1.1_DECaLS

March 8, 2018

1 GAMA-15 master catalogue

1.1 Preparation of DECam Legacy Survey data

This catalogue comes from `dmu0_DECaLS`.

In the catalogue, we keep:

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

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

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

```
WARNING: UnitsWarning: '1/deg^2' did not parse as fits unit: Numeric factor not supported by 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).

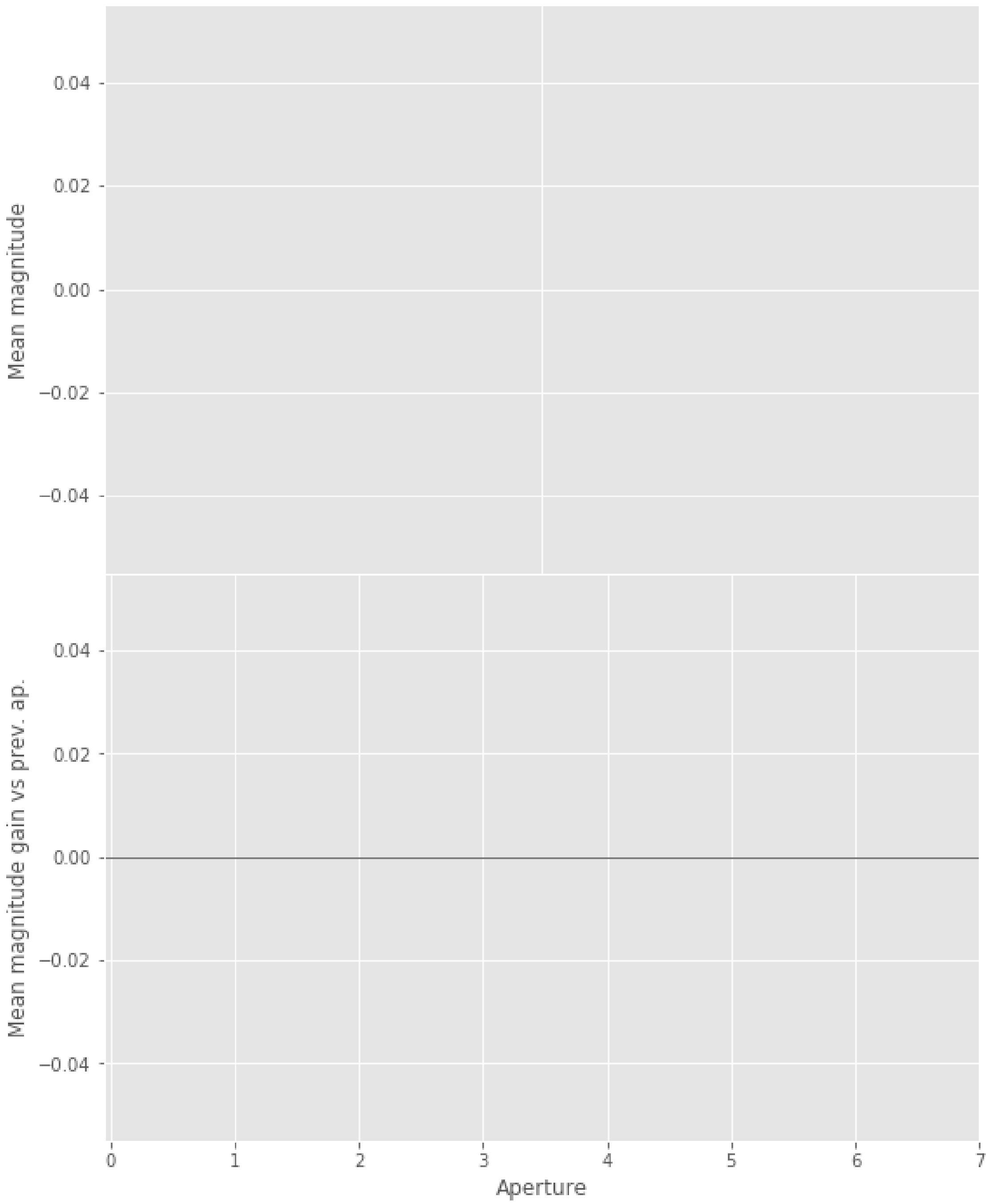
As target aperture, we should use the smallest (i.e. less noisy) aperture for which most of the flux is captures.

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

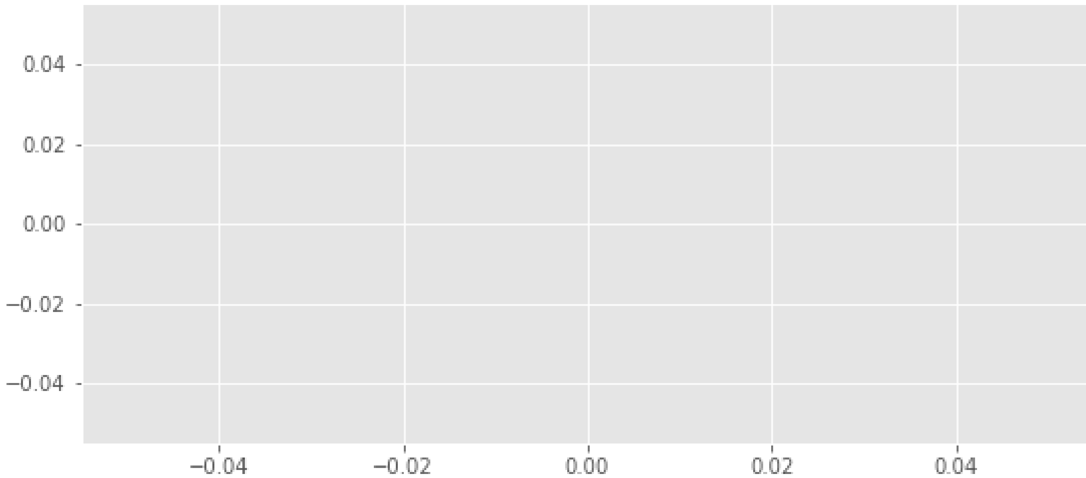
1.2.1 1.a u band

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

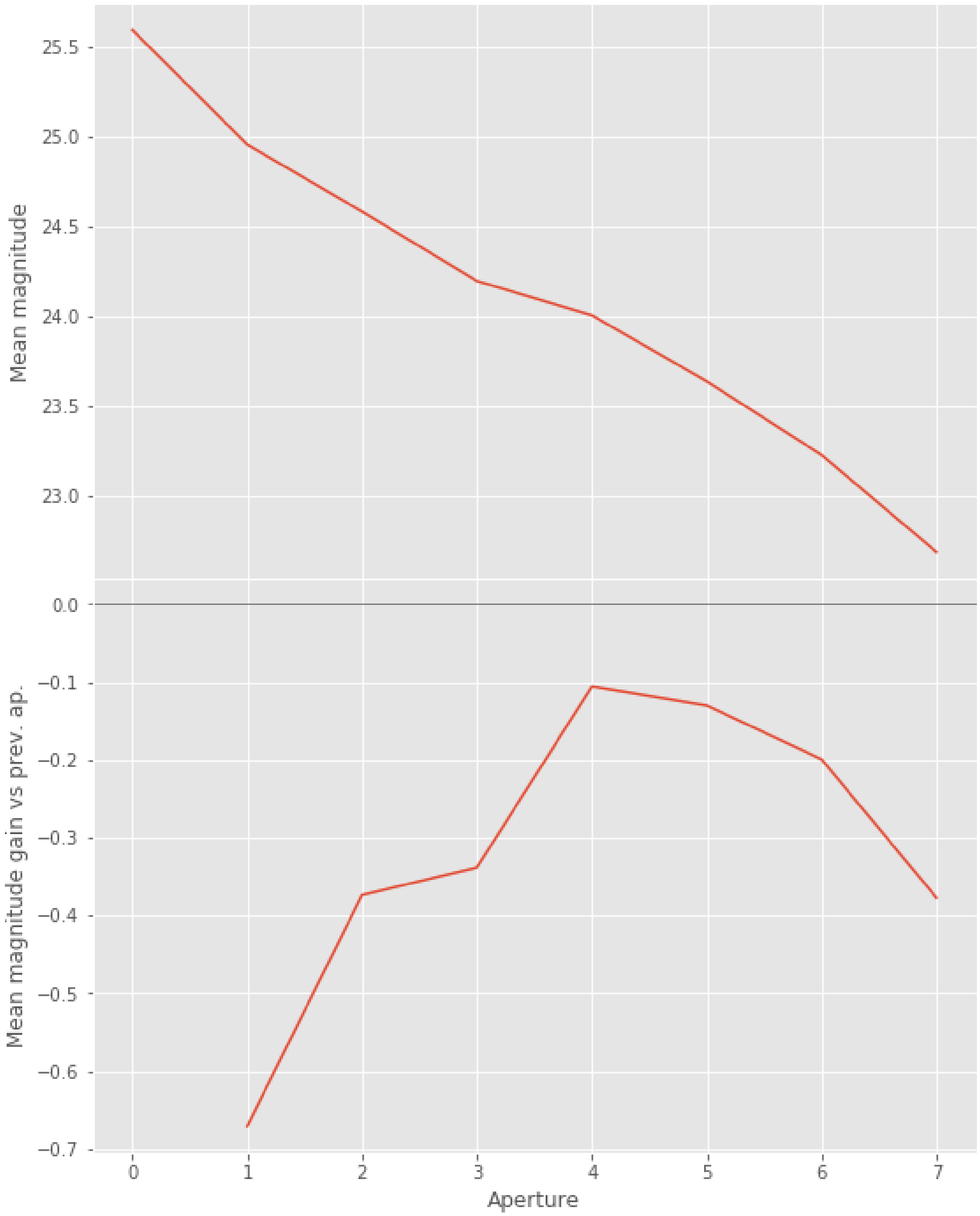


u band is all nan

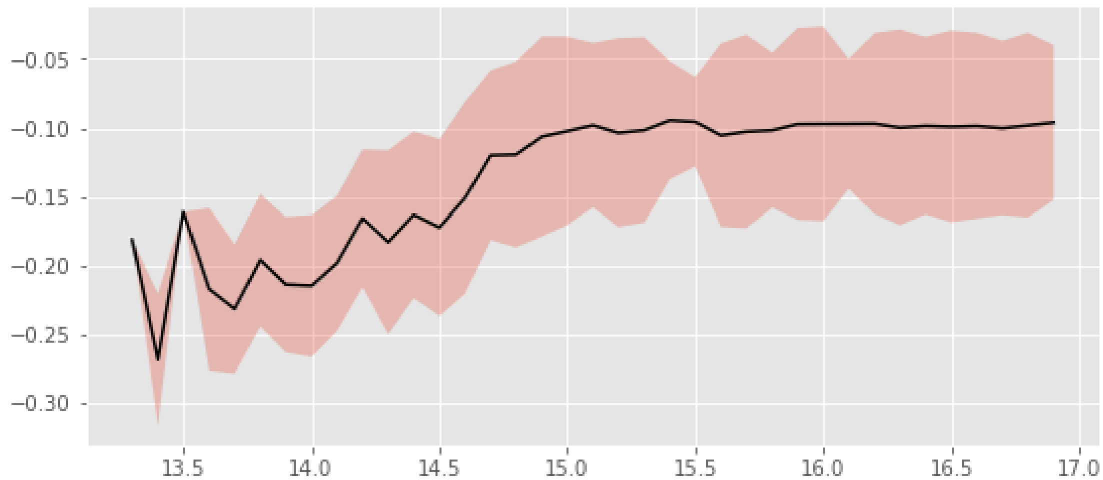
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```


0.04
0.02
0.00
−0.02
−0.04
−0.04
−0.02
0.00
0.02
0.04

1.2.2 I.a - g band



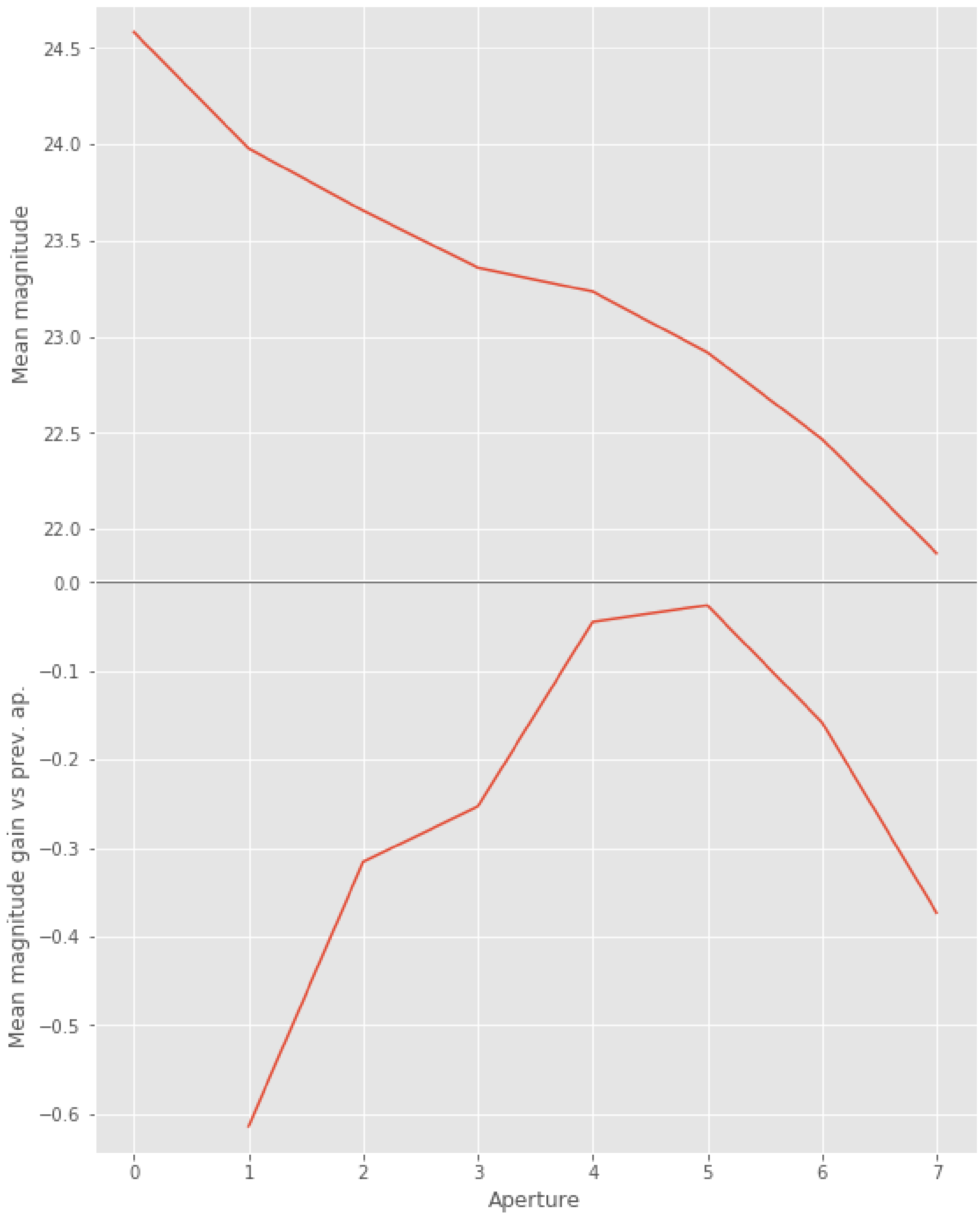
We will use aperture 5 as target.



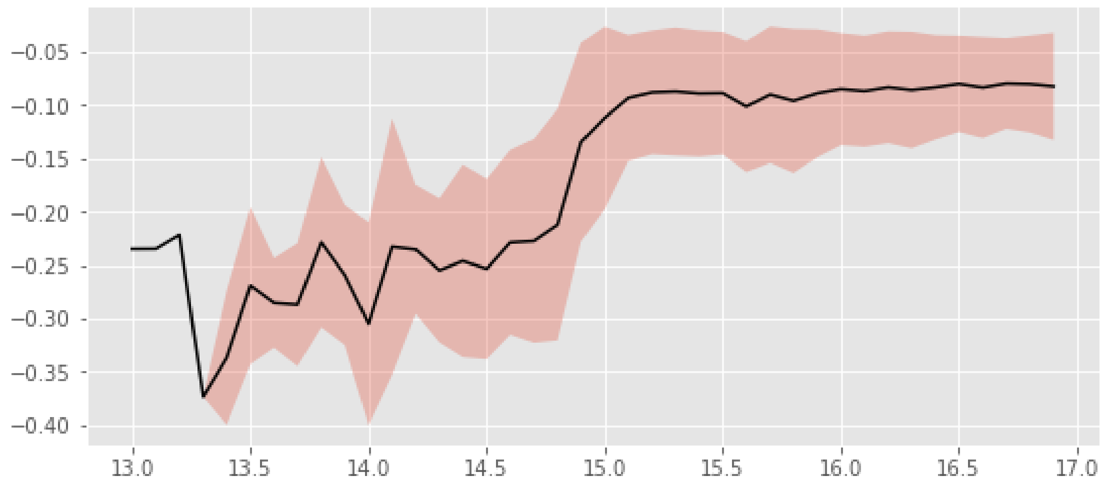
We will use magnitudes between 16.0 and 19.0

