1.1_INT-WFC

March 8, 2018

1 ELAIS-N2 master catalogue

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

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

In the catalogue, we keep:

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

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

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

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:8: R
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:9: R
```

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

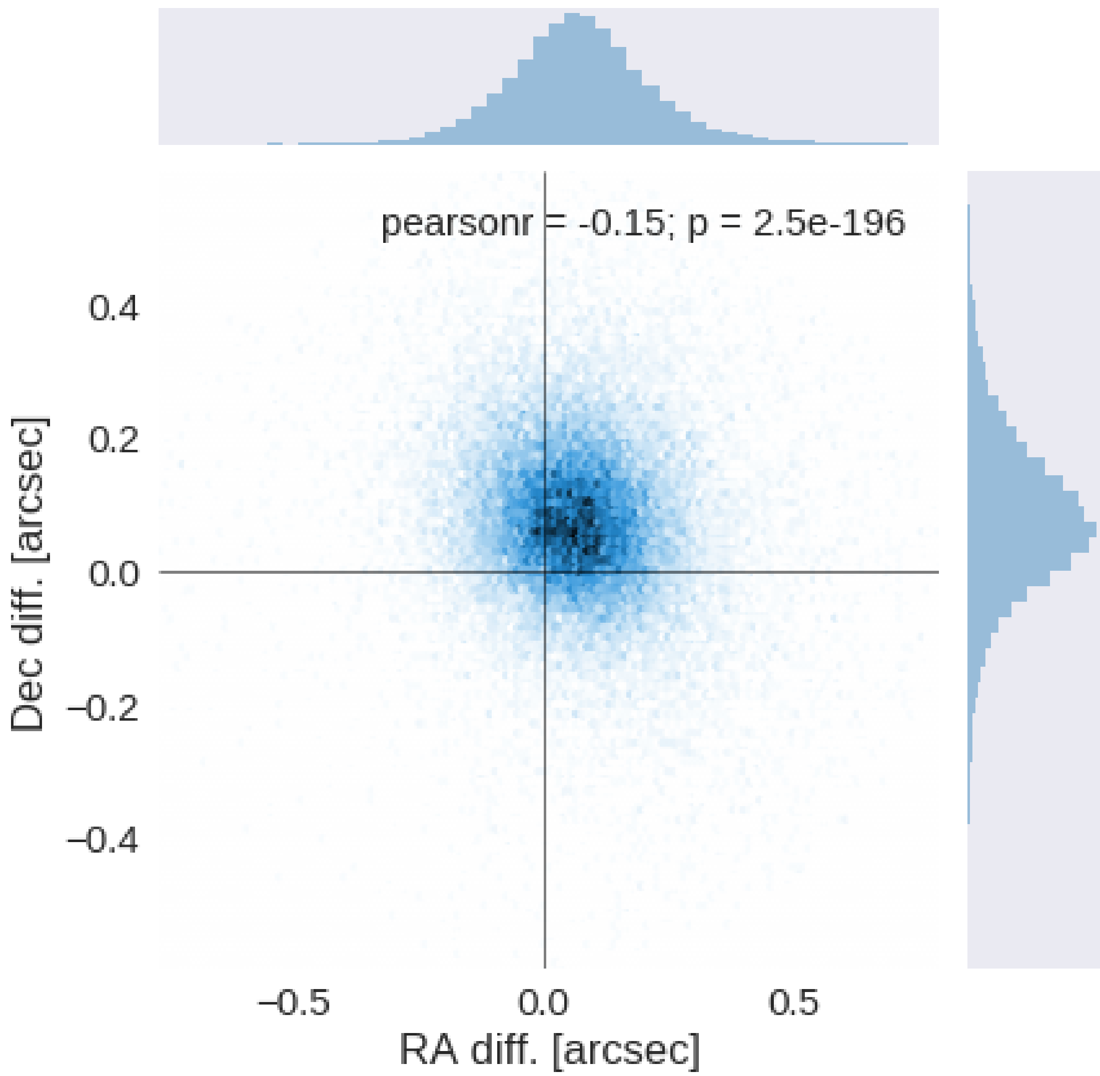
1.3 II - Removal of duplicated sources

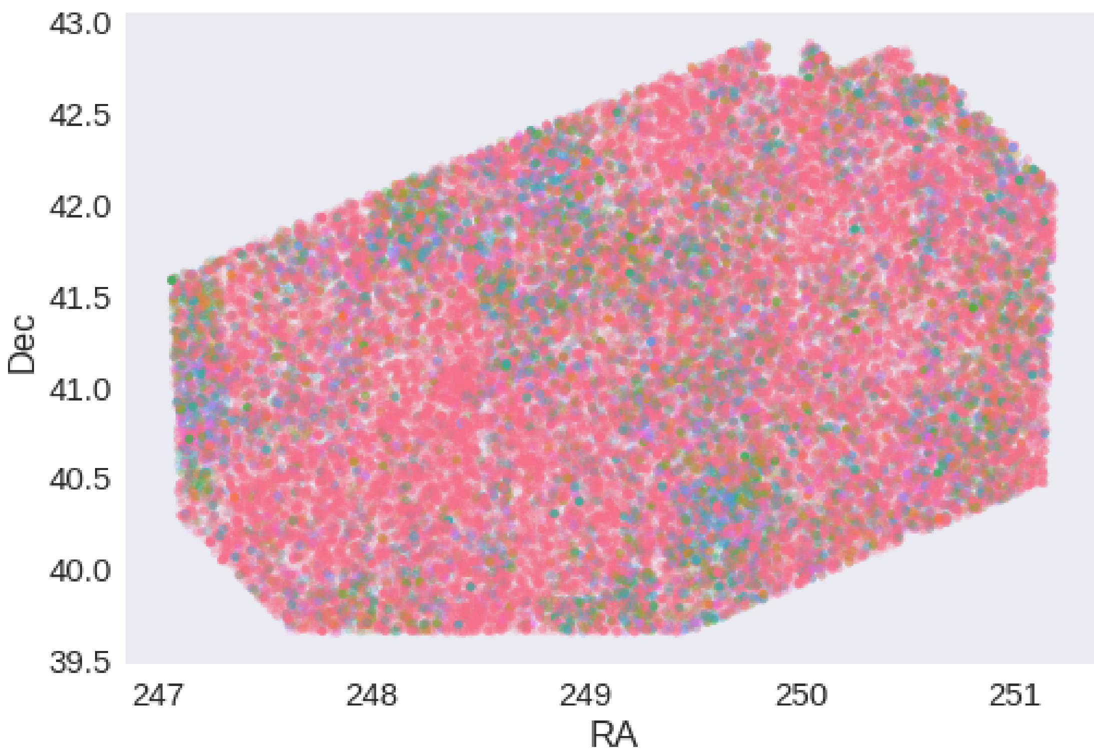
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 824958 sources.
The cleaned catalogue has 824957 sources (1 removed).
The cleaned catalogue has 1 sources flagged as having been cleaned
```

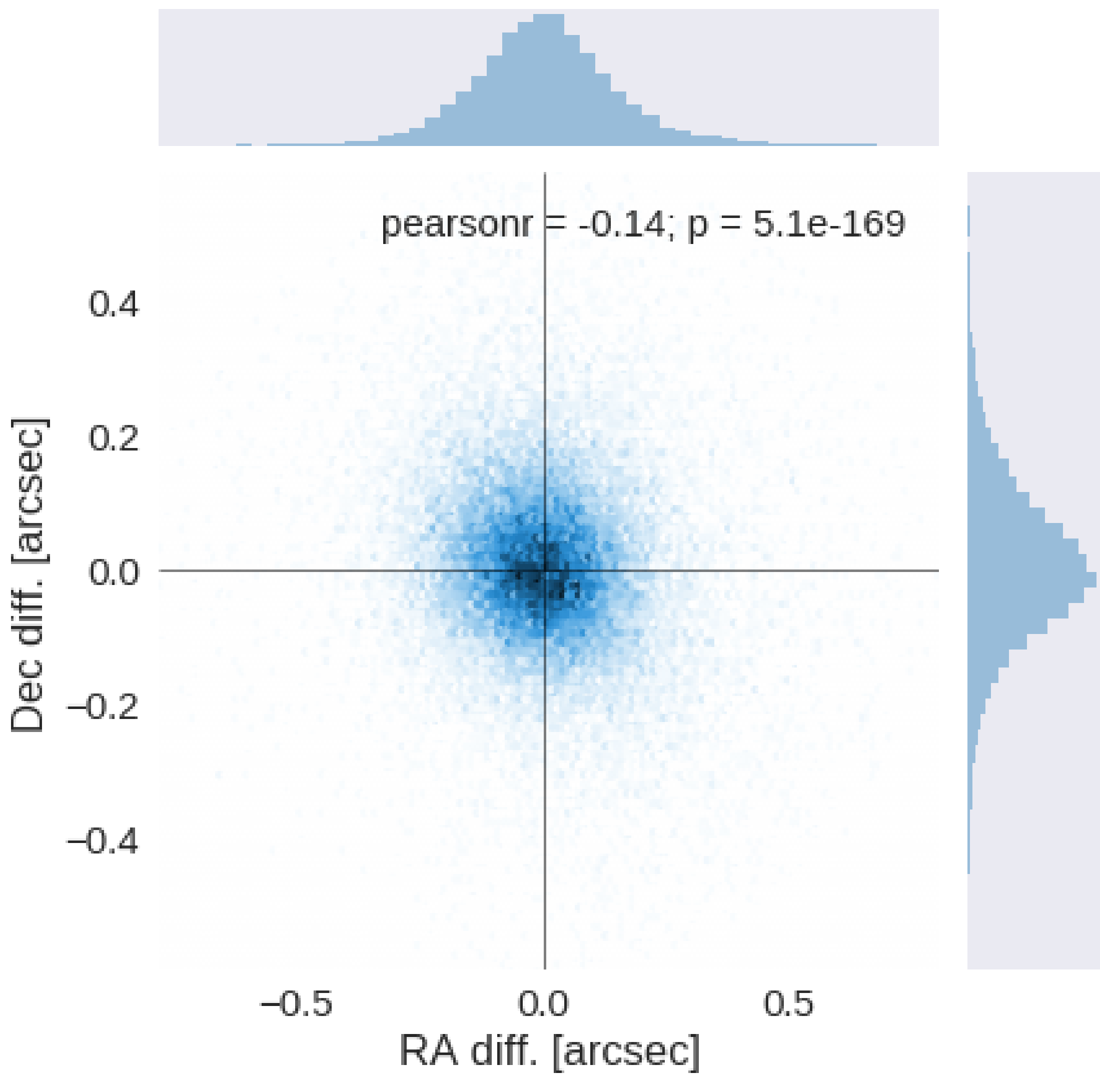
1.4 III - Astrometry correction

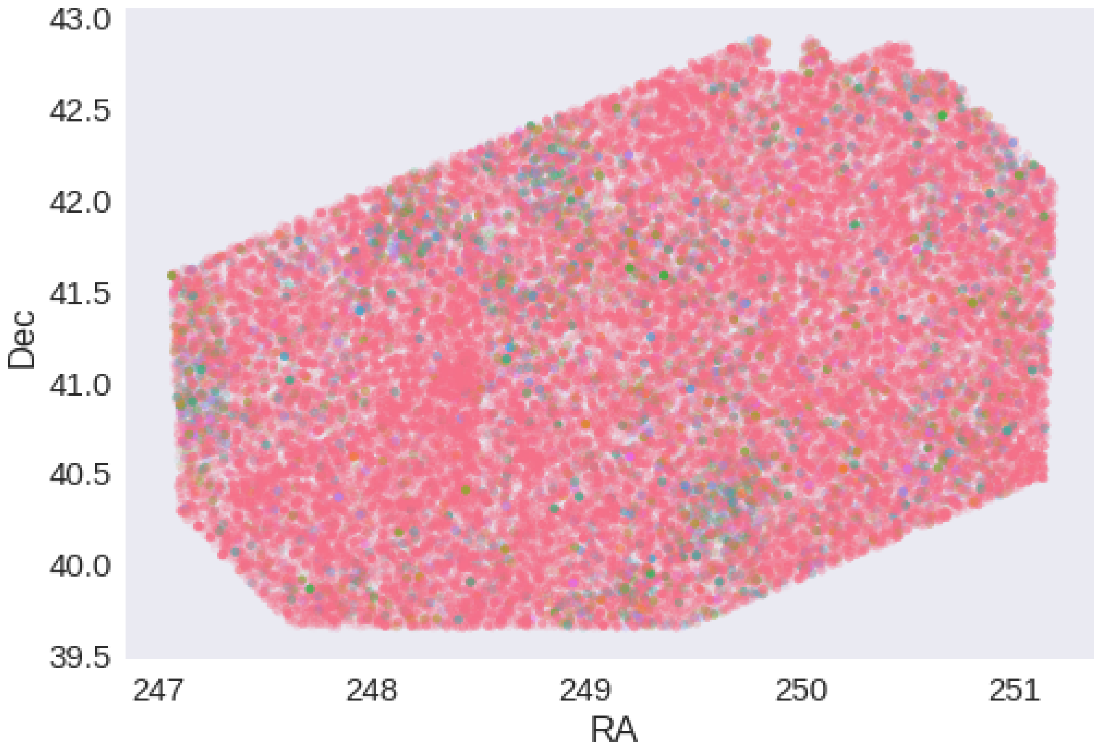
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.06821421482072765 arcsec
Dec correction: -0.07353264348779476 arcsec
```


pearsonr = -0.14; p = 5.1e-169
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

```
52708 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.2_RCSLenS

March 8, 2018

1 ELAIS N2 master catalogue

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

This catalogue comes from `dmu0_RCSLenS`.

In the catalogue, we keep:

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

1.1.1 Strange magnitudes

The missing values seems to be encoded as -99. but there are also quite some 99. magnitudes. The “sensible” range of magnitudes seems to go from 14 to 37 (depending on the bands and given that 37 is really faint and may not be reliable). In addition to that there are some very low magnitudes under -40. and very high ones above 90. We don’t know the meaning of these extreme values so we are removing all the negative magnitudes and and those above 80. We are also removing the sources for which we have no magnitude information given the modifications above.

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

1.2 I - Column selection

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

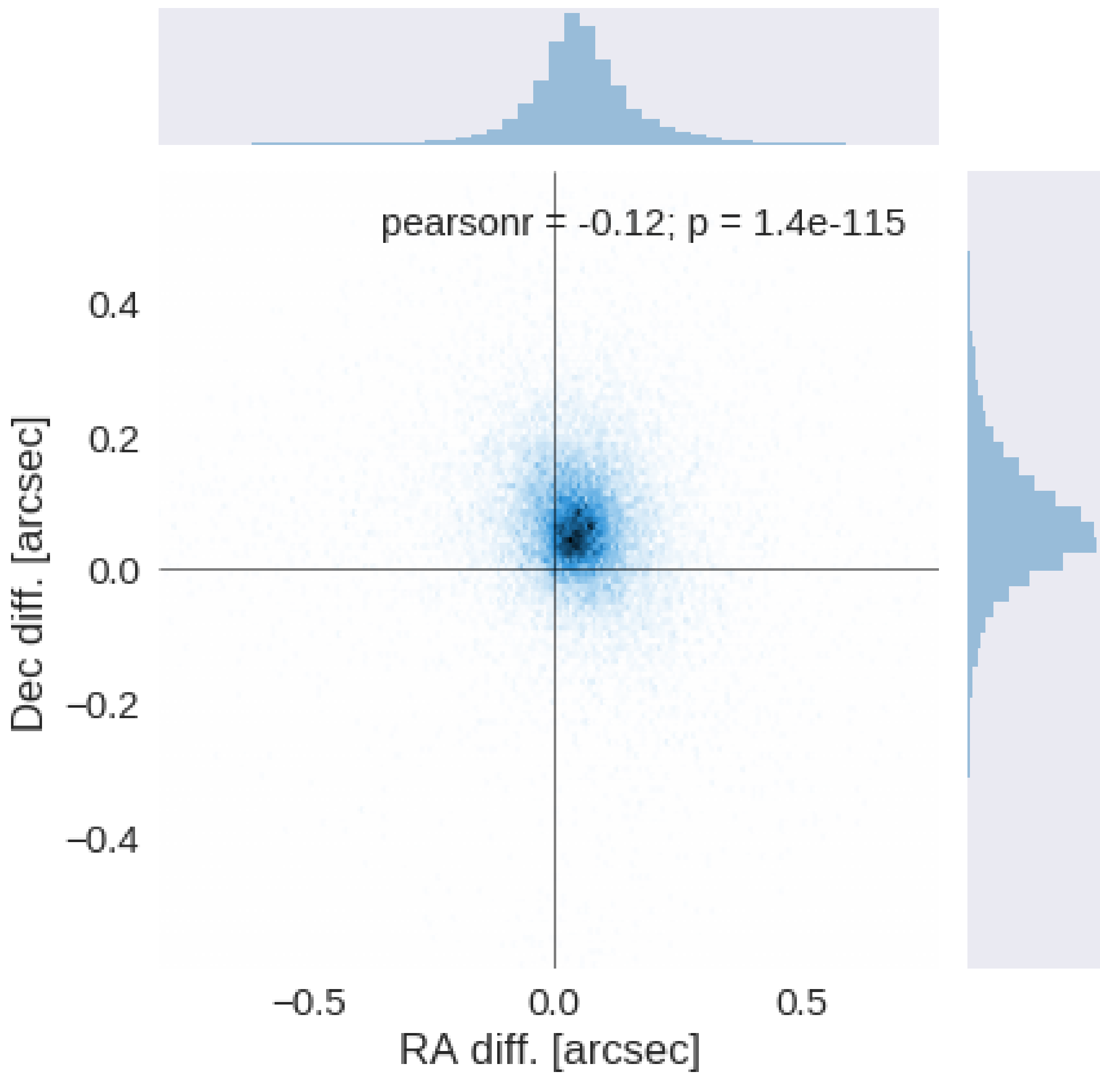
1.3 II - Removal of duplicated sources

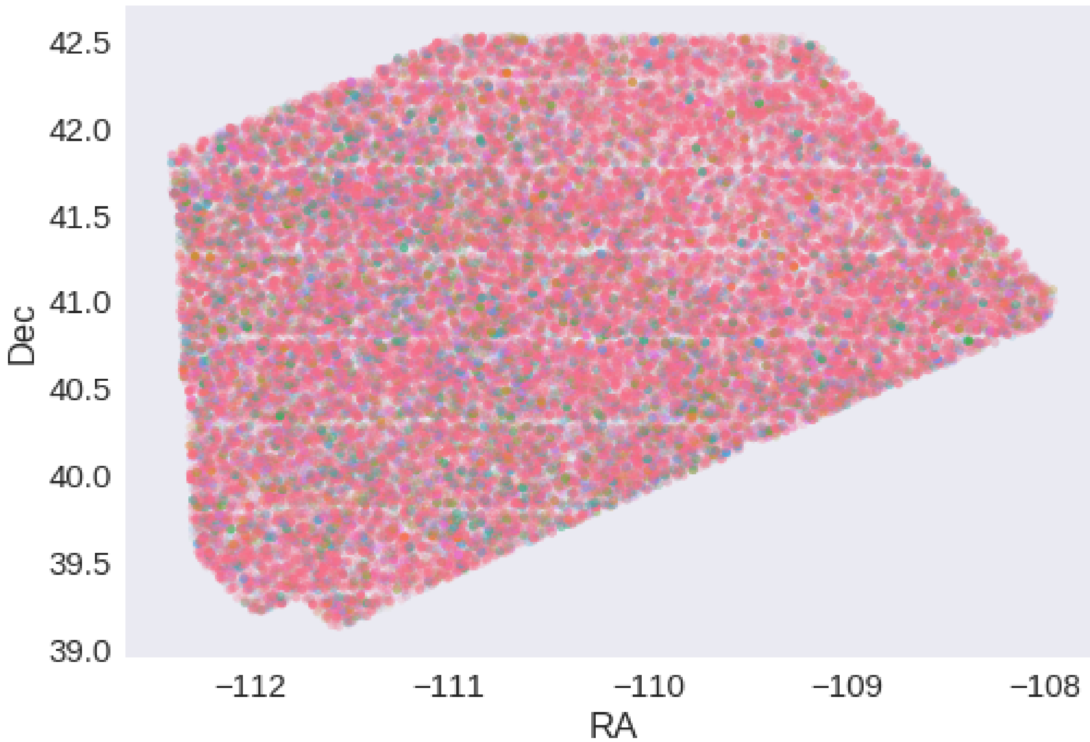
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 1086082 sources.
The cleaned catalogue has 1066558 sources (19524 removed).
The cleaned catalogue has 19420 sources flagged as having been cleaned
```

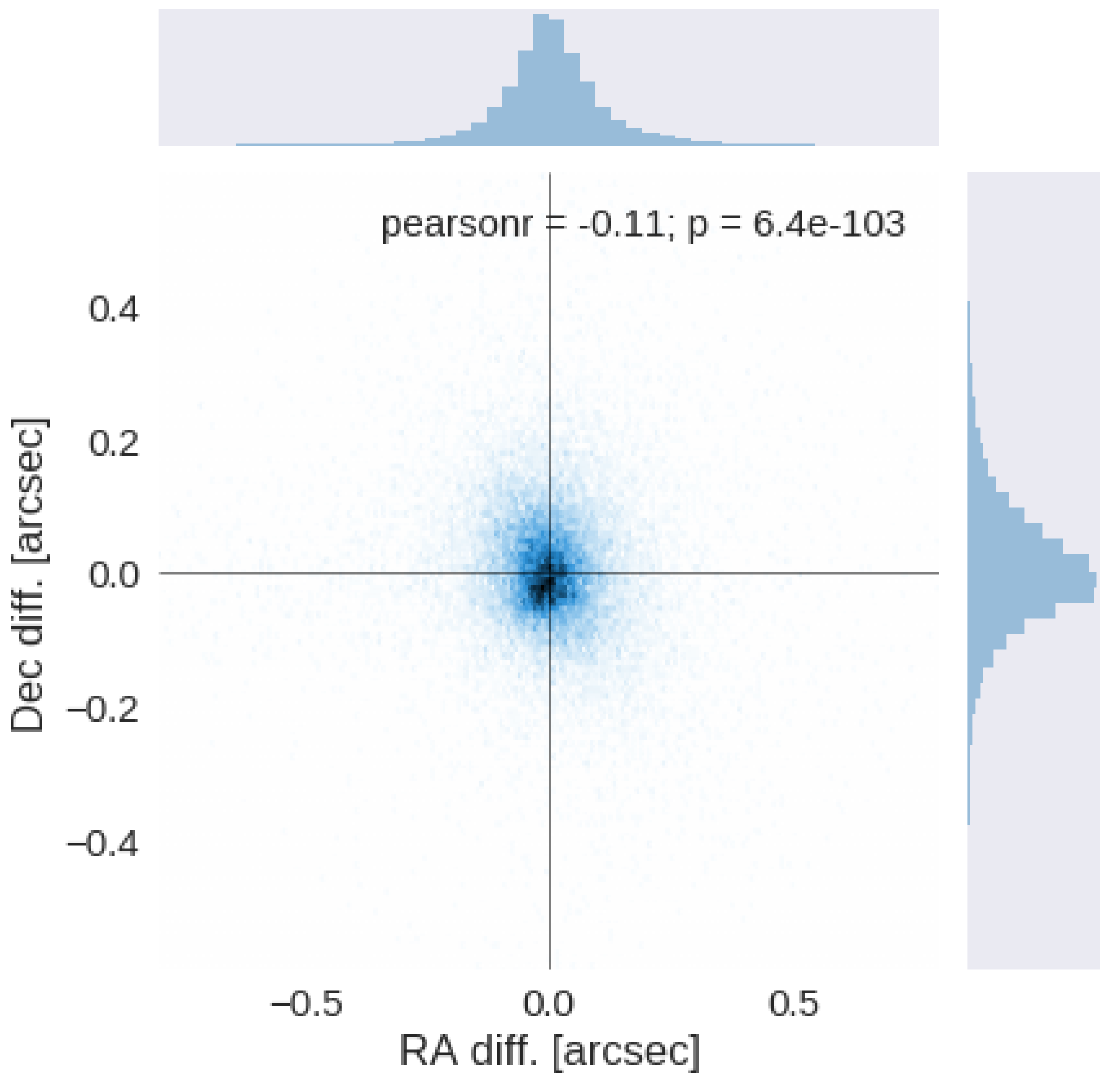
1.4 III - Astrometry correction

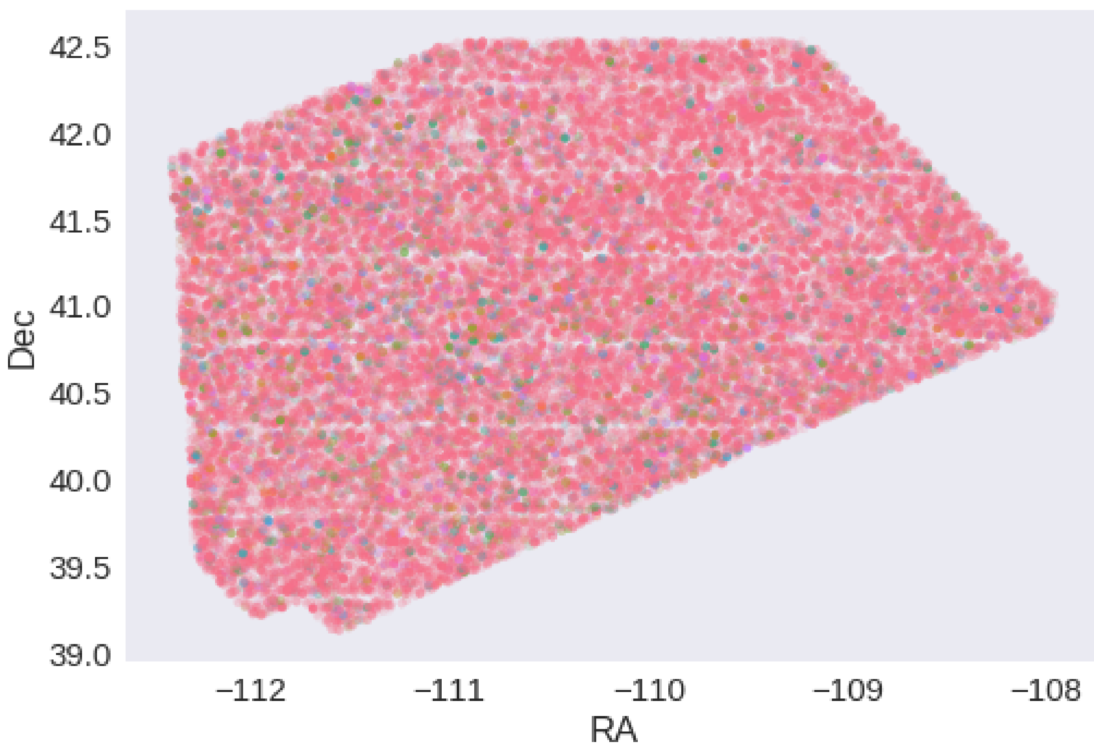
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.04817384640318778 arcsec
Dec correction: -0.061939390320731036 arcsec
```


pearsonr = -0.11; p = 6.4e-103
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

```
39681 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.3_PanSTARRS-3SS

March 8, 2018

1 ELAIS-N2 master catalogue

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

This catalogue comes from `dmu0_PanSTARRS1-3SS`.

In the catalogue, we keep:

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

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

The observations used for the catalogue where done between 2010 and 2015 (ref).

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

TODO: Check for stellarity.

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

1.2 I - Column selection

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

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

1.3 II - Removal of duplicated sources

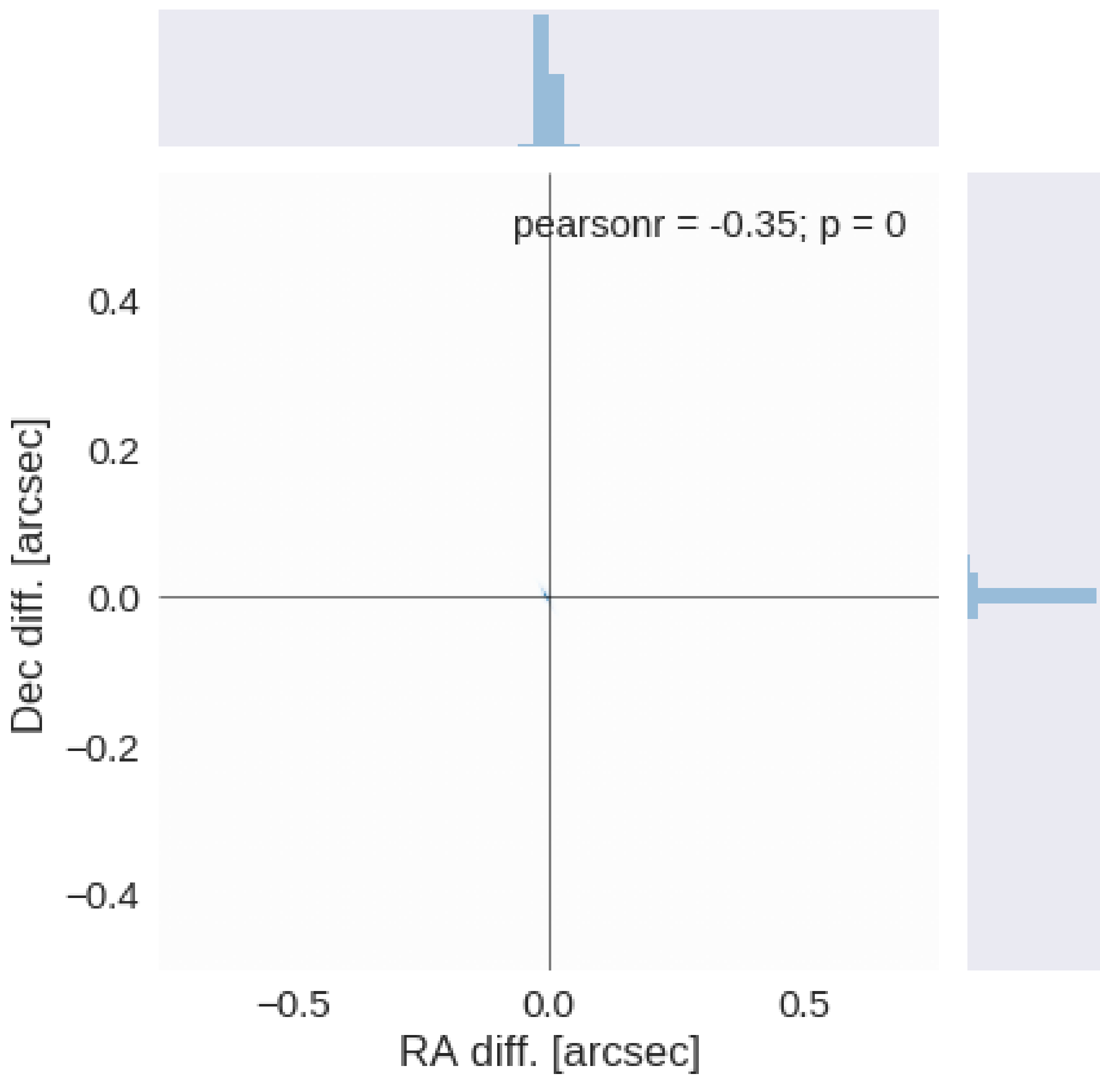
We remove duplicated objects from the input catalogues.

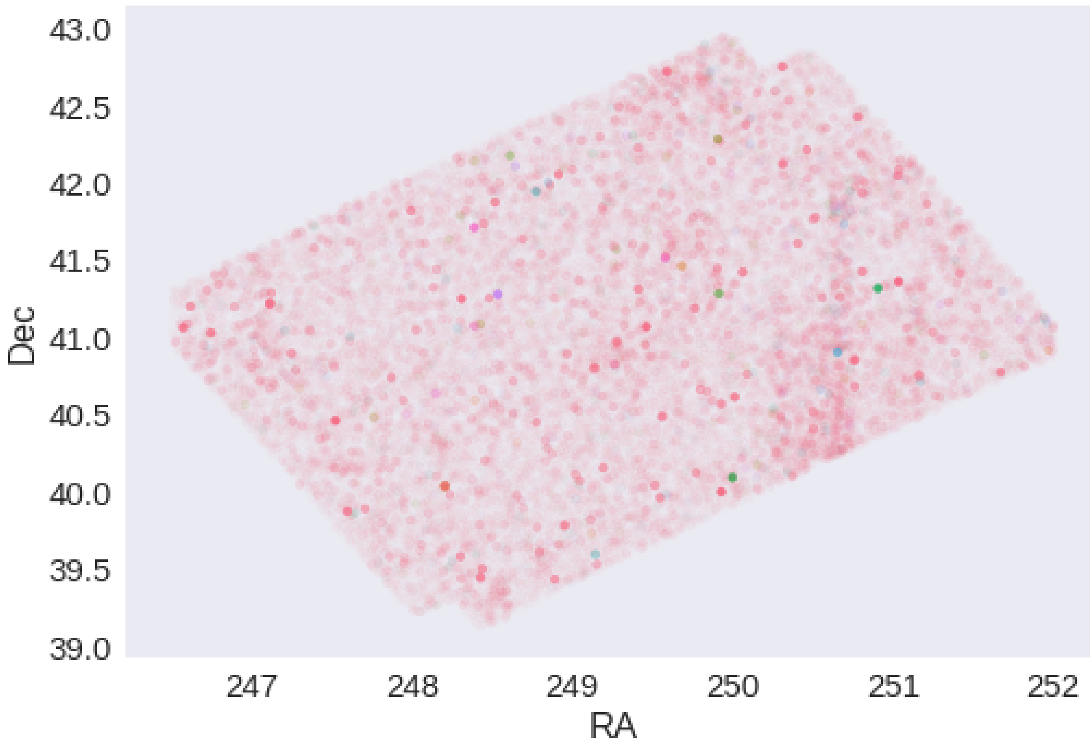
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 231114 sources.
The cleaned catalogue has 231052 sources (62 removed).
The cleaned catalogue has 62 sources flagged as having been cleaned
```

