Color-color and magnitude-color plots

```
Number of source used: 85805 / 4366298 (1.97%)
```

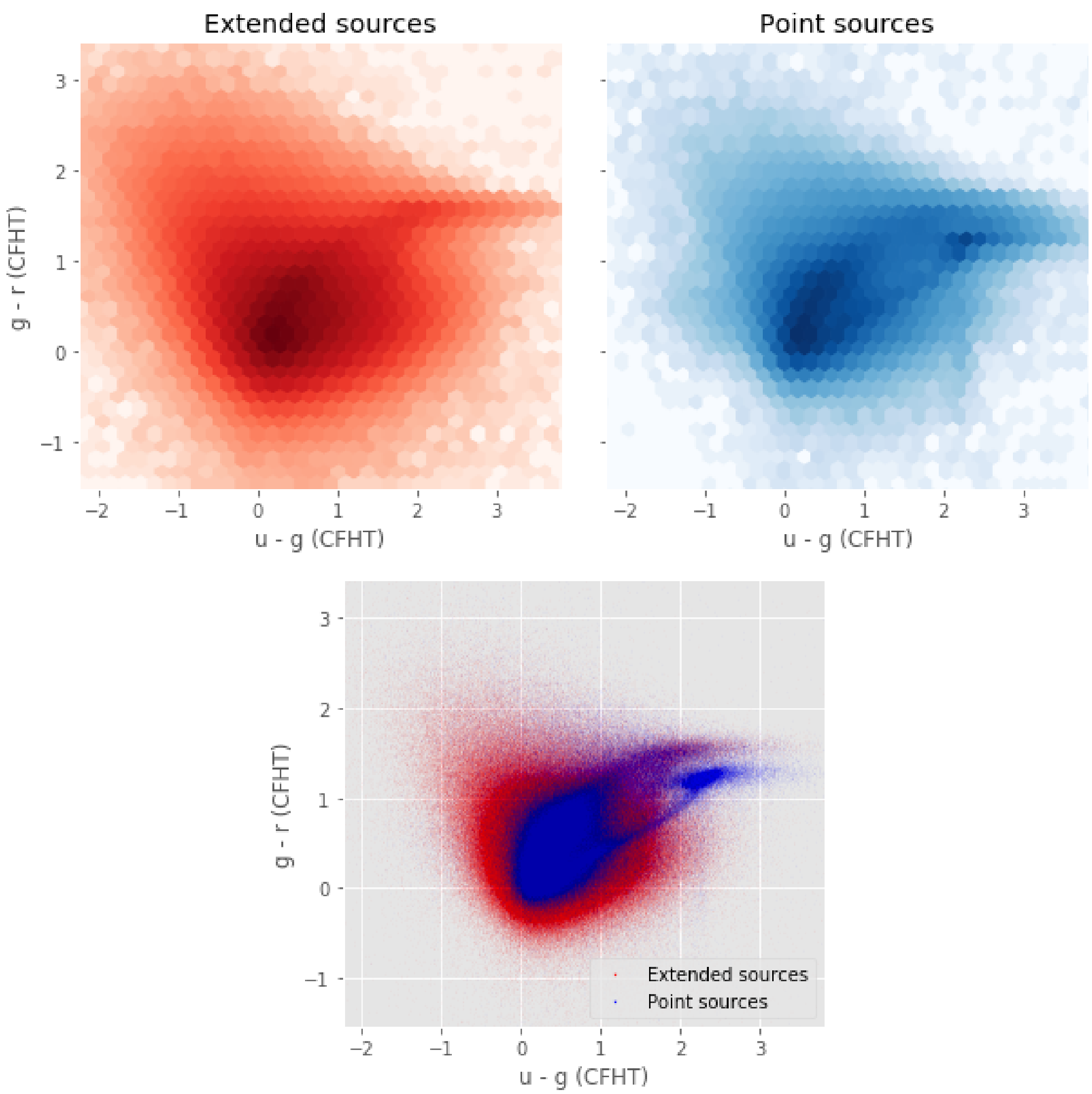



```
Number of source used: 129379 / 4366298 (2.96%)
```