```
Aperture correction for g band:
Correction: -0.0989504225602218
Number of source used: 21773
RMS: 0.06706803199655266
```

1.2.3 I.b - r band



We will use aperture 5 as target.

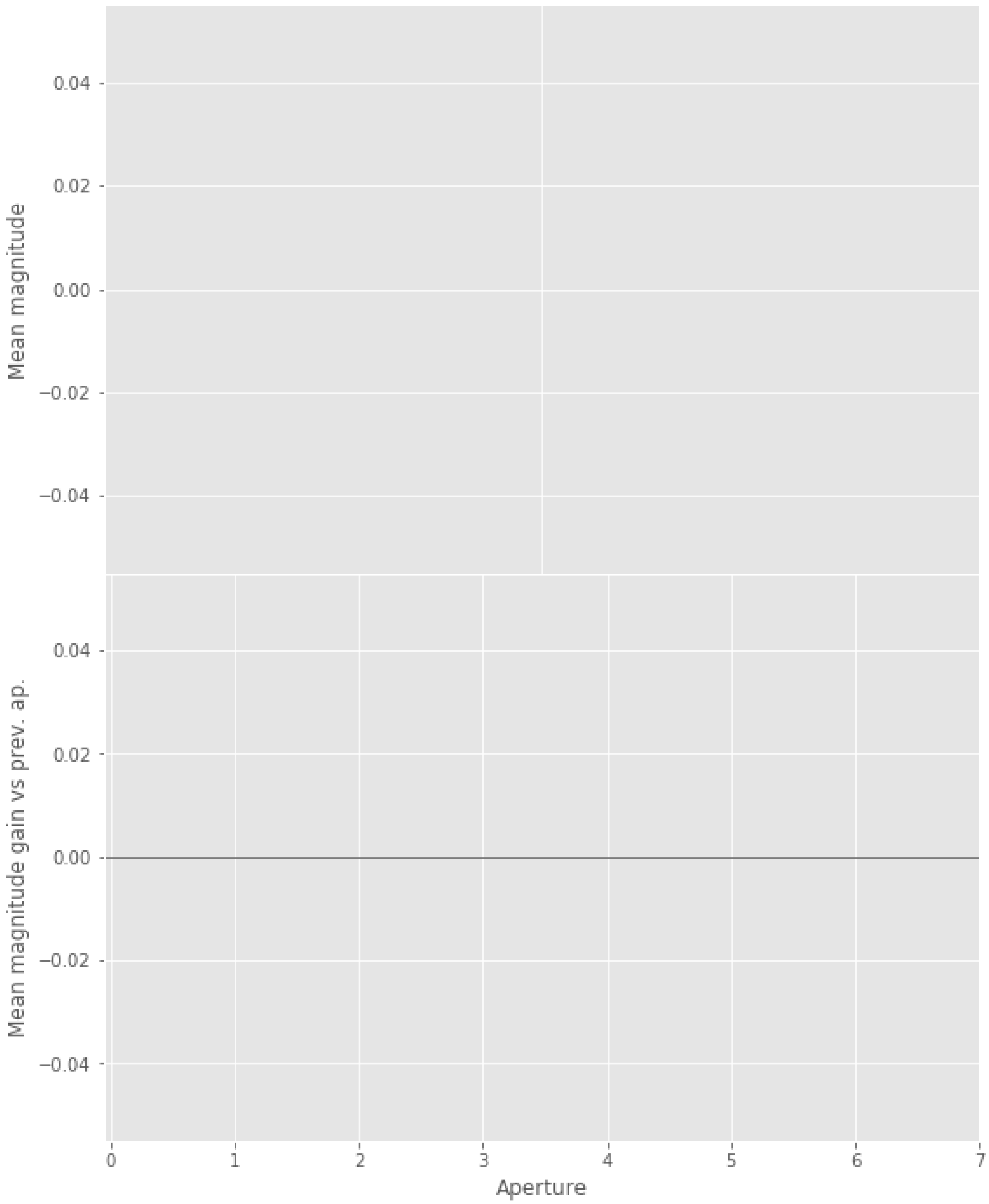


We use magnitudes between 16.0 and 18.0.

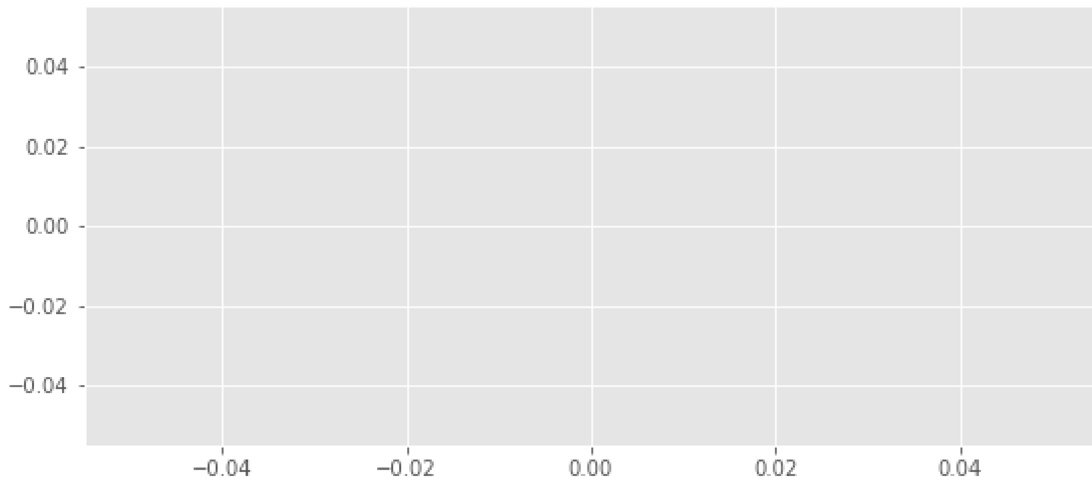
```
Aperture correction for r band:
Correction: -0.08127345912441797
Number of source used: 22453
RMS: 0.04655809967613256
```

1.2.4 I.d - i band

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

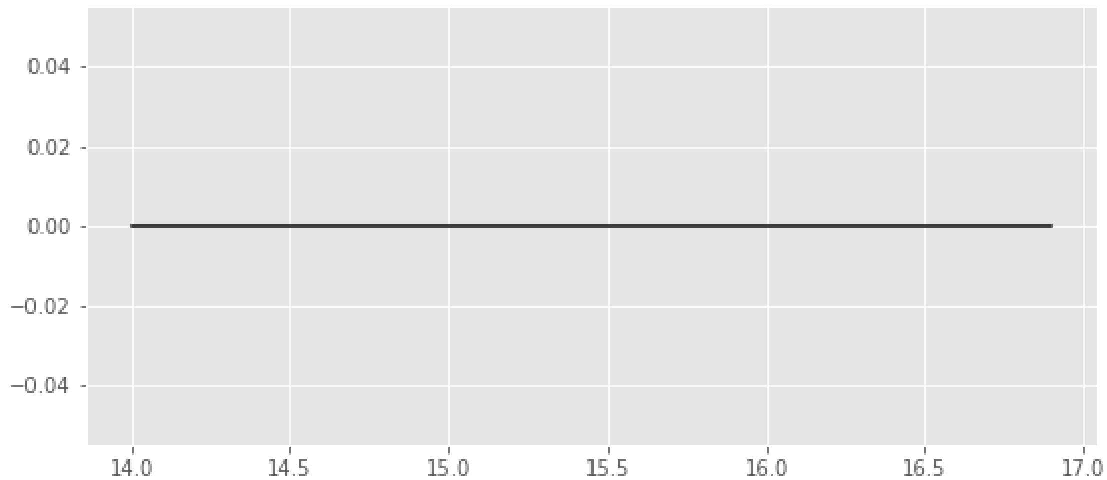



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```


0.04
0.02
0.00
−0.02
−0.04
−0.04
−0.02
0.00
0.02
0.04

1.2.5 I.e - z band

We will use aperture 4 as target.

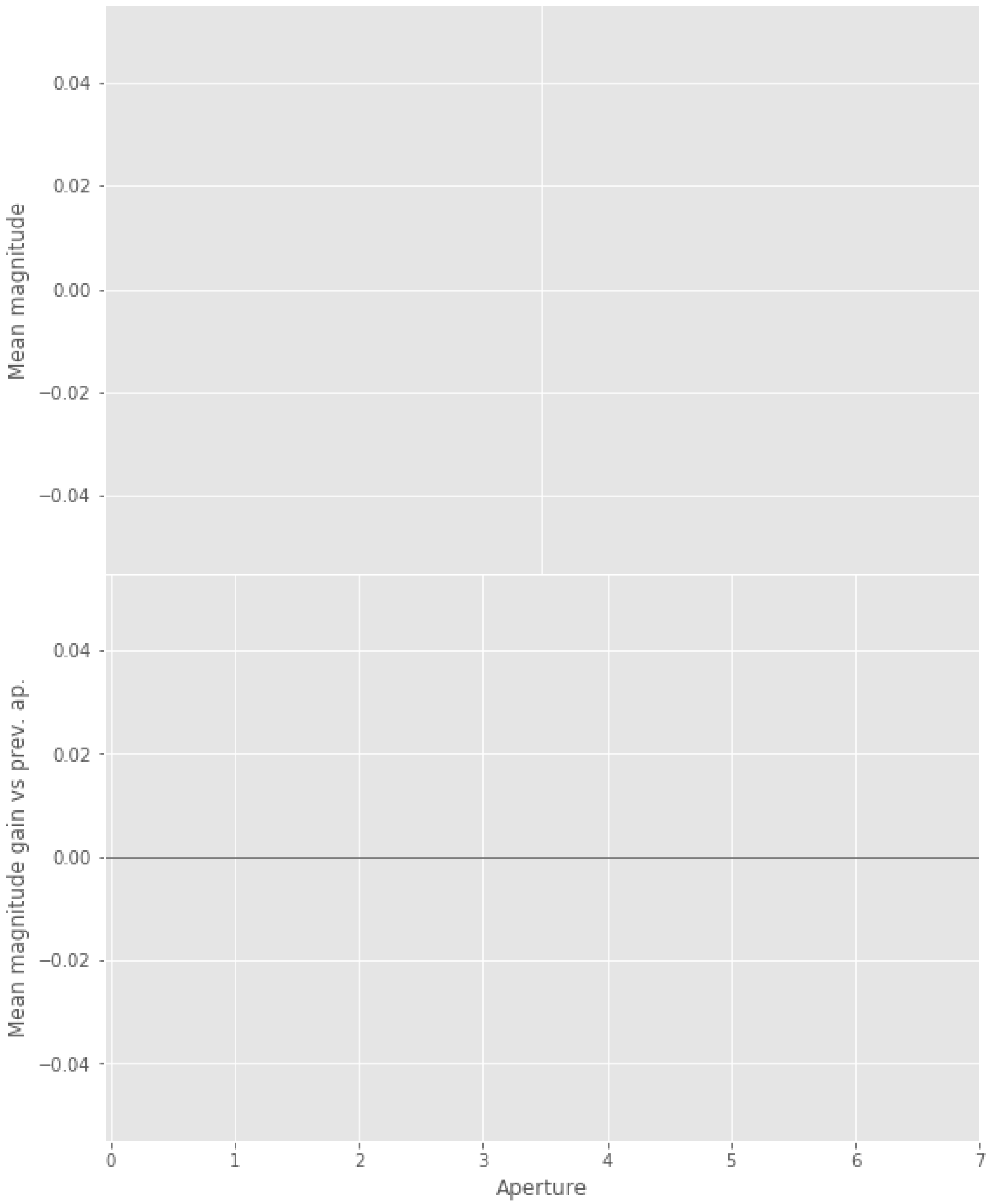


We use magnitudes between 16.0 and 17.5.

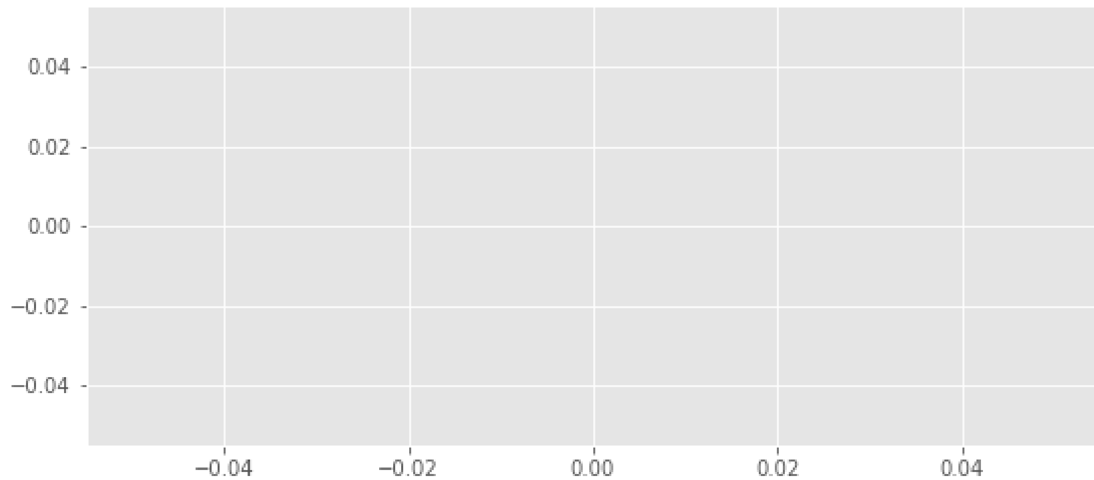
```
Aperture correction for z band:
Correction: 0.0
Number of source used: 53508
RMS: 0.0
```

1.2.6 I.f - Y band

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




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



1.3 II - Stellarity

Legacy Survey does not provide a 0 to 1 stellarity so we replace items flagged as PSF 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

```
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
```

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

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

1.5 III - Removal of duplicated sources

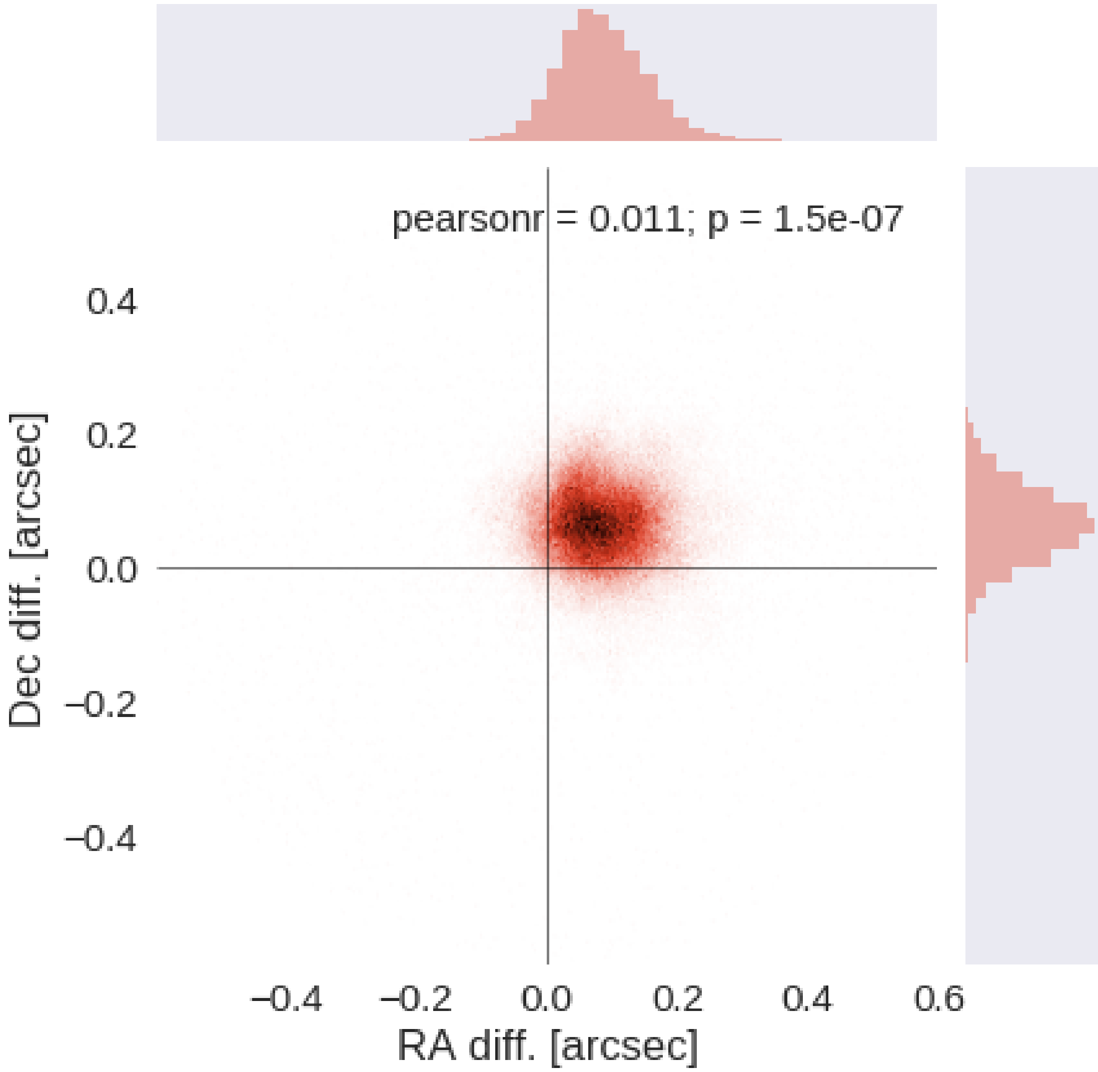
We remove duplicated objects from the input catalogues.

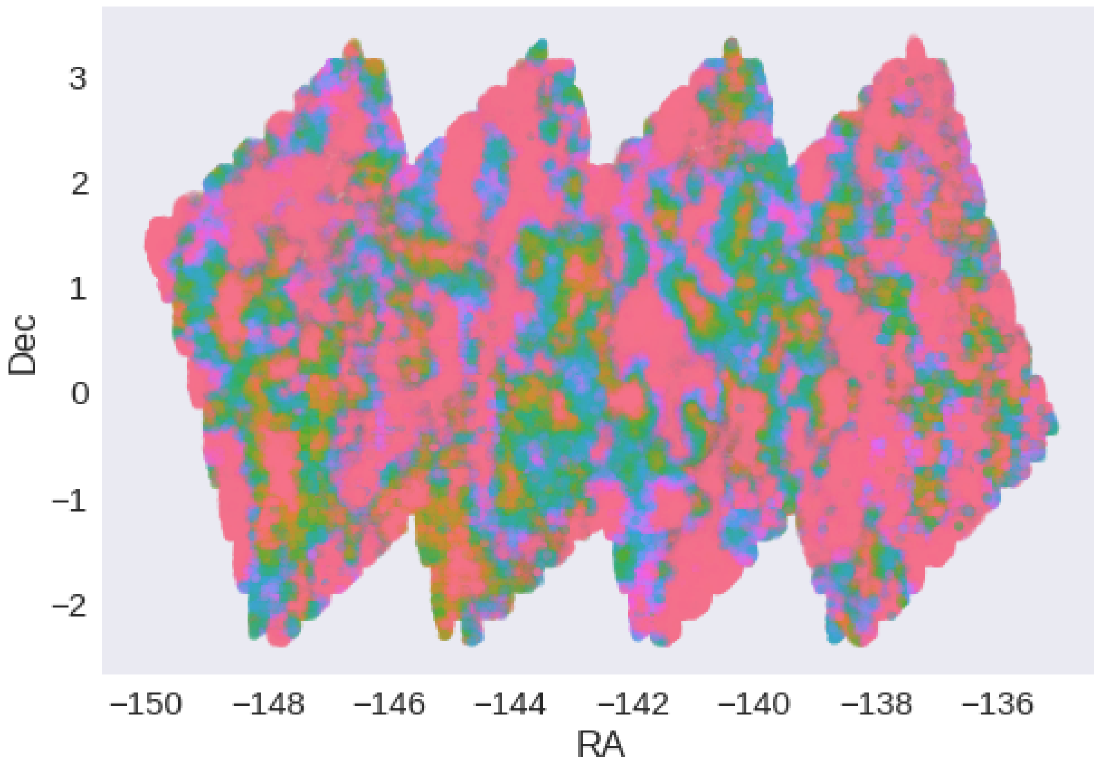
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)


The initial catalogue had 3897945 sources.
The cleaned catalogue has 3897084 sources (861 removed).
The cleaned catalogue has 859 sources flagged as having been cleaned
```