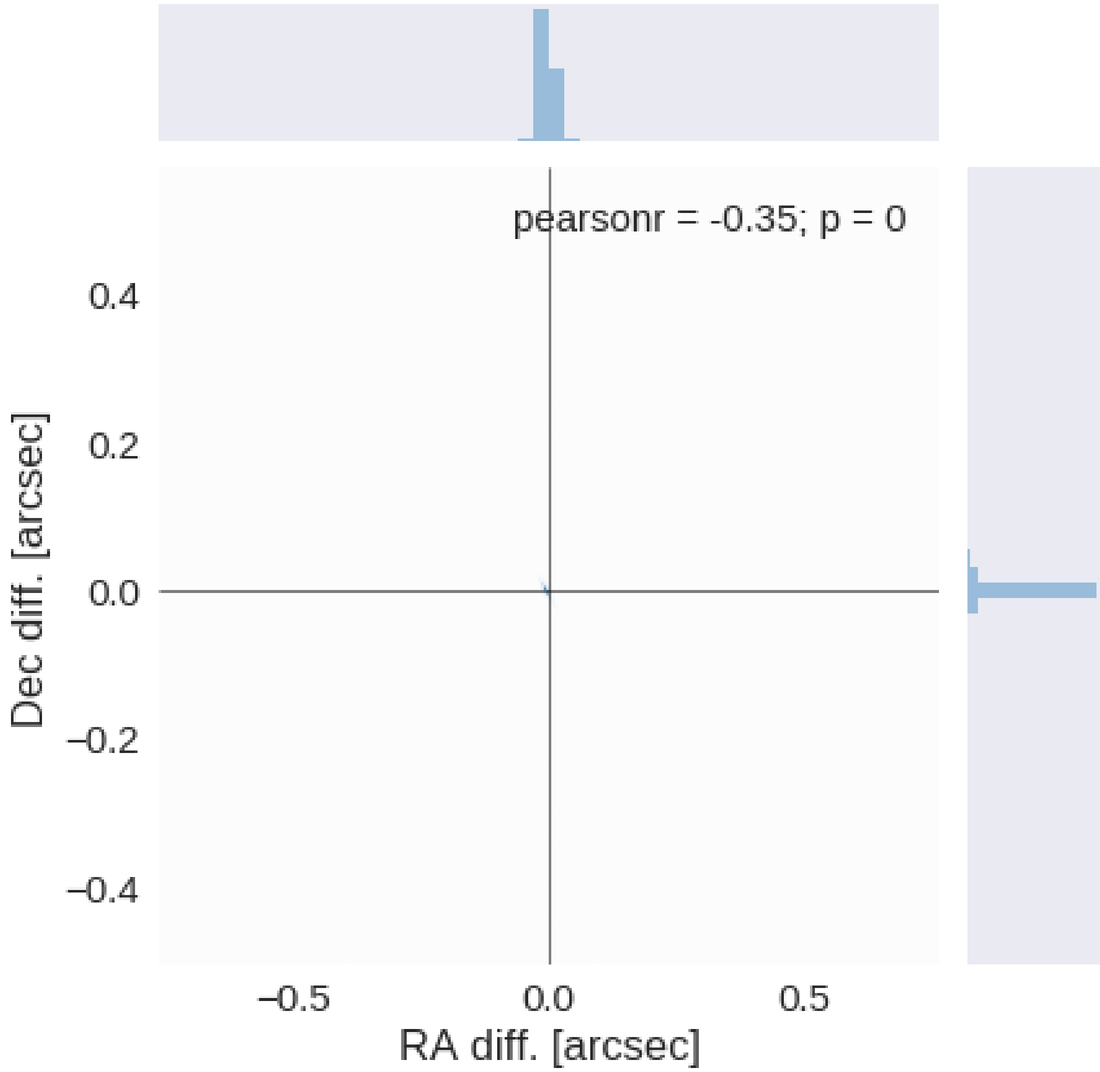
1.4 III - Astrometry correction

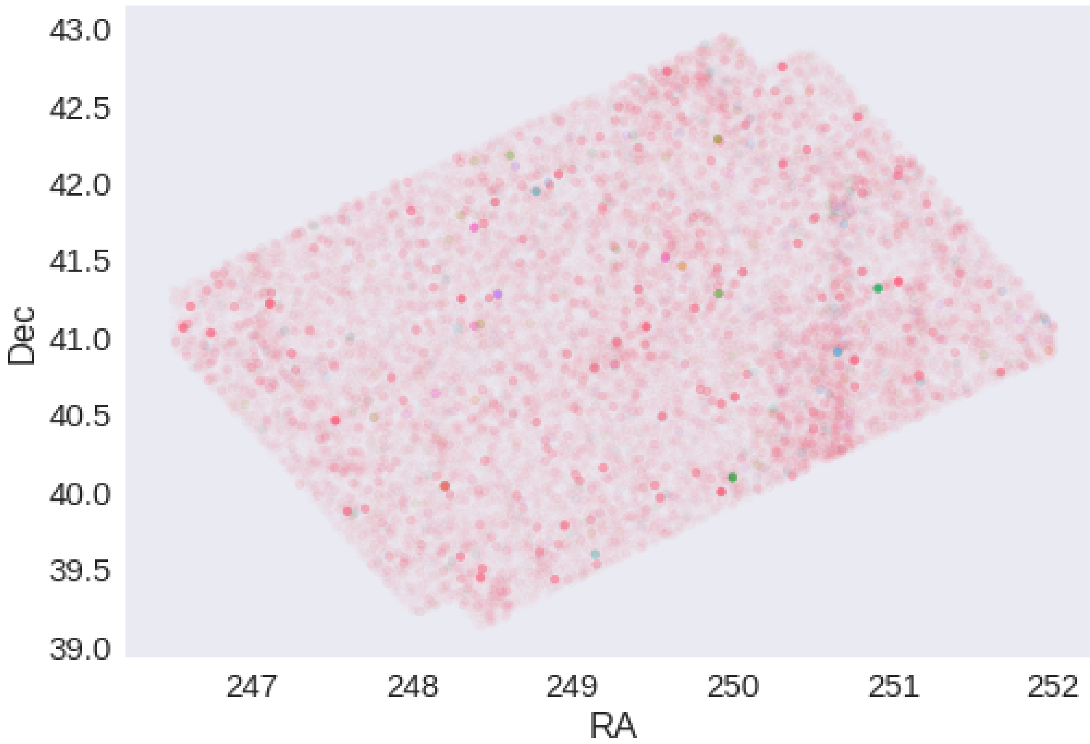
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: 0.00037055522170703625 arcsec
Dec correction: -0.0010222747192756287 arcsec
```


pearsonr = -0.35; 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

```
48202 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.4_SpARCS

March 8, 2018

1 ELAIS-N2 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.

Is there y band data?

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

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

1.2 I - Parametres for aperture correction

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

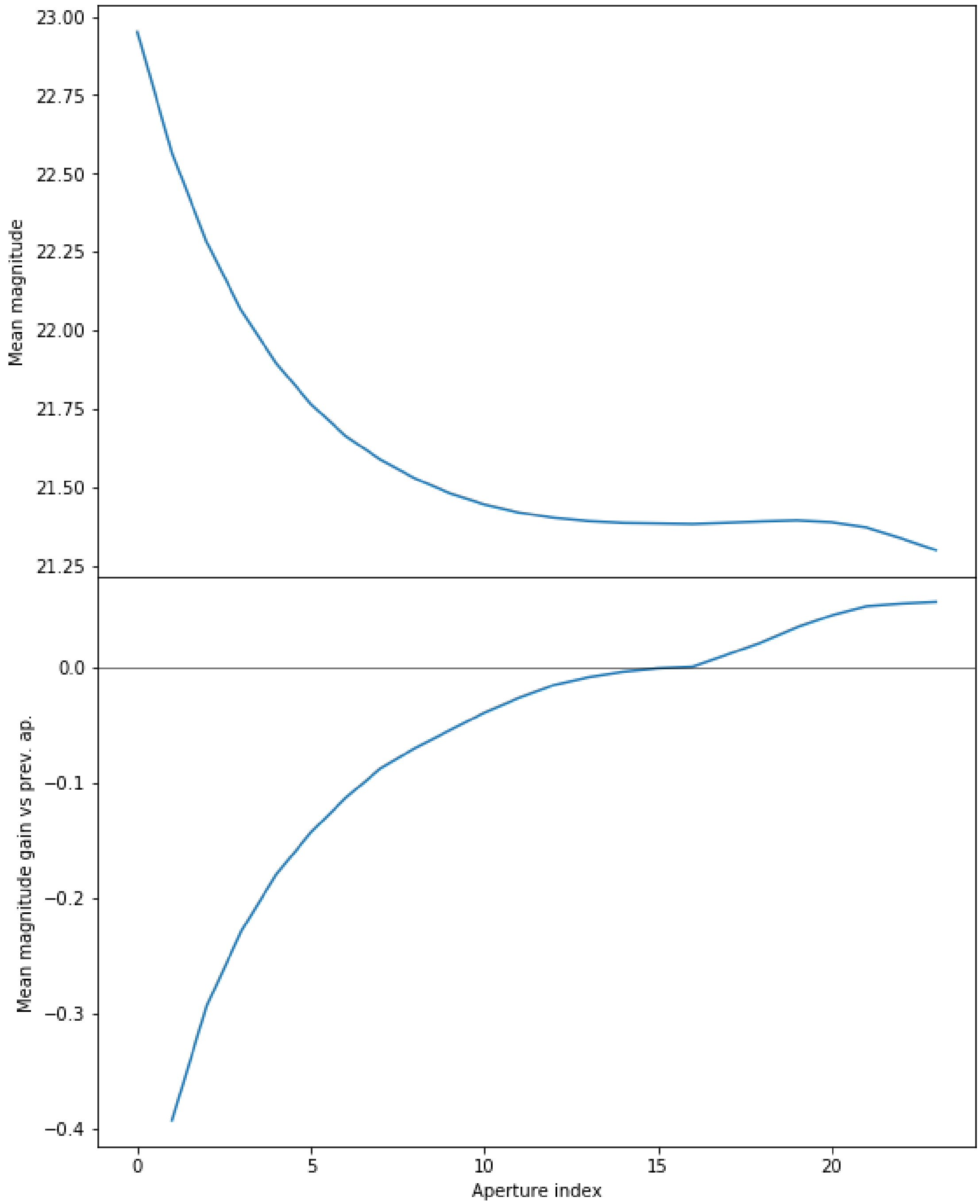
Target aperture: To determine the target aperture, we simulate a curve of growth using the provided apertures and draw two figures: - The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude. - The mean gain (loss when negative) of magnitude is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

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

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

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

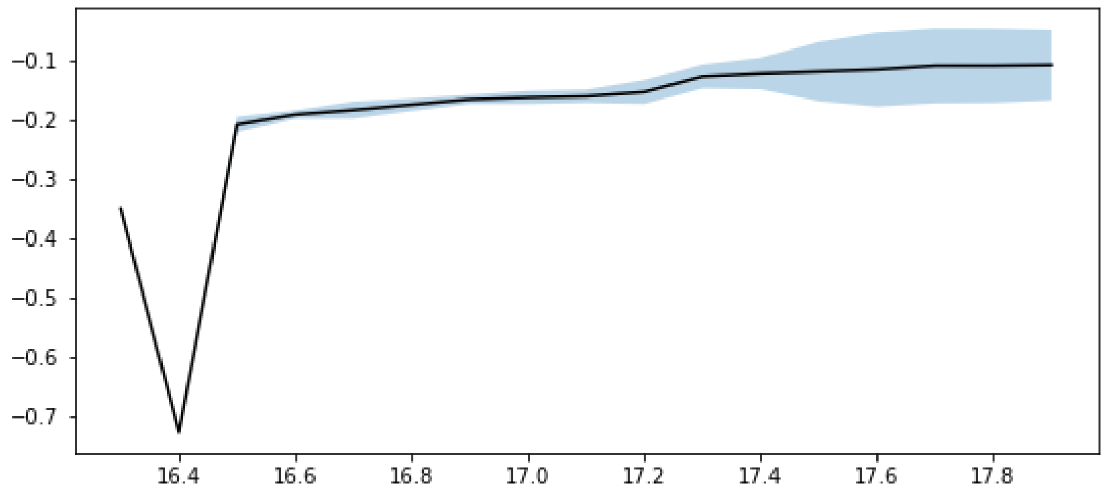
1.2.1 I.a r-band



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

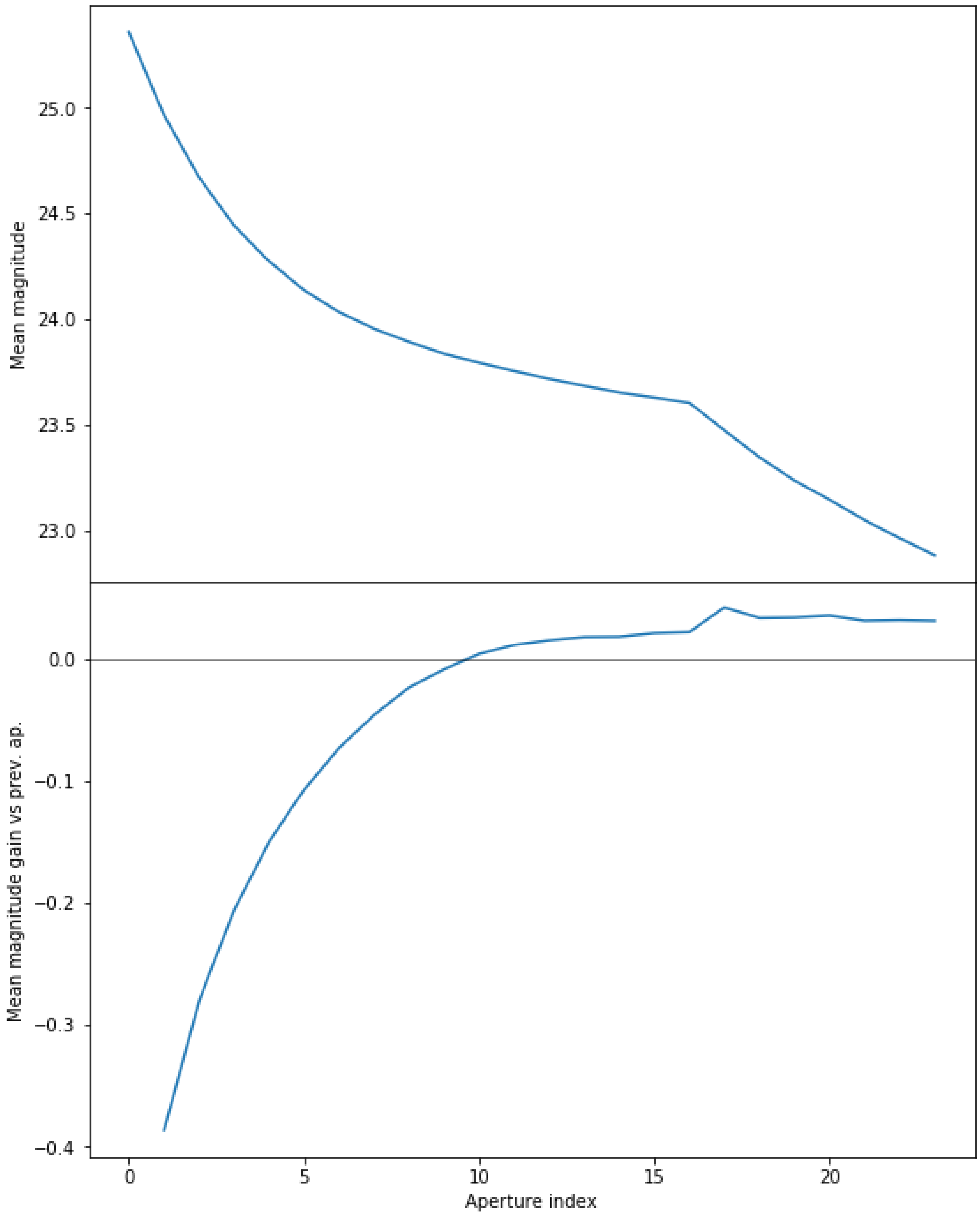
```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid value enc
```

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



We use magnitudes between 17 and 17.9.

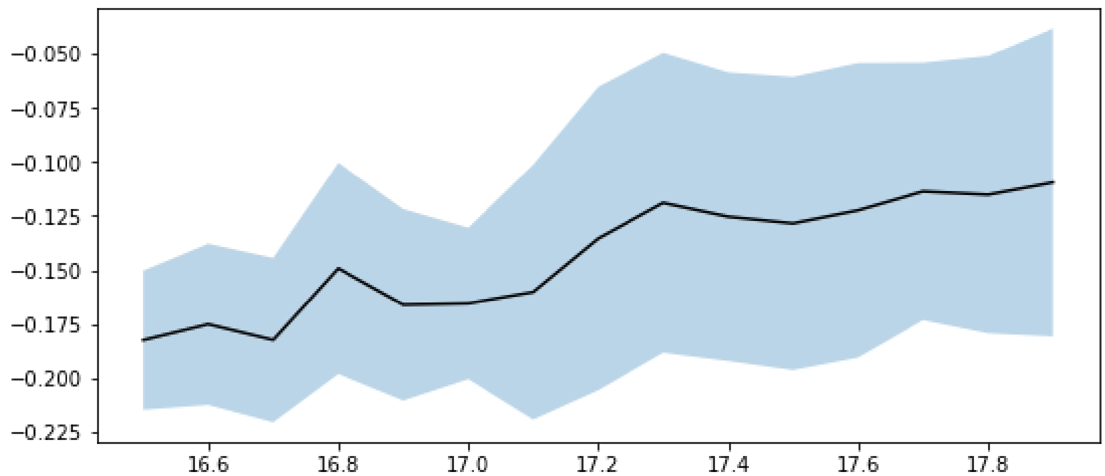
1.2.2 I.b u-band



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

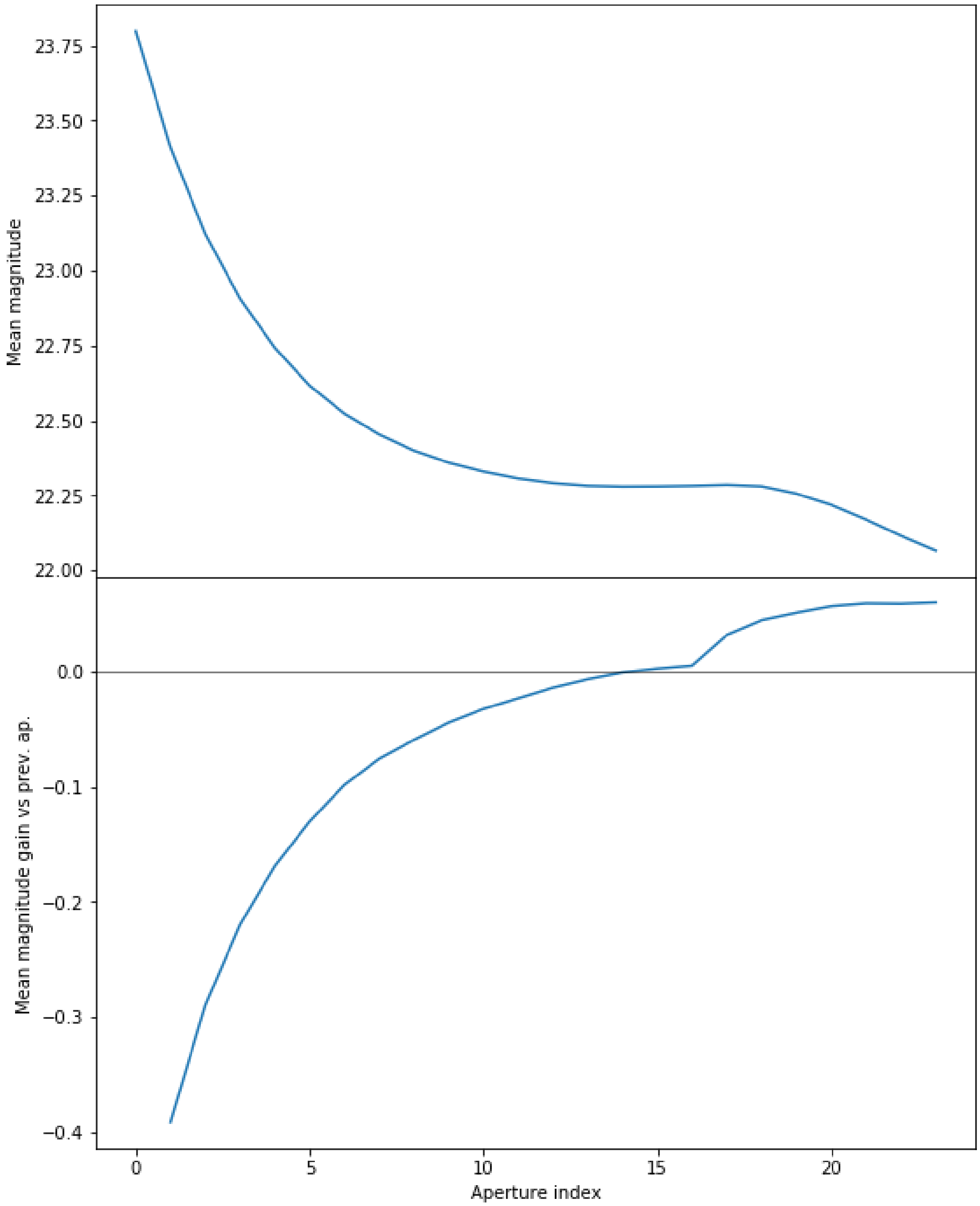
```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
```

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



We use magnitudes between 17 and 17.9.

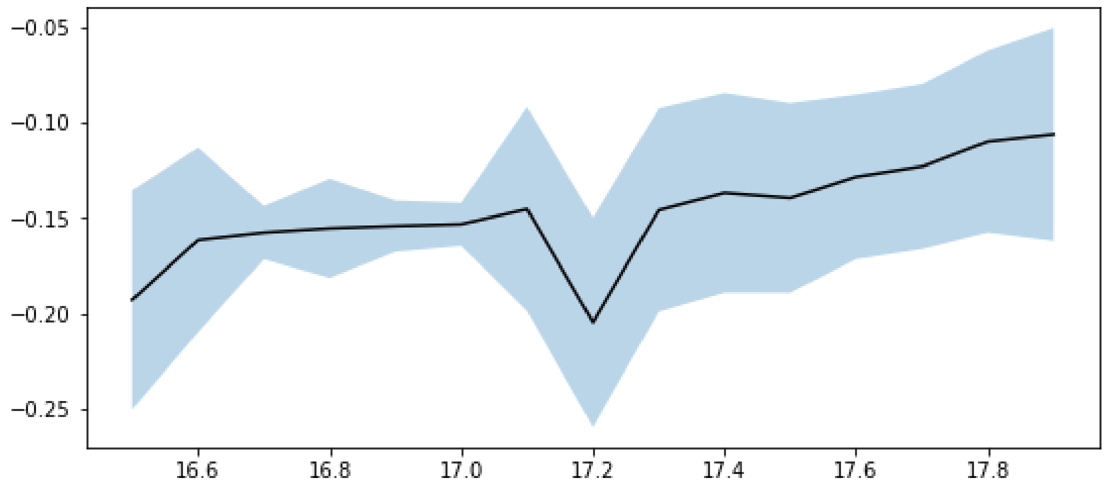
1.2.3 I.c g-band



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

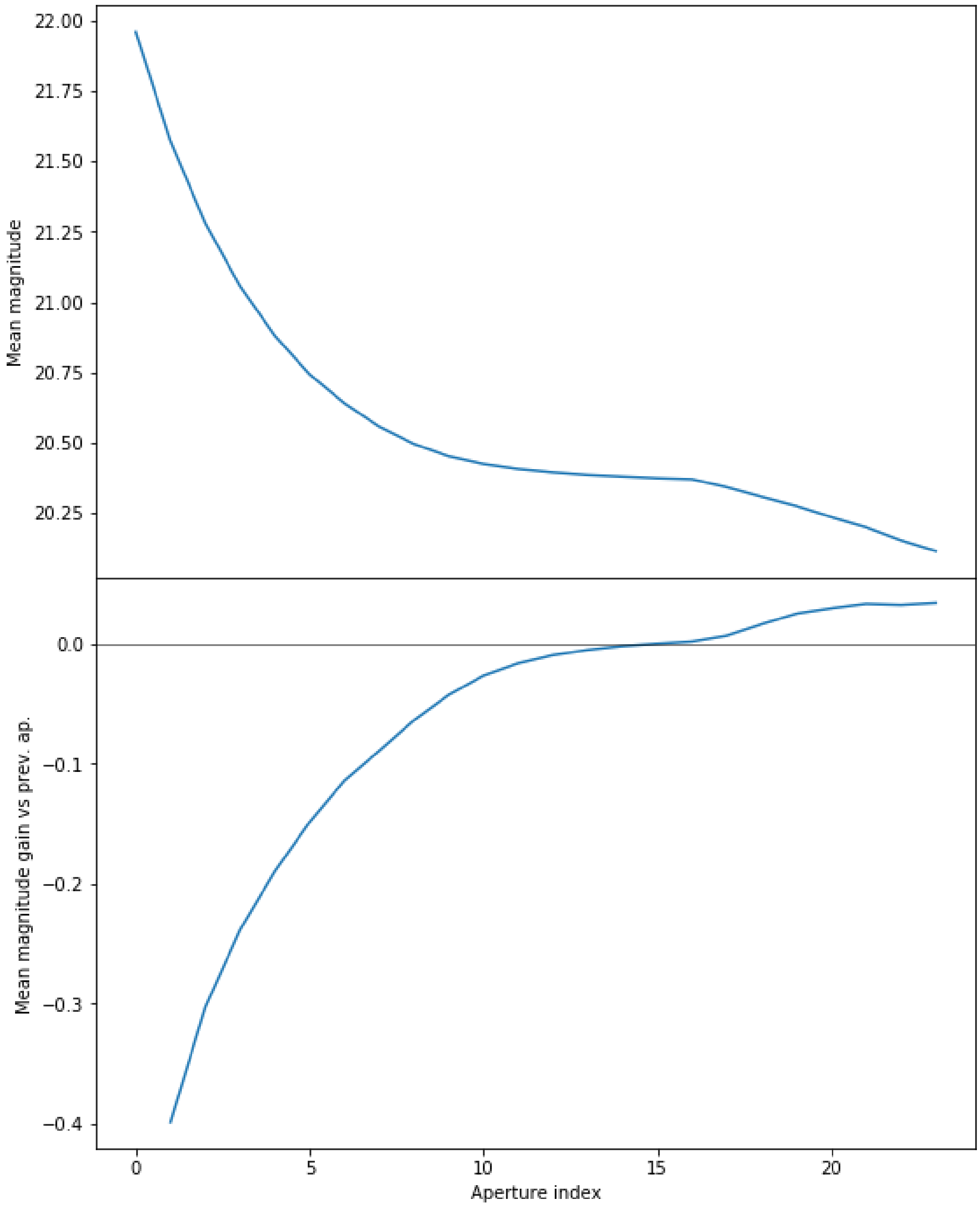
```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid value enc
```

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



We use magnitudes between 17.2 and 18.