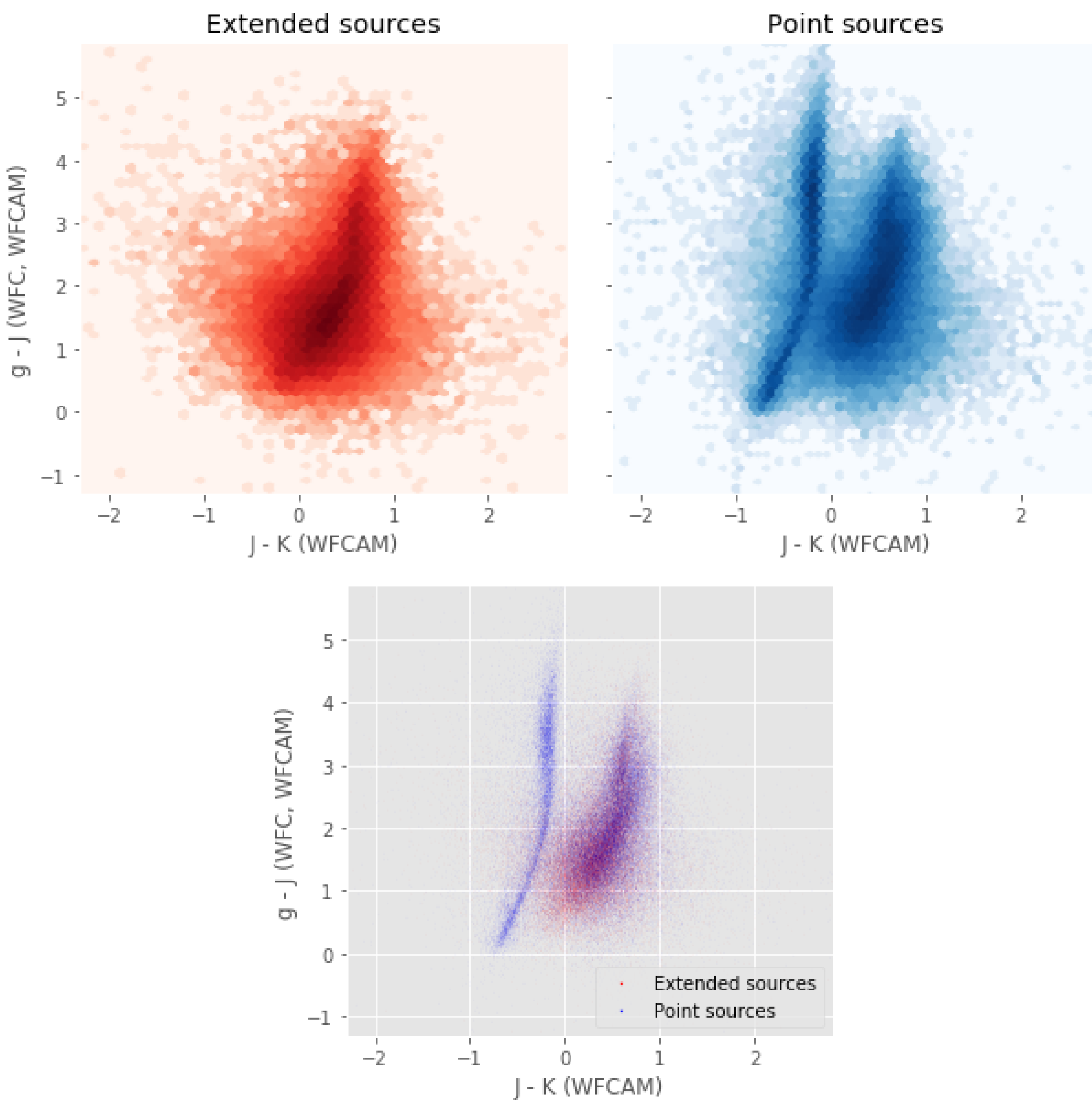




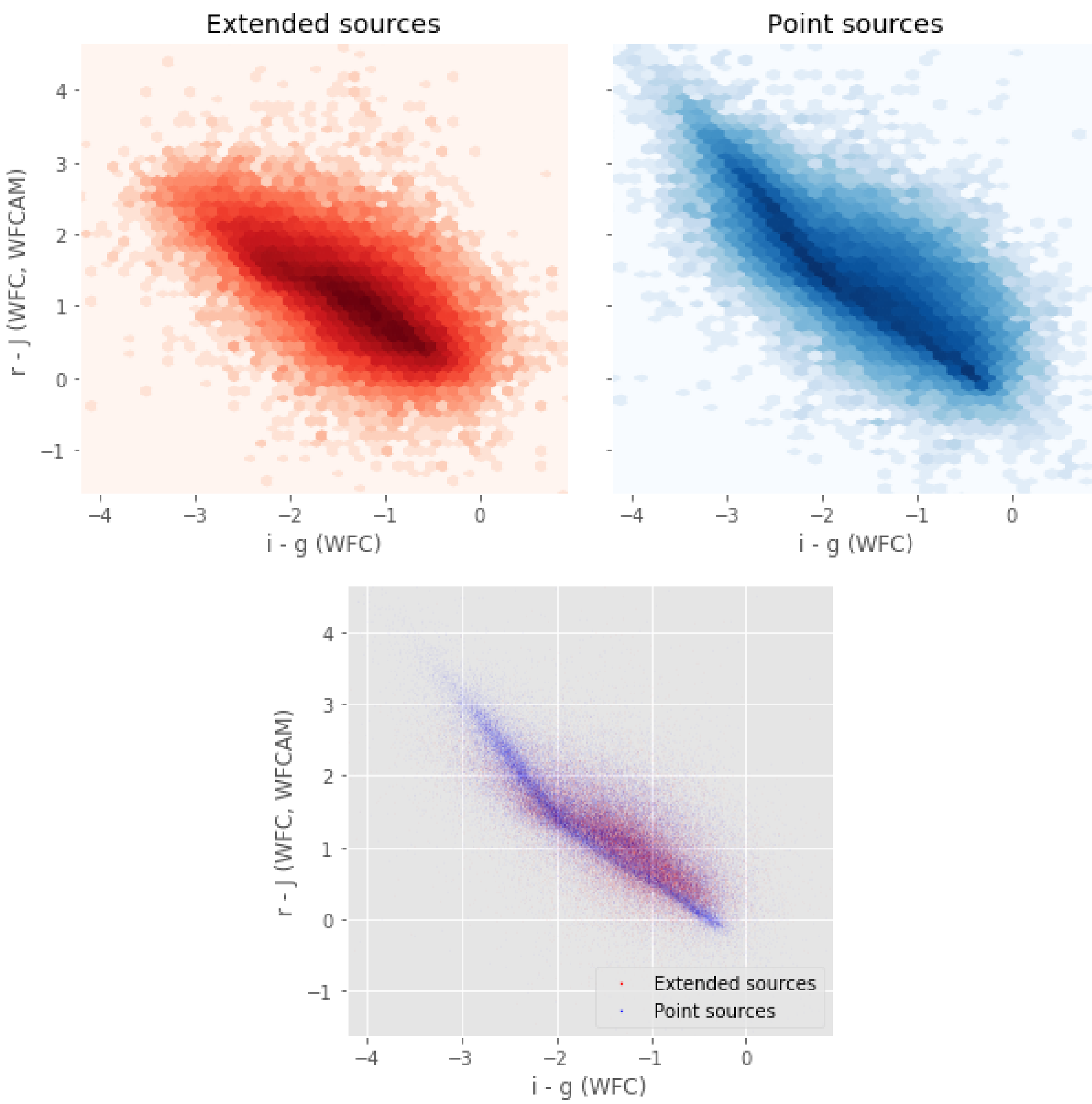

```
Number of source used: 2072647 / 4366298 (47.47%)
```