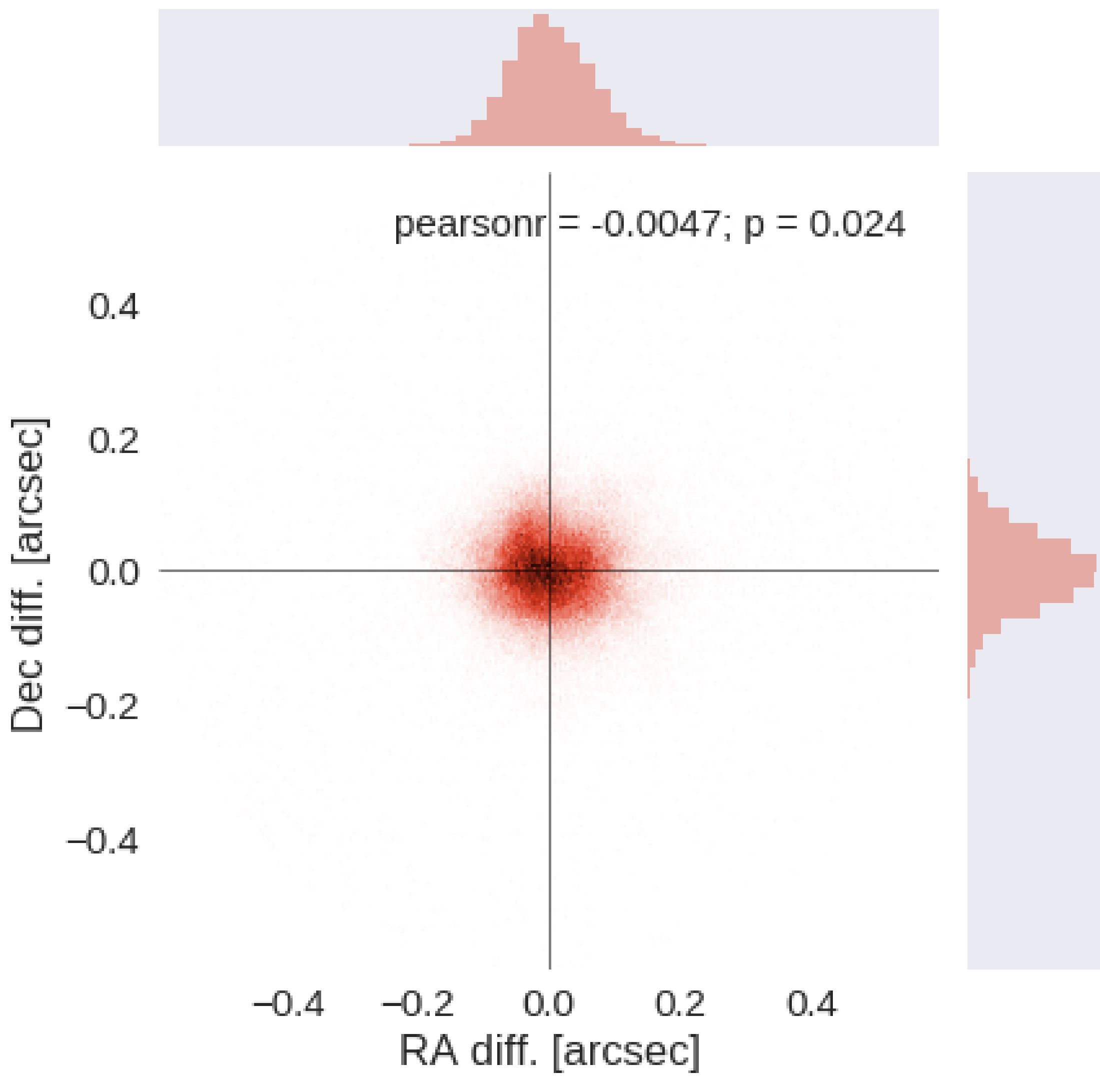
1.6 III - Astrometry correction

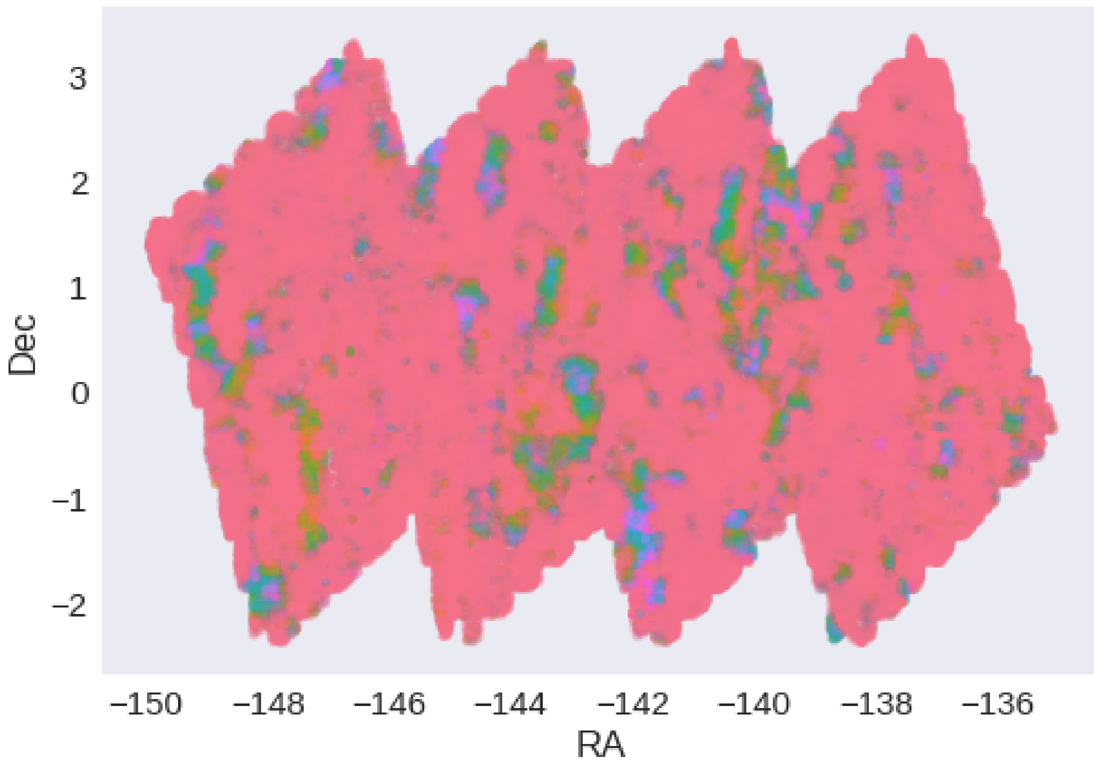
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = 0.011; p = 1.5e-07
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
0.6
RA diff. [arcsec]




```
RA correction: -0.080361738230294 58 arcsec
Dec correction: -0.06566866211070721 arcsec
```


pearsonr = -0.0047; p = 0.024
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
RA diff. [arcsec]



1.7 IV - Flagging Gaia objects

```
234282 sources flagged.
```

2 V - Saving to disk

1.2_HSC-SSP

March 8, 2018

1 GAMA-15 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 (no N921) aperture magnitude in 2" that we aperture correct;
- The g, r, i, z, y (no 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.

We use 2016 as the epoch.

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

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.

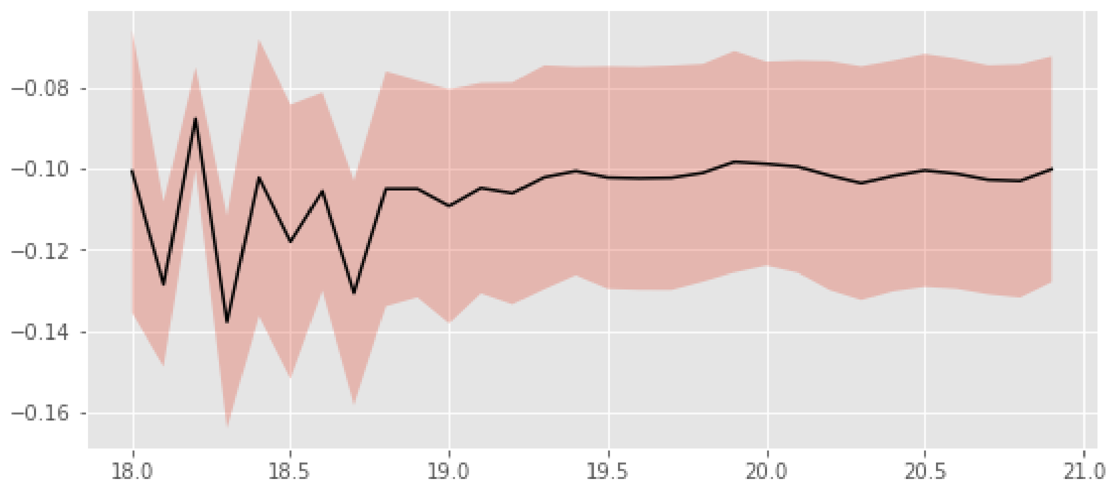
```
No error column for a y band aperture magnitude.
```

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)
```



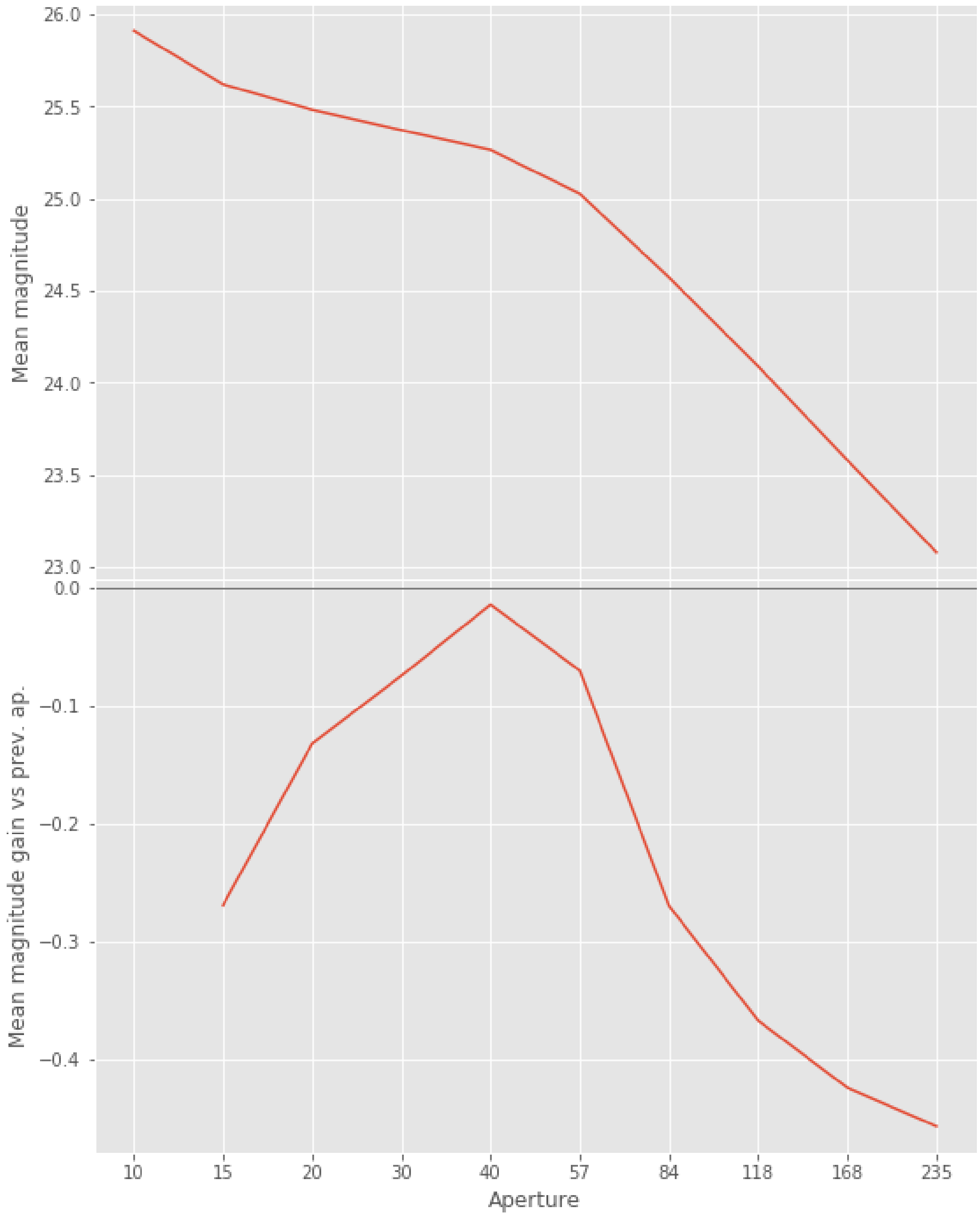
We will use magnitudes between 18.5 and 20.8

```
Aperture correction for g band:
Correction: -0.10141181945800781
Number of source used: 15286
RMS: 0.027612784472519653
```

```
/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

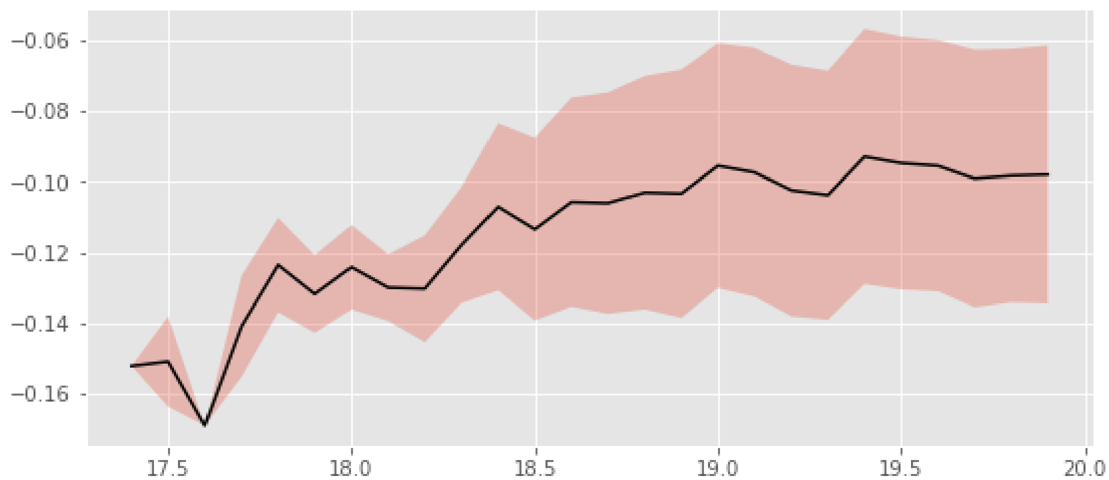
```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```



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: -0.10055923461914062
Number of source used: 9943
RMS: 0.03515977580827814
```

```
/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)
```