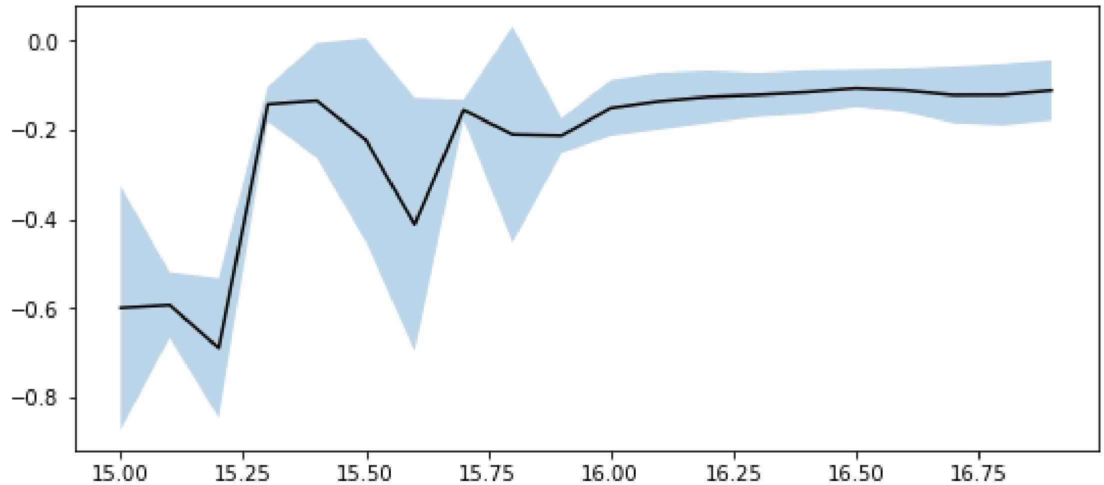
1.2.4 I.d z-band



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

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

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



We use magnitudes between 16 and 17.

1.3 II - Column selection

```
WARNING: UnitsWarning: '""' did not parse as fits unit: Invalid character at col 0 [astropy.unit
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:131: RuntimeWarning: invalid value enc
  mask &= (mag >= mag_min)
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:133: RuntimeWarning: invalid value enc
  mask &= (mag <= mag_max)


Aperture correction for SpARCS band u:
Correction: -0.12485599517822266
Number of source used: 1001
RMS: 0.06557130828443923

Aperture correction for SpARCS band g:
Correction: -0.13389968872070312
Number of source used: 1252
RMS: 0.052055042021584536

Aperture correction for SpARCS band r:
Correction: -0.1177825927734375
Number of source used: 2187
RMS: 0.05621025637278401
```

```
Aperture correction for SpARCS band z:
Correction: -0.11841869354248047
Number of source used: 1581
RMS: 0.06271163119030113
```

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

1.4 II - Removal of duplicated sources

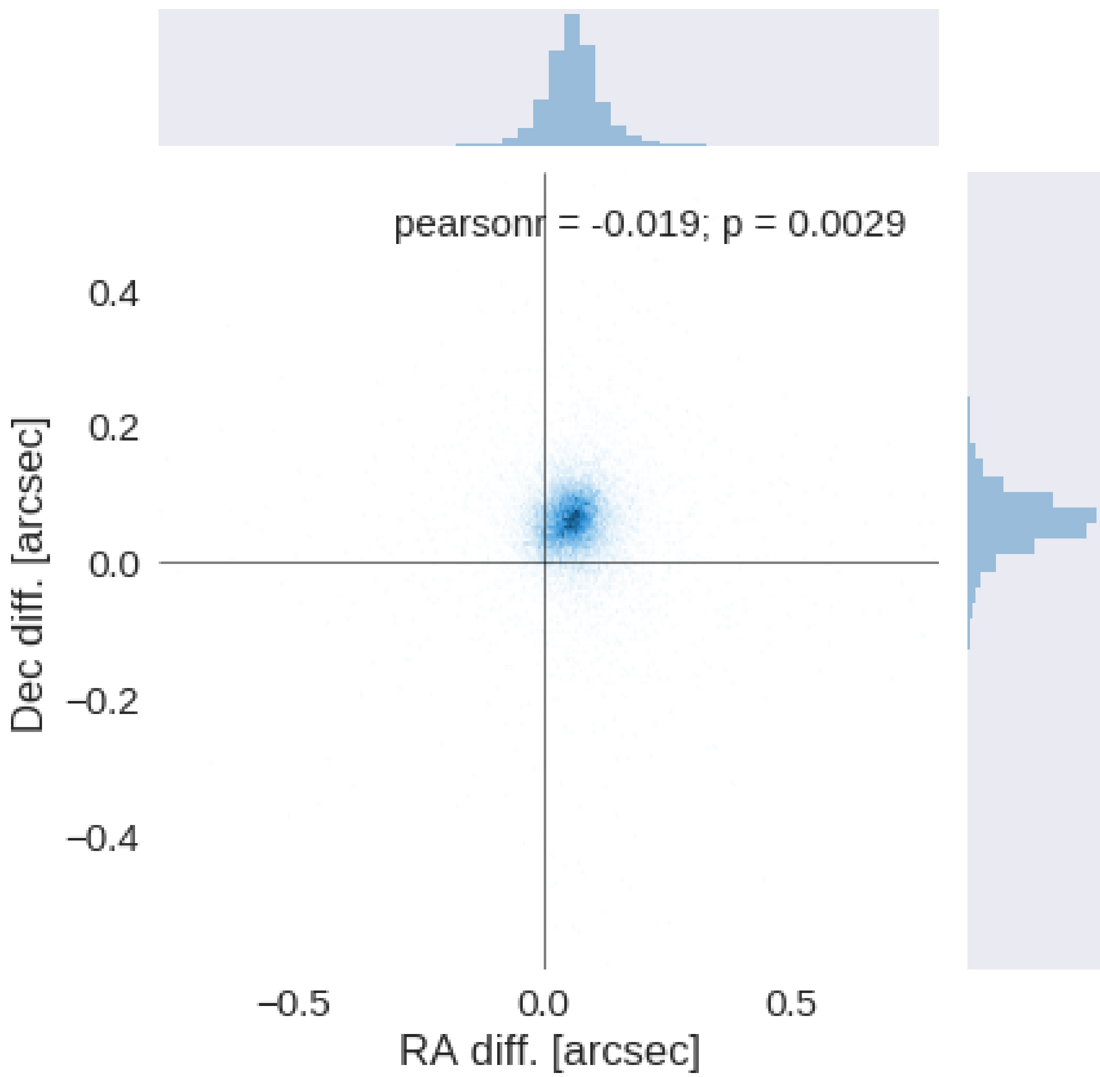
We remove duplicated objects from the input catalogues.

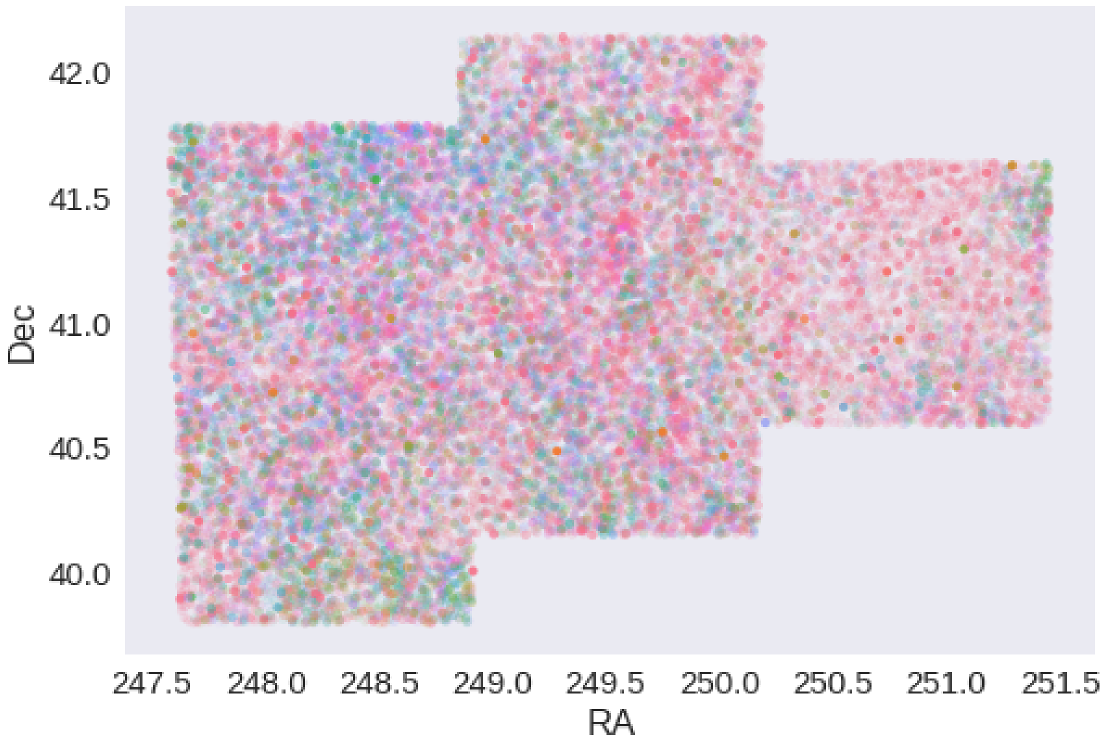
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 785579 sources.
The cleaned catalogue has 785579 sources (0 removed).
The cleaned catalogue has 0 sources flagged as having been cleaned
```

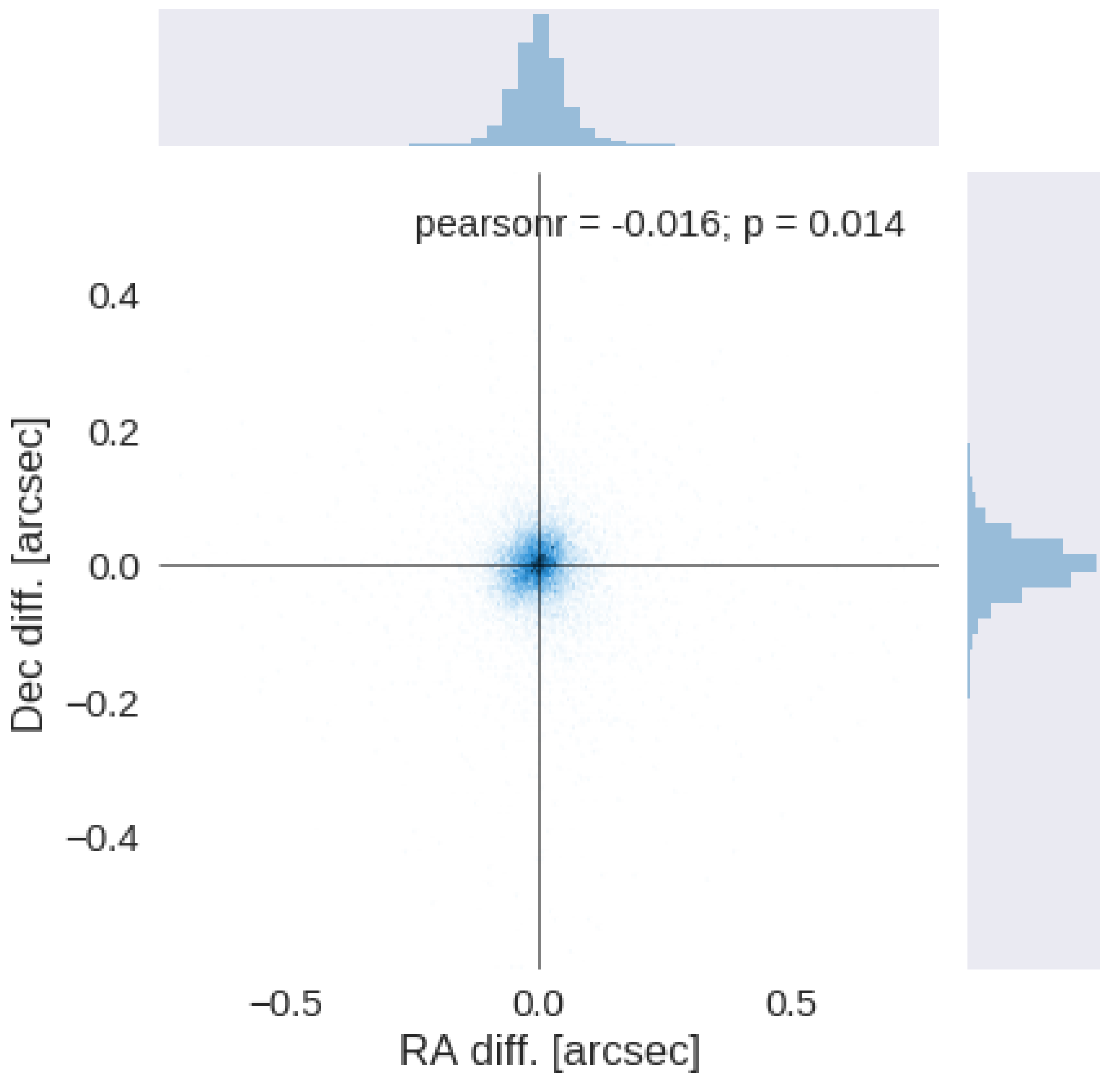
1.5 III - Astrometry correction

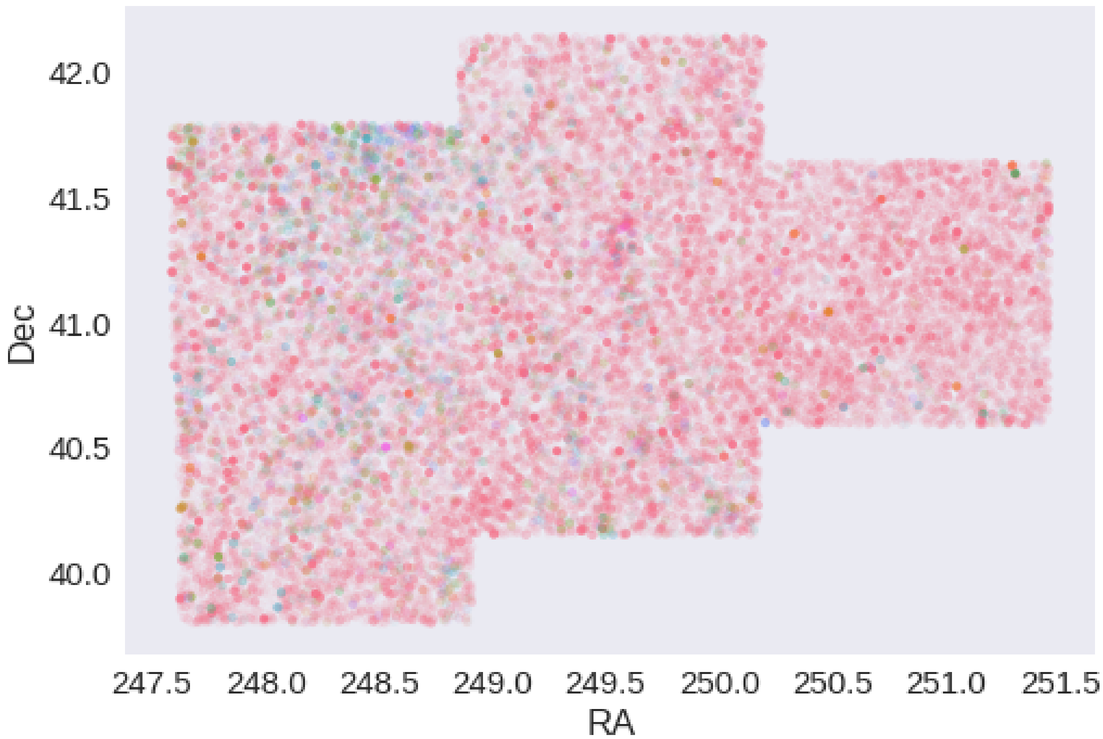
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = -0.019; p = 0.0029
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.5
0.0
0.5
RA diff. [arcsec]




```
RA correction: -0.061004910895690045 arcsec
Dec correction: -0.06102552299012132 arcsec
```


pearsonr = -0.016; p = 0.014
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.5
0.0
0.5
RA diff. [arcsec]



1.6 IV - Flagging Gaia objects

```
26154 sources flagged.
```

1.7 V - Flagging objects near bright stars

1.8 VI - Saving to disk

1.5_SWIRE

March 8, 2018

1 ELAIS-N2 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. Is ELAIS N2 different?

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

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

1.2 I - Column selection

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

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

1.3 II - Removal of duplicated sources

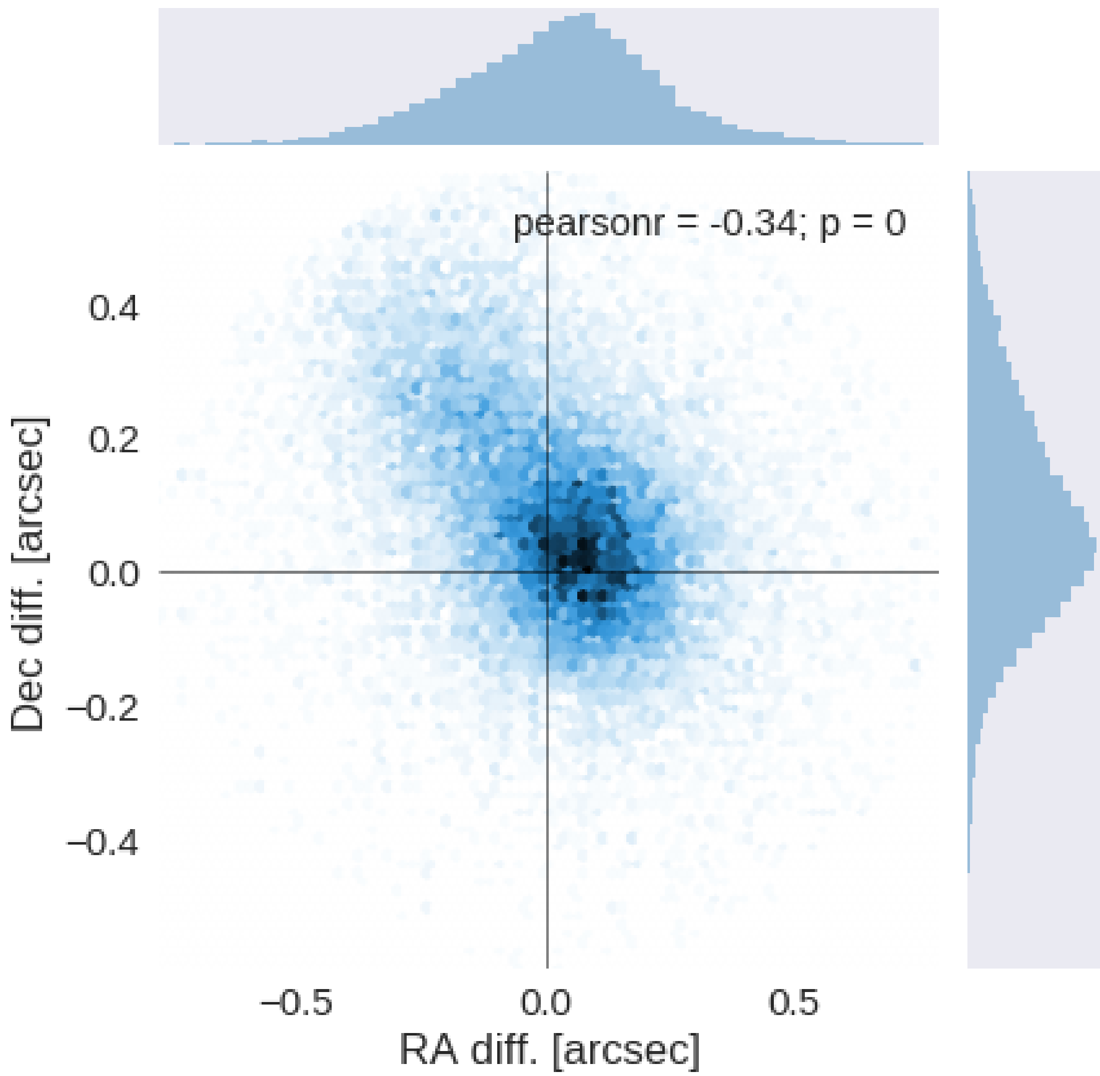
We remove duplicated objects from the input catalogues.

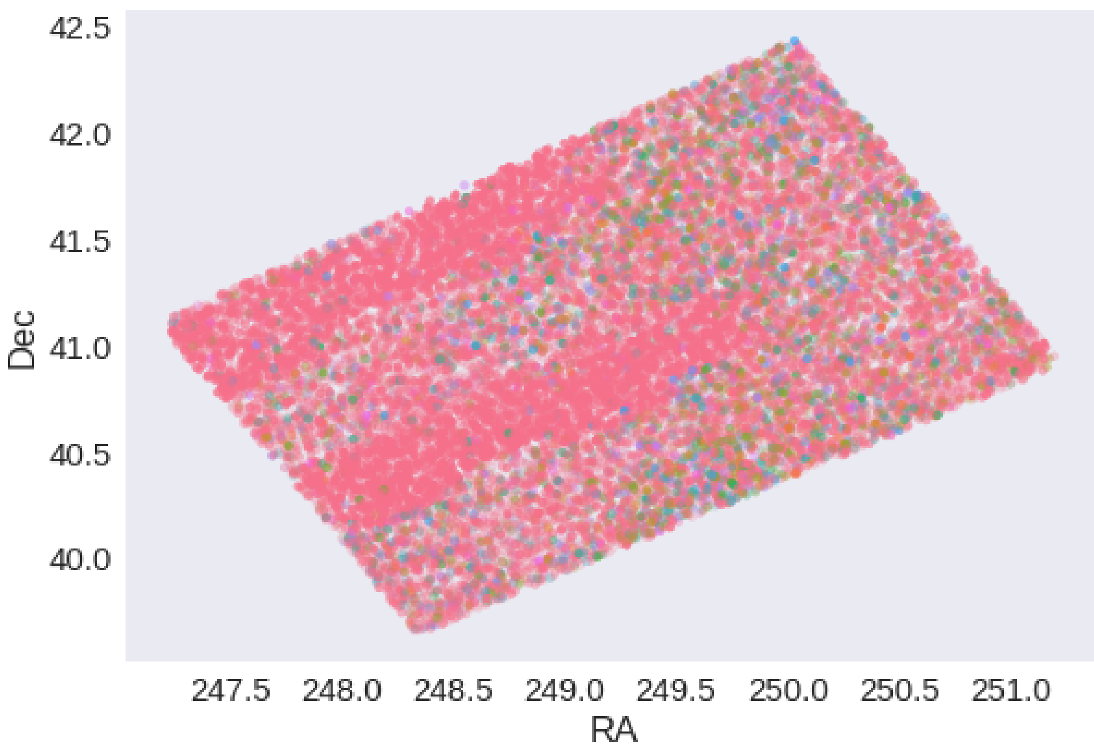
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 273650 sources.
The cleaned catalogue has 273392 sources (258 removed).
The cleaned catalogue has 258 sources flagged as having been cleaned
```

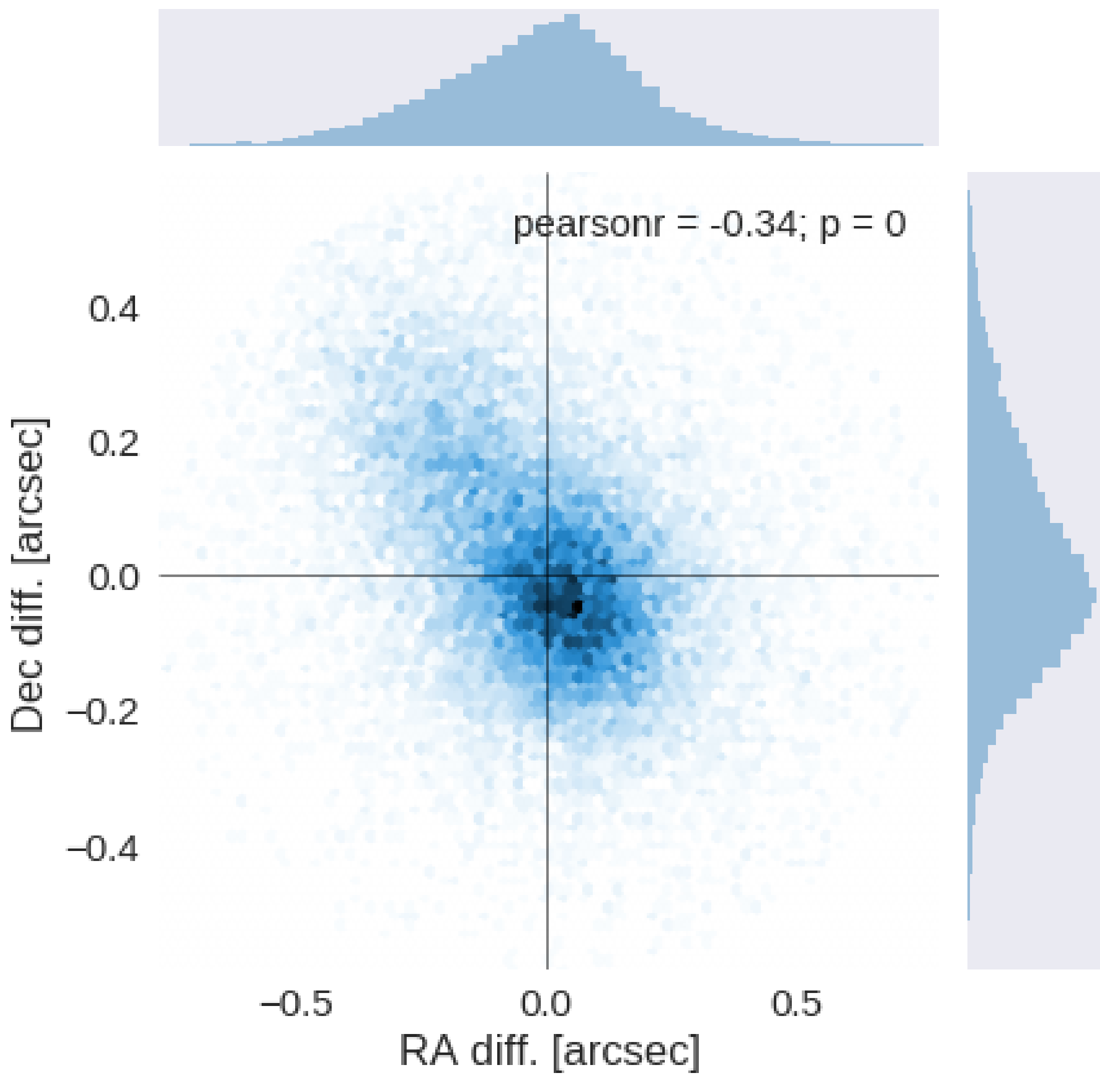
1.4 III - Astrometry correction

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.

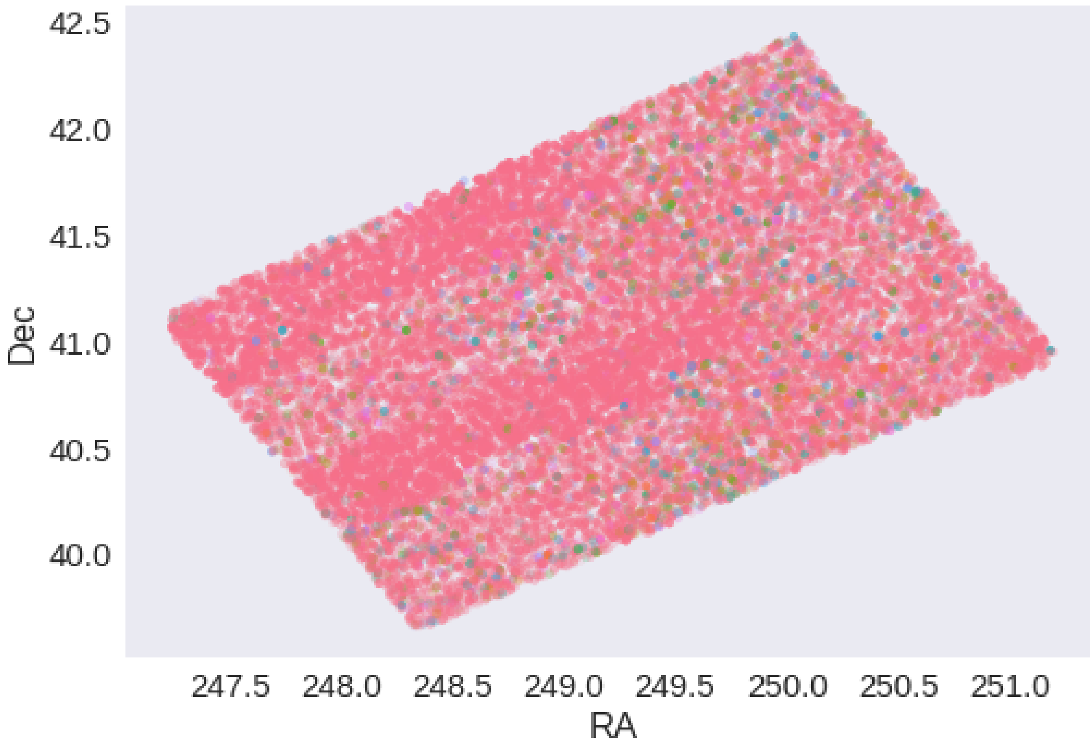





```
RA correction: -0.03311454242975742 arcsec
Dec correction: -0.06647202361023119 arcsec
```



pearsonr = -0.34; 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

```
22663 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

2_Merging

March 8, 2018

1 ELAIS-N2 master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on ELAIS-N2.

