1.1_INT-WFC

March 8, 2018

1 ELAIS-N1 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:
284b2ef (Mon Aug 14 20:02:12 2017 +0100)
```

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>
```

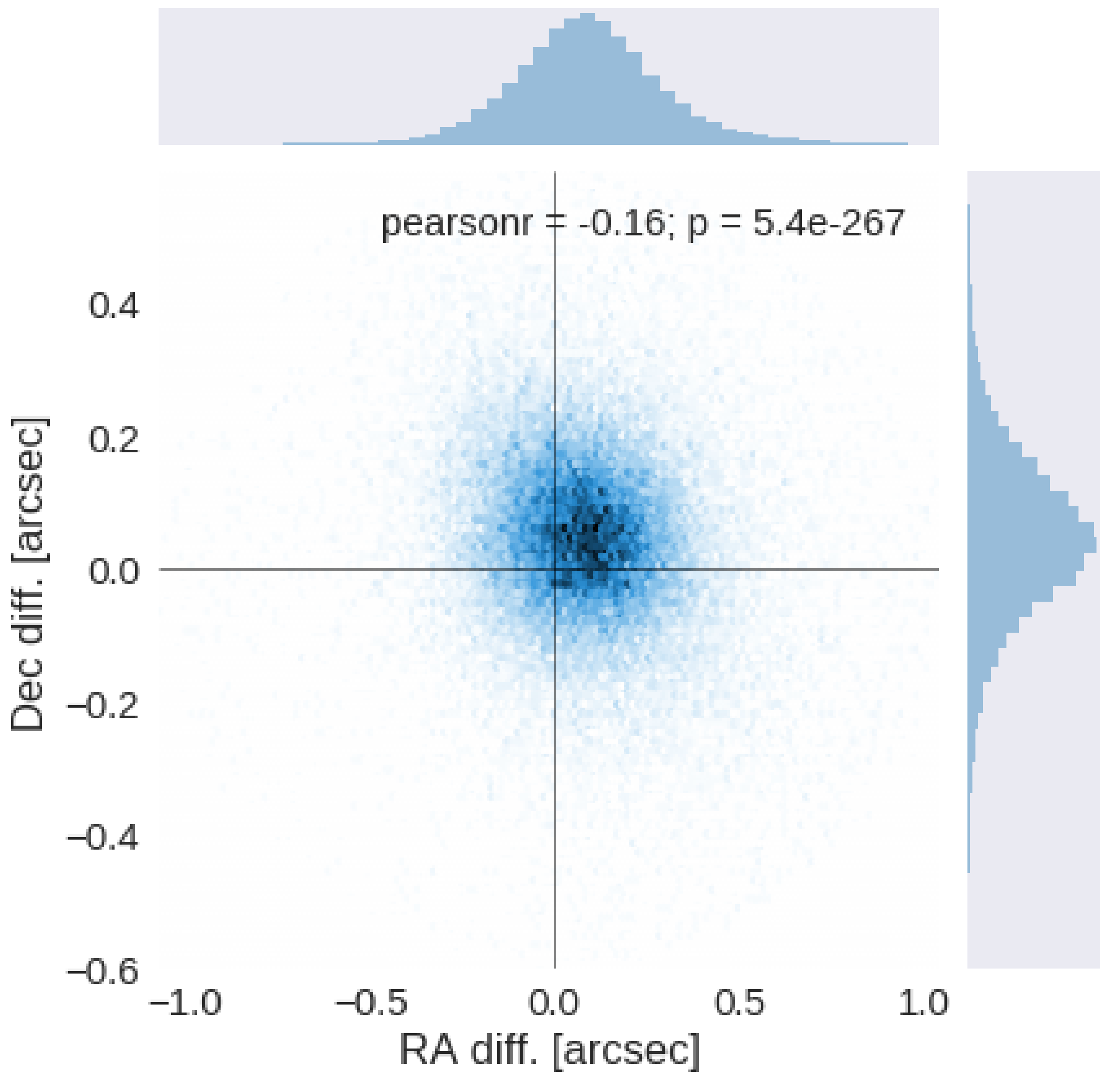
1.3 II - Removal of duplicated sources

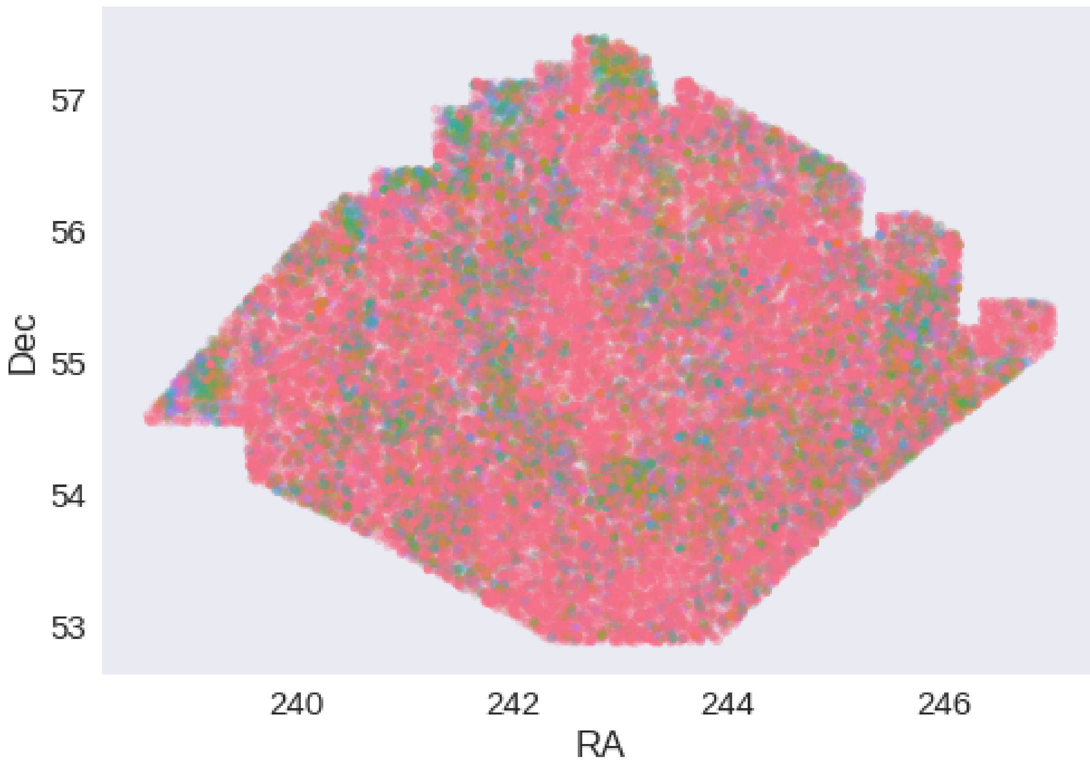
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 1143872 sources.
The cleaned catalogue has 1143463 sources (409 removed).
The cleaned catalogue has 409 sources flagged as having been cleaned
```

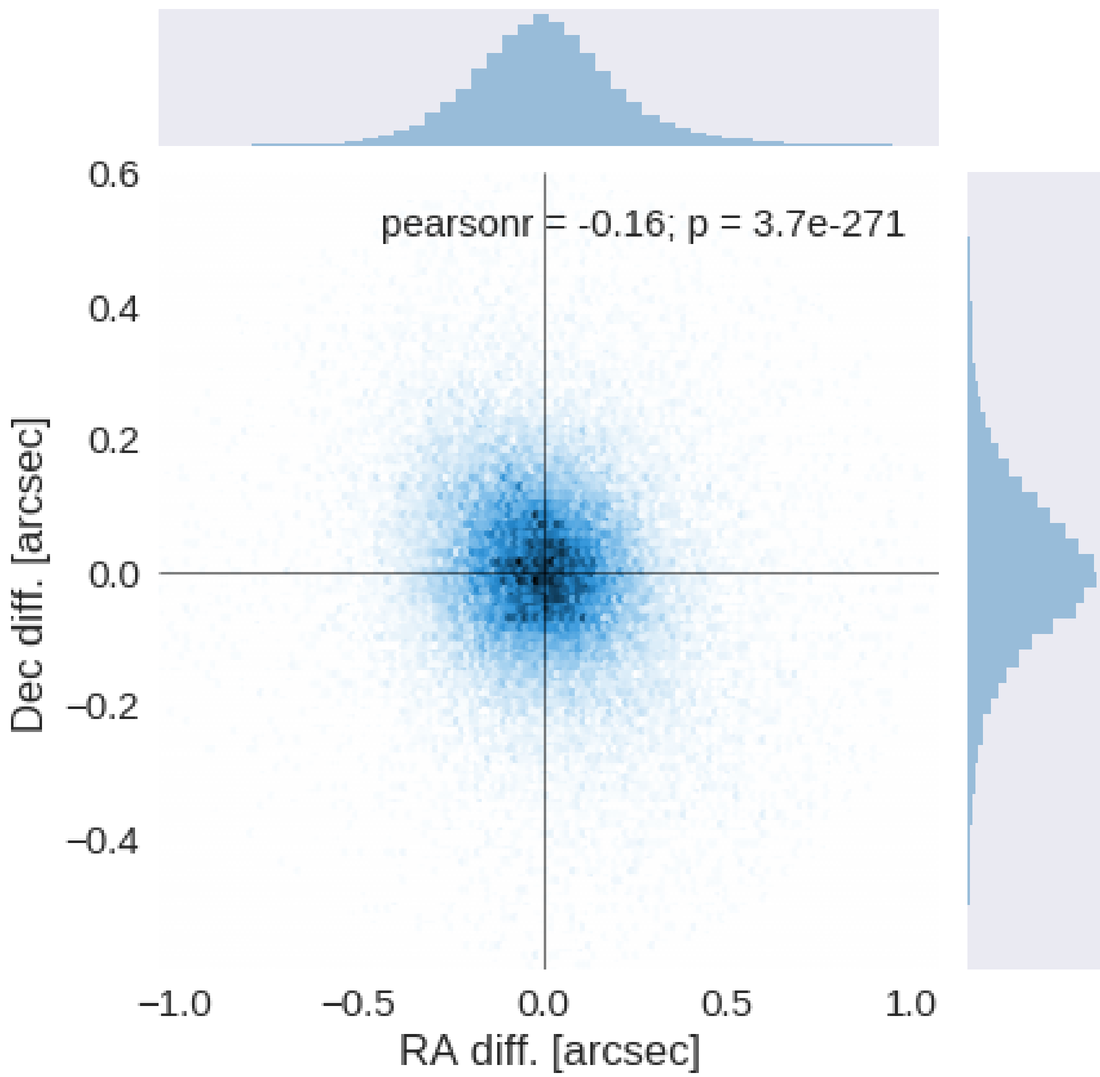
1.4 III - Astrometry correction

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.

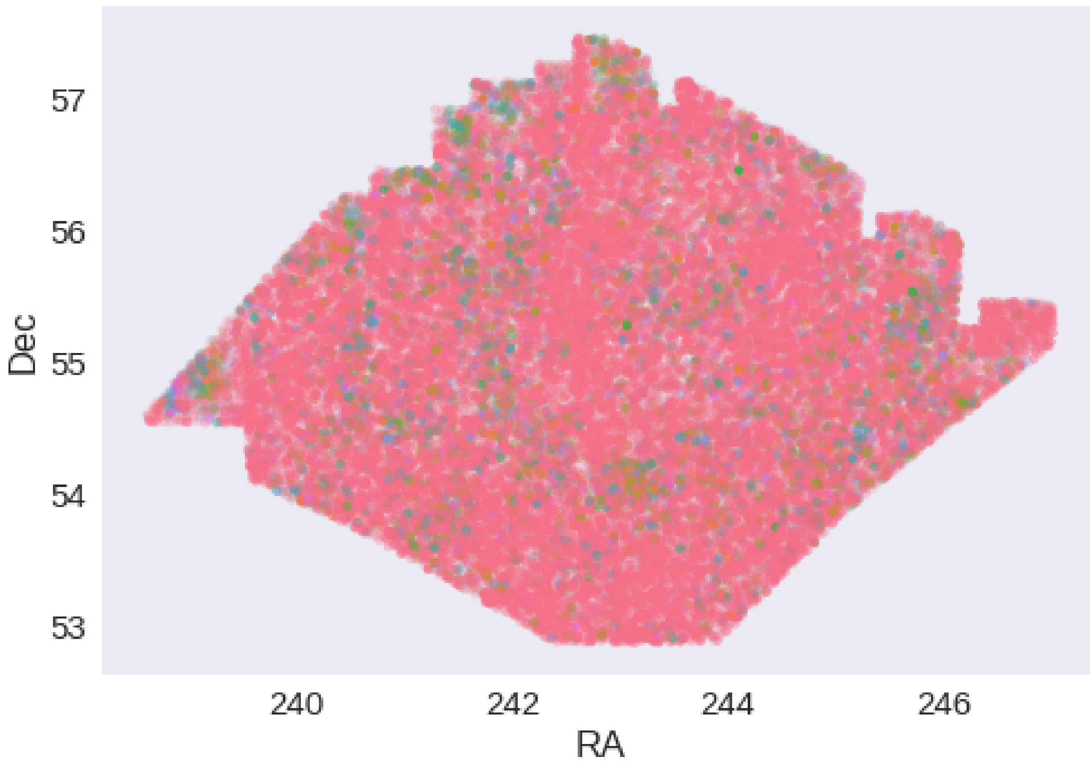





```
RA correction: -0.084394594762216 arcsec
Dec correction: -0.04639860251529626 arcsec
```



pearsonr = -0.16; p = 3.7e-271
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]



1.5 IV - Flagging Gaia objects

```
52542 sources flagged.
```

2 V - Saving to disk

1.2_UKIDSS-DXS

March 8, 2018

1 ELAIS-N1 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:
284b2ef (Mon Aug 14 20:02:12 2017 +0100)
```

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>
```

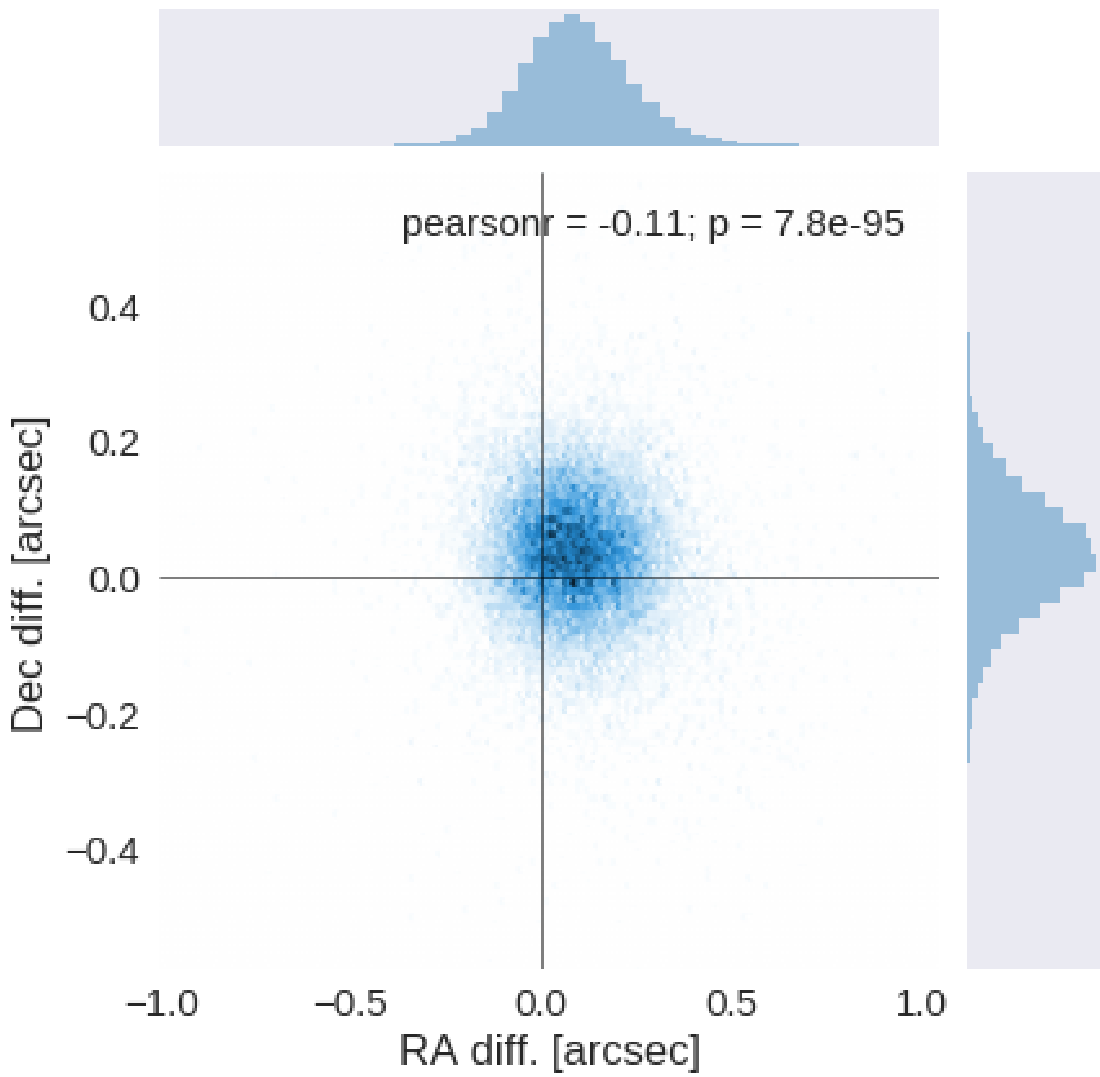
1.3 II - Removal of duplicated sources

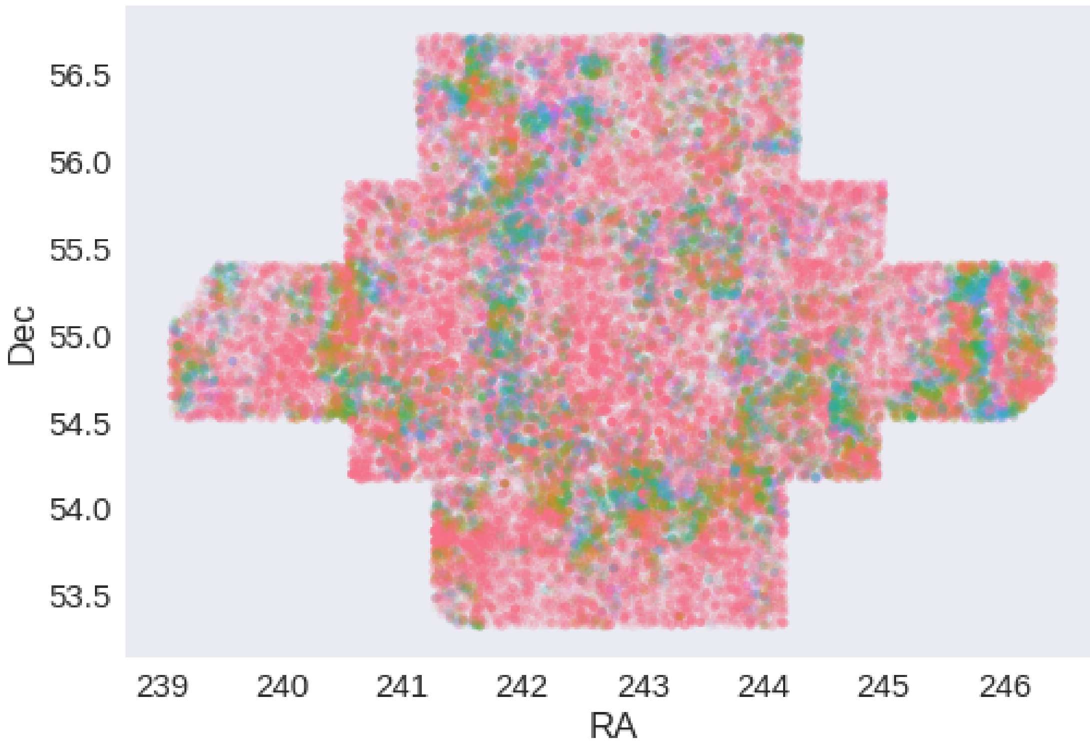
We remove duplicated objects from the input catalogues.

```
/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 780316 sources.
The cleaned catalogue has 779436 sources (880 removed).
The cleaned catalogue has 876 sources flagged as having been cleaned
```

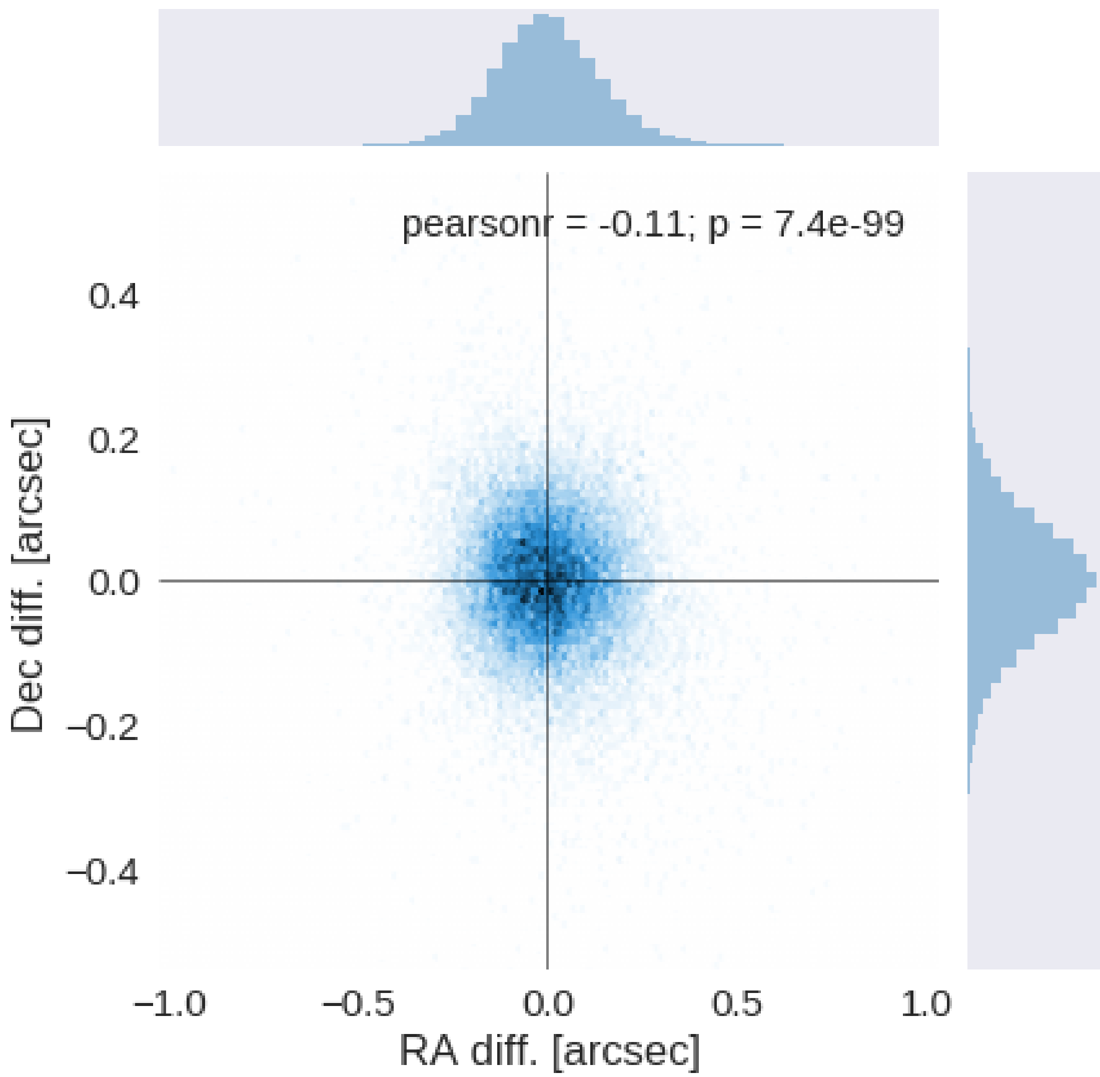
1.4 III - Astrometry correction

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 = -0.11; p = 7.8e-95
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: -0.09201103617897388 arcsec
Dec correction: -0.033934257209011776 arcsec
```


pearsonr = -0.11; p = 7.4e-99
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

```
35058 sources flagged.
```

2 V - Saving to disk

1.3_HSC-SSP

March 8, 2018

1 ELAIS-N1 master catalogue

1.1 Preparation of Hyper Suprime-Cam Subaru Strategic Program Catalogues (HSC-SSP) data

This catalogue comes from `dmu0_HSC`.

In the catalogue, we keep:

- The `object_id` as unique object identifier;
- The position;
- The g, r, i, z, y, N921 aperture magnitude in 2" that we aperture correct;
- The g, r, i, z, y, N921 kron fluxes and magnitudes.
- The extended flag that we convert to a stellariy.

Note: On ELAIS-N1 the HSC-SSP catalogue does not contain any N816 magnitudes.

TODO: Check that the magnitudes are AB.

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 - 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:

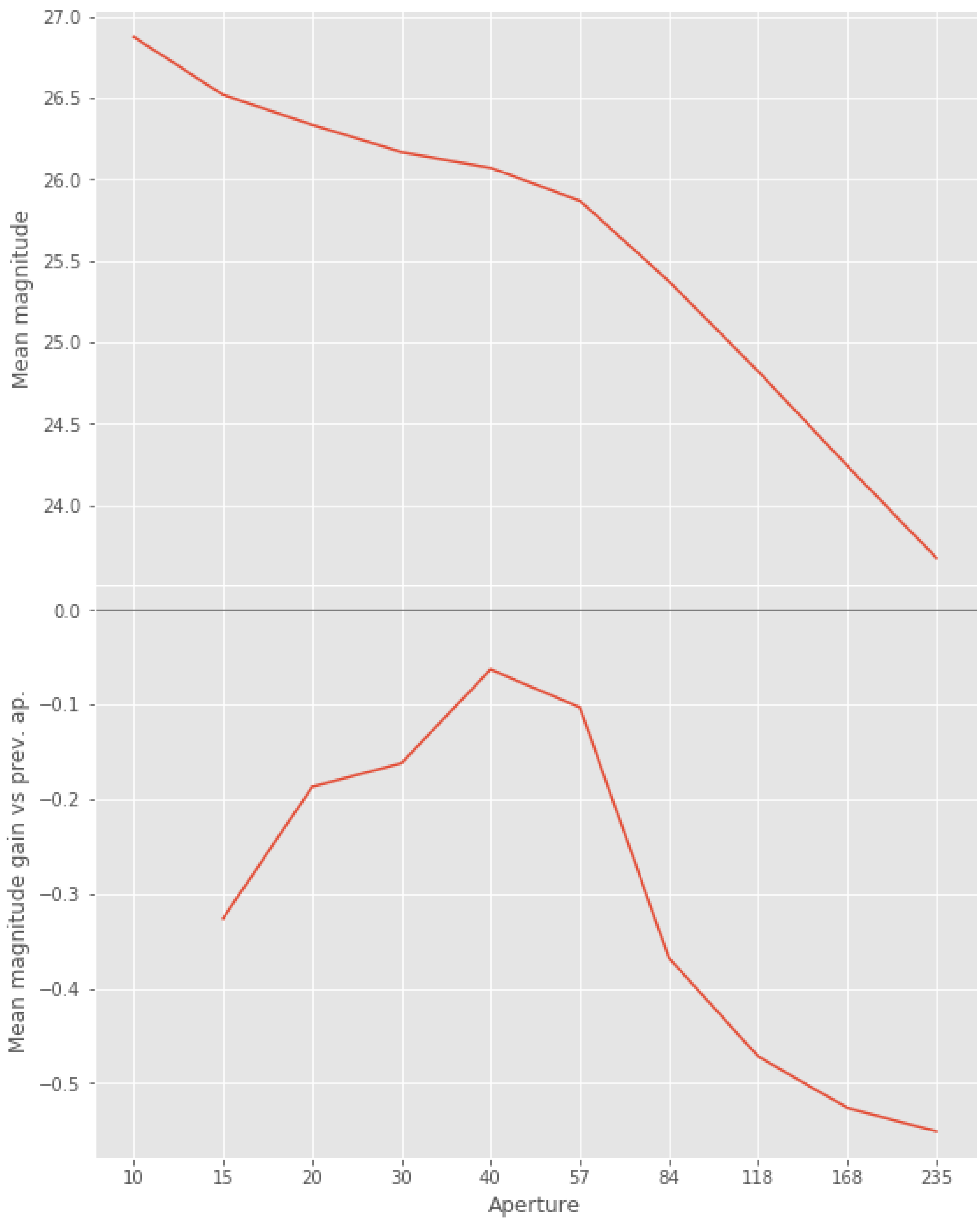
- The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude.
- The mean gain (loss when negative) of magnitude is each aperture compared to the previous (except for the first of course).

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.

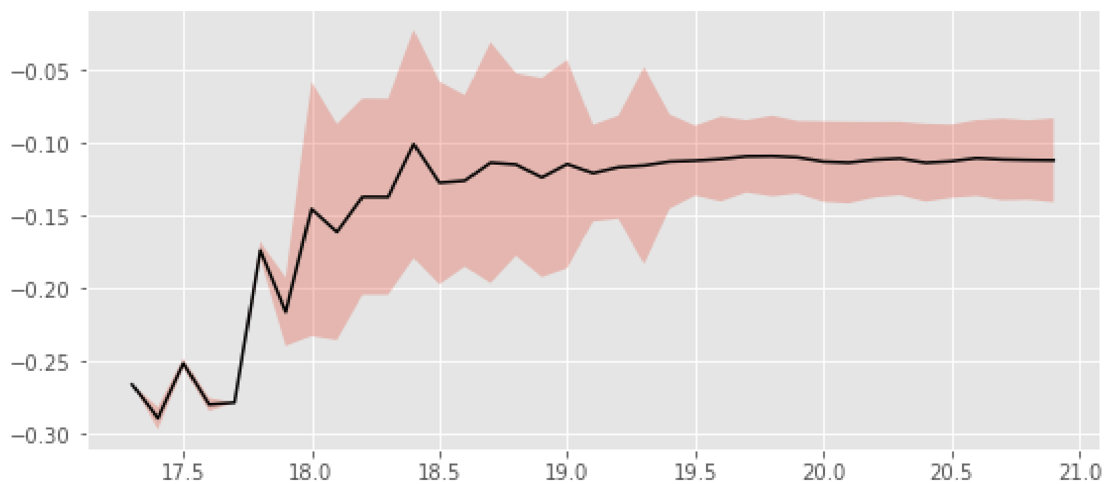
1.2.1 I.a - g band

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```



We will use aperture 40 as target.

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:903: RuntimeWarning: invalid valu
  mask = stellarity > .9
/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:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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 will use magnitudes between 18.5 and 20.8

```
Aperture correction for g band:
Correction: -0.11107730865478516
Number of source used: 4125
RMS: 0.0268361195668441
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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)
```

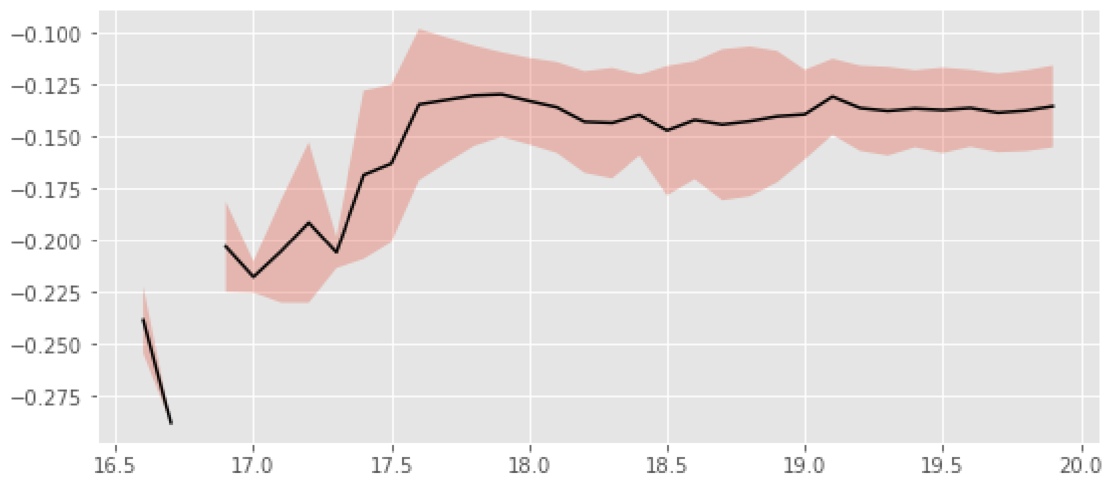
1.2.2 I.b - r band

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```

We will use aperture 40 as target.

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:903: RuntimeWarning: invalid valu
  mask = stellarity > .9
/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:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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 17.6 and 19.7.

```
Aperture correction for r band:
Correction: -0.13634300231933594
Number of source used: 2643
RMS: 0.021289841062501185
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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)
```

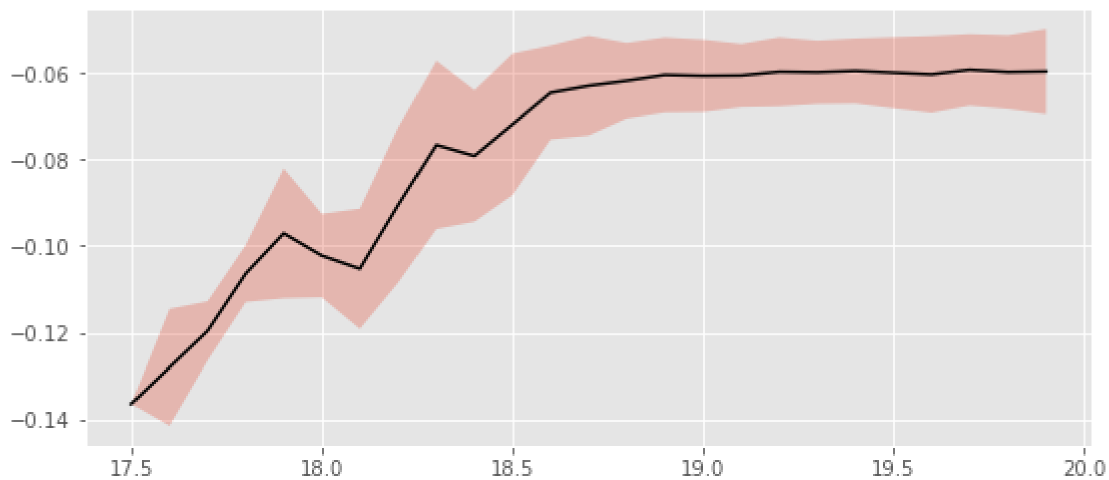
1.2.3 I.c - i band

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```

We will use aperture 40 as target.

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:903: RuntimeWarning: invalid valu
  mask = stellarity > .9
/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:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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 18.5 and 19.8.

```
Aperture correction for i band:
Correction: -0.06008434295654297
Number of source used: 7243
RMS: 0.00823770015735675
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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)
```

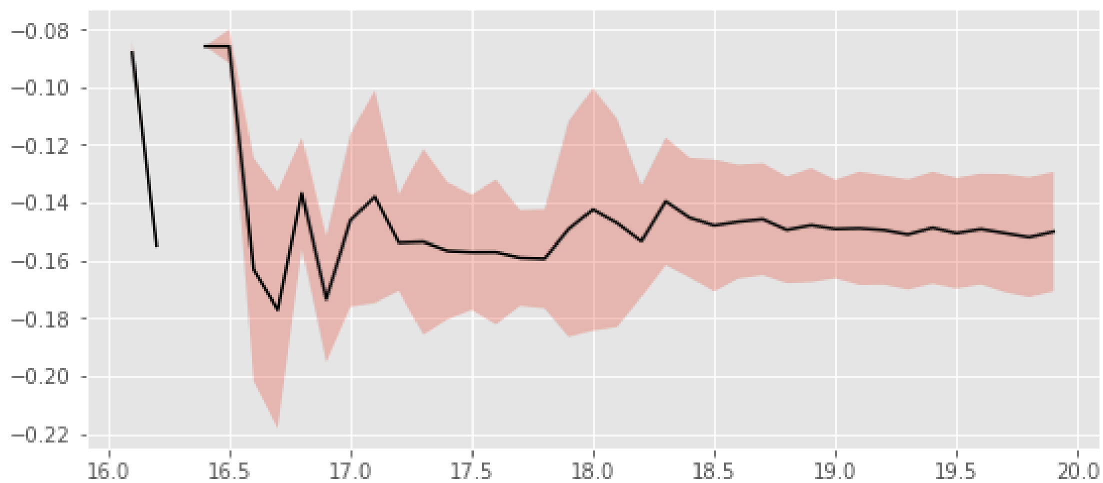
1.2.4 I.d - z band

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```

We will use aperture 40 as target.

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:903: RuntimeWarning: invalid valu
  mask = stellarity > .9
/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:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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)
```



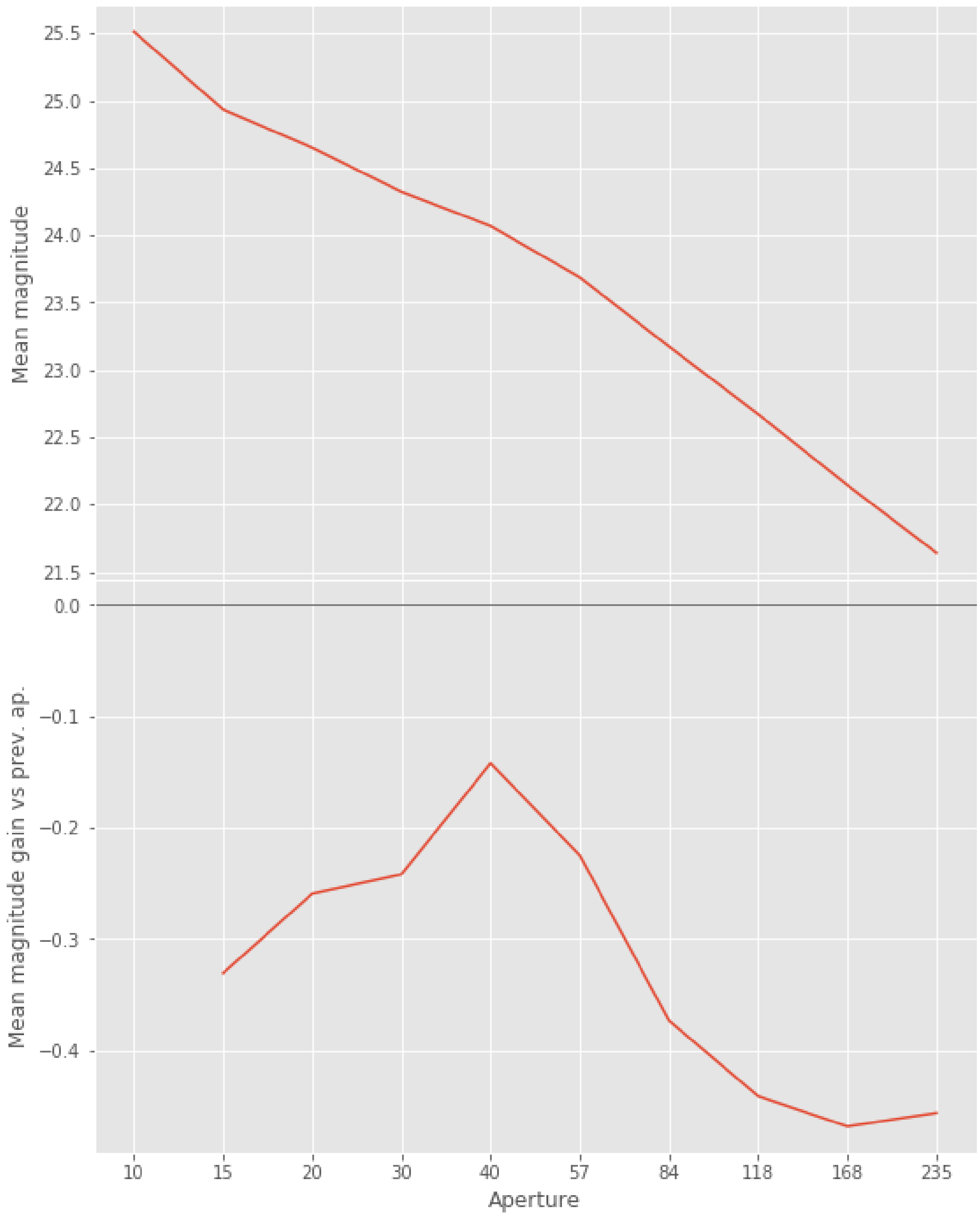
We use magnitudes between 17.5 and 19.8.

```
Aperture correction for z band:
Correction: -0.14914608001708984
Number of source used: 11013
RMS: 0.01947626737010215
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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)
```

1.2.5 I.e - y band

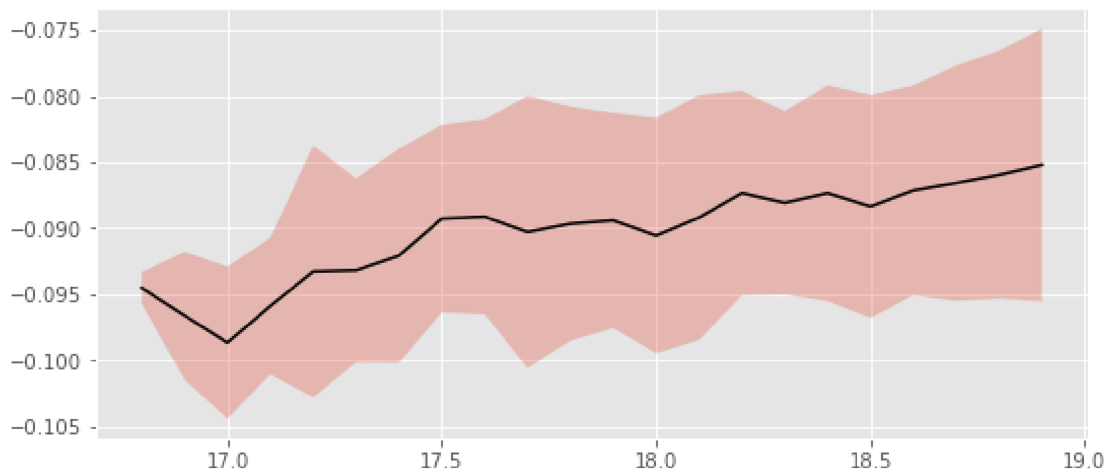
```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```



We will use aperture 40 as target.

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:903: RuntimeWarning: invalid valu
  mask = stellarity > .9
/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:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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)
```



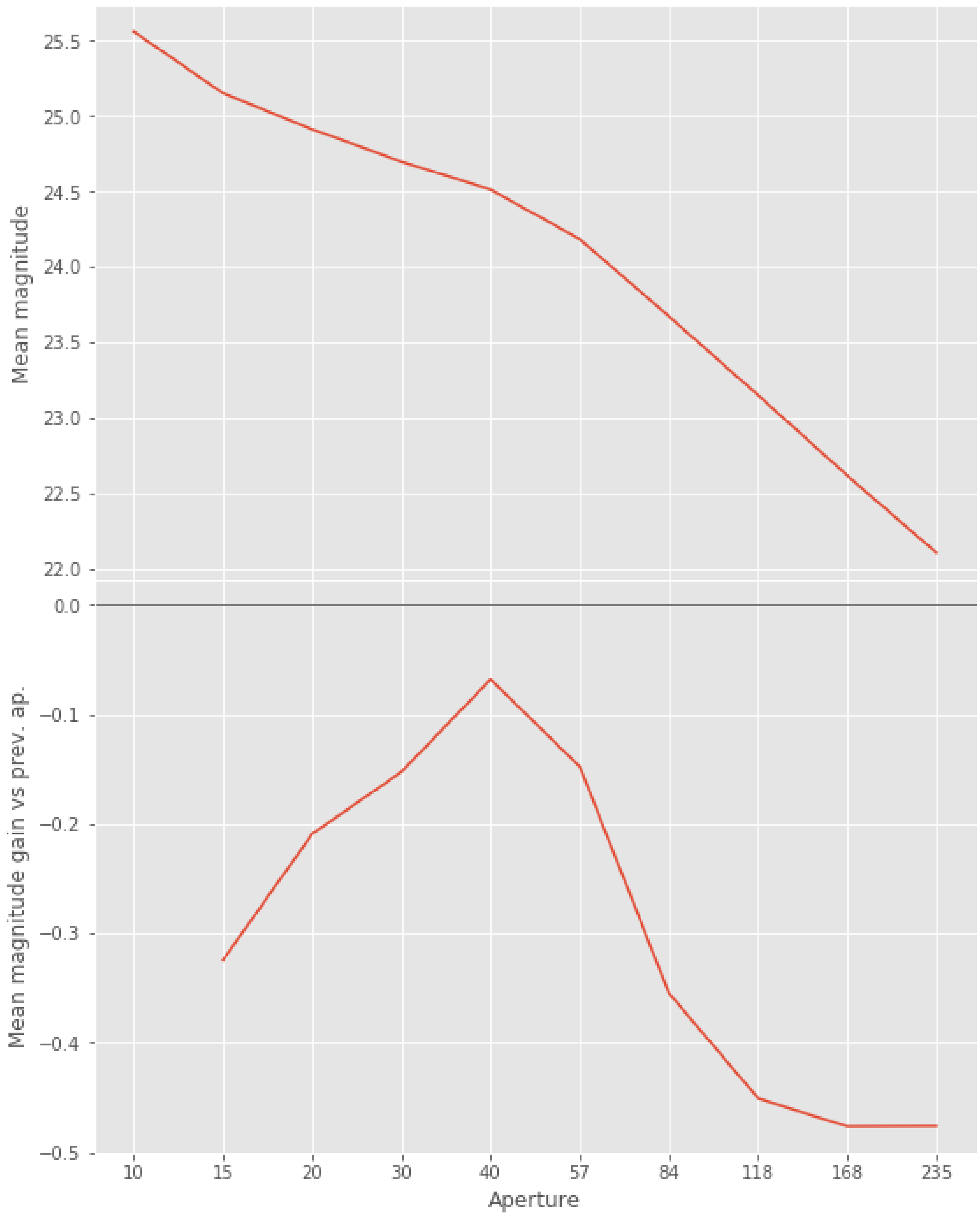
We use magnitudes between 17 and 18.7.

```
Aperture correction for y band:
Correction: -0.08827590942382812
Number of source used: 2717
RMS: 0.008183069341610581
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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)
```

1.2.6 I.f - N921 band

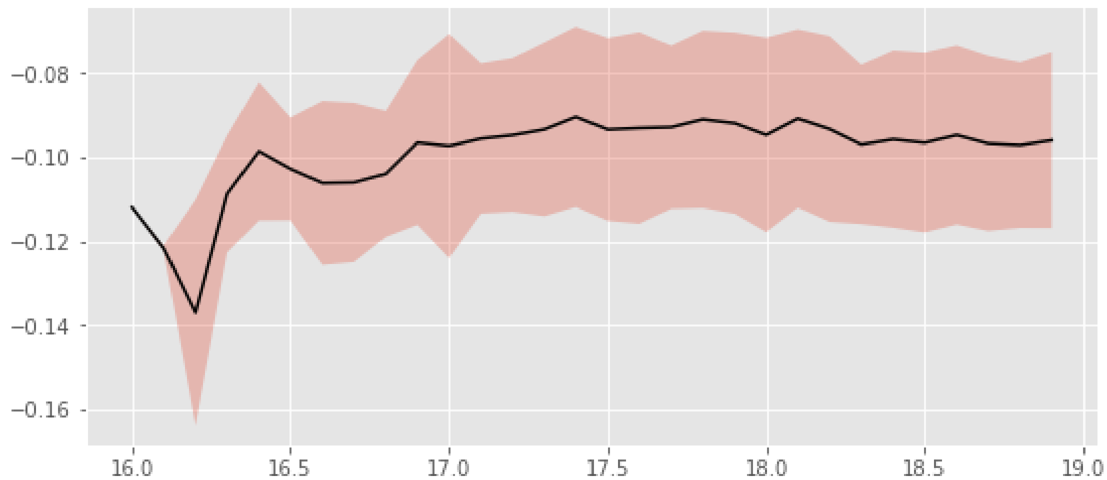
```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```



We will use aperture 40 as target.

```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:903: RuntimeWarning: invalid valu
  mask = stellarity > .9
/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:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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 16.5 and 18.7.

```
Aperture correction for N921 band:
Correction: -0.09531402587890625
Number of source used: 1119
RMS: 0.01992793401881194
```

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:129: RuntimeWarning: invalid value enc
  mask &= (stellarity > 0.9)
/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)
```

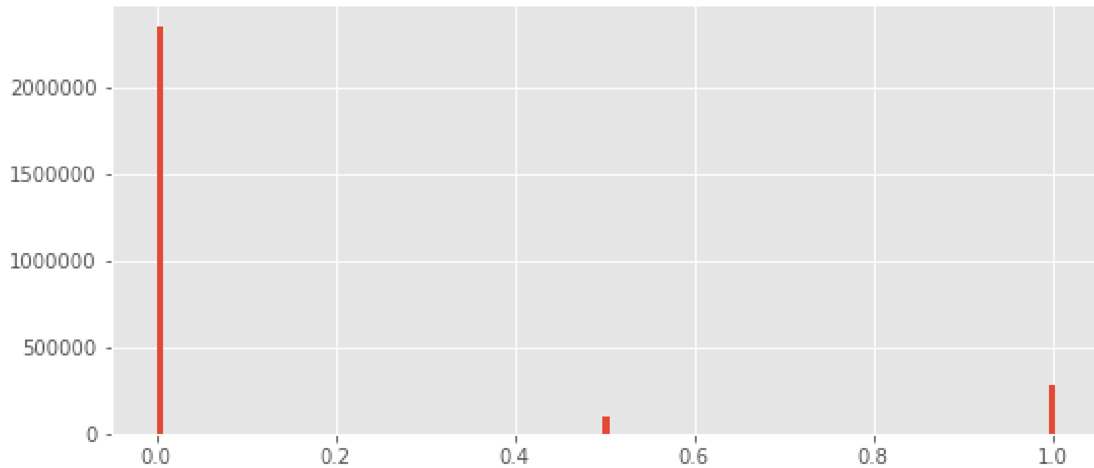
1.3 II - Stellarity

HSC does not provide a 0 to 1 stellarity value but a 0/1 extended flag in each band. We are using the same method as UKIDSS (cf this page) to compute a stellarity based on the class in each band:

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

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

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



1.4 II - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:8: R
/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[32]: <IPython.core.display.HTML object>

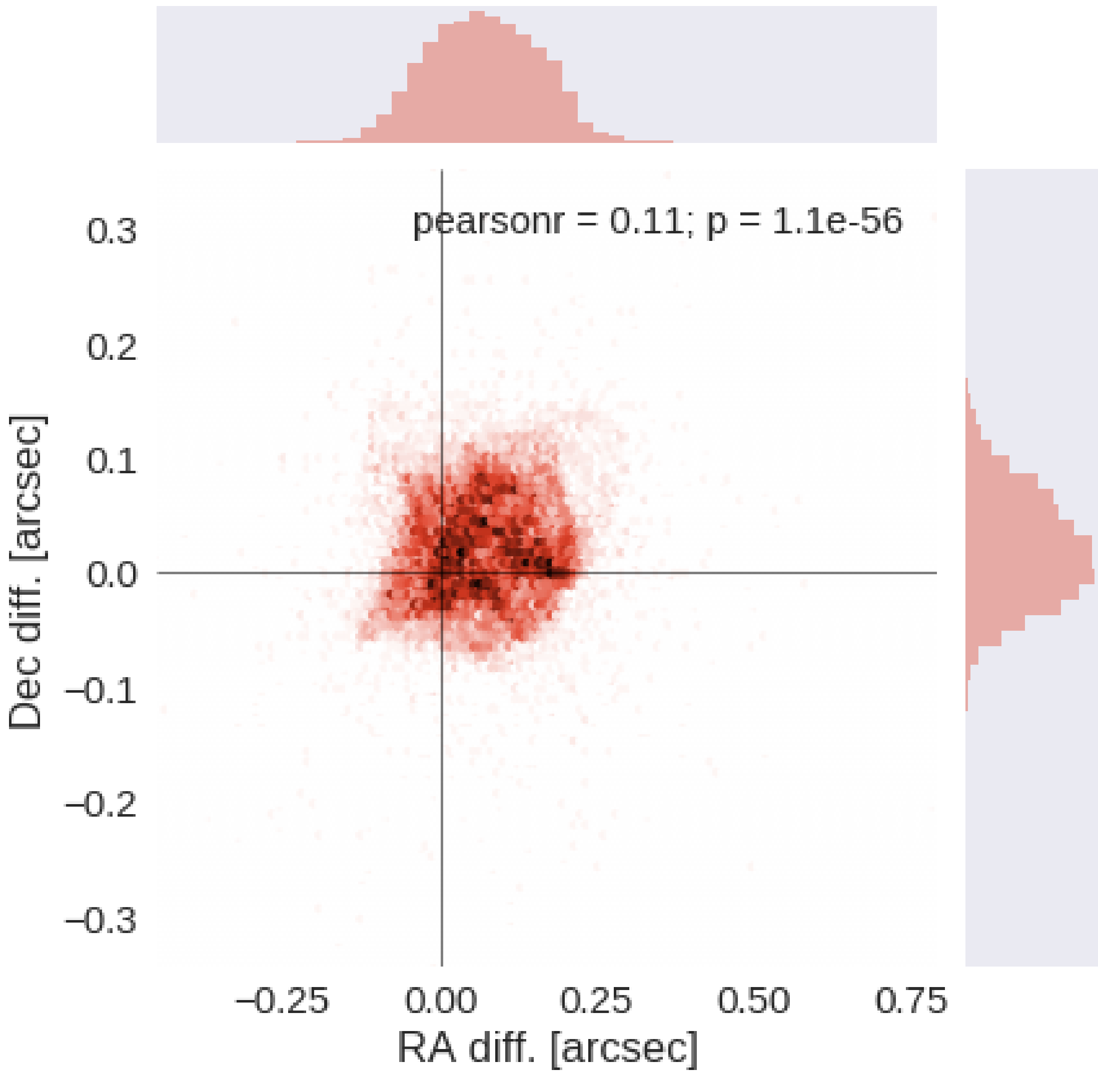
1.5 III - Removal of duplicated sources

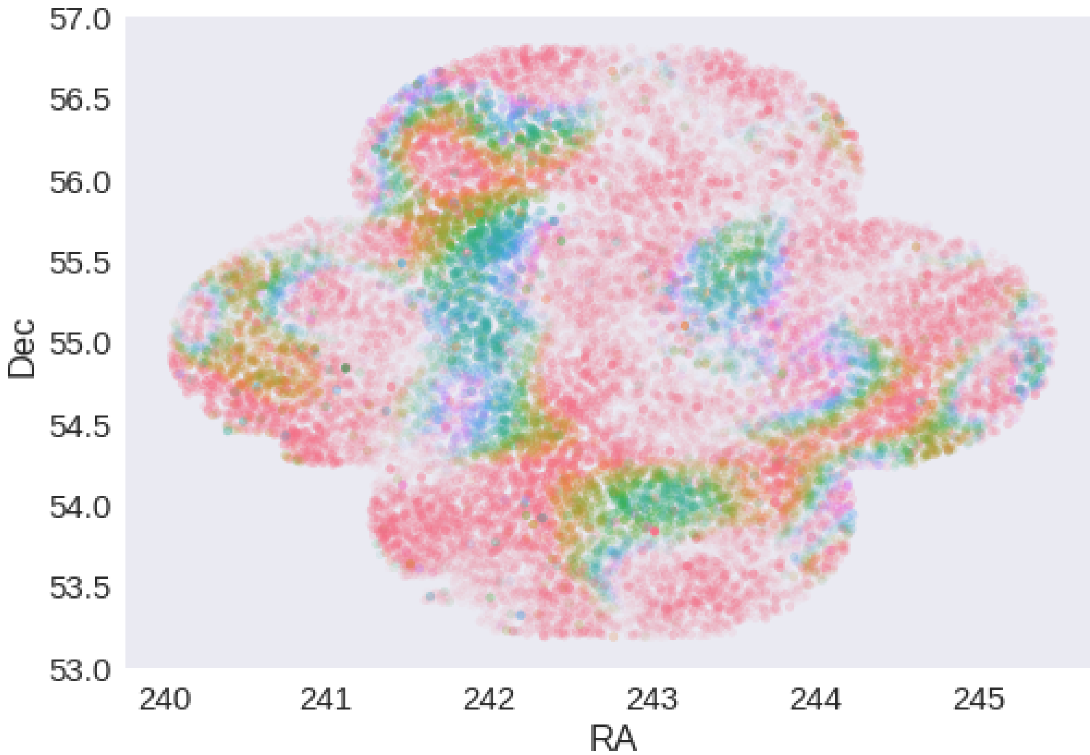
We remove duplicated objects from the input catalogues.