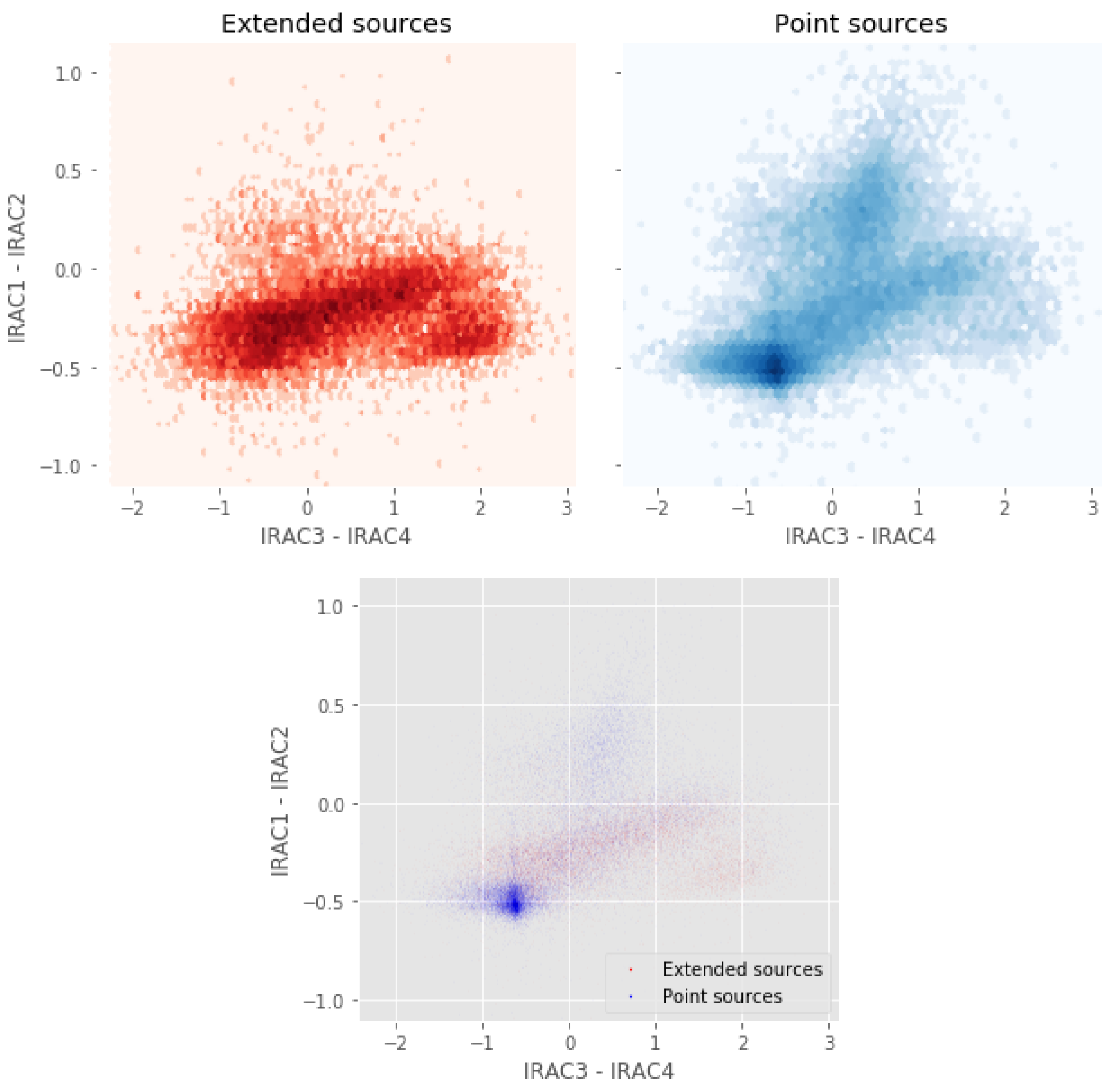
Number of source used: 108739 / 4366298 (2.49%)




```
Number of source used: 107975 / 4366298 (2.47%)
```



Number of source used: 38805 / 4366298 (0.89%)


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

4_Selection_function

March 8, 2018

1 Lockman-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 22:34:00.122817
```

```
Depth maps produced using: master_catalogue_lockman-swire_20180219.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