```
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:
2018-02-18 00:53:05.376795
```

1.1 I - Reading the prepared pristine catalogues

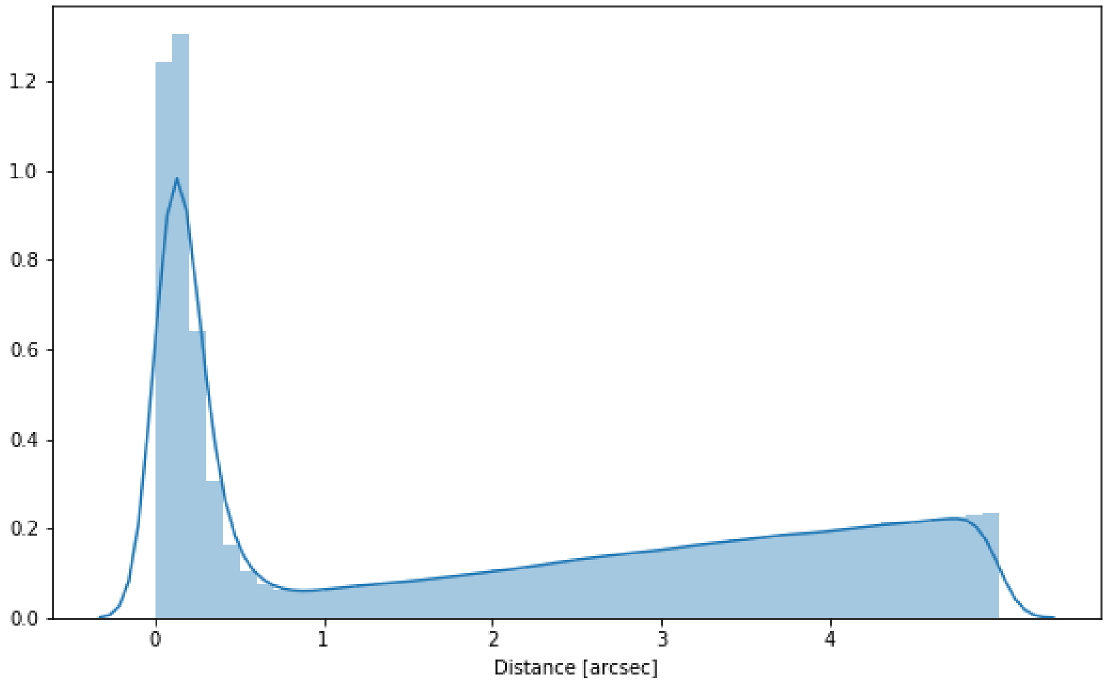
1.2 II - Merging tables

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

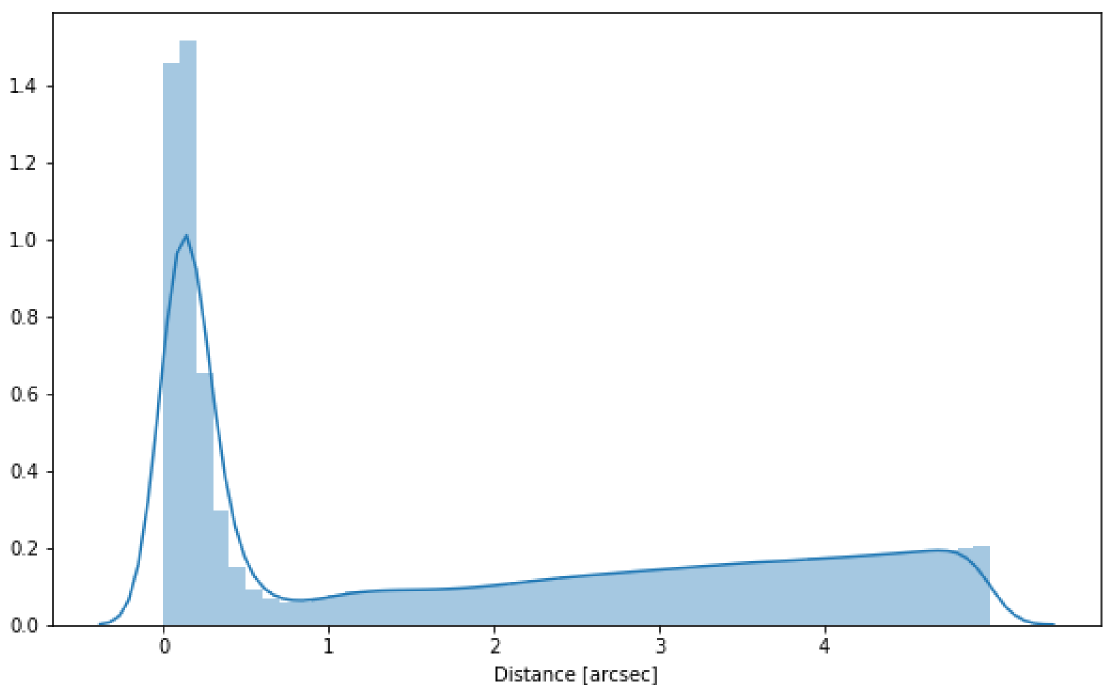
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 WFC

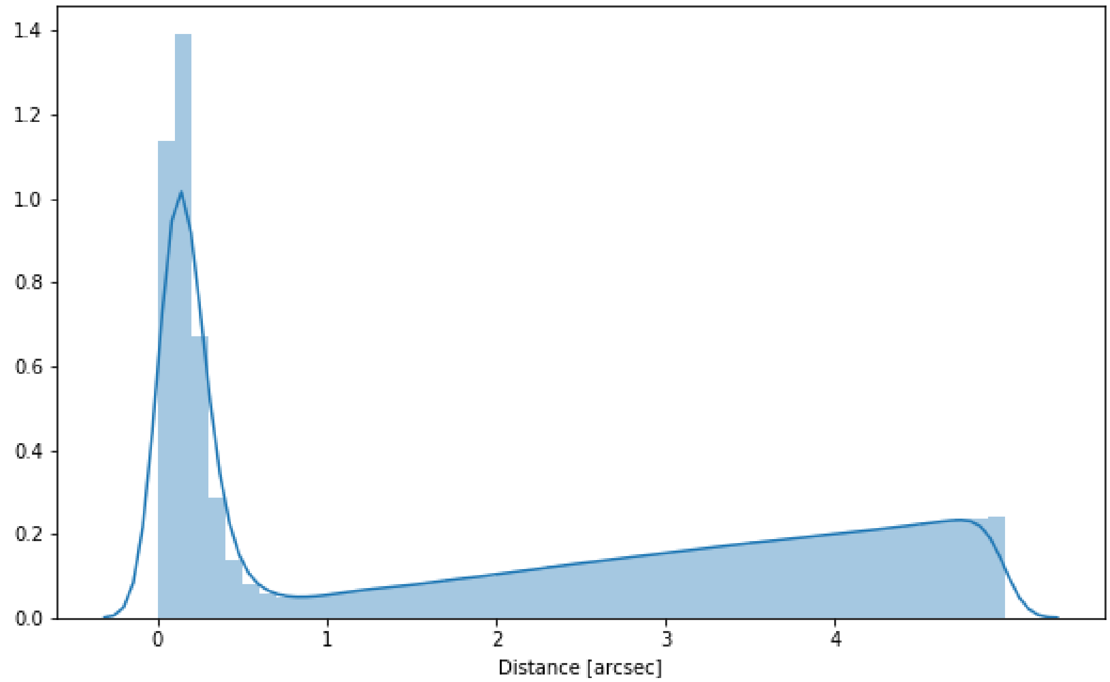
1.2.2 Add RCSLenS



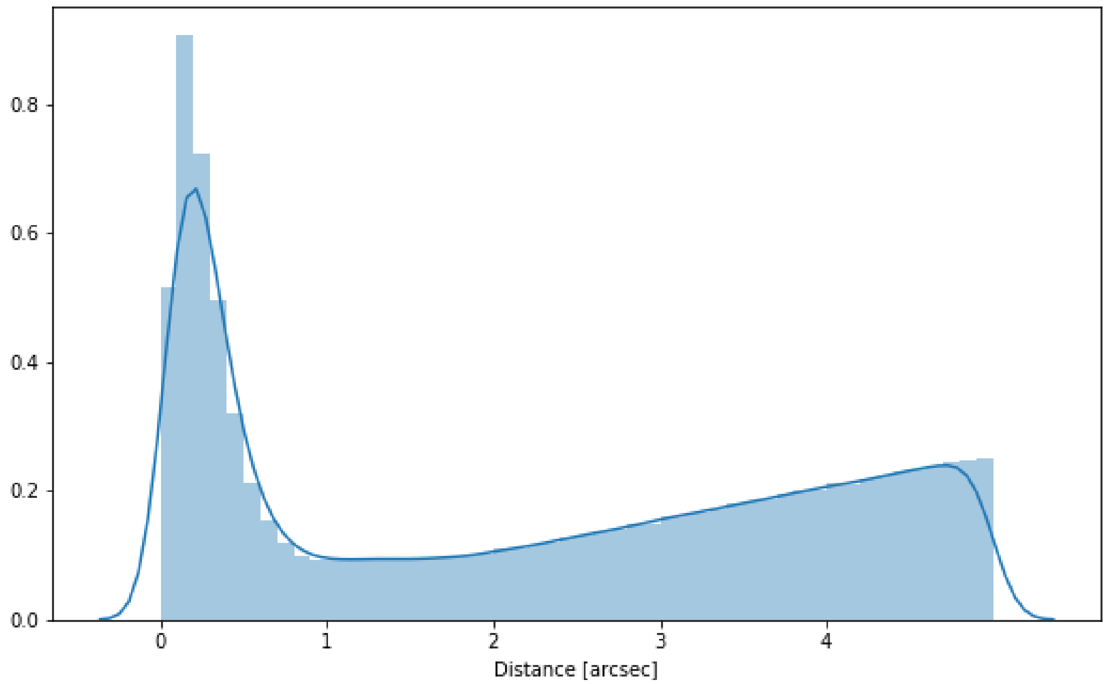
1.2.3 Add PanSTARRS



1.2.4 Add SpARCS



1.2.5 Add SWIRE



1.2.6 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[15]: <IPython.core.display.HTML object>
```

1.3 III - Merging flags and stellarity

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

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

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

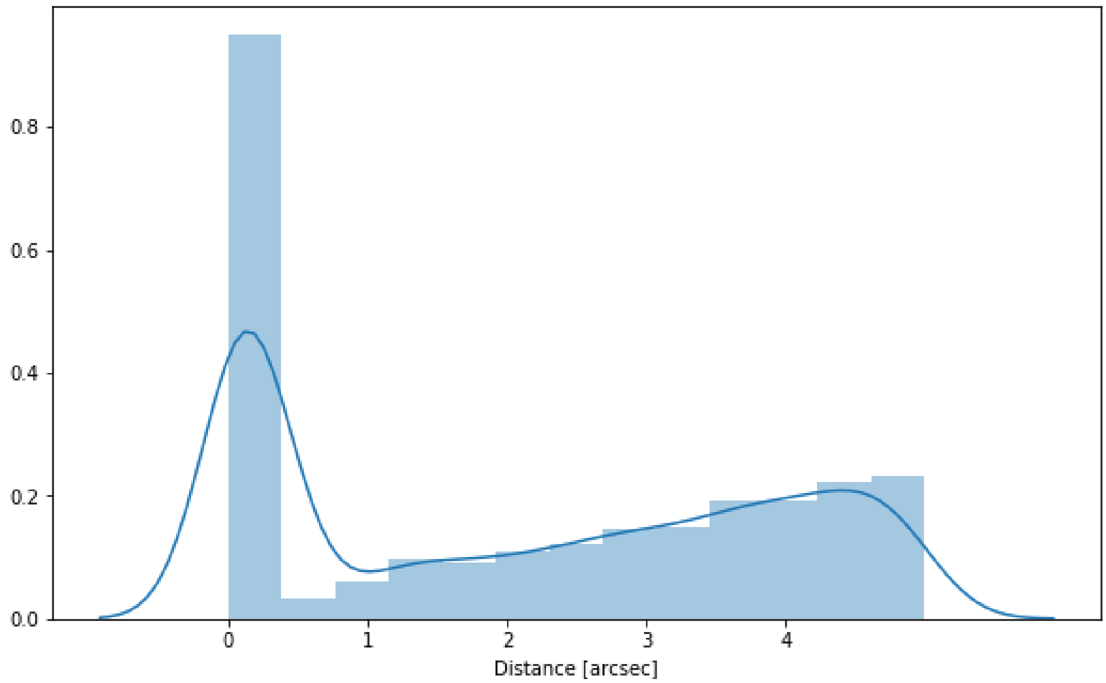
```
wfc_stellarity, rcs_stellarity, sparcs_stellarity, swire_stellarity
```

1.4 IV - Adding E(B-V) column

1.5 V.a - Adding HELP unique identifiers and field columns

```
OK!
```

1.6 V.b - Adding Spec-z



1.7 VI - Choosing between multiple values for the same filter

1.7.1 CFHT Megacam SpARCS vs RCSLenS

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

Survey	Bands
SpARCS	ugrz
RCSLenS	grizy

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

```
Out[30]: <IPython.core.display.HTML object>
```

1.8 VII.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 VII.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 VIII - Cross-identification table

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

1.11 IX - Adding HEALPix index

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

1.12 IX - Saving the catalogue

```
Missing columns: {'flag_megacam_g', 'flag_gpc1_z', 'specz_id', 'flag_wfc_i', 'flag_megacam_u', '
```

3_Checks_and_diagnostics

March 8, 2018

1 ELAIS-N2 master catalogue

1.1 Checks and diagnostics

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

```
Diagnostics done using: master_catalogue_elais-n2_20171207.fits
```

1.2 0 - Quick checks

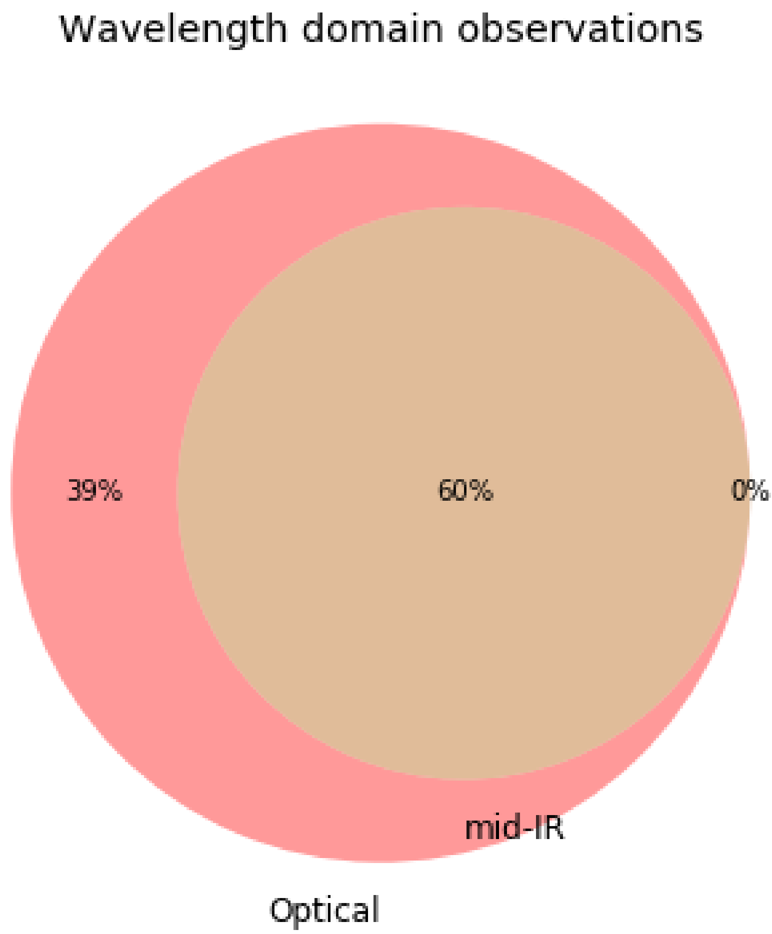
On the test square degree these showed megacam_y (From RCSLenS) to be empty. Perhaps we should remove it.

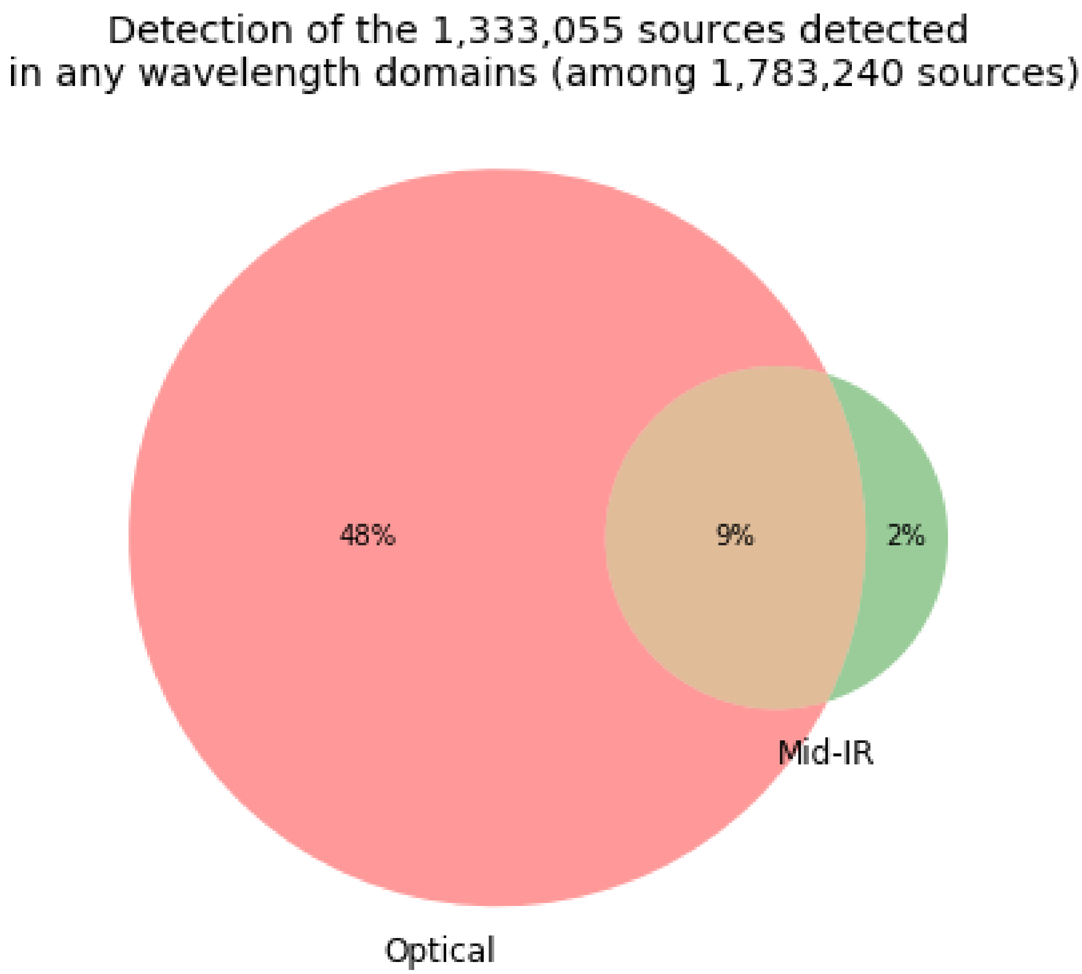
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype),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

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

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

1.3 I - Summary of wavelength domains



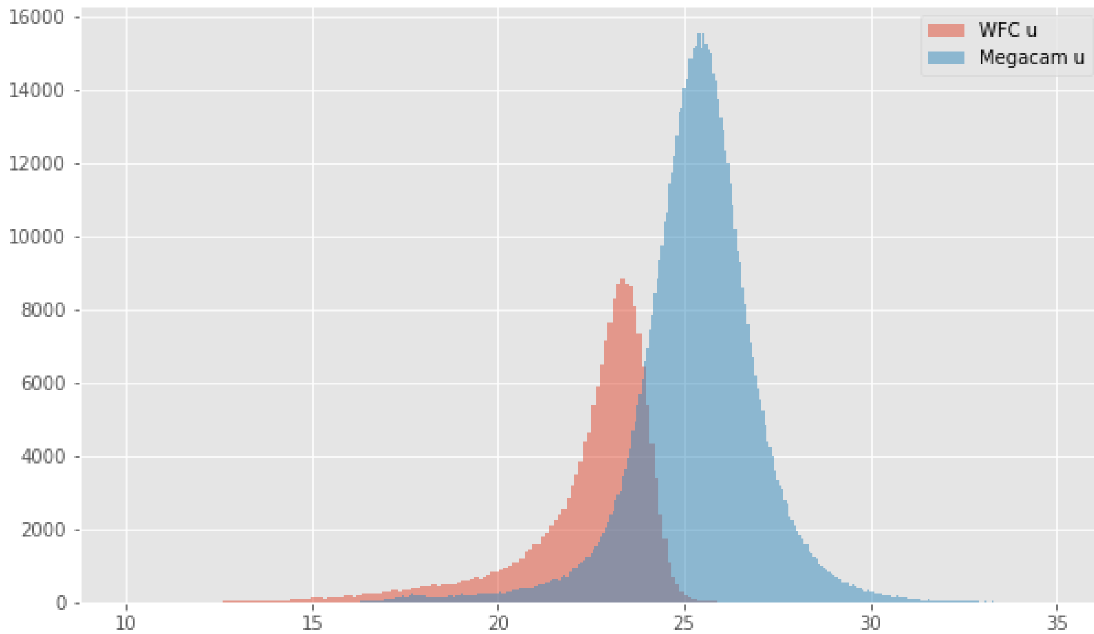


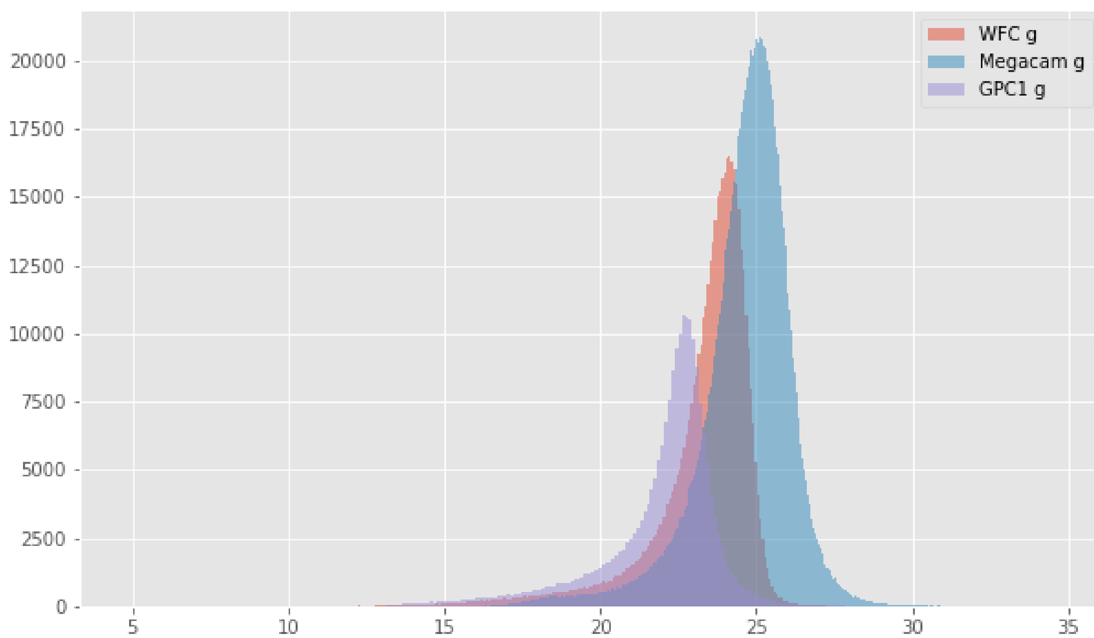
1.4 II - Comparing magnitudes in similar filters

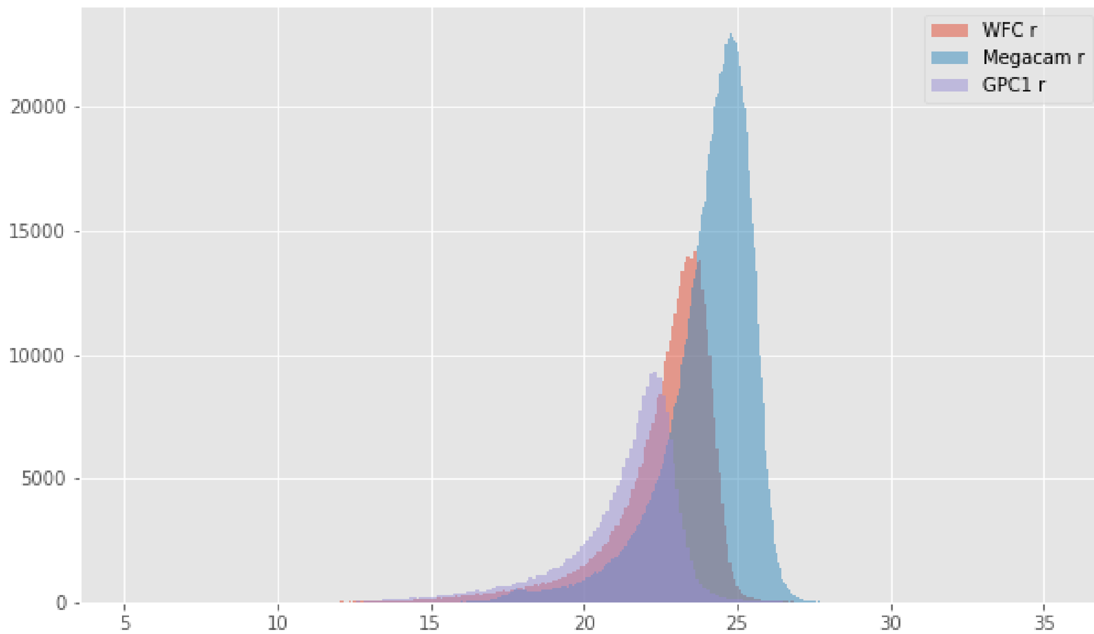
The master list if composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

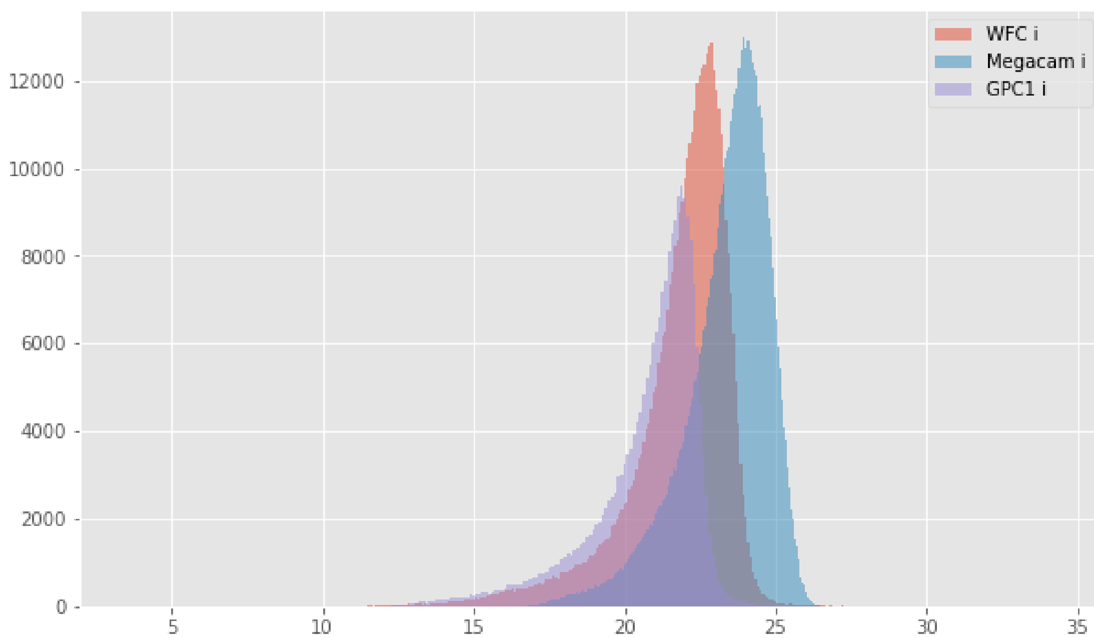
1.4.1 II.a - Comparing depths

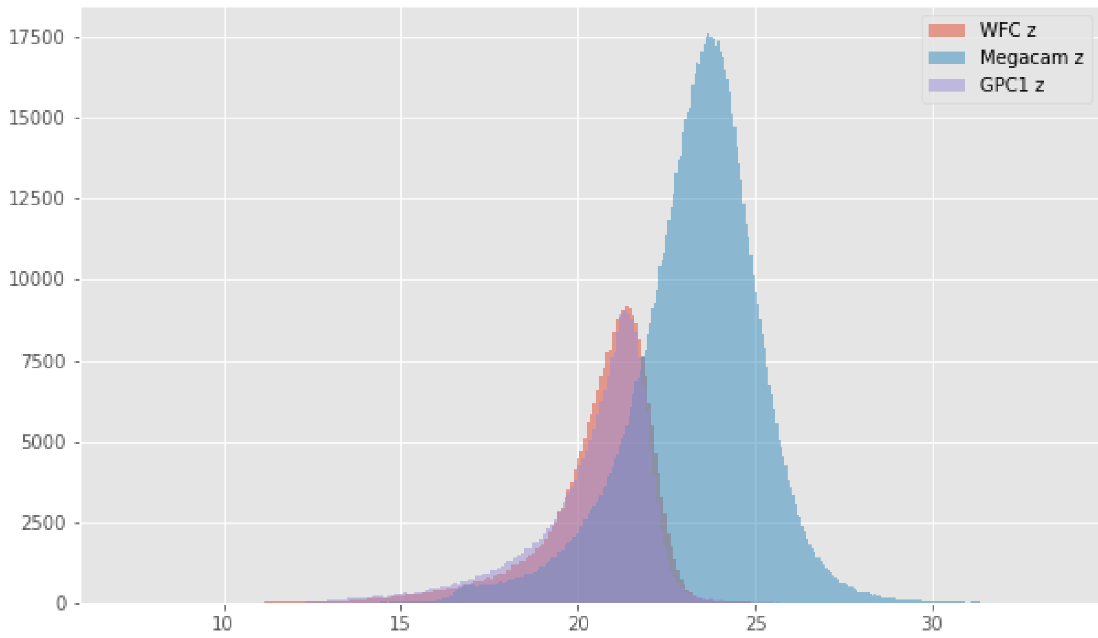
We compare the histograms of the total aperture magnitudes of similar bands.