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


The initial catalogue had 2733395 sources.
The cleaned catalogue has 2733236 sources (159 removed).
The cleaned catalogue has 154 sources flagged as having been cleaned
```

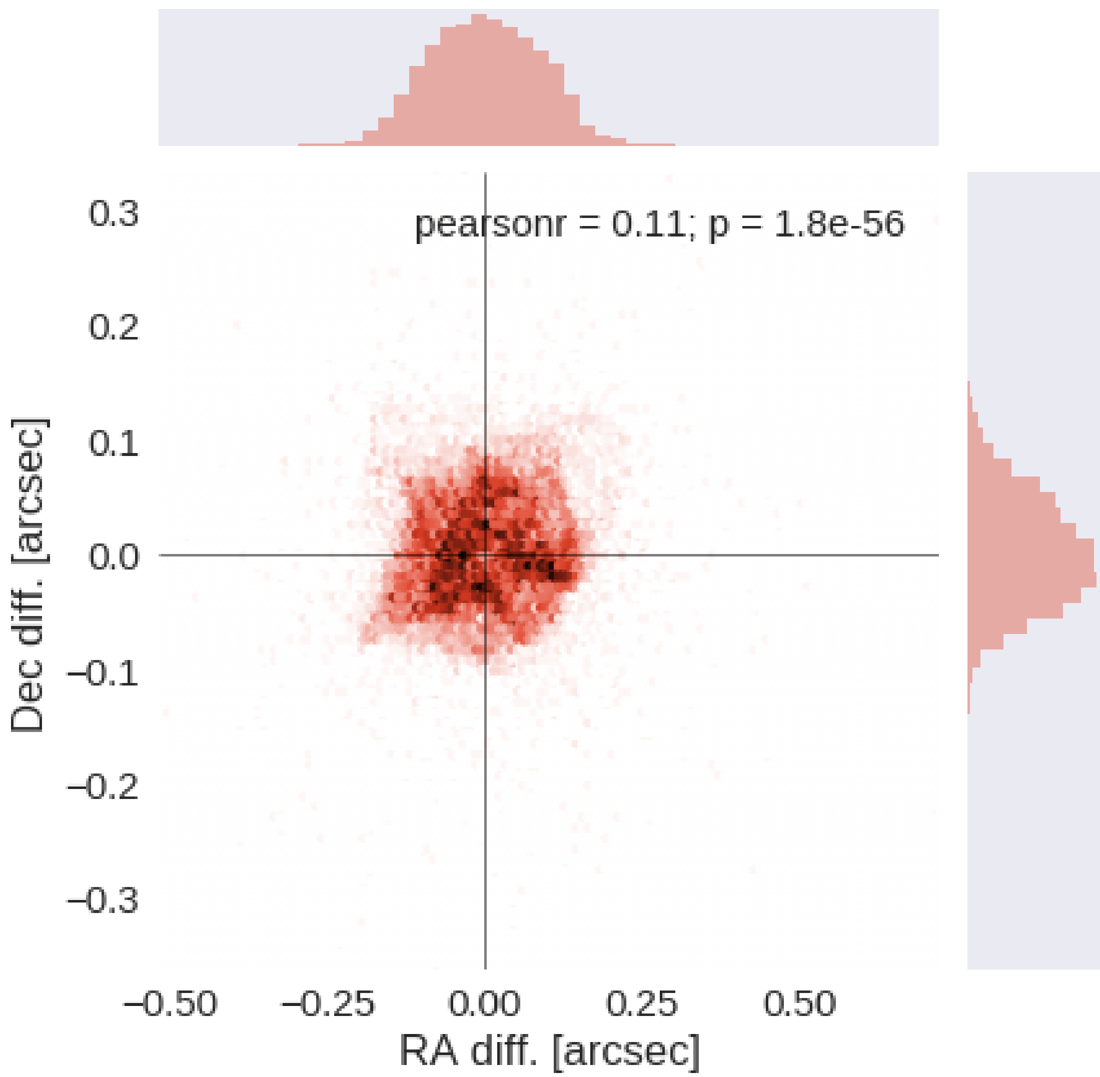
1.6 III - Astrometry correction

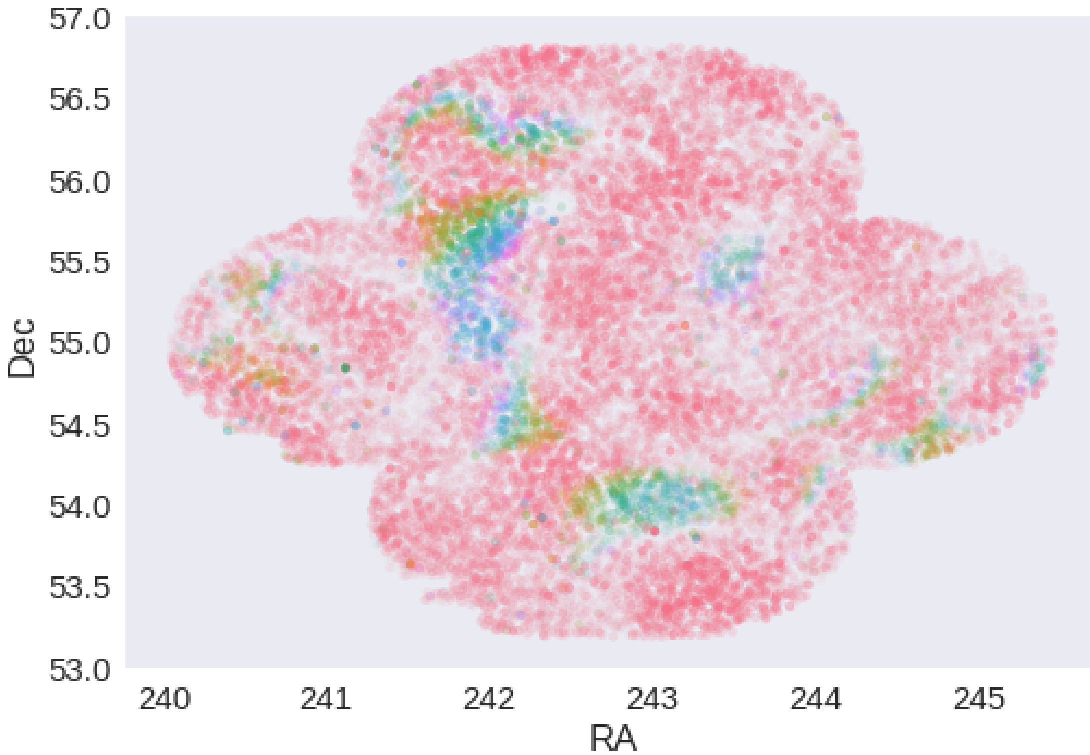
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.06906133751272137 arcsec
Dec correction: -0.018244228975561327 arcsec
```


pearsonr = 0.11; p = 1.8e-56
Dec diff. [arcsec]
RA diff. [arcsec]
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.50
−0.25
0.00
0.25
0.50



1.7 IV - Flagging Gaia objects

```
20343 sources flagged.
```

2 V - Saving to disk

1.4_PanSTARRS-3SS

March 8, 2018

1 ELAIS-N1 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>ApMag` aperture magnitude (see below);
- The grizy `<band>KronMag` 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:
284b2ef (Mon Aug 14 20:02:12 2017 +0100)
```

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

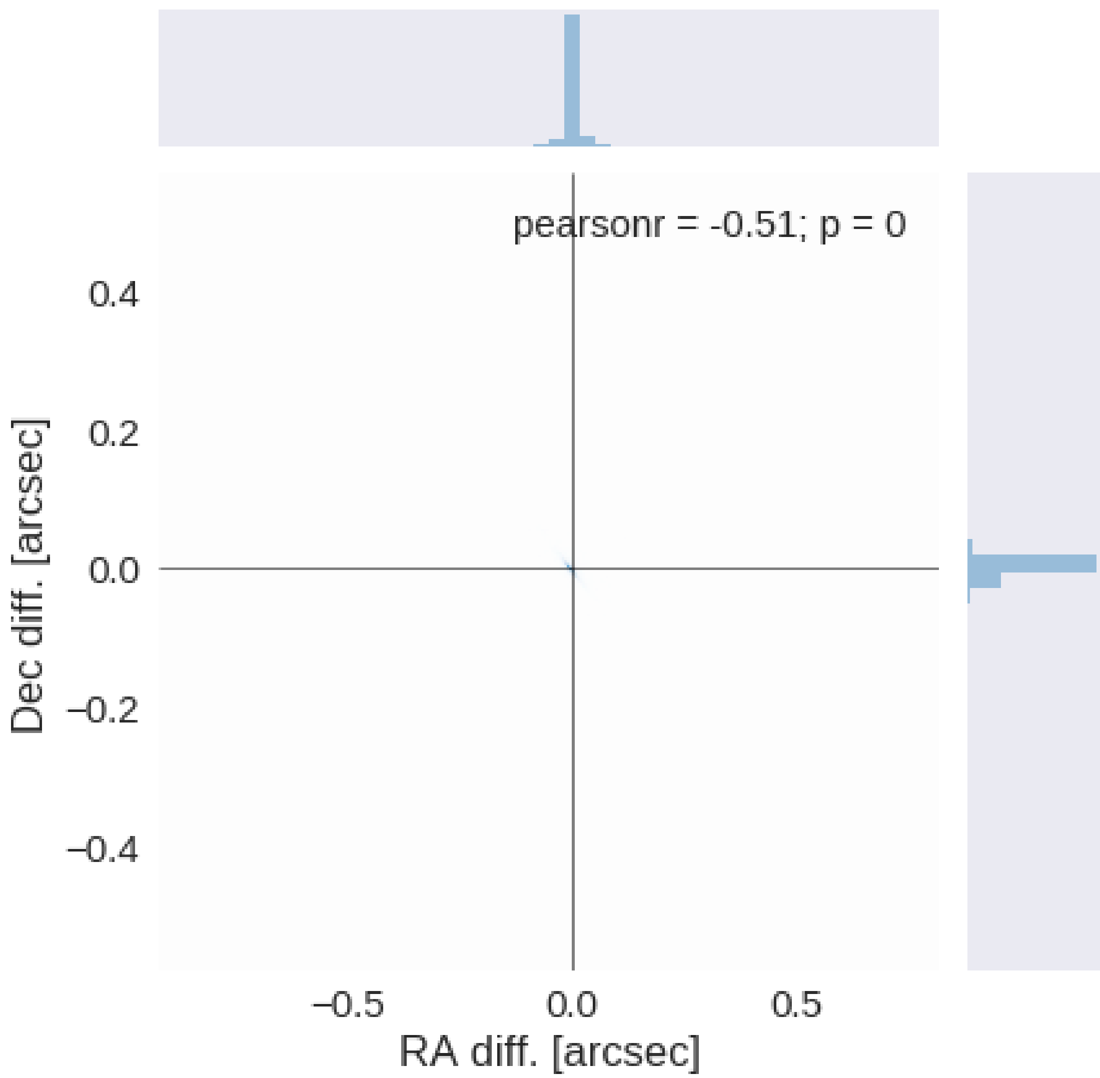
We remove duplicated objects from the input catalogues.

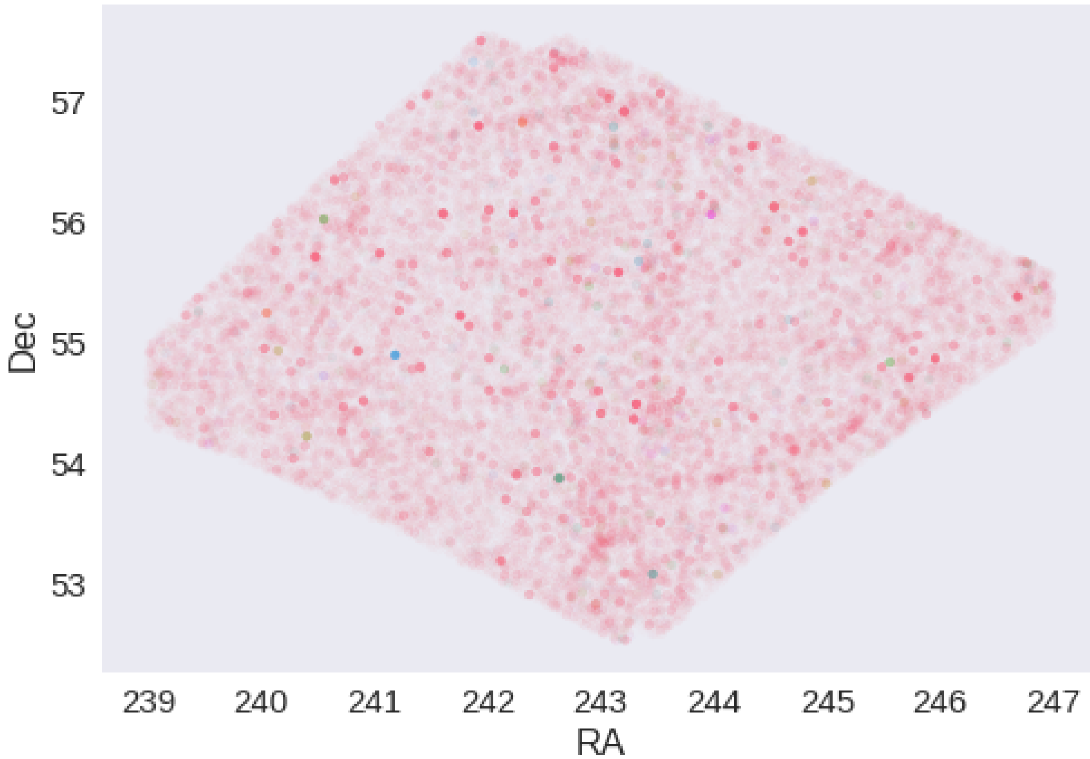
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 388700 sources.
The cleaned catalogue has 311453 sources (77247 removed).
The cleaned catalogue has 68405 sources flagged as having been cleaned
```

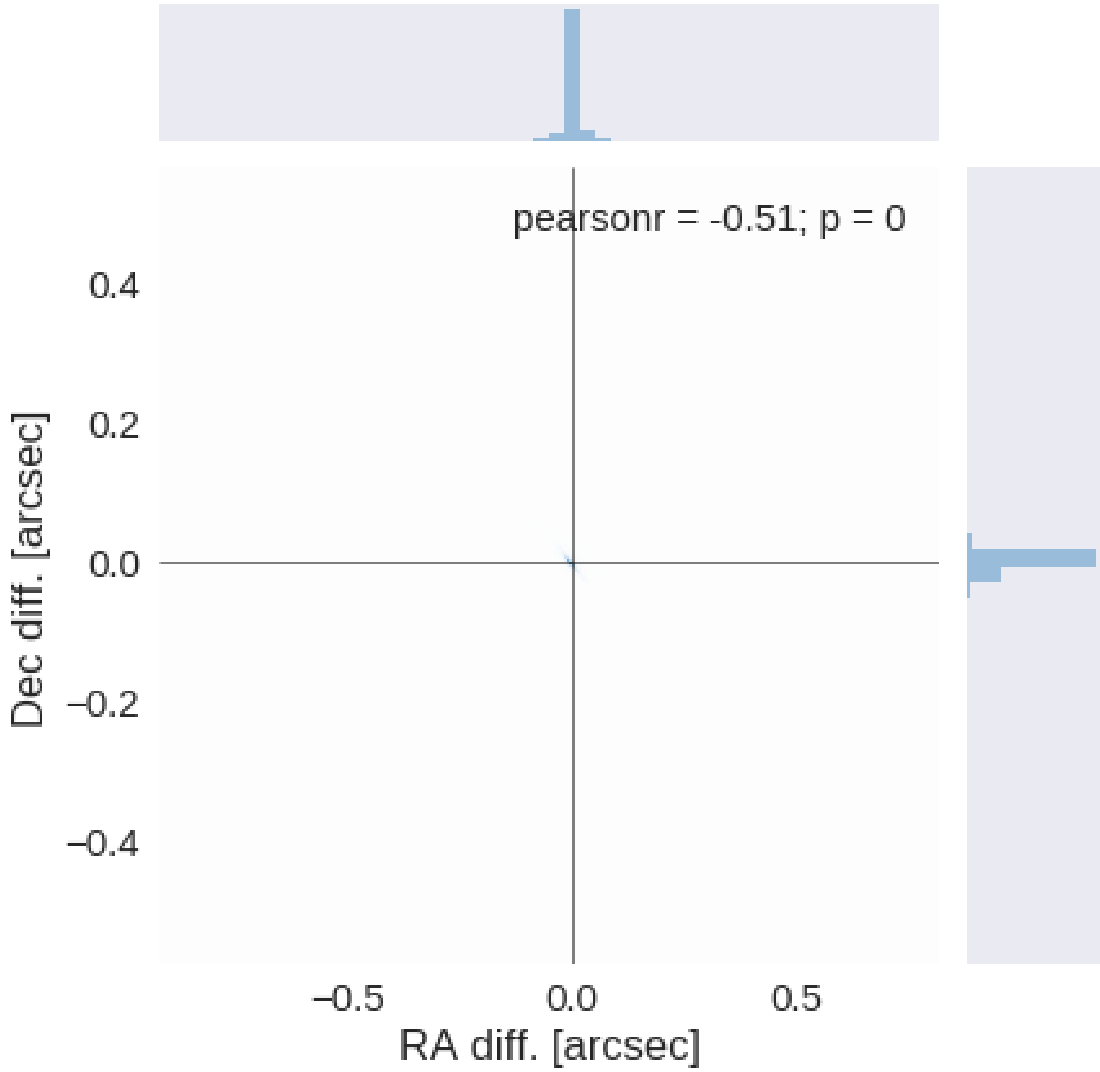
1.4 III - Astrometry correction

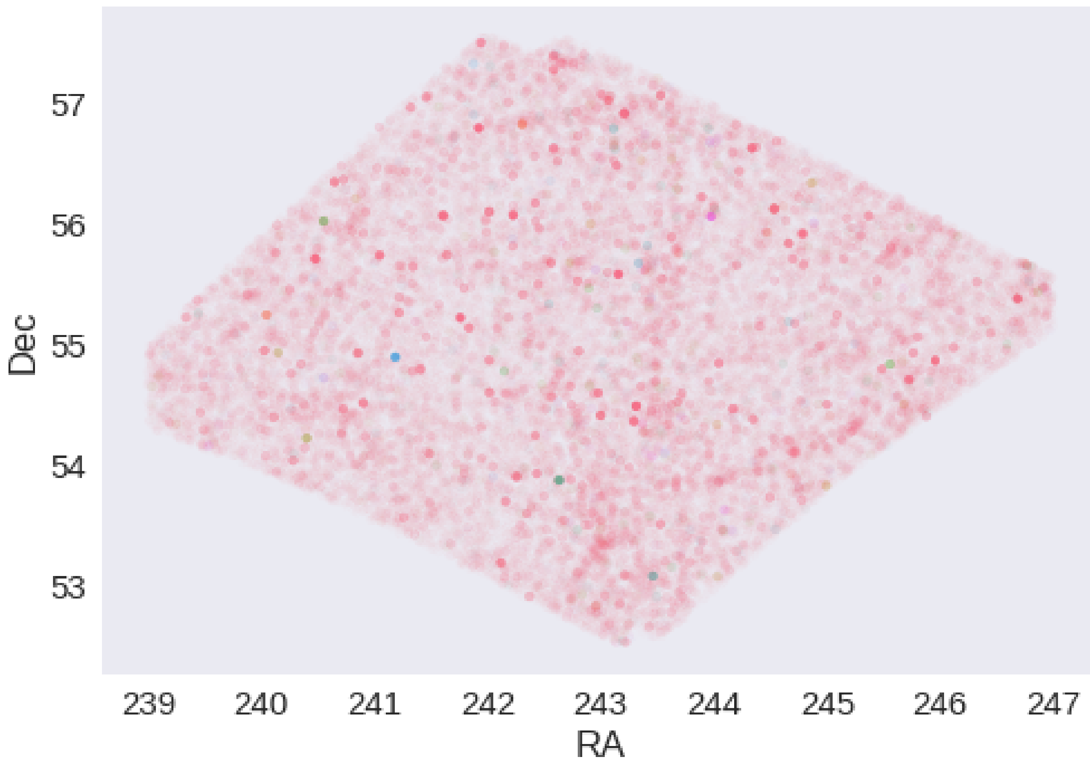
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 0.0001799550204850675 arcsec
Dec correction: -0.0005682078040081251 arcsec
```


pearsonr = -0.51; p = 0
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.5
0.0
0.5
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
53200 sources flagged.
```

2 V - Saving to disk

1.5_SpARCS

March 8, 2018

1 ELAIS-N1 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.

Note that there are y band columns because we combined all the SpARCS data in HeDaM, but there is no y data for the ELAIS-N1 sources.

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:
284b2ef (Mon Aug 14 20:02:12 2017 +0100)
```

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.

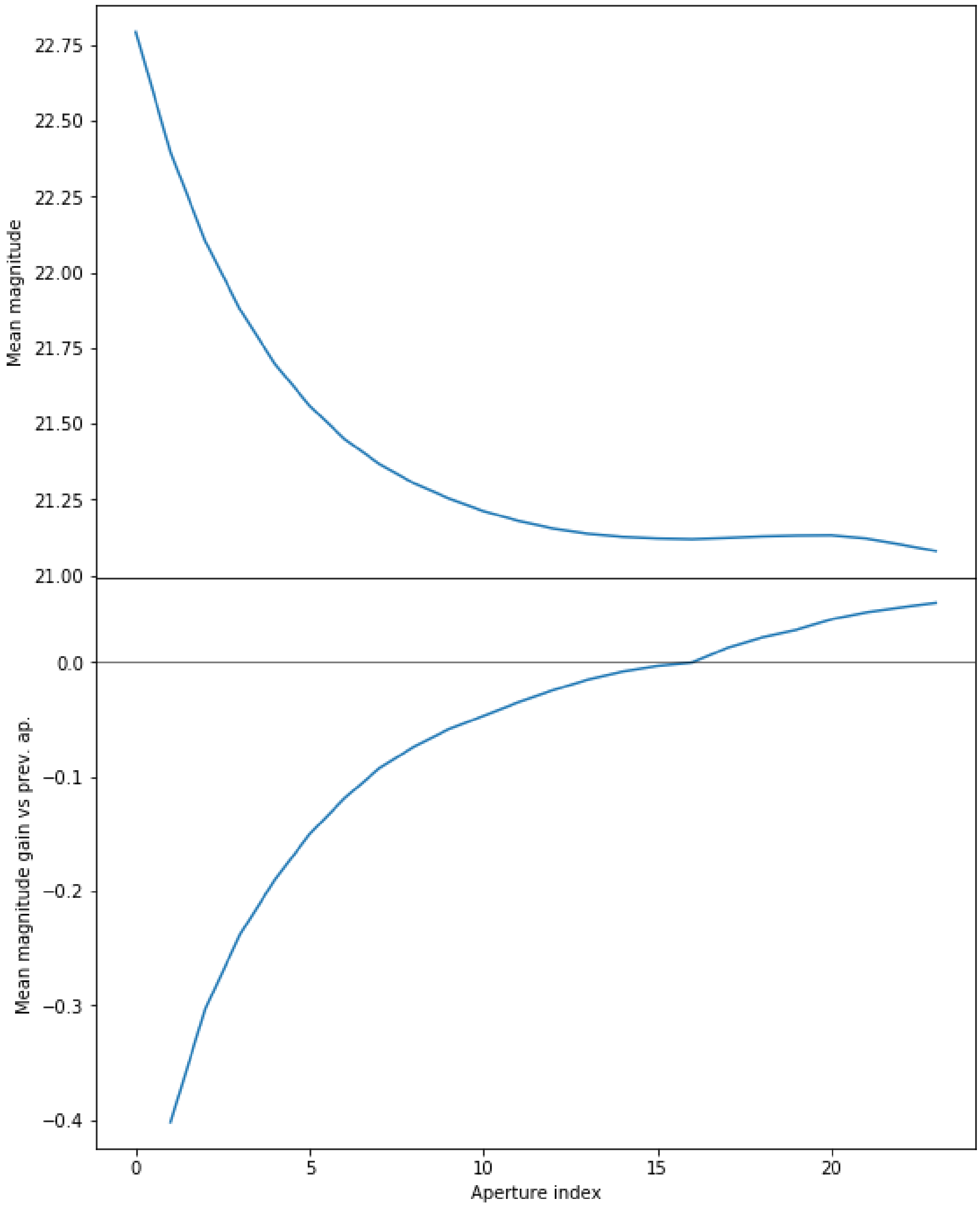
Target aperture: To determine the target aperture, we simulate a curve of growth using the provided apertures and draw two figures: - The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude. - The mean gain (loss when negative) of magnitude is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

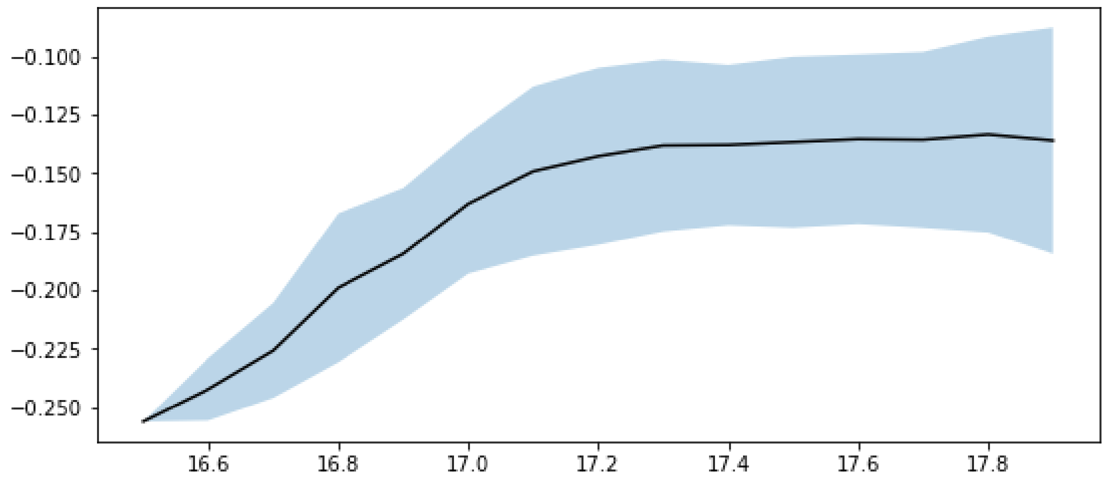
1.2.1 I.a r-band



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

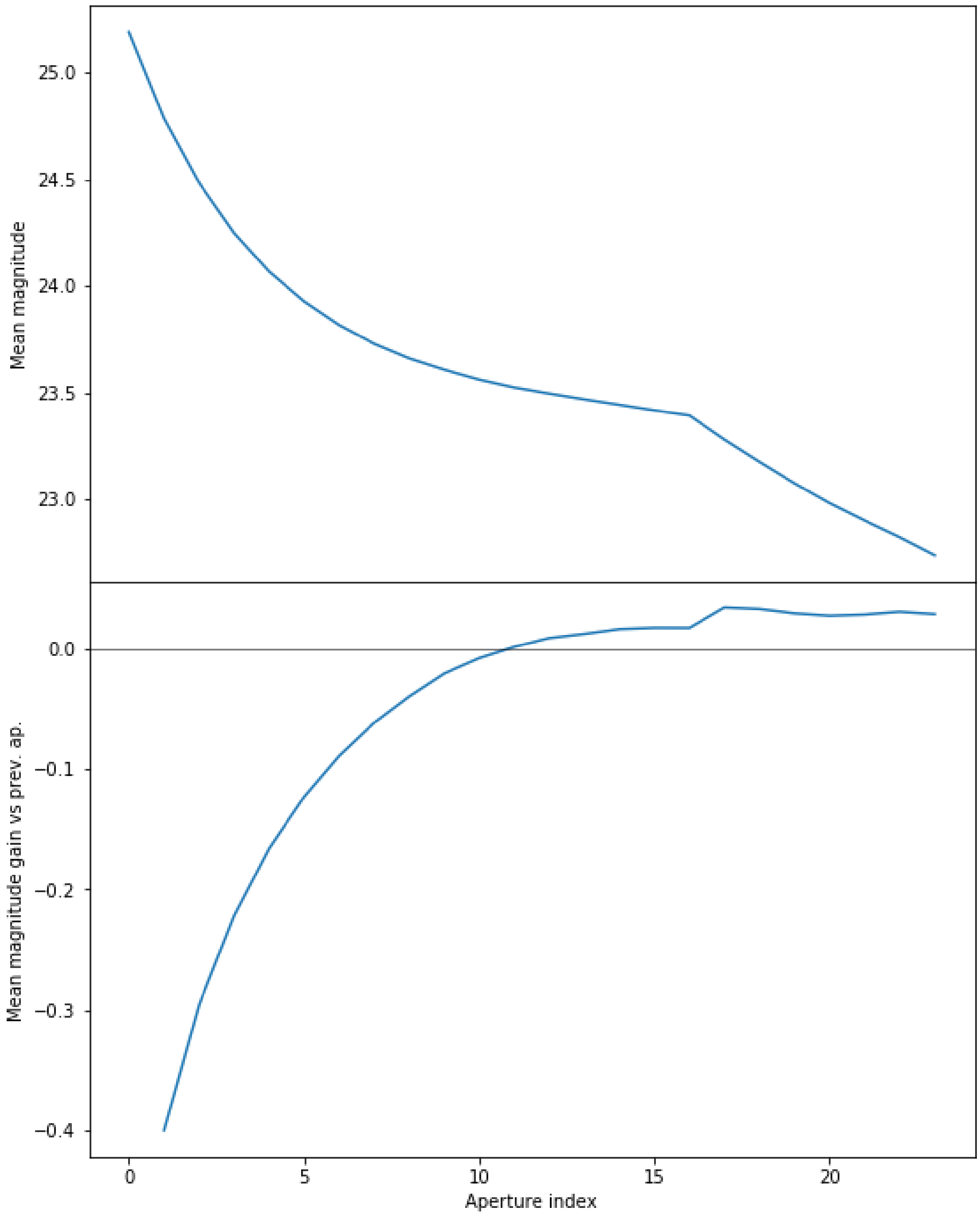
```
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid
  mask &= (mag >= mag_min)
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid
```

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



We use magnitudes between 17 and 17.9.

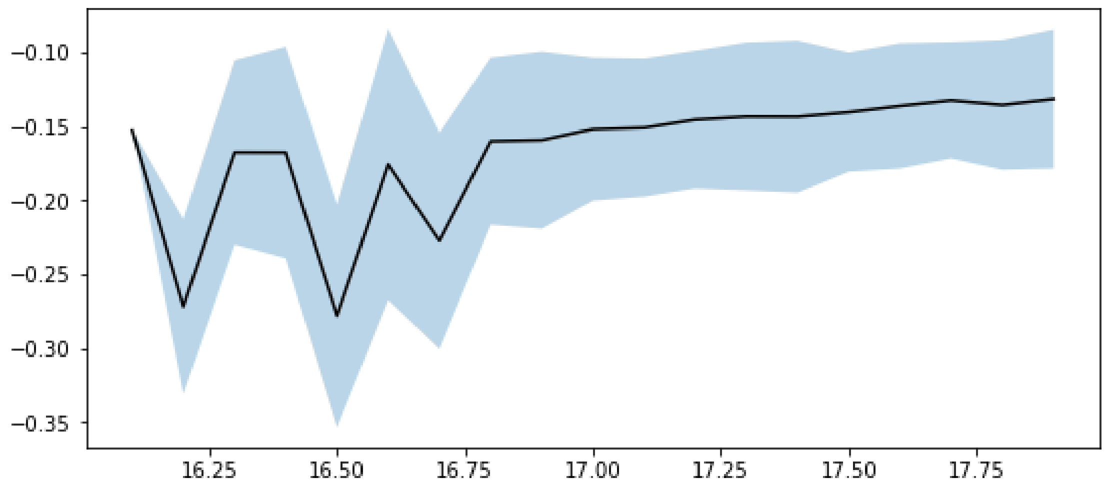
1.2.2 I.b u-band



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

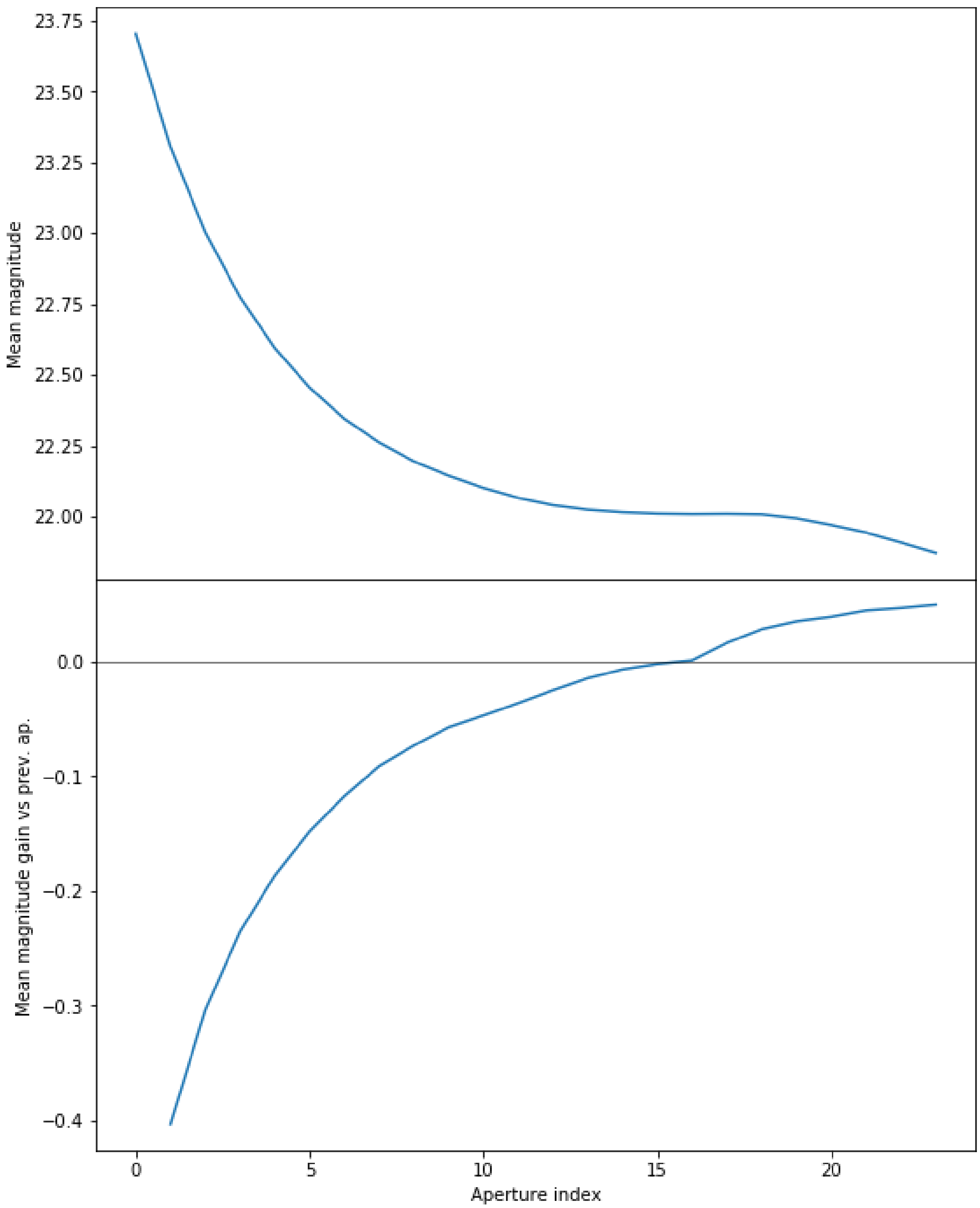
```
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid
  mask &= (mag >= mag_min)
```

```
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid
  mask &= (mag <= mag_max)
```



We use magnitudes between 17 and 17.9.

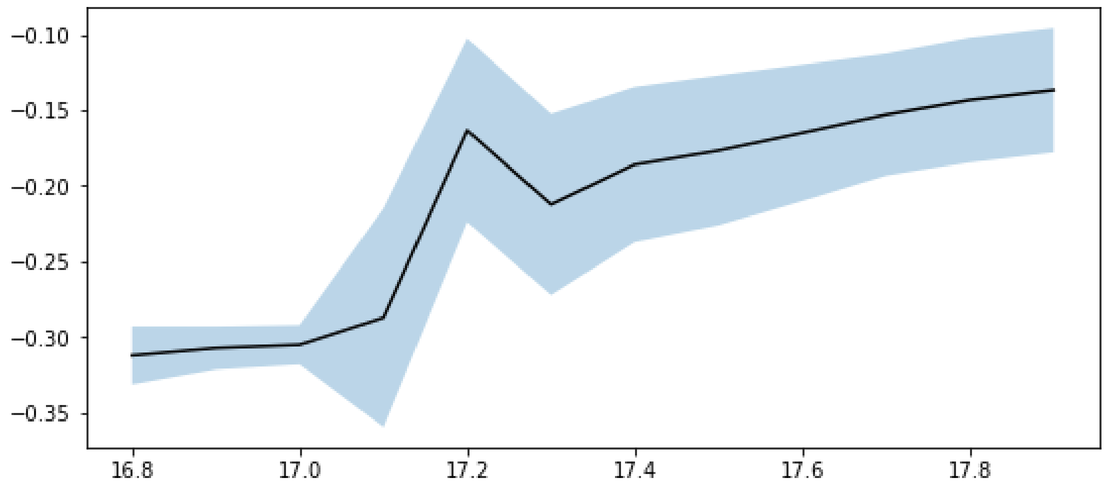
1.2.3 I.c g-band



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

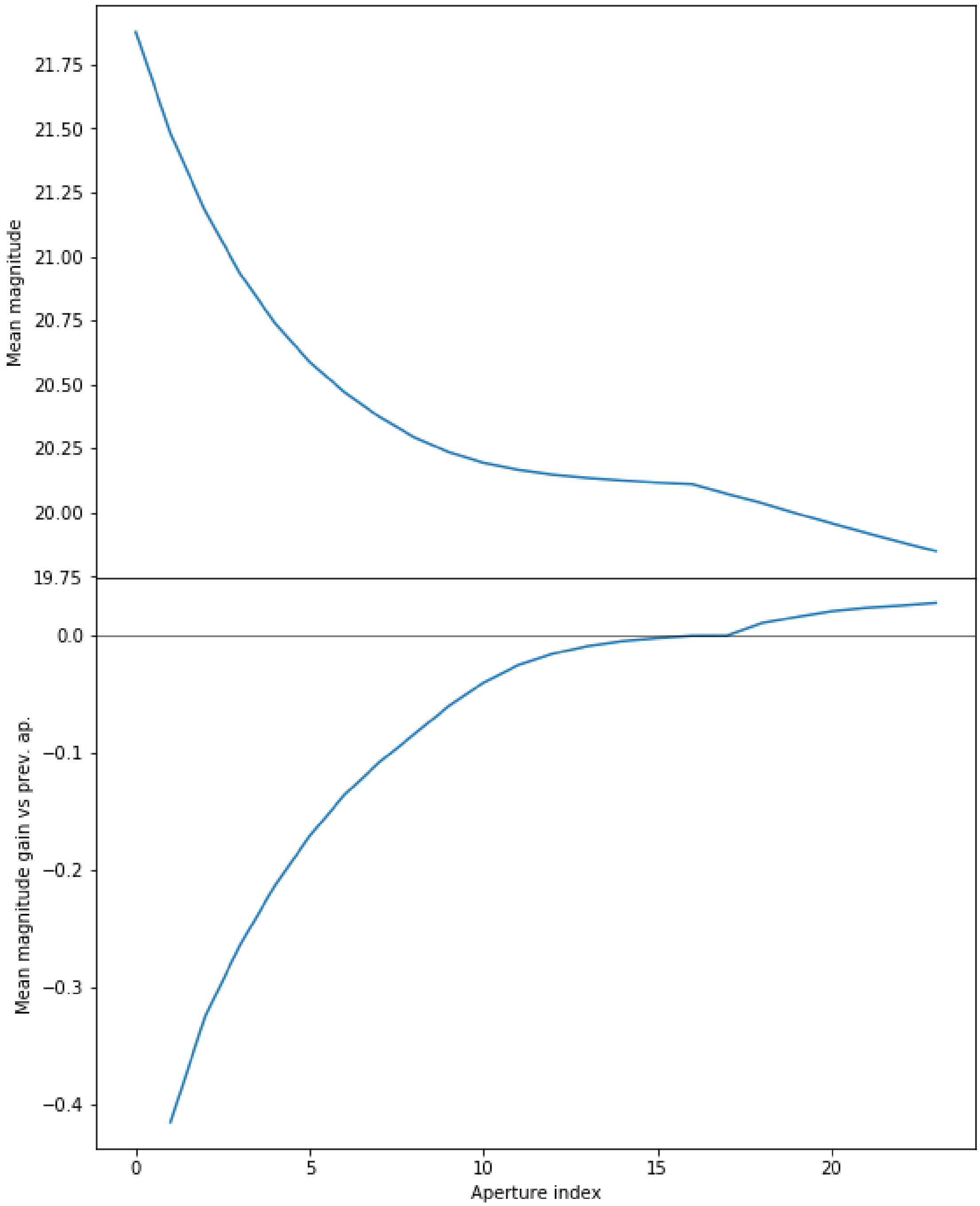
```
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid
  mask &= (mag >= mag_min)
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid
```

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



We use magnitudes between 17.2 and 18.

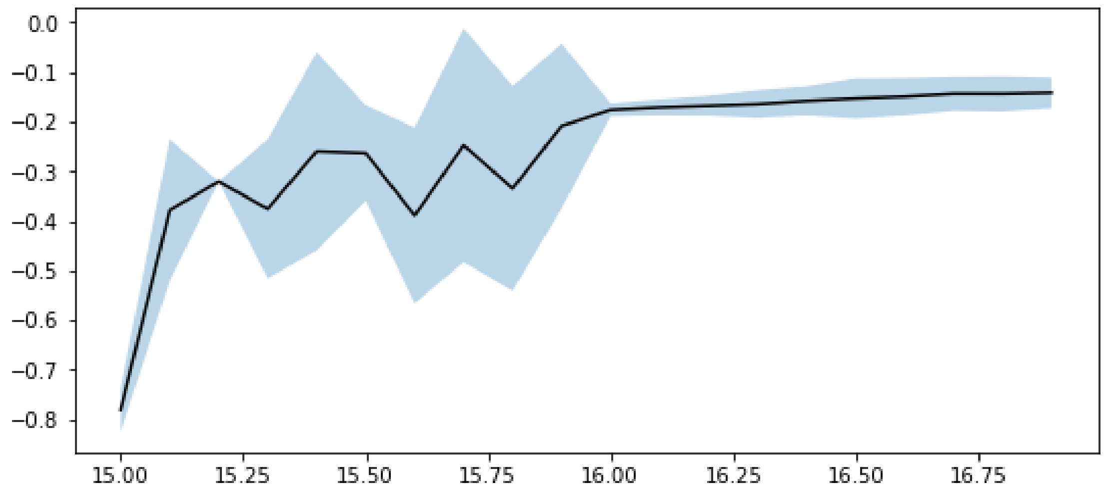
1.2.4 I.d z-band



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

```
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid
  mask &= (mag >= mag_min)
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid
```

```
  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)
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid
  mask &= (mag >= mag_min)
/home/yroehlly/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid
  mask &= (mag <= mag_max)


Aperture correction for SpARCS band u:
Correction: -0.14031028747558594
Number of source used: 1854
RMS: 0.04614434468089496

Aperture correction for SpARCS band g:
Correction: -0.15618896484375
Number of source used: 1655
RMS: 0.05094869324020216

Aperture correction for SpARCS band r:
Correction: -0.13660430908203125
Number of source used: 4415
RMS: 0.038120613108765716
```

```
Aperture correction for SpARCS band z:
Correction: -0.15040016174316406
Number of source used: 2359
RMS: 0.03453256417107372
```

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

1.4 II - Removal of duplicated sources

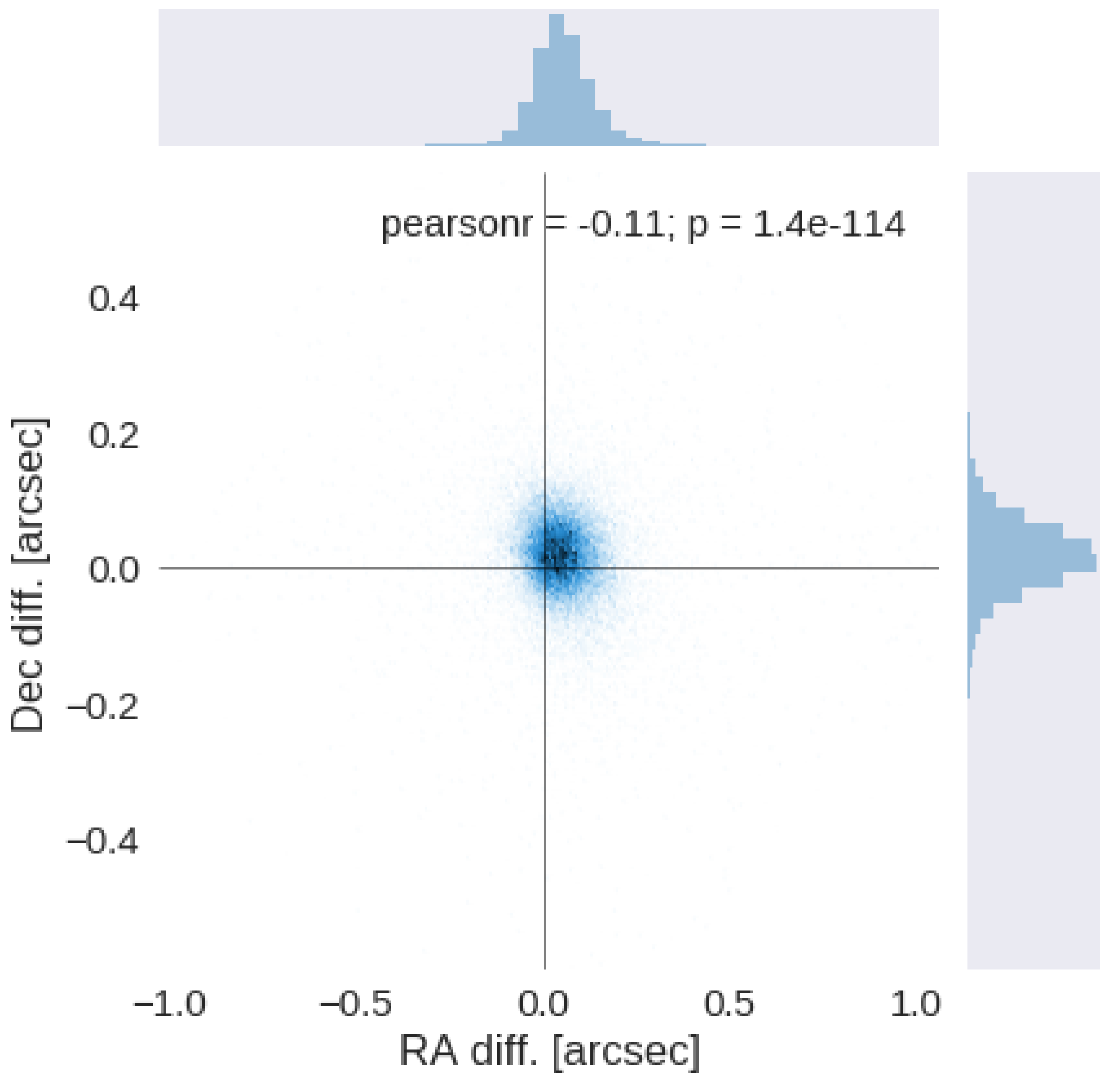
We remove duplicated objects from the input catalogues.