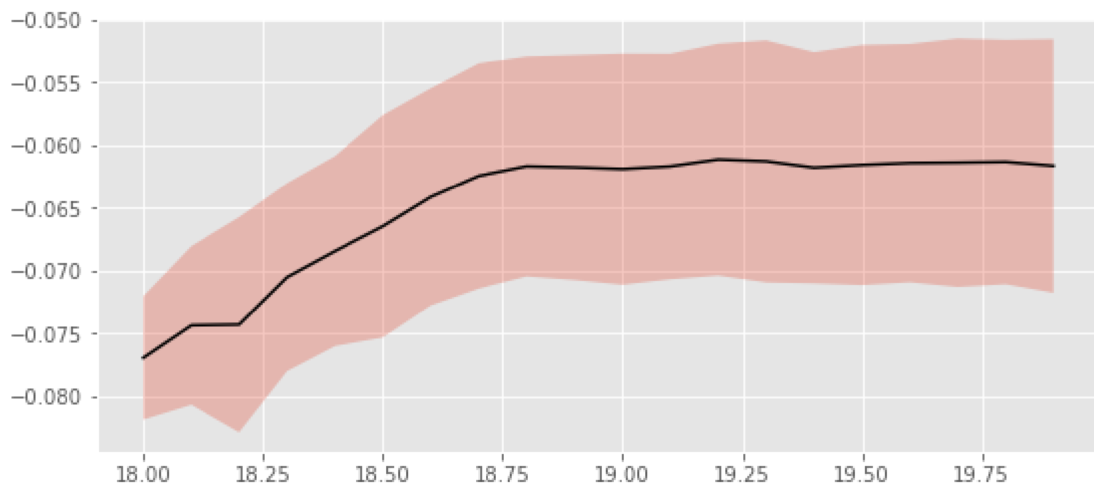
1.2.3 I.c - i band

```
/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)
```



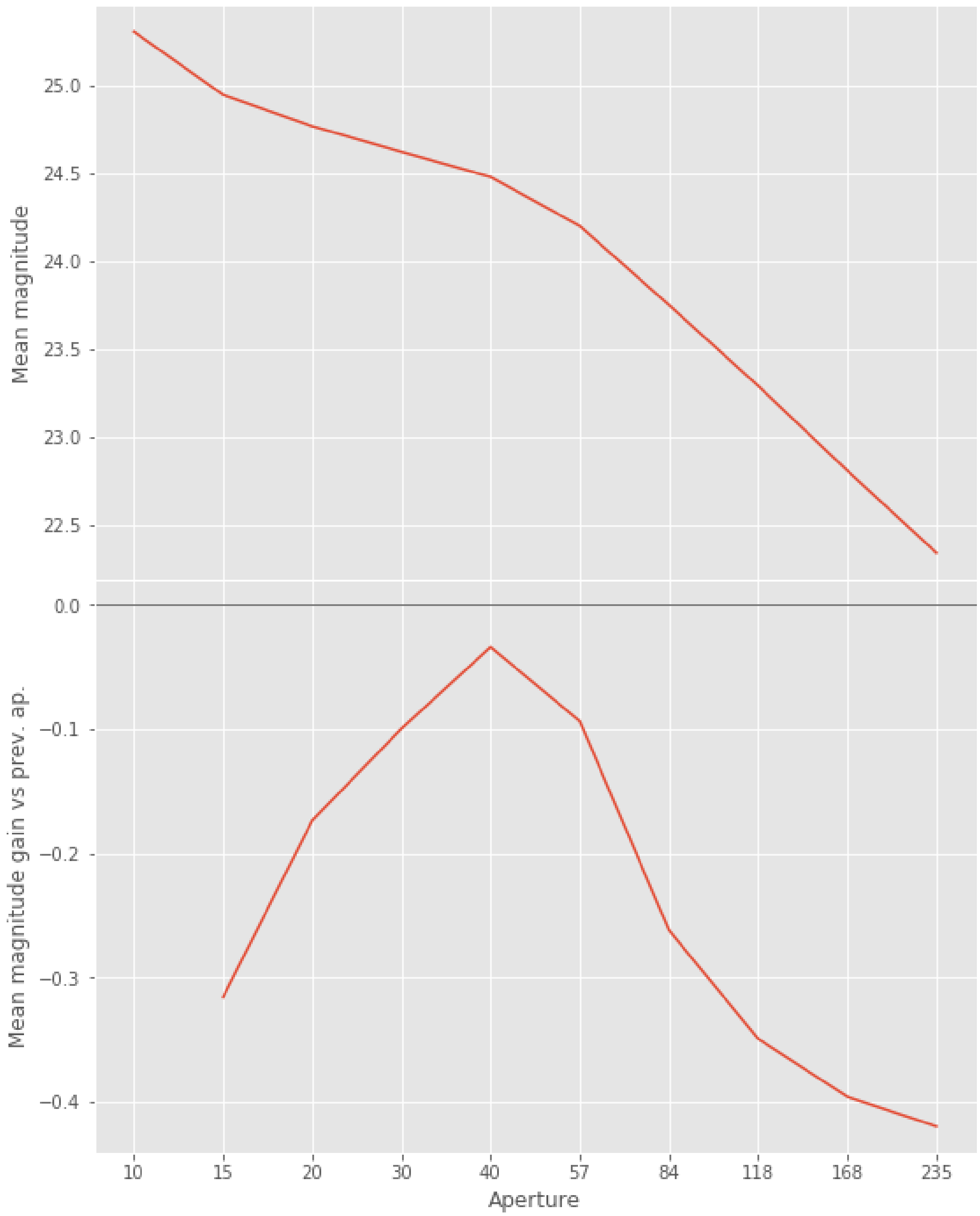
We use magnitudes between 18.5 and 19.8.

```
Aperture correction for i band:
Correction: -0.0619354248046875
Number of source used: 24834
RMS: 0.00930339810580967
```

```
/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

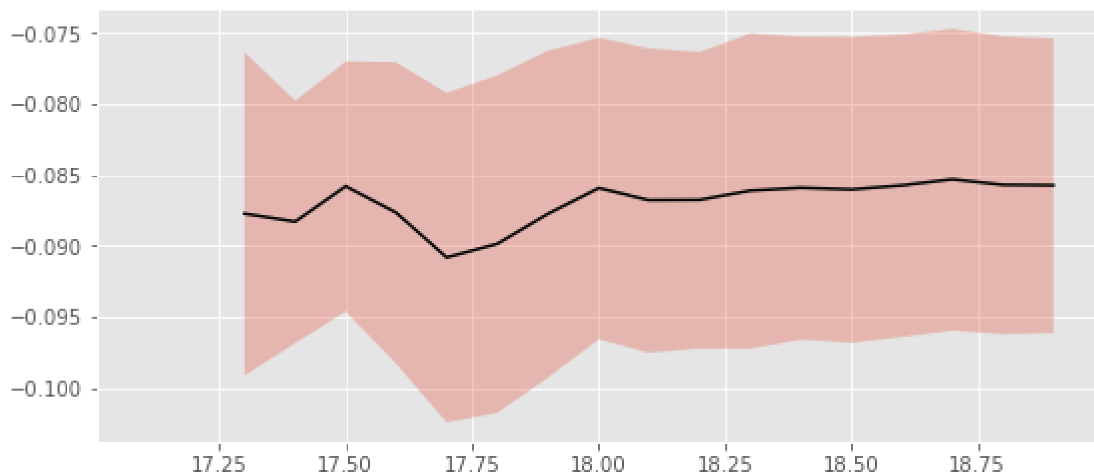
```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```



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)
```



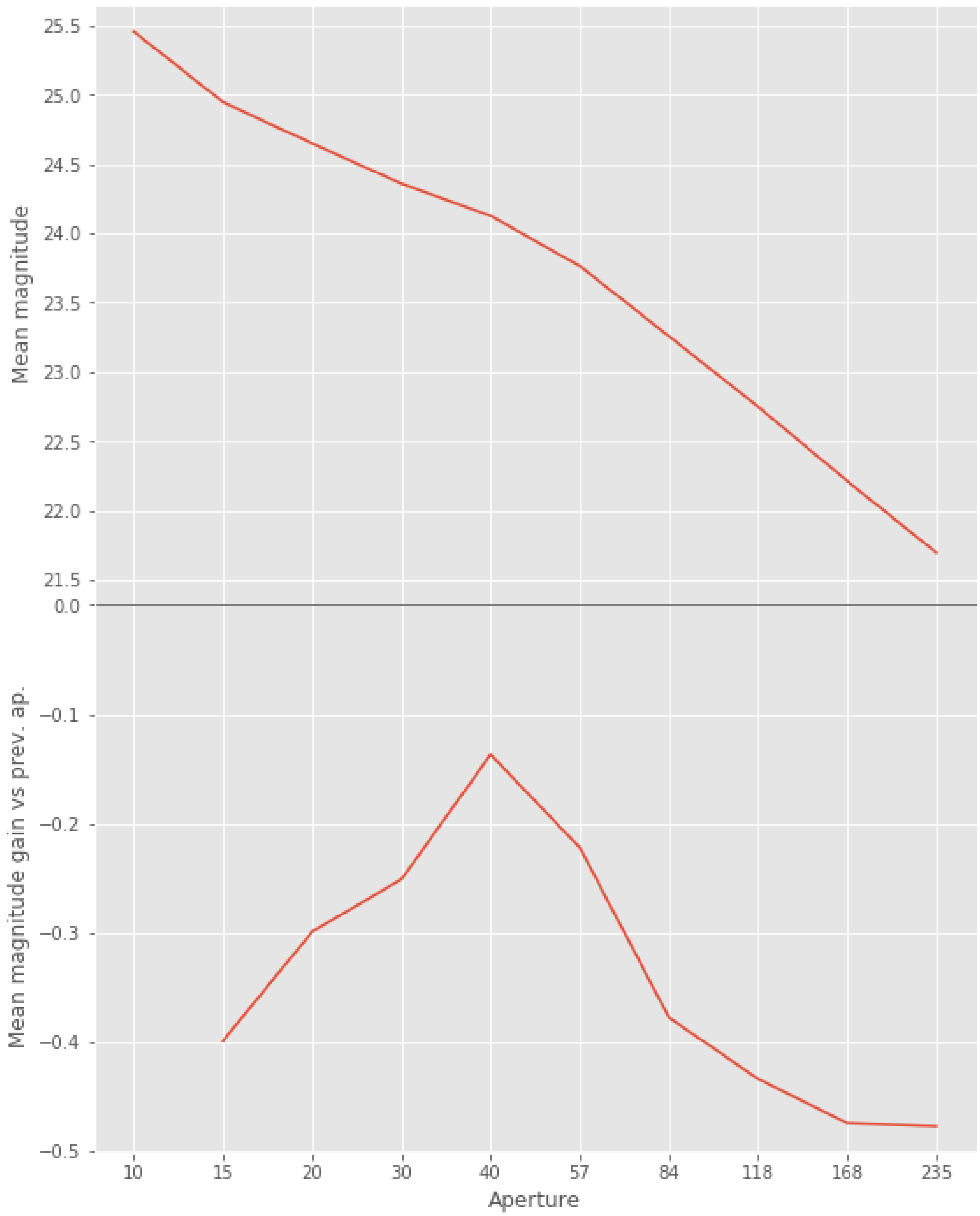
We use magnitudes between 17.5 and 19.8.

```
Aperture correction for z band:
Correction: -0.08566570281982422
Number of source used: 34829
RMS: 0.011217954880876388
```

```
/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

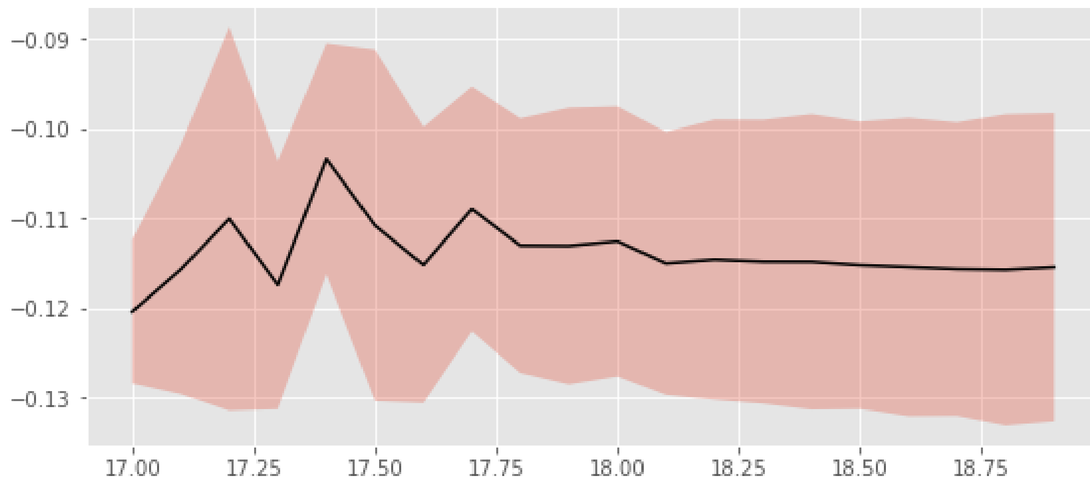
```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```



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: -0.11461448669433594
Number of source used: 9295
RMS: 0.015907751991162174
```

```
/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)
```

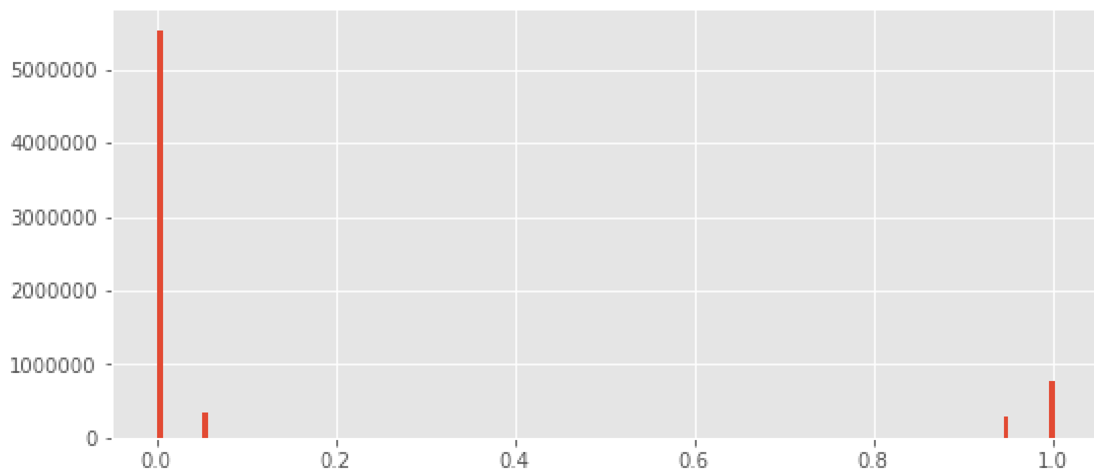
1.3 II - Stellarity

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

Out[29]: <IPython.core.display.HTML object>

1.5 III - Removal of duplicated sources

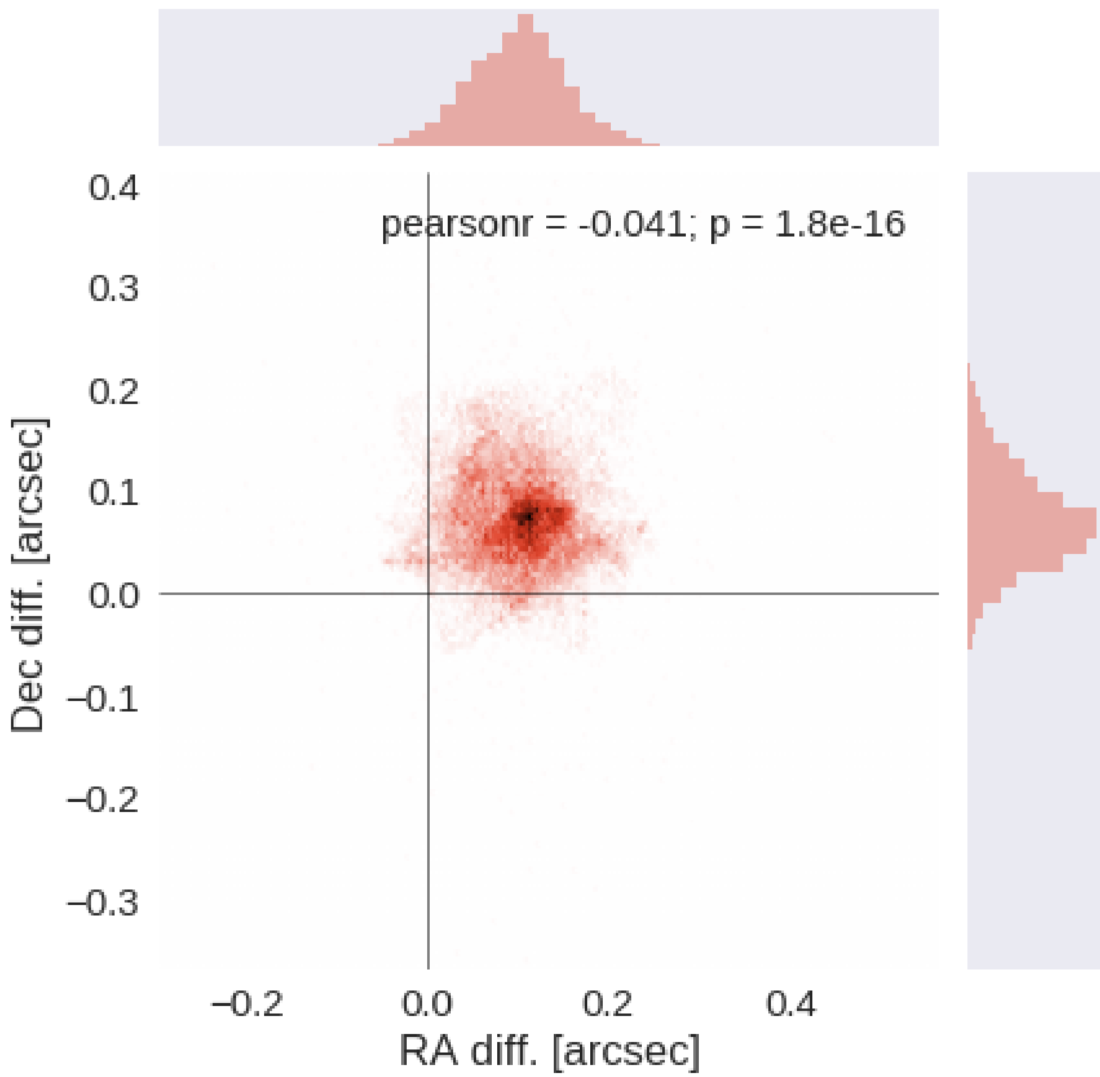
We remove duplicated objects from the input catalogues.