WFC u
Megacam u
0
2000
4000
6000
8000
10000
12000
14000
16000
10
15
20
25
30
35

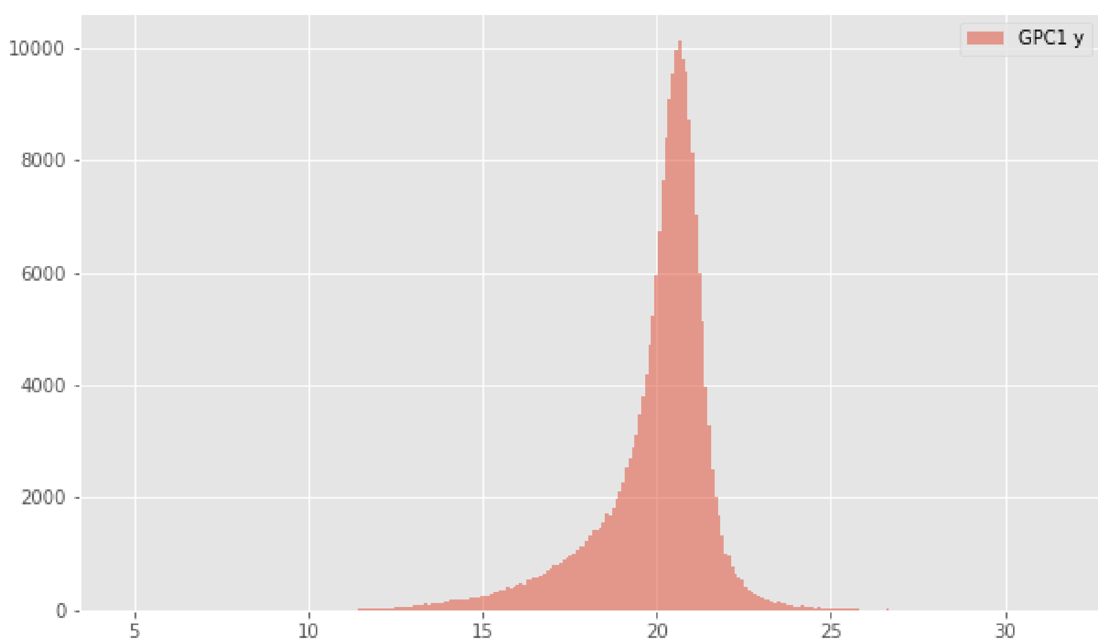

WFC g
Megacam g
GPC1 g
0
2500
5000
7500
10000
12500
15000
17500
20000
5
10
15
20
25
30
35


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


WFC i
Megacam i
GPC1 i
12000
10000
8000
6000
4000
2000
0
5
10
15
20
25
30
35



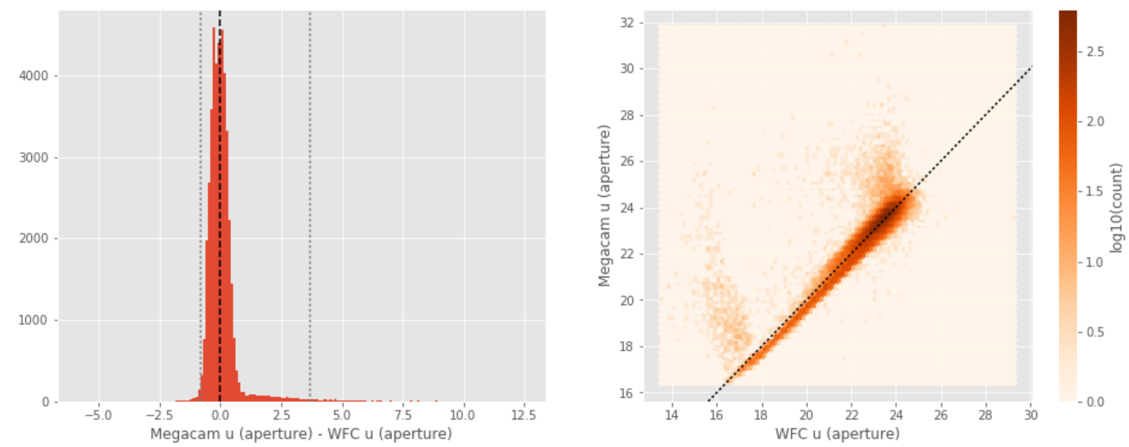
HELP warning: the column m_megacam_y (Megacam y) is empty.



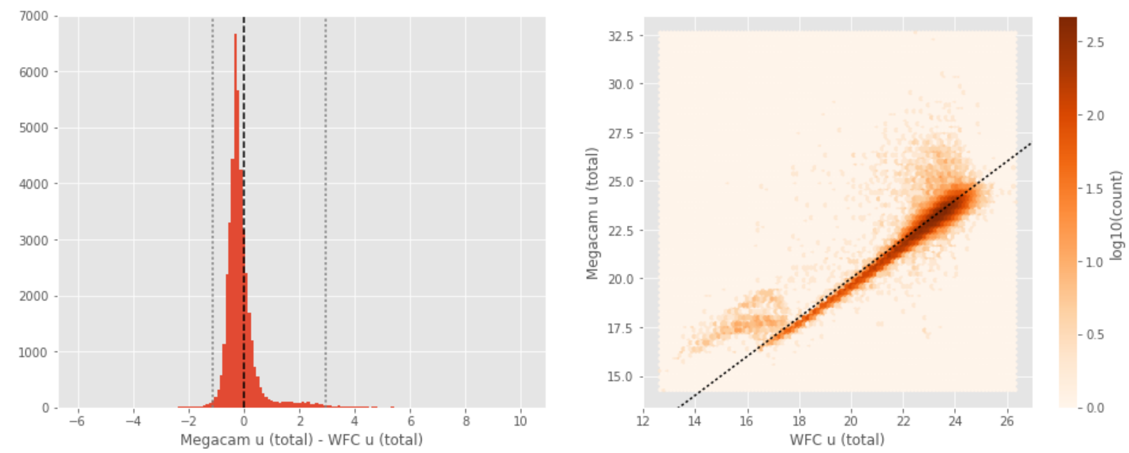
1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

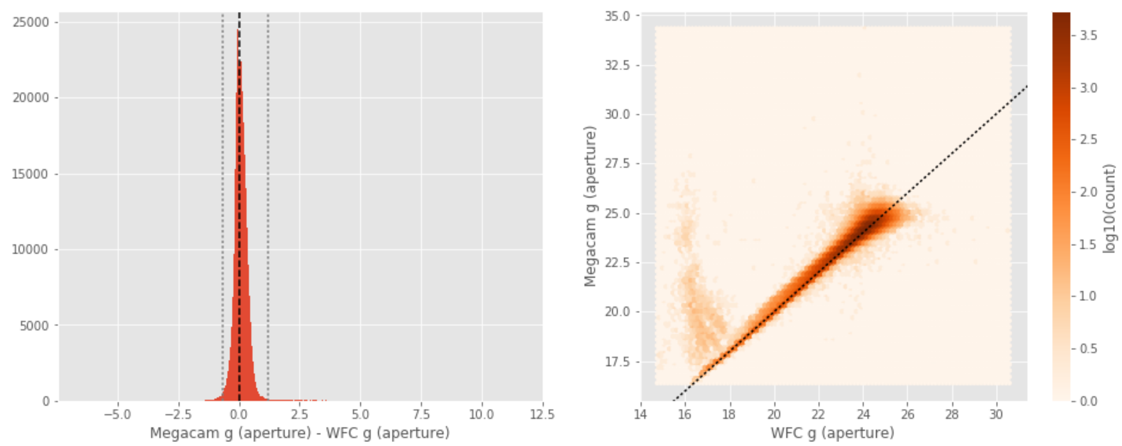
```
Megacam u (aperture) - WFC u (aperture):
- Median: -0.04
- Median Absolute Deviation: 0.25
- 1% percentile: -0.8018979835510254
- 99% percentile: 3.7088455772399915
```



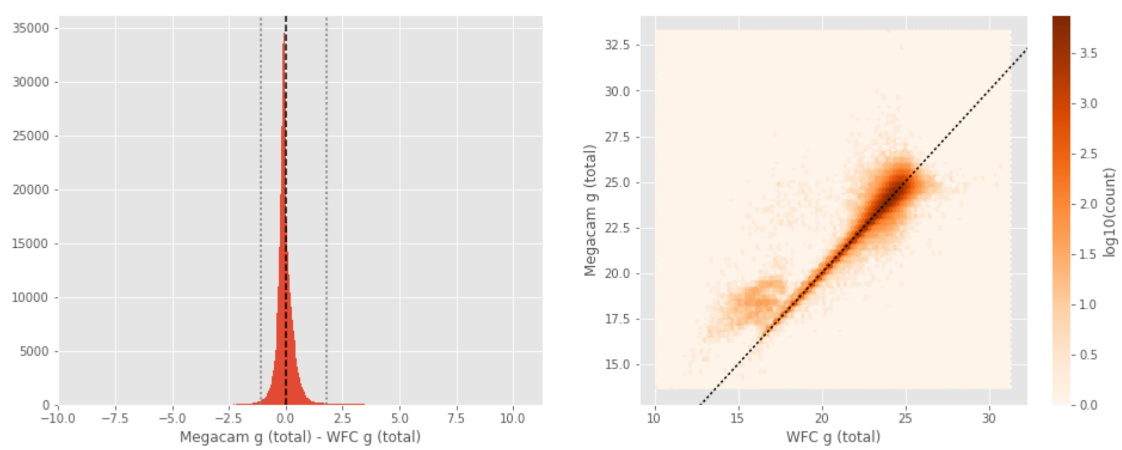

```
Megacam u (total) - WFC u (total):
- Median: -0.24
- Median Absolute Deviation: 0.20
- 1% percentile: -1.133989028930664
- 99% percentile: 2.9416127777099588
```



Megacam g (aperture) - WFC g (aperture):
- Median: 0.07
- Median Absolute Deviation: 0.16
- 1% percentile: -0.6488978195190429
- 99% percentile: 1.2106095886230488

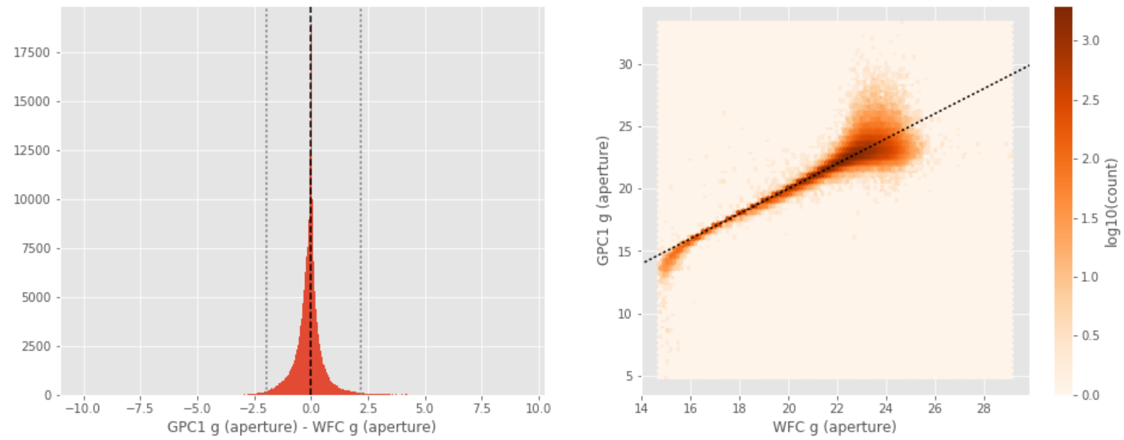


Megacam g (total) - WFC g (total):
- Median: -0.07
- Median Absolute Deviation: 0.16
- 1% percentile: -1.0853500366210938
- 99% percentile: 1.7762260437011719

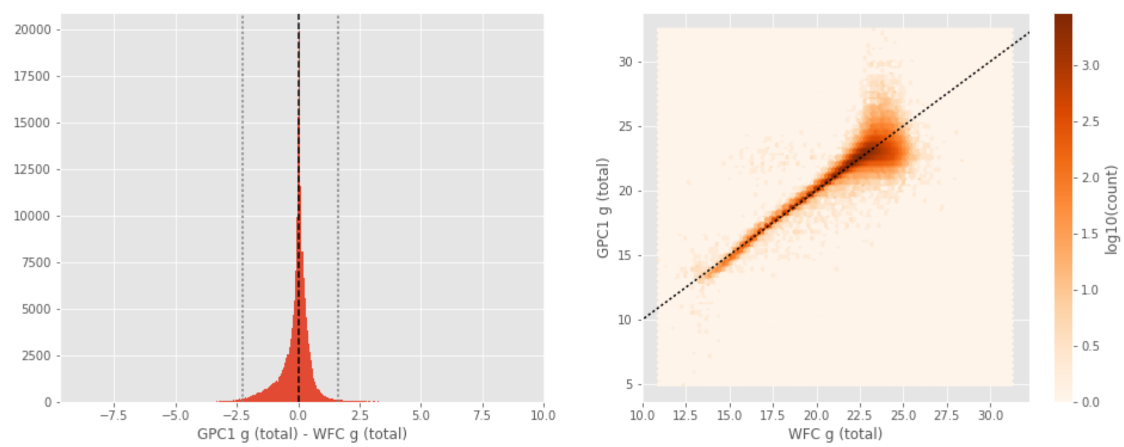


GPC1 g (aperture) - WFC g (aperture):
- Median: -0.04

- Median Absolute Deviation: 0.23
- 1% percentile: -1.936914939880371
- 99% percentile: 2.213923206329347

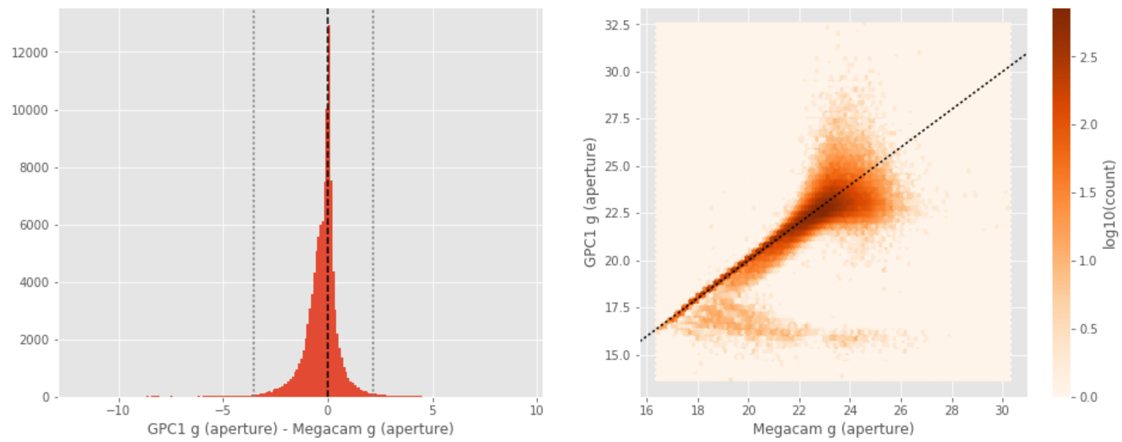


GPC1 g (total) - WFC g (total):
- Median: 0.03
- Median Absolute Deviation: 0.21
- 1% percentile: -2.2826806068420407
- 99% percentile: 1.6533357620239293

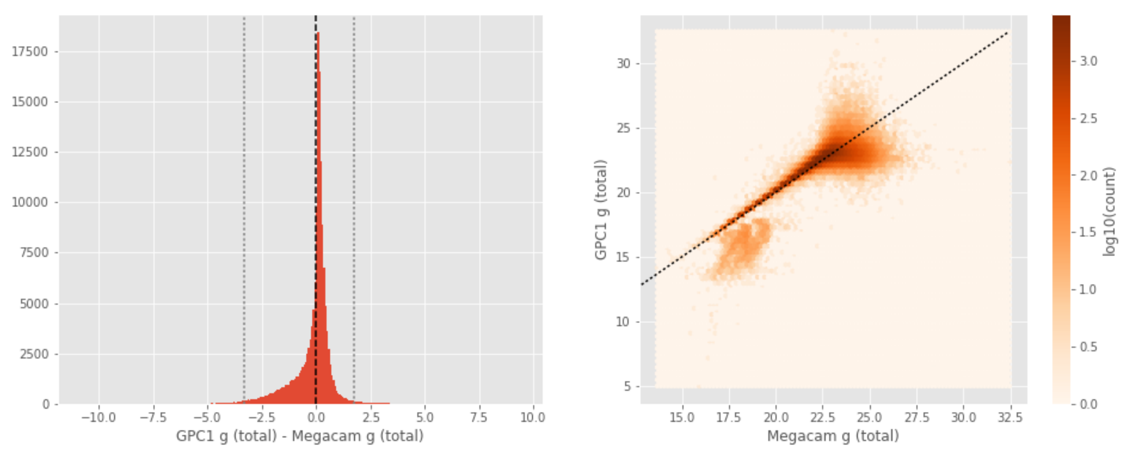


GPC1 g (aperture) - Megacam g (aperture):
- Median: -0.14
- Median Absolute Deviation: 0.34
- 1% percentile: -3.5418136596679686

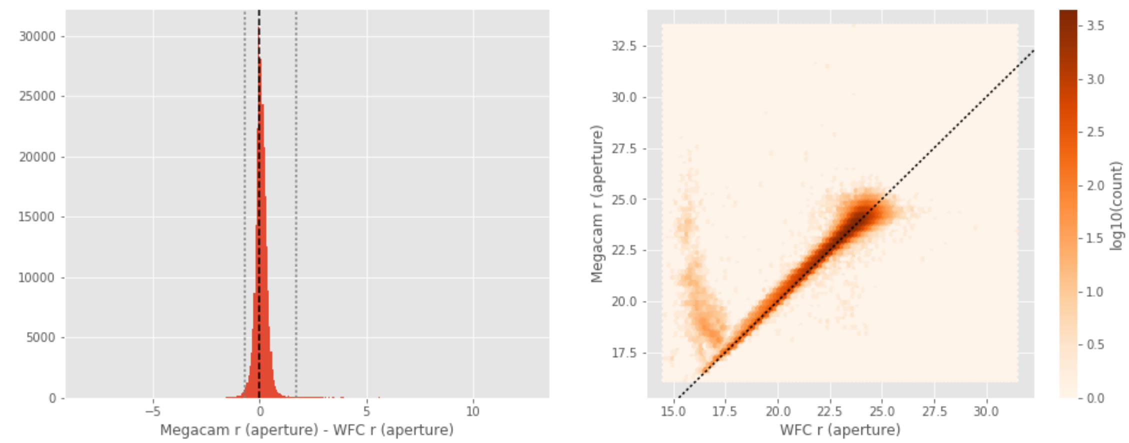
- 99% percentile: 2.190652847290034



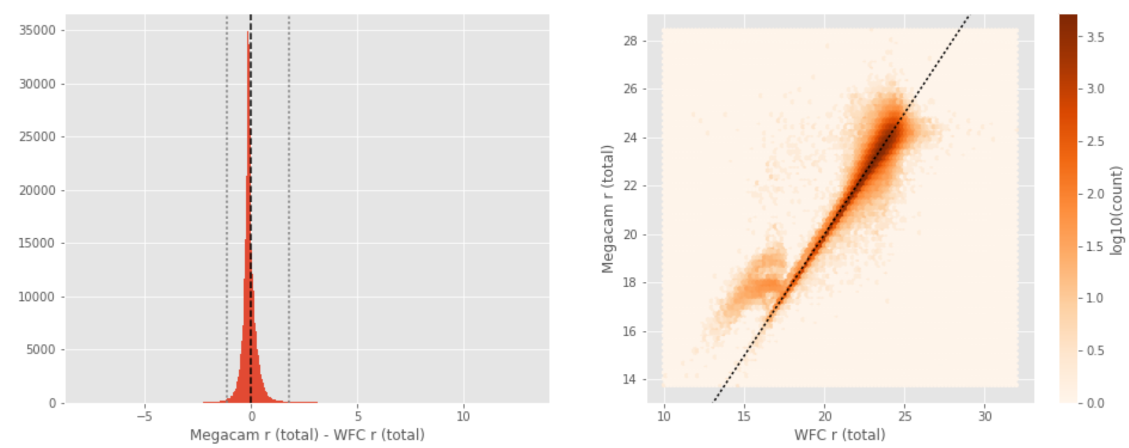
GPC1 g (total) - Megacam g (total):
- Median: 0.09
- Median Absolute Deviation: 0.24
- 1% percentile: -3.3011077880859374
- 99% percentile: 1.7509324264526356



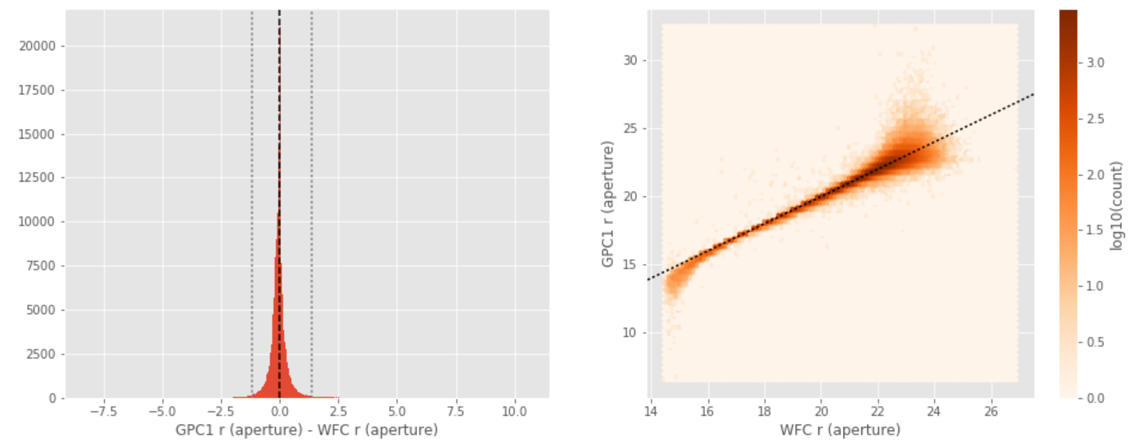
Megacam r (aperture) - WFC r (aperture):
- Median: 0.06
- Median Absolute Deviation: 0.15
- 1% percentile: -0.6783035278320313
- 99% percentile: 1.7159394073486296



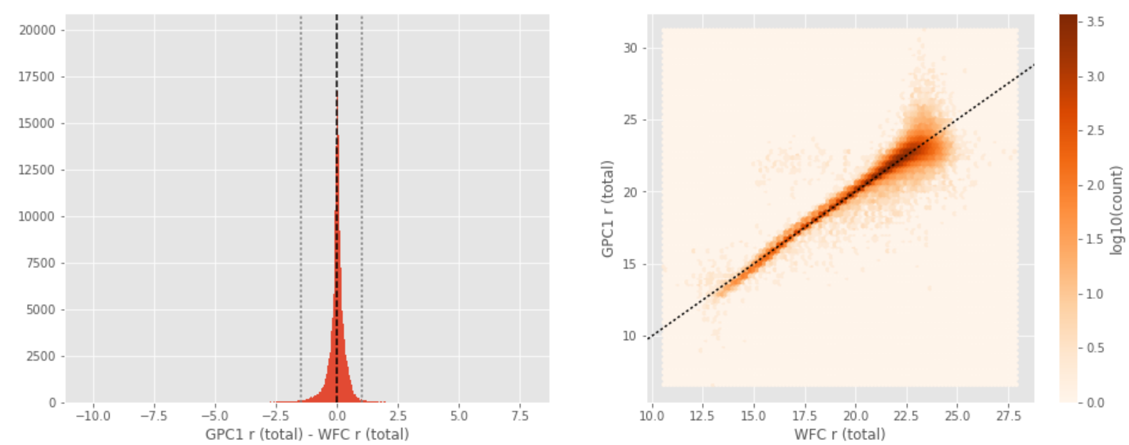
Megacam r (total) - WFC r (total):
- Median: -0.11
- Median Absolute Deviation: 0.14
- 1% percentile: -1.1467682075500487
- 99% percentile: 1.8119490242004397



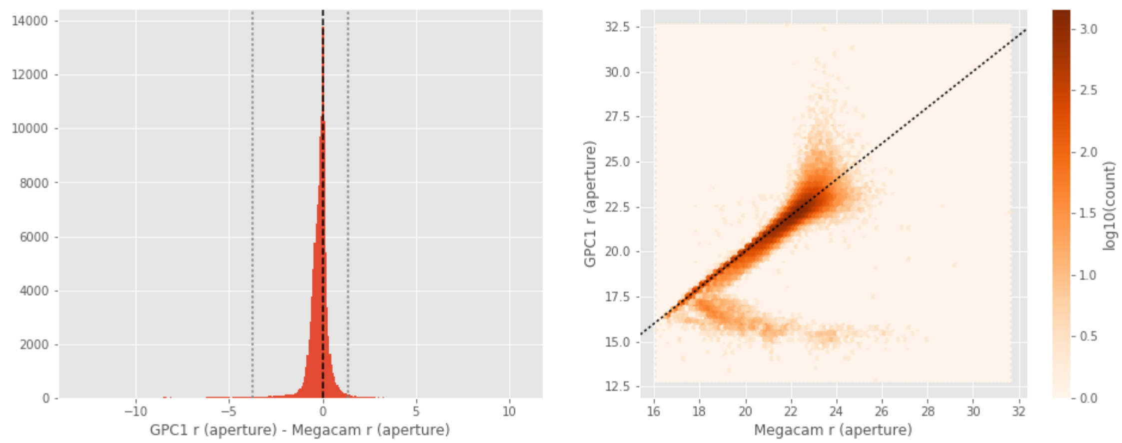
GPC1 r (aperture) - WFC r (aperture):
- Median: -0.04
- Median Absolute Deviation: 0.13
- 1% percentile: -1.1710252380371093
- 99% percentile: 1.3535482025146466



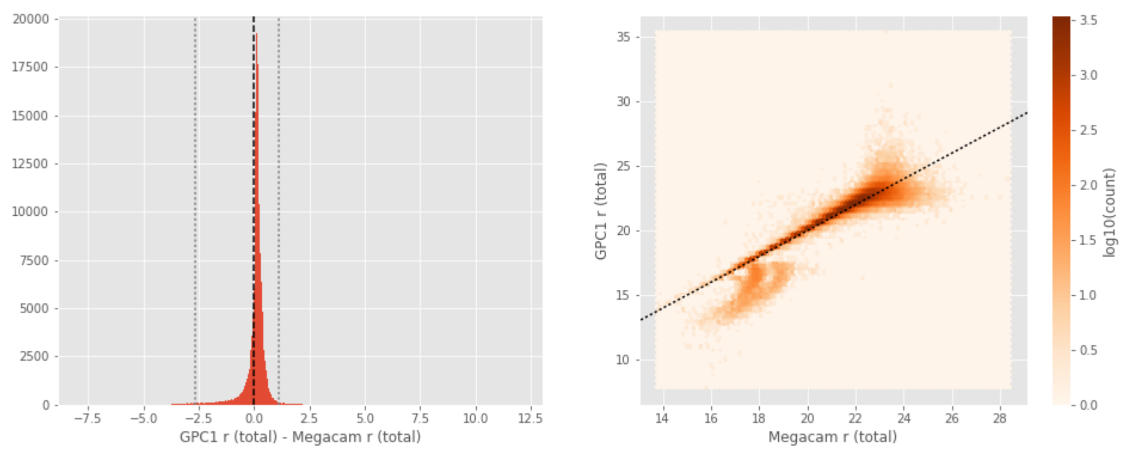
GPC1 r (total) - WFC r (total):
- Median: 0.03
- Median Absolute Deviation: 0.12
- 1% percentile: -1.5002924537658693
- 99% percentile: 1.019995574951169



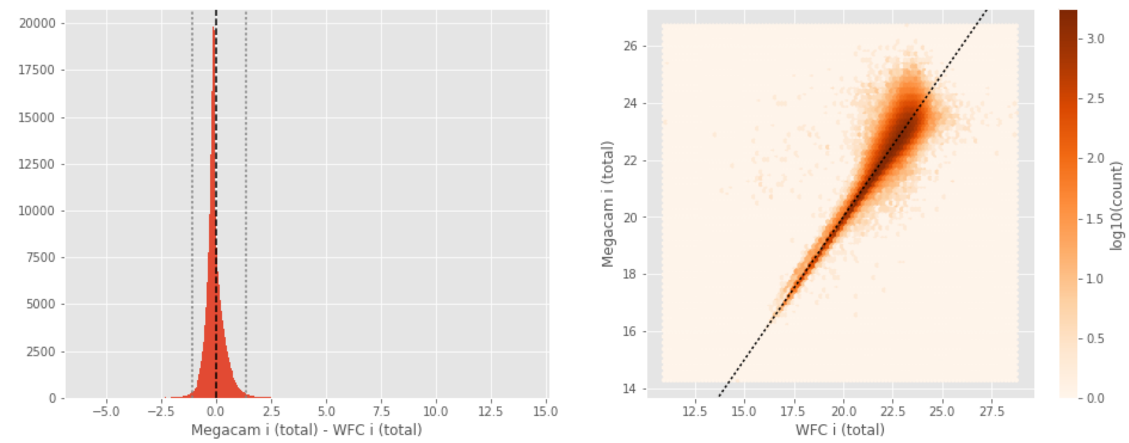
GPC1 r (aperture) - Megacam r (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.22
- 1% percentile: -3.7211384391784668
- 99% percentile: 1.368954734802246



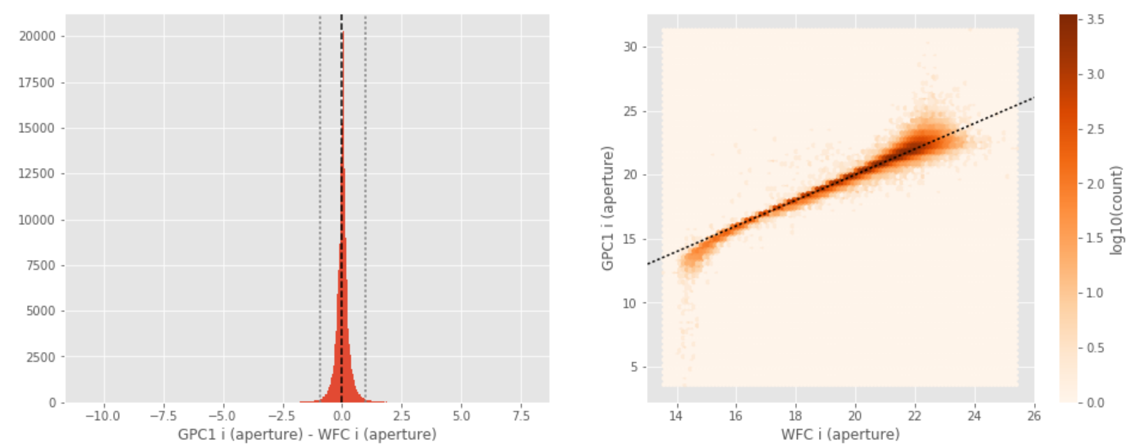
GPC1 r (total) - Megacam r (total):
- Median: 0.13
- Median Absolute Deviation: 0.12
- 1% percentile: -2.6343079566955567
- 99% percentile: 1.1148523330688487



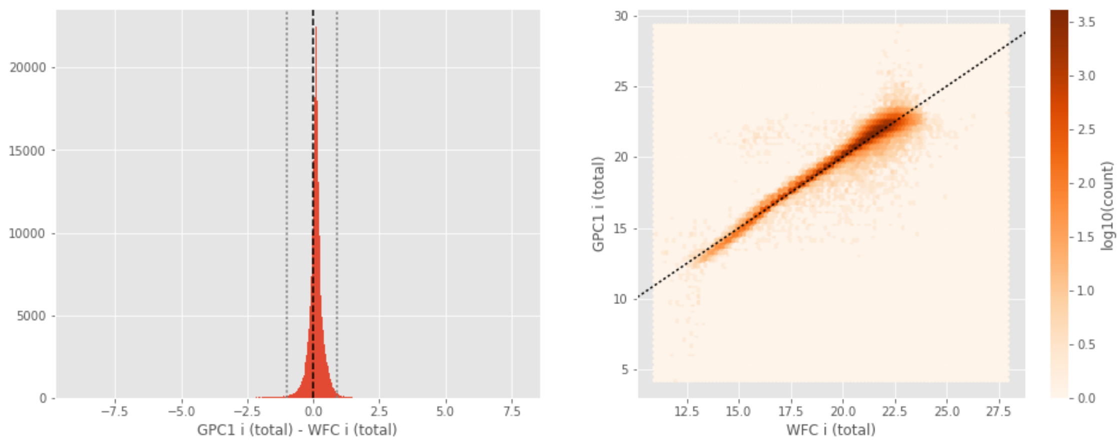
Megacam i (total) - WFC i (total):
- Median: -0.10
- Median Absolute Deviation: 0.18
- 1% percentile: -1.0972267913818359
- 99% percentile: 1.3545275878906249