```
/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)
```

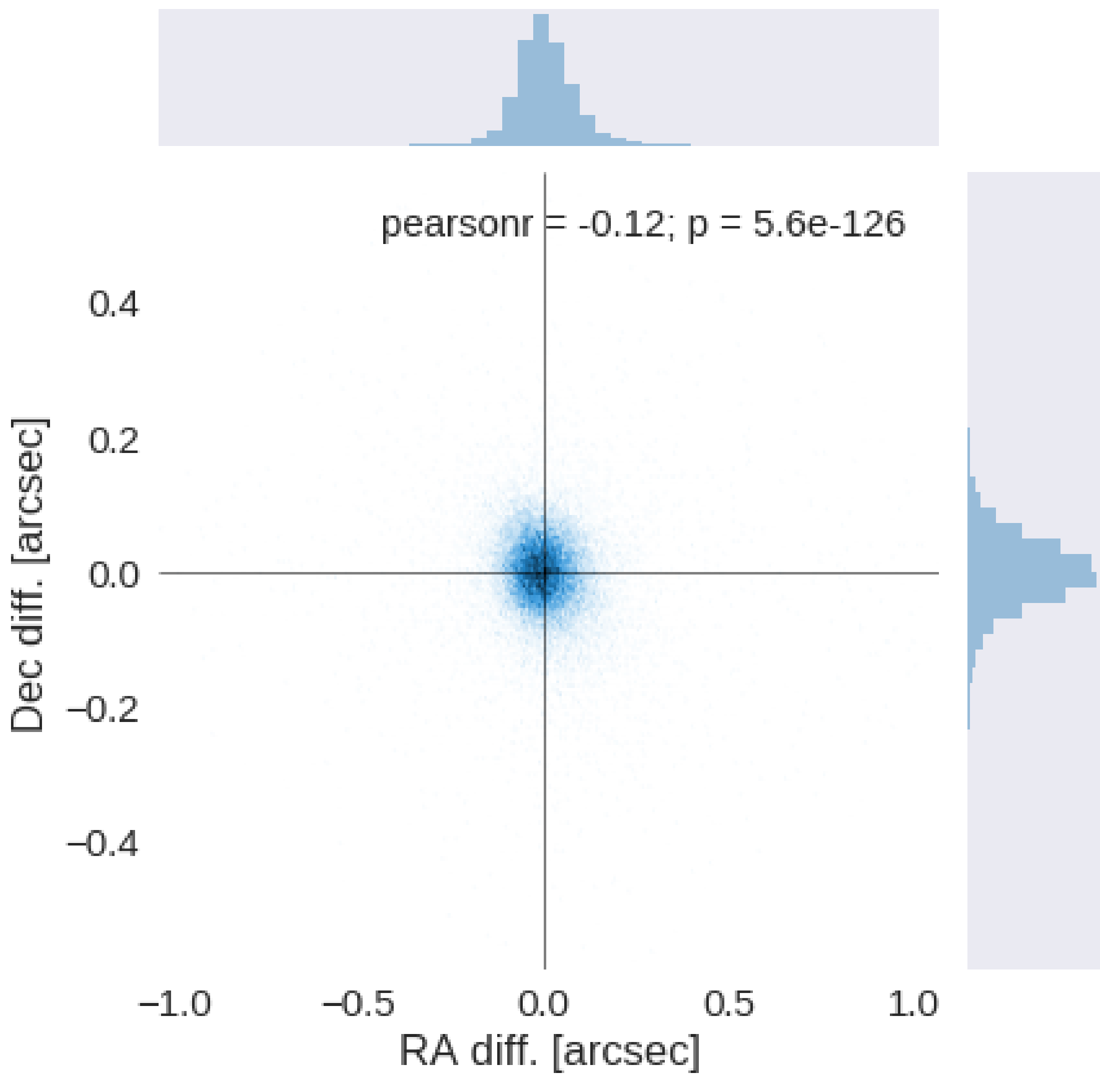
```
The initial catalogue had 1522722 sources.
The cleaned catalogue has 1522722 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned
```

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 = -0.11; p = 1.4e-114
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: -0.049572454224744443 arcsec
Dec correction: -0.01778054084127234 arcsec
```


pearsonr = -0.12; p = 5.6e-126
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

```
43241 sources flagged.
```

1.7 V - Saving to disk

1.6_SERVS

March 8, 2018

1 ELAIS-N1 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:
284b2ef (Mon Aug 14 20:02:12 2017 +0100)
```

1.2 I - Column selection

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

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

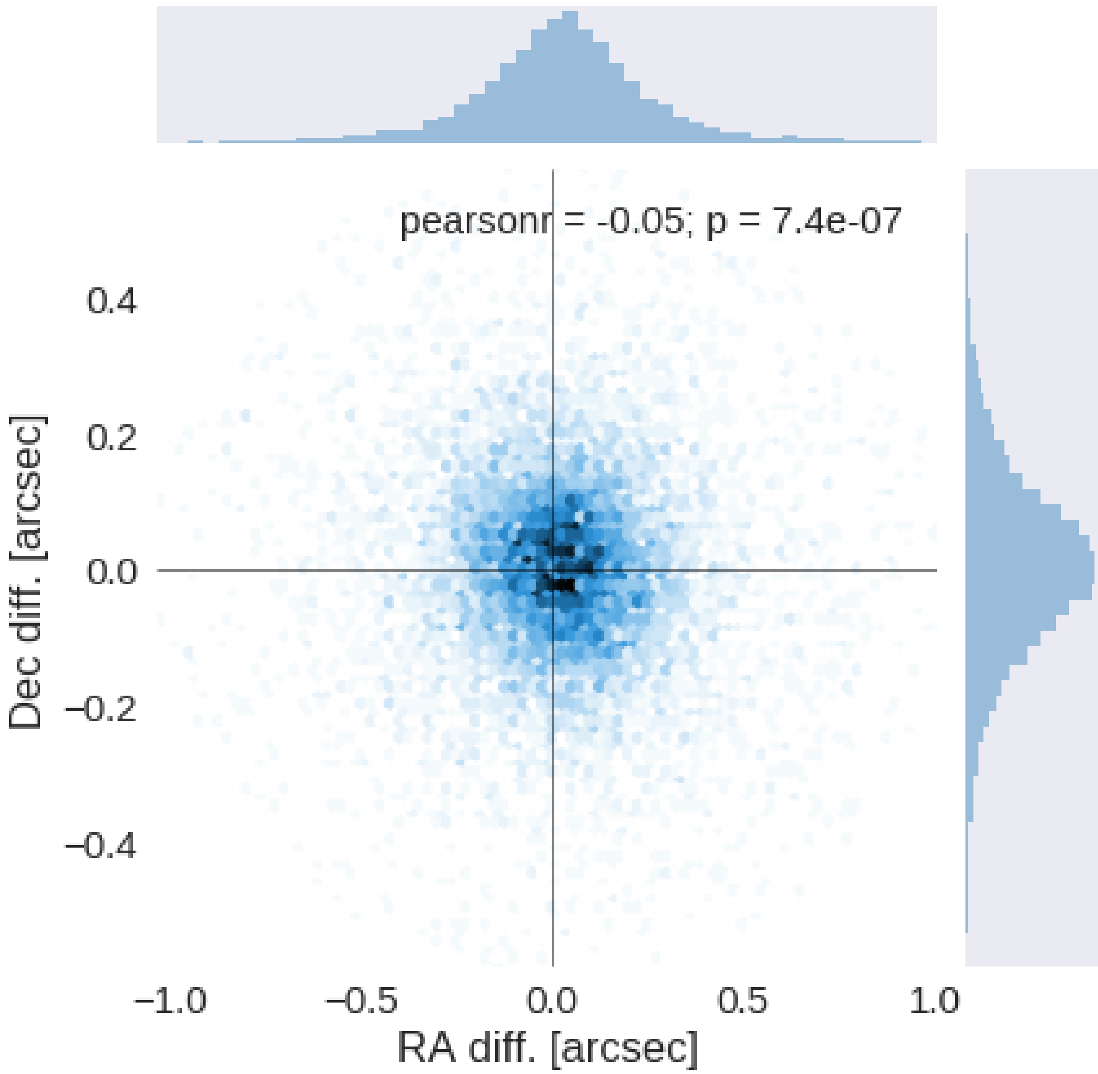
1.3 II - Removal of duplicated sources

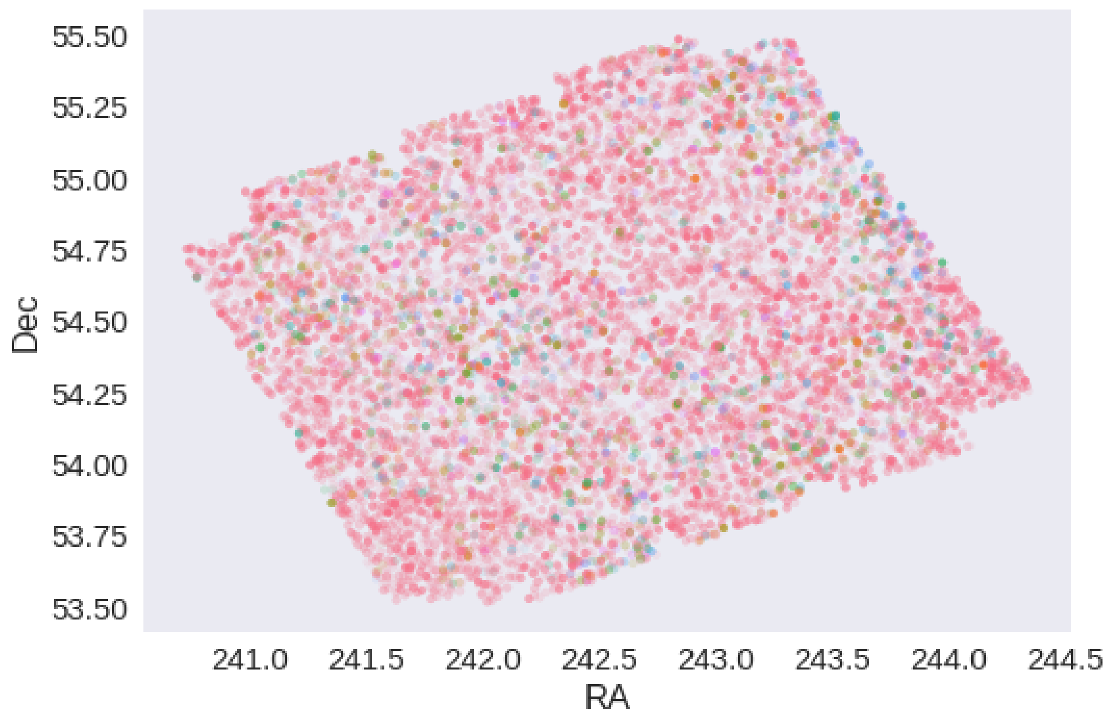
We remove duplicated objects from the input catalogues.

```
/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 395243 sources.
The cleaned catalogue has 395243 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned
```

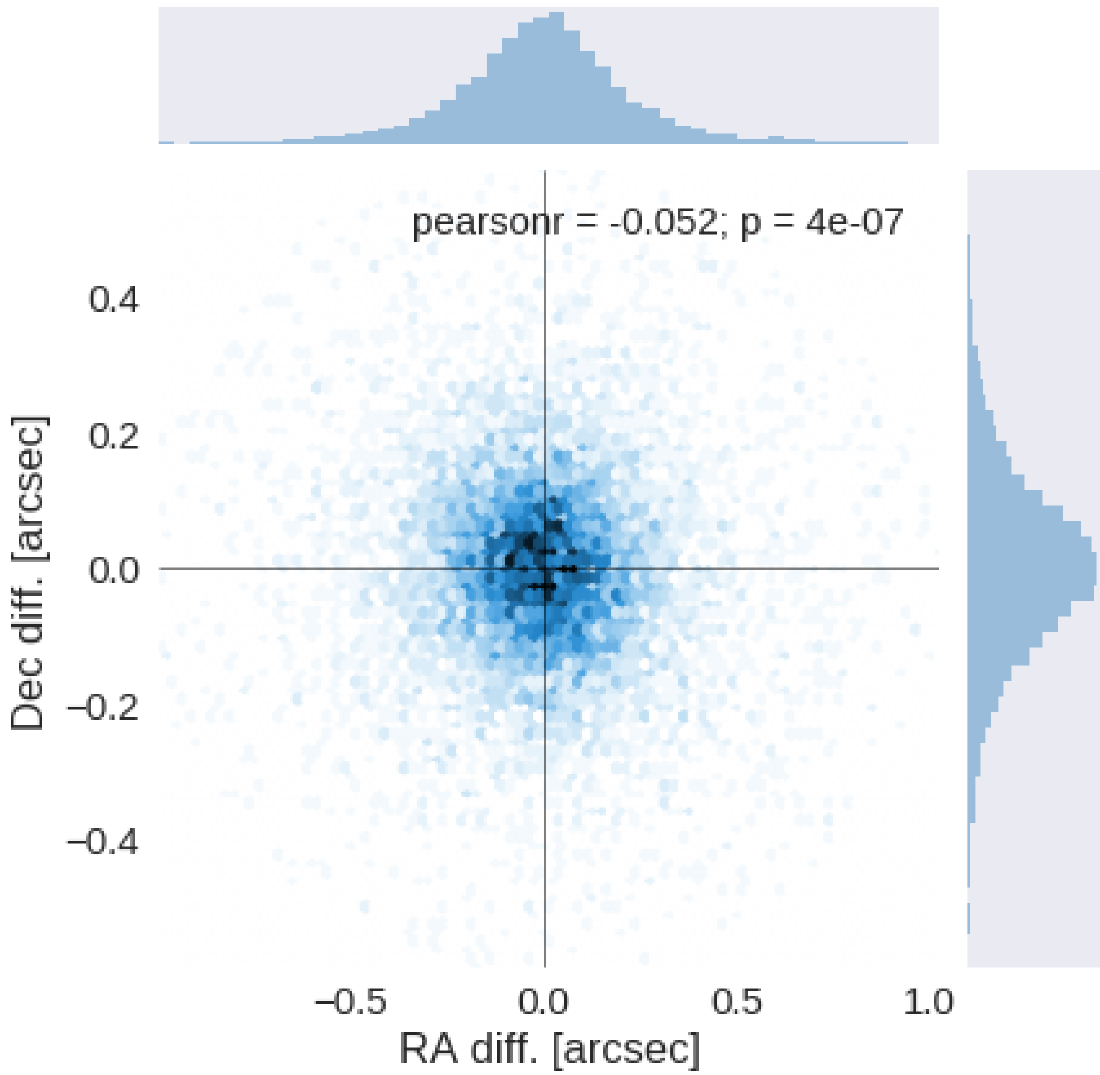
1.4 III - Astrometry correction

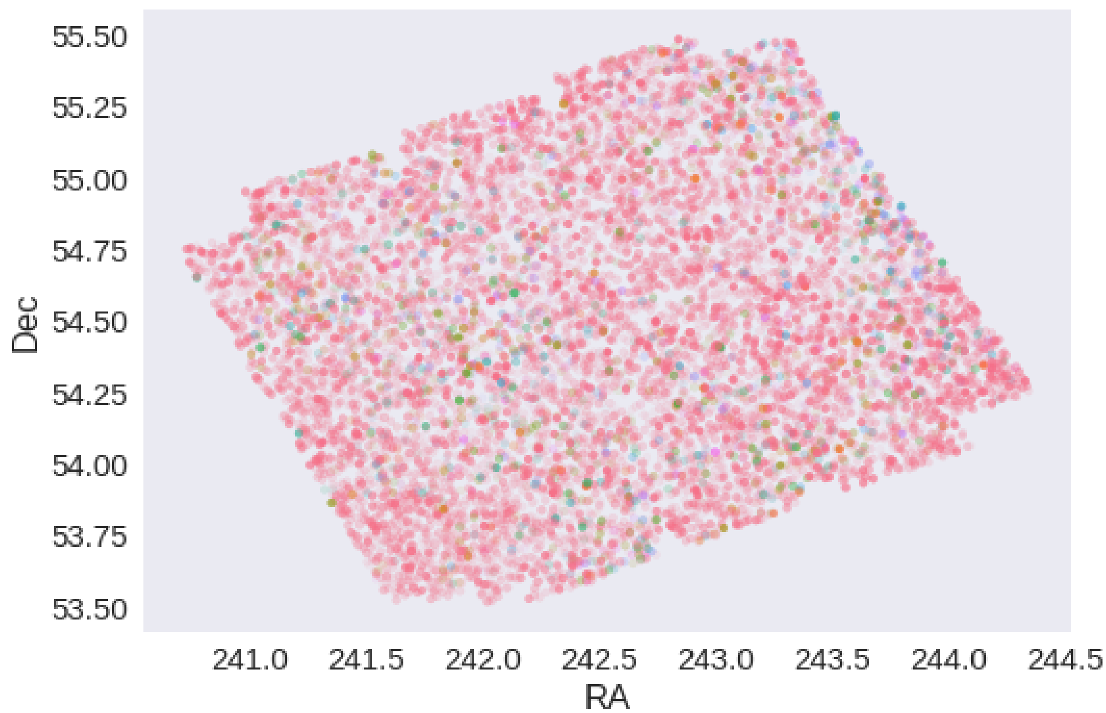
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.025643899829219663 arcsec
Dec correction: -0.004405288319730971 arcsec
```


pearsonr = -0.052; p = 4e-07
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
10149 sources flagged.
```

1.6 V - Saving to disk

1.7_SWIRE

March 8, 2018

1 ELAIS-N1 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:
284b2ef (Mon Aug 14 20:02:12 2017 +0100)
```

1.2 I - Column selection

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

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

1.3 II - Removal of duplicated sources

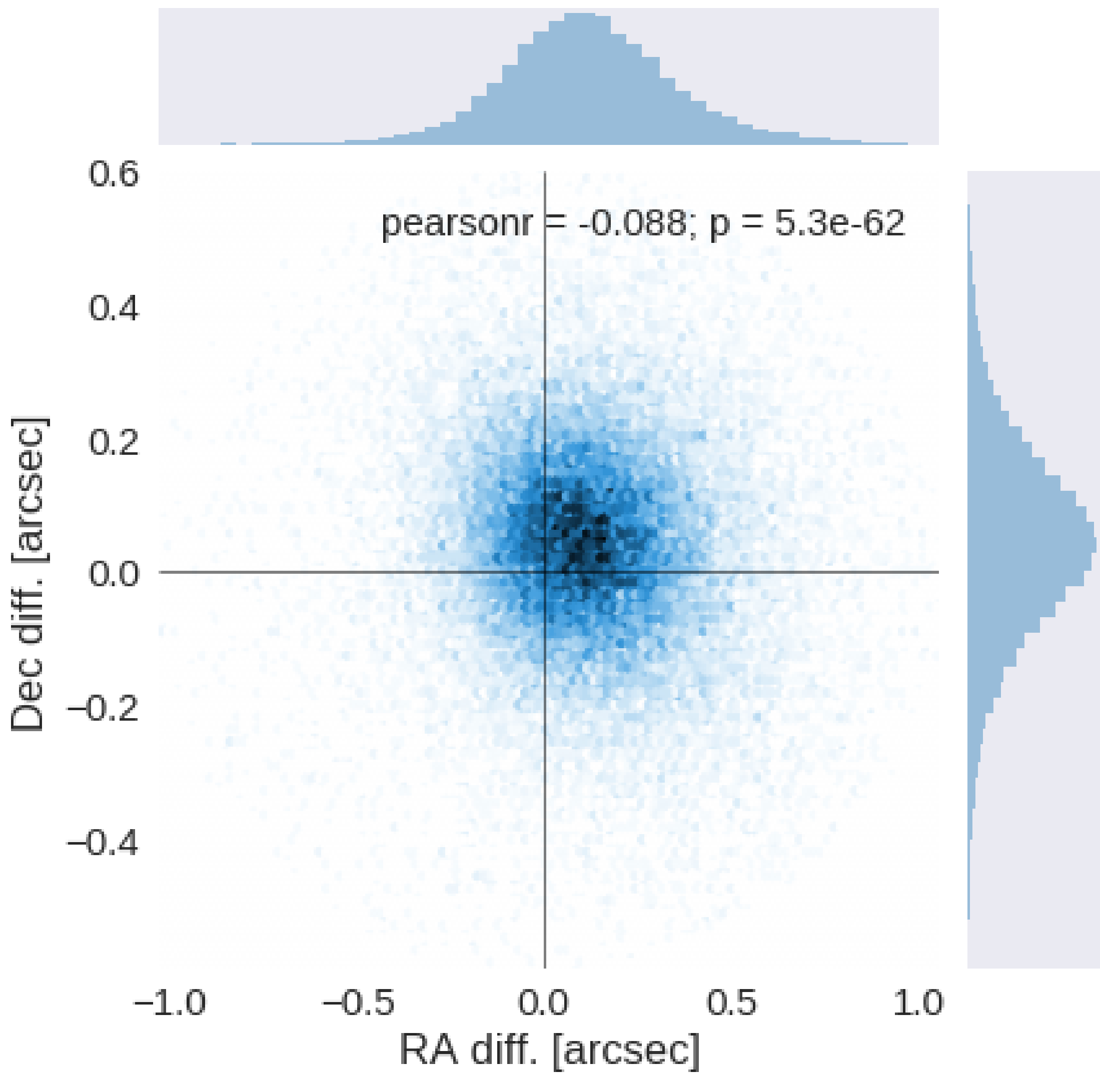
We remove duplicated objects from the input catalogues.

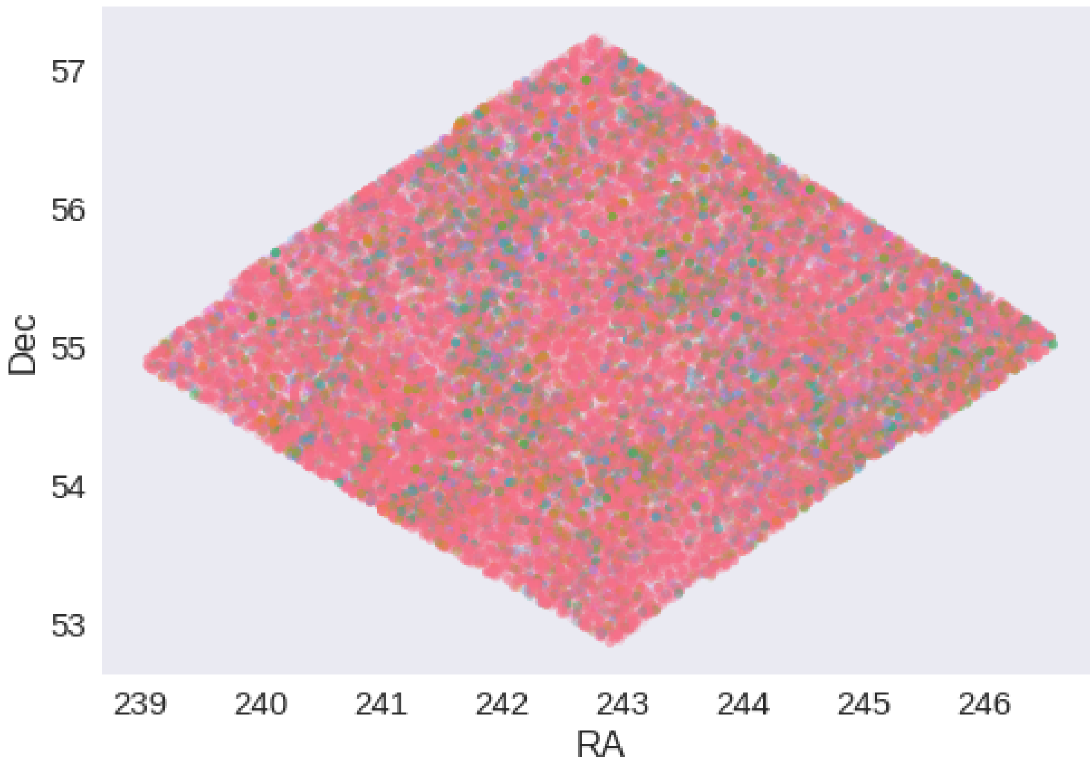
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 573843 sources.
The cleaned catalogue has 573794 sources (49 removed).
The cleaned catalogue has 49 sources flagged as having been cleaned
```

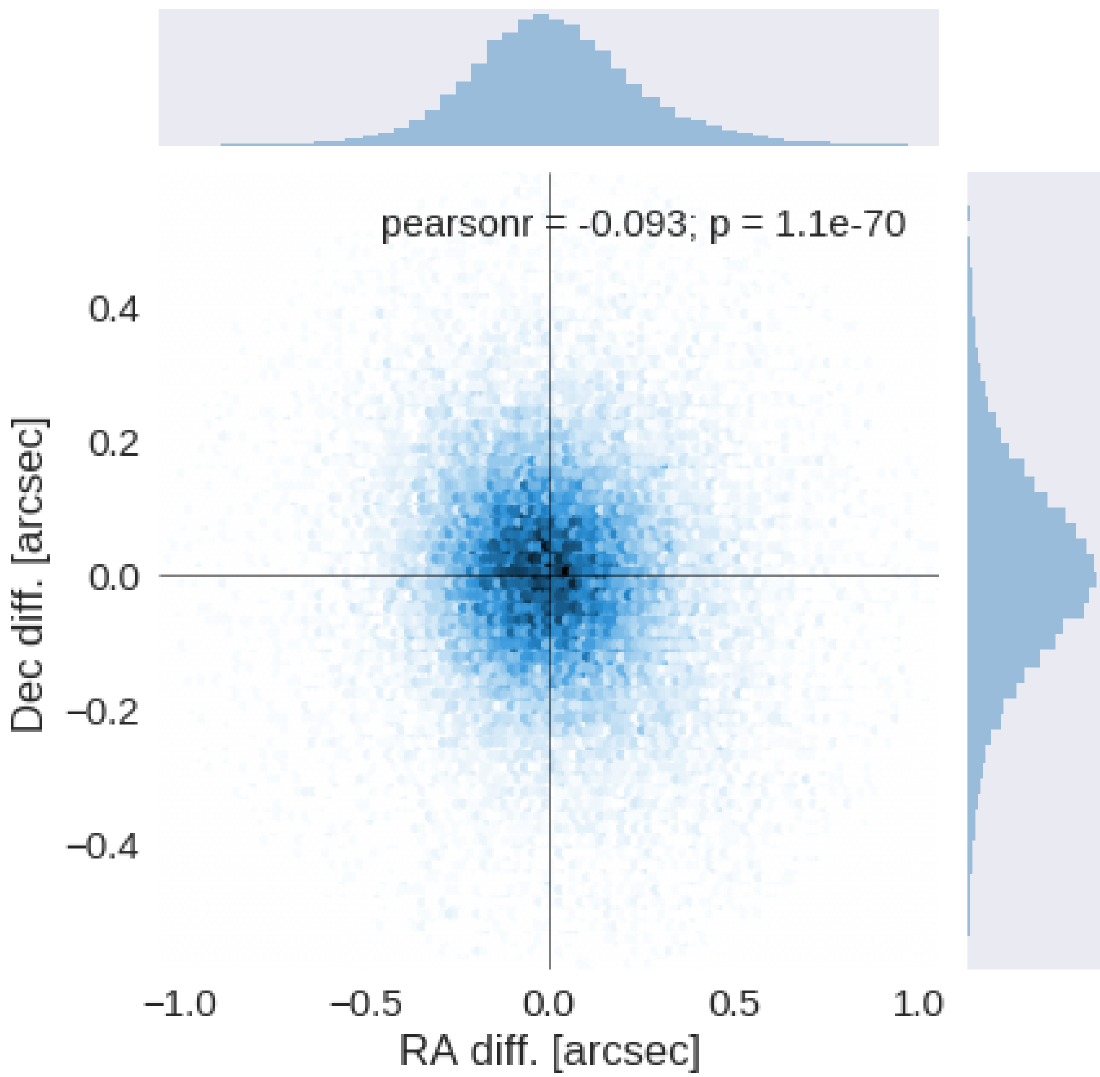
1.4 III - Astrometry correction

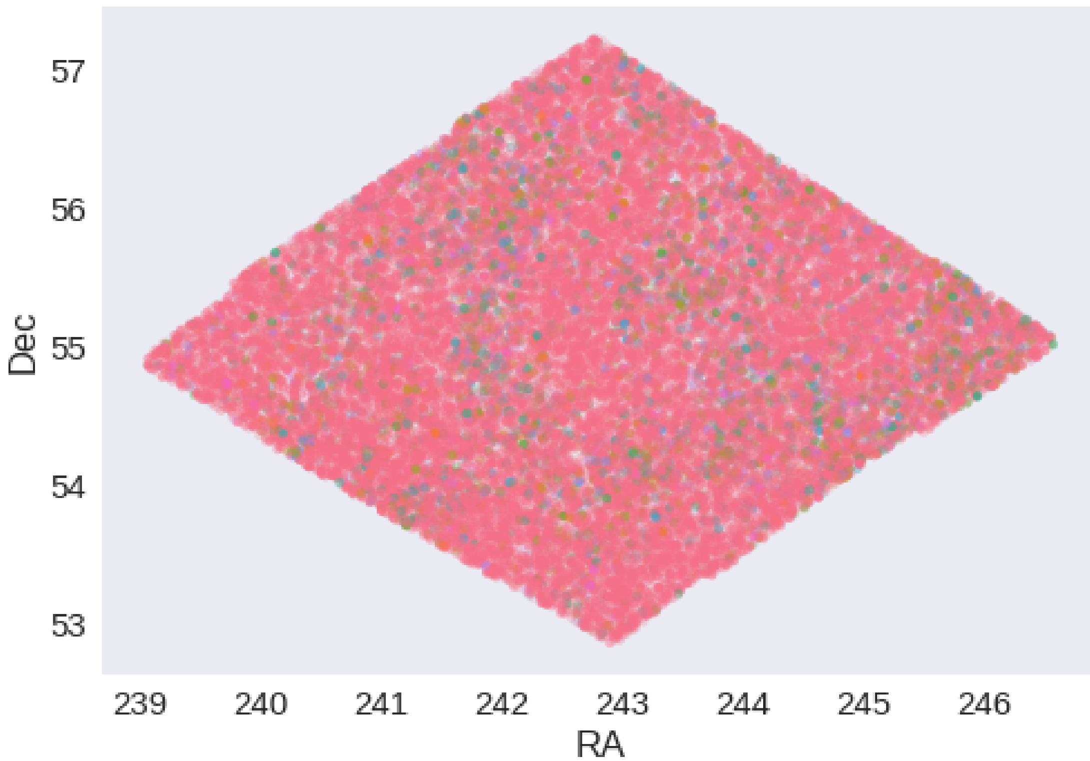
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.11121544077354883 arcsec
Dec correction: -0.04267586375164001 arcsec
```


pearsonr = -0.093; p = 1.1e-70
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

```
37537 sources flagged.
```

2 V - Saving to disk

1.8_KPNO-FLS

March 8, 2018

1 xFLS master catalogue

1.1 Preparation of KPNO-FLS data

KPNO-FLS catalogue: the catalogue comes from `dmu0_KPNO-FLS`.

In the catalogue, we keep:

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

1.2 I - Column selection

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

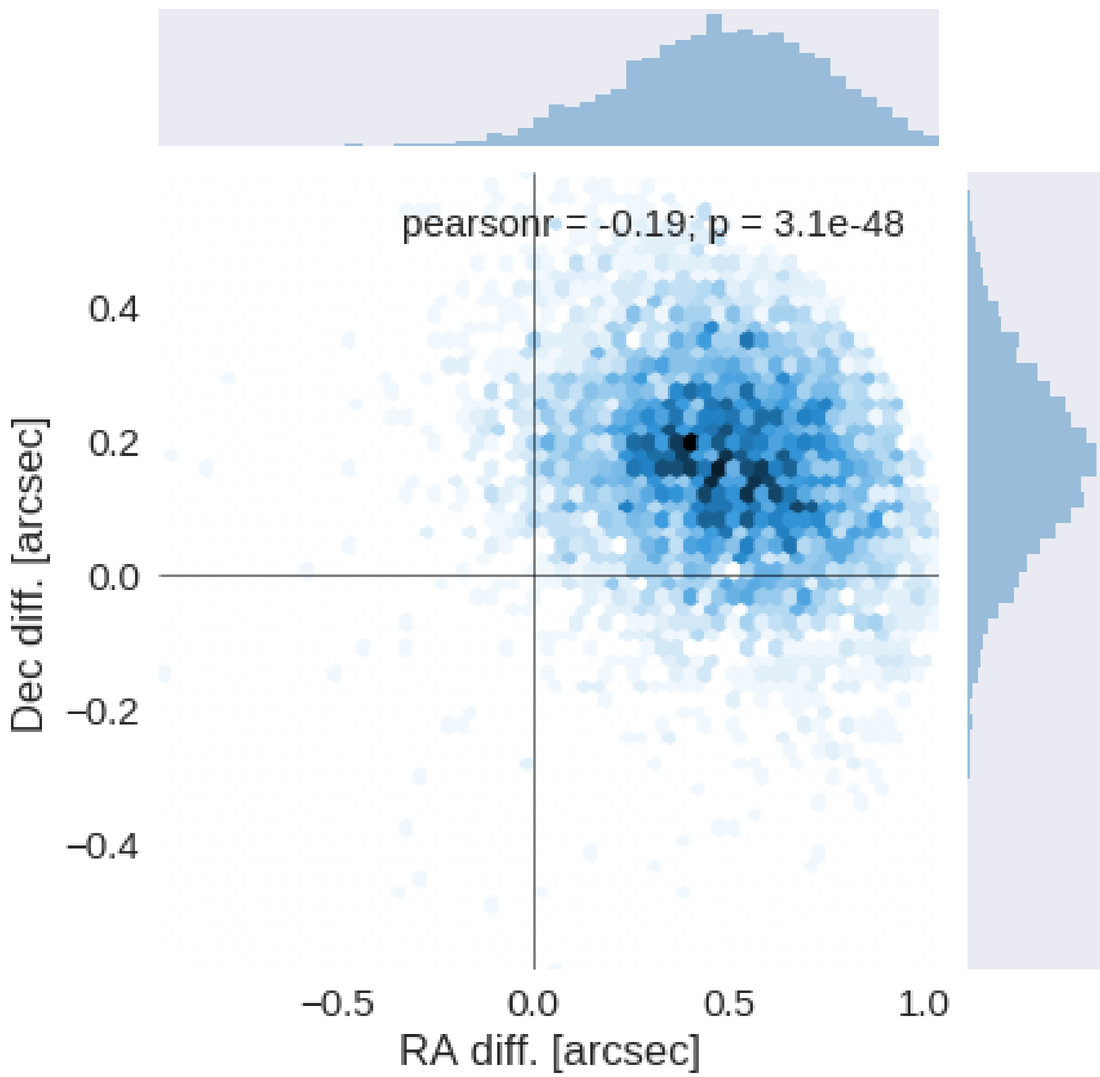
1.3 II - Removal of duplicated sources

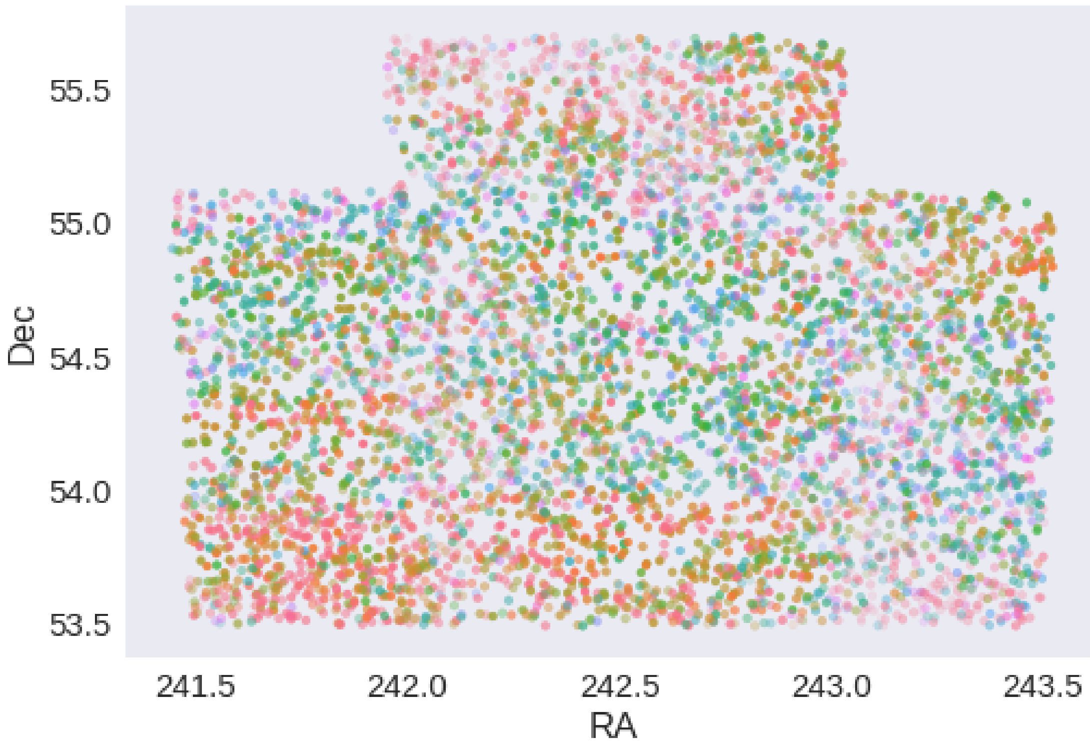
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 273541 sources.
The cleaned catalogue has 244534 sources (29007 removed).
The cleaned catalogue has 28542 sources flagged as having been cleaned
```

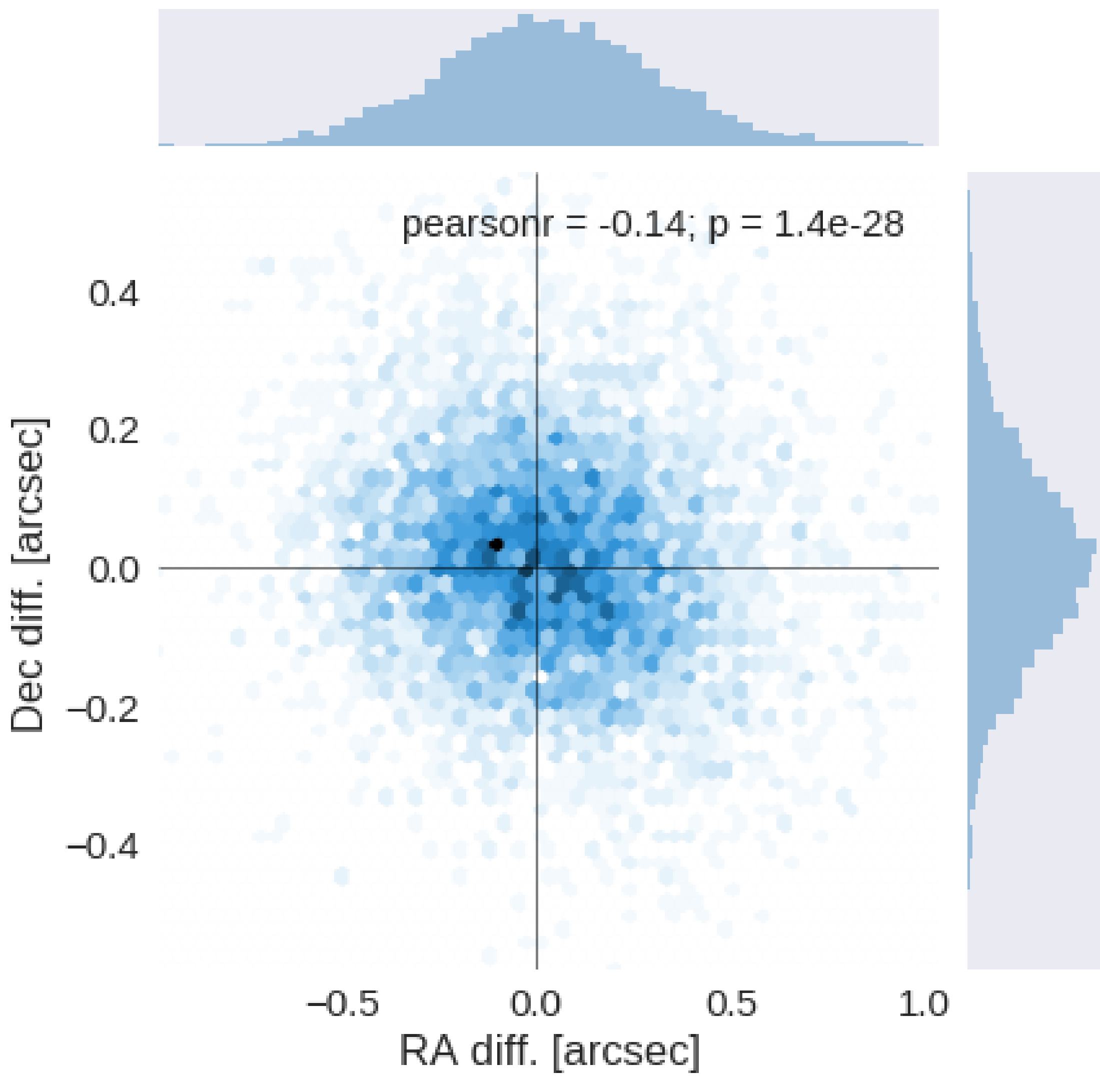
1.4 III - Astrometry correction

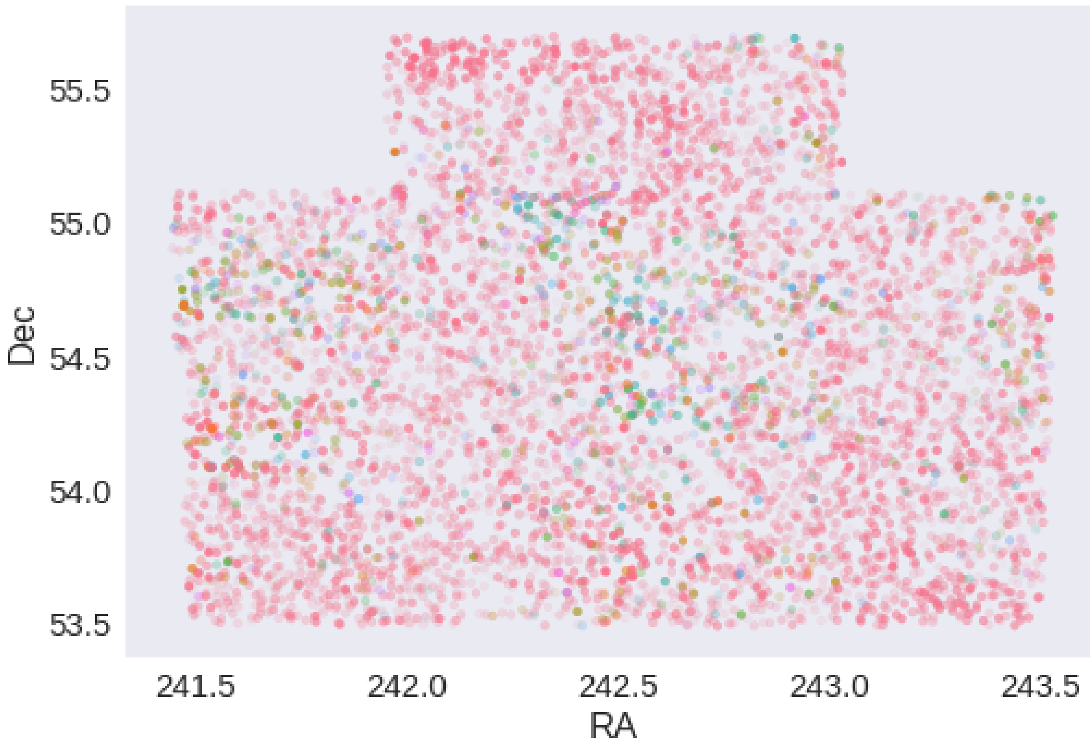
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = -0.19; p = 3.1e-48
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.5
0.0
0.5
1.0
RA diff. [arcsec]




```
RA correction: -0.49299694316005116 arcsec
Dec correction: -0.16615041888883297 arcsec
```


pearsonr = -0.14; p = 1.4e-28
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.5
0.0
0.5
1.0
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
6442 sources flagged.
```

2 V - Saving to disk

1.9_UHS

March 8, 2018

1 Bootes master catalogue

1.1 Preparation of UKIRT Hemisphere Survey (UHS) data

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

In the catalogue, we keep:

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

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

```
This notebook was run with herschelhelp_internal version:
0246c5d (Thu Jan 25 17:01:47 2018 +0000) [with local modifications]
This notebook was executed on:
2018-02-16 15:18:34.817025
```

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

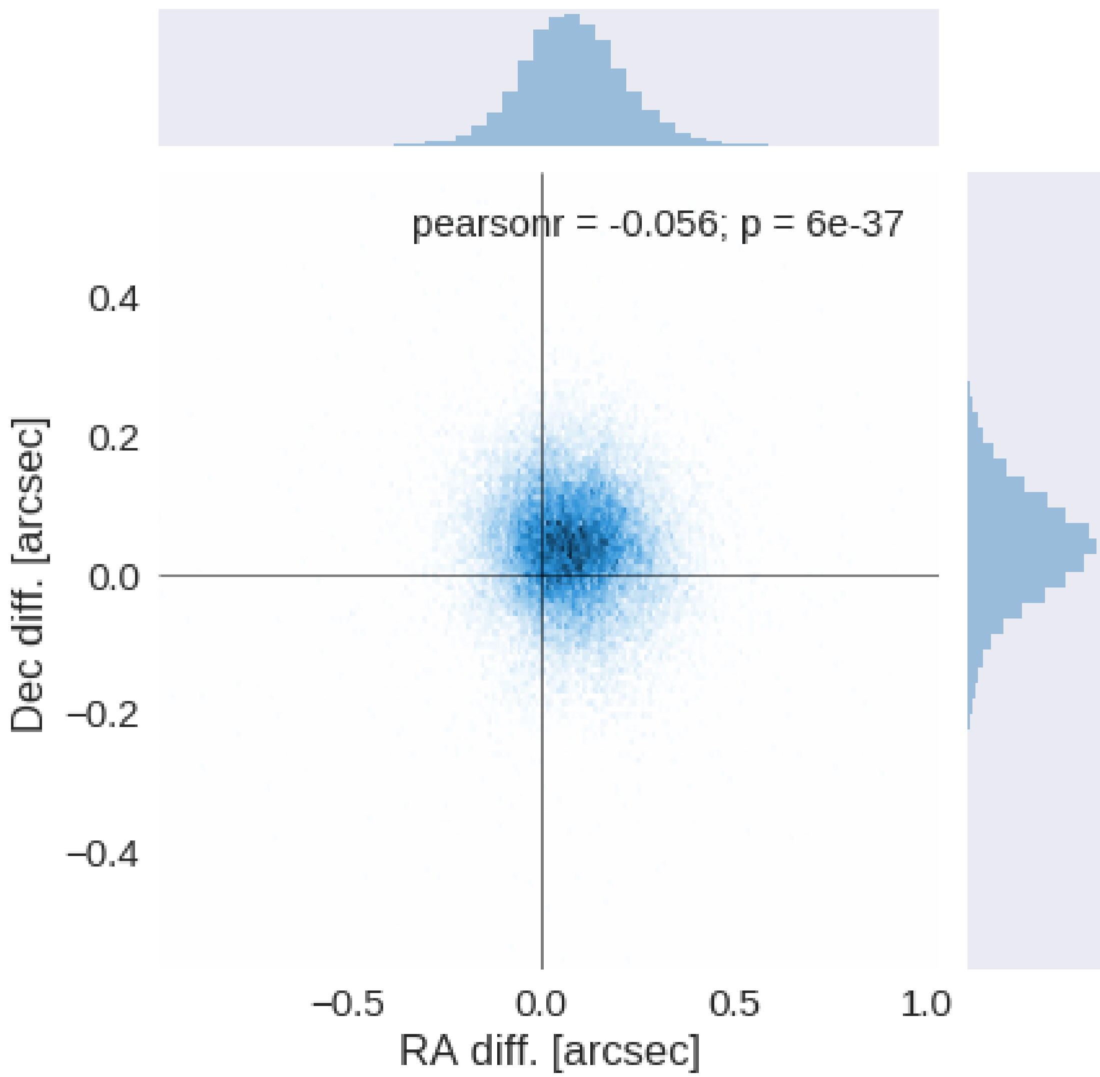
We remove duplicated objects from the input catalogues.

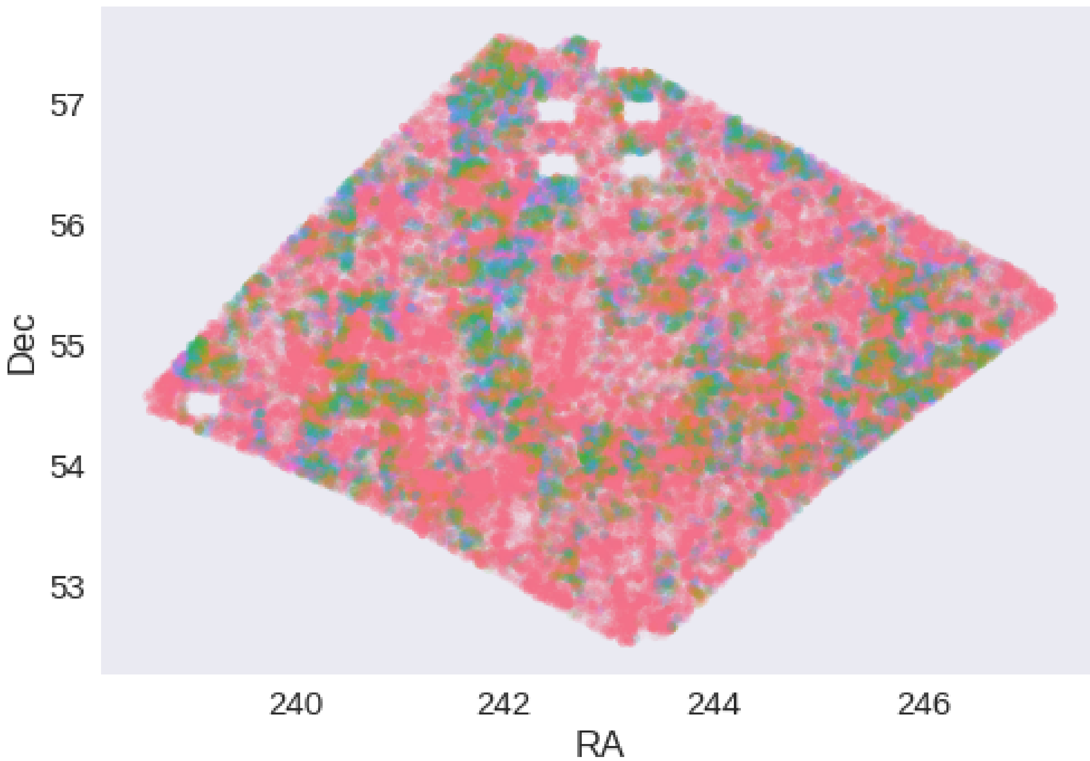
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 168669 sources.
The cleaned catalogue has 157486 sources (11183 removed).
The cleaned catalogue has 10747 sources flagged as having been cleaned
```

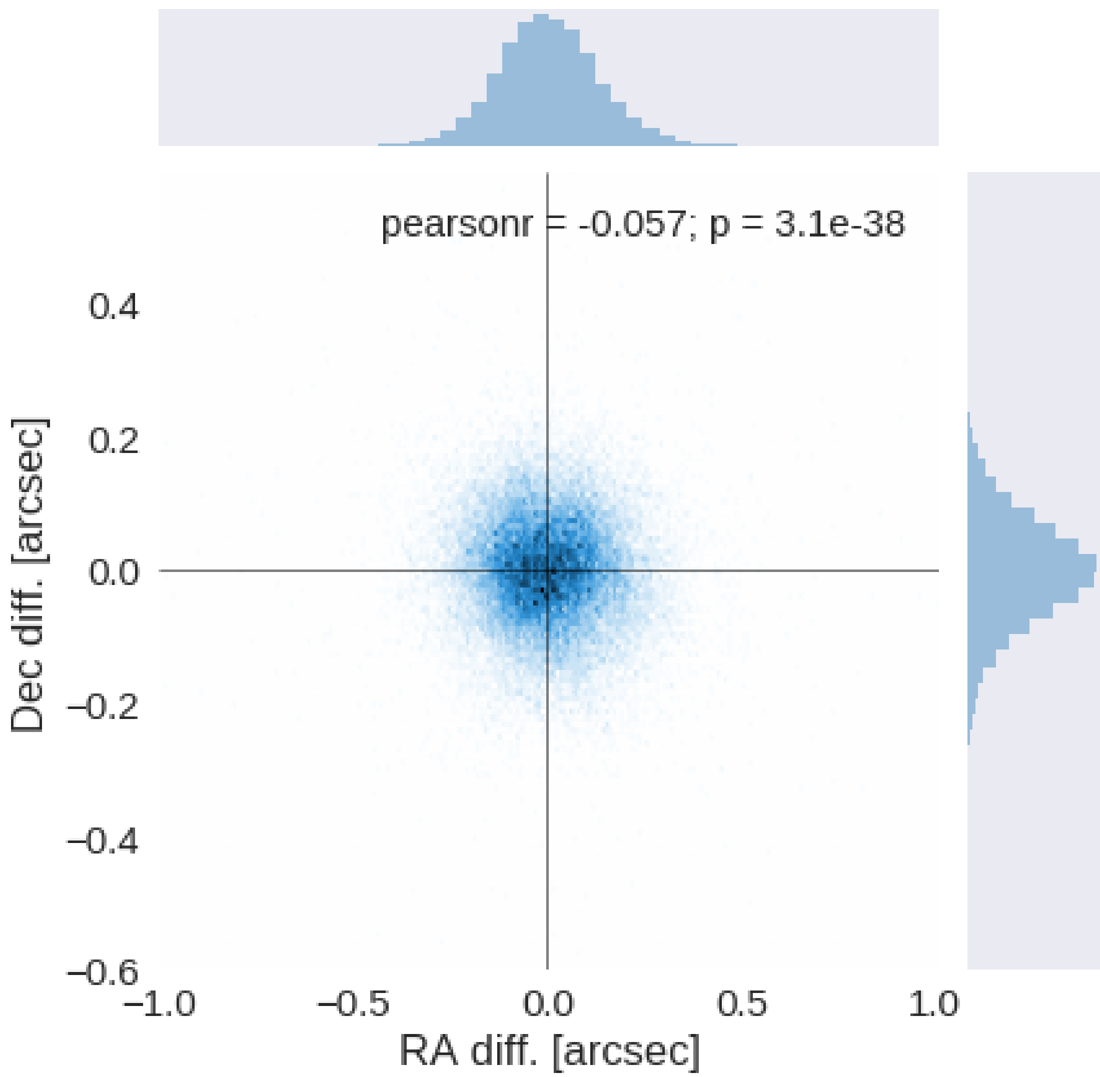
1.4 III - Astrometry correction

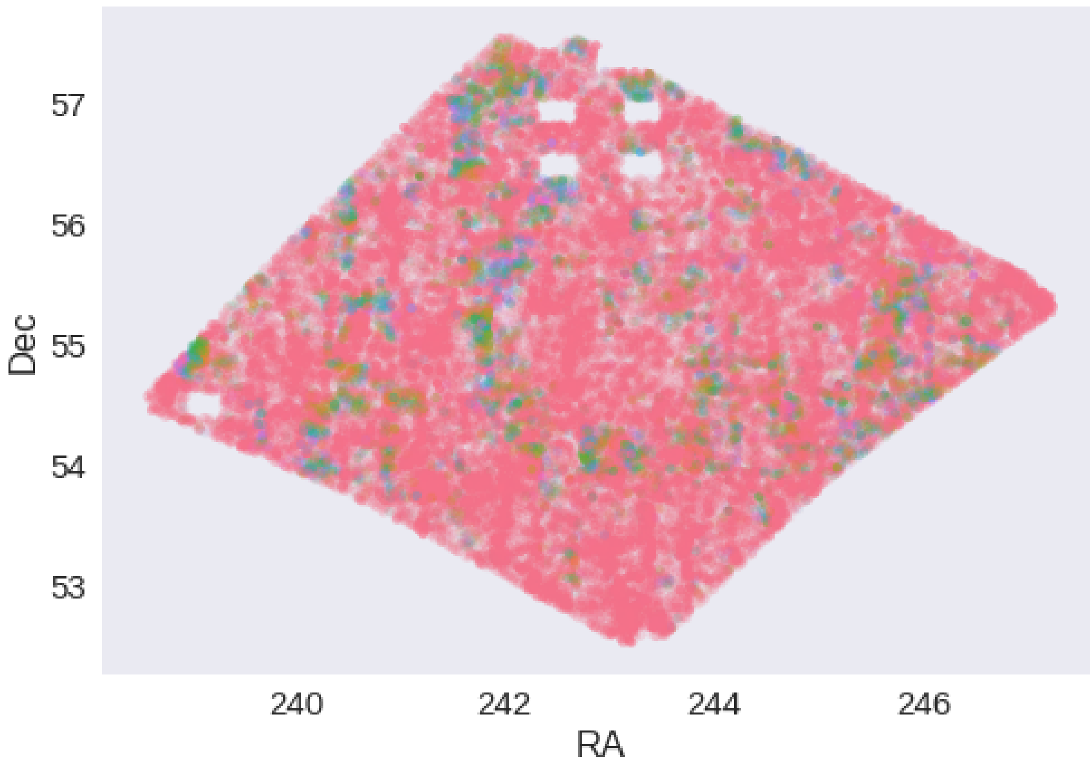
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = -0.056; p = 6e-37
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.5
0.0
0.5
1.0
RA diff. [arcsec]




```
RA correction: -0.07932785636057815 arcsec
Dec correction: -0.03944465994152324 arcsec
```


pearsonr = -0.057; p = 3.1e-38
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

```
52211 sources flagged.
```

2 V - Saving to disk

1.10_LegacySurvey

March 8, 2018

1 Bootes master catalogue

1.1 Preparation of Legacy Survey data

The catalogue comes from `dmu0_LegacySurvey`.

In the catalogue, we keep:

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

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

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

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

1.2 I - 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).

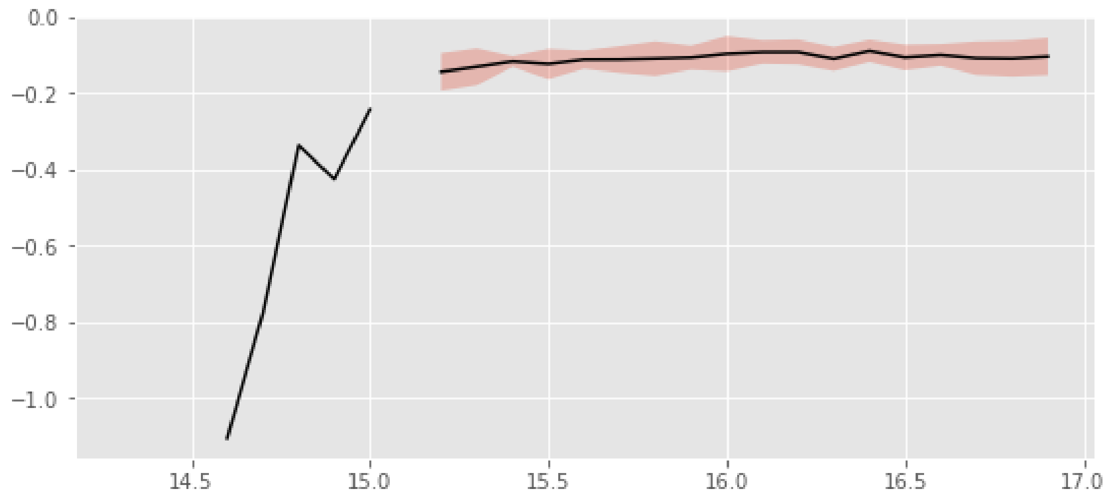
As target aperture, we should use the smallest (i.e. less noisy) aperture for which most of the flux is captures.

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.