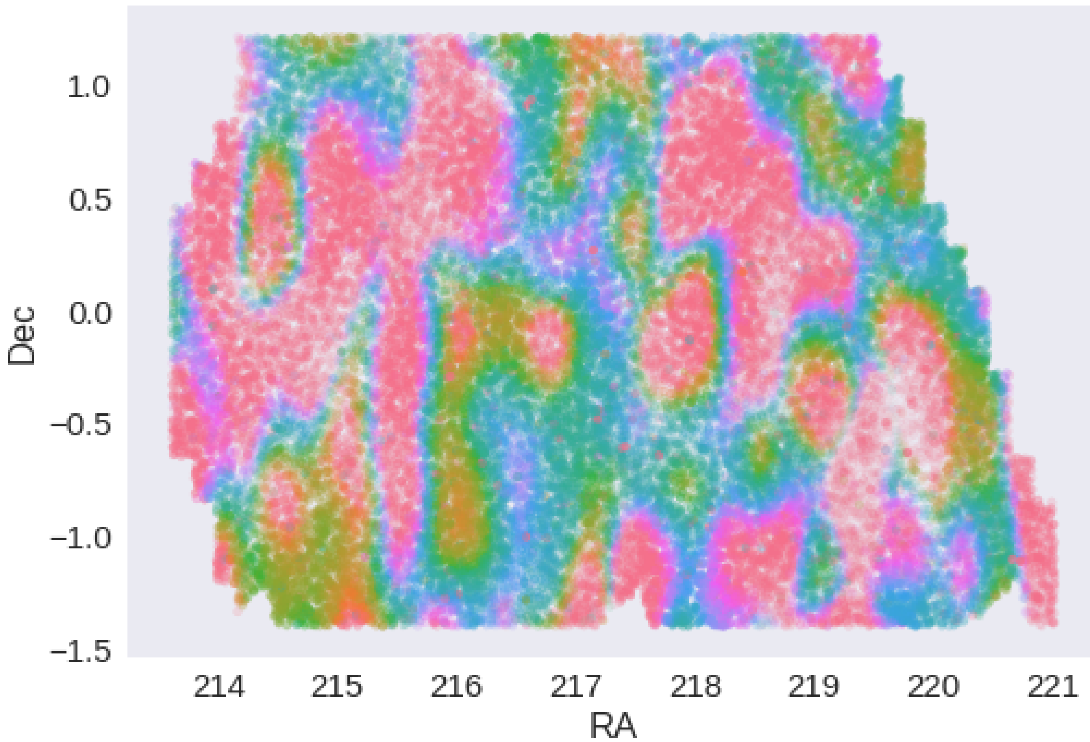
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)


The initial catalogue had 6952860 sources.
The cleaned catalogue has 6952601 sources (259 removed).
The cleaned catalogue has 258 sources flagged as having been cleaned
```

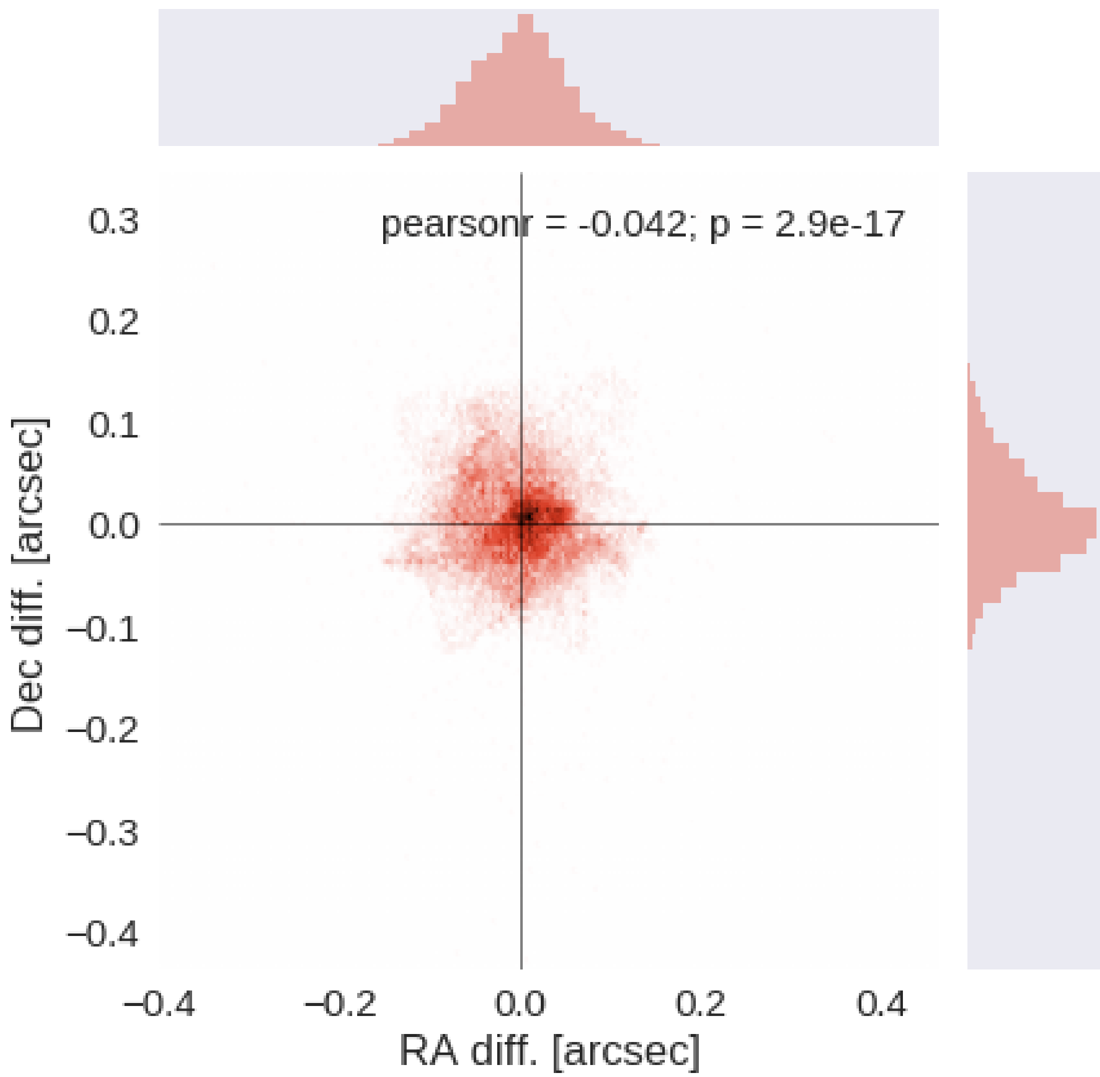
1.6 III - Astrometry correction

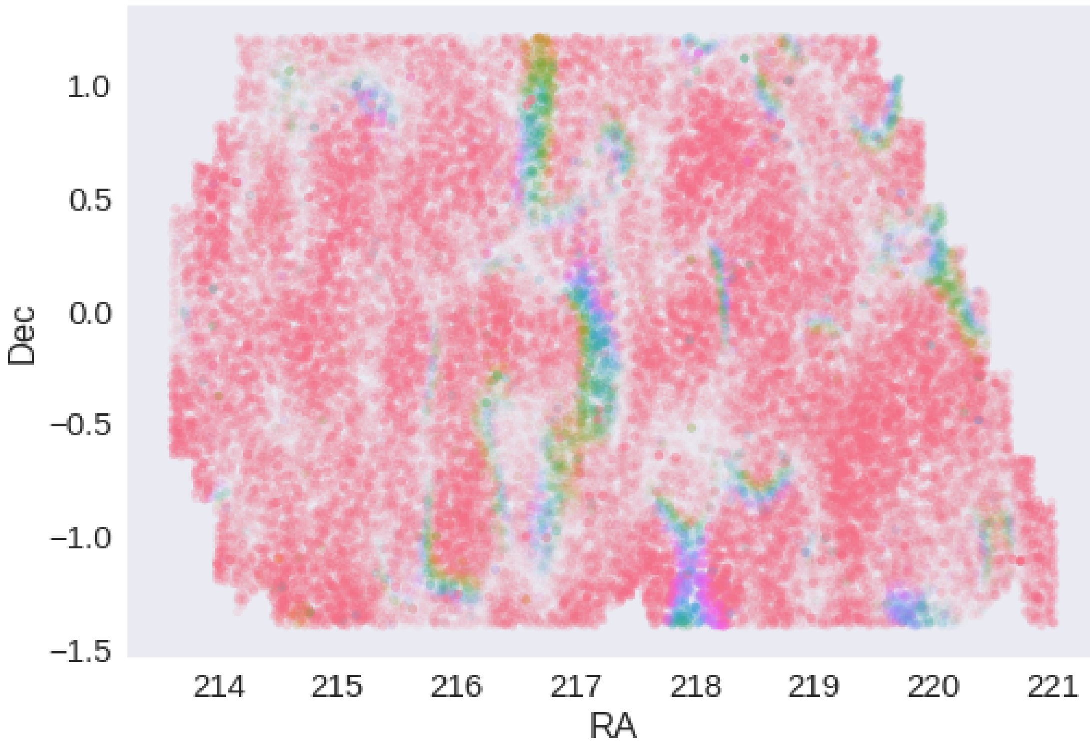
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = -0.041; p = 1.8e-16
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
Dec diff. [arcsec]
−0.2
0.0
0.2
0.4
RA diff. [arcsec]




```
RA correction: -0.10107775475489689 arcsec
Dec correction: -0.06822208740950853 arcsec
```


pearsonr = -0.042; p = 2.9e-17
Dec diff. [arcsec]
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
−0.4
−0.2
0.0
0.2
0.4
RA diff. [arcsec]



1.7 IV - Flagging Gaia objects

```
43661 sources flagged.
```

1.8 V - Flagging objects near bright stars

2 VI - Saving to disk

1.3_KIDS

March 8, 2018

1 GAMA-15 master catalogue

1.1 Preparation of KIDS/VST data

Kilo Degree Survey/VLT Survey Telescope catalogue: the catalogue comes from `dmu0_KIDS`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture corrected aperture magnitude in each band (10 pixels = 2")
- The Petrosian magnitude to be used as total magnitude (no "auto" magnitude is provided).

We take 2014 as the observation year from a typical image header.

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

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

1.3 II - Removal of duplicated sources

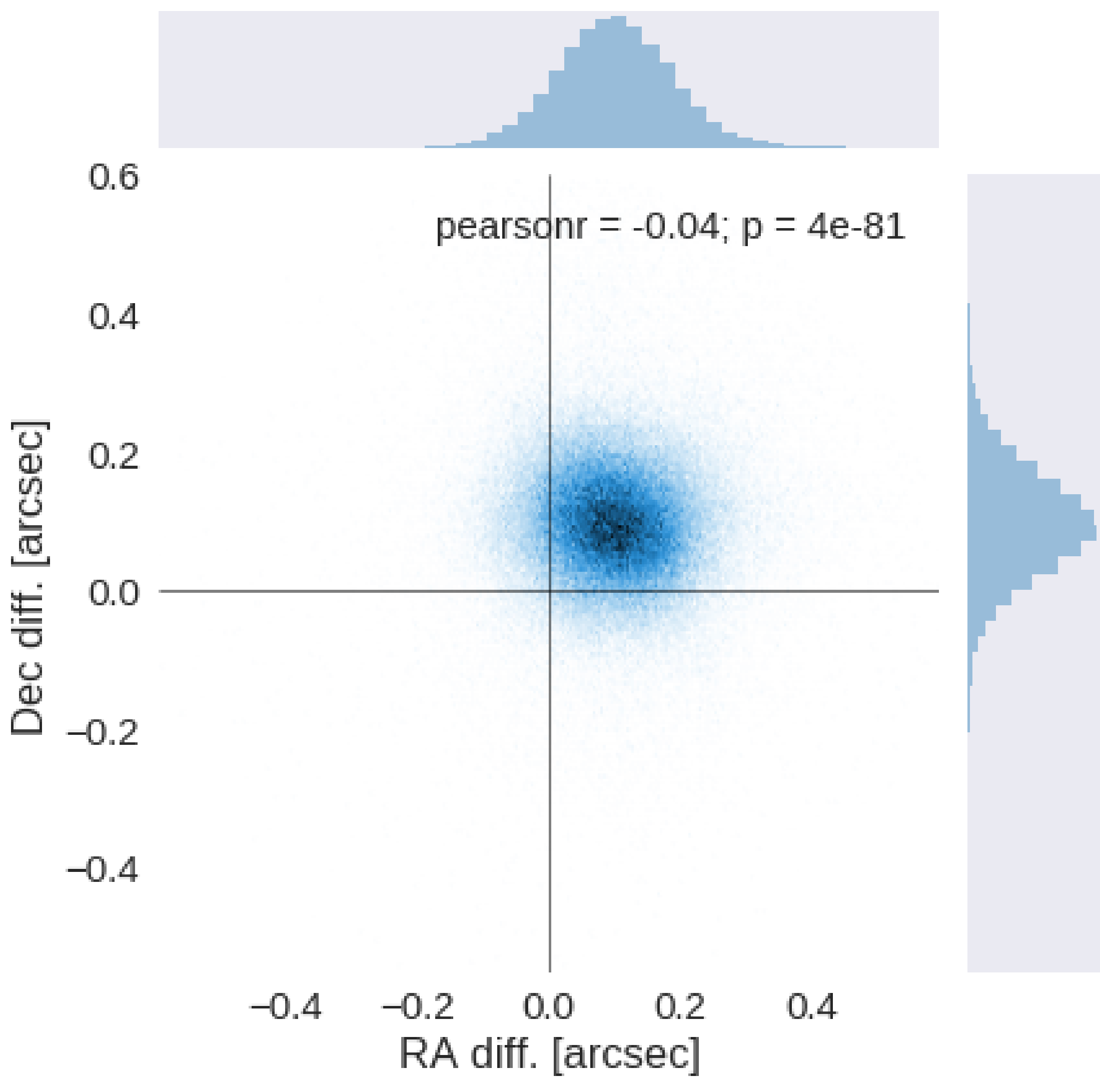
We remove duplicated objects from the input catalogues.

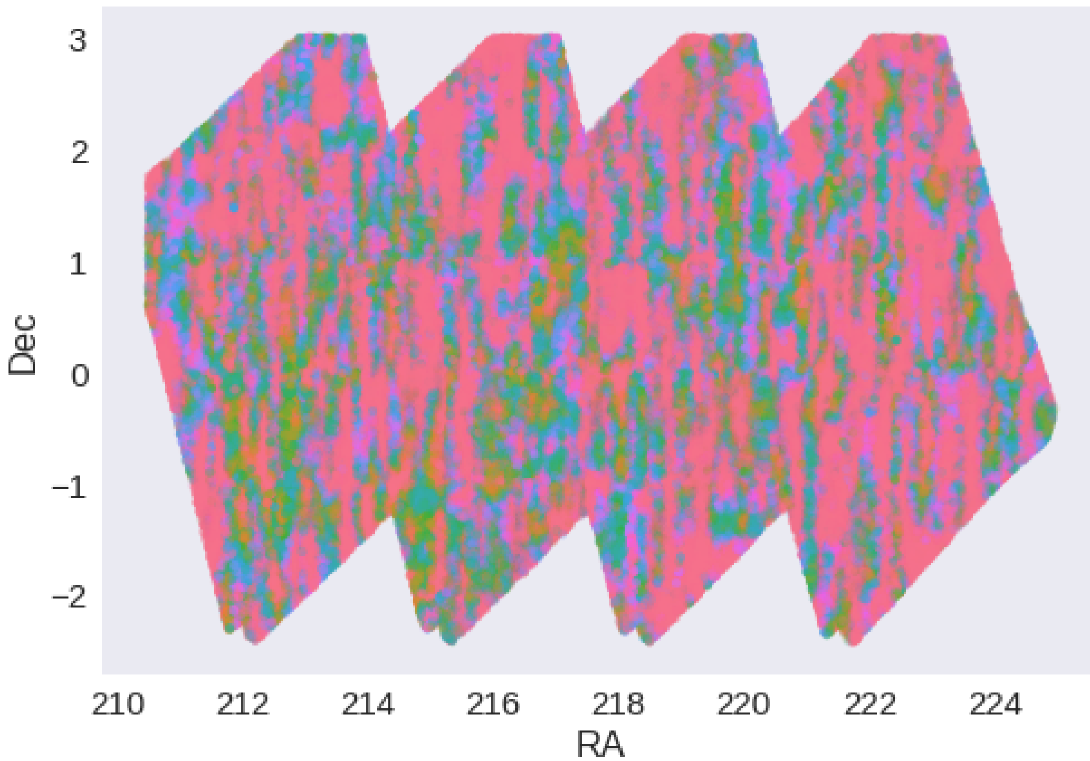
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 6861811 sources.
The cleaned catalogue has 6861671 sources (140 removed).
The cleaned catalogue has 140 sources flagged as having been cleaned
```