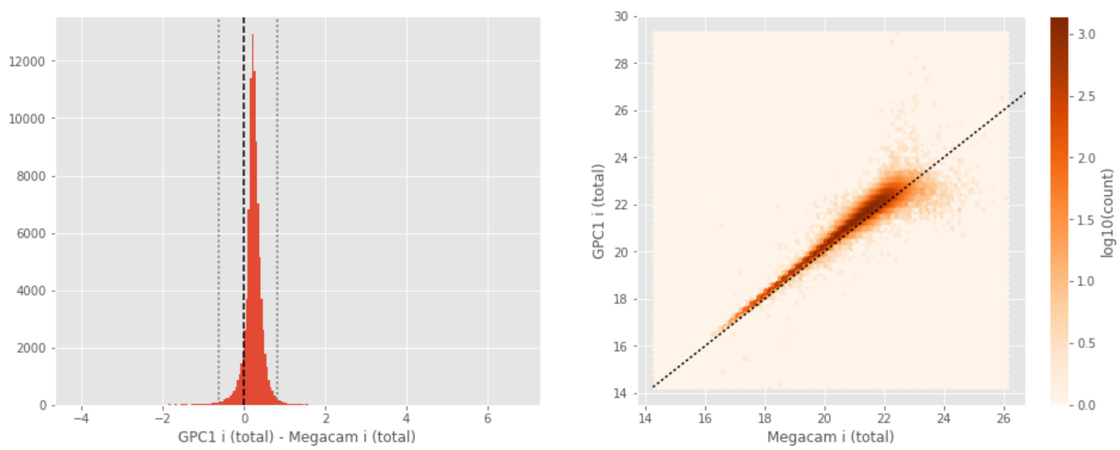
GPC1 i (aperture) - WFC i (aperture):
- Median: 0.03
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9274186611175538
- 99% percentile: 0.9799727630615245



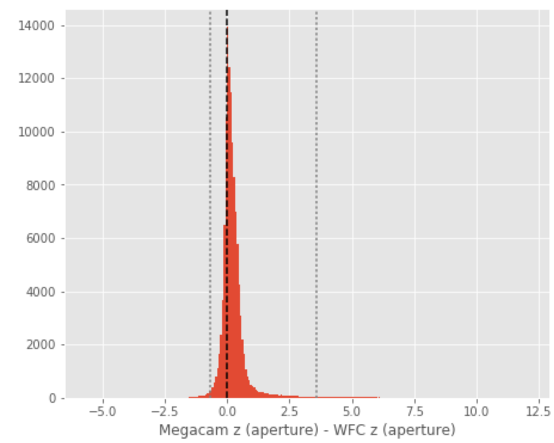
GPC1 i (total) - WFC i (total):
- Median: 0.10
- Median Absolute Deviation: 0.11
- 1% percentile: -1.008834228515625
- 99% percentile: 0.8782679748535149

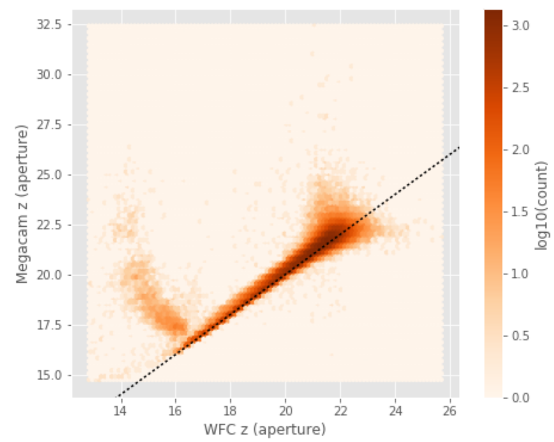


GPC1 i (total) - Megacam i (total):
- Median: 0.23
- Median Absolute Deviation: 0.09
- 1% percentile: -0.6308538055419921
- 99% percentile: 0.8275779342651322

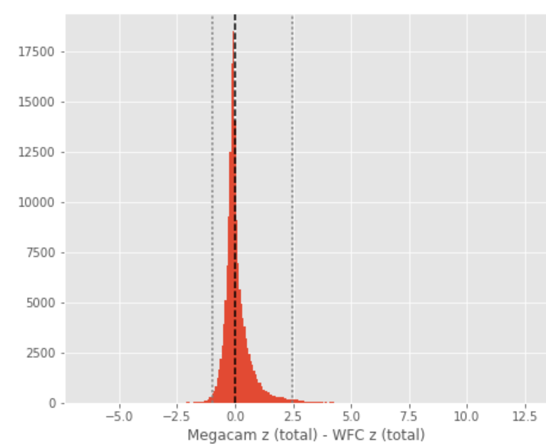


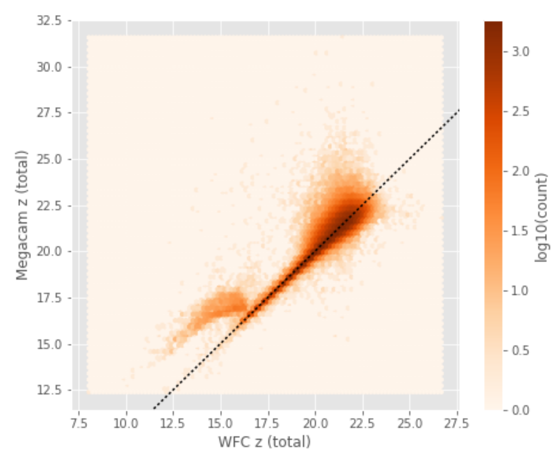
Megacam z (aperture) - WFC z (aperture):
- Median: 0.14
- Median Absolute Deviation: 0.17
- 1% percentile: -0.6702371978759765
- 99% percentile: 3.5893981742858516



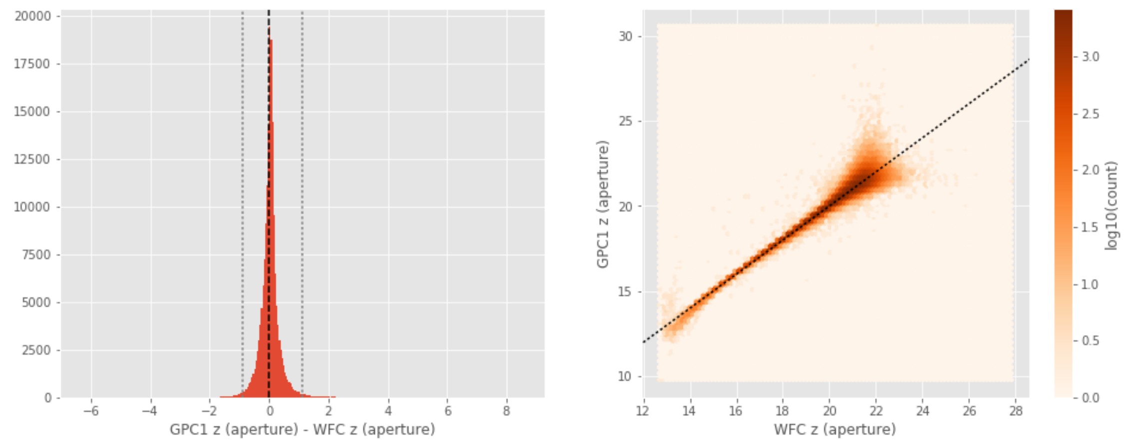


Megacam z (total) - WFC z (total):
- Median: -0.05
- Median Absolute Deviation: 0.21
- 1% percentile: -0.9880290985107422
- 99% percentile: 2.491147117614756

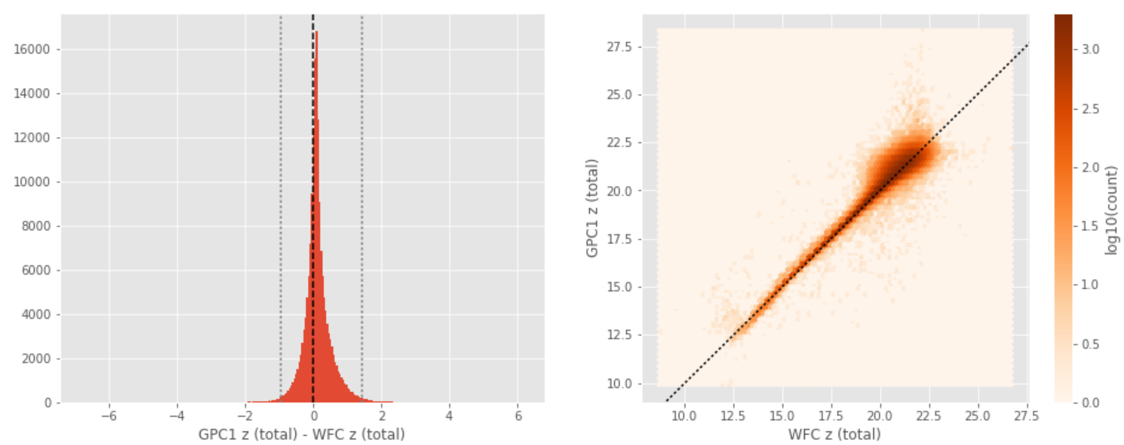




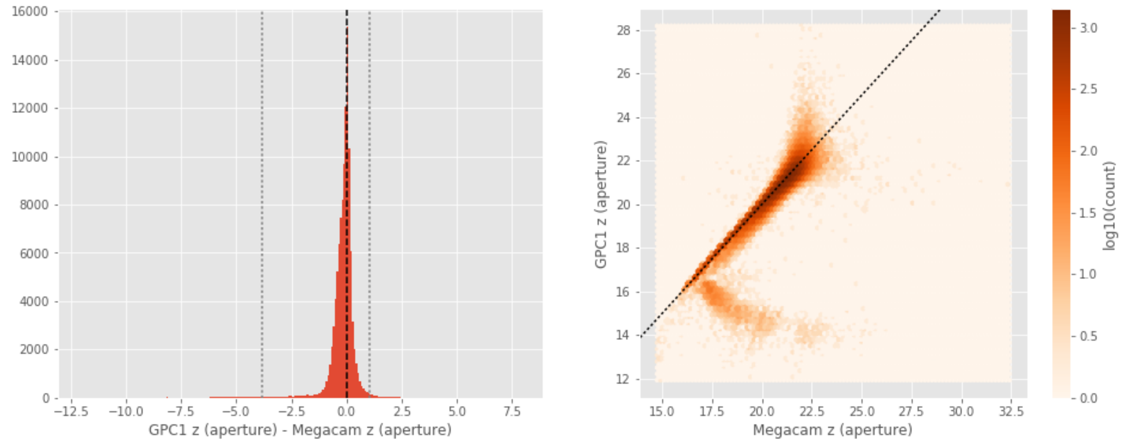
GPC1 z (aperture) - WFC z (aperture):
- Median: 0.04
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8755176925659179
- 99% percentile: 1.1334119796752926



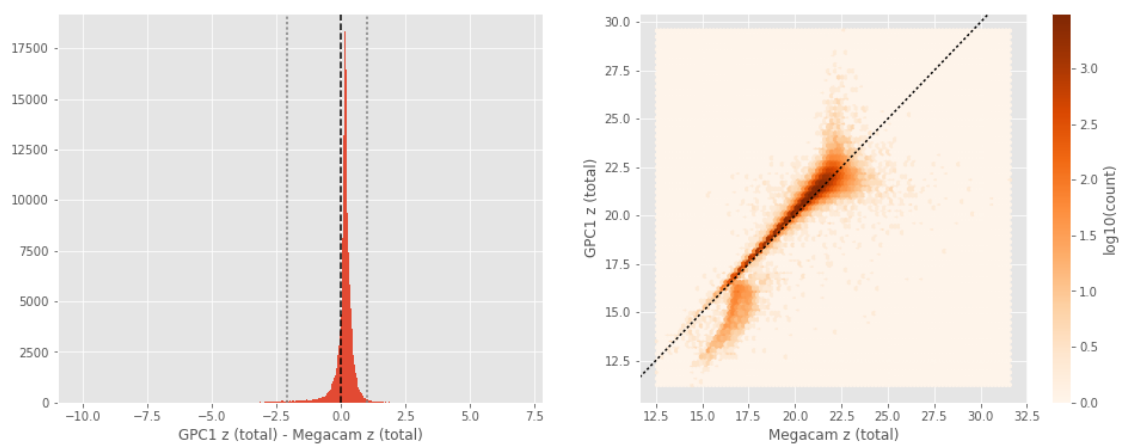
GPC1 z (total) - WFC z (total):
- Median: 0.08
- Median Absolute Deviation: 0.17
- 1% percentile: -0.9569845581054688
- 99% percentile: 1.4286836242675776



GPC1 z (aperture) - Megacam z (aperture):
- Median: -0.06
- Median Absolute Deviation: 0.20
- 1% percentile: -3.8274253082275393
- 99% percentile: 1.0357662200927726




```
GPC1 z (total) - Megacam z (total):
- Median: 0.16
- Median Absolute Deviation: 0.11
- 1% percentile: -2.113486852645874
- 99% percentile: 0.9969313812255862
```




```
No sources have both Megacam y (total) and GPC1 y (total) values.
```

1.5 III - Comparing magnitudes to reference bands

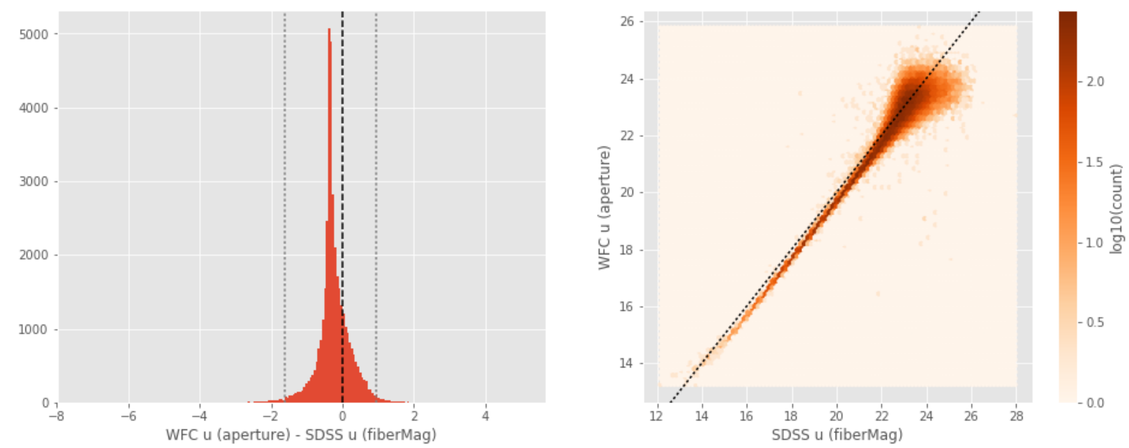
Cross-match the master list to SDSS magnitudes.

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

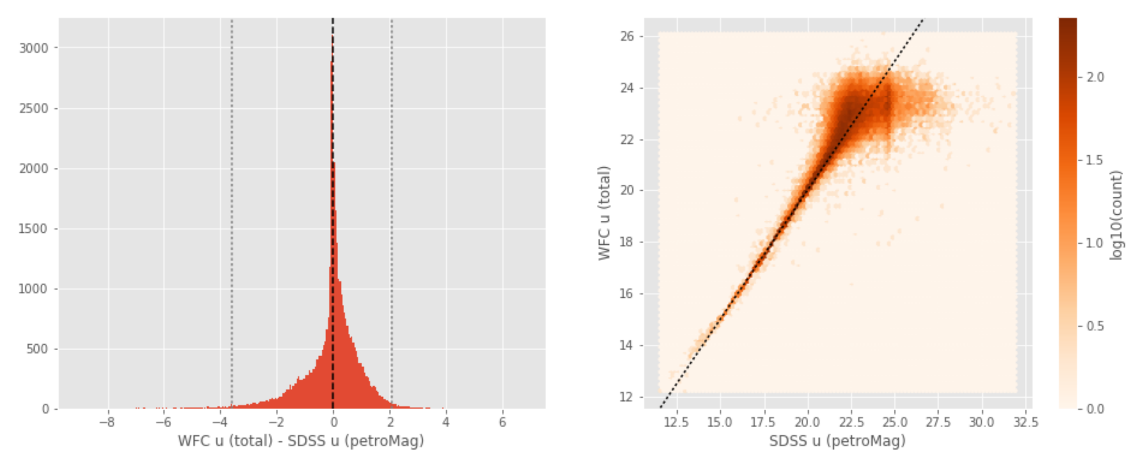
The catalogue is cross-matched to SDSS-DR13 withing 0.2 arcsecond.

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.

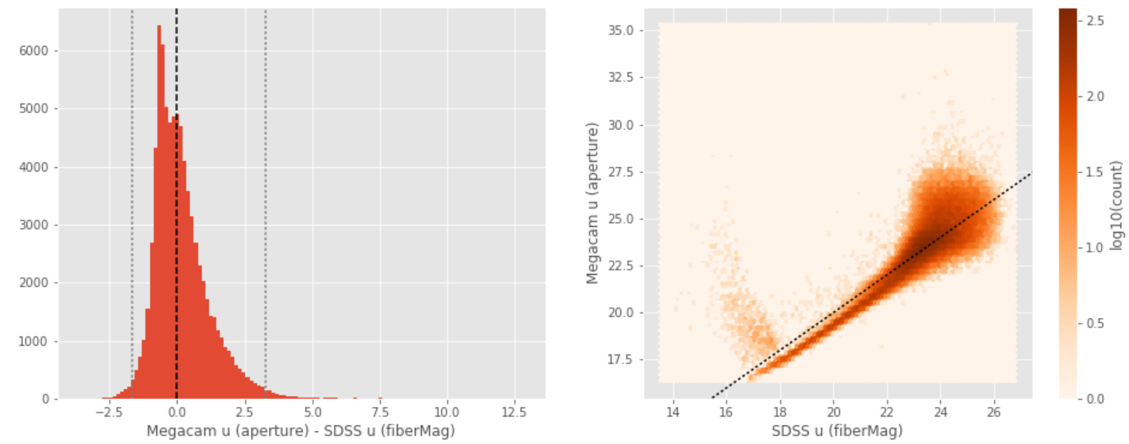
```
WFC u (aperture) - SDSS u (fiberMag):
- Median: -0.30
- Median Absolute Deviation: 0.18
- 1% percentile: -1.6183706665039062
- 99% percentile: 0.9621364212036125
```



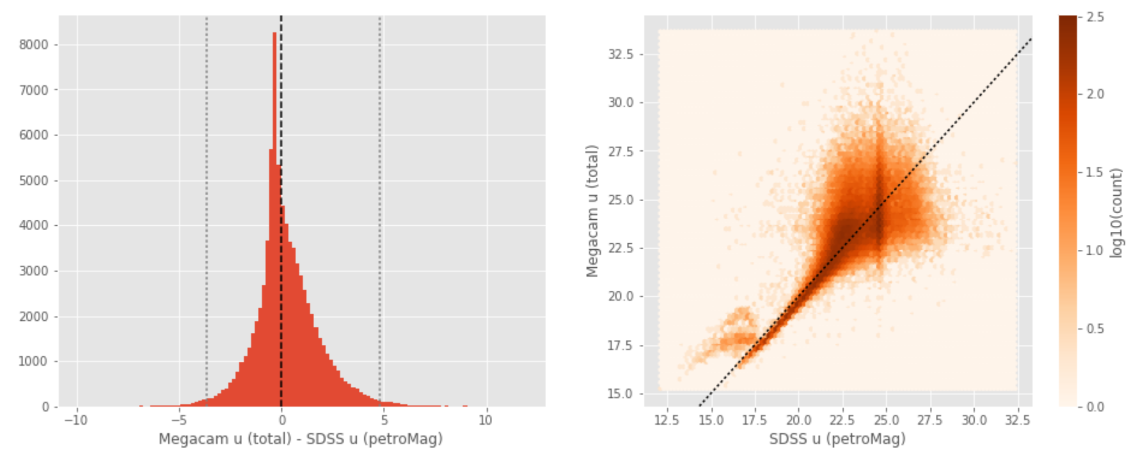

```
WFC u (total) - SDSS u (petroMag):
- Median: 0.02
- Median Absolute Deviation: 0.39
- 1% percentile: -3.5911664962768555
- 99% percentile: 2.0833364486694332
```



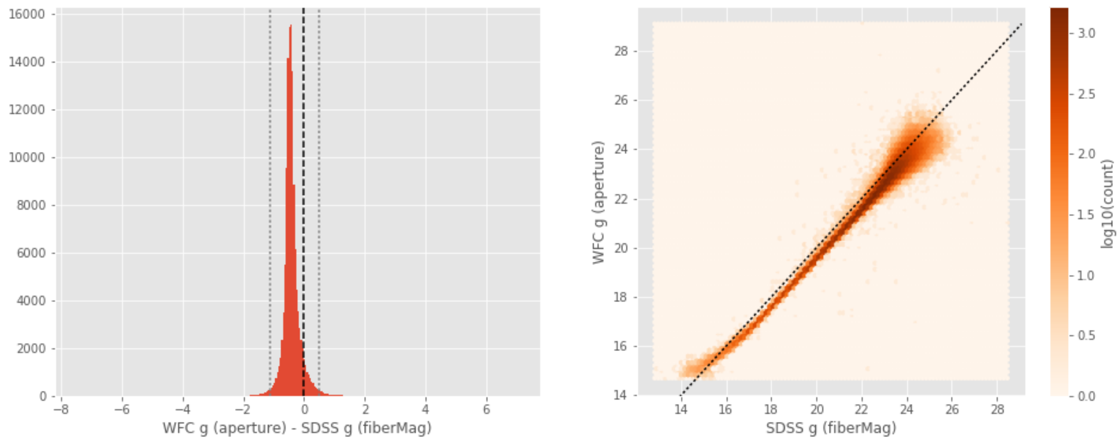
```
Megacam u (aperture) - SDSS u (fiberMag):
- Median: -0.04
- Median Absolute Deviation: 0.58
- 1% percentile: -1.6583412170410157
- 99% percentile: 3.297002315521247
```



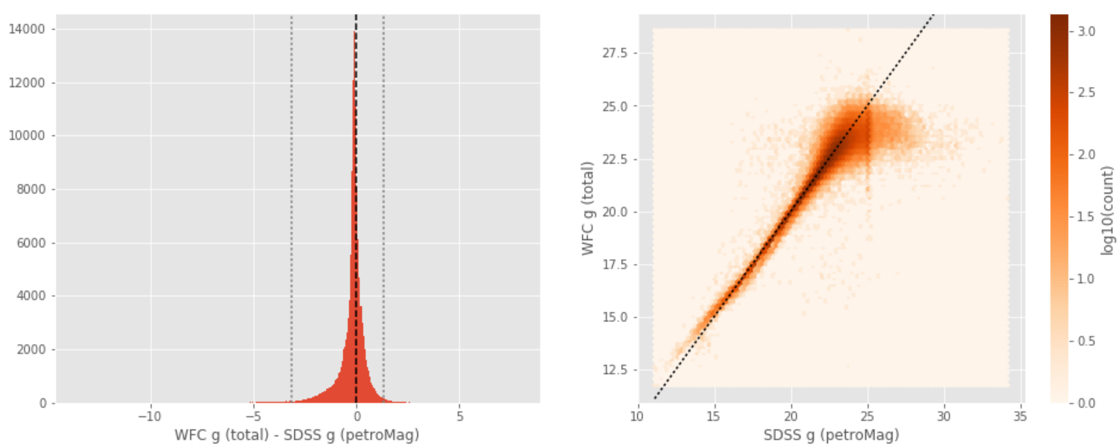

```
Megacam u (total) - SDSS u (petroMag):
- Median: 0.01
- Median Absolute Deviation: 0.78
- 1% percentile: -3.667929153442383
- 99% percentile: 4.777685279846186
```



WFC g (aperture) - SDSS g (fiberMag):
- Median: -0.44
- Median Absolute Deviation: 0.11
- 1% percentile: -1.1331189155578614
- 99% percentile: 0.5049597740173323

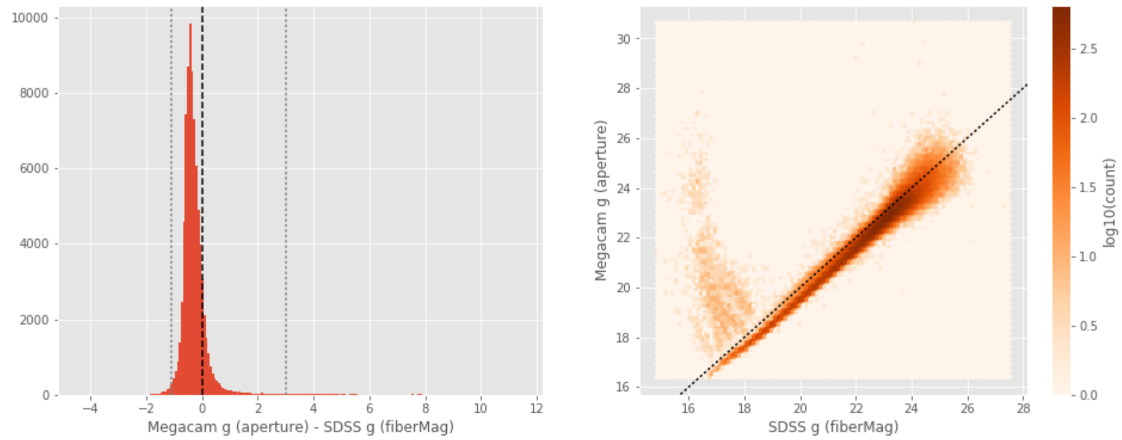


WFC g (total) - SDSS g (petroMag):
- Median: -0.10
- Median Absolute Deviation: 0.20
- 1% percentile: -3.129057636260986
- 99% percentile: 1.3354981803893995

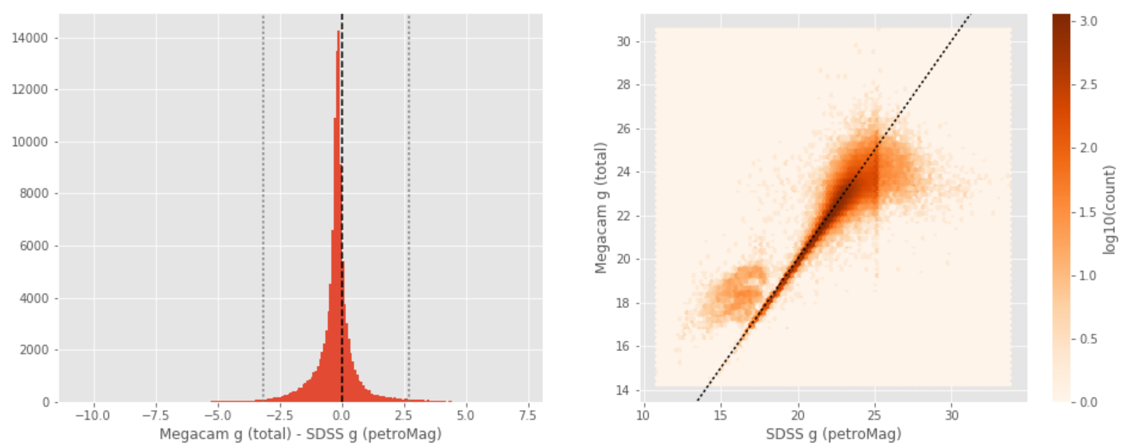


Megacam g (aperture) - SDSS g (fiberMag):
- Median: -0.36

- Median Absolute Deviation: 0.18
- 1% percentile: -1.1016152000427246
- 99% percentile: 3.0158825111388934

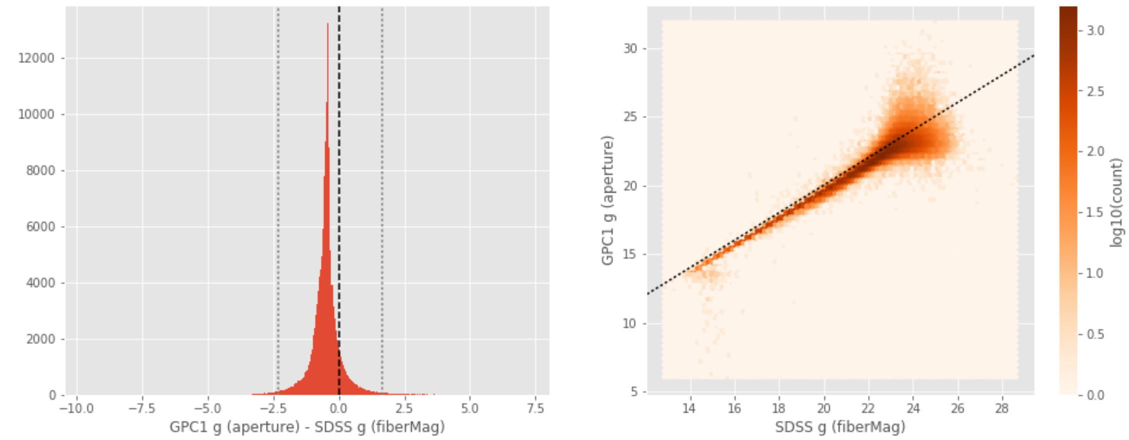


Megacam g (total) - SDSS g (petroMag):
- Median: -0.19
- Median Absolute Deviation: 0.22
- 1% percentile: -3.1404543685913087
- 99% percentile: 2.7350458717346218

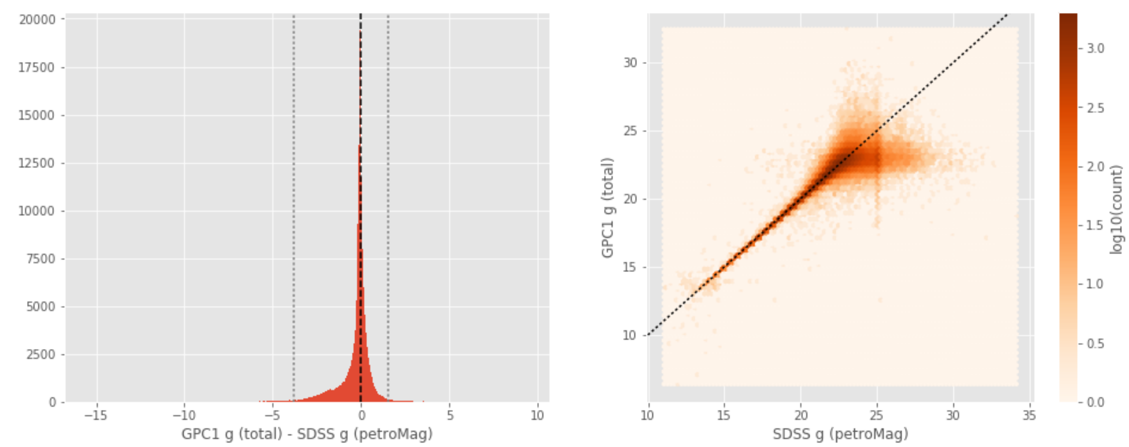


GPC1 g (aperture) - SDSS g (fiberMag):
- Median: -0.46
- Median Absolute Deviation: 0.20
- 1% percentile: -2.3214307403564454