```
/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: invalid value enco
  errors = 2.5 / np.log(10) * errors_on_fluxes / fluxes
```

1.2.1 I.a - g band

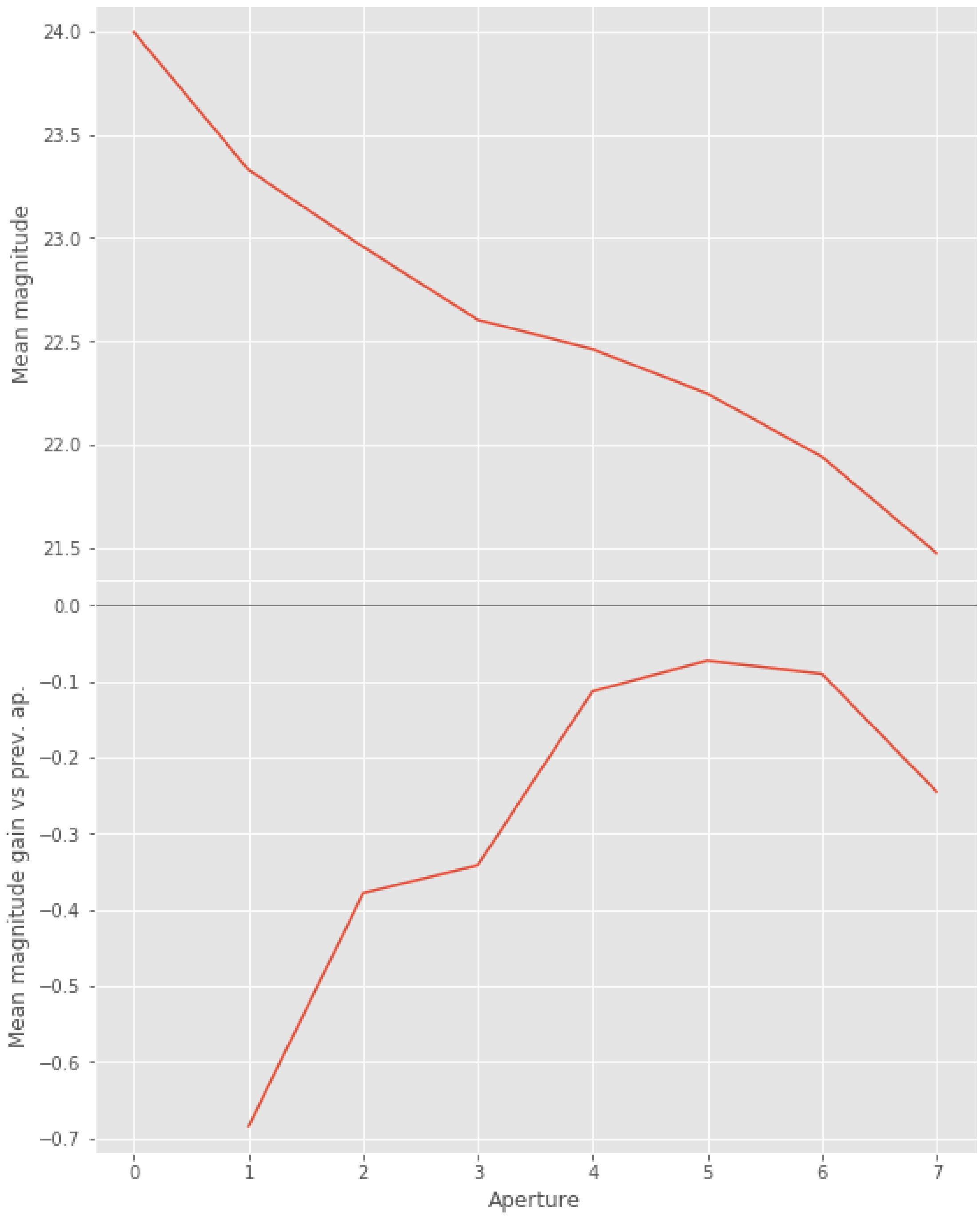
We will use aperture 5 as target.



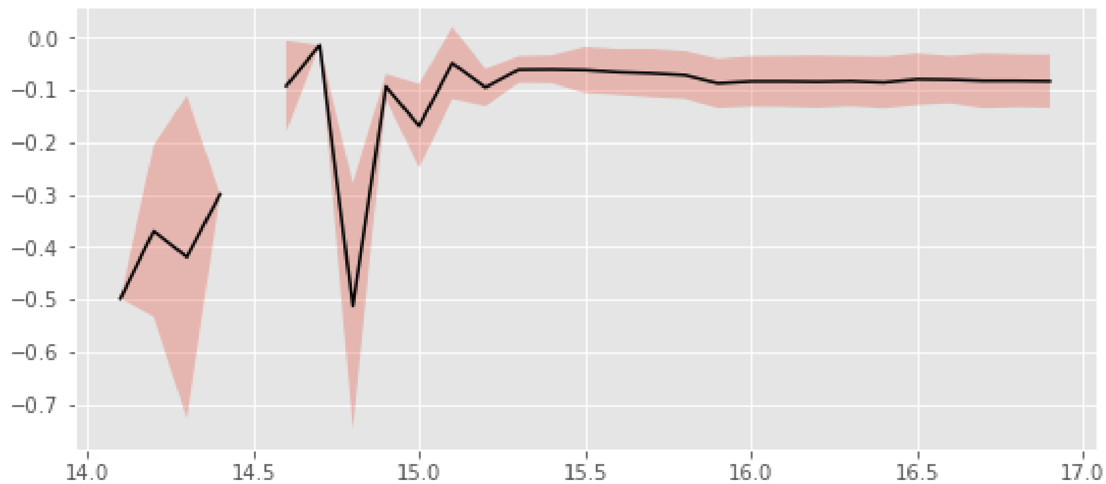
We will use magnitudes between 17.0 and 18.5

```
Aperture correction for g band:
Correction: -0.10953948800625568
Number of source used: 5427
RMS: 0.044375142986281785
```

1.2.2 I.b - r band



We will use aperture 5 as target.

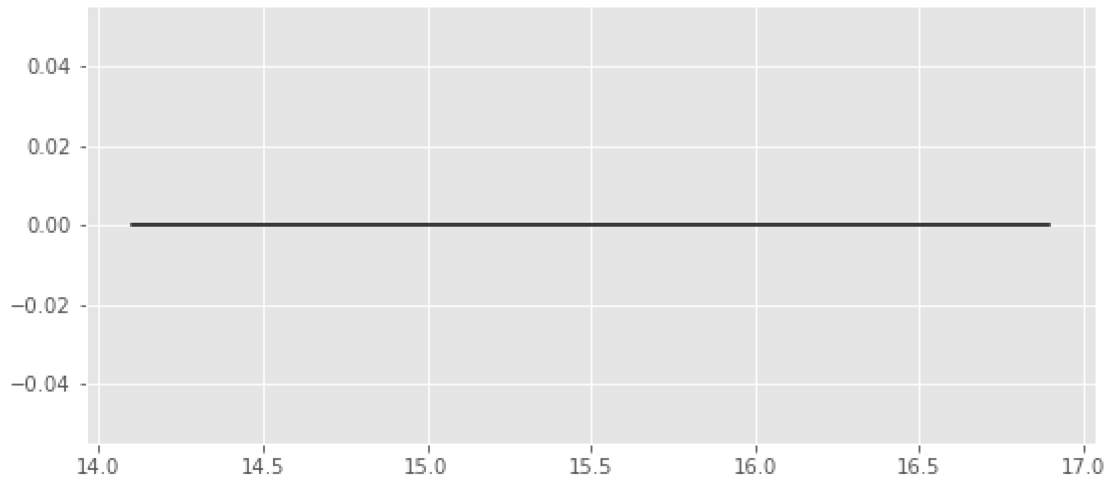


We use magnitudes between 17.0 and 18.5.

```
Aperture correction for r band:
Correction: -0.08892021919108117
Number of source used: 9279
RMS: 0.050458118896177 35
```

1.2.3 I.c - z band

We will use aperture 4 as target.



We use magnitudes between 16.0 and 17.5.

```
Aperture correction for z band:
Correction: -0.035849571116841616
Number of source used: 9522
RMS: 0.009878632017650733
```

1.3 II - Stellarity

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

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

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

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

1.4 II - Column selection

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

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value enco
  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[19]: <IPython.core.display.HTML object>
```

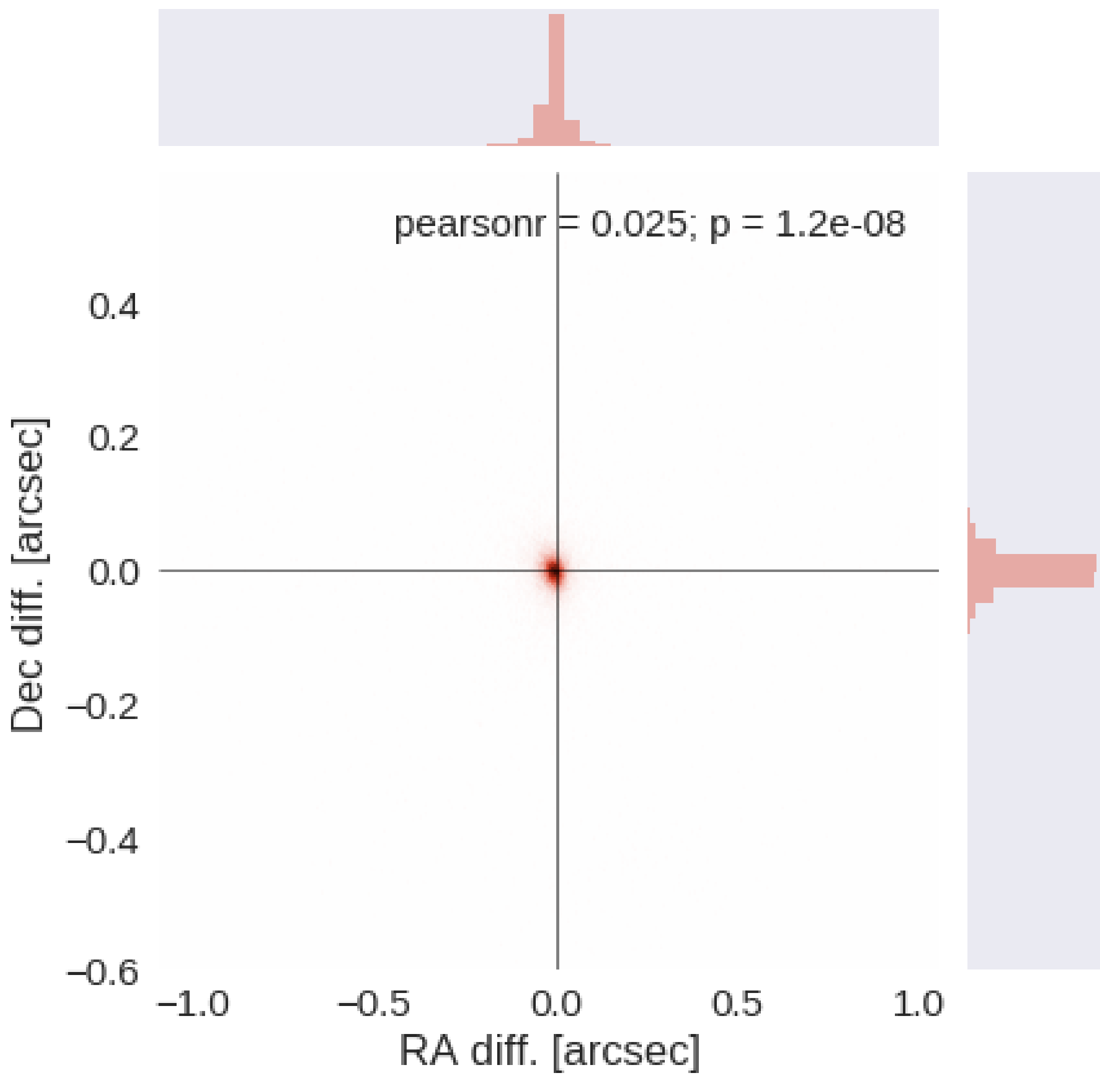
1.5 III - Removal of duplicated sources

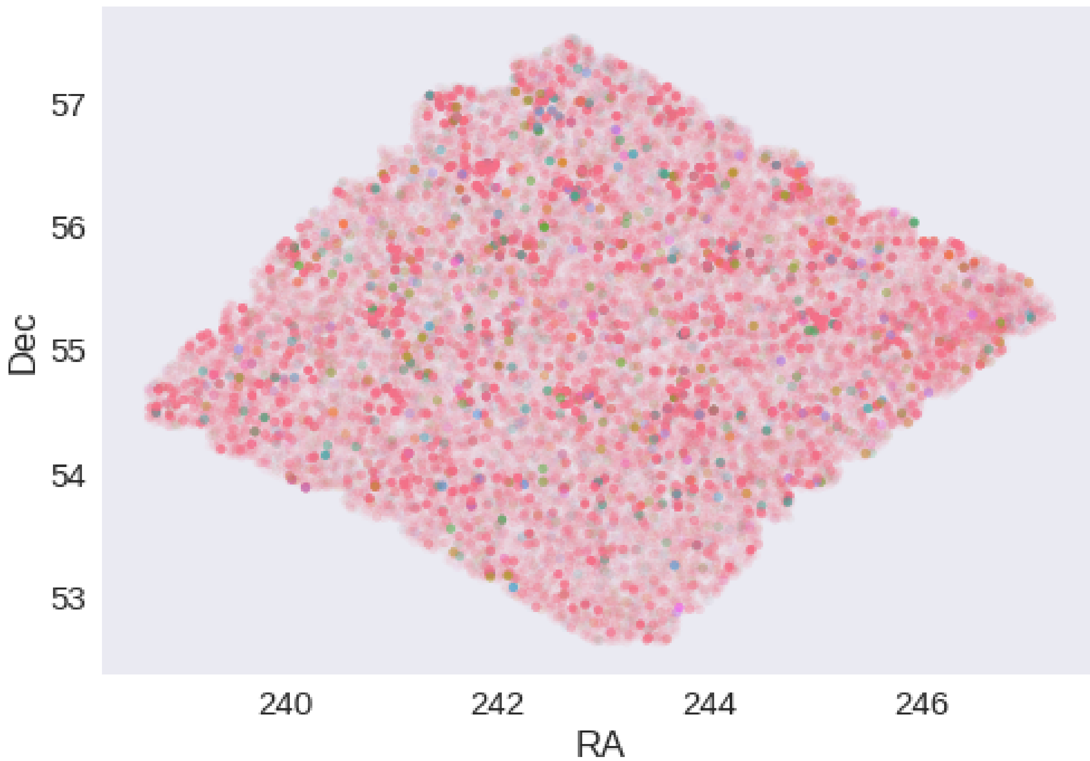
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 611319 sources.
The cleaned catalogue has 598717 sources (12602 removed).
The cleaned catalogue has 12427 sources flagged as having been cleaned
```

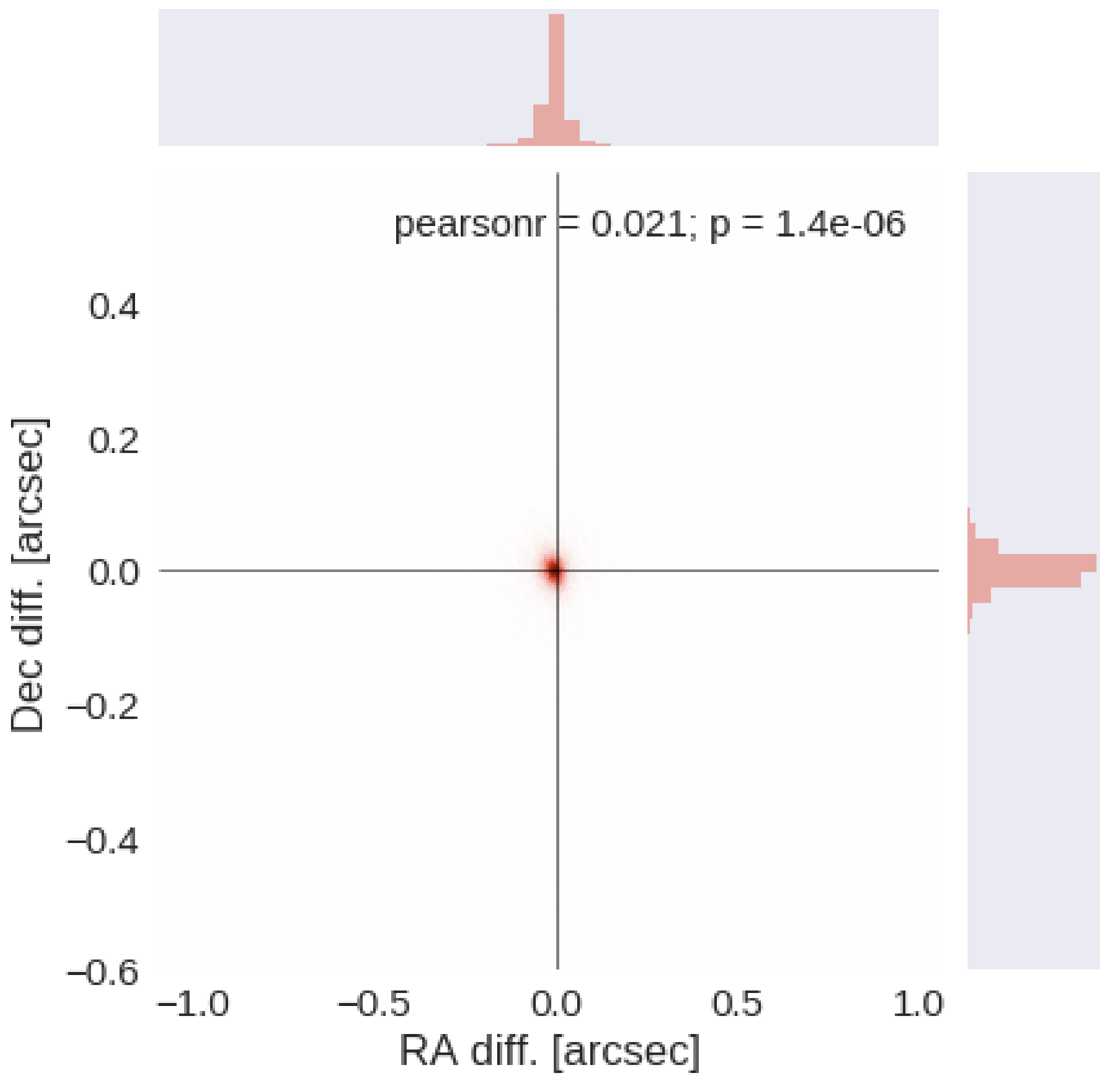
1.6 III - Astrometry correction

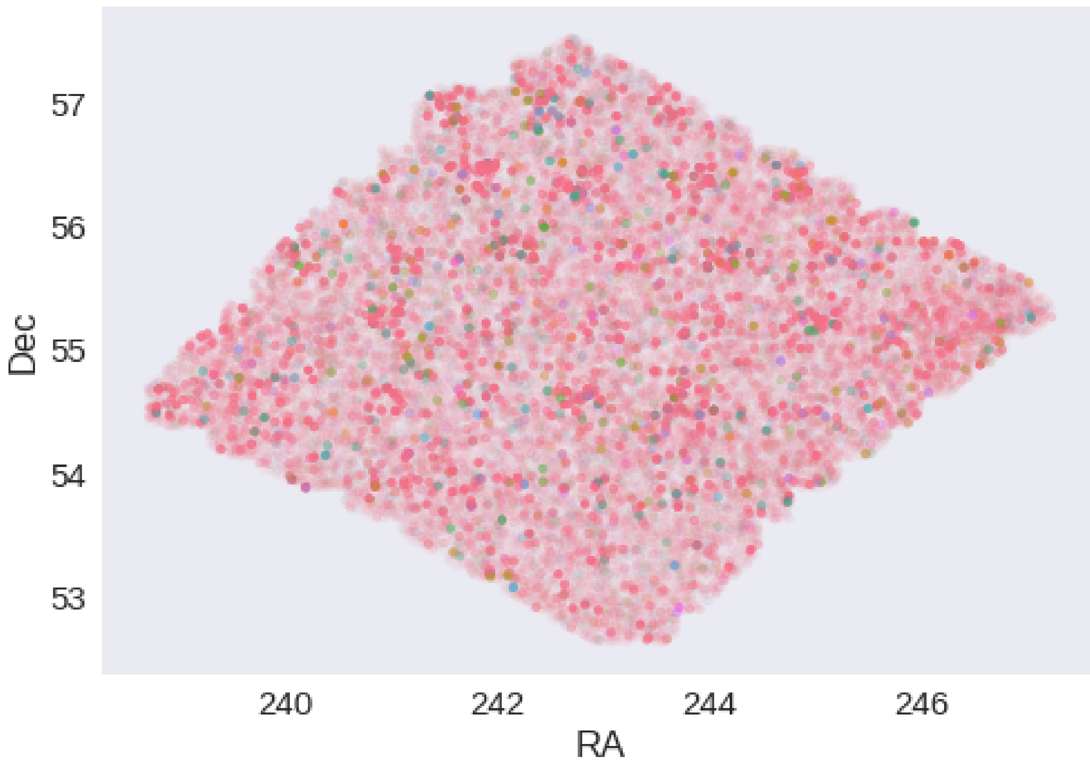
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = 0.025; p = 1.2e-08
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]




```
RA correction: -0.0001348266778222751 arcsec
Dec correction: 0.0020895110282026508 arcsec
```


pearsonr = 0.021; p = 1.4e-06
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]



1.7 IV - Flagging Gaia objects

```
53631 sources flagged.
```

2 V - Saving to disk

2_Merging

March 8, 2018

1 ELAIS-N1 master catalogue

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

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

1.1 I - Reading the prepared pristine catalogues

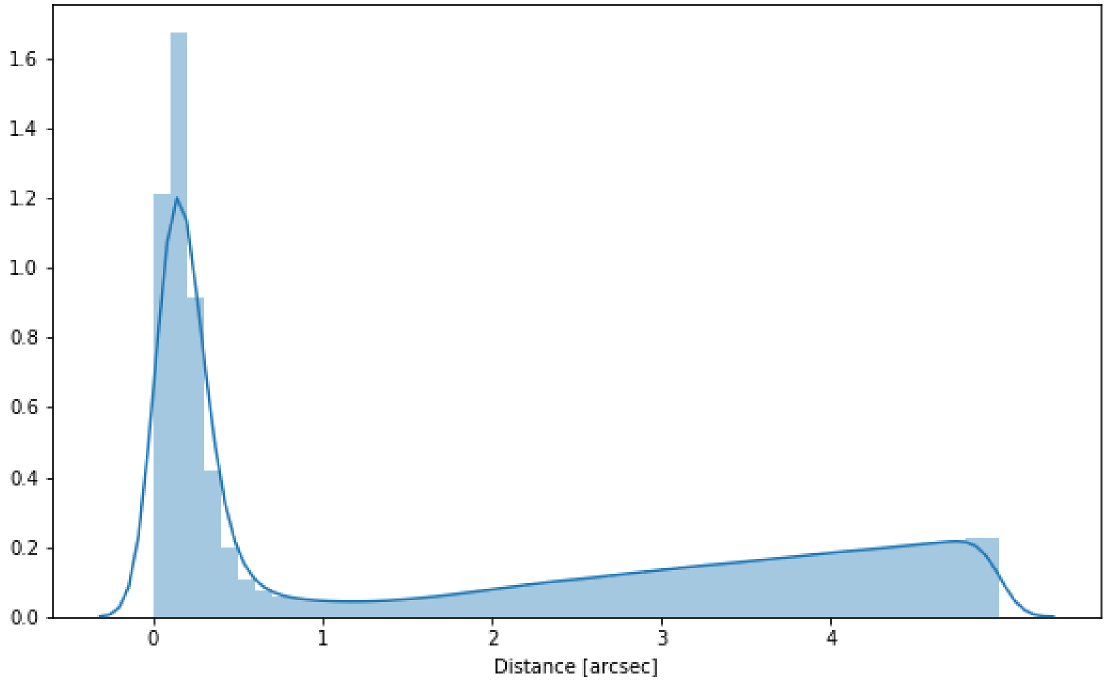
1.2 II - Merging tables

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

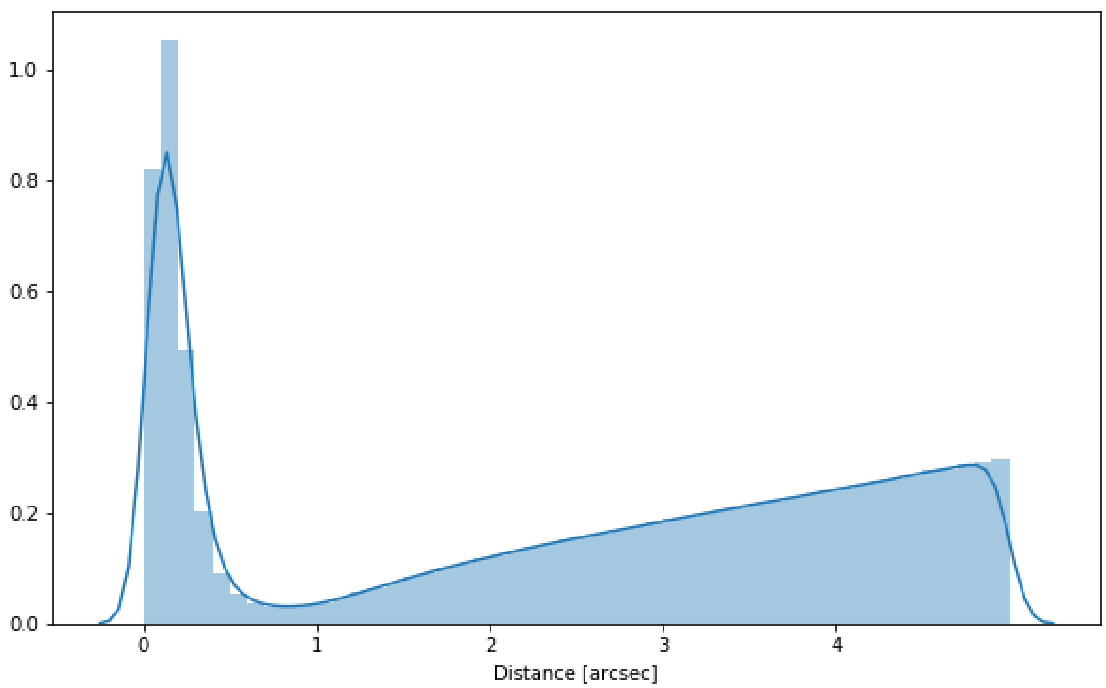
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 WFC

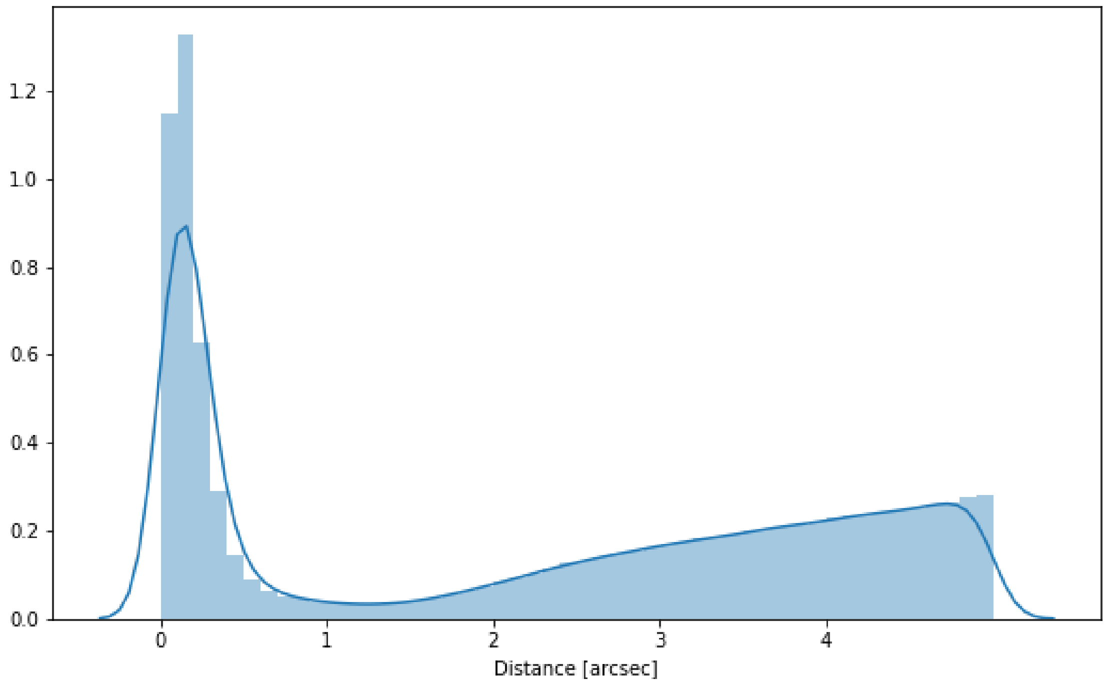
1.2.2 Add SpARCS



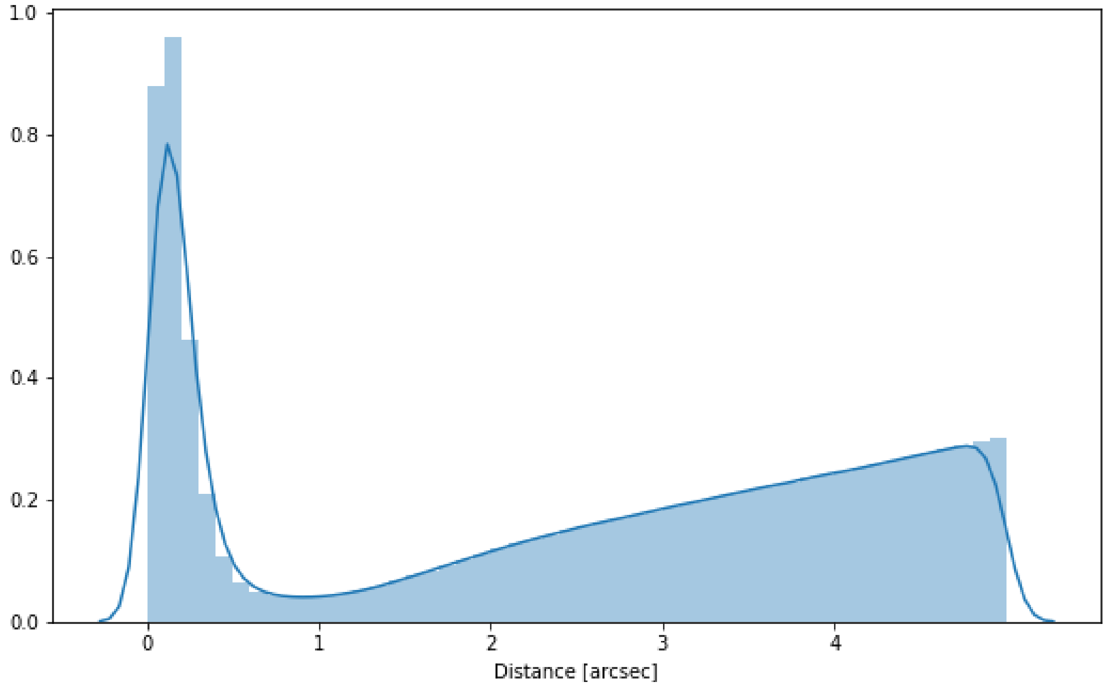
1.2.3 Add HSC-PSS



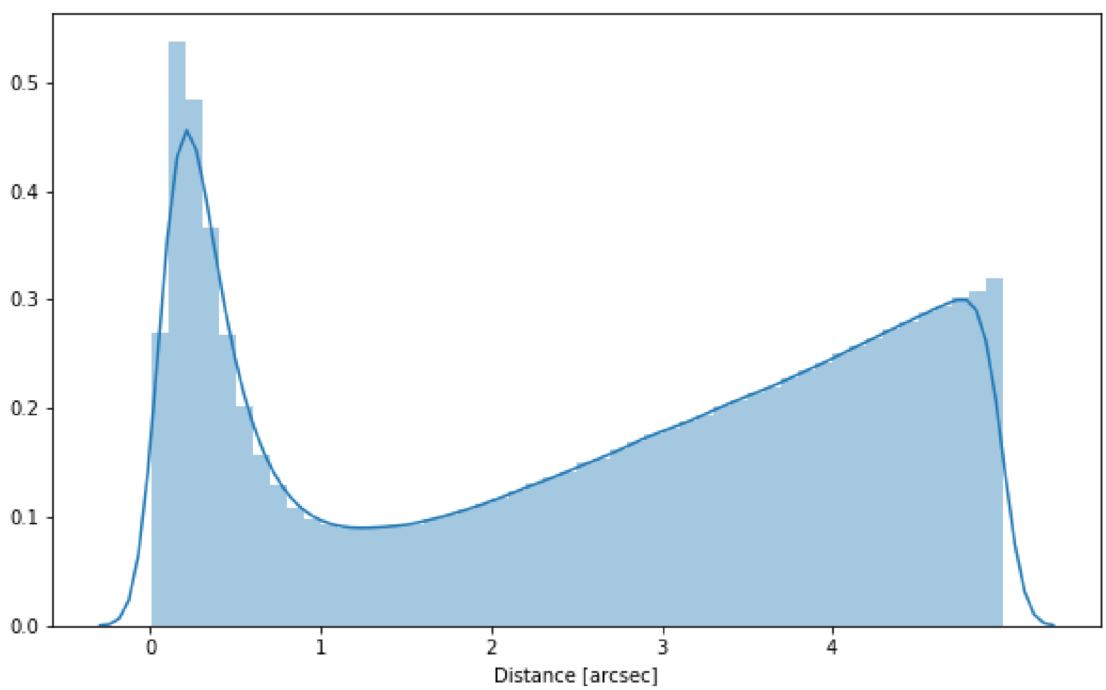
1.2.4 Add PanSTARRS



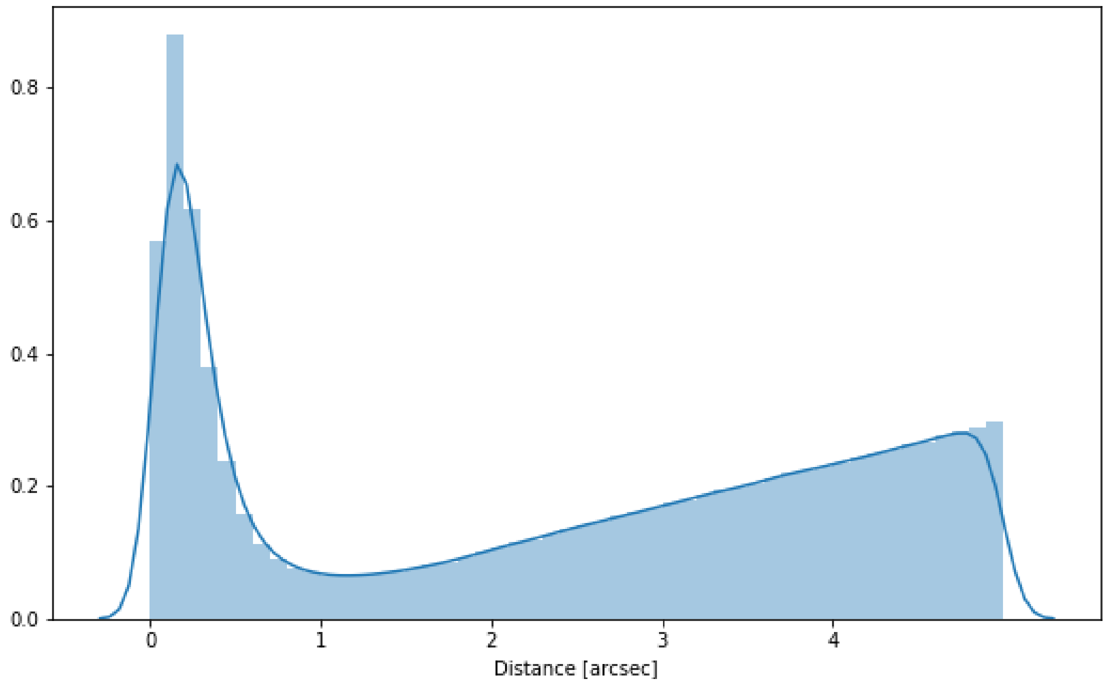
1.2.5 Add DXS



1.2.6 Add SERVS



1.2.7 Add SWIRE



1.2.8 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[19]: <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. We keep trace of the origin of the stellarity.

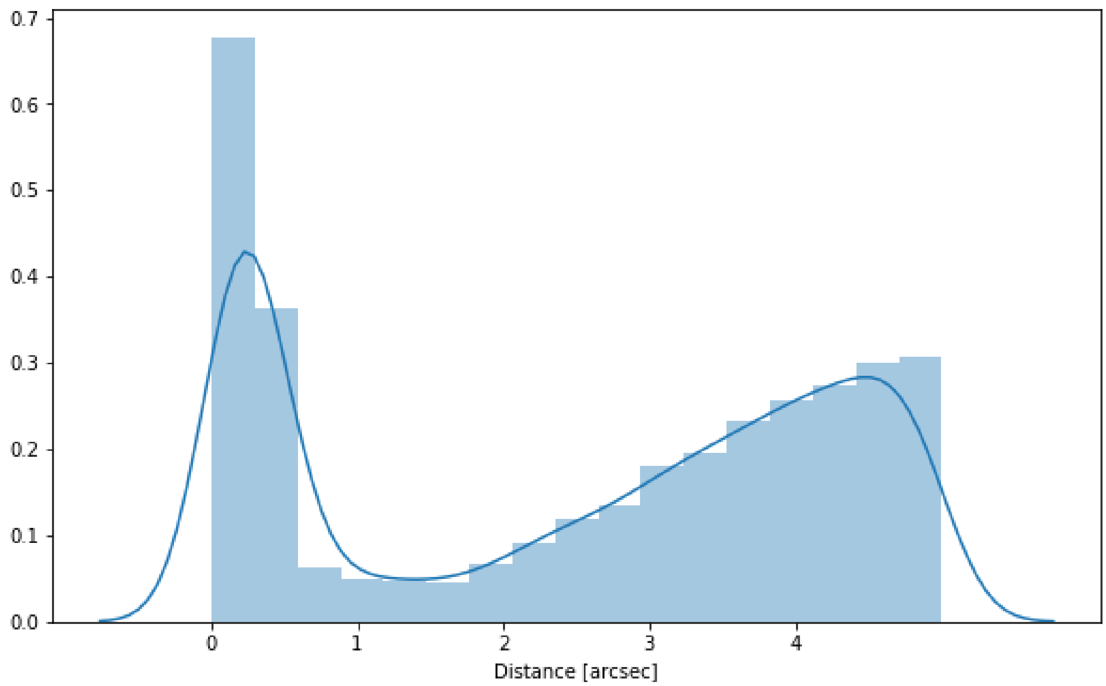
```
wfc_stellarity, sparcs_stellarity, hsc_stellarity, dxs_stellarity, servs_stellarity_irac_i1, ser
```

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

```
OK!
```

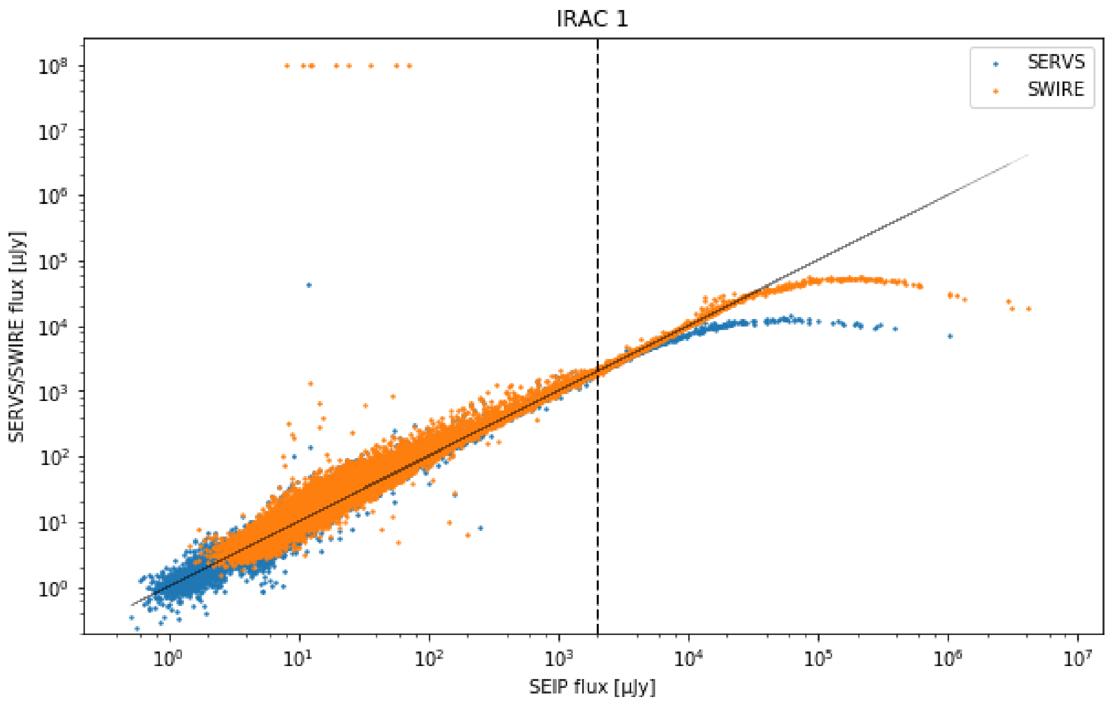
1.6 VI - Cross-matching with spec-z catalogue

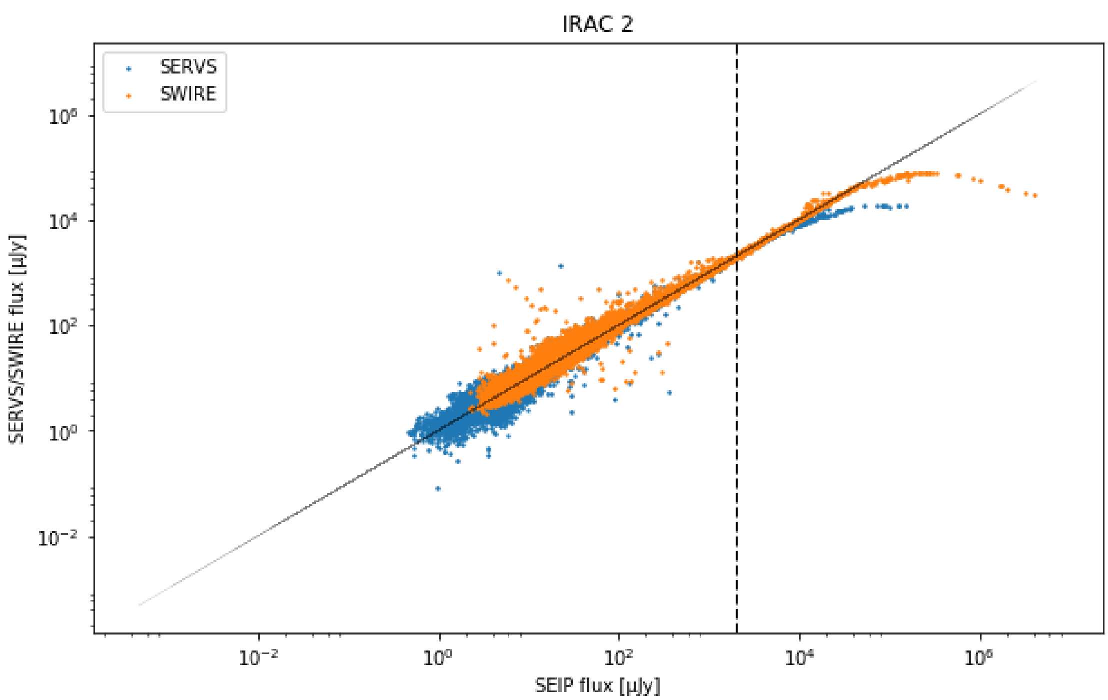


1.7 VII - Choosing between multiple values for the same filter

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.