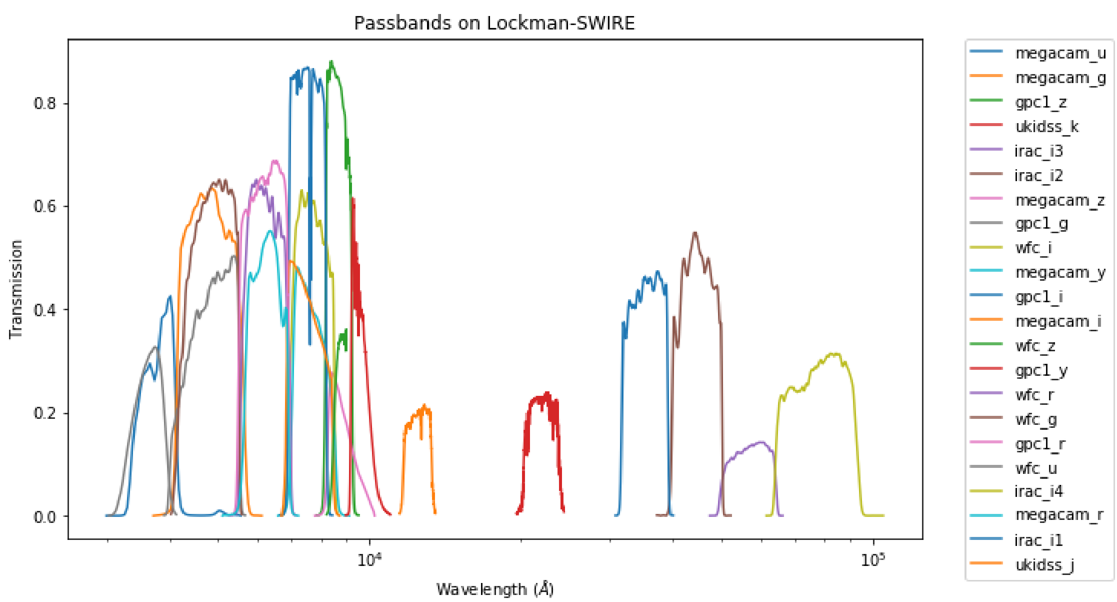
1.5 IV - Overview plots

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]: {'gpc1_g',
          'gpc1_i',
          'gpc1_r',
          'gpc1_y',
          'gpc1_z',
          'irac_i1',
          'irac_i2',
          'irac_i3',
          'irac_i4',
          'megacam_g',
          'megacam_i',
          'megacam_r',
          'megacam_u',
          'megacam_y',
          'megacam_z',
          'ukidss_j',
          'ukidss_k',
          'wfc_g',
          'wfc_i',
          'wfc_r',
          'wfc_u',
          'wfc_z'}
```

```
Out[15]: <matplotlib.text.Text at 0x7ff2bc1e1be0>
```



1.5.2 IV.a - Depth overview

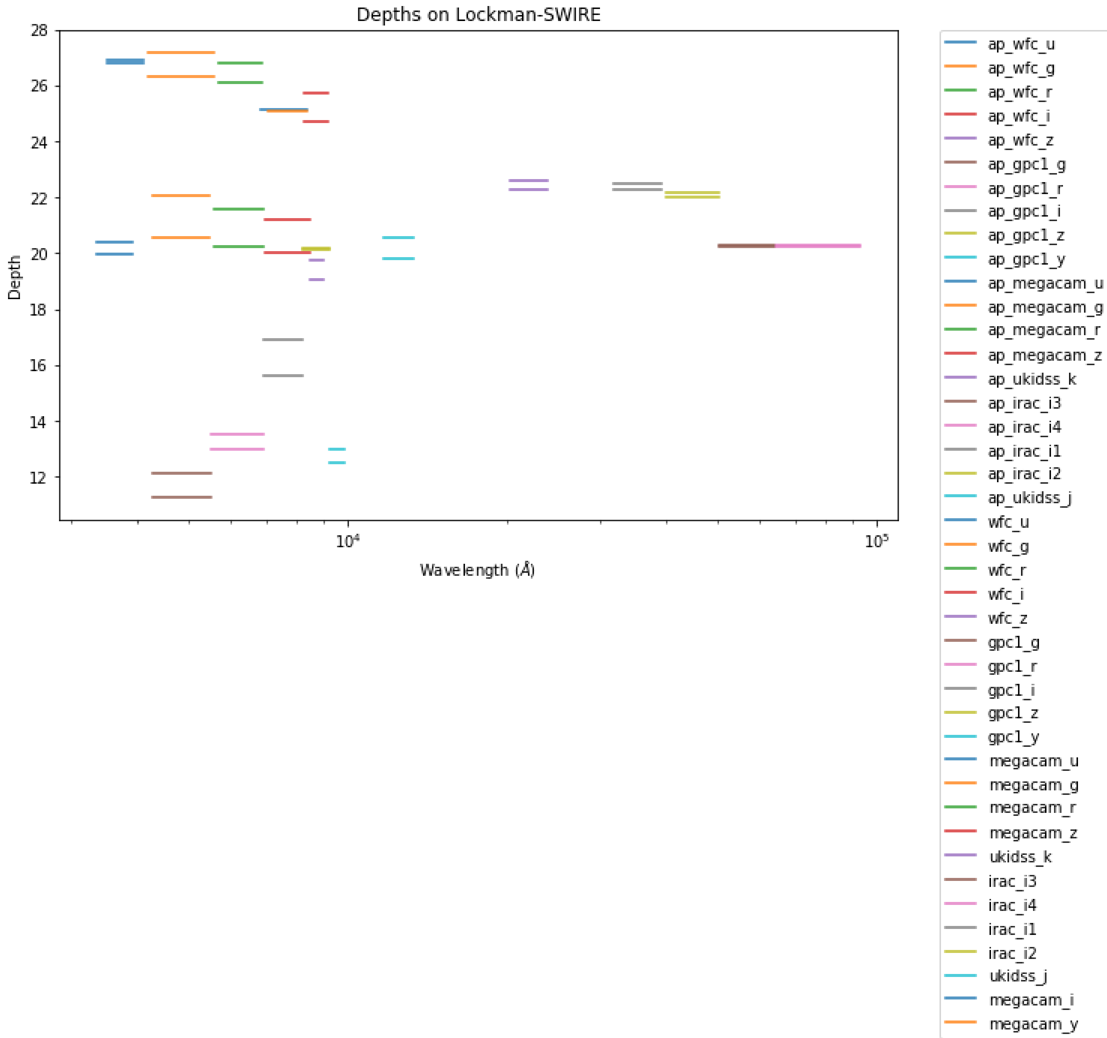
Then we plot the mean depths available across the area a given band is available