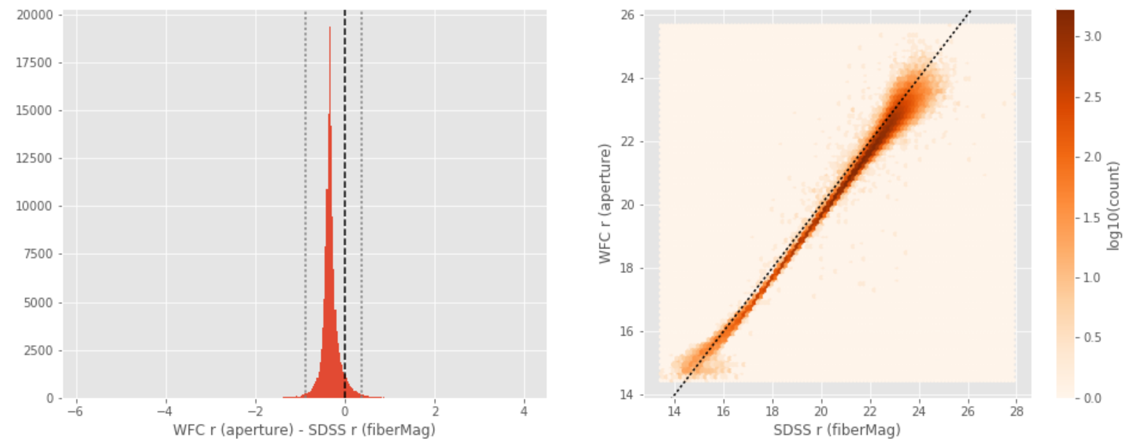
- 99% percentile: 1.6727563476562555



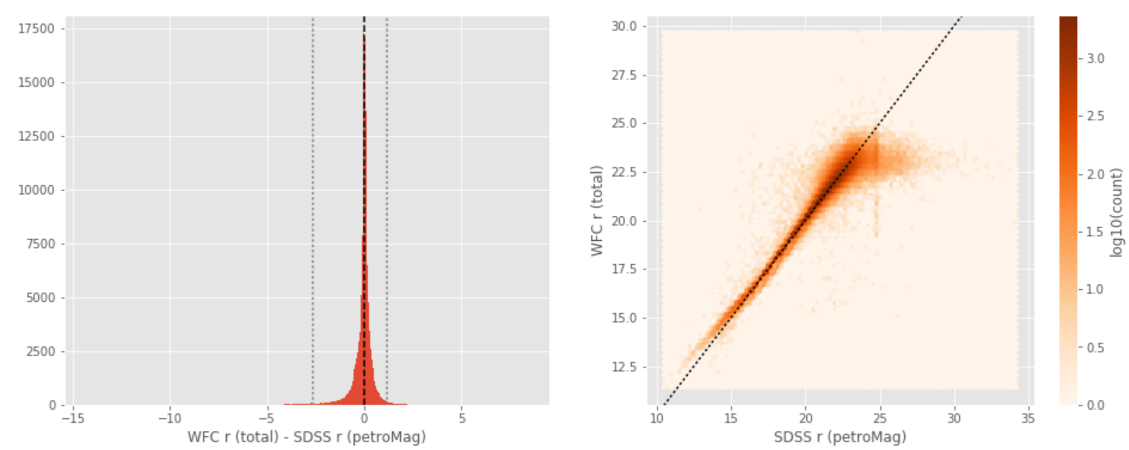
GPC1 g (total) - SDSS g (petroMag):
- Median: -0.07
- Median Absolute Deviation: 0.21
- 1% percentile: -3.8290951538085936
- 99% percentile: 1.566672172546387



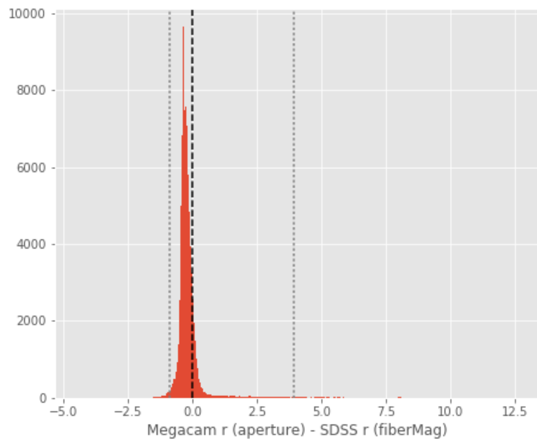
WFC r (aperture) - SDSS r (fiberMag):
- Median: -0.34
- Median Absolute Deviation: 0.07
- 1% percentile: -0.890346794128418
- 99% percentile: 0.36871064186096253

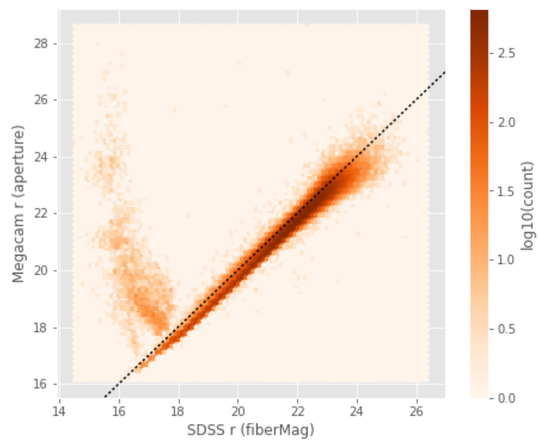


WFC r (total) - SDSS r (petroMag):
- Median: 0.02
- Median Absolute Deviation: 0.13
- 1% percentile: -2.631558589935303
- 99% percentile: 1.1928212451934812

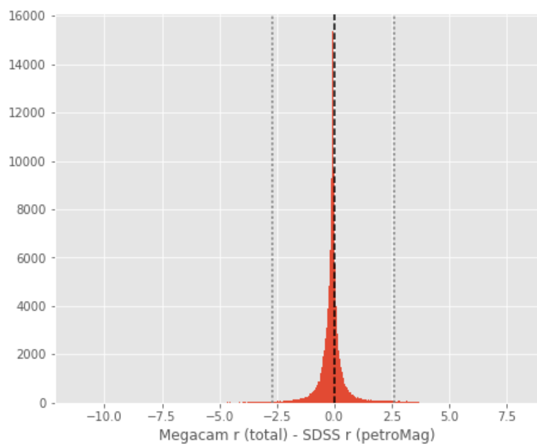


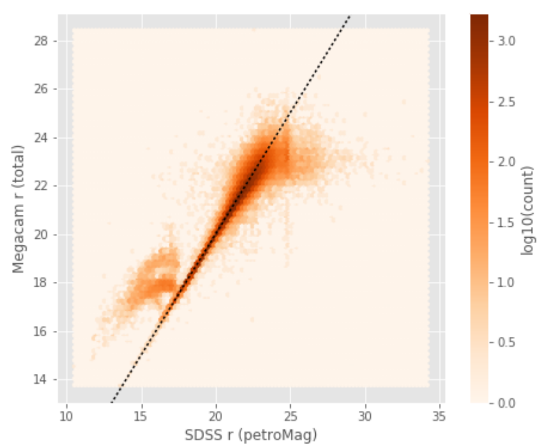
Megacam r (aperture) - SDSS r (fiberMag):
- Median: -0.27
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8717788696289063
- 99% percentile: 3.9546873378753666



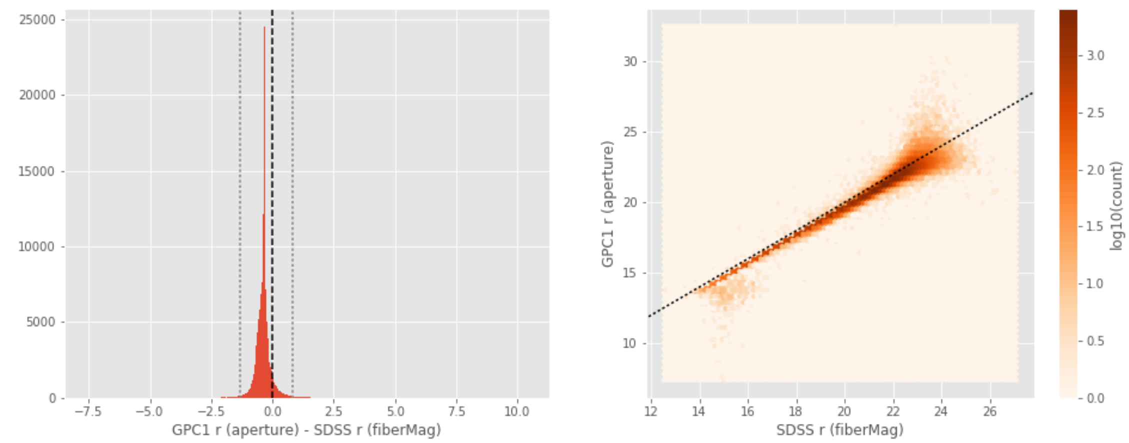


Megacam r (total) - SDSS r (petroMag):
- Median: -0.08
- Median Absolute Deviation: 0.14
- 1% percentile: -2.6924261474609374
- 99% percentile: 2.625380144119263

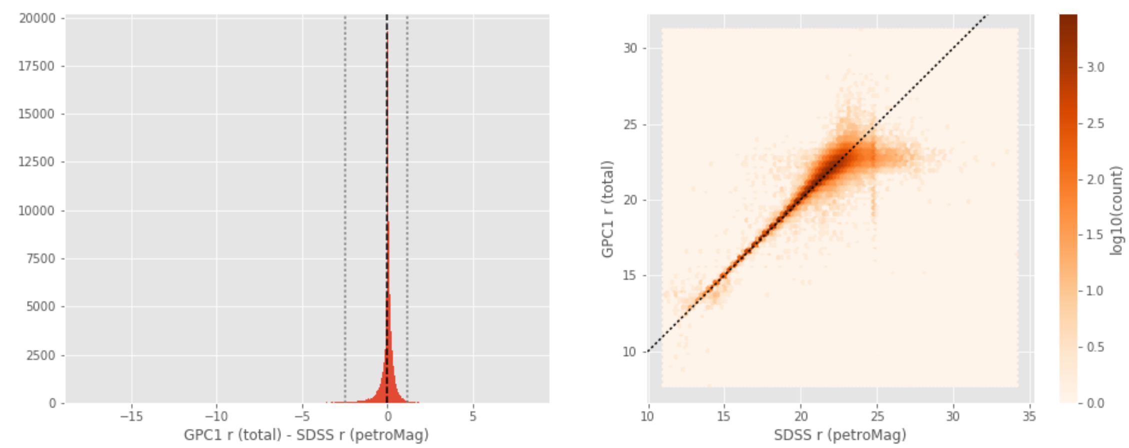




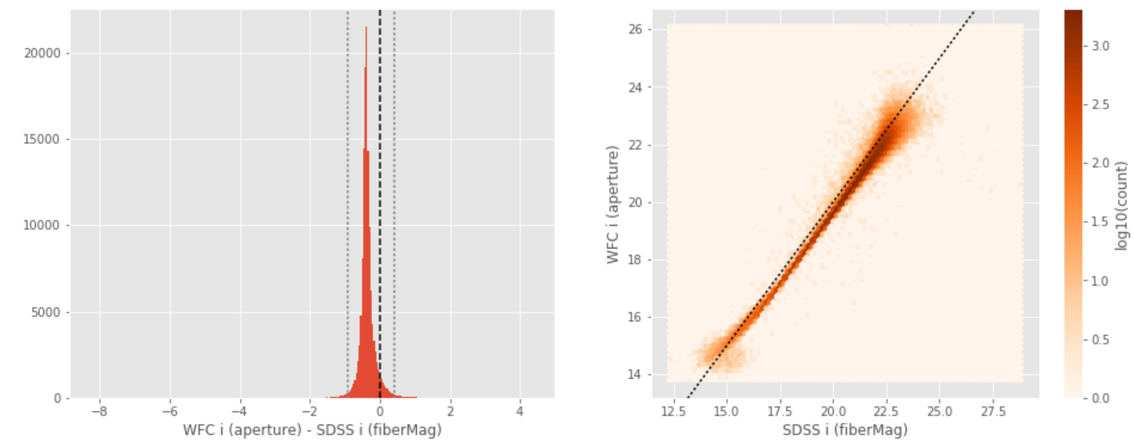
GPC1 r (aperture) - SDSS r (fiberMag):
- Median: -0.35
- Median Absolute Deviation: 0.11
- 1% percentile: -1.2985172271728516
- 99% percentile: 0.8457000732421677



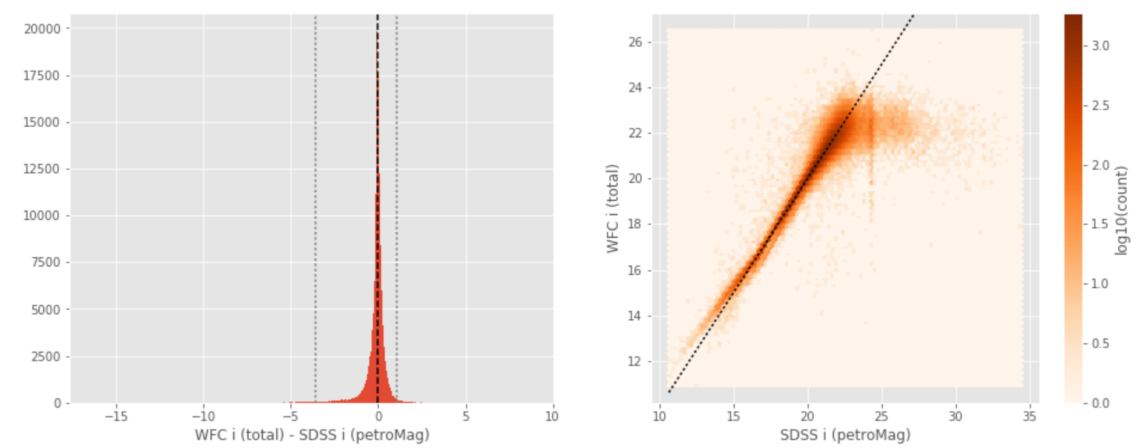
GPC1 r (total) - SDSS r (petroMag):
- Median: 0.04
- Median Absolute Deviation: 0.12
- 1% percentile: -2.490856704711914
- 99% percentile: 1.1595484161376994



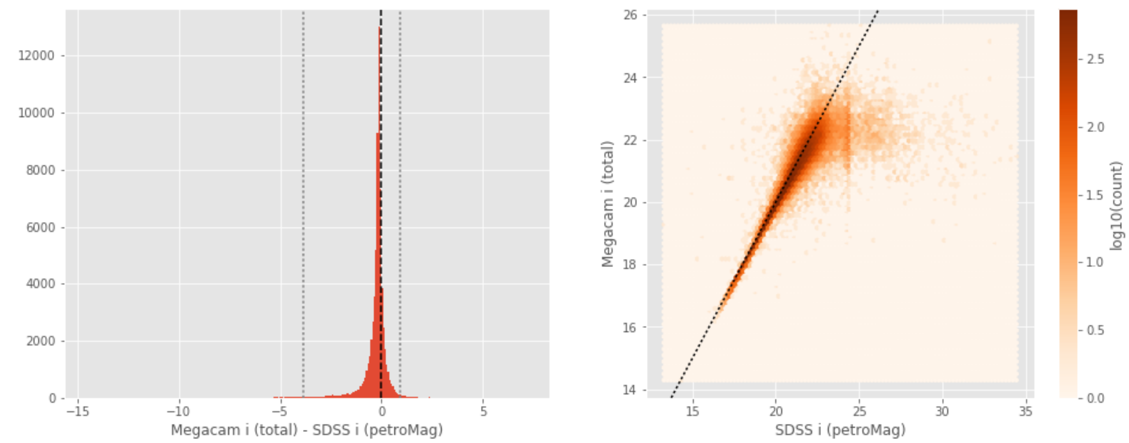
WFC i (aperture) - SDSS i (fiberMag):
- Median: -0.39
- Median Absolute Deviation: 0.08
- 1% percentile: -0.9288136291503907
- 99% percentile: 0.4154920196533197



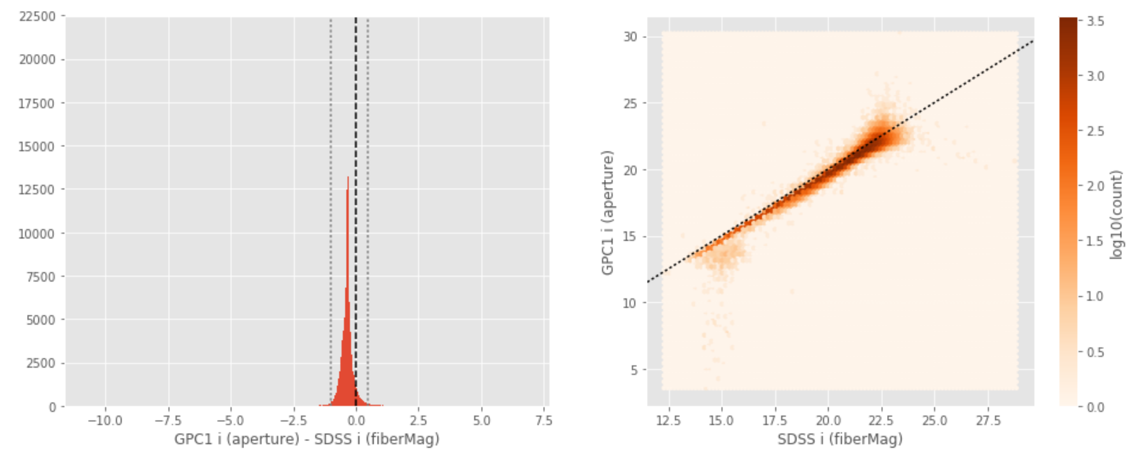
WFC i (total) - SDSS i (petroMag):
- Median: -0.03
- Median Absolute Deviation: 0.15
- 1% percentile: -3.5953659820556645
- 99% percentile: 1.096096134185793



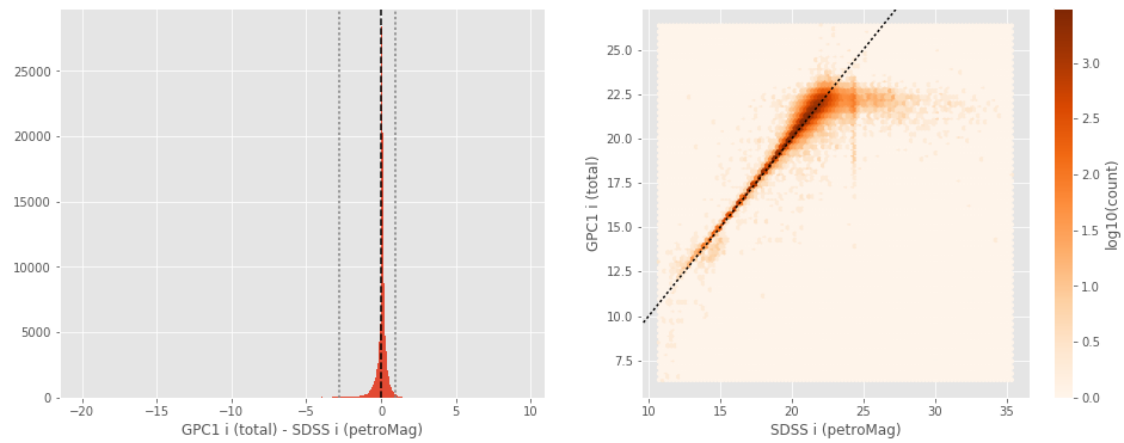
Megacam i (total) - SDSS i (petroMag):
- Median: -0.15
- Median Absolute Deviation: 0.14
- 1% percentile: -3.882351112365723
- 99% percentile: 0.9395841598510641



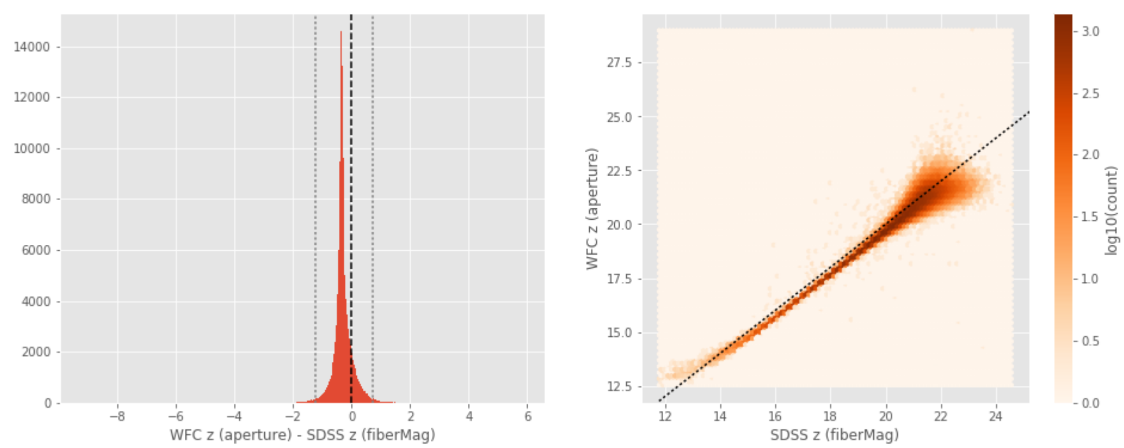
GPC1 i (aperture) - SDSS i (fiberMag):
- Median: -0.34
- Median Absolute Deviation: 0.09
- 1% percentile: -1.0123353004455566
- 99% percentile: 0.48122777938842726



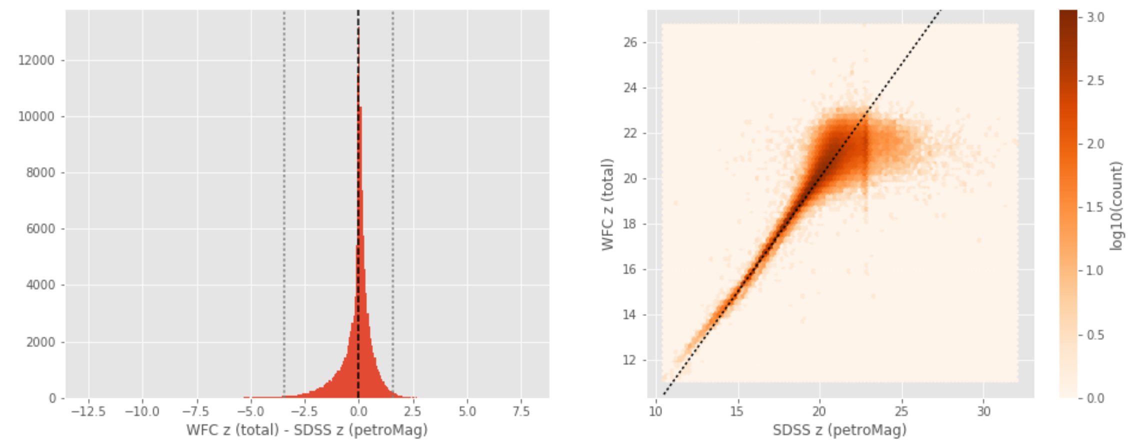
GPC1 i (total) - SDSS i (petroMag):
- Median: 0.06
- Median Absolute Deviation: 0.10
- 1% percentile: -2.792536354064941
- 99% percentile: 0.9313366699218764



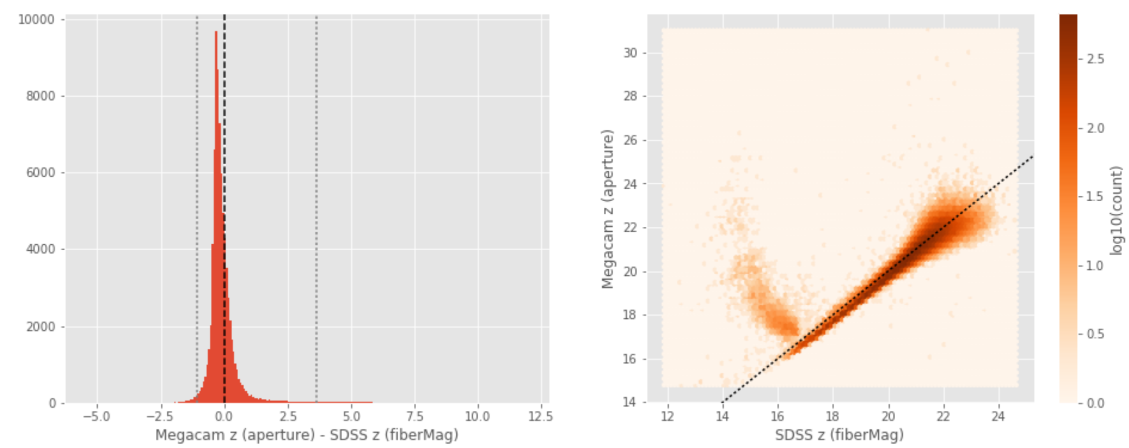
WFC z (aperture) - SDSS z (fiberMag):
- Median: -0.33
- Median Absolute Deviation: 0.11
- 1% percentile: -1.2395364761352539
- 99% percentile: 0.7405158233642565



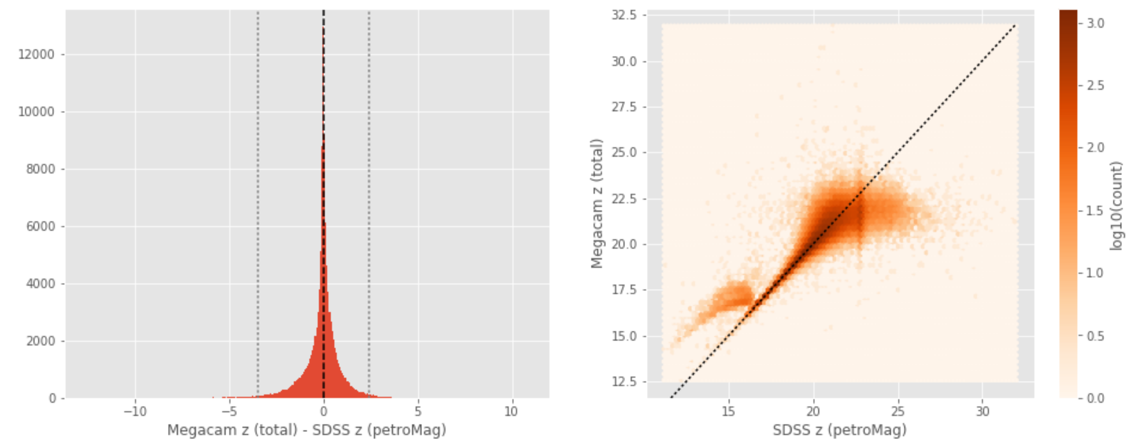
WFC z (total) - SDSS z (petroMag):
- Median: 0.02
- Median Absolute Deviation: 0.25
- 1% percentile: -3.4191538238525396
- 99% percentile: 1.5841140365600588



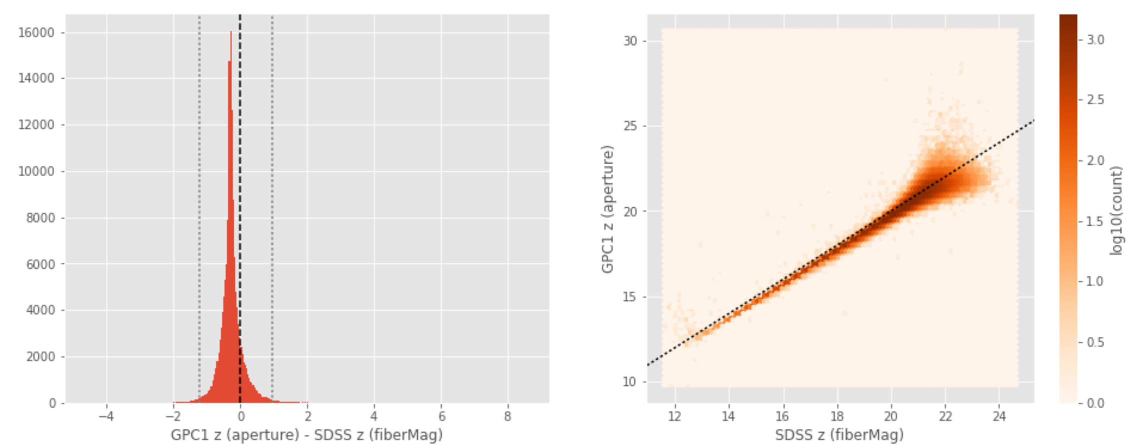
Megacam z (aperture) - SDSS z (fiberMag):
- Median: -0.19
- Median Absolute Deviation: 0.19
- 1% percentile: -1.0708820343017578
- 99% percentile: 3.6499409675597967



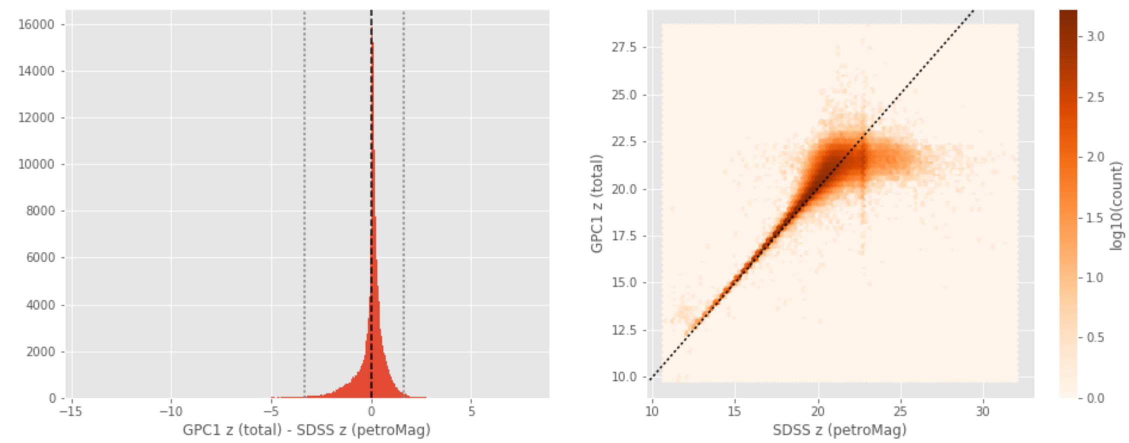
Megacam z (total) - SDSS z (petroMag):
- Median: -0.02
- Median Absolute Deviation: 0.29
- 1% percentile: -3.4646348953247066
- 99% percentile: 2.3932061958312985



GPC1 z (aperture) - SDSS z (fiberMag):
- Median: -0.29
- Median Absolute Deviation: 0.13
- 1% percentile: -1.2182876586914062
- 99% percentile: 0.9481426239013657



GPC1 z (total) - SDSS z (petroMag):
- Median: 0.10
- Median Absolute Deviation: 0.22
- 1% percentile: -3.3037926483154294
- 99% percentile: 1.6336569023132324



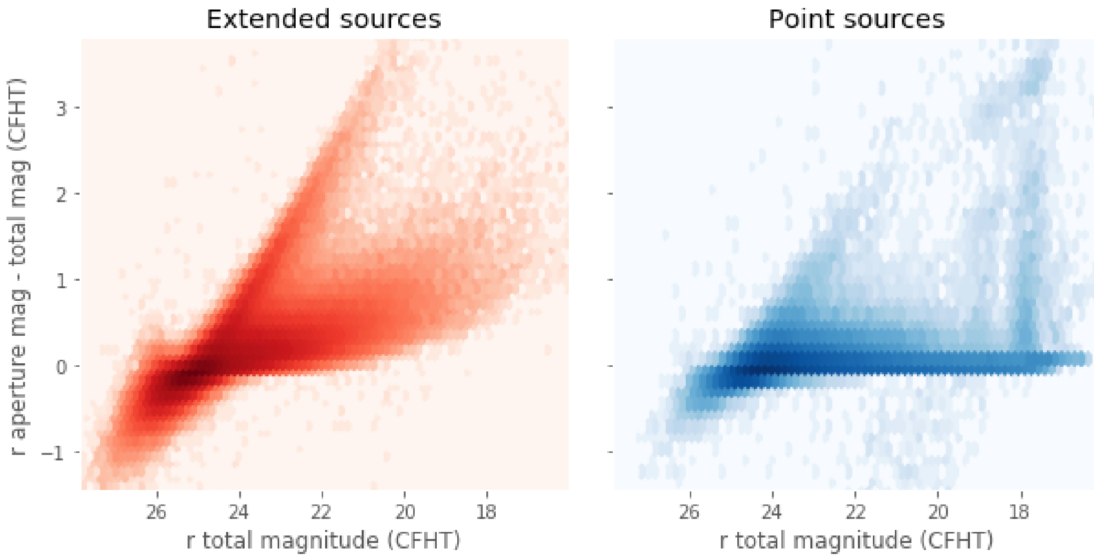
1.6 Keeping only sources with good signal to noise ratio

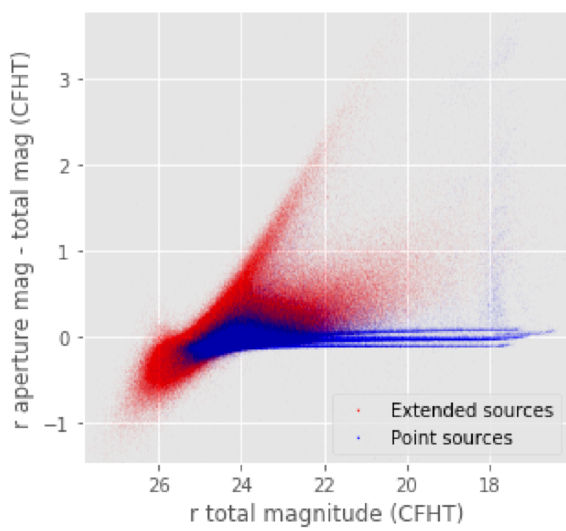
From here, we are only comparing sources with a signal to noise ratio above 3, i.e. roughly we a magnitude error below 0.3.