```
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.

```
293912 sources with SERVS flux
535110 sources with SWIRE flux
124465 sources with SERVS and SWIRE flux
293347 sources for which we use SERVS
411210 sources for which we use SWIRE
```

```
293912 sources with SERVS flux
535030 sources with SWIRE flux
124464 sources with SERVS and SWIRE flux
293311 sources for which we use SERVS
411167 sources for which we use SWIRE
```

```
300193 sources with SERVS flux
390203 sources with SWIRE flux
93525 sources with SERVS and SWIRE flux
299810 sources for which we use SERVS
297061 sources for which we use SWIRE
```

```
300193 sources with SERVS flux
390193 sources with SWIRE flux
93525 sources with SERVS and SWIRE flux
299792 sources for which we use SERVS
297069 sources for which we use SWIRE
```

1.8 VIII.a Wavelength domain coverage

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

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

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

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

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

1.9 VIII.b Wavelength domain detection

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

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

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

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

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

1.10 IX - Cross-identification table

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

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

```
126 master list rows had multiple associations.
```

```
['wfc_id', 'sparcs_intid', 'hsc_id', 'ps1_id', 'dxs_id', 'servs_intid', 'swire_intid', 'help_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: set()
```

3.1_Checks_and_diagnostics

March 8, 2018

1 ELAIS-N1 master catalogue

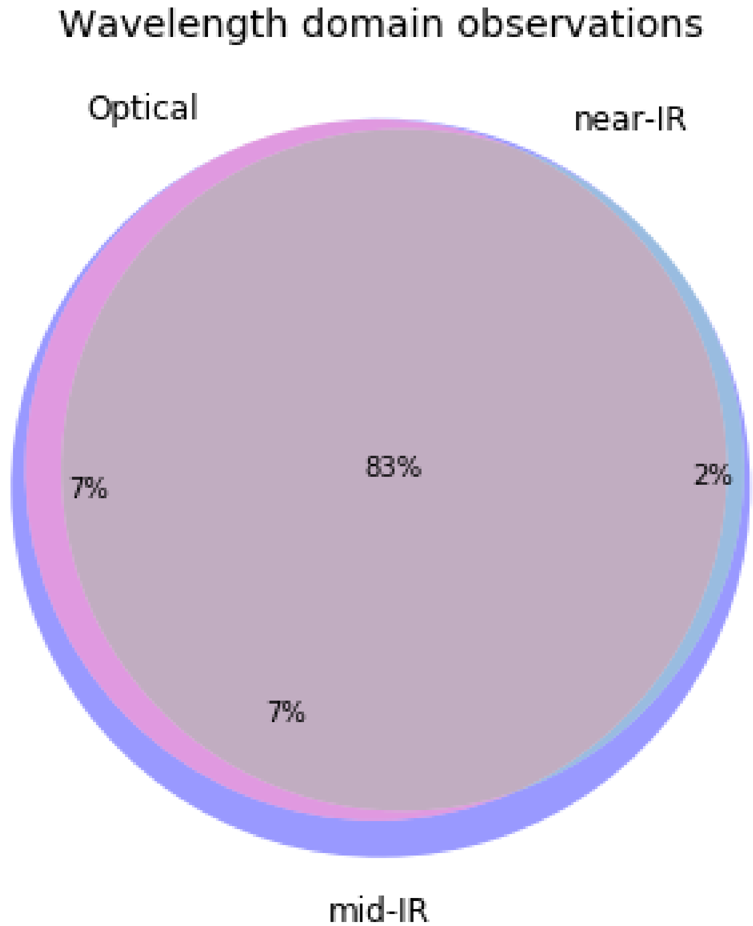
1.1 Checks and diagnostics

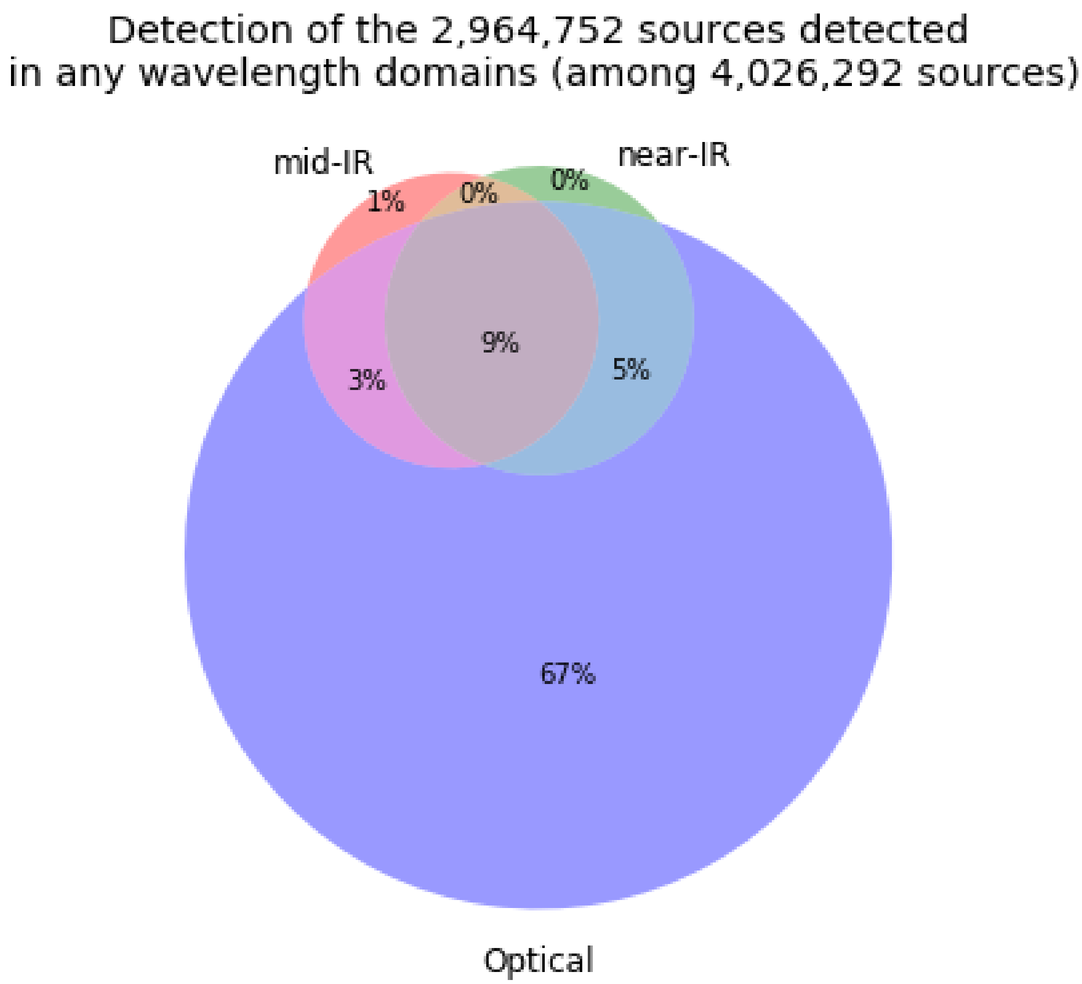
```
This notebook was run with herschelhelp_internal version:
255270d (Fri Nov 24 10:35:51 2017 +0000)


Diagnostics done using: master_catalogue_elais-n1_20171016.fits
```

1.2 0 - Quick checks

```
The column f_ap_suprime_g contains 134 zero or negative values!it's minimum is 0.0.
The column f_suprime_g contains 274 zero or negative values!it's minimum is 0.0.
The column f_ap_suprime_r contains 363 zero or negative values!it's minimum is 0.0.
The column f_suprime_r contains 567 zero or negative values!it's minimum is 0.0.
The column f_ap_suprime_i contains 4 zero or negative values!it's minimum is 0.0.
The column f_suprime_i contains 12 zero or negative values!it's minimum is 0.0.
The column f_suprime_z contains 140 zero or negative values!it's minimum is 0.0.
The column f_ap_suprime_y contains 69 zero or negative values!it's minimum is 0.0.
The column f_suprime_y contains 173 zero or negative values!it's minimum is 0.0.
The column f_ap_suprime_n921 contains 371 zero or negative values!it's minimum is 0.0.
The column f_suprime_n921 contains 739 zero or negative values!it's minimum is 0.0.
The column merr_gpc1_r contains 1 zero or negative values!it's minimum is 0.0.
The column merr_ap_gpc1_y contains 1 zero or negative values!it's minimum is 0.0.
The column f_ap_irac_i1 contains 861 zero or negative values!it's minimum is -263238.122402173.
The column merr_ap_irac_i1 contains 861 zero or negative values!it's minimum is -12638.354838083
The column f_irac_i1 contains 1740 zero or negative values!it's minimum is -470521.088058024.
The column merr_irac_i1 contains 1740 zero or negative values!it's minimum is -7343.653061571807
The column f_ap_irac_i2 contains 1266 zero or negative values!it's minimum is -7.57307525969056.
The column merr_ap_irac_i2 contains 1266 zero or negative values!it's minimum is -2160.391951305
The column f_irac_i2 contains 1373 zero or negative values!it's minimum is -127.657072585999.
The column merr_irac_i2 contains 1373 zero or negative values!it's minimum is -5513.251330987990
```

1.3 I - Summary of wavelength domains



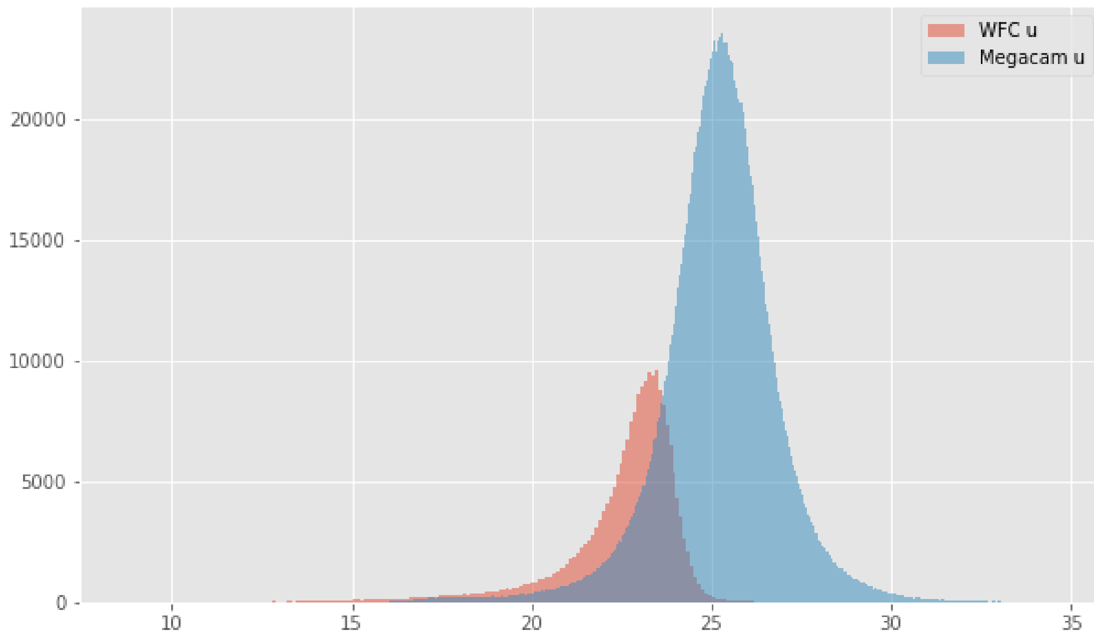


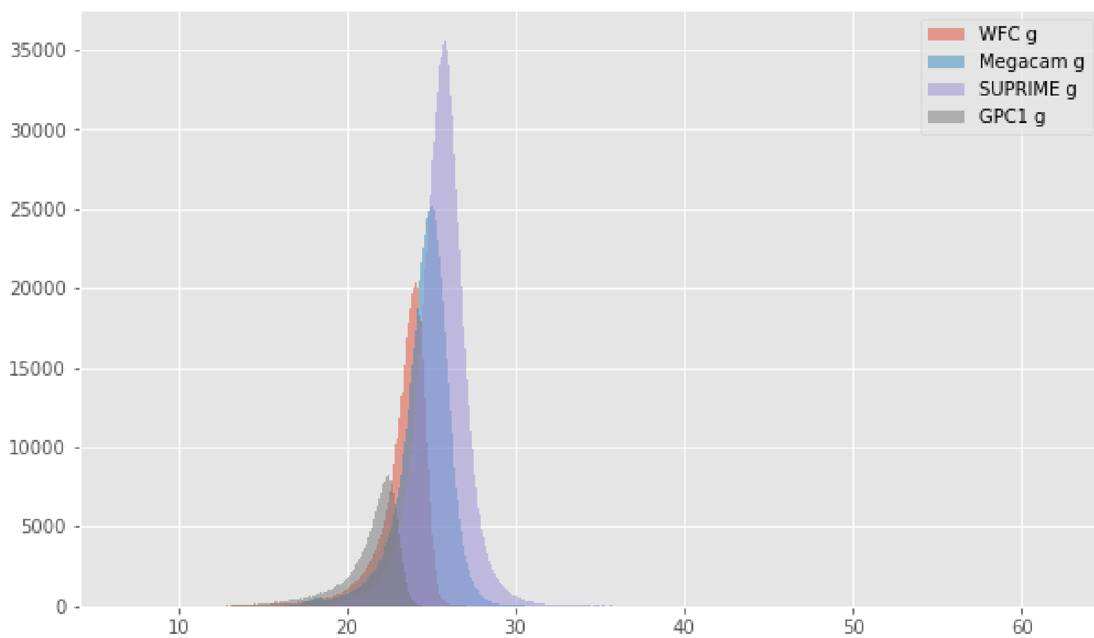
1.4 II - Comparing magnitudes in similar filters

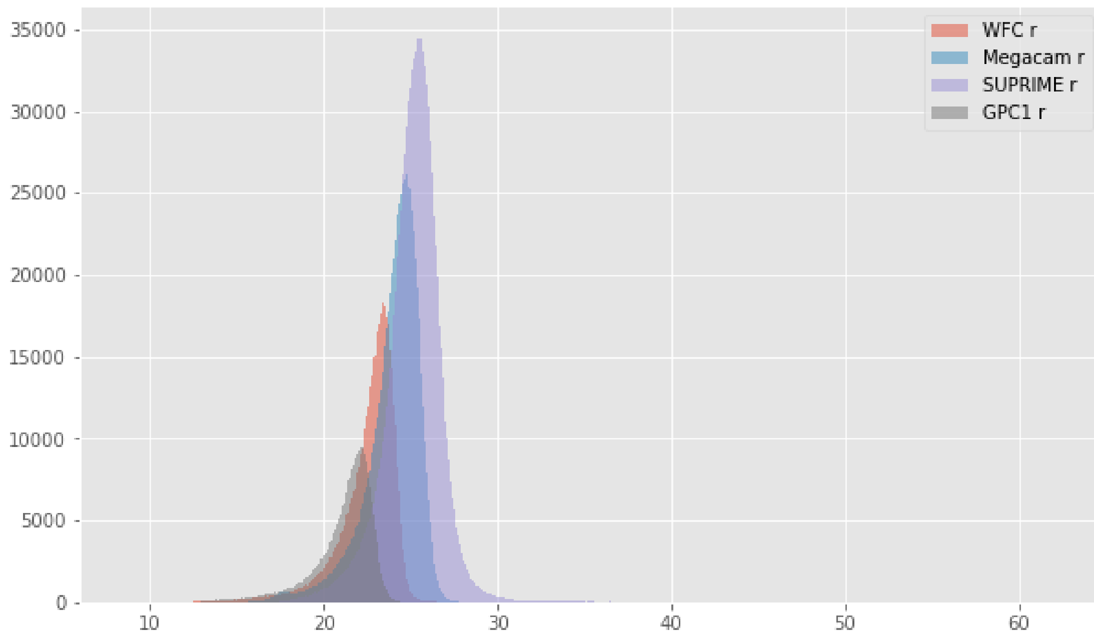
The master list if composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

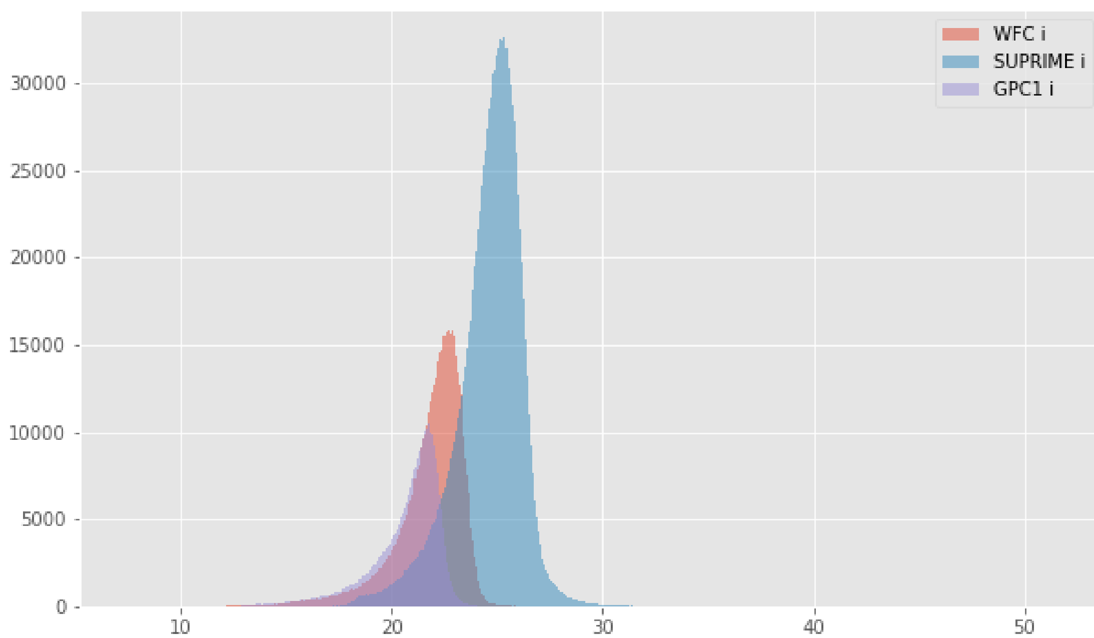
1.4.1 II.a - Comparing depths

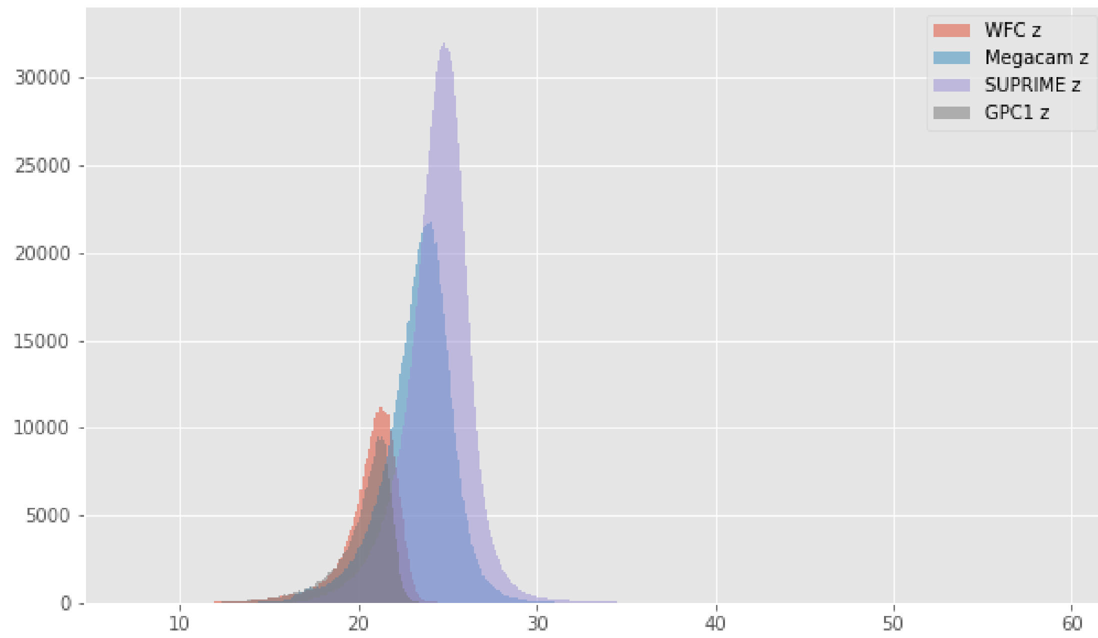
We compare the histograms of the total aperture magnitudes of similar bands.

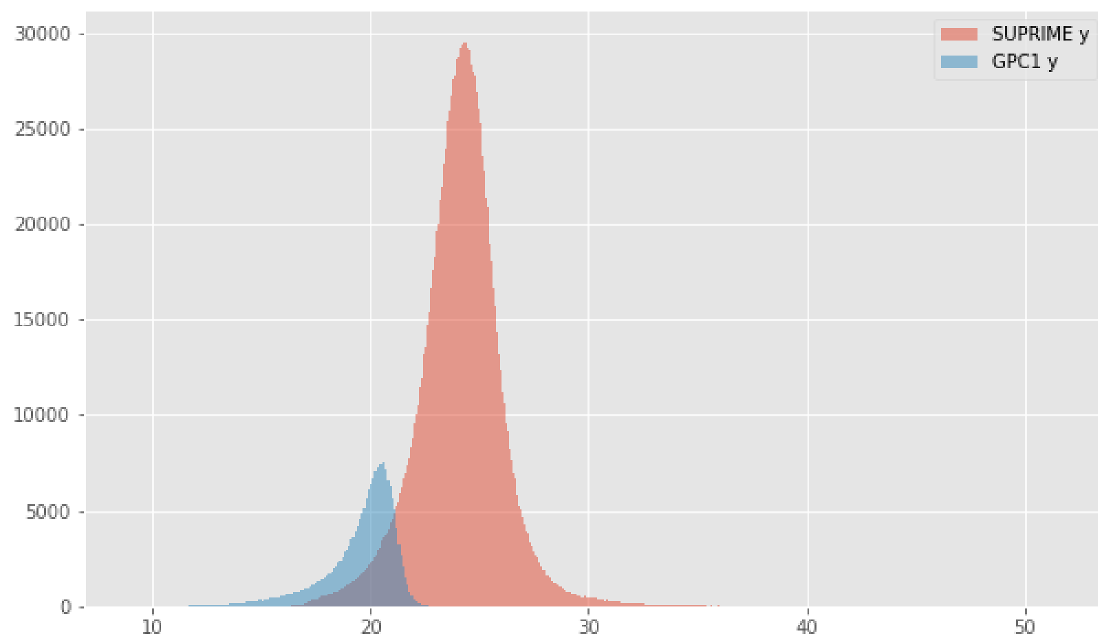

WFC u
Megacam u
20000
15000
10000
5000
0
10
15
20
25
30
35


WFC g
Megacam g
SUPRIME g
GPC1 g
35000
30000
25000
20000
15000
10000
5000
0
10
20
30
40
50
60


WFC r
Megacam r
SUPRIME r
GPC1 r
35000
30000
25000
20000
15000
10000
5000
0
10
20
30
40
50
60


WFC i
SUPRIME i
GPC1 i
30000
25000
20000
15000
10000
5000
0
10
20
30
40
50

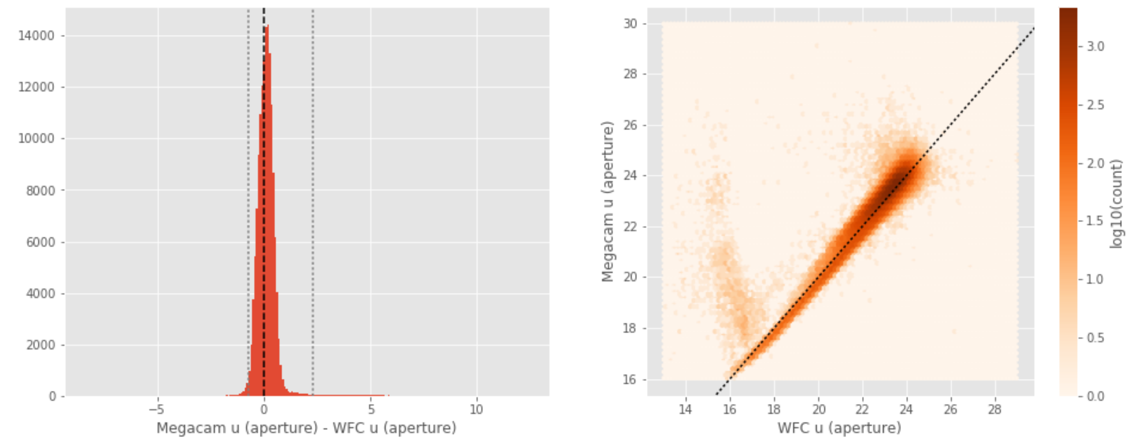




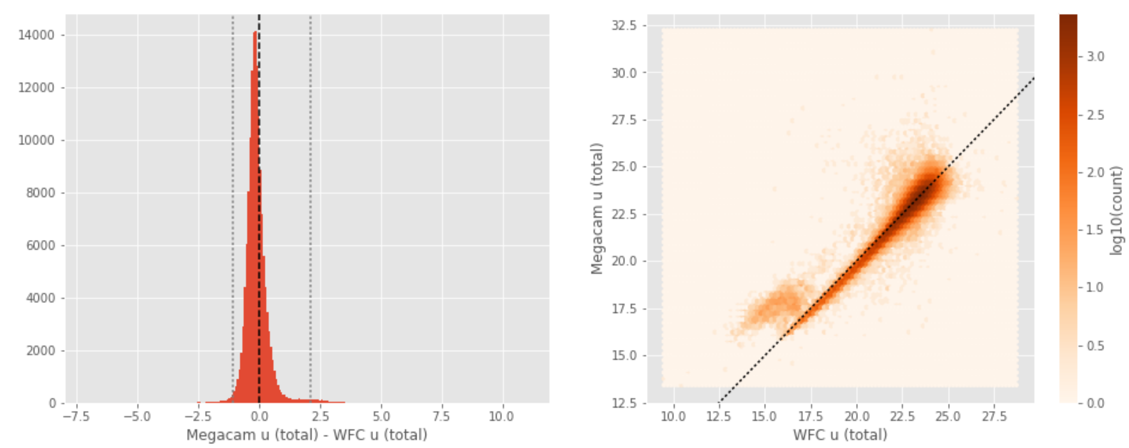
1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

Megacam u (aperture) - WFC u (aperture):
- Median: 0.10
- Median Absolute Deviation: 0.24
- 1% percentile: -0.7272730255126953
- 99% percentile: 2.3119604682922468

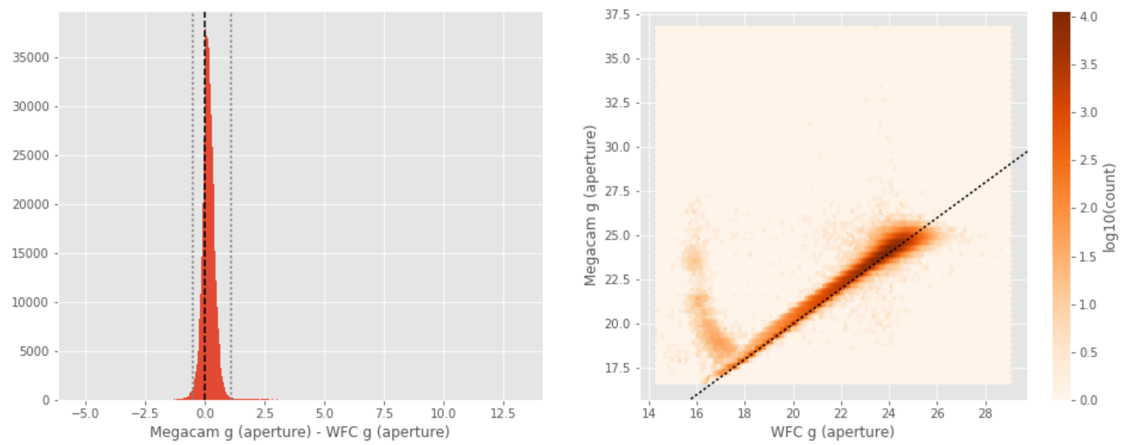


Megacam u (total) - WFC u (total):
- Median: -0.15
- Median Absolute Deviation: 0.21
- 1% percentile: -1.0918270874023437
- 99% percentile: 2.1320125770568796

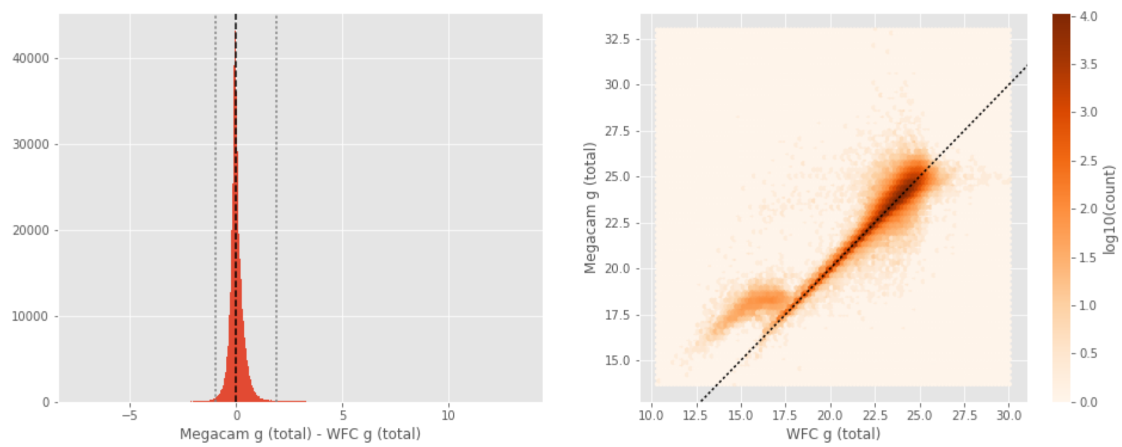


Megacam g (aperture) - WFC g (aperture):
- Median: 0.14

- Median Absolute Deviation: 0.15
- 1% percentile: -0.5219296264648438
- 99% percentile: 1.085785179138184

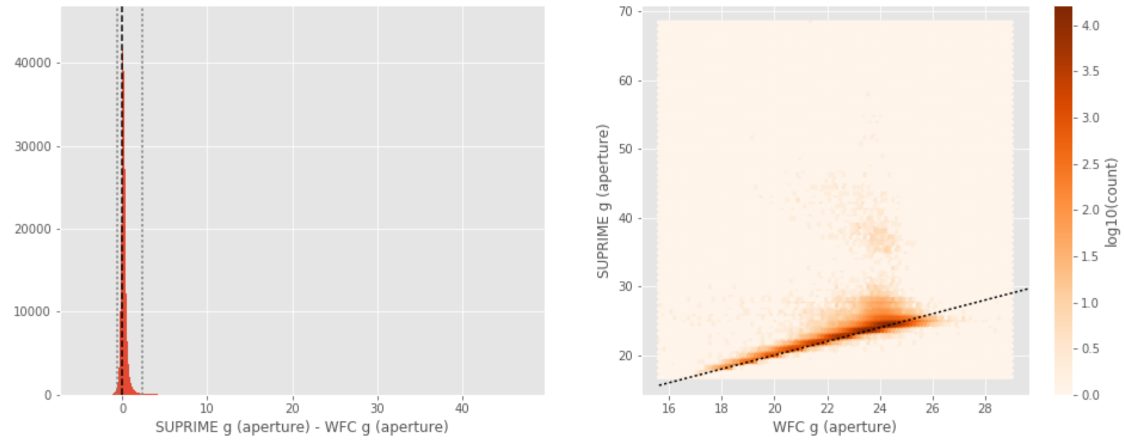


Megacam g (total) - WFC g (total):
- Median: -0.02
- Median Absolute Deviation: 0.15
- 1% percentile: -0.9512448883056641
- 99% percentile: 1.8764633178711005

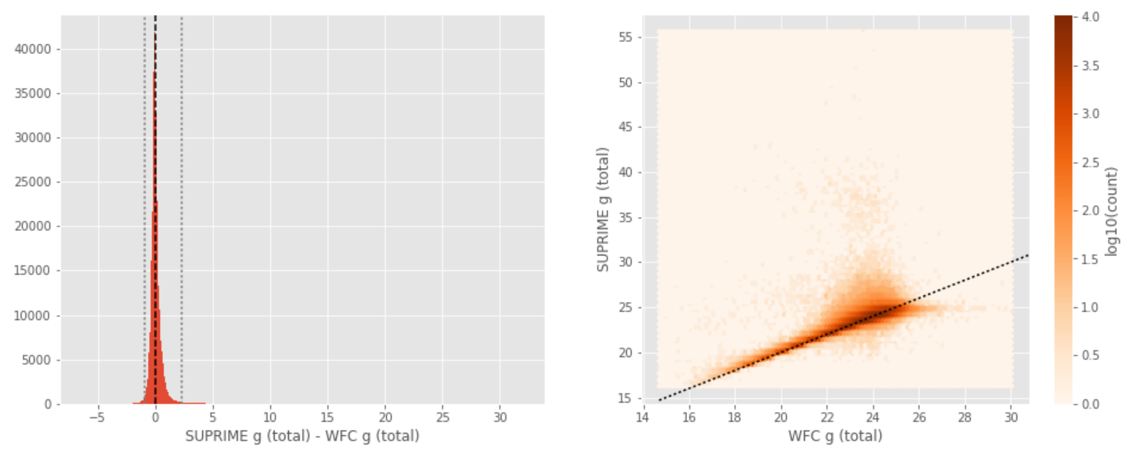


SUPRIME g (aperture) - WFC g (aperture):
- Median: 0.16
- Median Absolute Deviation: 0.16
- 1% percentile: -0.5483207702636718

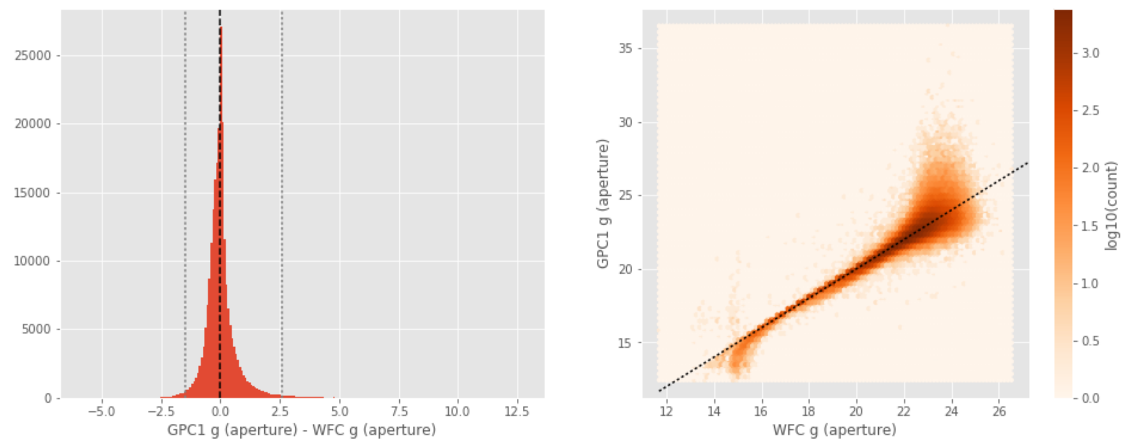
- 99% percentile: 2.319765567779542



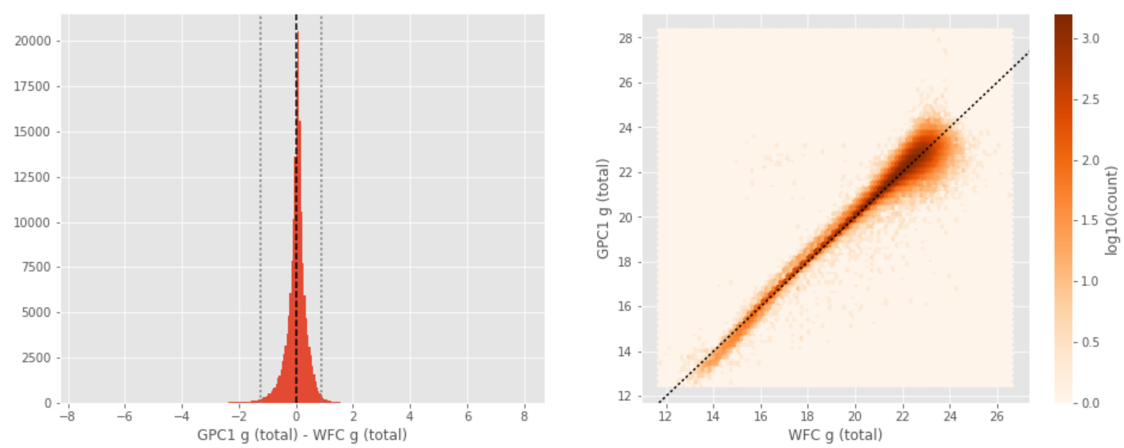
SUPRIME g (total) - WFC g (total):
- Median: 0.01
- Median Absolute Deviation: 0.19
- 1% percentile: -0.9150347518920898
- 99% percentile: 2.3162221145629904



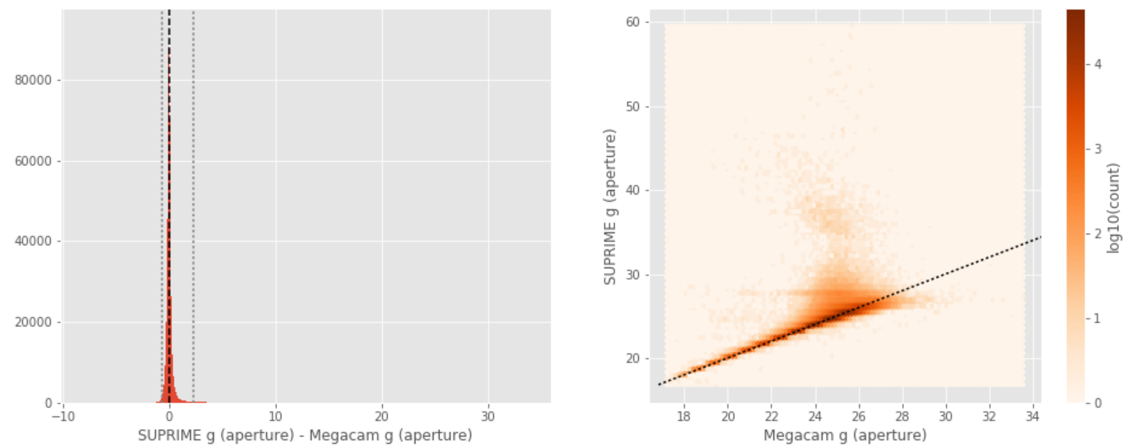
GPC1 g (aperture) - WFC g (aperture):
- Median: -0.03
- Median Absolute Deviation: 0.25
- 1% percentile: -1.4681995010375974
- 99% percentile: 2.598815269470216



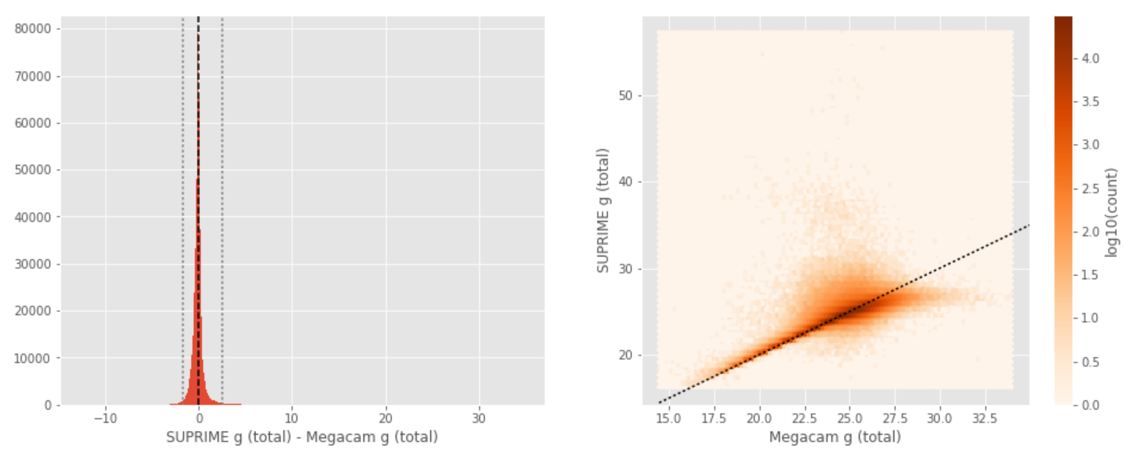
GPC1 g (total) - WFC g (total):
- Median: 0.06
- Median Absolute Deviation: 0.15
- 1% percentile: -1.235805778503418
- 99% percentile: 0.8852024841308583



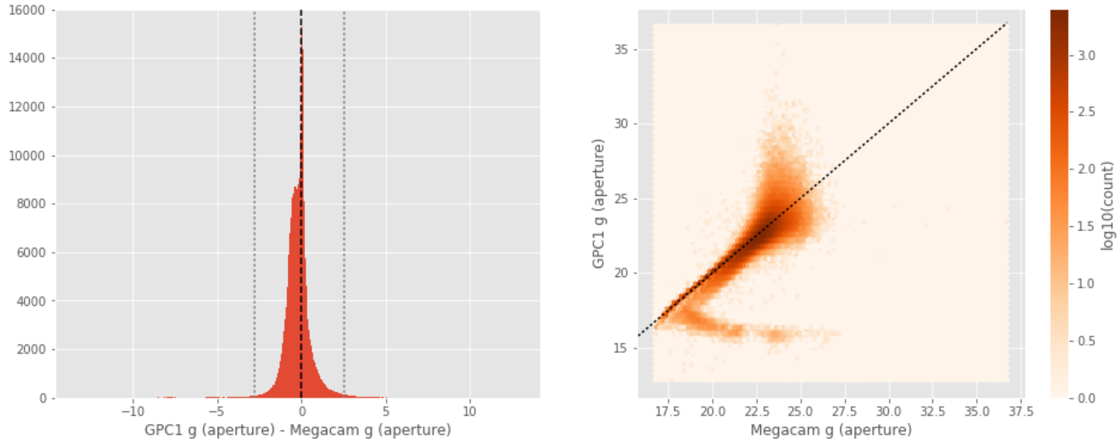
SUPRIME g (aperture) - Megacam g (aperture):
- Median: -0.03
- Median Absolute Deviation: 0.11
- 1% percentile: -0.6601028442382812
- 99% percentile: 2.253218078613278



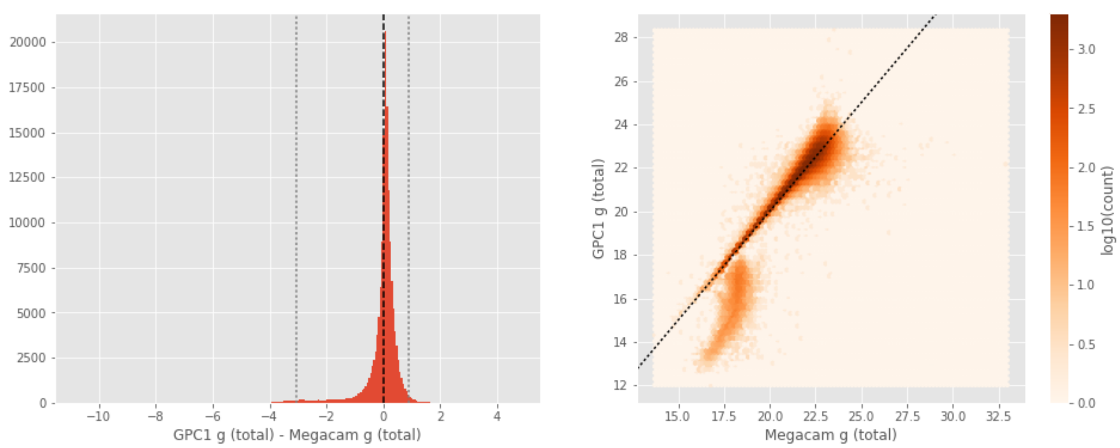
SUPRIME g (total) - Megacam g (total):
- Median: -0.08
- Median Absolute Deviation: 0.20
- 1% percentile: -1.6540432739257813
- 99% percentile: 2.5875380706787094



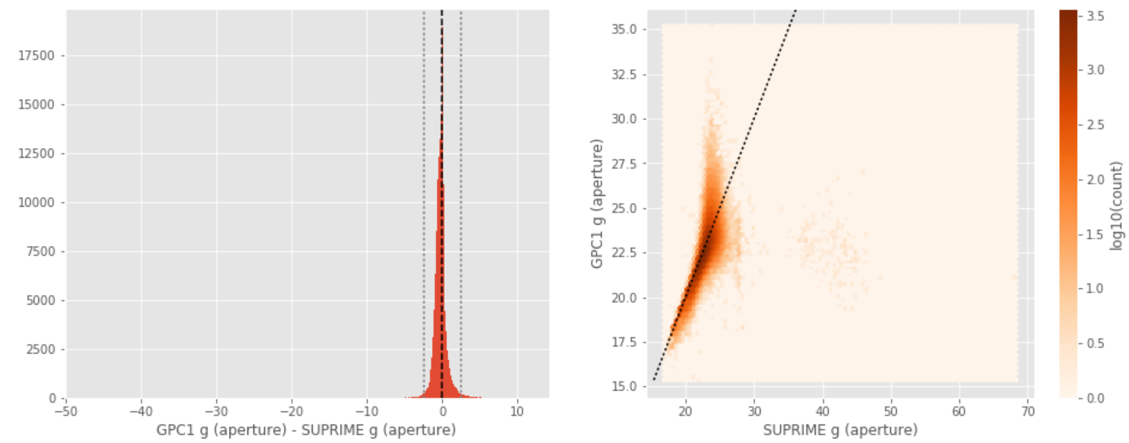
GPC1 g (aperture) - Megacam g (aperture):
- Median: -0.19
- Median Absolute Deviation: 0.35
- 1% percentile: -2.7744883155822753
- 99% percentile: 2.5329534912109364



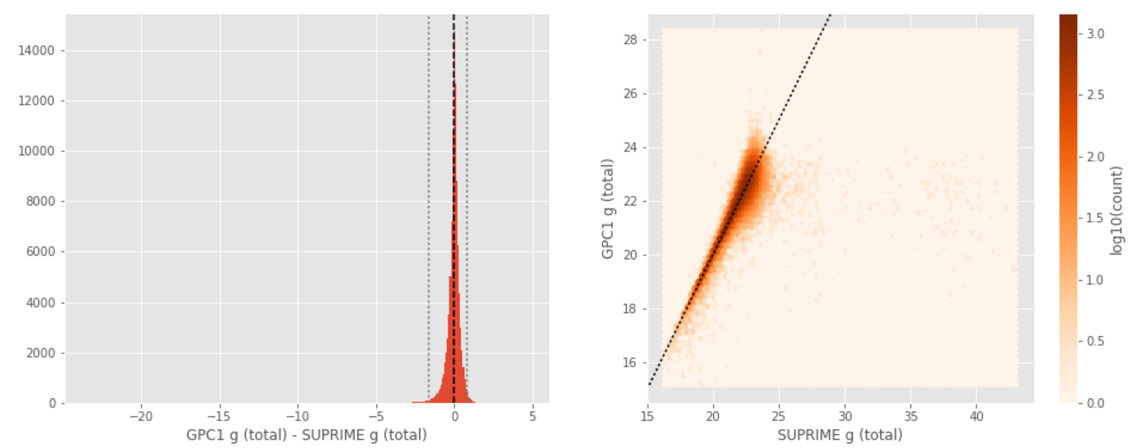
GPC1 g (total) - Megacam g (total):
- Median: 0.08
- Median Absolute Deviation: 0.15
- 1% percentile: -3.053208236694336
- 99% percentile: 0.909821548461915



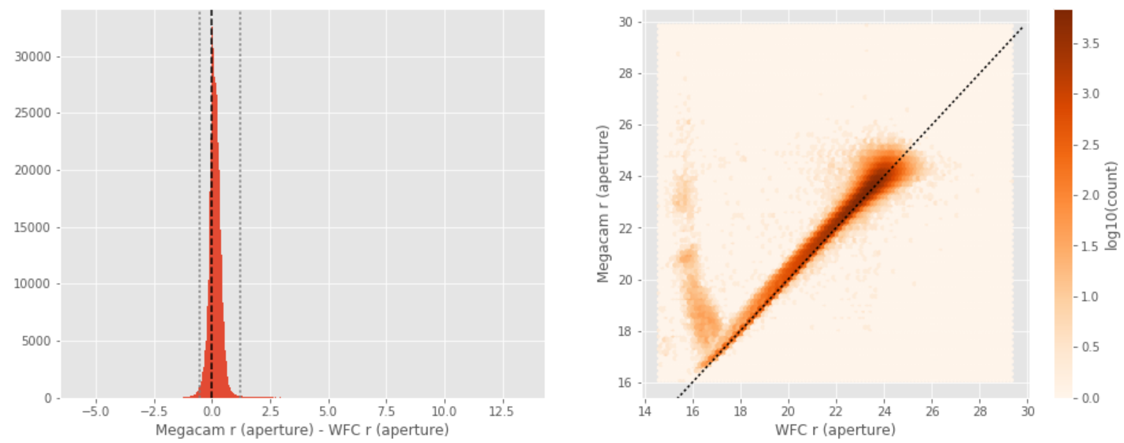
GPC1 g (aperture) - SUPRIME g (aperture):
- Median: -0.25
- Median Absolute Deviation: 0.35
- 1% percentile: -2.450922222137451
- 99% percentile: 2.5137275123596465



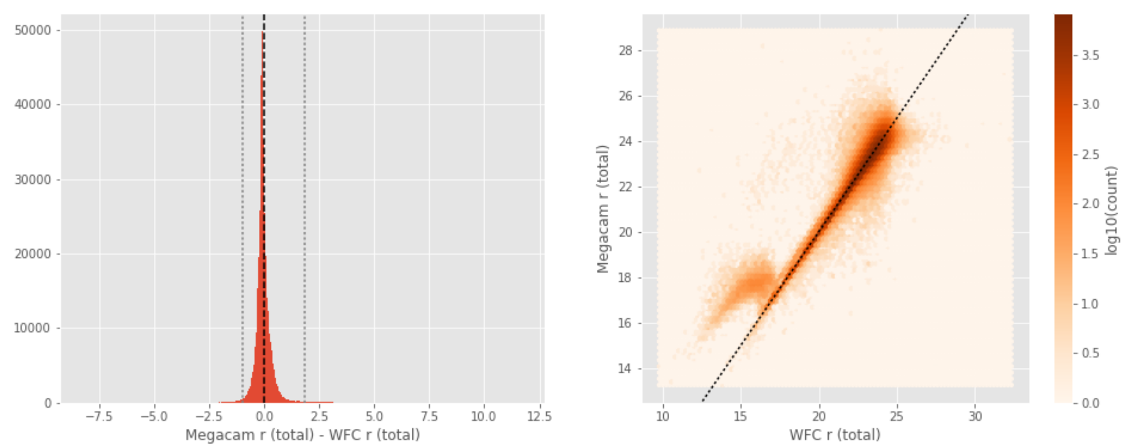
GPC1 g (total) - SUPRIME g (total):
- Median: 0.01
- Median Absolute Deviation: 0.17
- 1% percentile: -1.6039471626281738
- 99% percentile: 0.8286709785461426



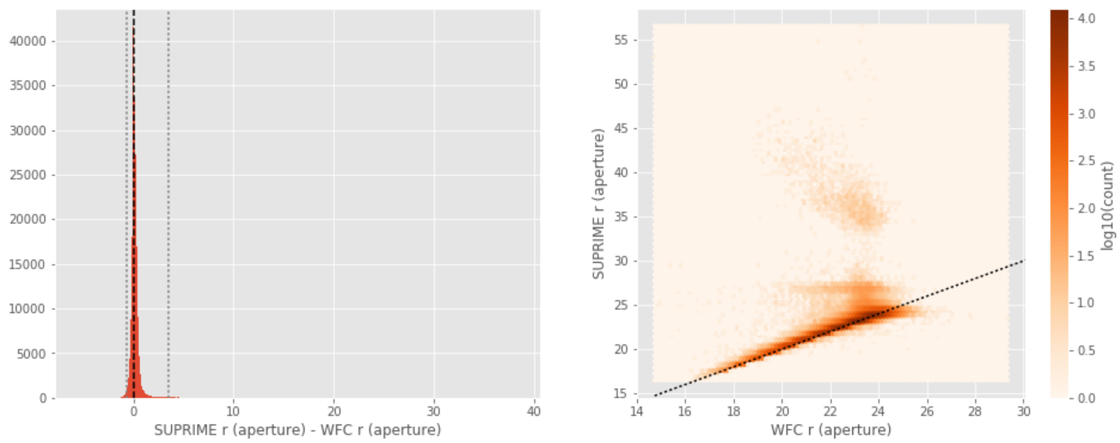
Megacam r (aperture) - WFC r (aperture):
- Median: 0.12
- Median Absolute Deviation: 0.15
- 1% percentile: -0.5586348533630371
- 99% percentile: 1.2267741394042968



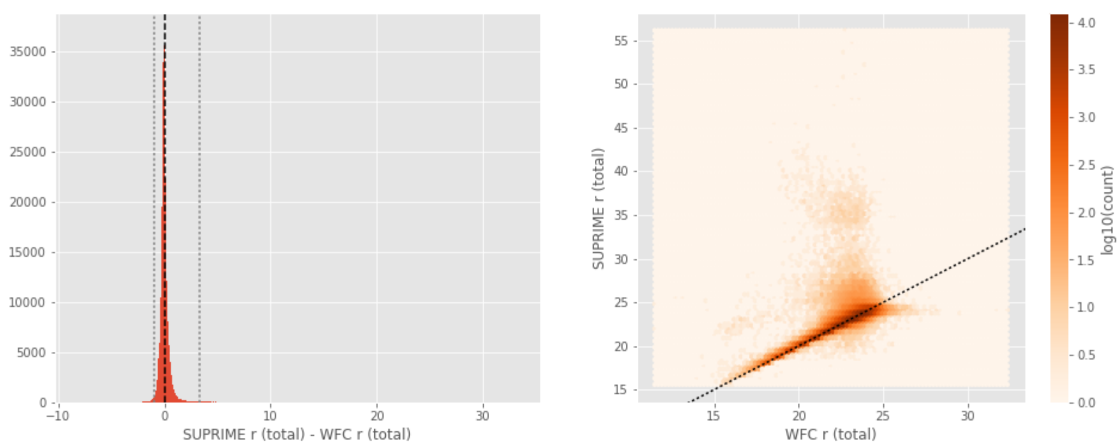
Megacam r (total) - WFC r (total):
- Median: -0.07
- Median Absolute Deviation: 0.13
- 1% percentile: -0.9979226684570313
- 99% percentile: 1.865820007324213



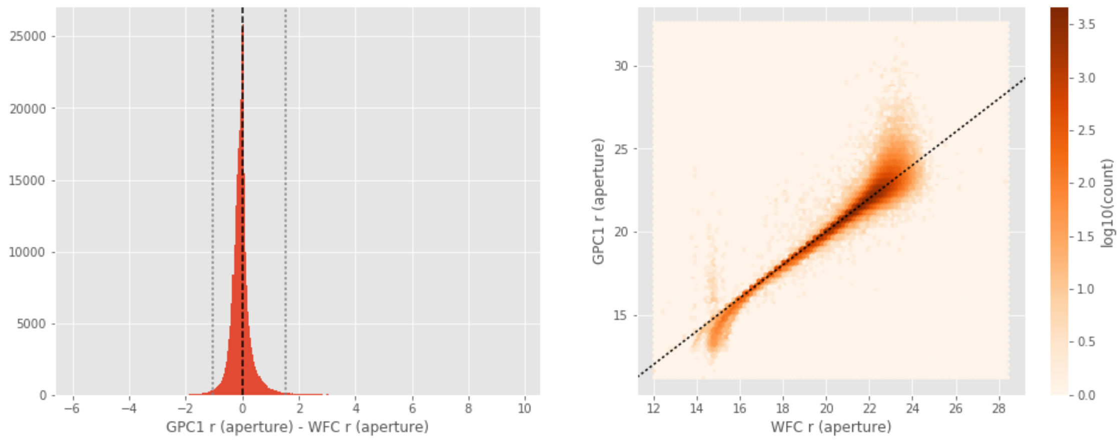
SUPRIME r (aperture) - WFC r (aperture):
- Median: 0.09
- Median Absolute Deviation: 0.15
- 1% percentile: -0.6121678924560547
- 99% percentile: 3.518004989624025



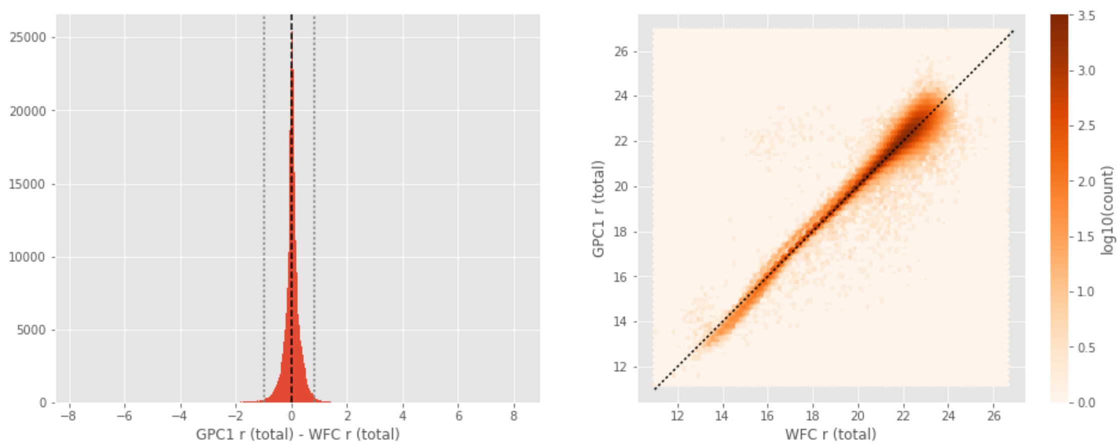
SUPRIME r (total) - WFC r (total):
- Median: -0.05
- Median Absolute Deviation: 0.16
- 1% percentile: -0.9259447097778319
- 99% percentile: 3.3509555816649943