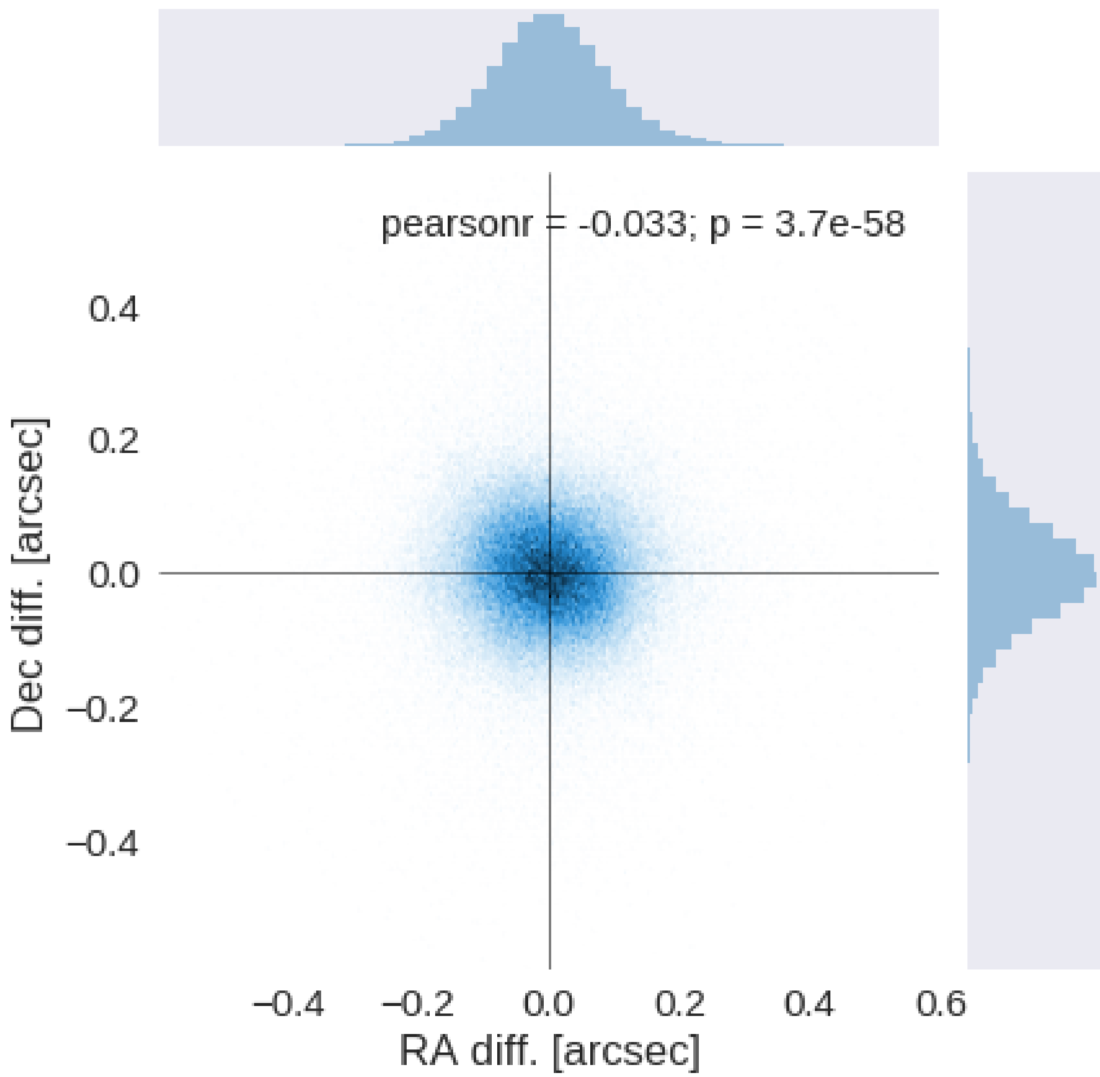
1.4 III - Astrometry correction

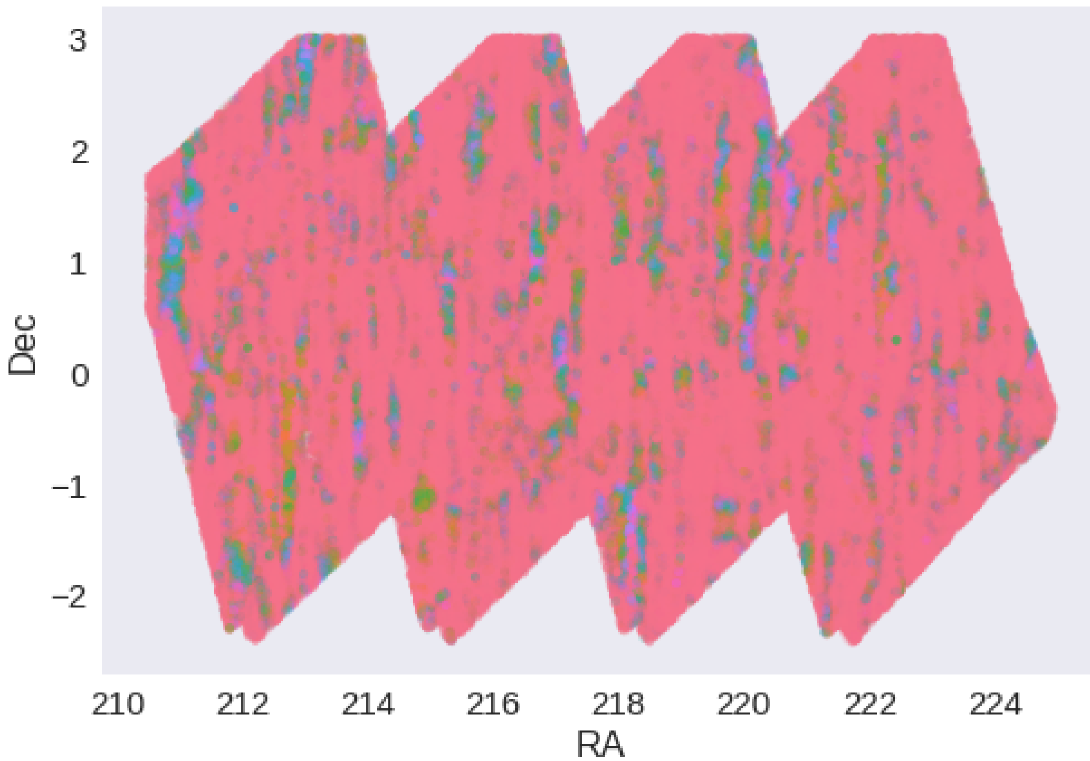
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.10032077190089694 arcsec
Dec correction: -0.09517612471143799 arcsec
```


pearsonr = -0.033; p = 3.7e-58
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
0.6
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
246362 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.4_PanSTARRS

March 8, 2018

1 GAMA-15 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 'F' means we take the forced photometry from chi-squared image priors. We also use an updated catalogue with significatnly fewer duplicates. See DMU_0 for details of how we reduced the duplicate sources.

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).

```
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

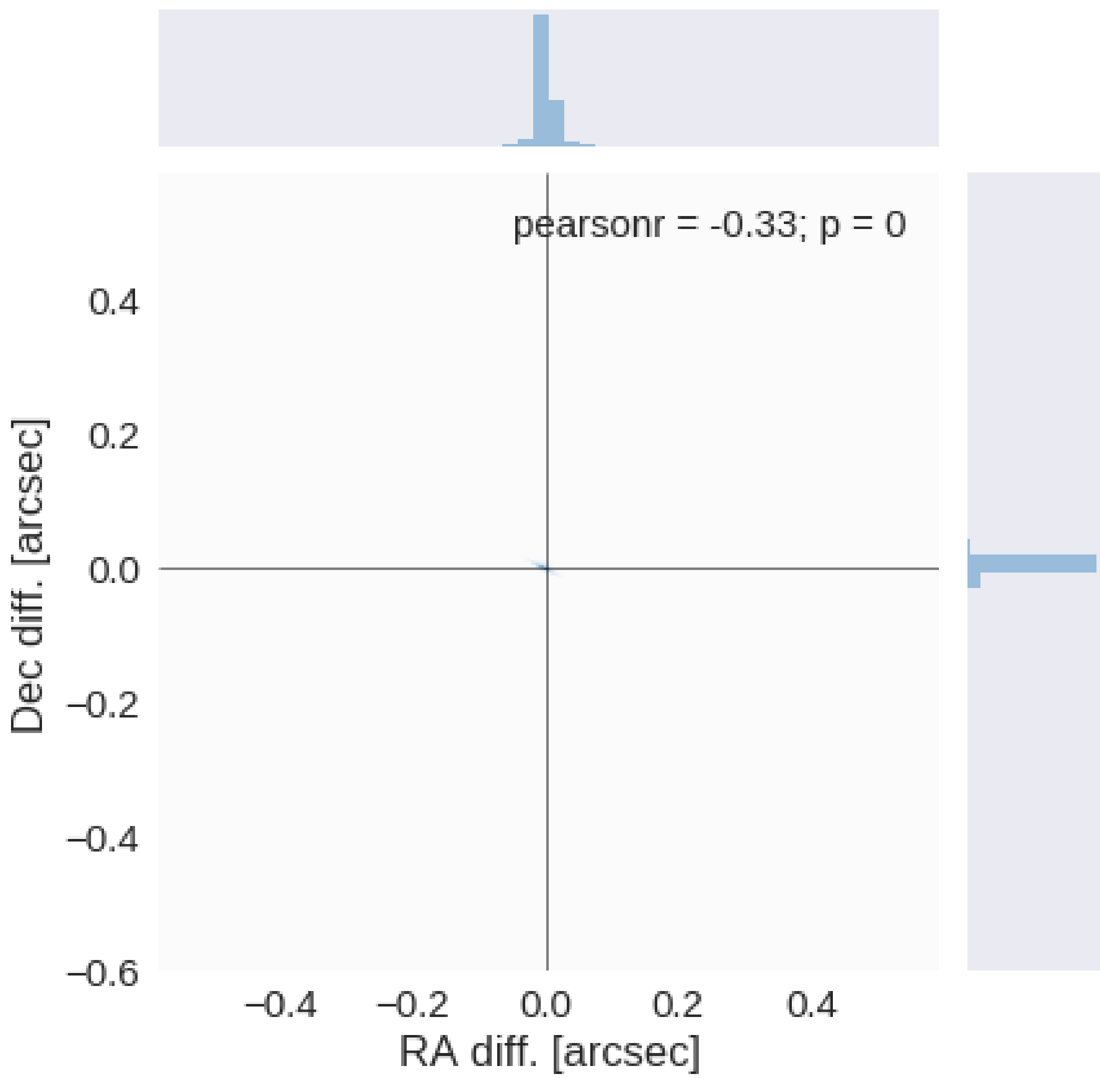
We remove duplicated objects from the input catalogues.

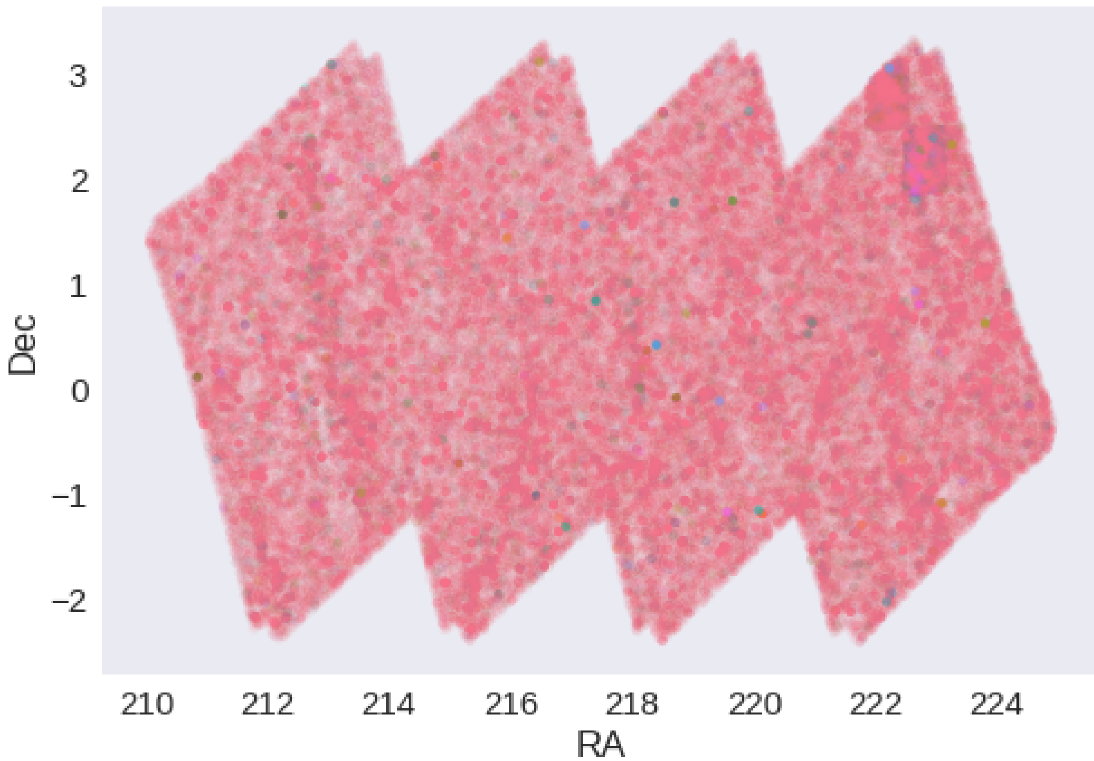
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 1401806 sources.
The cleaned catalogue has 1401443 sources (363 removed).
The cleaned catalogue has 363 sources flagged as having been cleaned
```

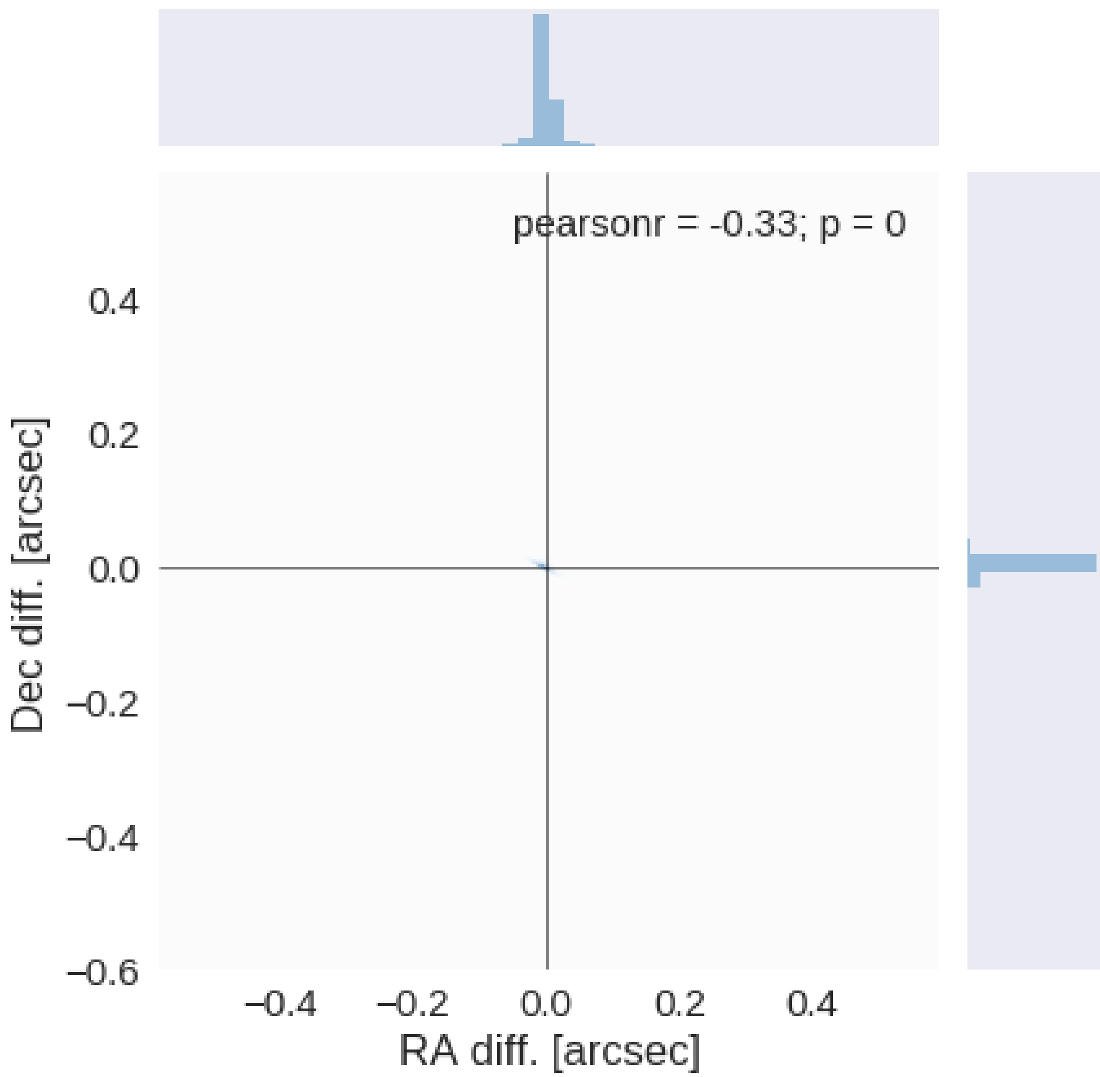
1.4 III - Astrometry correction

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.

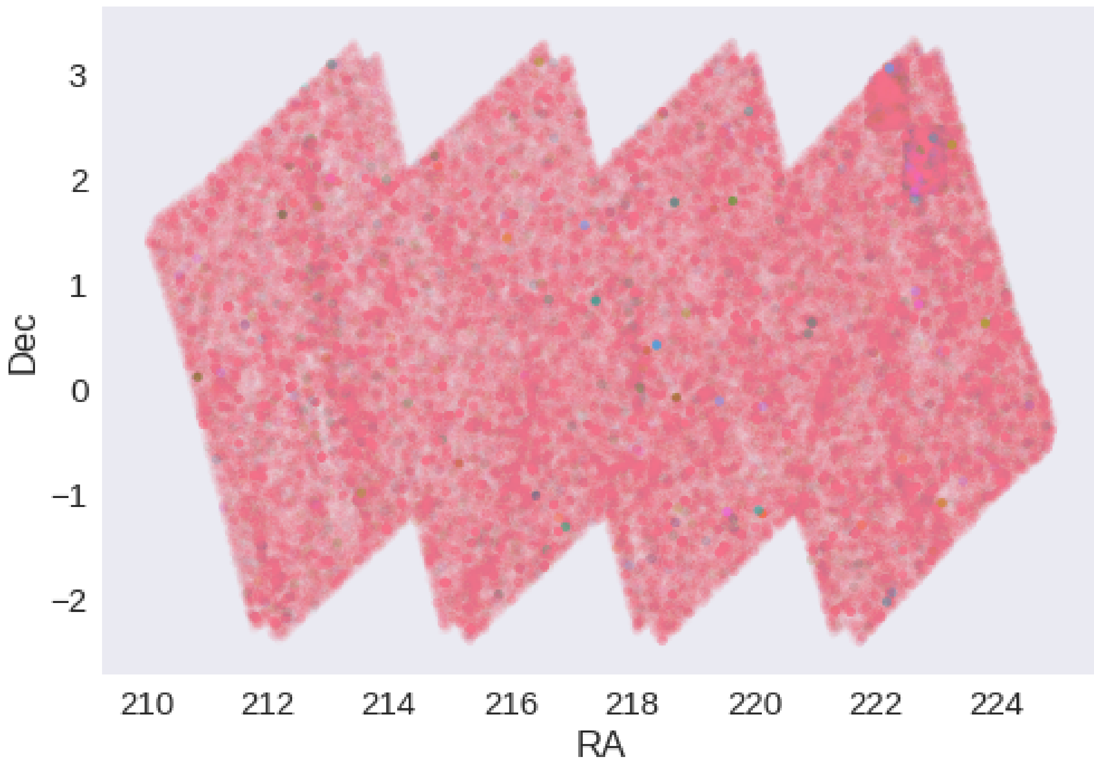