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.

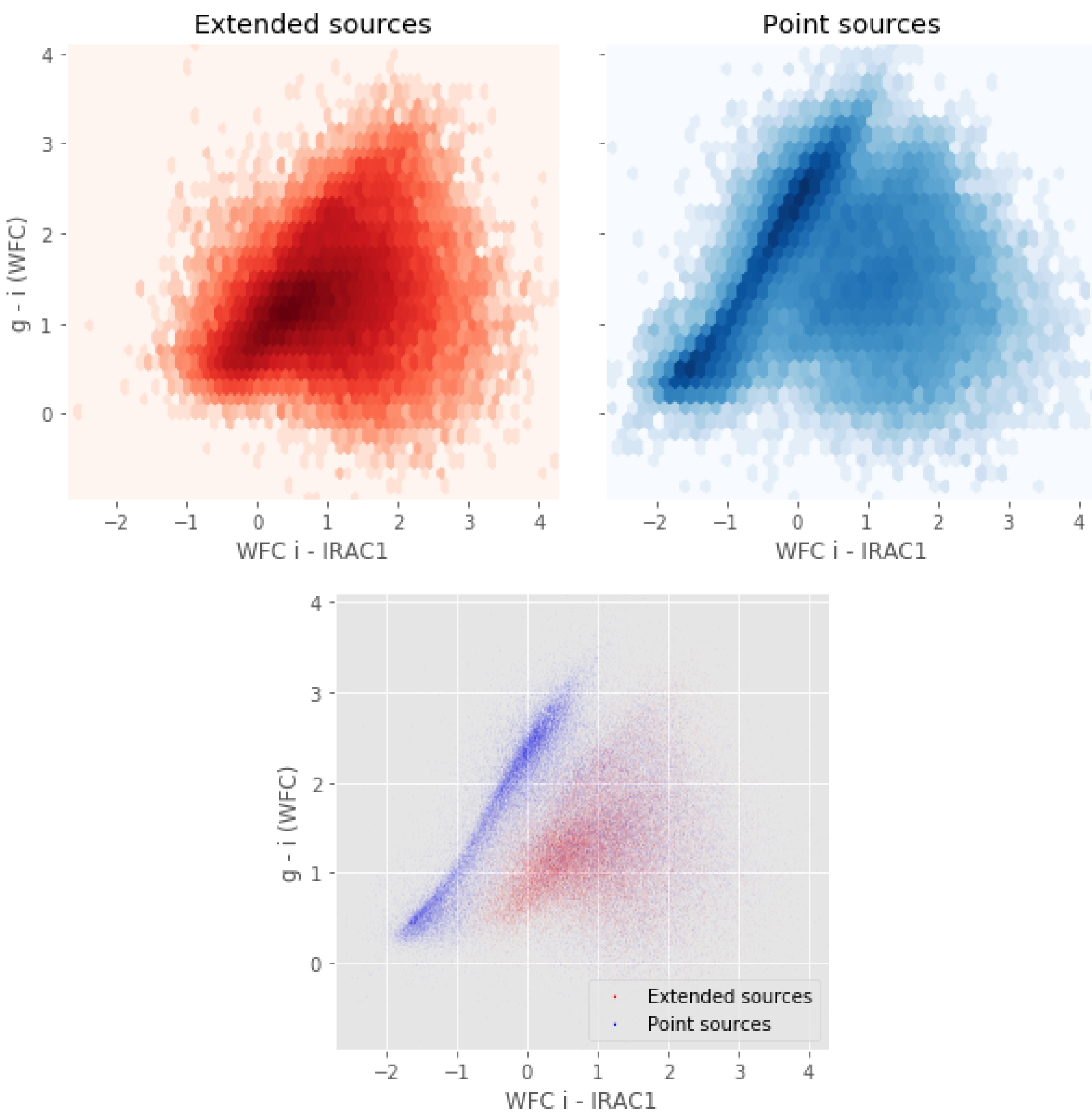
```
Number of source used: 764942 / 1783240 (42.90%)
```



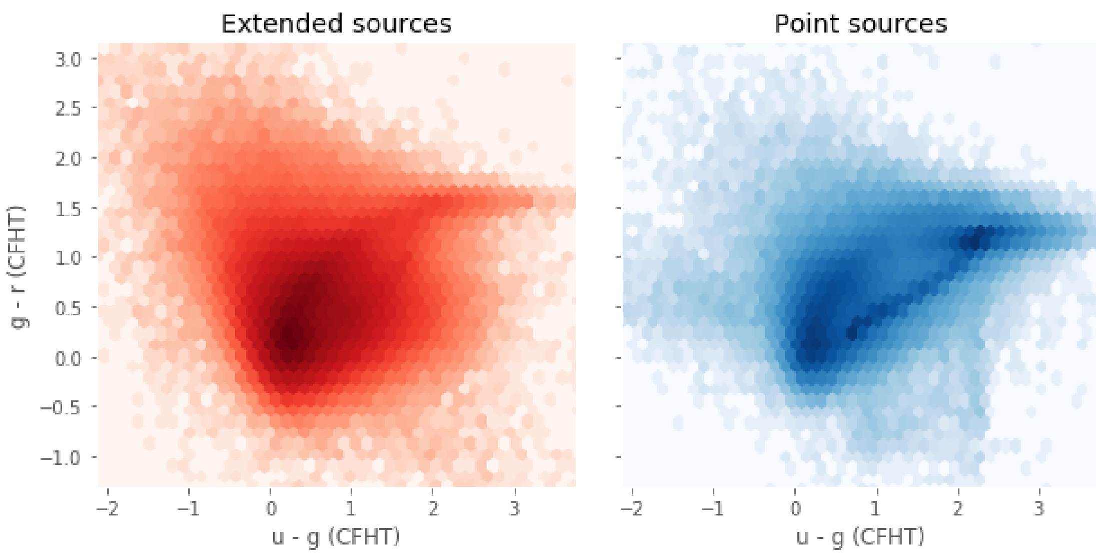


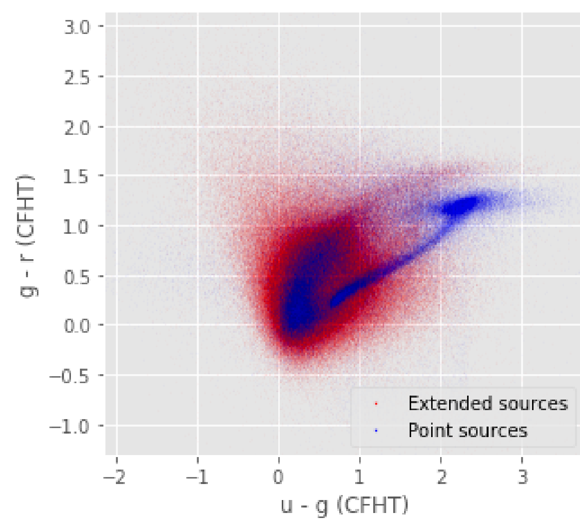
1.8 V - Color-color and magnitude-color plots

```
Number of source used: 102035 / 1783240 (5.72%)
```

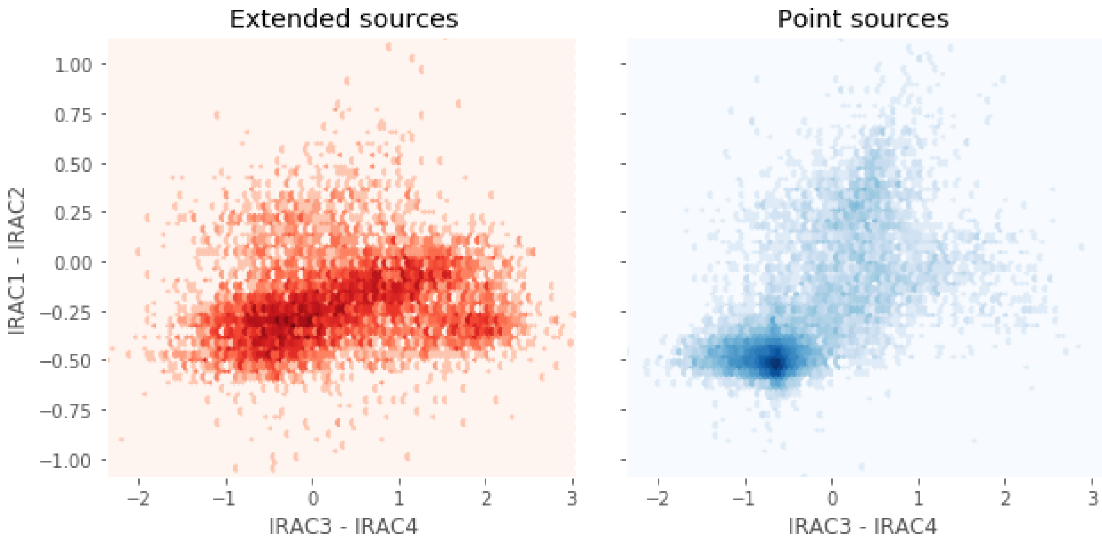


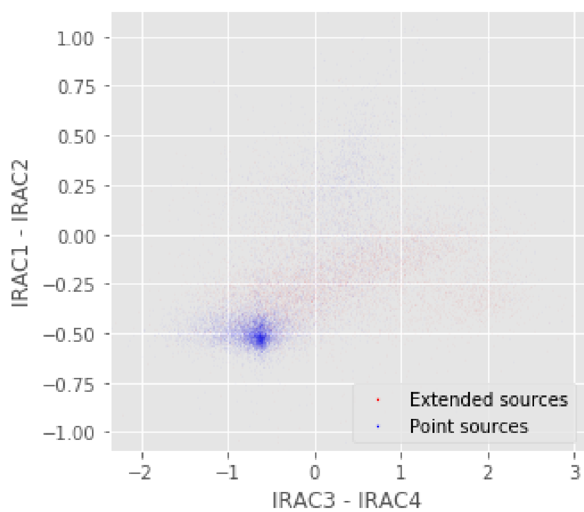
Number of source used: 666339 / 1783240 (37.37%)






```
Number of source used: 19548 / 1783240 (1.10%)
```


Extended sources
Point sources
IRAC1 - IRAC2
IRAC3 - IRAC4
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−2
−1
0
1
2
3


IRAC1 - IRAC2
IRAC3 - IRAC4
Extended sources
Point sources
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−2
−1
0
1
2
3

4_Selection_function

March 8, 2018

1 ELAIS-N2 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 20:46:38.136501
```

```
Depth maps produced using: master_catalogue_elais-n2_20180218.fits
```

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

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

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

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

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

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

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

1.4 III - Save the depth map table

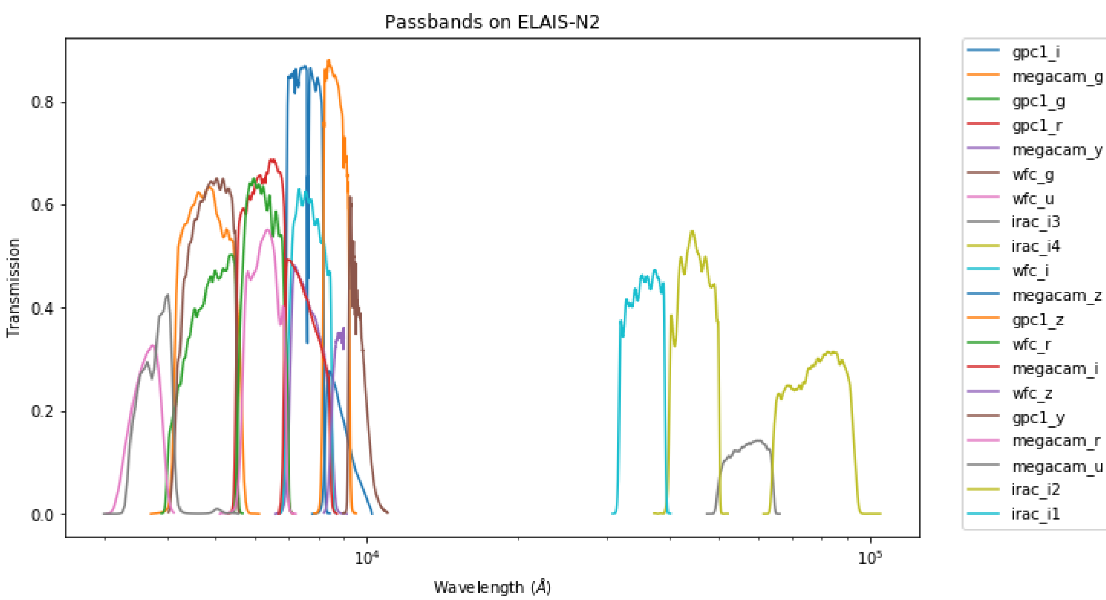
1.5 IV - Overview plots

1.5.1 IV.a - Filters

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

```
Out[14]: {'gpc1_g',
          'gpc1_i',
          'gpc1_r',
          'gpc1_y',
          'gpc1_z',
          'irac_i1',
          'irac_i2',
          'irac_i3',
          'irac_i4',
          'megacam_g',
          'megacam_i',
          'megacam_r',
          'megacam_u',
          'megacam_y',
          'megacam_z',
          'wfc_g',
          'wfc_i',
          'wfc_r',
          'wfc_u',
          'wfc_z'}
```

```
Out[15]: <matplotlib.text.Text at 0x7fab7e543ba8>
```



1.5.2 IV.a - Depth overview

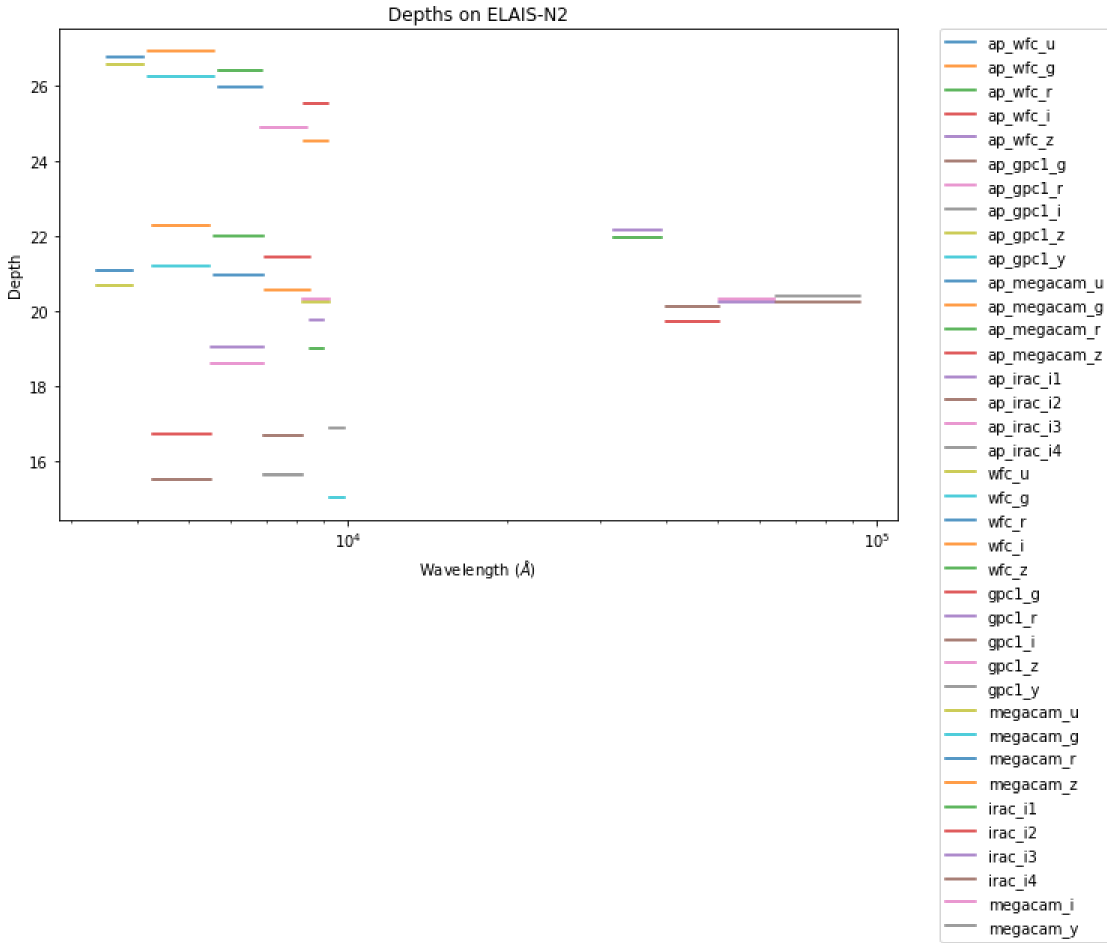
Then we plot the mean depths available across the area a given band is available

```
wfc_u: mean flux error: 2.707310199737549, 3sigma in AB mag (Aperture): 21.625851814542862
wfc_g: mean flux error: 0.8930113911628723, 3sigma in AB mag (Aperture): 22.830054366350062
wfc_r: mean flux error: 1.1431512832641602, 3sigma in AB mag (Aperture): 22.561937592682433
wfc_i: mean flux error: 1.8998199701309204, 3sigma in AB mag (Aperture): 22.010415741980758
wfc_z: mean flux error: 9.140722235701249, 3sigma in AB mag (Aperture): 20.304745583224125
gpc1_g: mean flux error: 445.76862986796755, 3sigma in AB mag (Aperture): 16.084423106802866
gpc1_r: mean flux error: 26.65651684368098, 3sigma in AB mag (Aperture): 19.142688362321373
gpc1_i: mean flux error: 412.04631114782217, 3sigma in AB mag (Aperture): 16.16983178704006
gpc1_z: mean flux error: 5.721158636530188, 3sigma in AB mag (Aperture): 20.813486888029594
gpc1_y: mean flux error: 696.8996115385006, 3sigma in AB mag (Aperture): 15.599271307105333
megacam_u: mean flux error: 0.014376260340213776, 3sigma in AB mag (Aperture): 27.31308204113467
megacam_g: mean flux error: 0.012265769764780998, 3sigma in AB mag (Aperture): 27.48545984199435
megacam_r: mean flux error: 0.01957886293530464, 3sigma in AB mag (Aperture): 26.977728198064987
megacam_z: mean flux error: 0.045153290033340454, 3sigma in AB mag (Aperture): 26.07047336299627
irac_i1: mean flux error: 0.9869013923953526, 3sigma in AB mag (Aperture): 22.72151245892784
irac_i2: mean flux error: 6.440256551173726, 3sigma in AB mag (Aperture): 20.68493894303895
irac_i3: mean flux error: 5.399856515339477, 3sigma in AB mag (Aperture): 20.876241313376845
irac_i4: mean flux error: 5.091050562440103, 3sigma in AB mag (Aperture): 20.940178337421635
wfc_u: mean flux error: 3.8052480220794678, 3sigma in AB mag (Total): 21.25623944097965
wfc_g: mean flux error: 2.3747789809039648, 3sigma in AB mag (Total): 21.76813887234116
wfc_r: mean flux error: 2.972396526059261, 3sigma in AB mag (Total): 21.524430000553217
wfc_i: mean flux error: 4.253242793789795, 3sigma in AB mag (Total): 21.135396426052814
wfc_z: mean flux error: 18.230205535888672, 3sigma in AB mag (Total): 19.555217950395125
gpc1_g: mean flux error: 148.4476318213597, 3sigma in AB mag (Total): 17.27826367893517
gpc1_r: mean flux error: 17.264502802496242, 3sigma in AB mag (Total): 19.614311673970725
gpc1_i: mean flux error: 153.745154178122, 3sigma in AB mag (Total): 17.24019327235647
gpc1_z: mean flux error: 5.406278613566402, 3sigma in AB mag (Total): 20.874950804736493
gpc1_y: mean flux error: 128.07595480699501, 3sigma in AB mag (Total): 17.438527857629943
megacam_u: mean flux error: 0.01715118996798992, 3sigma in AB mag (Total): 27.12146122009596
megacam_g: mean flux error: 0.022457983897224542, 3sigma in AB mag (Total): 26.82876994794764
megacam_r: mean flux error: 0.029622873498061517, 3sigma in AB mag (Total): 26.52812890330987
megacam_z: mean flux error: 0.11214411338828534, 3sigma in AB mag (Total): 25.082755658819814
irac_i1: mean flux error: 1.204303589179223, 3sigma in AB mag (Total): 22.505356911499653
irac_i2: mean flux error: 9.547149566373069, 3sigma in AB mag (Total): 20.25751254742918
irac_i3: mean flux error: 5.73690816315948, 3sigma in AB mag (Total): 20.810502118899272
irac_i4: mean flux error: 5.786097583852566, 3sigma in AB mag (Total): 20.801232478578335
megacam_i: mean flux error: 0.07988616824150085, 3sigma in AB mag (Total): 25.451017886643093
megacam_y: mean flux error: nan, 3sigma in AB mag (Total): nan


ap_wfc_u (3355.0, 3925.0, 570.0)
ap_wfc_g (4260.0, 5485.0, 1225.0)
ap_wfc_r (5575.0, 6910.0, 1335.0)
ap_wfc_i (6970.0, 8485.0, 1515.0)
ap_wfc_z (8500.0, 9000.0, 500.0)
```

```
ap_gpc1_g (4260.0, 5500.0, 1240.0)
ap_gpc1_r (5500.0, 6900.0, 1400.0)
ap_gpc1_i (6910.0, 8190.0, 1280.0)
ap_gpc1_z (8190.0, 9210.0, 1020.0)
ap_gpc1_y (9200.0, 9820.0, 620.0)
ap_megacam_u (3500.0, 4100.0, 600.0)
ap_megacam_g (4180.0, 5580.0, 1400.0)
ap_megacam_r (5680.0, 6880.0, 1200.0)
ap_megacam_z (8280.0, 9160.0, 880.0)
ap_irac_i1 (31754.0, 39164.801, 7410.8008)
ap_irac_i2 (39980.102, 50052.301, 10072.199)
ap_irac_i3 (50246.301, 64096.699, 13850.398)
ap_irac_i4 (64415.199, 92596.797, 28181.598)
wfc_u (3355.0, 3925.0, 570.0)
wfc_g (4260.0, 5485.0, 1225.0)
wfc_r (5575.0, 6910.0, 1335.0)
wfc_i (6970.0, 8485.0, 1515.0)
wfc_z (8500.0, 9000.0, 500.0)
gpc1_g (4260.0, 5500.0, 1240.0)
gpc1_r (5500.0, 6900.0, 1400.0)
gpc1_i (6910.0, 8190.0, 1280.0)
gpc1_z (8190.0, 9210.0, 1020.0)
gpc1_y (9200.0, 9820.0, 620.0)
megacam_u (3500.0, 4100.0, 600.0)
megacam_g (4180.0, 5580.0, 1400.0)
megacam_r (5680.0, 6880.0, 1200.0)
megacam_z (8280.0, 9160.0, 880.0)
irac_i1 (31754.0, 39164.801, 7410.8008)
irac_i2 (39980.102, 50052.301, 10072.199)
irac_i3 (50246.301, 64096.699, 13850.398)
irac_i4 (64415.199, 92596.797, 28181.598)
megacam_i (6831.7305, 8388.5557, 1556.8252)
megacam_y (7040.0, 8360.0, 1320.0)
```

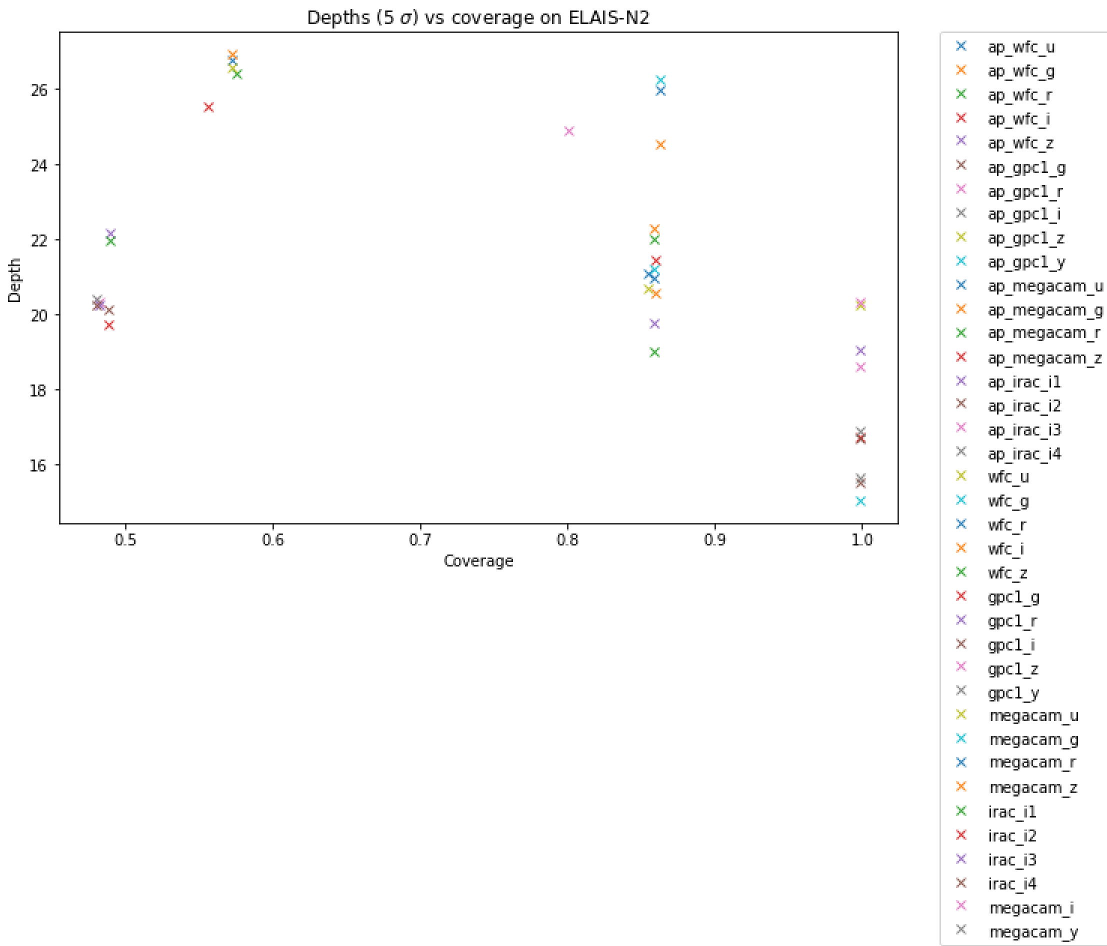
```
Out[20]: <matplotlib.text.Text at 0x7fab7c887e80>
```



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 0x7fab7c619cc0>
```



Depths (5 σ) vs coverage on ELAIS-N2
Depth
Coverage
26
24
22
20
18
16
0.5
0.6
0.7
0.8
0.9
1.0
ap_wfc_u
ap_wfc_g
ap_wfc_r
ap_wfc_i
ap_wfc_z
ap_gpc1_g
ap_gpc1_r
ap_gpc1_i
ap_gpc1_z
ap_gpc1_y
ap_megacam_u
ap_megacam_g
ap_megacam_r
ap_megacam_z
ap_irac_i1
ap_irac_i2
ap_irac_i3
ap_irac_i4
wfc_u
wfc_g
wfc_r
wfc_i
wfc_z
gpc1_g
gpc1_r
gpc1_i
gpc1_z
gpc1_y
megacam_u
megacam_g
megacam_r
megacam_z
irac_i1
irac_i2
irac_i3
irac_i4
megacam_i
megacam_y