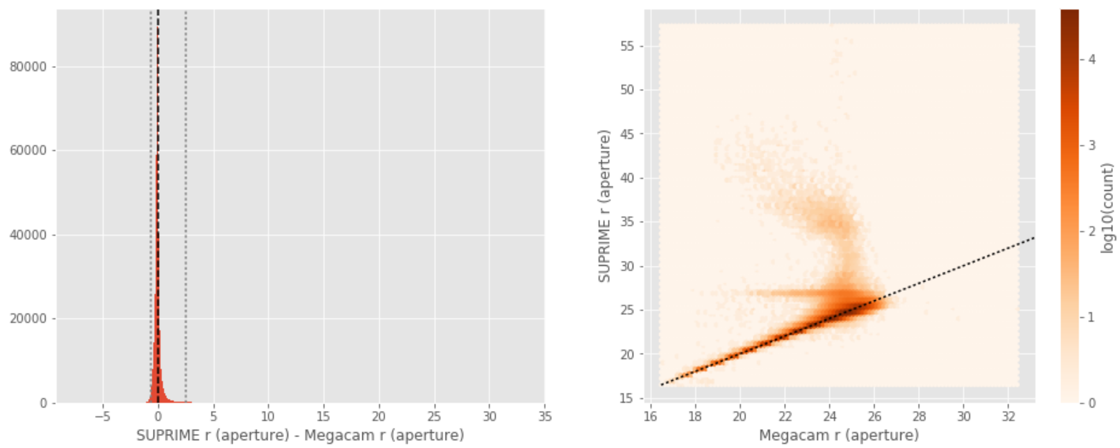
GPC1 r (aperture) - WFC r (aperture):
- Median: -0.05
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0388346672058106
- 99% percentile: 1.5338702201843275



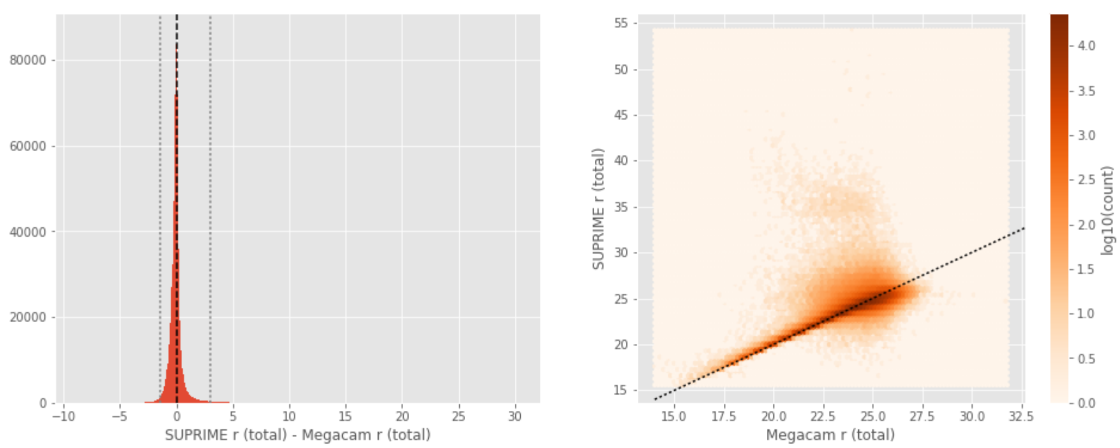
GPC1 r (total) - WFC r (total):
- Median: 0.03
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9682998657226562
- 99% percentile: 0.8239599800109849



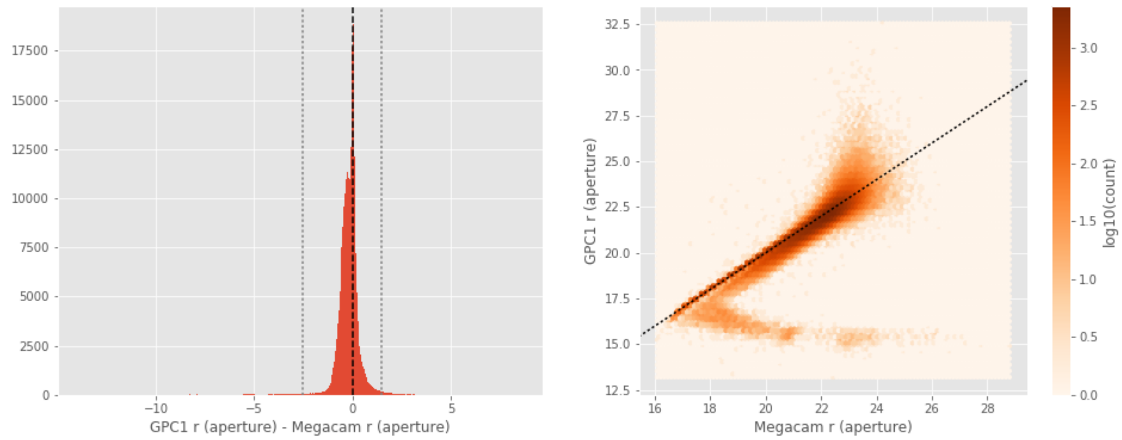
SUPRIME r (aperture) - Megacam r (aperture):
- Median: -0.04
- Median Absolute Deviation: 0.11
- 1% percentile: -0.6416191864013672
- 99% percentile: 2.4968240737914904



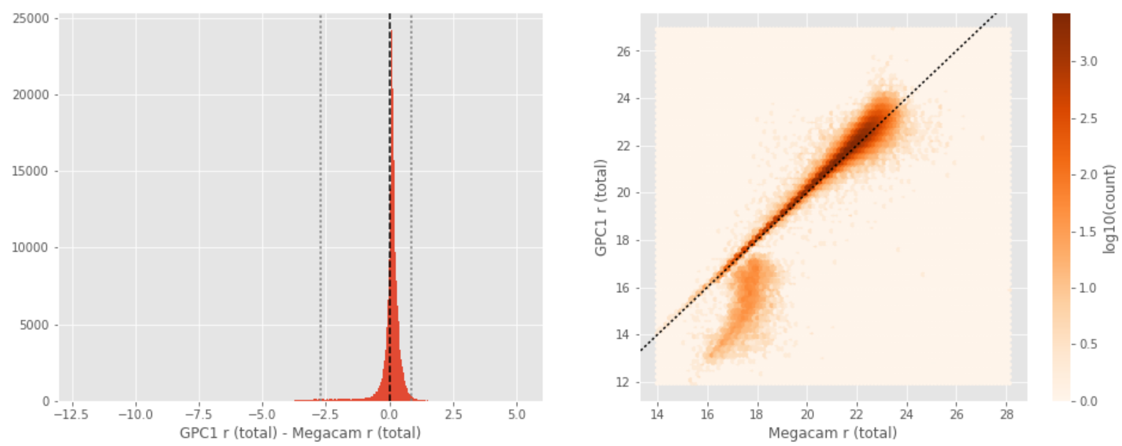
SUPRIME r (total) - Megacam r (total):
- Median: -0.05
- Median Absolute Deviation: 0.20
- 1% percentile: -1.462252655029297
- 99% percentile: 2.9655048751831057



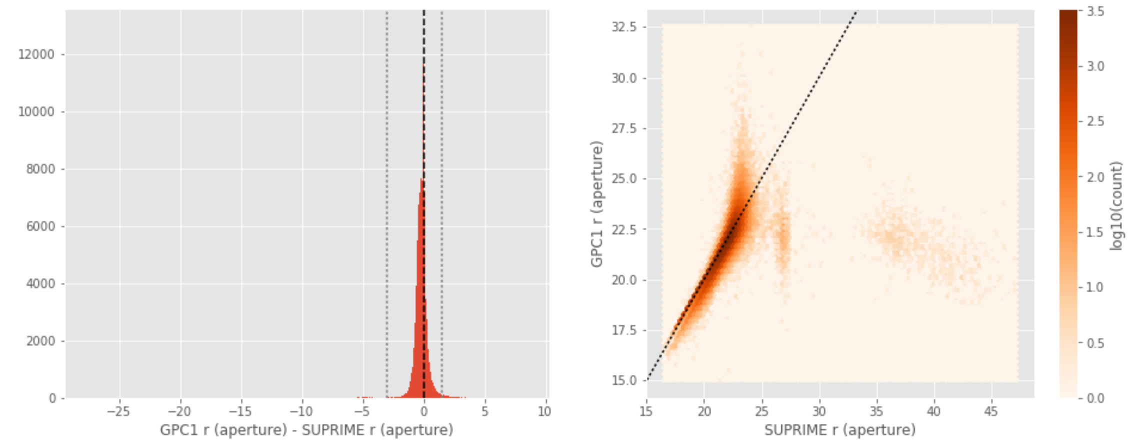
GPC1 r (aperture) - Megacam r (aperture):
- Median: -0.16
- Median Absolute Deviation: 0.24
- 1% percentile: -2.5137132263183597
- 99% percentile: 1.4576556015014677



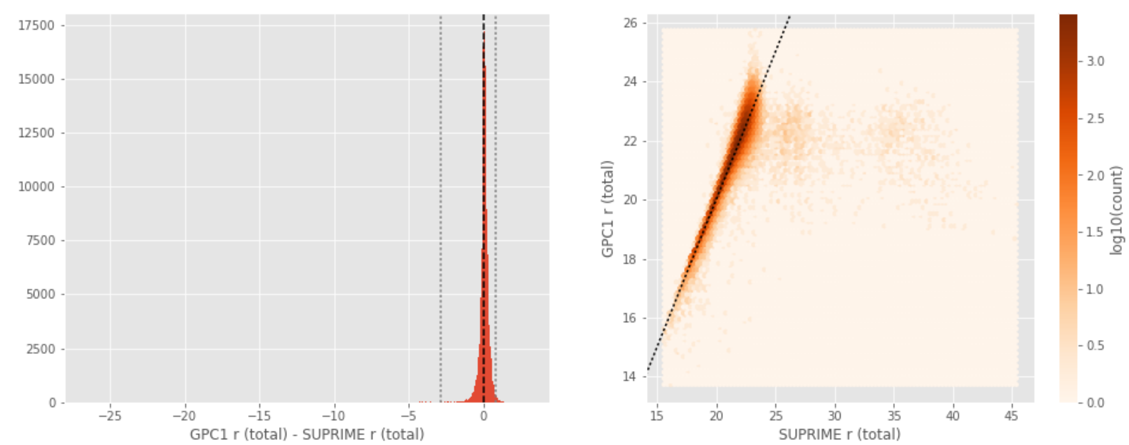
GPC1 r (total) - Megacam r (total):
- Median: 0.11
- Median Absolute Deviation: 0.11
- 1% percentile: -2.6895561695098875
- 99% percentile: 0.8498268508911129



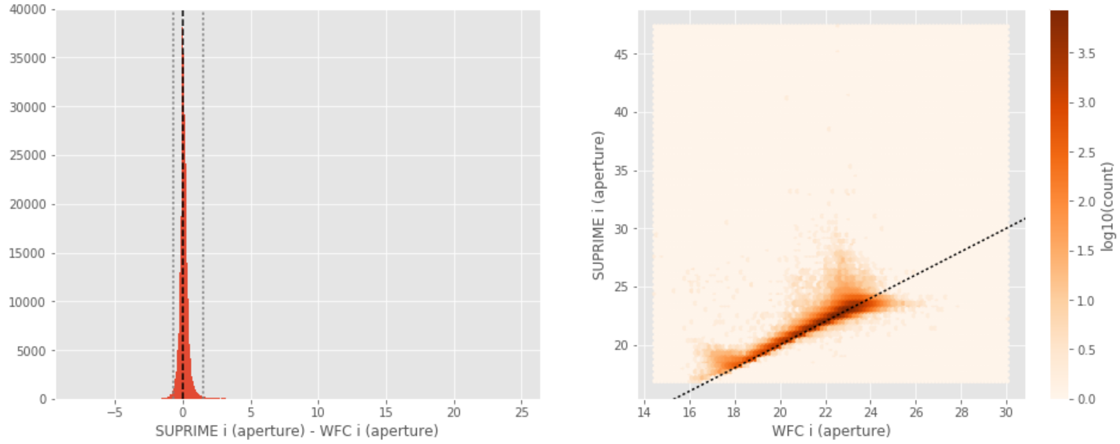
GPC1 r (aperture) - SUPRIME r (aperture):
- Median: -0.16
- Median Absolute Deviation: 0.23
- 1% percentile: -2.961479415893555
- 99% percentile: 1.4932370567321622



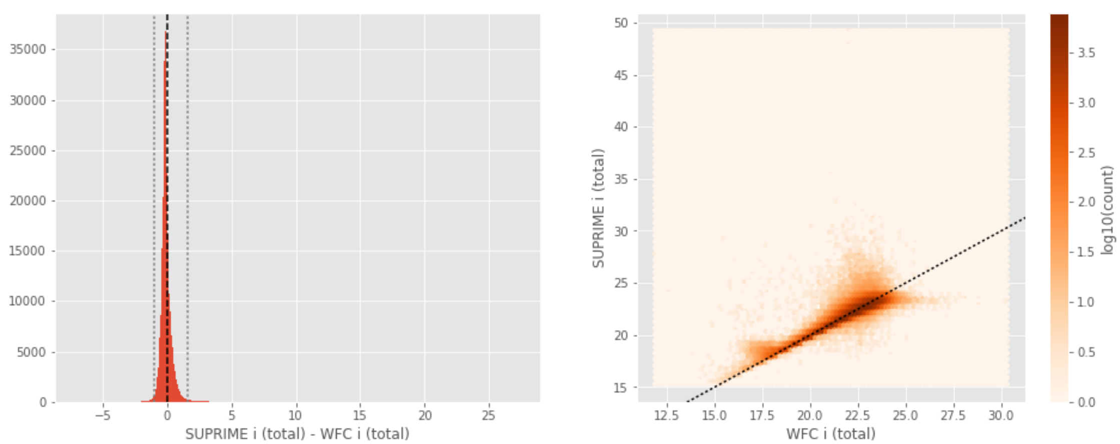
GPC1 r (total) - SUPRIME r (total):
- Median: 0.06
- Median Absolute Deviation: 0.13
- 1% percentile: -2.829697322845459
- 99% percentile: 0.7763437843322756



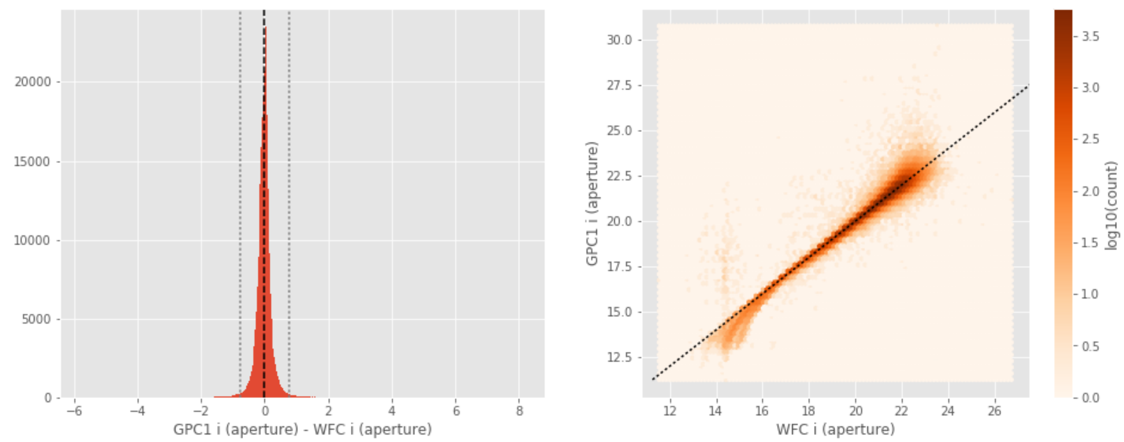
SUPRIME i (aperture) - WFC i (aperture):
- Median: 0.07
- Median Absolute Deviation: 0.15
- 1% percentile: -0.7344942092895508
- 99% percentile: 1.4884119033813477



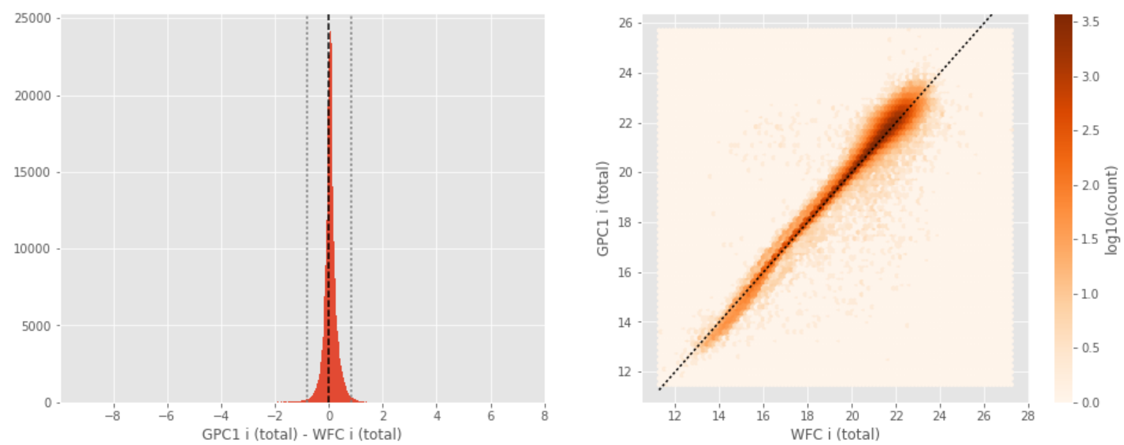
SUPRIME i (total) - WFC i (total):
- Median: -0.13
- Median Absolute Deviation: 0.17
- 1% percentile: -1.0118545150756835
- 99% percentile: 1.584526290893563



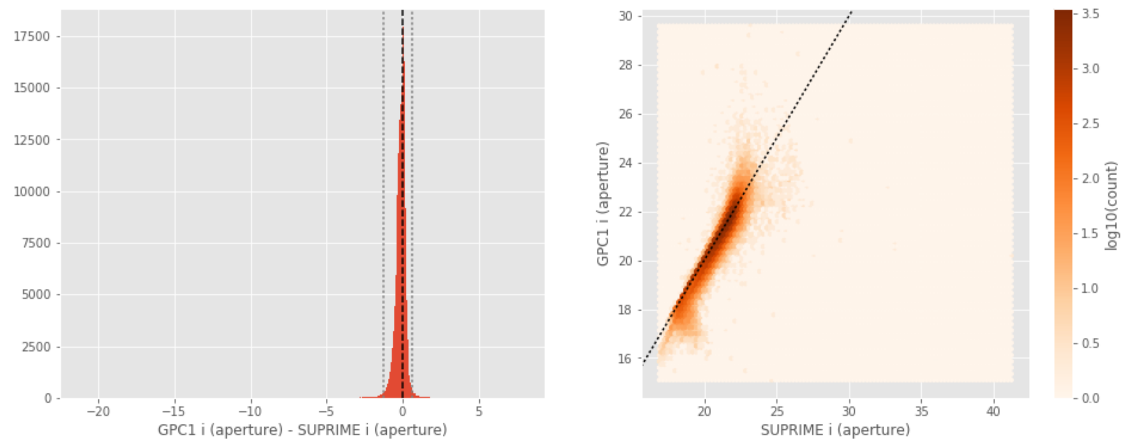
GPC1 i (aperture) - WFC i (aperture):
- Median: -0.01
- Median Absolute Deviation: 0.11
- 1% percentile: -0.7514700889587402
- 99% percentile: 0.7729697227478038



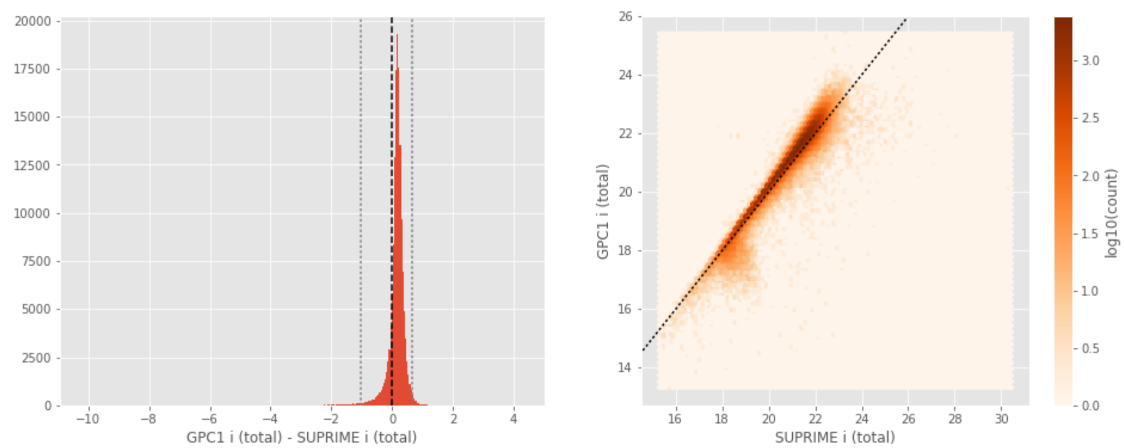
GPC1 i (total) - WFC i (total):
- Median: 0.06
- Median Absolute Deviation: 0.11
- 1% percentile: -0.8002008056640624
- 99% percentile: 0.8199679565429681



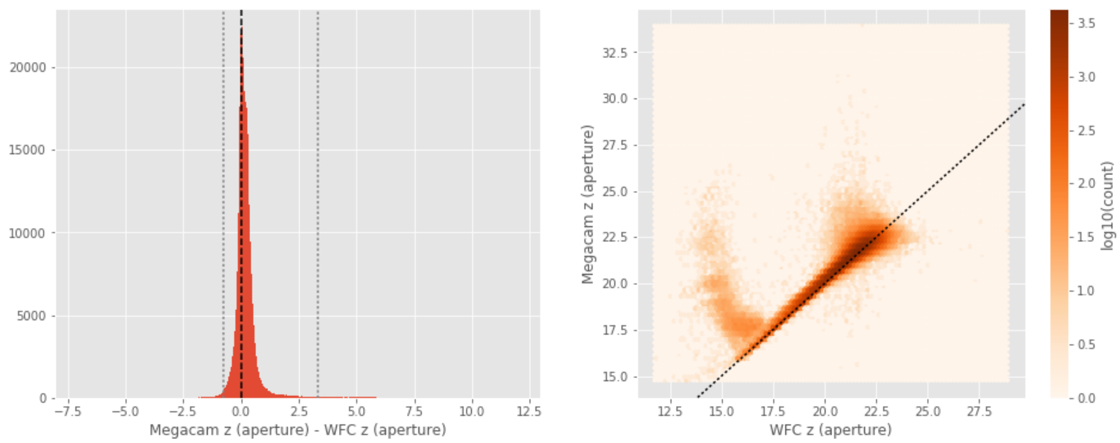
GPC1 i (aperture) - SUPRIME i (aperture):
- Median: -0.09
- Median Absolute Deviation: 0.19
- 1% percentile: -1.259005832672119
- 99% percentile: 0.6624520874023434



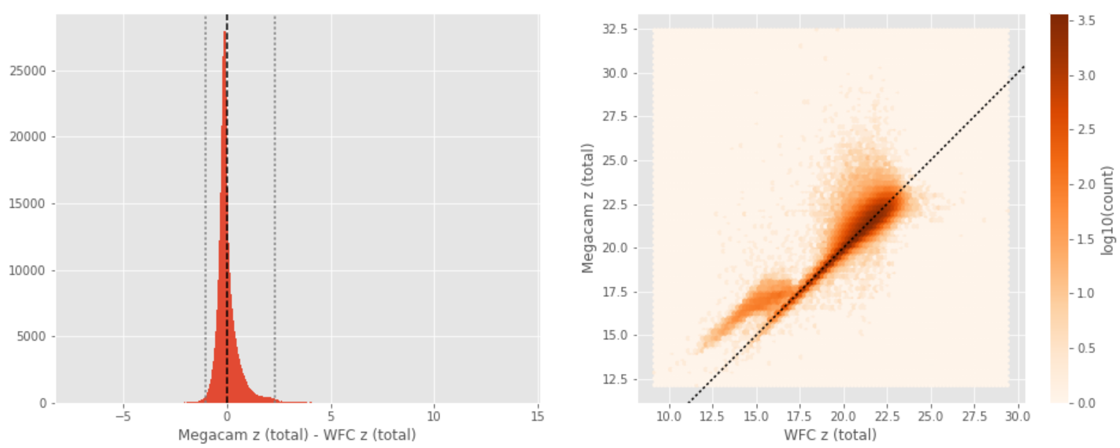
GPC1 i (total) - SUPRIME i (total):
- Median: 0.18
- Median Absolute Deviation: 0.10
- 1% percentile: -1.0342599487304687
- 99% percentile: 0.6791699981689452



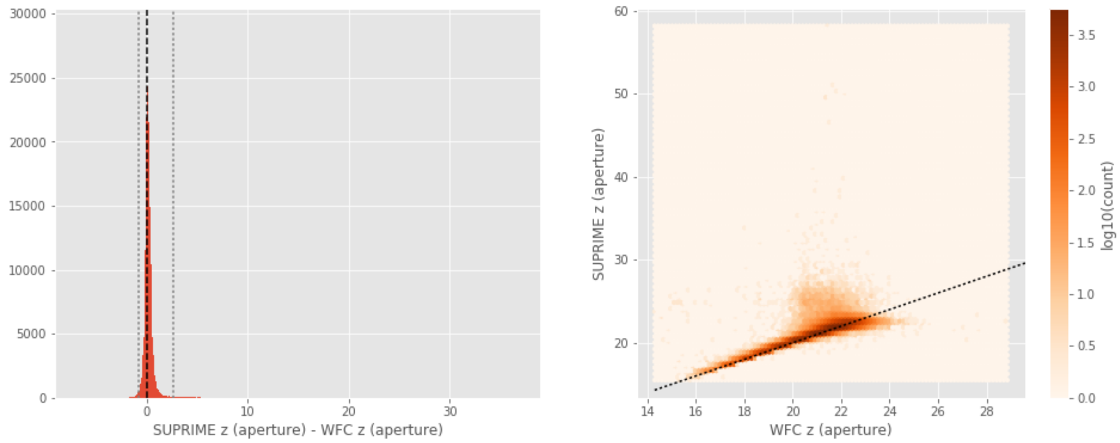
Megacam z (aperture) - WFC z (aperture):
- Median: 0.13
- Median Absolute Deviation: 0.18
- 1% percentile: -0.7321368980407714
- 99% percentile: 3.3361961364746464



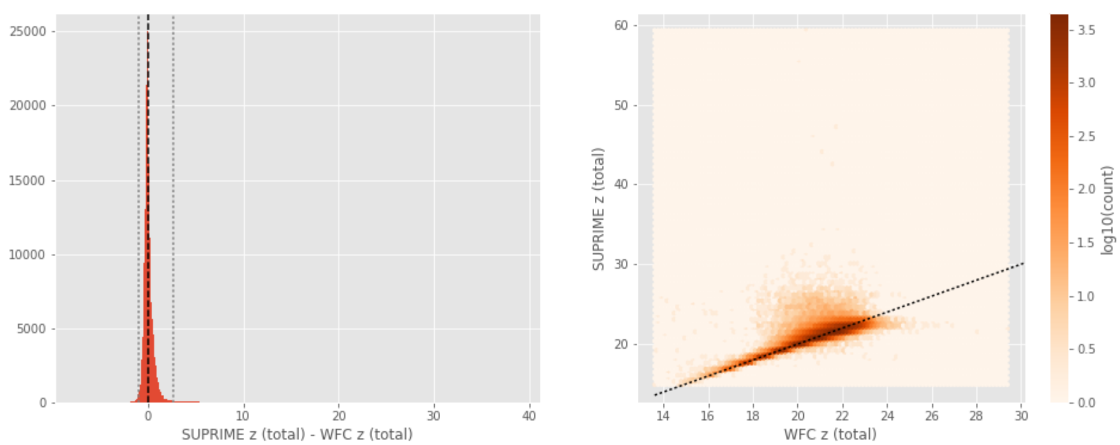
Megacam z (total) - WFC z (total):
- Median: -0.07
- Median Absolute Deviation: 0.20
- 1% percentile: -0.9955057525634765
- 99% percentile: 2.3412176895141594



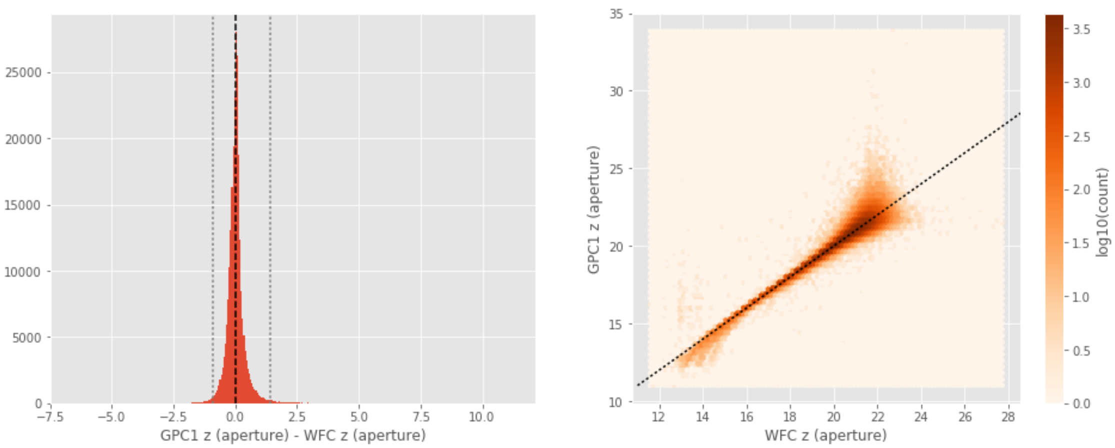
SUPRIME z (aperture) - WFC z (aperture):
- Median: 0.10
- Median Absolute Deviation: 0.17
- 1% percentile: -0.7828454971313477
- 99% percentile: 2.5906721115112408



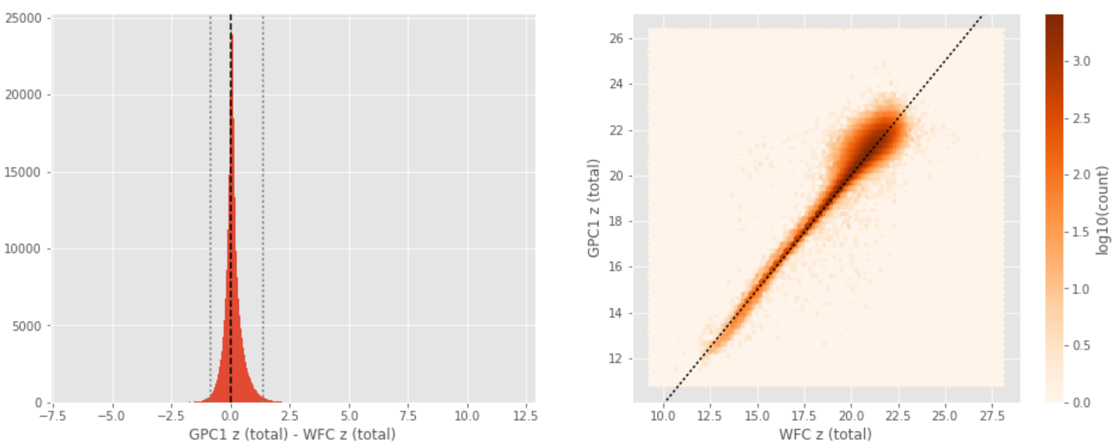
SUPRIME z (total) - WFC z (total):
- Median: -0.03
- Median Absolute Deviation: 0.22
- 1% percentile: -0.9388100051879882
- 99% percentile: 2.6204393005370985



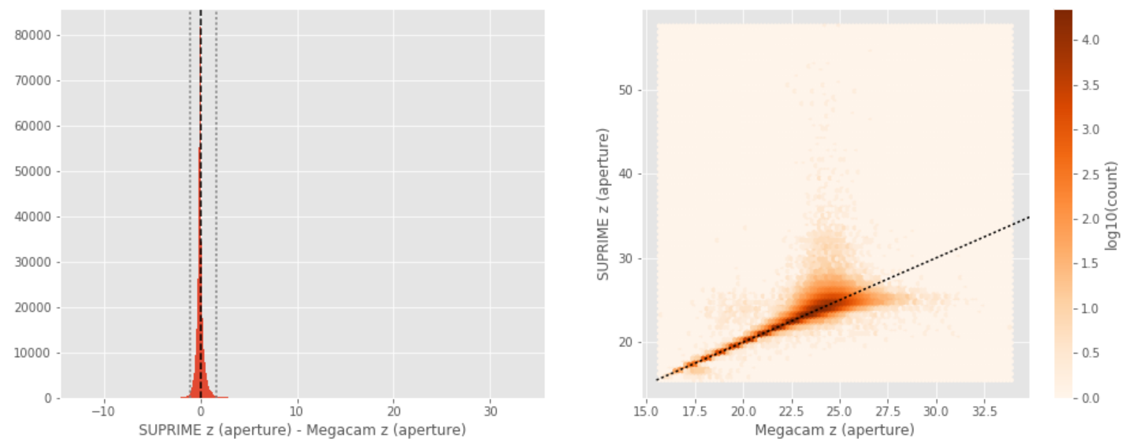
GPC1 z (aperture) - WFC z (aperture):
- Median: 0.01
- Median Absolute Deviation: 0.15
- 1% percentile: -0.8958967590332031
- 99% percentile: 1.408468627929681



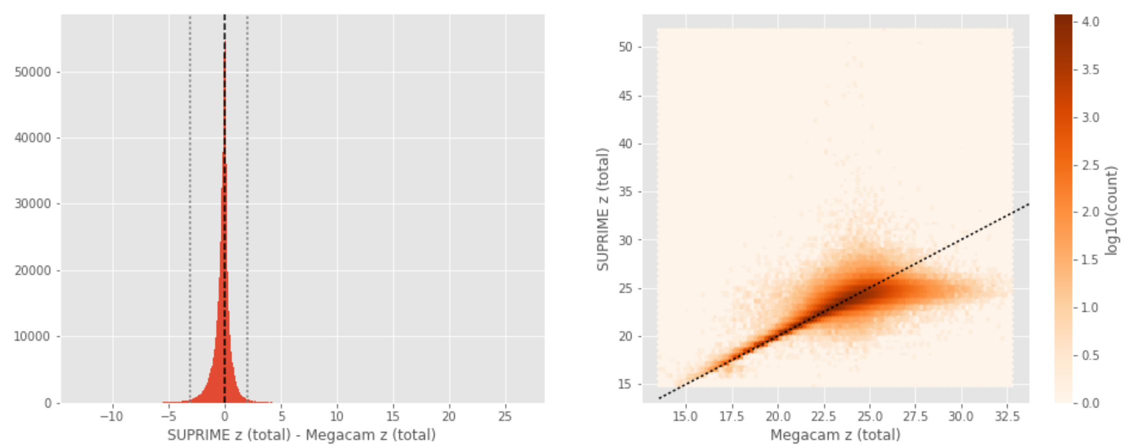
GPC1 z (total) - WFC z (total):
- Median: 0.07
- Median Absolute Deviation: 0.16
- 1% percentile: -0.8547391891479492
- 99% percentile: 1.3617404937744164



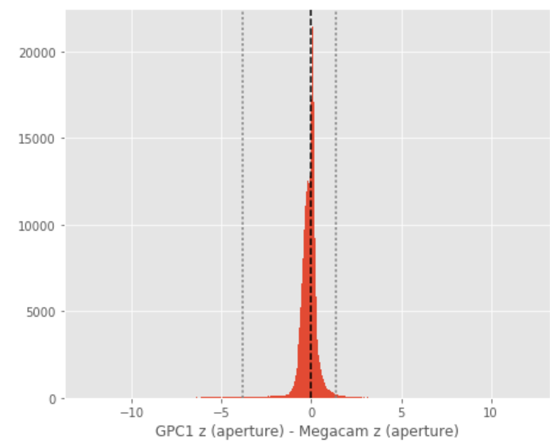
SUPRIME z (aperture) - Megacam z (aperture):
- Median: -0.04
- Median Absolute Deviation: 0.15
- 1% percentile: -1.104429817199707
- 99% percentile: 1.5991294288635258

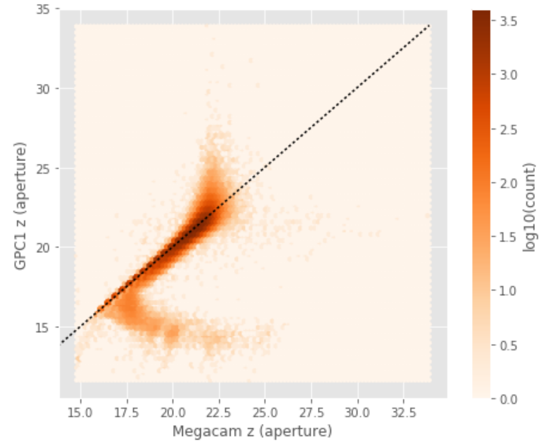


SUPRIME z (total) - Megacam z (total):
- Median: -0.07
- Median Absolute Deviation: 0.28
- 1% percentile: -3.1023595046997072
- 99% percentile: 2.069321308135987

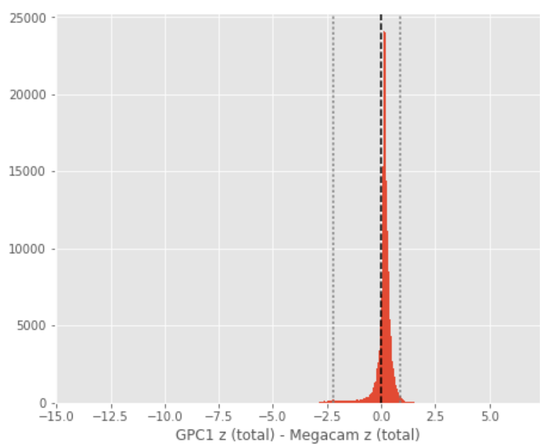


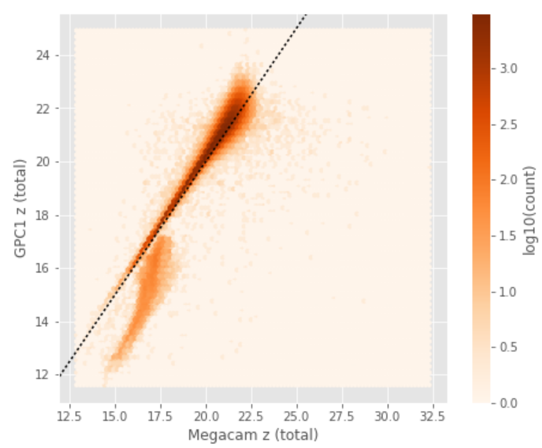
GPC1 z (aperture) - Megacam z (aperture):
- Median: -0.09
- Median Absolute Deviation: 0.22
- 1% percentile: -3.8263822555541993
- 99% percentile: 1.387774467468262



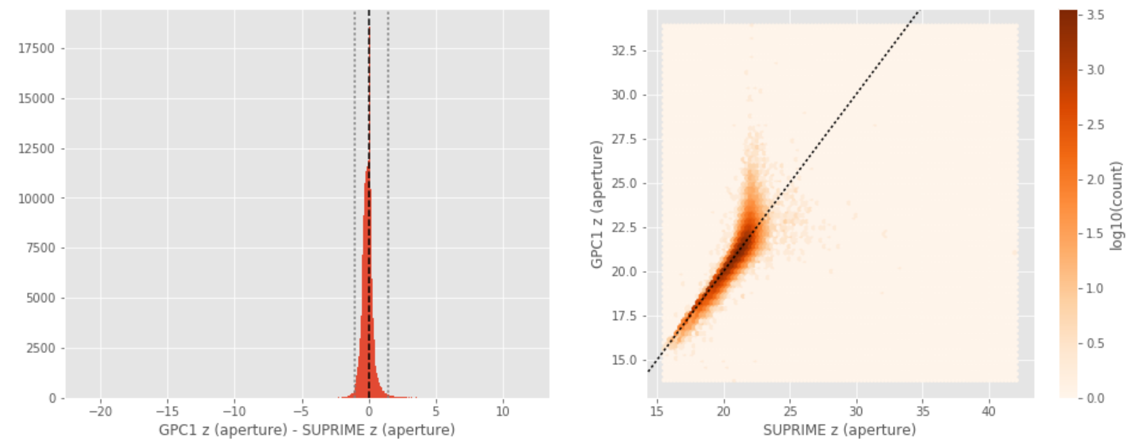


GPC1 z (total) - Megacam z (total):
- Median: 0.17
- Median Absolute Deviation: 0.11
- 1% percentile: -2.2160144233703614
- 99% percentile: 0.9042765426635738

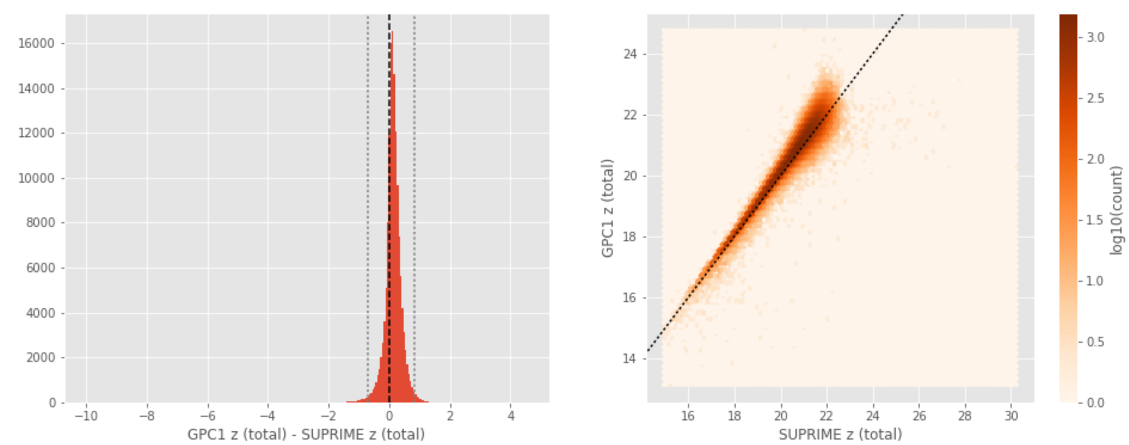




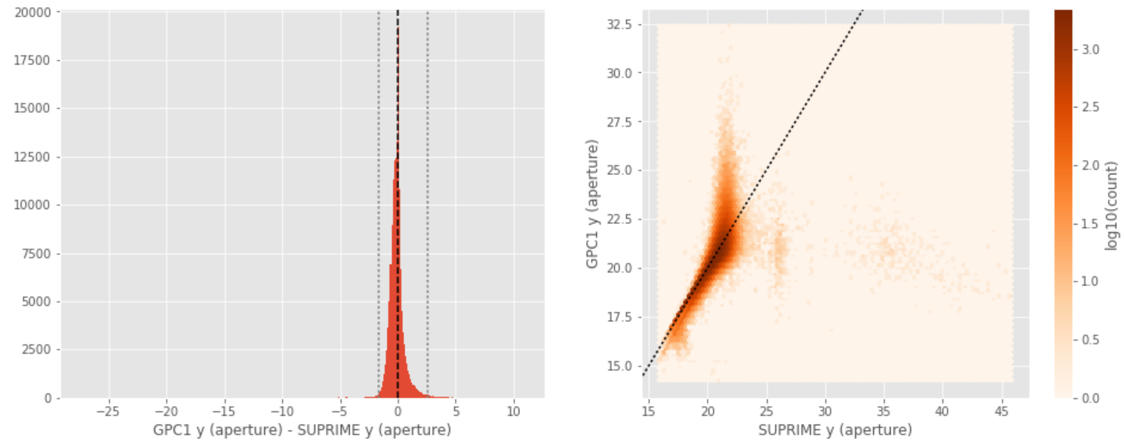
GPC1 z (aperture) - SUPRIME z (aperture):
- Median: -0.05
- Median Absolute Deviation: 0.21
- 1% percentile: -1.0826454162597656
- 99% percentile: 1.4541187286376953



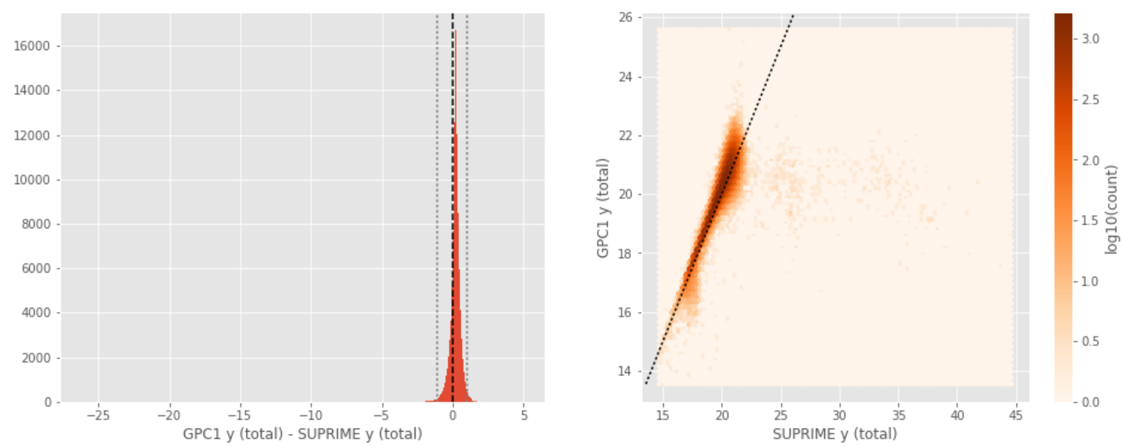
GPC1 z (total) - SUPRIME z (total):
- Median: 0.13
- Median Absolute Deviation: 0.13
- 1% percentile: -0.7019862365722657
- 99% percentile: 0.8331898117065466



GPC1 y (aperture) - SUPRIME y (aperture):
- Median: -0.11
- Median Absolute Deviation: 0.29
- 1% percentile: -1.6758161926269532
- 99% percentile: 2.540292816162108



GPC1 y (total) - SUPRIME y (total):
- Median: 0.20
- Median Absolute Deviation: 0.16
- 1% percentile: -1.1161381721496582
- 99% percentile: 1.035216197967529



1.5 III - Comparing magnitudes to reference bands

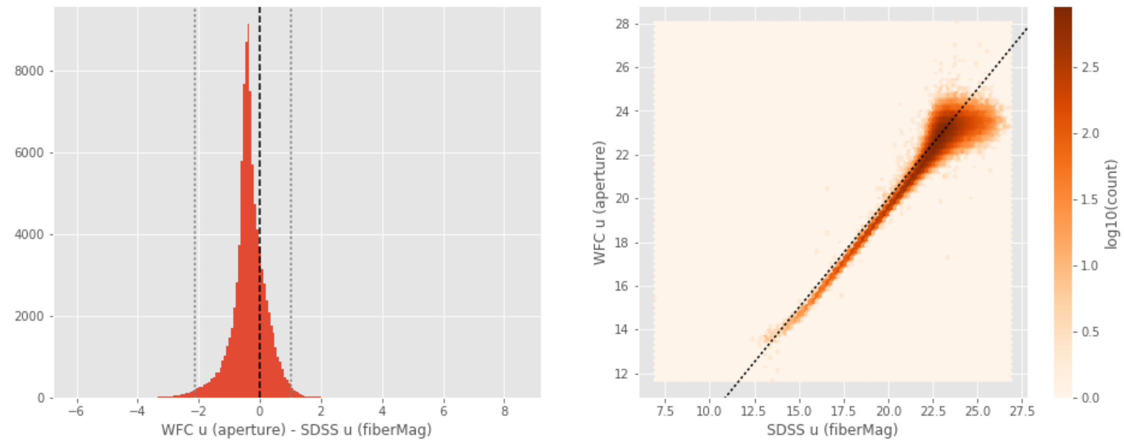
Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

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

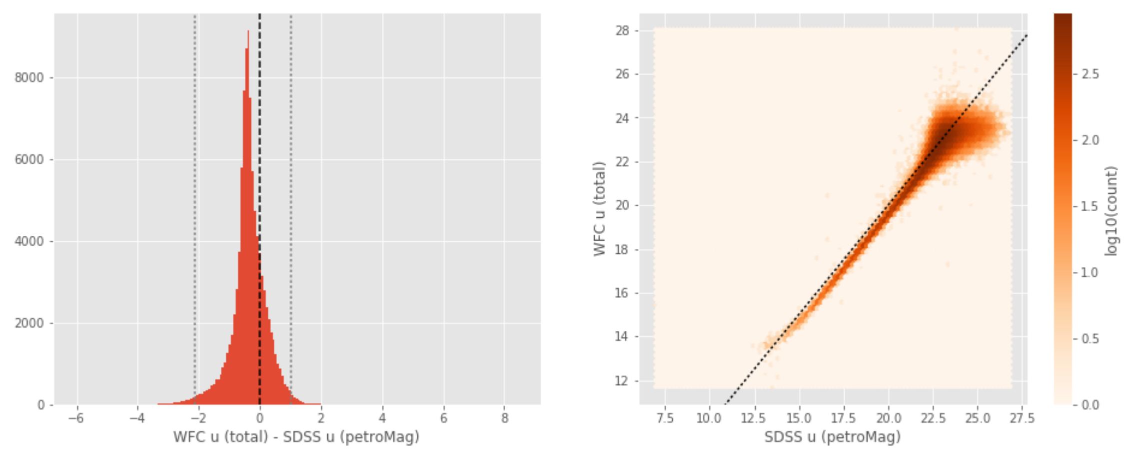
The catalogue is cross-matched to SDSS-DR13 withing 0.2 arcsecond.