```
RA correction: -0.0005758271811373561 arcsec
Dec correction: -0.0002114812548081879 arcsec
```



pearsonr = -0.33; p = 0
0.4
0.2
0.0
−0.2
−0.4
−0.6
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
239049 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.5_UKIDSS-LAS

March 8, 2018

1 GAMA-15 master catalogue

1.1 Preparation of UKIRT Infrared Deep Sky Survey / Large Area Survey (UKIDSS/LAS)

Information about UKIDSS can be found at http://www.ukidss.org/surveys/surveys.html

The catalogue comes from `dmu0_UKIDSS-LAS`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band in aperture 3 (2 arcsec).
- The hall magnitude is described as the total magnitude.

J band magnitudes are available in two eopchs. We take the first arbitrarily.

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

Band	AB offset
Y	0.634
J	0.938
H	1.379
K	1.900

Each source is associated with an epoch. These range between 2005 and 2007. We take 2006 for the epoch.

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

1.2 I - Column selection

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

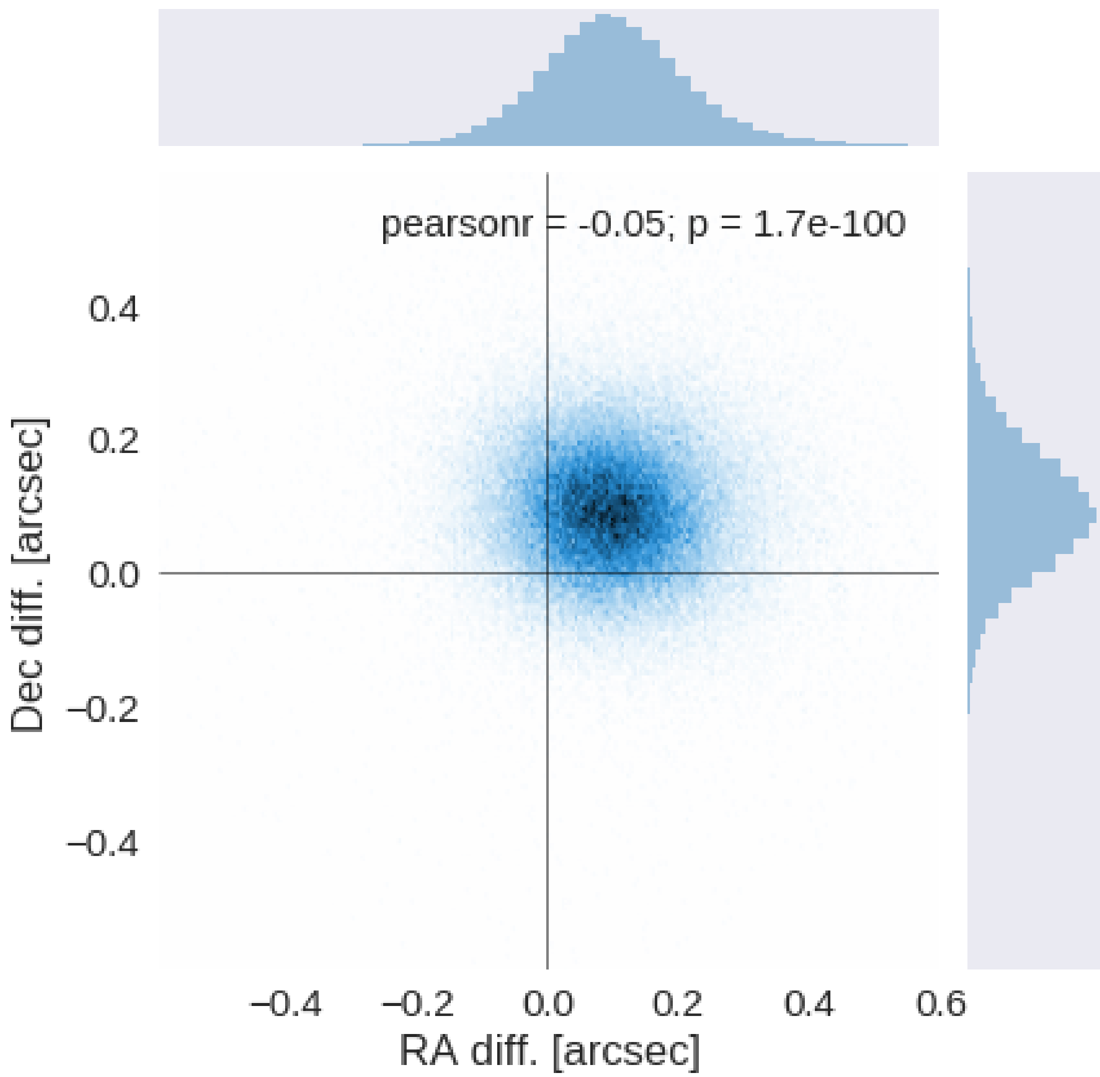
We remove duplicated objects from the input catalogues.

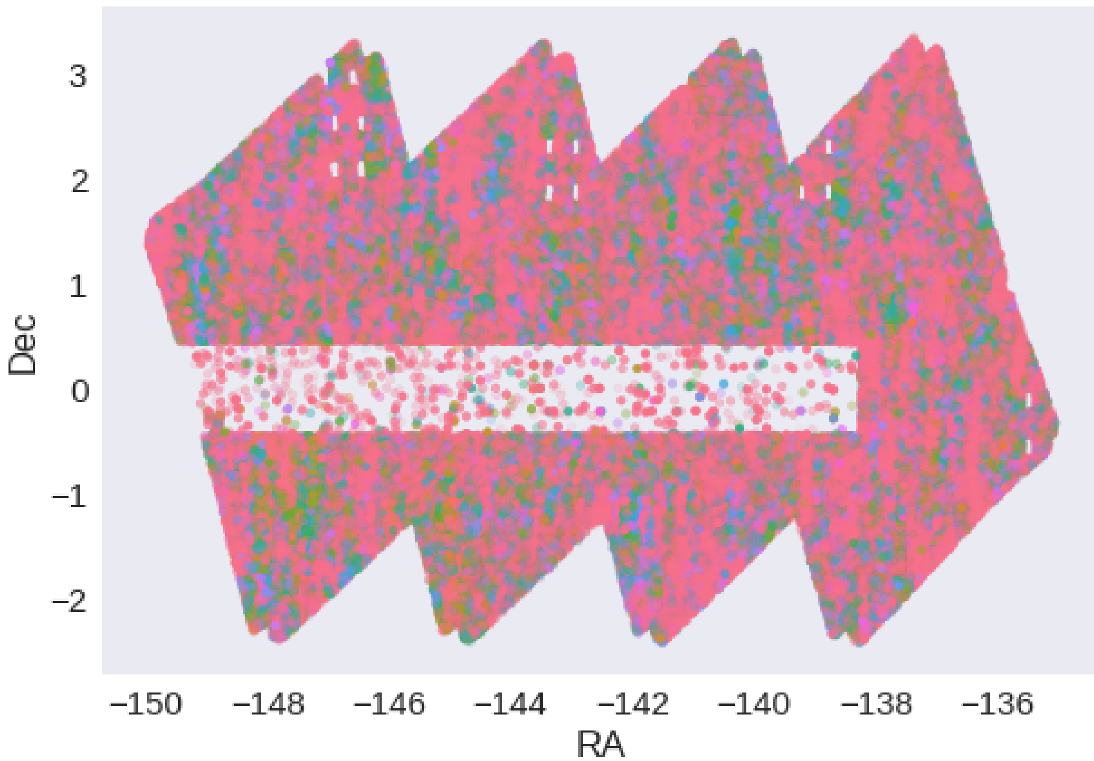
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 1497654 sources.
The cleaned catalogue has 1497176 sources (478 removed).
The cleaned catalogue has 471 sources flagged as having been cleaned
```

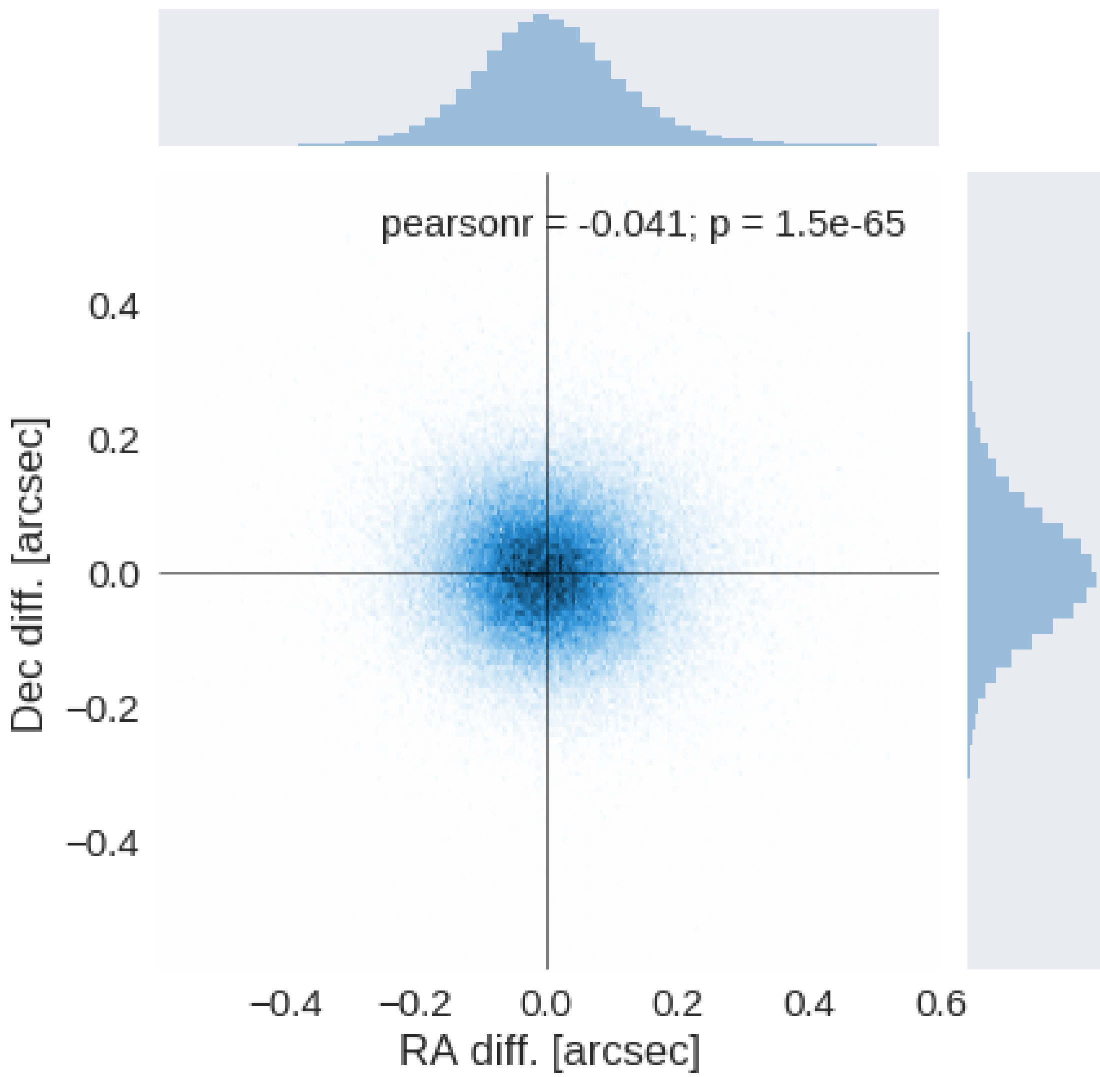
1.4 III - Astrometry correction

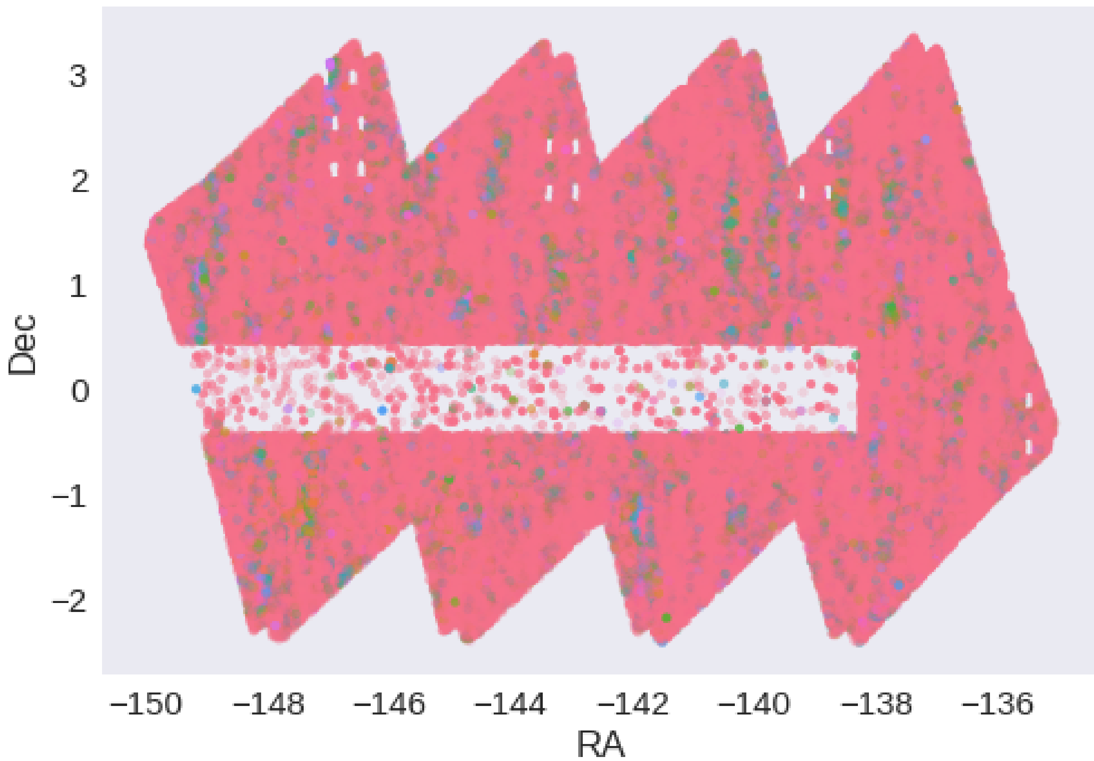
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = -0.05; p = 1.7e-100
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
0.6
RA diff. [arcsec]




```
RA correction: -0.09769077962573647 arcsec
Dec correction: -0.09119343336112529 arcsec
```


pearsonr = -0.041; p = 1.5e-65
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
0.6
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
183382 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.6_VISTA-VIKING

March 8, 2018

1 GAMA-15 master catalogue

1.1 Preparation of VIKING data

VISTA telescope/VIKING catalogue: the catalogue comes from `dmu0_VIKING`.