```
wfc_u: mean flux error: 4.936374187469482, 3sigma in AB mag (Aperture): 20.973676681447323
wfc_g: mean flux error: 1.0692477226257324, 3sigma in AB mag (Aperture): 22.634501028369094
wfc_r: mean flux error: 1.7183113098144531, 3sigma in AB mag (Aperture): 22.119442241694152
wfc_i: mean flux error: 2.39717435836792, 3sigma in AB mag (Aperture): 21.75794780427112
wfc_z: mean flux error: 9.264328956604004, 3sigma in AB mag (Aperture): 20.290161944376102
gpc1_g: mean flux error: 22836.553930125847, 3sigma in AB mag (Aperture): 11.810620441110146
gpc1_r: mean flux error: 4714.364691803354, 3sigma in AB mag (Aperture): 13.523638924565283
gpc1_i: mean flux error: 410.7571563940765, 3sigma in AB mag (Aperture): 16.1732340165887
gpc1_z: mean flux error: 6.249840500078714, 3sigma in AB mag (Aperture): 20.71752452816849
gpc1_y: mean flux error: 7207.466044379377, 3sigma in AB mag (Aperture): 13.062740350629461
megacam_u: mean flux error: 0.012559091672301292, 3sigma in AB mag (Aperture): 27.45980128698537
megacam_g: mean flux error: 0.009579558856785297, 3sigma in AB mag (Aperture): 27.75383308801885
megacam_r: mean flux error: 0.01368408091366291, 3sigma in AB mag (Aperture): 27.36665777946552
megacam_z: mean flux error: 0.03702336922287941, 3sigma in AB mag (Aperture): 26.28600701784449
ukidss_k: mean flux error: 0.6445478796958923, 3sigma in AB mag (Aperture): 23.18405890298282
irac_i3: mean flux error: 5.587946030580211, 3sigma in AB mag (Aperture): 20.839066355786592
irac_i4: mean flux error: 5.510331076157393, 3sigma in AB mag (Aperture): 20.854252630032967
irac_i1: mean flux error: 0.741503966996547, 3sigma in AB mag (Aperture): 23.031913166158354
irac_i2: mean flux error: 0.9710257052174538, 3sigma in AB mag (Aperture): 22.739120046190017
ukidss_j: mean flux error: 4.242930995262659, 3sigma in AB mag (Aperture): 21.13803194146775
wfc_u: mean flux error: 7.447465896606445, 3sigma in AB mag (Total): 20.52717555526882
wfc_g: mean flux error: 4.331153392791748, 3sigma in AB mag (Total): 21.11568795059562
wfc_r: mean flux error: 5.704468727111816, 3sigma in AB mag (Total): 20.816658854210793
wfc_i: mean flux error: 7.161104202270508, 3sigma in AB mag (Total): 20.569746880064166
wfc_z: mean flux error: 17.43876838684082, 3sigma in AB mag (Total): 19.603407339130122
gpc1_g: mean flux error: 10448.993585157154, 3sigma in AB mag (Total): 12.659510706810721
gpc1_r: mean flux error: 2823.125685080908, 3sigma in AB mag (Total): 14.080371329964223
gpc1_i: mean flux error: 125.44896266978421, 3sigma in AB mag (Total): 17.46102917692702
gpc1_z: mean flux error: 6.482695389234409, 3sigma in AB mag (Total): 20.67780782488179
gpc1_y: mean flux error: 4609.548993826724, 3sigma in AB mag (Total): 13.54805077482117
megacam_u: mean flux error: 0.013520908541977406, 3sigma in AB mag (Total): 27.379682175327652
megacam_g: mean flux error: 0.02123516167670021, 3sigma in AB mag (Total): 26.889557933457034
megacam_r: mean flux error: 0.0264785972726119, 3sigma in AB mag (Total): 26.64995942760536
megacam_z: mean flux error: 0.09379626891408026, 3sigma in AB mag (Total): 25.27673295547958
ukidss_k: mean flux error: 0.8938177824020386, 3sigma in AB mag (Total): 22.829074386578135
irac_i3: mean flux error: 5.96751838912753, 3sigma in AB mag (Total): 20.767712448262635
irac_i4: mean flux error: 5.952550581386076, 3sigma in AB mag (Total): 20.77043912700119
irac_i1: mean flux error: 0.9066543092579276, 3sigma in AB mag (Total): 22.81359253805146
irac_i2: mean flux error: 1.1163381637116847, 3sigma in AB mag (Total): 22.58770743317603
ukidss_j: mean flux error: 8.450241164784773, 3sigma in AB mag (Total): 20.39002410412818
megacam_i: mean flux error: 0.06349747627973557, 3sigma in AB mag (Total): 25.70030570192231
```