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: -0.37
- Median Absolute Deviation: 0.26
- 1% percentile: -2.1387645721435544
- 99% percentile: 1.0094253540039075

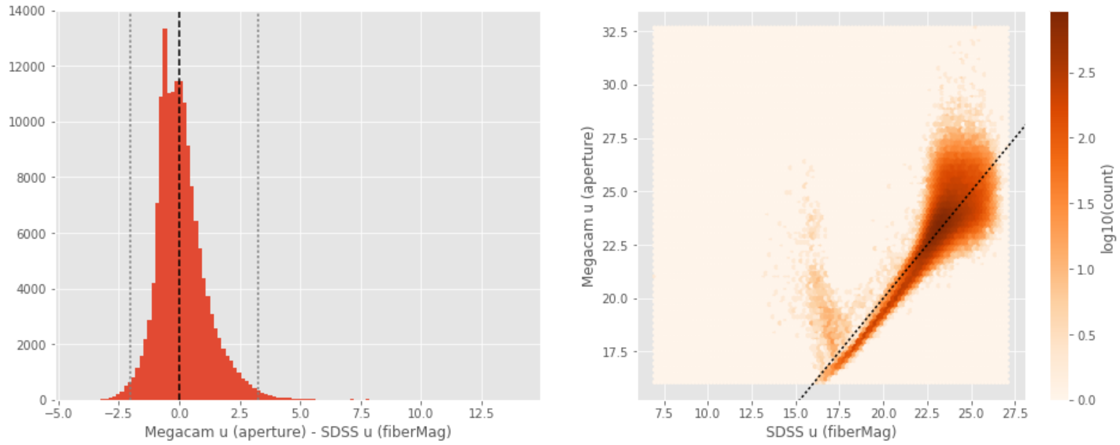


WFC u (total) - SDSS u (petroMag):
- Median: -0.37
- Median Absolute Deviation: 0.26
- 1% percentile: -2.1387645721435544
- 99% percentile: 1.0094253540039075

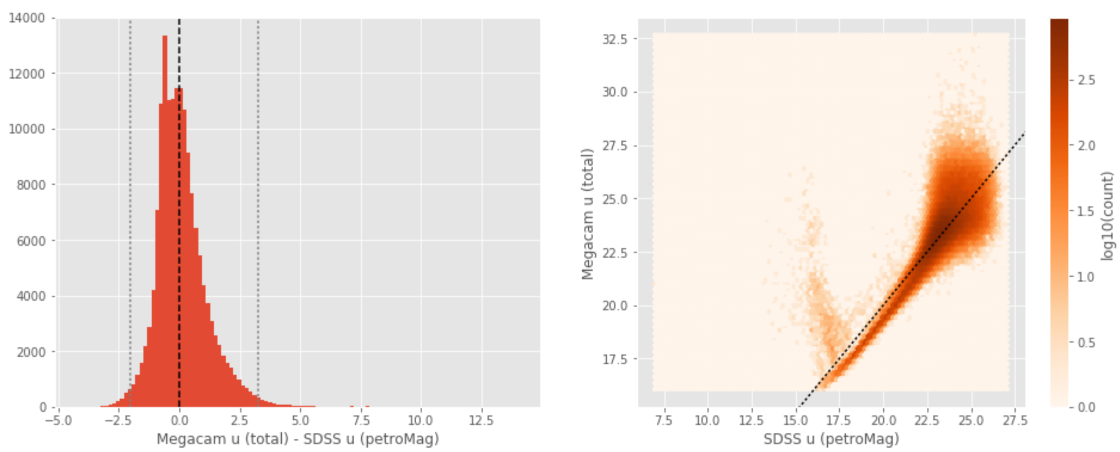


Megacam u (aperture) - SDSS u (fiberMag):
- Median: -0.04

- Median Absolute Deviation: 0.59
- 1% percentile: -2.044686393737793
- 99% percentile: 3.2575323295593246

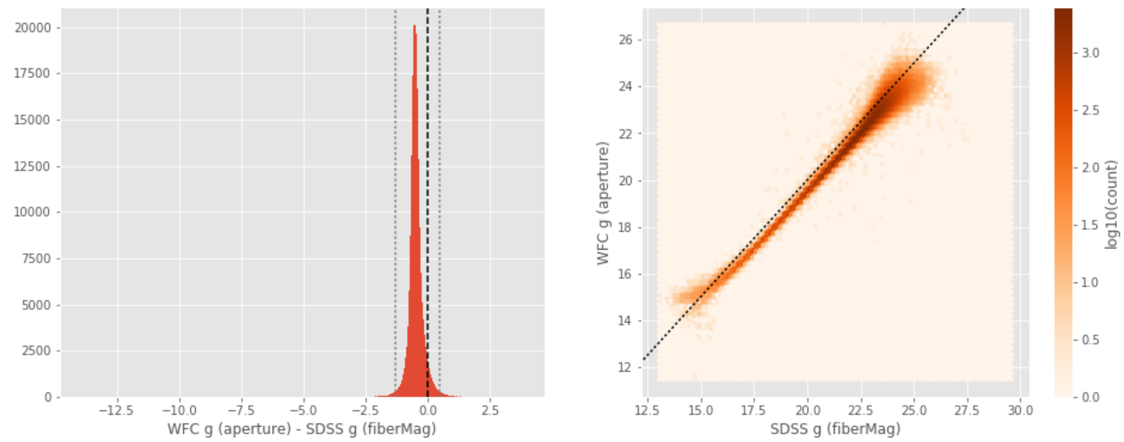


Megacam u (total) - SDSS u (petroMag):
- Median: -0.04
- Median Absolute Deviation: 0.59
- 1% percentile: -2.044686393737793
- 99% percentile: 3.2575323295593246

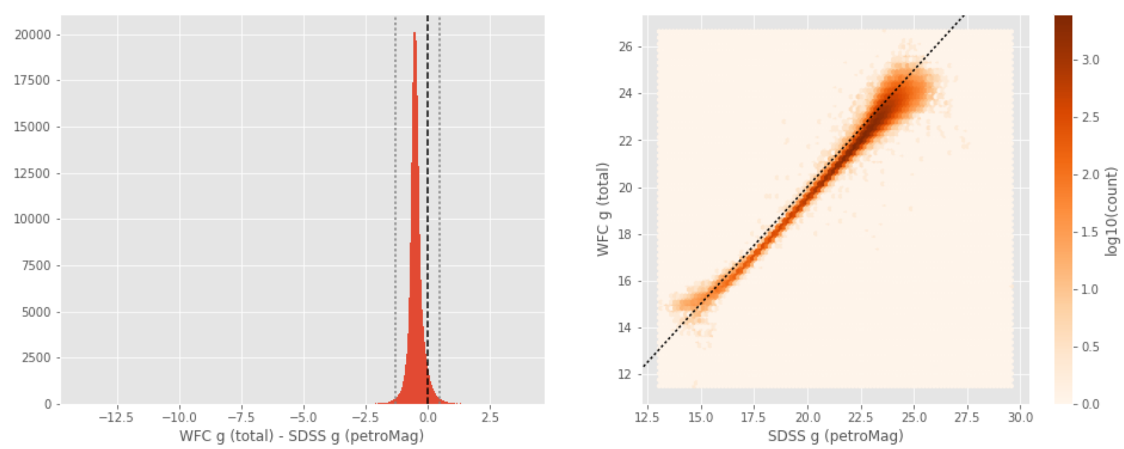


WFC g (aperture) - SDSS g (fiberMag):
- Median: -0.49
- Median Absolute Deviation: 0.12
- 1% percentile: -1.2727931022644043

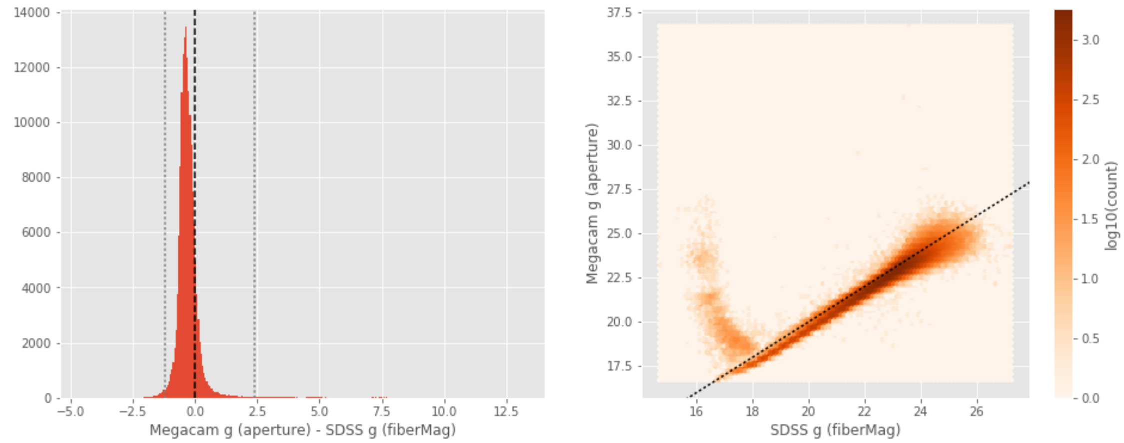
- 99% percentile: 0.46194868087768726



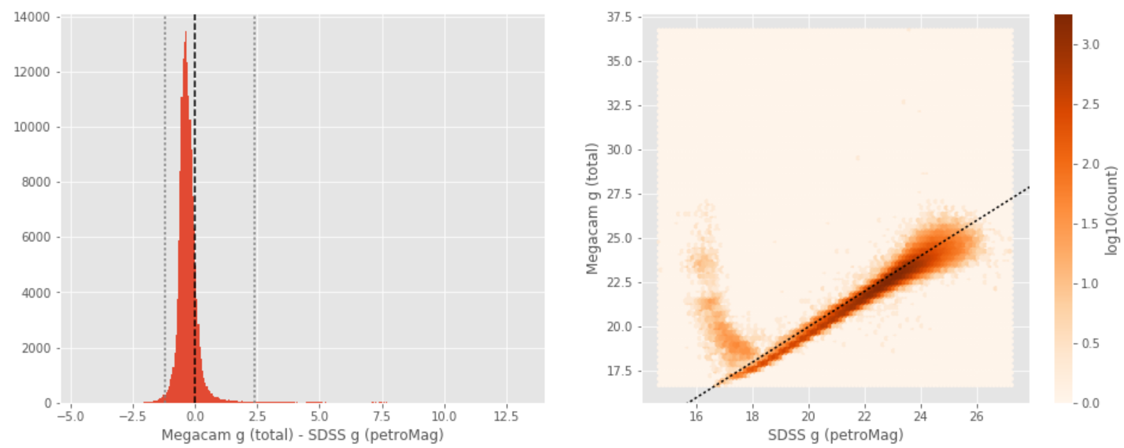
WFC g (total) - SDSS g (petroMag):
- Median: -0.49
- Median Absolute Deviation: 0.12
- 1% percentile: -1.2727931022644043
- 99% percentile: 0.46194868087768726



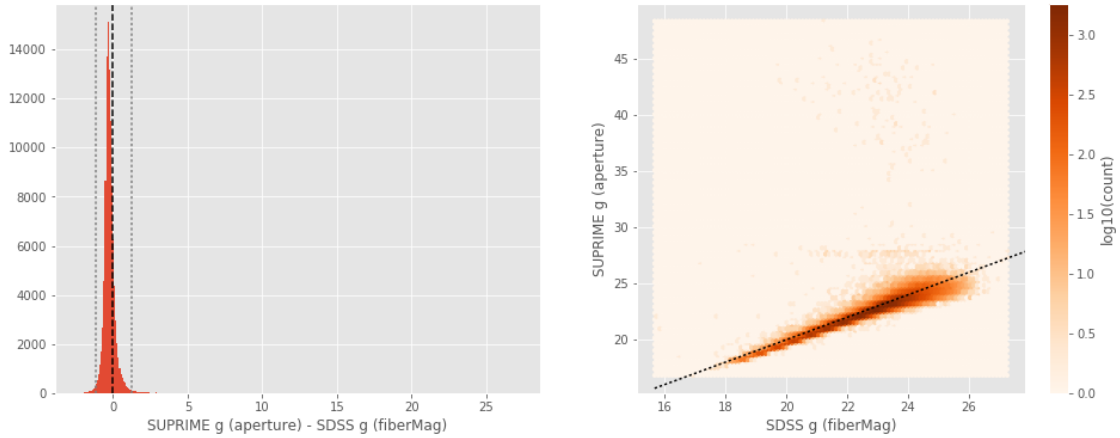
Megacam g (aperture) - SDSS g (fiberMag):
- Median: -0.33
- Median Absolute Deviation: 0.19
- 1% percentile: -1.2042931175231935
- 99% percentile: 2.403406810760495



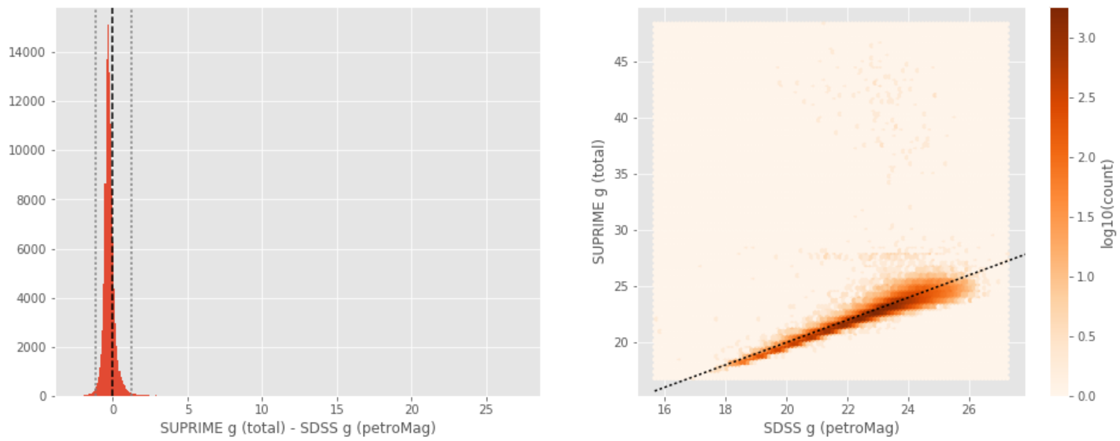
Megacam g (total) - SDSS g (petroMag):
- Median: -0.33
- Median Absolute Deviation: 0.19
- 1% percentile: -1.2042931175231935
- 99% percentile: 2.403406810760495



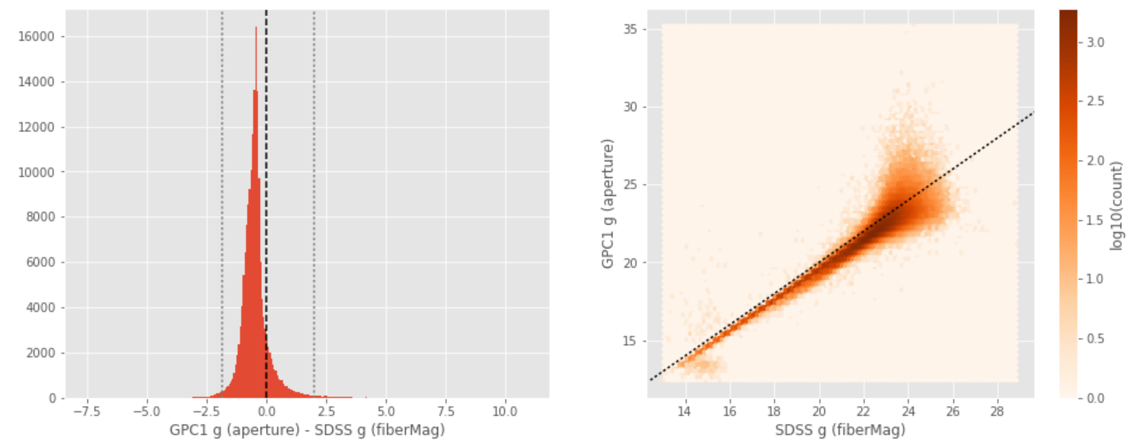
SUPRIME g (aperture) - SDSS g (fiberMag):
- Median: -0.28
- Median Absolute Deviation: 0.17
- 1% percentile: -1.1439088821411132
- 99% percentile: 1.2356151580810513



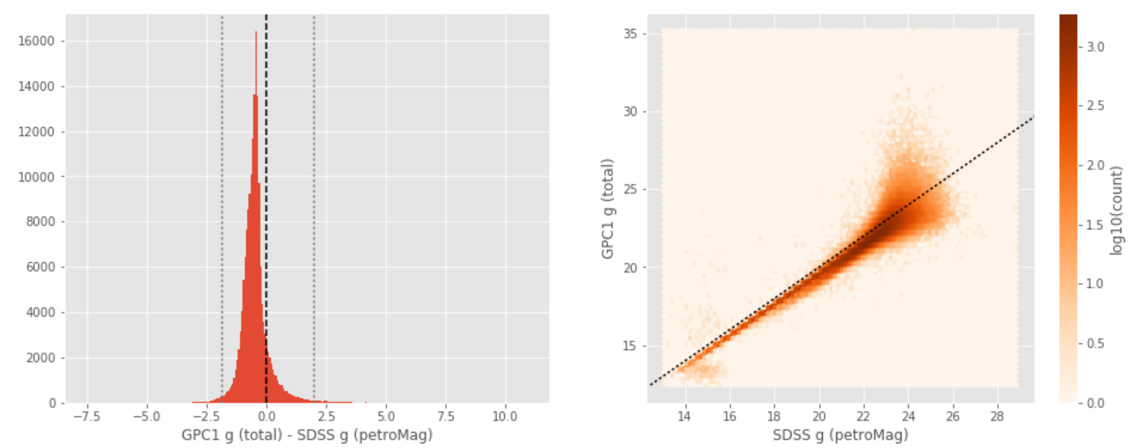
SUPRIME g (total) - SDSS g (petroMag):
- Median: -0.28
- Median Absolute Deviation: 0.17
- 1% percentile: -1.1439088821411132
- 99% percentile: 1.2356151580810513



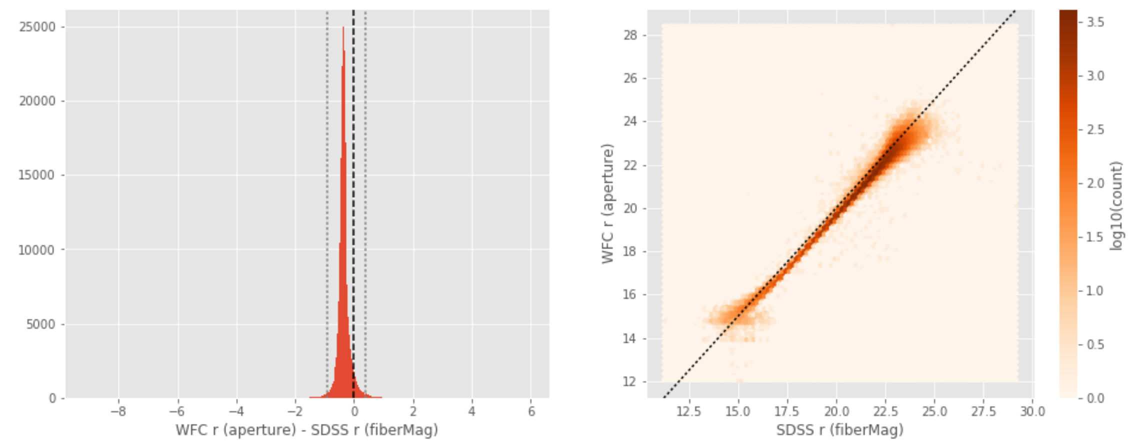
GPC1 g (aperture) - SDSS g (fiberMag):
- Median: -0.51
- Median Absolute Deviation: 0.24
- 1% percentile: -1.874479866027832
- 99% percentile: 1.9854761123657223



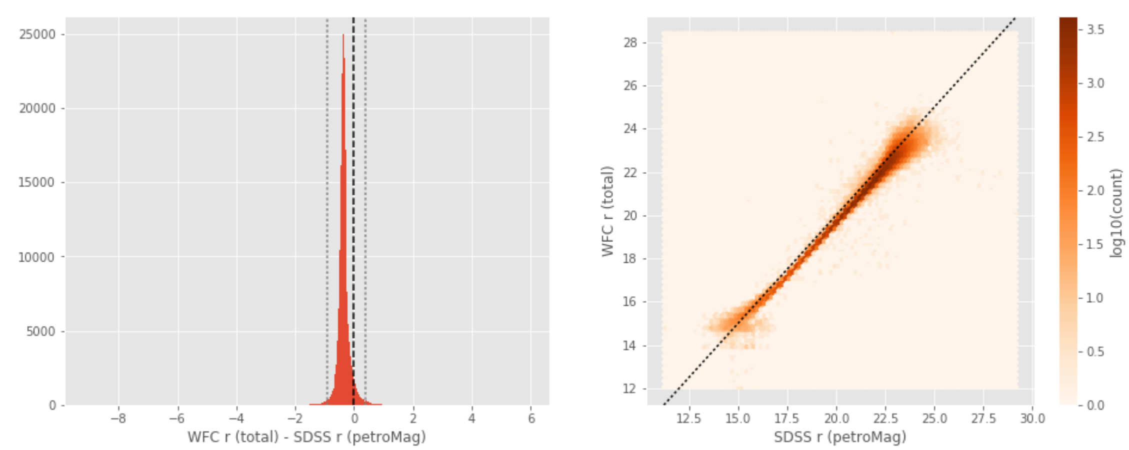
GPC1 g (total) - SDSS g (petroMag):
- Median: -0.51
- Median Absolute Deviation: 0.24
- 1% percentile: -1.874479866027832
- 99% percentile: 1.9854761123657223



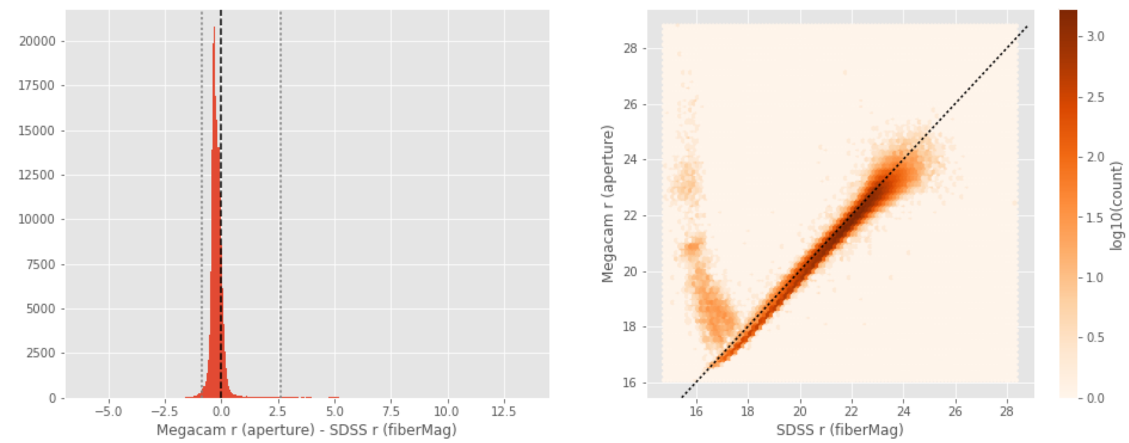
WFC r (aperture) - SDSS r (fiberMag):
- Median: -0.35
- Median Absolute Deviation: 0.08
- 1% percentile: -0.9242410278320312
- 99% percentile: 0.37569358825683397



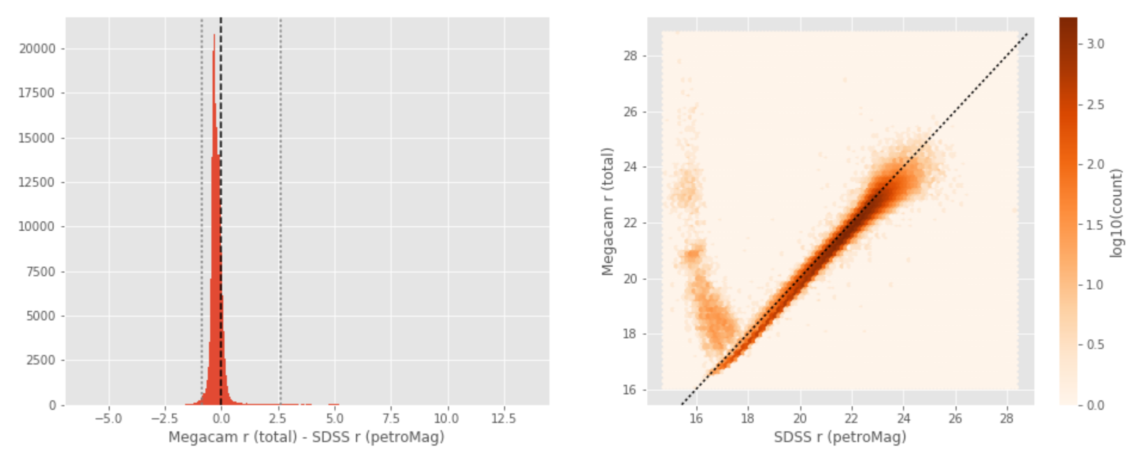
WFC r (total) - SDSS r (petroMag):
- Median: -0.35
- Median Absolute Deviation: 0.08
- 1% percentile: -0.9242410278320312
- 99% percentile: 0.37569358825683397



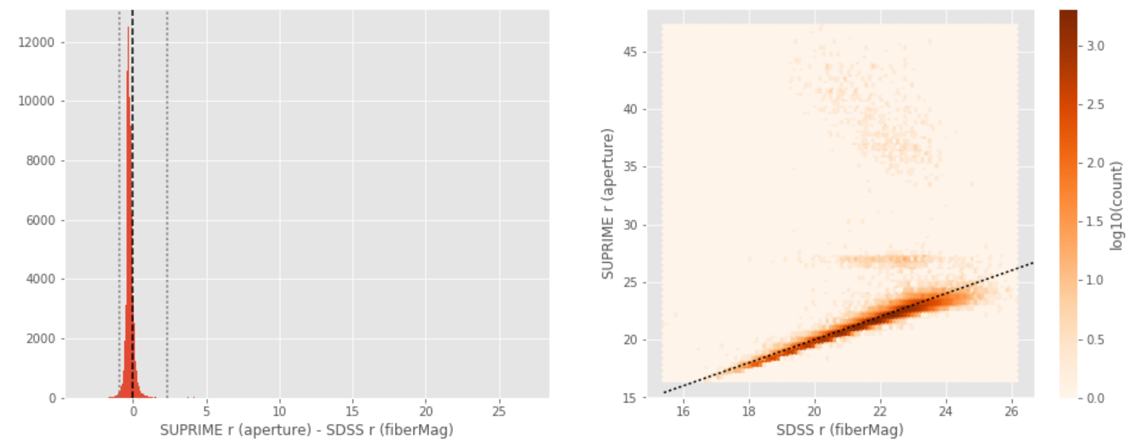
Megacam r (aperture) - SDSS r (fiberMag):
- Median: -0.24
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8530236053466798
- 99% percentile: 2.6363726997375587



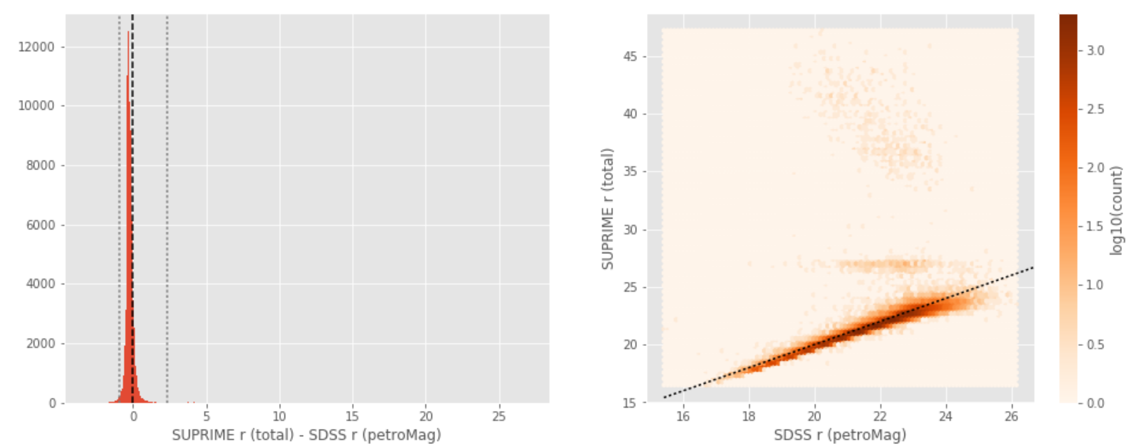
Megacam r (total) - SDSS r (petroMag):
- Median: -0.24
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8530236053466798
- 99% percentile: 2.6363726997375587



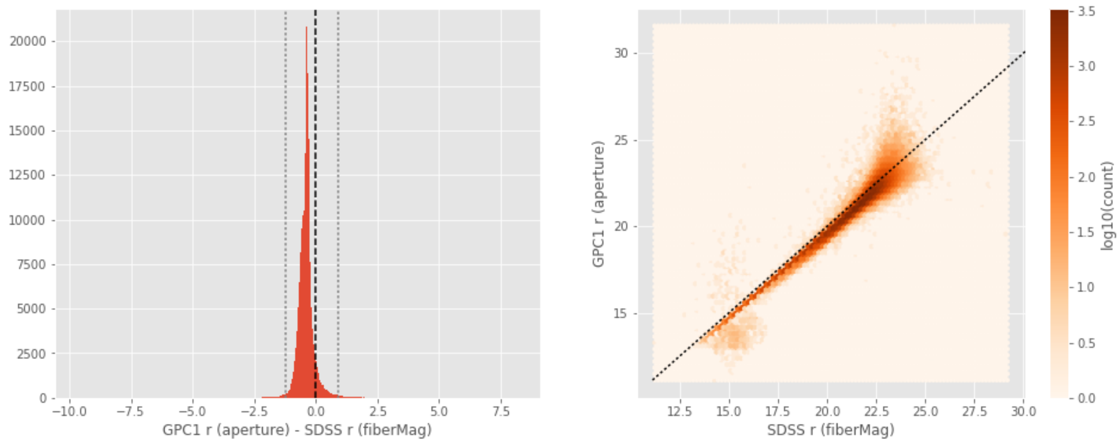
SUPRIME r (aperture) - SDSS r (fiberMag):
- Median: -0.25
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8844428634643554
- 99% percentile: 2.346479873657227



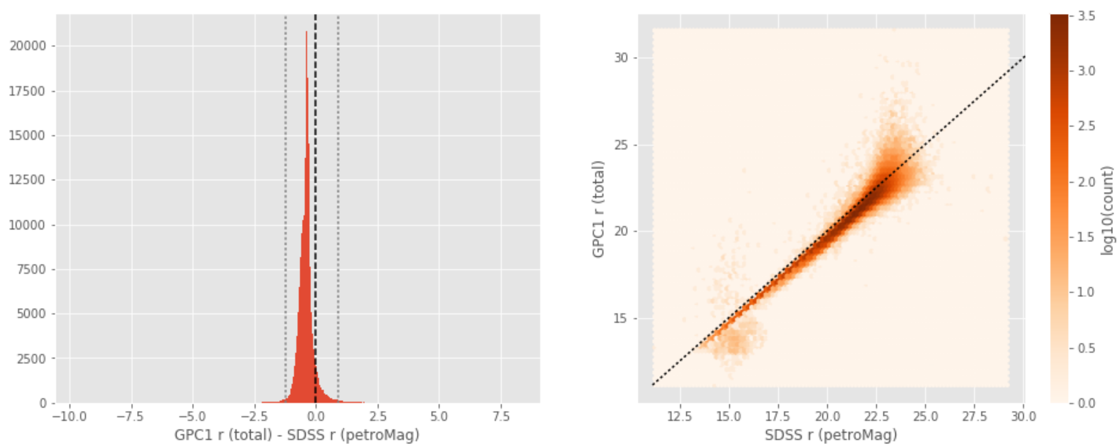
SUPRIME r (total) - SDSS r (petroMag):
- Median: -0.25
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8844428634643554
- 99% percentile: 2.346479873657227



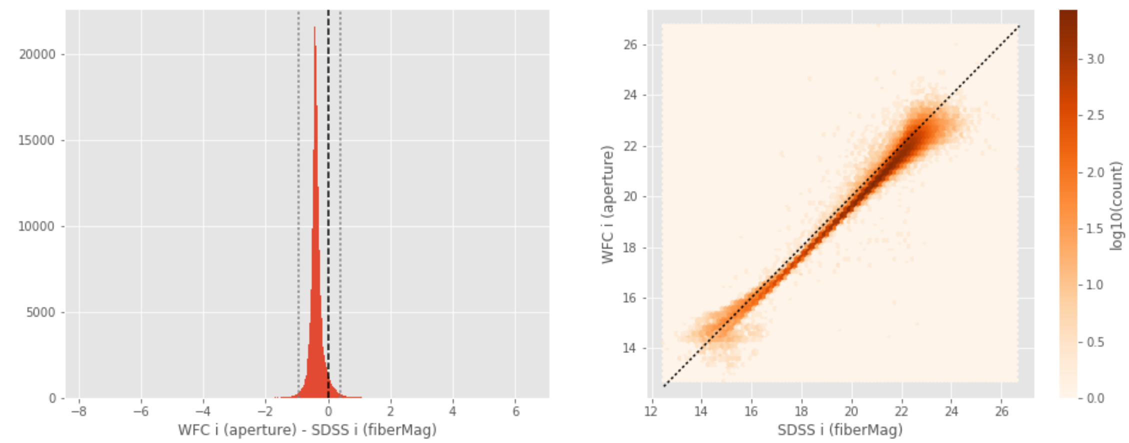
GPC1 r (aperture) - SDSS r (fiberMag):
- Median: -0.38
- Median Absolute Deviation: 0.14
- 1% percentile: -1.2143004417419432
- 99% percentile: 0.9139746665954609



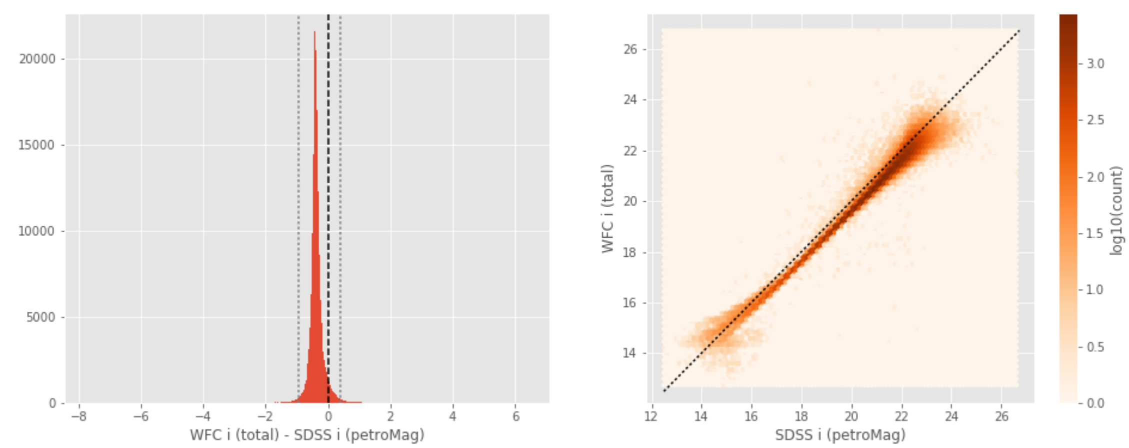
GPC1 r (total) - SDSS r (petroMag):
- Median: -0.38
- Median Absolute Deviation: 0.14
- 1% percentile: -1.2143004417419432
- 99% percentile: 0.9139746665954609



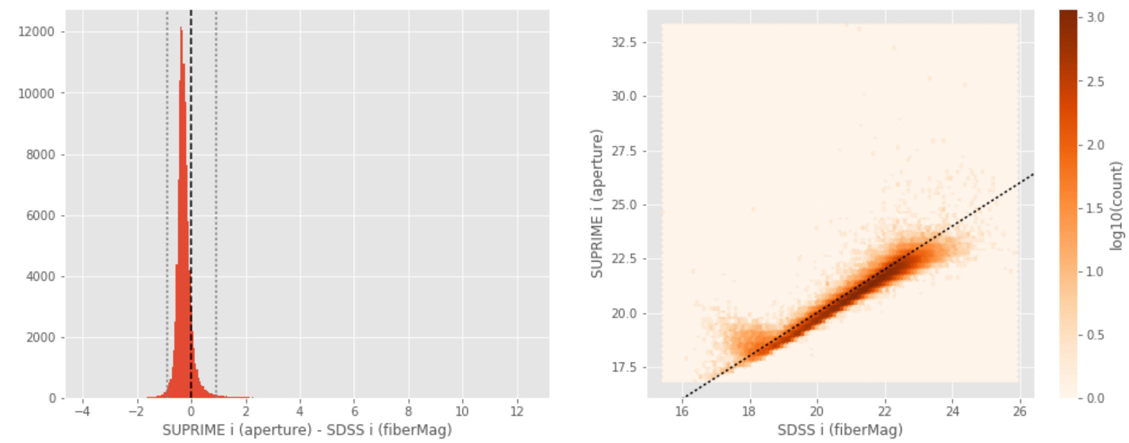
WFC i (aperture) - SDSS i (fiberMag):
- Median: -0.39
- Median Absolute Deviation: 0.08
- 1% percentile: -0.9540224075317383
- 99% percentile: 0.3984149932861357



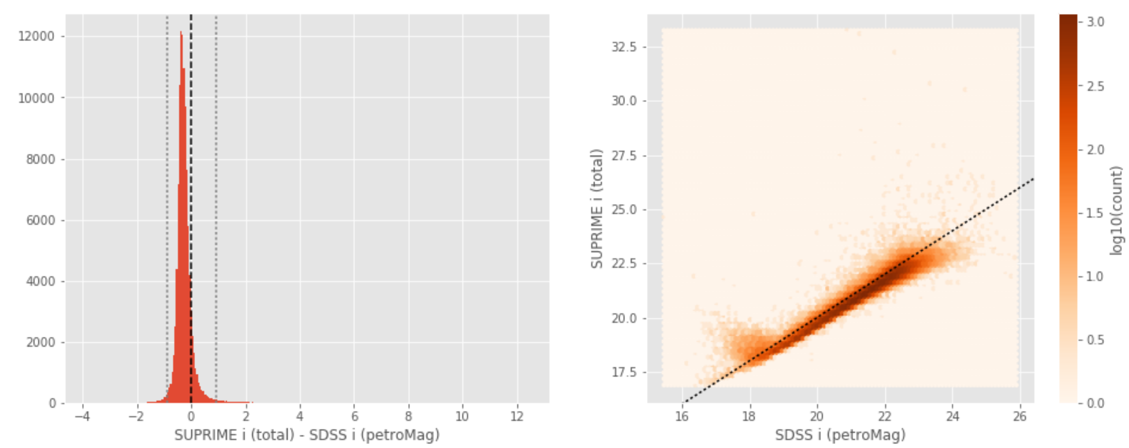
WFC i (total) - SDSS i (petroMag):
- Median: -0.39
- Median Absolute Deviation: 0.08
- 1% percentile: -0.9540224075317383
- 99% percentile: 0.3984149932861357



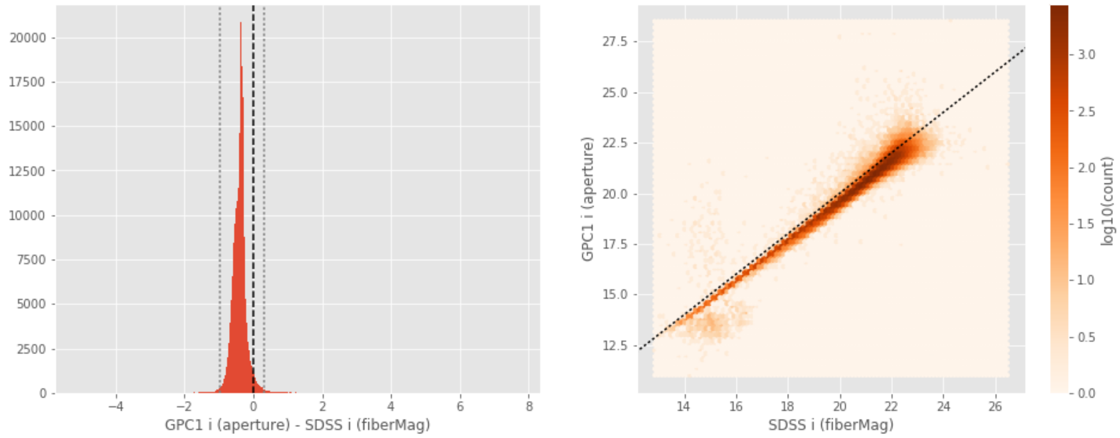
SUPRIME i (aperture) - SDSS i (fiberMag):
- Median: -0.30
- Median Absolute Deviation: 0.13
- 1% percentile: -0.890188274383545
- 99% percentile: 0.9026821899414045



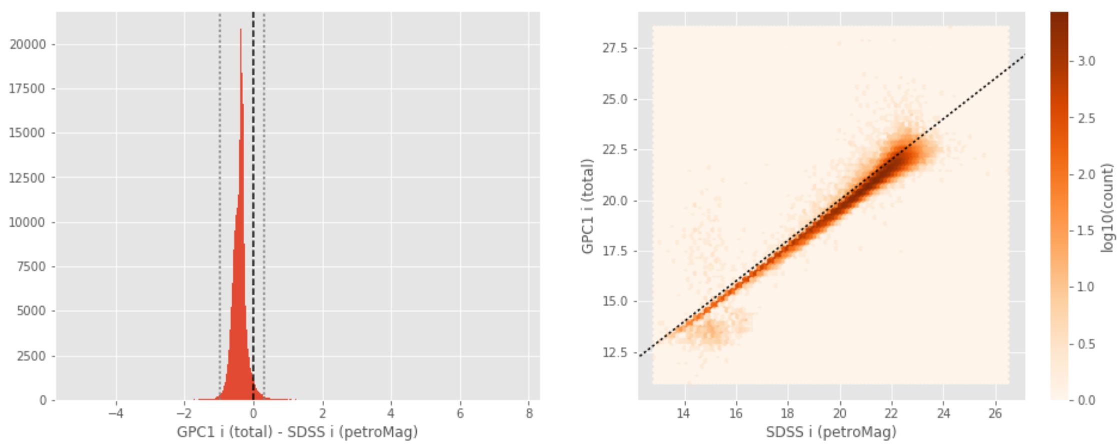
SUPRIME i (total) - SDSS i (petroMag):
- Median: -0.30
- Median Absolute Deviation: 0.13
- 1% percentile: -0.890188274383545
- 99% percentile: 0.9026821899414045



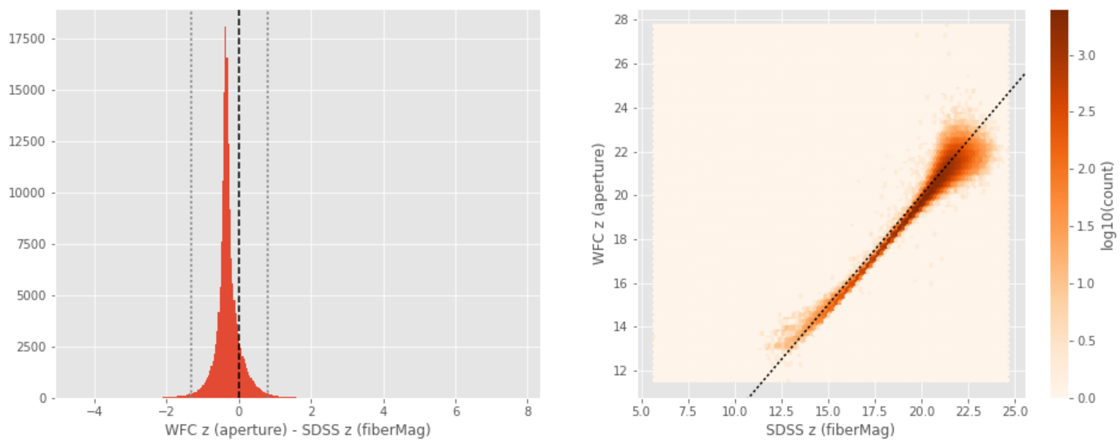
GPC1 i (aperture) - SDSS i (fiberMag):
- Median: -0.38
- Median Absolute Deviation: 0.10
- 1% percentile: -0.9555757713317872
- 99% percentile: 0.31397663116455077



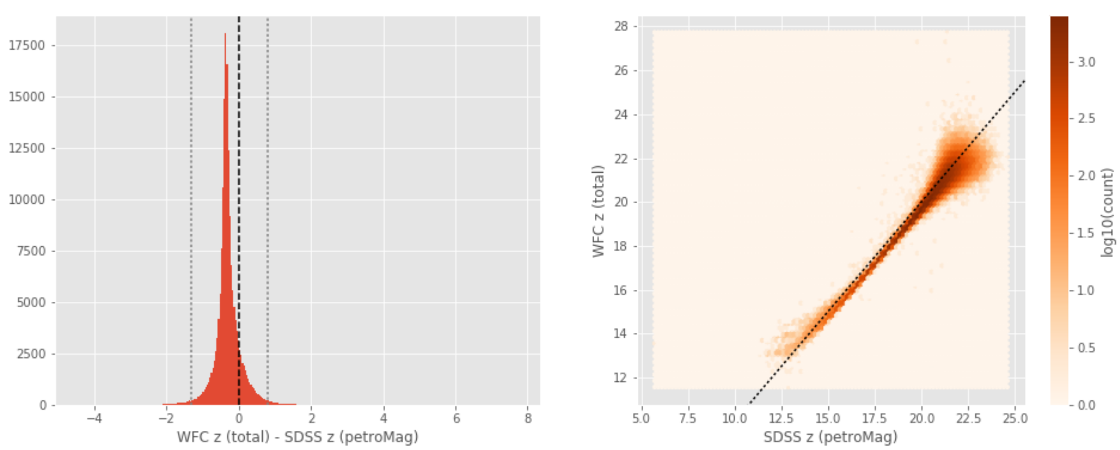
GPC1 i (total) - SDSS i (petroMag):
- Median: -0.38
- Median Absolute Deviation: 0.10
- 1% percentile: -0.9555757713317872
- 99% percentile: 0.31397663116455077



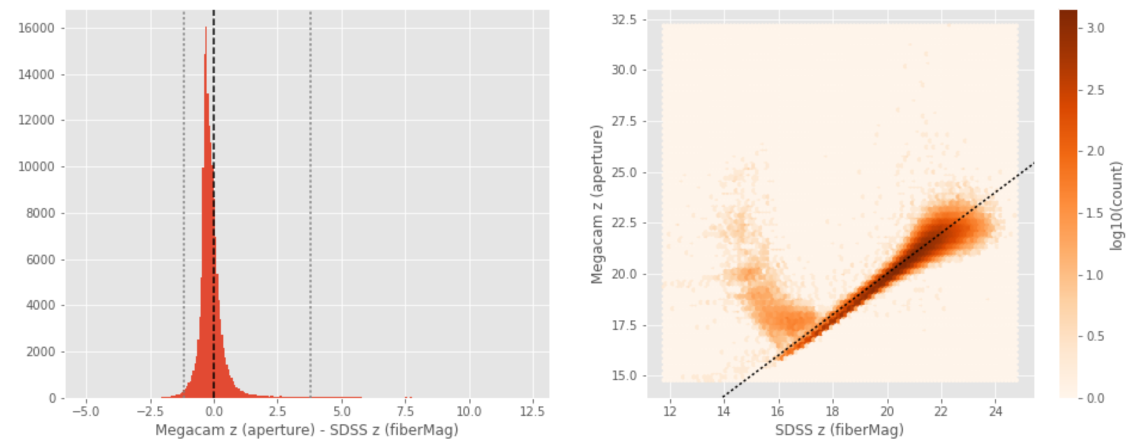
WFC z (aperture) - SDSS z (fiberMag):
- Median: -0.33
- Median Absolute Deviation: 0.13
- 1% percentile: -1.307823715209961
- 99% percentile: 0.7922947692871078



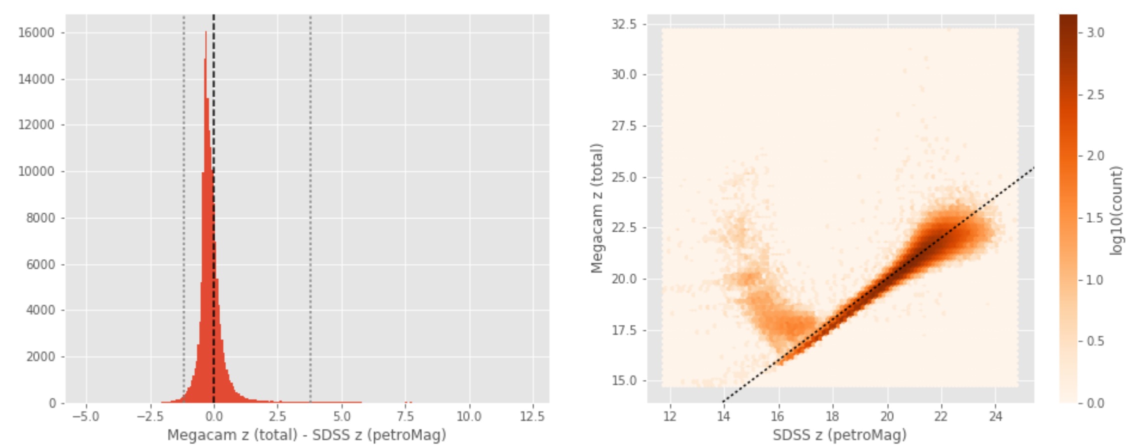
WFC z (total) - SDSS z (petroMag):
- Median: -0.33
- Median Absolute Deviation: 0.13
- 1% percentile: -1.307823715209961
- 99% percentile: 0.7922947692871078



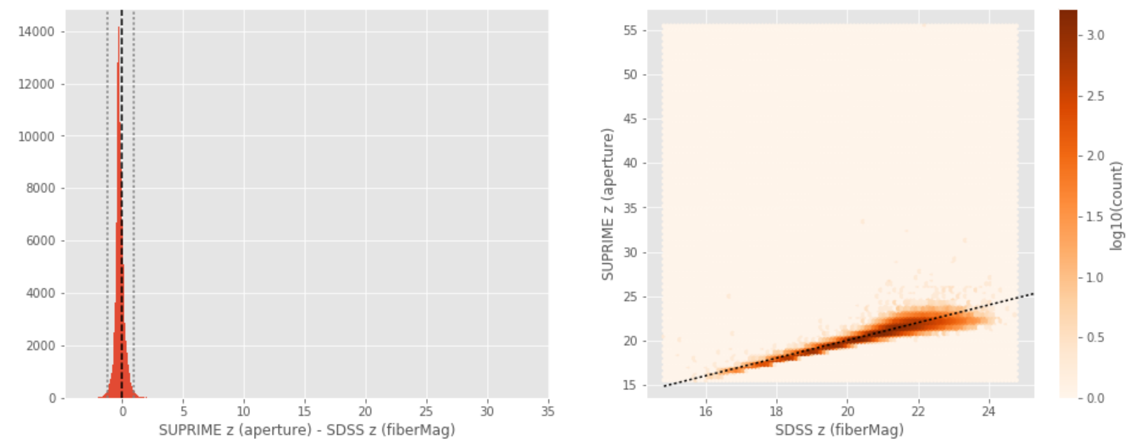
Megacam z (aperture) - SDSS z (fiberMag):
- Median: -0.19
- Median Absolute Deviation: 0.19
- 1% percentile: -1.167172966003418
- 99% percentile: 3.8105573463439564



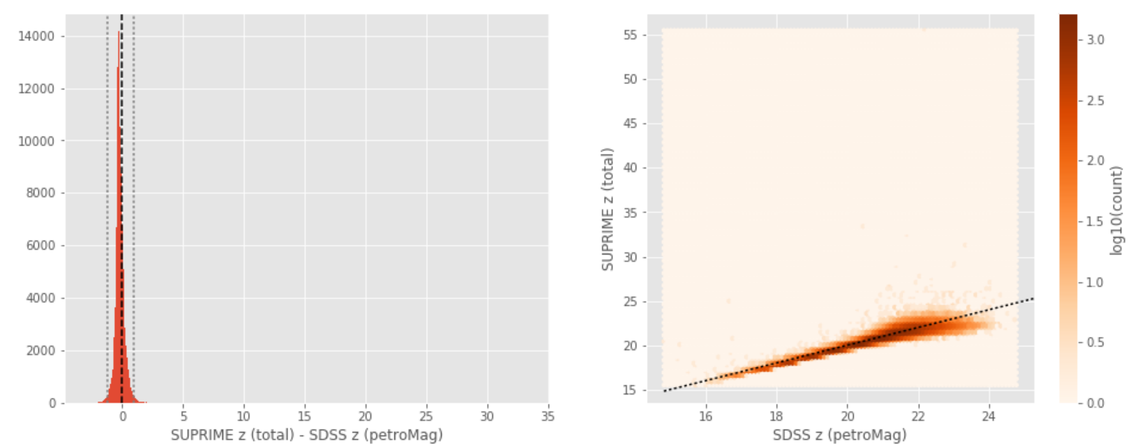
Megacam z (total) - SDSS z (petroMag):
- Median: -0.19
- Median Absolute Deviation: 0.19
- 1% percentile: -1.167172966003418
- 99% percentile: 3.8105573463439564



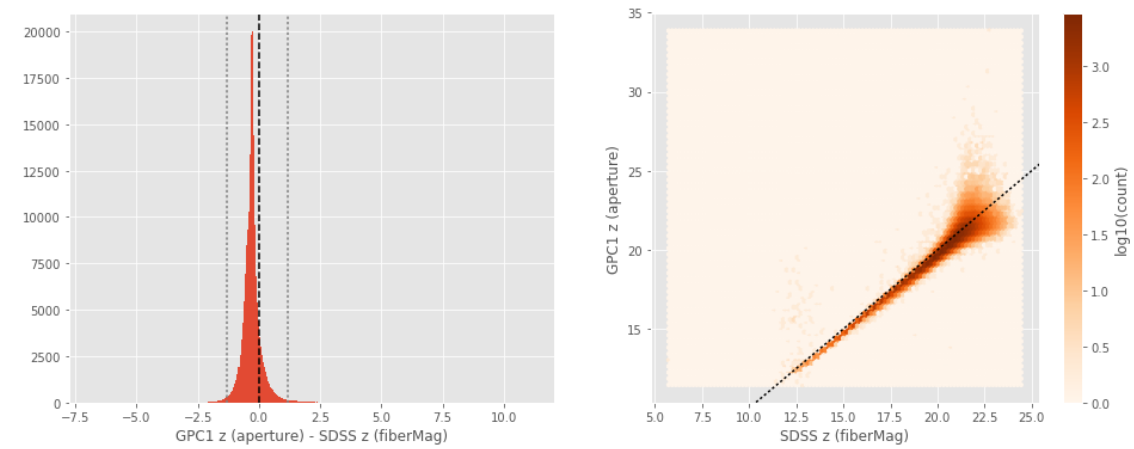
SUPRIME z (aperture) - SDSS z (fiberMag):
- Median: -0.22
- Median Absolute Deviation: 0.18
- 1% percentile: -1.1998800659179687
- 99% percentile: 0.9810749053955068



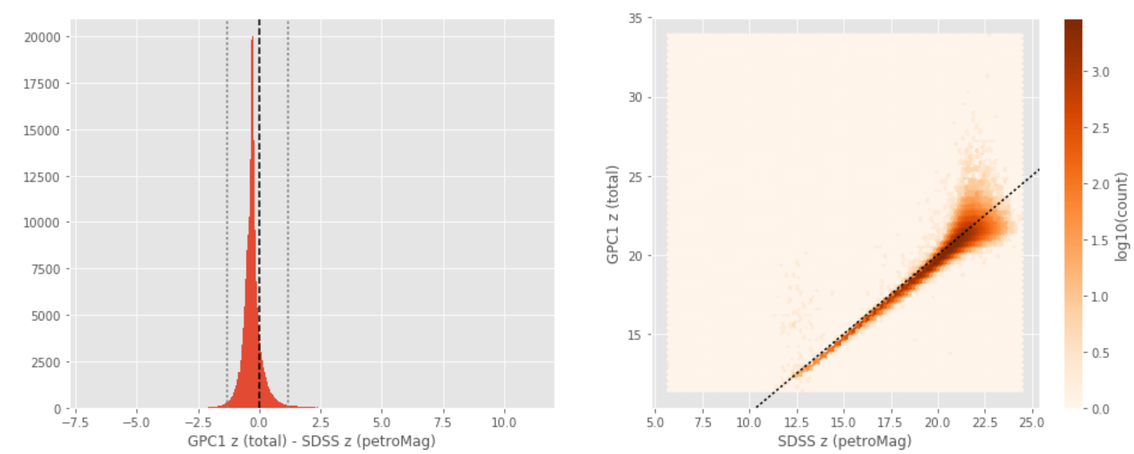
SUPRIME z (total) - SDSS z (petroMag):
- Median: -0.22
- Median Absolute Deviation: 0.18
- 1% percentile: -1.1998800659179687
- 99% percentile: 0.9810749053955068



GPC1 z (aperture) - SDSS z (fiberMag):
- Median: -0.30
- Median Absolute Deviation: 0.16
- 1% percentile: -1.2933573722839355
- 99% percentile: 1.1849651336669922



GPC1 z (total) - SDSS z (petroMag):
- Median: -0.30
- Median Absolute Deviation: 0.16
- 1% percentile: -1.2933573722839355
- 99% percentile: 1.1849651336669922



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.

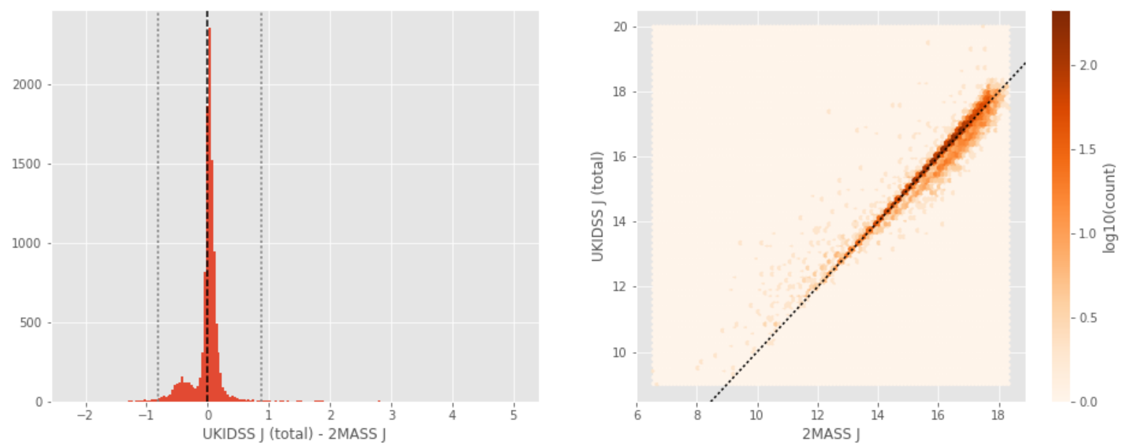
The 2MASS magnitudes are "*Vega-like*" and we have to convert them to AB magnitudes using the zero points provided on this page:

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

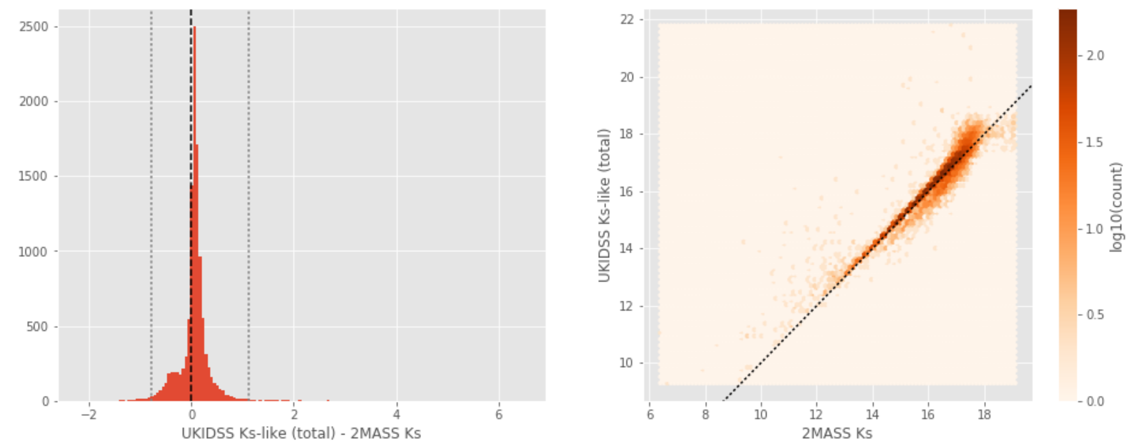
In addition, UKIDSS uses a K band whereas 2MASS uses a Ks ("short") band, this page give a correction to convert the K band in a Ks band with the formula:

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

```
UKIDSS J (total) - 2MASS J:
- Median: 0.02
- Median Absolute Deviation: 0.05
- 1% percentile: -0.8077035259916129
- 99% percentile: 0.8731615960786883
```




```
UKIDSS Ks-like (total) - 2MASS Ks:
- Median: 0.07
- Median Absolute Deviation: 0.08
- 1% percentile: -0.7857970560320414
- 99% percentile: 1.1150006786481284
```



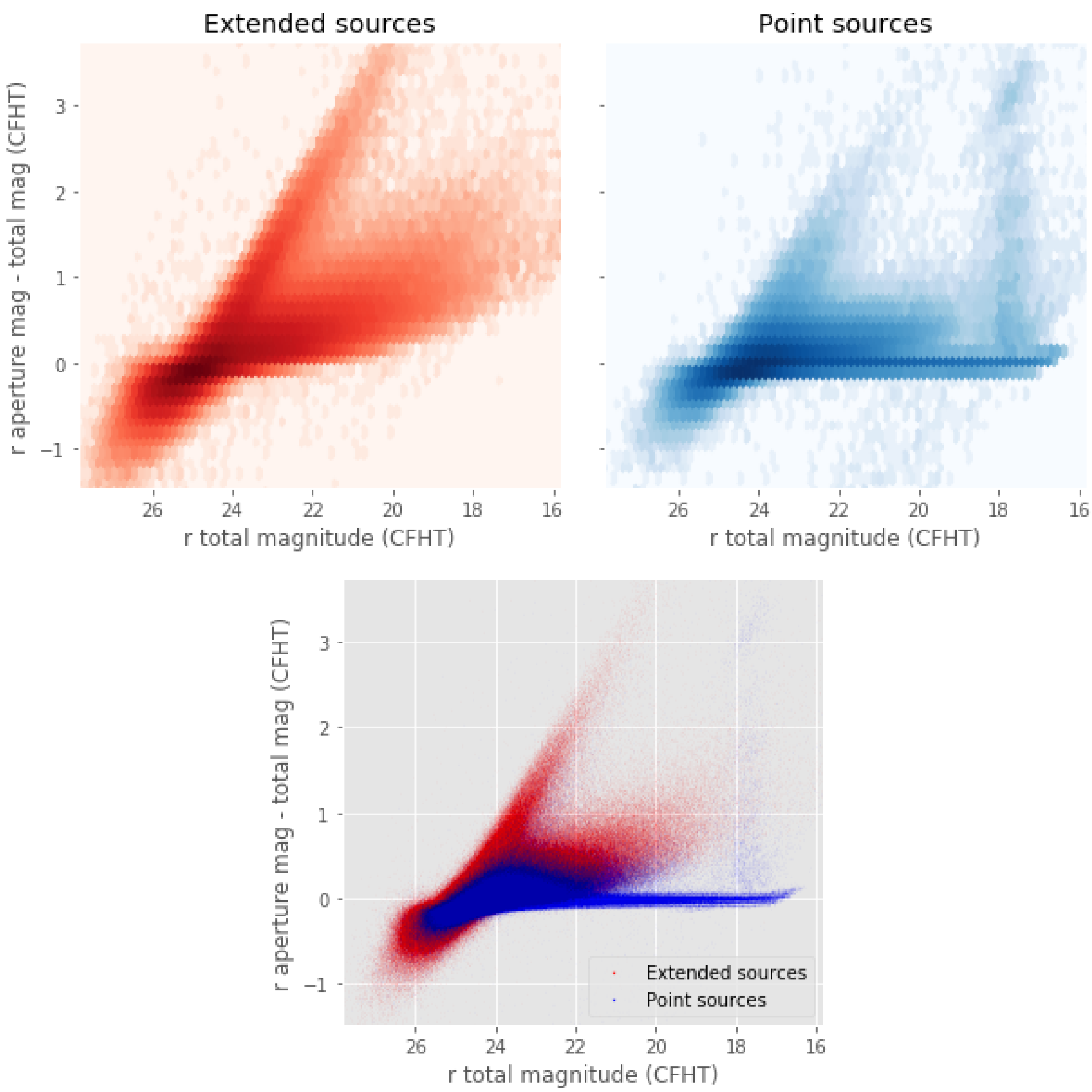
1.6 Keeping only sources with good signal to noise ratio

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.

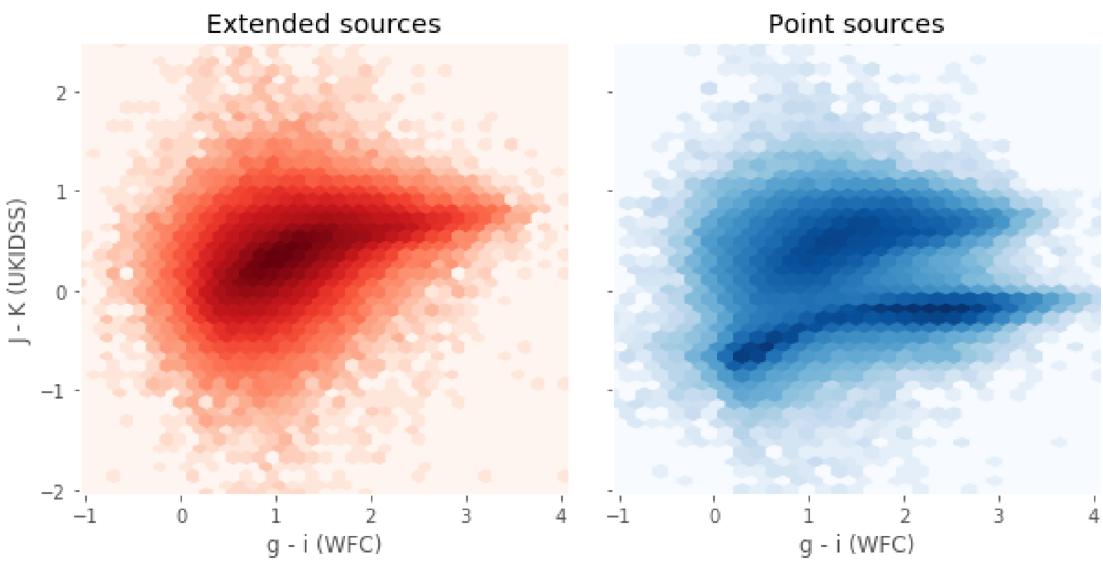
1.7 IV - Comparing aperture magnitudes to total ones.

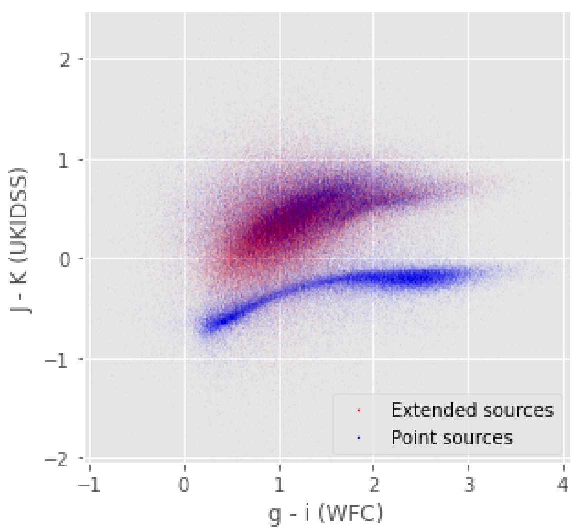
```
Number of source used: 1487261 / 4026292 (36.94%)
```



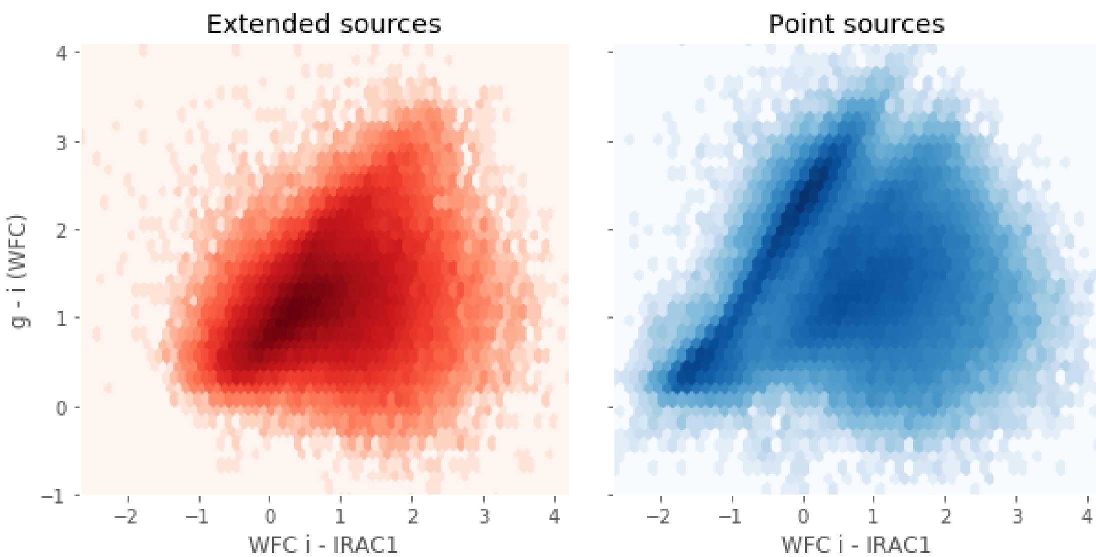
1.8 V - Color-color and magnitude-color plots

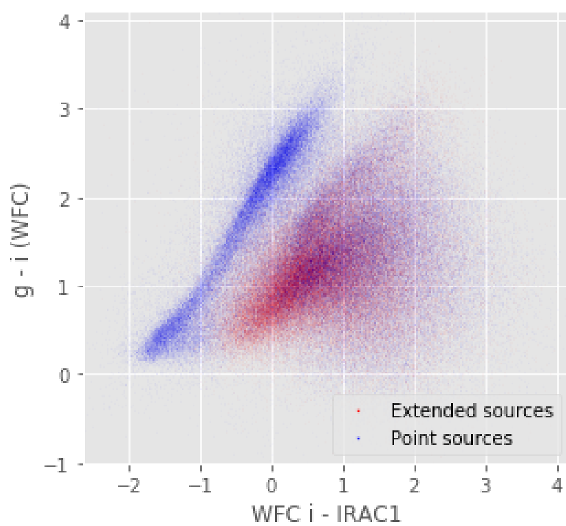
```
Number of source used: 239478 / 4026292 (5.95%)
```



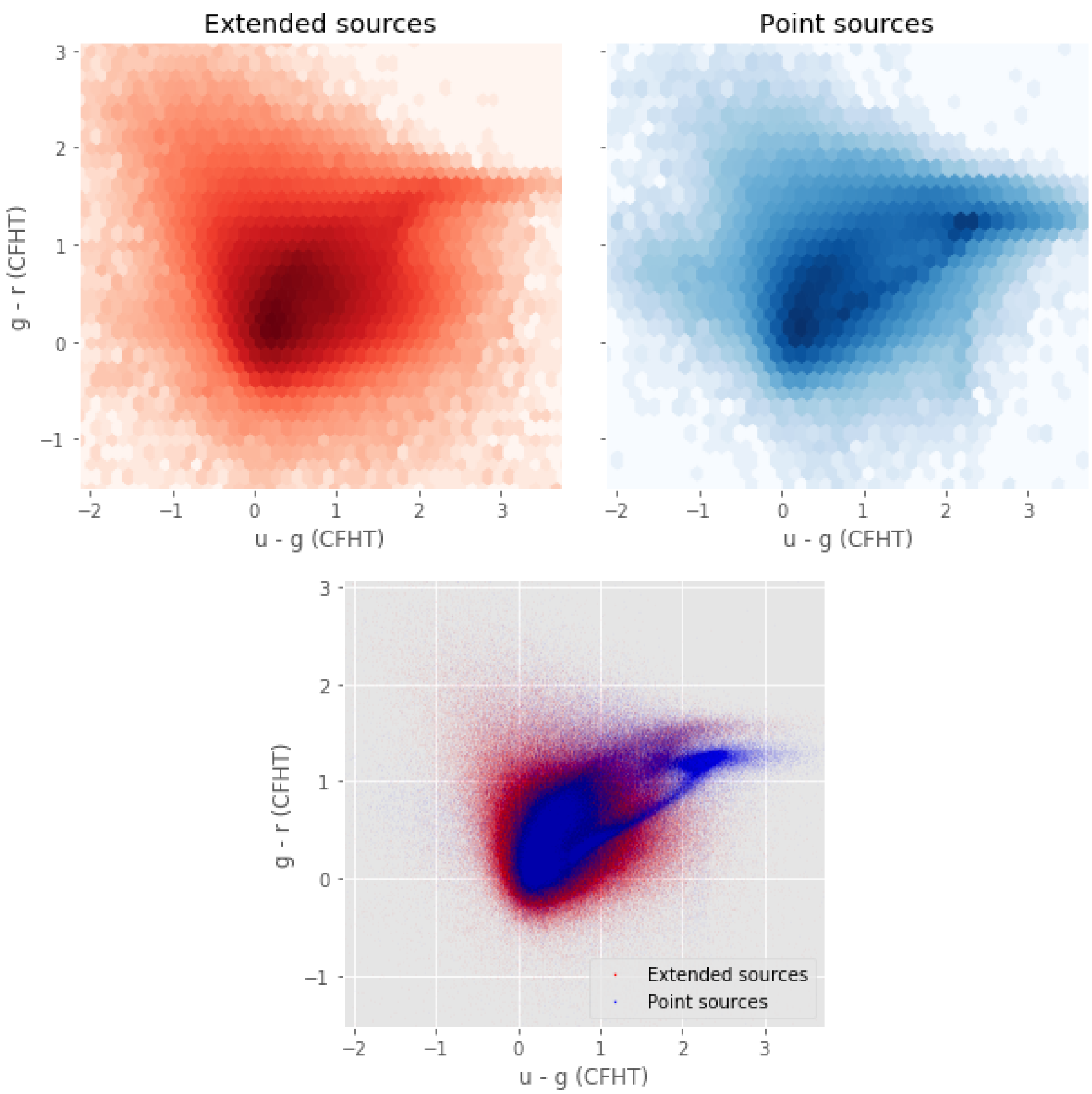


Number of source used: 222833 / 4026292 (5.53%)

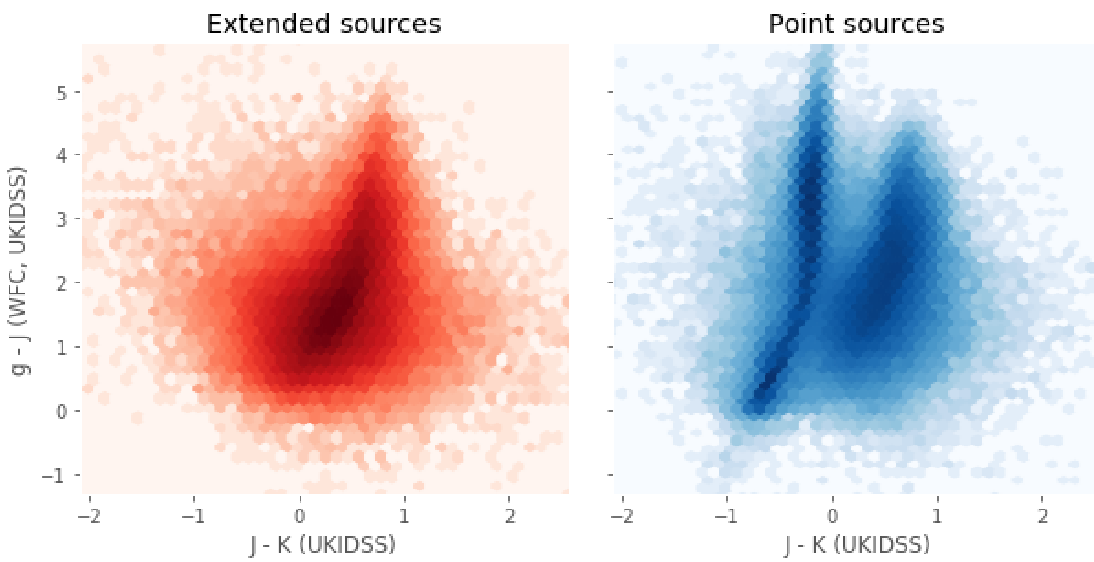


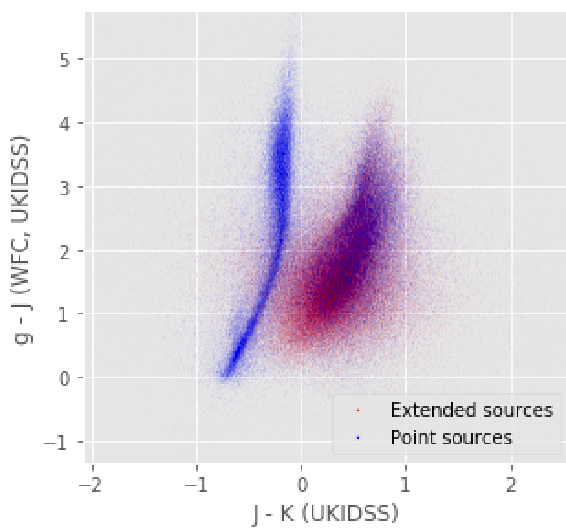


Number of source used: 1296100 / 4026292 (32.19%)

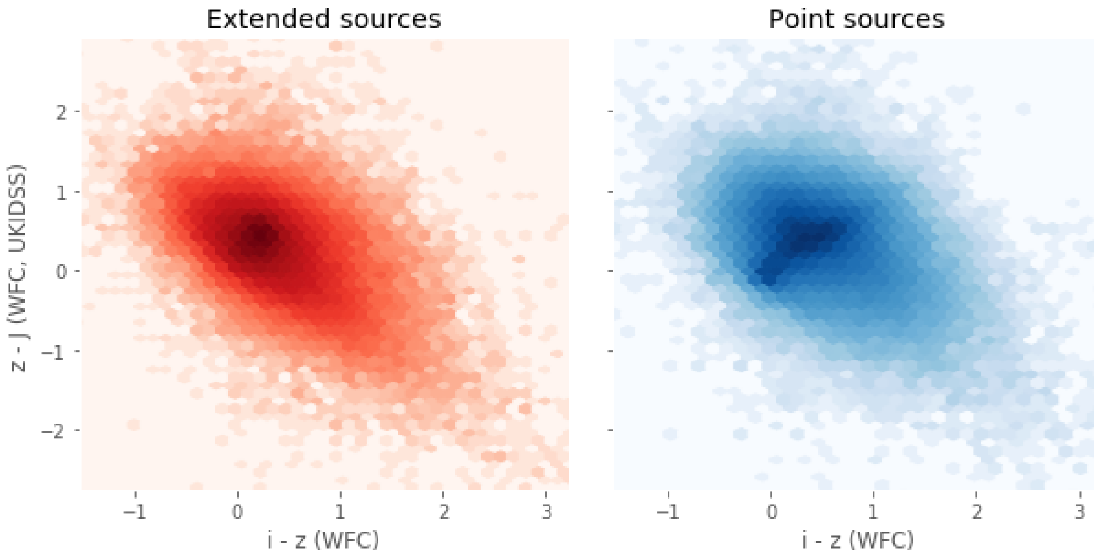


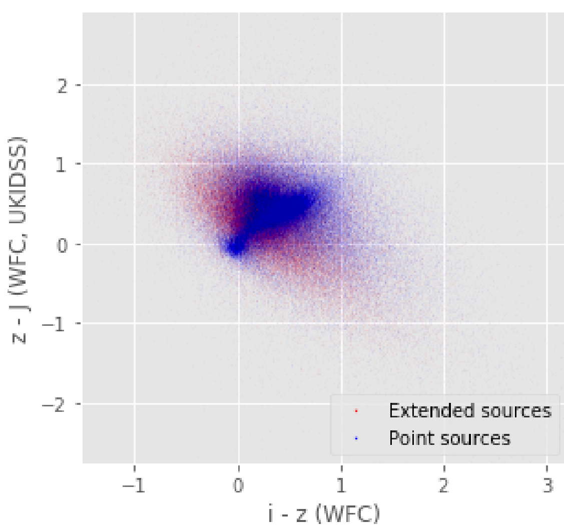
Number of source used: 272308 / 4026292 (6.76%)



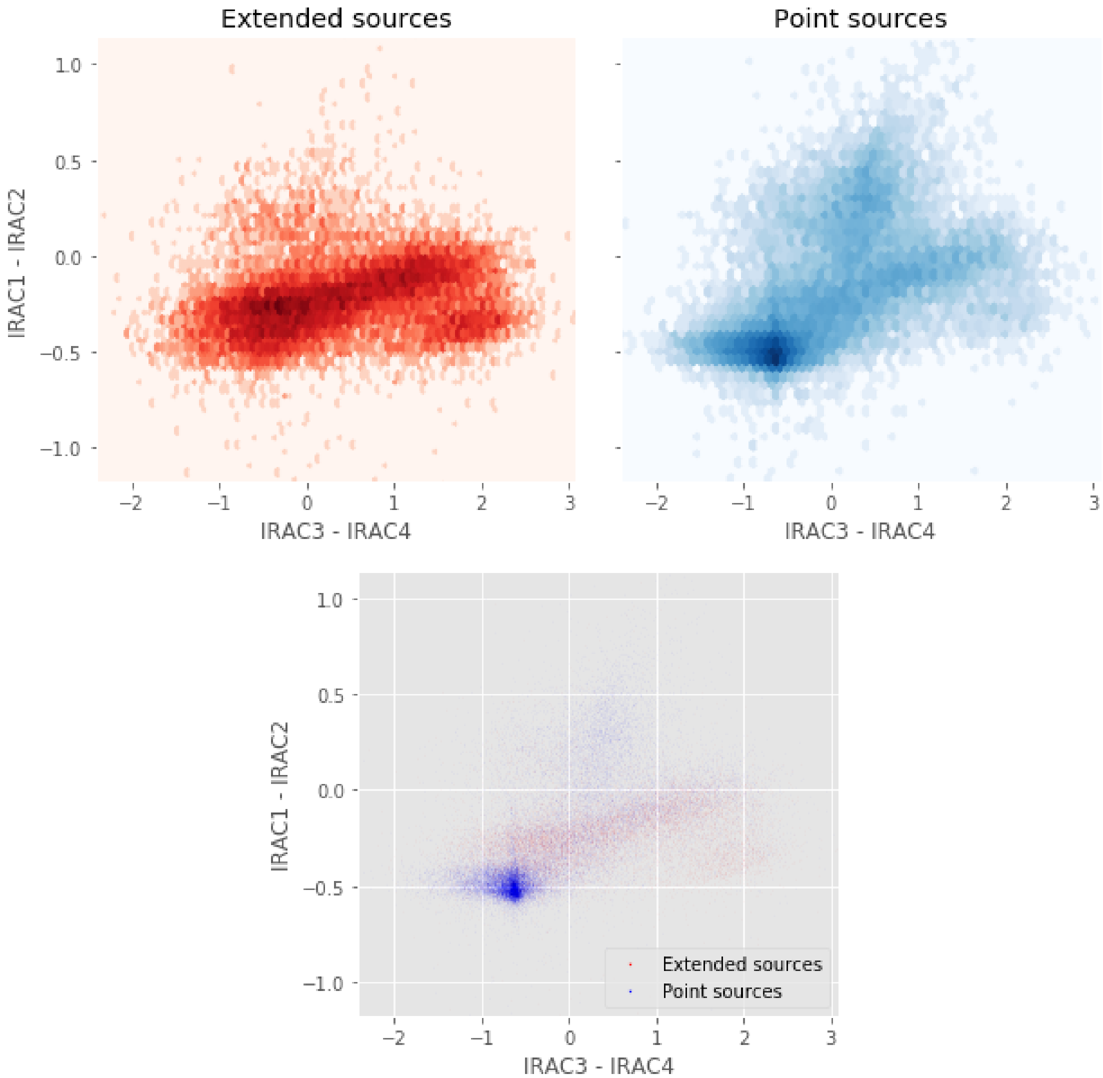



```
Number of source used: 214619 / 4026292 (5.33%)
```






```
Number of source used: 40827 / 4026292 (1.01%)
```


Extended sources
Point sources
IRAC1 - IRAC2
IRAC3 - IRAC4
1.0
0.5
0.0
−0.5
−1.0
−2
−1
0
1
2
3
Extended sources
Point sources

3.2_Flagging

March 8, 2018

1 ELAIS-N1 master catalogue: Flags

We create flags for spurious measurements based on the validation work that is described in 'dmu6/dmu6_v_ELAIS-N1'.

1.1 1. Magnitudes and magnitude erros

1.1.1 1.a Pan-STARRS Aperture and Total magnitude errors

```
GPC1 g
  Aperture magnitude
    Number of flagged objects: 107
  Total magnitude
    Number of flagged objects: 0
GPC1 r
  Aperture magnitude
    Number of flagged objects: 174
  Total magnitude
    Number of flagged objects: 4
GPC1 i
  Aperture magnitude
    Number of flagged objects: 150
  Total magnitude
    Number of flagged objects: 0
GPC1 z
  Aperture magnitude
    Number of flagged objects: 70
  Total magnitude
    Number of flagged objects: 1
GPC1 y
  Aperture magnitude
    Number of flagged objects: 37
  Total magnitude
    Number of flagged objects: 1
```

1.1.2 2.c IRAC Aperture magnitudes

```
IRAC i1
  Aperture magnitude
    Number of flagged objects: 0
IRAC i2
  Aperture magnitude
    Number of flagged objects: 0
IRAC i3
  Aperture magnitude
    Number of flagged objects: 0
IRAC i4
  Aperture magnitude
    Number of flagged objects: 0
```

1.2 2. Outliers

```
Megacam u (aperture) - WFC u (aperture):
  Number of outliers: 0
Megacam u (total) - WFC u (total):
  Number of outliers: 0
Megacam g (aperture) - WFC g (aperture):
  Number of outliers: 0
Megacam g (total) - WFC g (total):
  Number of outliers: 35
SUPRIME g (aperture) - WFC g (aperture):
  Number of outliers: 0
SUPRIME g (total) - WFC g (total):
  Number of outliers: 6
GPC1 g (aperture) - WFC g (aperture):
  Number of outliers: 0
GPC1 g (total) - WFC g (total):
  Number of outliers: 0
SUPRIME g (aperture) - Megacam g (aperture):
  Number of outliers: 1
SUPRIME g (total) - Megacam g (total):
  Number of outliers: 0
GPC1 g (aperture) - Megacam g (aperture):
  Number of outliers: 0
GPC1 g (total) - Megacam g (total):
  Number of outliers: 752
GPC1 g (aperture) - SUPRIME g (aperture):
  Number of outliers: 0
GPC1 g (total) - SUPRIME g (total):
  Number of outliers: 23
Megacam r (aperture) - WFC r (aperture):
  Number of outliers: 0
```

```
Megacam r (total) - WFC r (total):
  Number of outliers: 22
SUPRIME r (aperture) - WFC r (aperture):
  Number of outliers: 0
SUPRIME r (total) - WFC r (total):
  Number of outliers: 6
GPC1 r (aperture) - WFC r (aperture):
  Number of outliers: 0
GPC1 r (total) - WFC r (total):
  Number of outliers: 0
SUPRIME r (aperture) - Megacam r (aperture):
  Number of outliers: 0
SUPRIME r (total) - Megacam r (total):
  Number of outliers: 0
GPC1 r (aperture) - Megacam r (aperture):
  Number of outliers: 0
GPC1 r (total) - Megacam r (total):
  Number of outliers: 584
GPC1 r (aperture) - SUPRIME r (aperture):
  Number of outliers: 0
GPC1 r (total) - SUPRIME r (total):
  Number of outliers: 31
SUPRIME i (aperture) - WFC i (aperture):
  Number of outliers: 0
SUPRIME i (total) - WFC i (total):
  Number of outliers: 0
GPC1 i (aperture) - WFC i (aperture):
  Number of outliers: 0
GPC1 i (total) - WFC i (total):
  Number of outliers: 0
GPC1 i (aperture) - SUPRIME i (aperture):
  Number of outliers: 0
GPC1 i (total) - SUPRIME i (total):
  Number of outliers: 161
Megacam z (aperture) - WFC z (aperture):
  Number of outliers: 0
Megacam z (total) - WFC z (total):
  Number of outliers: 0
SUPRIME z (aperture) - WFC z (aperture):
  Number of outliers: 0
SUPRIME z (total) - WFC z (total):
  Number of outliers: 0
GPC1 z (aperture) - WFC z (aperture):
  Number of outliers: 0
GPC1 z (total) - WFC z (total):
  Number of outliers: 0
SUPRIME z (aperture) - Megacam z (aperture):
  Number of outliers: 6
```

```
SUPRIME z (total) - Megacam z (total):
  Number of outliers: 0
GPC1 z (aperture) - Megacam z (aperture):
  Number of outliers: 0
GPC1 z (total) - Megacam z (total):
  Number of outliers: 1
GPC1 z (aperture) - SUPRIME z (aperture):
  Number of outliers: 0
GPC1 z (total) - SUPRIME z (total):
  Number of outliers: 28
GPC1 y (aperture) - SUPRIME y (aperture):
  Number of outliers: 0
GPC1 y (total) - SUPRIME y (total):
  Number of outliers: 9
```

1.3 3. Save table

4_Selection_function

March 8, 2018

1 ELAIS-N1 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 19:30:48.376011


Depth maps produced using: master_catalogue_elais-n1_20180216.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

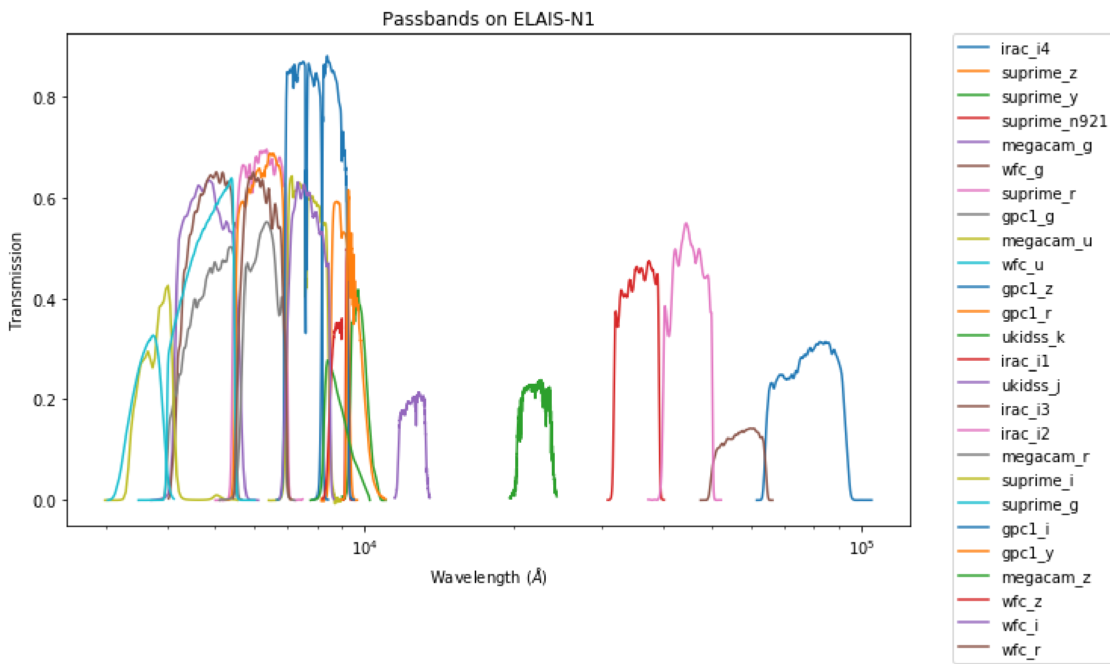
1.5 IV - Overview plots

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_r',
          'megacam_u',
          'megacam_z',
          'suprime_g',
          'suprime_i',
          'suprime_n921',
          'suprime_r',
          'suprime_y',
          'suprime_z',
          'ukidss_j',
          'ukidss_k',
          'wfc_g',
          'wfc_i',
          'wfc_r',
          'wfc_u',
          'wfc_z'}
```

```
Out[15]: <matplotlib.text.Text at 0x7fb46b860a90>
```



1.5.2 IV.a - Depth overview

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

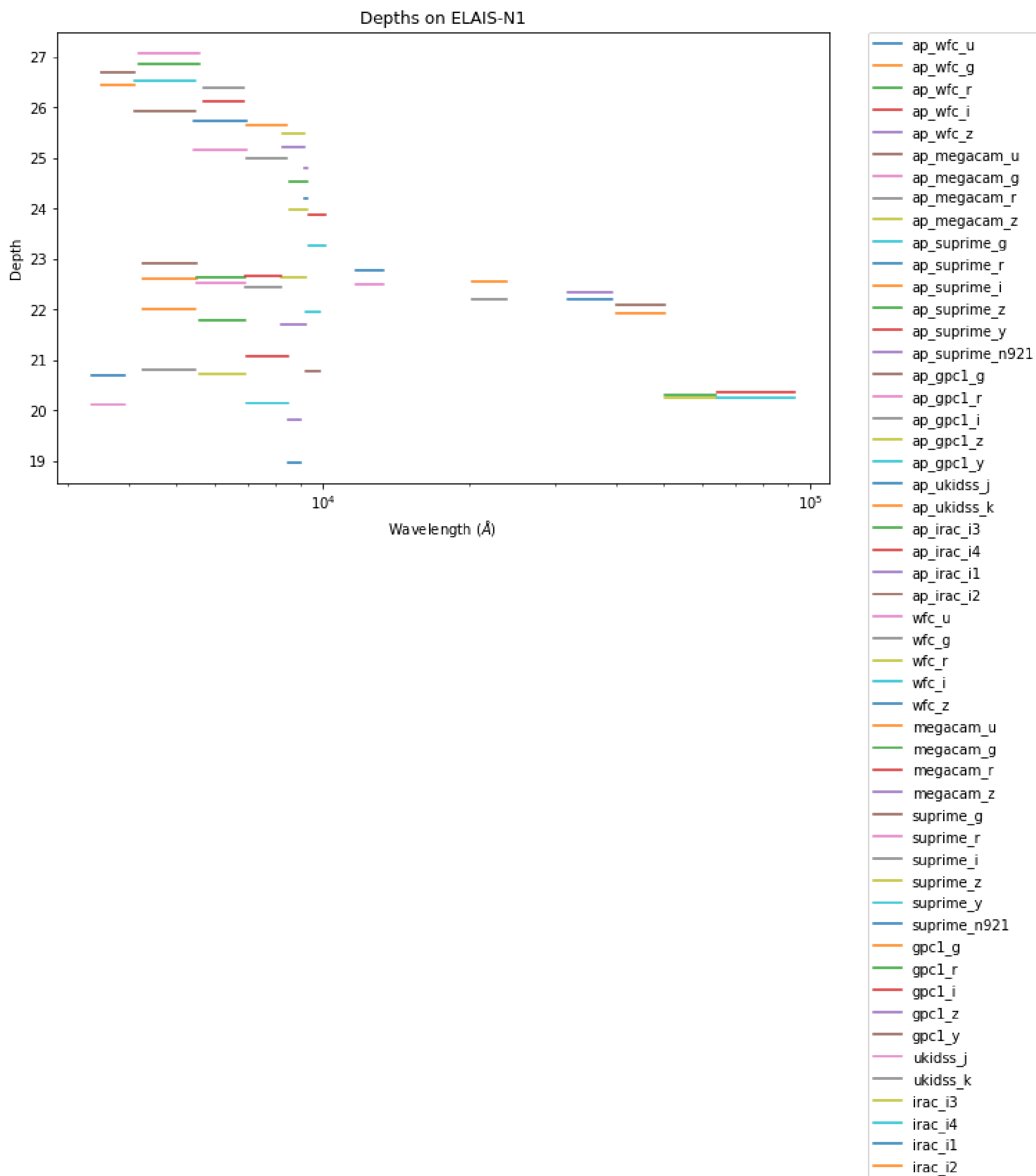
```
wfc_u: mean flux error: 3.872959613800049, 3sigma in AB mag (Aperture): 21.237089442446994
wfc_g: mean flux error: 1.1581119298934937, 3sigma in AB mag (Aperture): 22.547820524769882
wfc_r: mean flux error: 1.3853583335876465, 3sigma in AB mag (Aperture): 22.353291559353814
wfc_i: mean flux error: 2.7208027839660645, 3sigma in AB mag (Aperture): 21.6204542049471
wfc_z: mean flux error: 8.639183044433594, 3sigma in AB mag (Aperture): 20.366015173690393
megacam_u: mean flux error: 0.015346758998930454, 3sigma in AB mag (Aperture): 27.24215518036104
megacam_g: mean flux error: 0.010630748234689236, 3sigma in AB mag (Aperture): 27.64078728073534
megacam_r: mean flux error: 0.02017063833773136, 3sigma in AB mag (Aperture): 26.945397756963963
megacam_z: mean flux error: 0.04632145166397095, 3sigma in AB mag (Aperture): 26.042741460076122
suprime_g: mean flux error: 0.017699670046567917, 3sigma in AB mag (Aperture): 27.08728393716786
suprime_r: mean flux error: 0.0368429459631443, 3sigma in AB mag (Aperture): 26.291310990415887
suprime_i: mean flux error: 0.03992707282304764, 3sigma in AB mag (Aperture): 26.204028183469866
suprime_z: mean flux error: 0.11153997480869293, 3sigma in AB mag (Aperture): 25.088620508025507
suprime_y: mean flux error: 0.2042379379272461, 3sigma in AB mag (Aperture): 24.43185582070776
suprime_n921: mean flux error: 0.08668216317892075, 3sigma in AB mag (Aperture): 25.362372511376
gpc1_g: mean flux error: 0.4933097067663101, 3sigma in AB mag (Aperture): 23.474397710499424
gpc1_r: mean flux error: 0.7110018166369104, 3sigma in AB mag (Aperture): 23.07752008727524
gpc1_i: mean flux error: 0.7608664428843172, 3sigma in AB mag (Aperture): 23.003925787006317
gpc1_z: mean flux error: 0.6403589513712824, 3sigma in AB mag (Aperture): 23.191138151289415
gpc1_y: mean flux error: 1.1902217030338118, 3sigma in AB mag (Aperture): 22.518127200399796
ukidss_j: mean flux error: 0.5700793862342834, 3sigma in AB mag (Aperture): 23.317358519621216
ukidss_k: mean flux error: 0.6988920569419861, 3sigma in AB mag (Aperture): 23.096171601570823
```

```
irac_i3: mean flux error: 5.459272512170424, 3sigma in AB mag (Aperture): 20.86435992905806
irac_i4: mean flux error: 5.247558880937489, 3sigma in AB mag (Aperture): 20.907303562347842
irac_i1: mean flux error: 0.8456647695259187, 3sigma in AB mag (Aperture): 22.88920126765324
irac_i2: mean flux error: 1.07199636201014, 3sigma in AB mag (Aperture): 22.631713584420915
wfc_u: mean flux error: 6.57121467590332, 3sigma in AB mag (Total): 20.663082724581848
wfc_g: mean flux error: 3.470693349838257, 3sigma in AB mag (Total): 21.35615625408446
wfc_r: mean flux error: 3.742569923400879, 3sigma in AB mag (Total): 21.274272055383584
wfc_i: mean flux error: 6.332812786102295, 3sigma in AB mag (Total): 20.7032052397552
wfc_z: mean flux error: 18.854872976726085, 3sigma in AB mag (Total): 19.51863783581144
megacam_u: mean flux error: 0.019194457679986954, 3sigma in AB mag (Total): 26.99925724801367
megacam_g: mean flux error: 0.013056717813014984, 3sigma in AB mag (Total): 27.41761181802847
megacam_r: mean flux error: 0.02592267468571663, 3sigma in AB mag (Total): 26.67299733882725
megacam_z: mean flux error: 0.059888094663619995, 3sigma in AB mag (Total): 25.763845622577442
suprime_g: mean flux error: 0.0314384400844574, 3sigma in AB mag (Total): 26.463544390609336
suprime_r: mean flux error: 0.06283748149871826, 3sigma in AB mag (Total): 25.7116499372845
suprime_i: mean flux error: 0.07284048199653625, 3sigma in AB mag (Total): 25.55126483588844
suprime_z: mean flux error: 0.1884584128856659, 3sigma in AB mag (Total): 24.519158039802456
suprime_y: mean flux error: 0.36173444986343384, 3sigma in AB mag (Total): 23.811222186035913
suprime_n921: mean flux error: 0.15131063759326935, 3sigma in AB mag (Total): 24.757523209936345
gpc1_g: mean flux error: 0.6512263438058604, 3sigma in AB mag (Total): 23.17286696174542
gpc1_r: mean flux error: 0.640081019076807, 3sigma in AB mag (Total): 23.191609491088677
gpc1_i: mean flux error: 0.6296337885319795, 3sigma in AB mag (Total): 23.209476798546127
gpc1_z: mean flux error: 1.4999945074438719, 3sigma in AB mag (Total): 22.266972691213617
gpc1_y: mean flux error: 3.5347169176582893, 3sigma in AB mag (Total): 21.336310266964553
ukidss_j: mean flux error: 0.7292241454124451, 3sigma in AB mag (Total): 23.05004426272999
ukidss_k: mean flux error: 0.9628473520278931, 3sigma in AB mag (Total): 22.748303262281404
irac_i3: mean flux error: 5.6906116325004295, 3sigma in AB mag (Total): 20.819299494952894
irac_i4: mean flux error: 5.713443720848662, 3sigma in AB mag (Total): 20.8149519786871
irac_i1: mean flux error: 0.9701811686811482, 3sigma in AB mag (Total): 22.74006476152551
irac_i2: mean flux error: 1.2349660110246135, 3sigma in AB mag (Total): 22.478059350643996
```

```
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_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_suprime_g (4090.0, 5460.0, 1370.0)
ap_suprime_r (5440.0, 6960.0, 1520.0)
ap_suprime_i (6980.0, 8420.0, 1440.0)
ap_suprime_z (8540.0, 9280.0, 740.0)
ap_suprime_y (9360.0, 10120.0, 760.0)
ap_suprime_n921 (9146.5, 9279.0, 132.5)
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_ukidss_j (11695.0, 13280.0, 1585.0)
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)
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)
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)
suprime_g (4090.0, 5460.0, 1370.0)
suprime_r (5440.0, 6960.0, 1520.0)
suprime_i (6980.0, 8420.0, 1440.0)
suprime_z (8540.0, 9280.0, 740.0)
suprime_y (9360.0, 10120.0, 760.0)
suprime_n921 (9146.5, 9279.0, 132.5)
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)
ukidss_j (11695.0, 13280.0, 1585.0)
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)
```

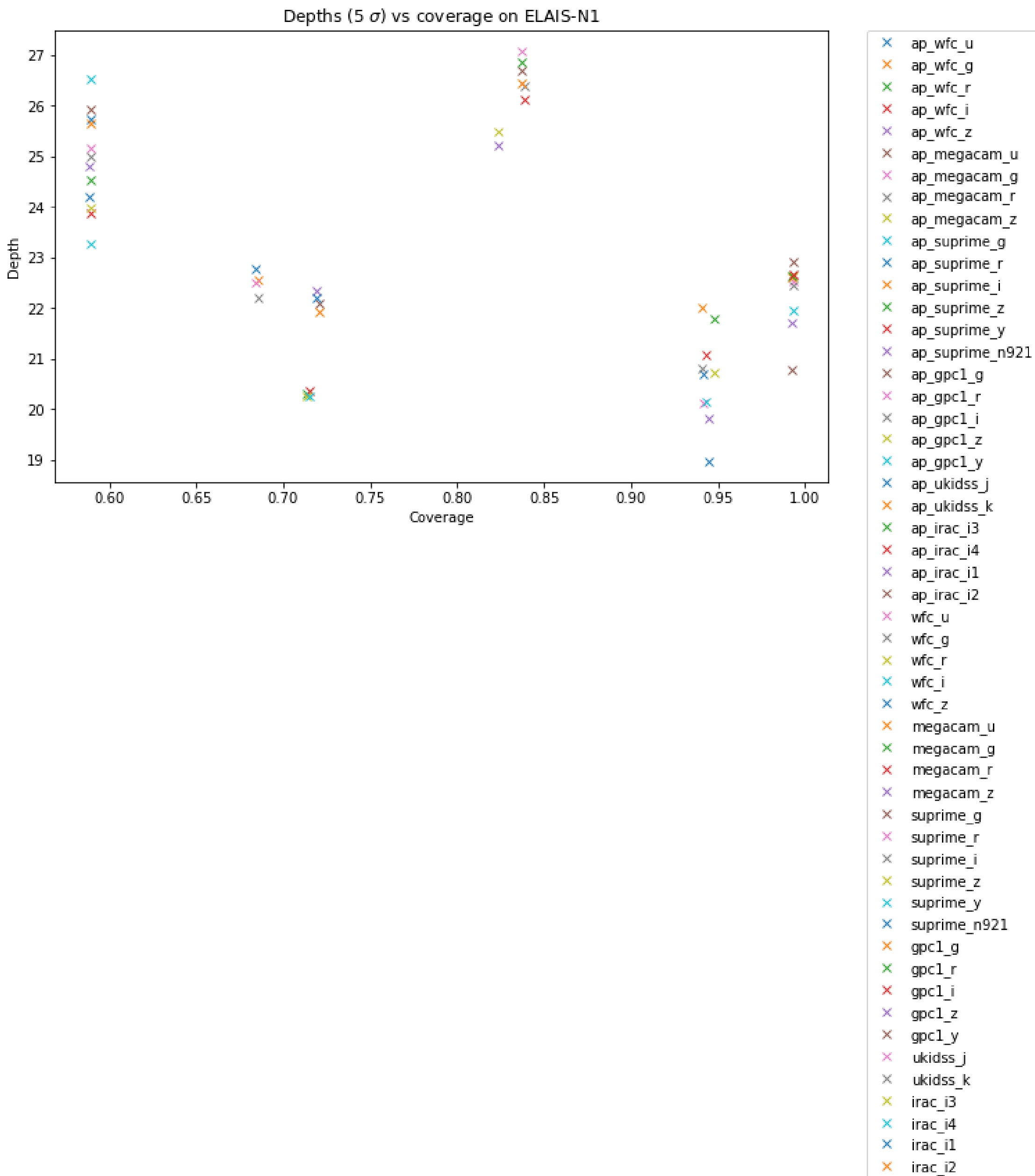
```
Out[20]: <matplotlib.text.Text at 0x7fb46b5dc668>
```



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 0x7fb4699fb320>
```


Depths (5 σ) vs coverage on ELAIS-N1
Depth
Coverage
27
26
25
24
23
22
21
20
19
0.60
0.65
0.70
0.75
0.80
0.85
0.90
0.95
1.00
ap_wfc_u
ap_wfc_g
ap_wfc_r
ap_wfc_i
ap_wfc_z
ap_megacam_u
ap_megacam_g
ap_megacam_r
ap_megacam_z
ap_suprime_g
ap_suprime_r
ap_suprime_i
ap_suprime_z
ap_suprime_y
ap_suprime_n921
ap_gpc1_g
ap_gpc1_r
ap_gpc1_i
ap_gpc1_z
ap_gpc1_y
ap_ukidss_j
ap_ukidss_k
ap_irac_i3
ap_irac_i4
ap_irac_i1
ap_irac_i2
wfc_u
wfc_g
wfc_r
wfc_i
wfc_z
megacam_u
megacam_g
megacam_r
megacam_z
suprime_g
suprime_r
suprime_i
suprime_z
suprime_y
suprime_n921
gpc1_g
gpc1_r
gpc1_i
gpc1_z
gpc1_y
ukidss_j
ukidss_k
irac_i3
irac_i4
irac_i1
irac_i2

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March 8, 2018

1 ELAIS-N1 master list creation

This folder contains the Jupyter notebooks used to create HELP mater list on ELAIS-N1.

1.1 Pristine catalogue preparations

For each pristine catalogue, a specific notebook is used for its preparation: the selection of columns, the conversion of some magnitudes or fluxes when needed, the removal of duplicated sources, the correction of astrometry using Gaia as reference, and the flagging of possible Gaia objects.

- `1.1_INT-WFC.html` for Isaac Newton Telescope / Wide Field Camera (INT/WFC) data
- `1.2_UKIDSS-DXS.html` for UKIRT Infrared Deep Sky Survey / Deep Extragalactic Survey (UKIDSS/DXS) data
- `1.3_HSC-SSP.html` for Hyper Suprime-Cam Subaru Strategic Program Catalogues (HSC-SSP) data
- `1.4_PanSTARRS-3SS.html` for Pan-STARRS1 - 3pi Steradian Survey (3SS) data
- `1.5_SpARCS.html` for Spitzer Adaptation of the Red-sequence Cluster Survey (SpARCS) data
- `1.6_SERVS.html` for Spitzer datafusion SERVS data
- `1.7_SWIRE.html` for Spitzer datafusion SWIRE data

1.2 Catalogue merging

The `2_Merging.html` notebook performs the merging of the pristine catalogues into the master list.

1.3 Diagnostics

The `3_Checks_and_diagnostics.html` notebook presents some checks and diagnostic plots on the final master list.