```
megacam_y: mean flux error: 0.06590443849563599, 3sigma in AB mag (Total): 25.659910202692636
```

```
ap_wfc_u (3355.0, 3925.0, 570.0)
ap_wfc_g (4260.0, 5485.0, 1225.0)
ap_wfc_r (5575.0, 6910.0, 1335.0)
ap_wfc_i (6970.0, 8485.0, 1515.0)
ap_wfc_z (8500.0, 9000.0, 500.0)
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_megacam_u (3500.0, 4100.0, 600.0)
ap_megacam_g (4180.0, 5580.0, 1400.0)
ap_megacam_r (5680.0, 6880.0, 1200.0)
ap_megacam_z (8280.0, 9160.0, 880.0)
ap_ukidss_k (20290.0, 23820.0, 3530.0)
ap_irac_i3 (50246.301, 64096.699, 13850.398)
ap_irac_i4 (64415.199, 92596.797, 28181.598)
ap_irac_i1 (31754.0, 39164.801, 7410.8008)
ap_irac_i2 (39980.102, 50052.301, 10072.199)
ap_ukidss_j (11695.0, 13280.0, 1585.0)
wfc_u (3355.0, 3925.0, 570.0)
wfc_g (4260.0, 5485.0, 1225.0)
wfc_r (5575.0, 6910.0, 1335.0)
wfc_i (6970.0, 8485.0, 1515.0)
wfc_z (8500.0, 9000.0, 500.0)
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)
megacam_u (3500.0, 4100.0, 600.0)
megacam_g (4180.0, 5580.0, 1400.0)
megacam_r (5680.0, 6880.0, 1200.0)
megacam_z (8280.0, 9160.0, 880.0)
ukidss_k (20290.0, 23820.0, 3530.0)
irac_i3 (50246.301, 64096.699, 13850.398)
irac_i4 (64415.199, 92596.797, 28181.598)
irac_i1 (31754.0, 39164.801, 7410.8008)
irac_i2 (39980.102, 50052.301, 10072.199)
ukidss_j (11695.0, 13280.0, 1585.0)
megacam_i (6831.7305, 8388.5557, 1556.8252)
megacam_y (7040.0, 8360.0, 1320.0)
```

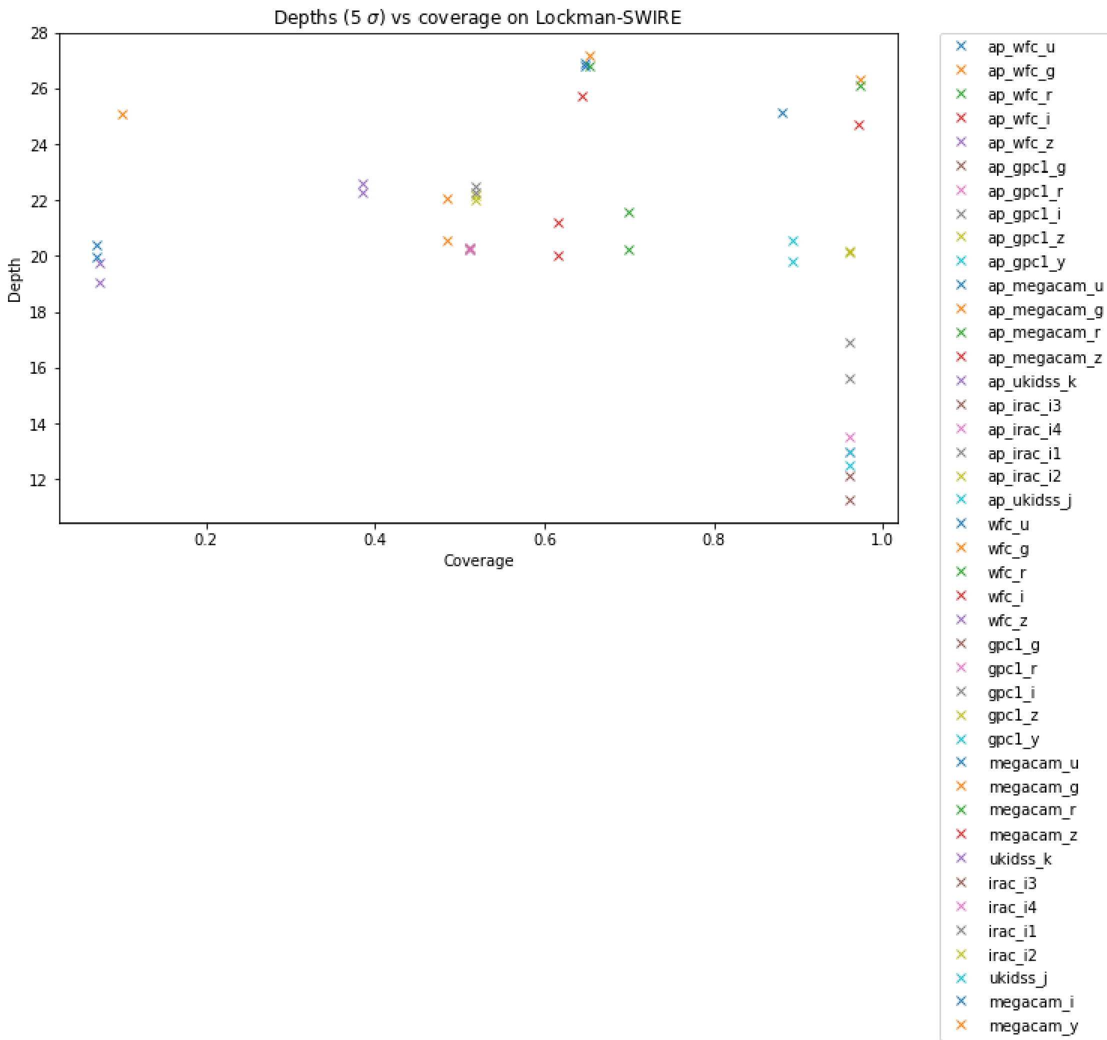
```
Out[20]: <matplotlib.text.Text at 0x7ff2ba751630>
```



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 0x7ff2ba707080>
```



Depths (5 σ) vs coverage on Lockman-SWIRE
Depth
Coverage
ap_wfc_u
ap_wfc_g
ap_wfc_r
ap_wfc_i
ap_wfc_z
ap_gpc1_g
ap_gpc1_r
ap_gpc1_i
ap_gpc1_z
ap_gpc1_y
ap_megacam_u
ap_megacam_g
ap_megacam_r
ap_megacam_z
ap_ukidss_k
ap_irac_i3
ap_irac_i4
ap_irac_i1
ap_irac_i2
ap_ukidss_j
wfc_u
wfc_g
wfc_r
wfc_i
wfc_z
gpc1_g
gpc1_r
gpc1_i
gpc1_z
gpc1_y
megacam_u
megacam_g
megacam_r
megacam_z
ukidss_k
irac_i3
irac_i4
irac_i1
irac_i2
ukidss_j
megacam_i
megacam_y