In the catalogue, we keep:

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

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

```
This notebook was run with herschelhelp_internal version:
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[7]: <IPython.core.display.HTML object>
```

1.3 II - Removal of duplicated sources

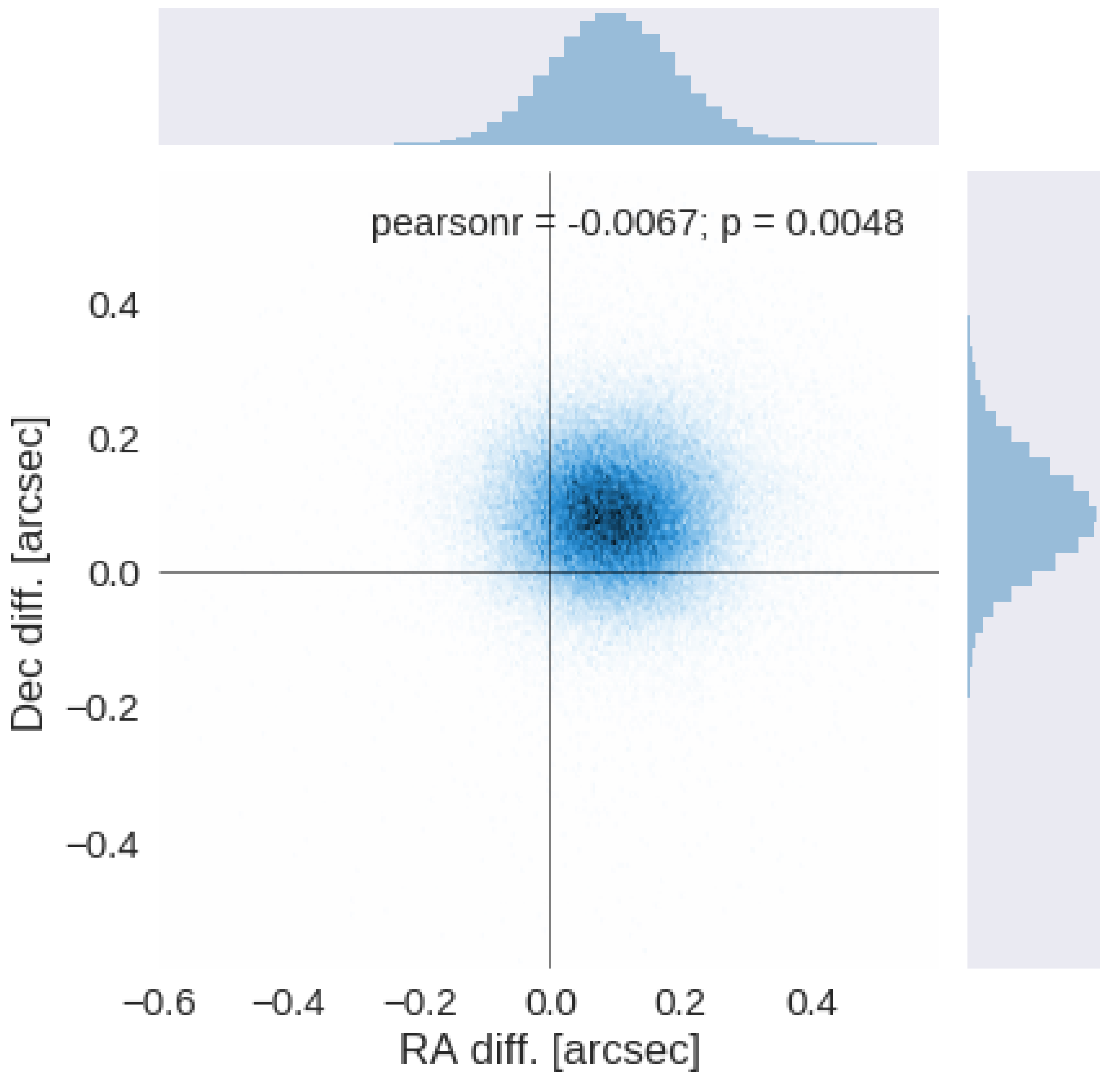
We remove duplicated objects from the input catalogues.

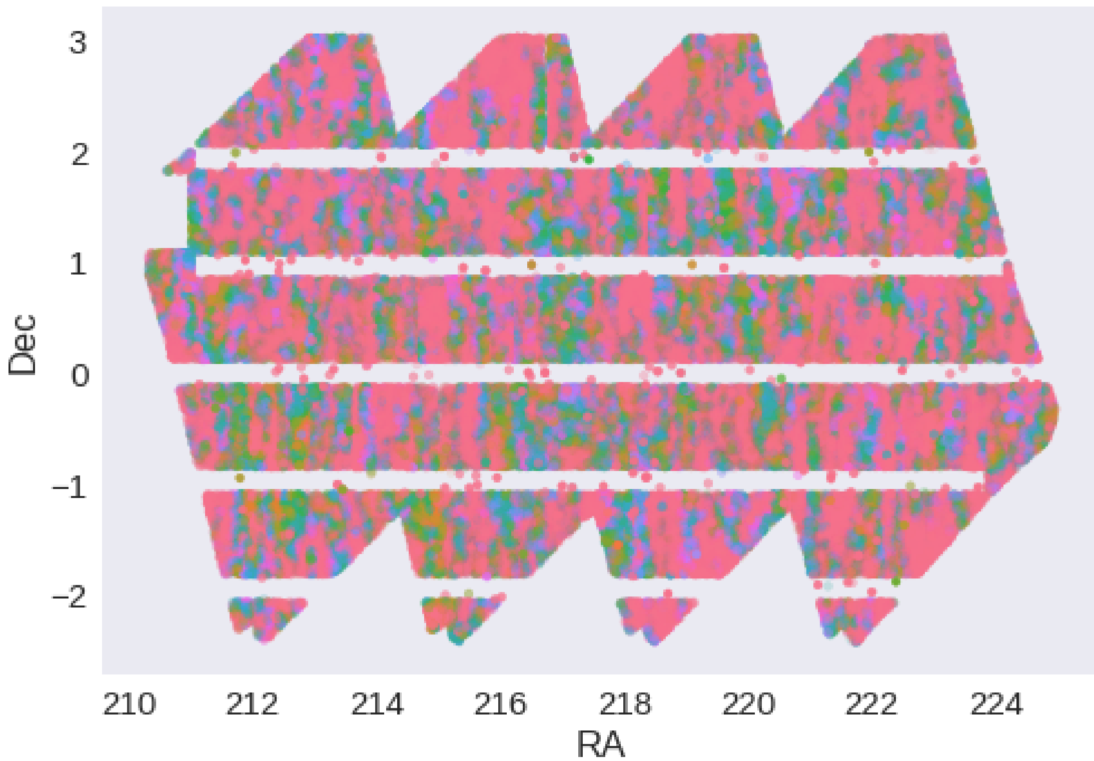
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 3349591 sources.
The cleaned catalogue has 3348955 sources (636 removed).
The cleaned catalogue has 632 sources flagged as having been cleaned
```

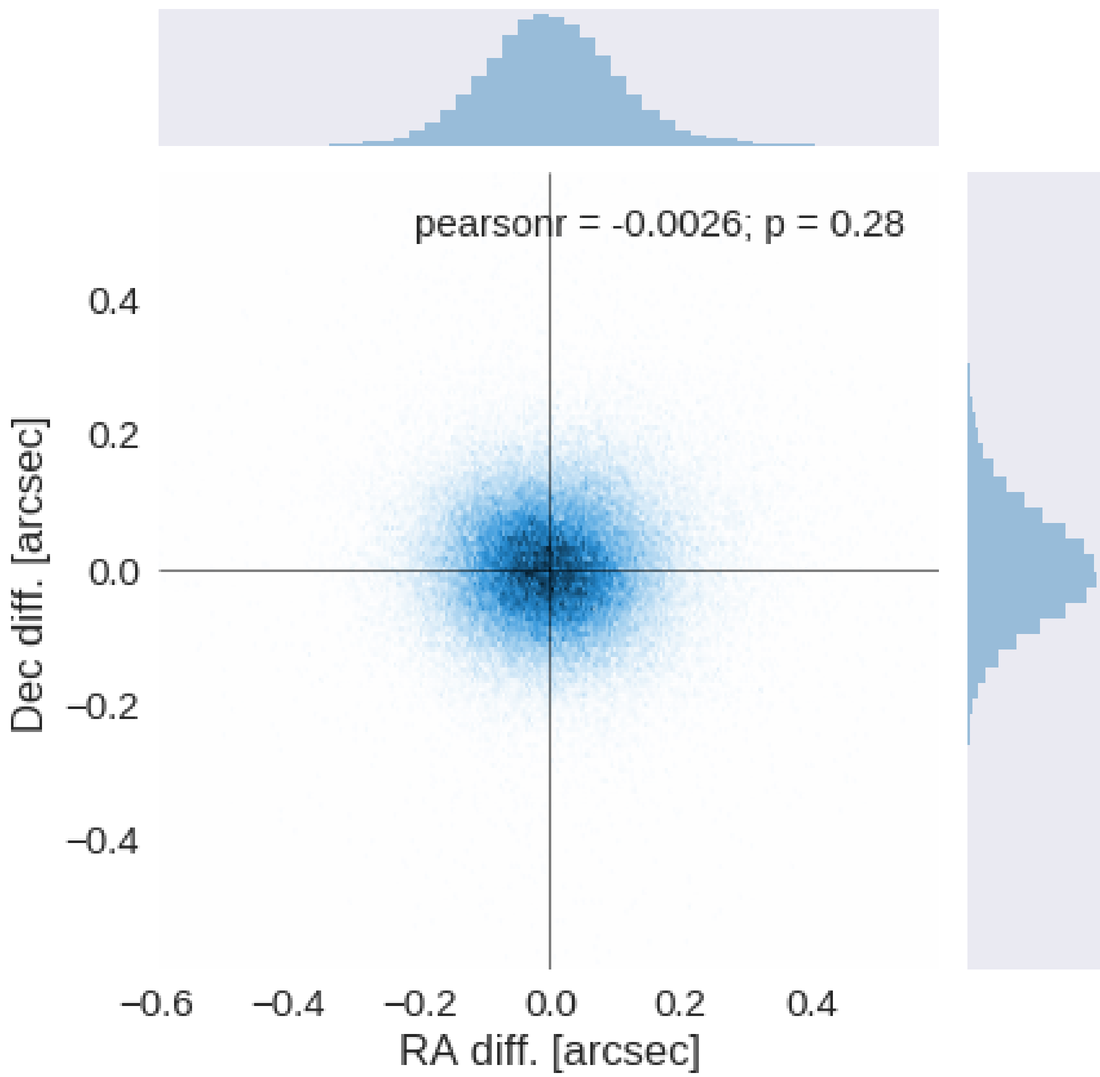
1.4 III - Astrometry correction

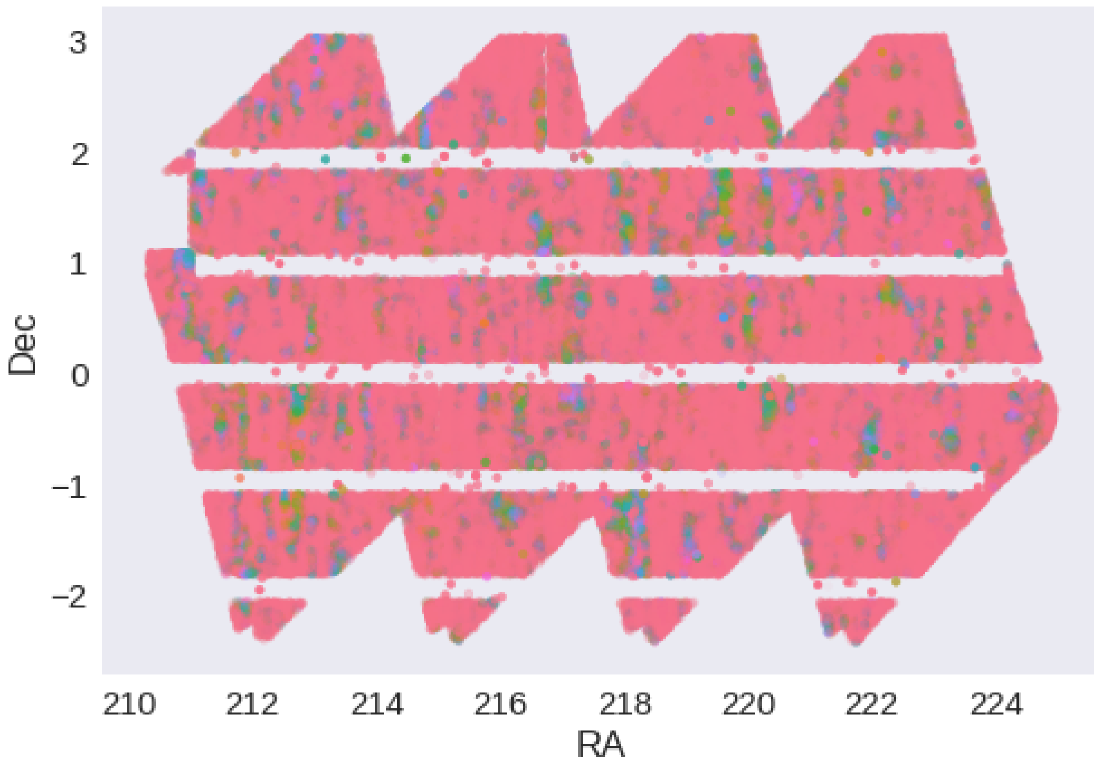
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.09687912408935517 arcsec
Dec correction: -0.08577507370057802 arcsec
```


pearsonr = -0.0026; p = 0.28
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.6
−0.4
−0.2
0.0
0.2
0.4
RA diff. [arcsec]



1.5 IV - Flagging Gaia objects

```
178880 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

2_Merging

March 8, 2018

1 GAMA-15 master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-15.

```
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

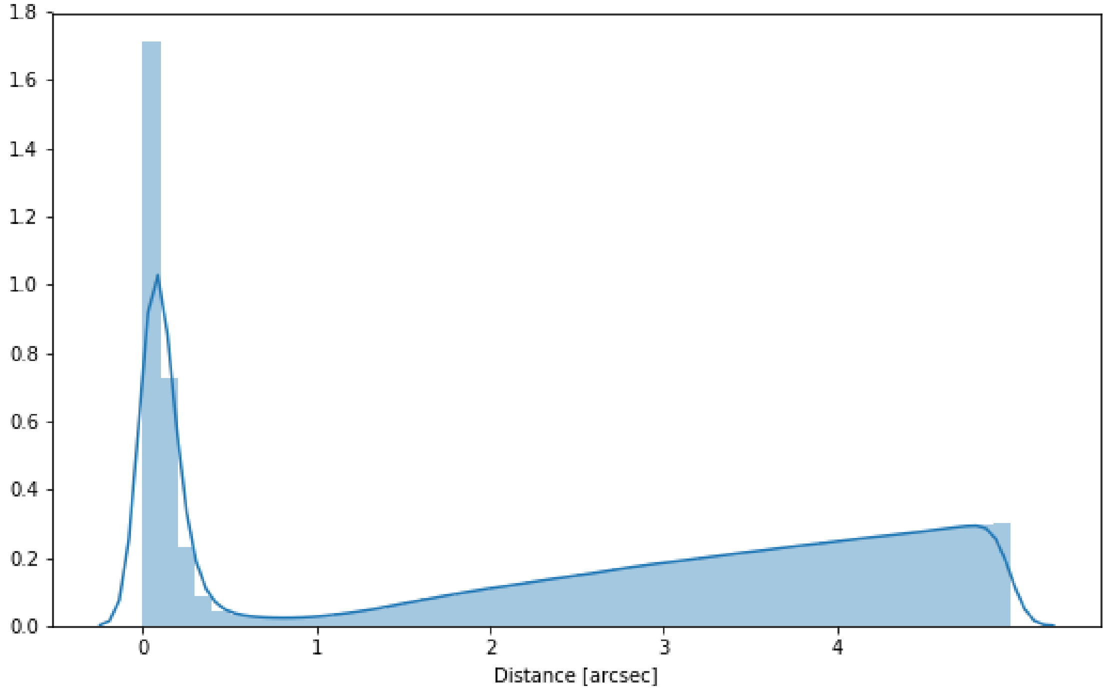
1.2 II - Merging tables

We first merge the optical catalogues and then add the infrared ones: DECaLS, HSC, KIDS, PanSTARRS, UKIDSS-LAS, and VISTA-VIKING.

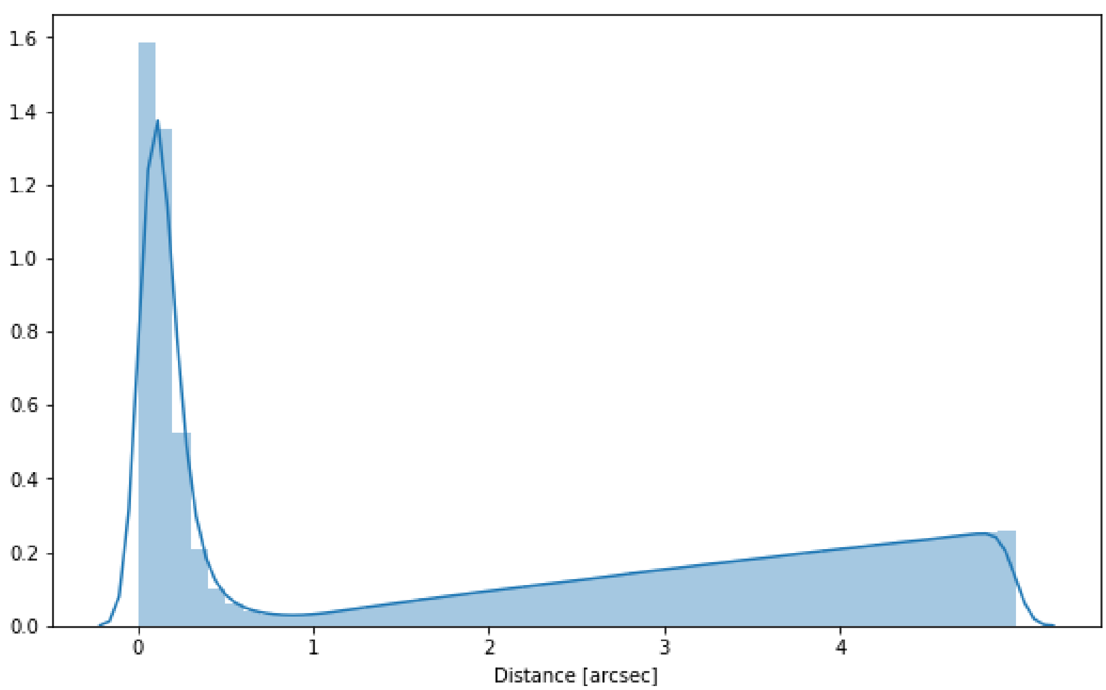
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 DECaLS

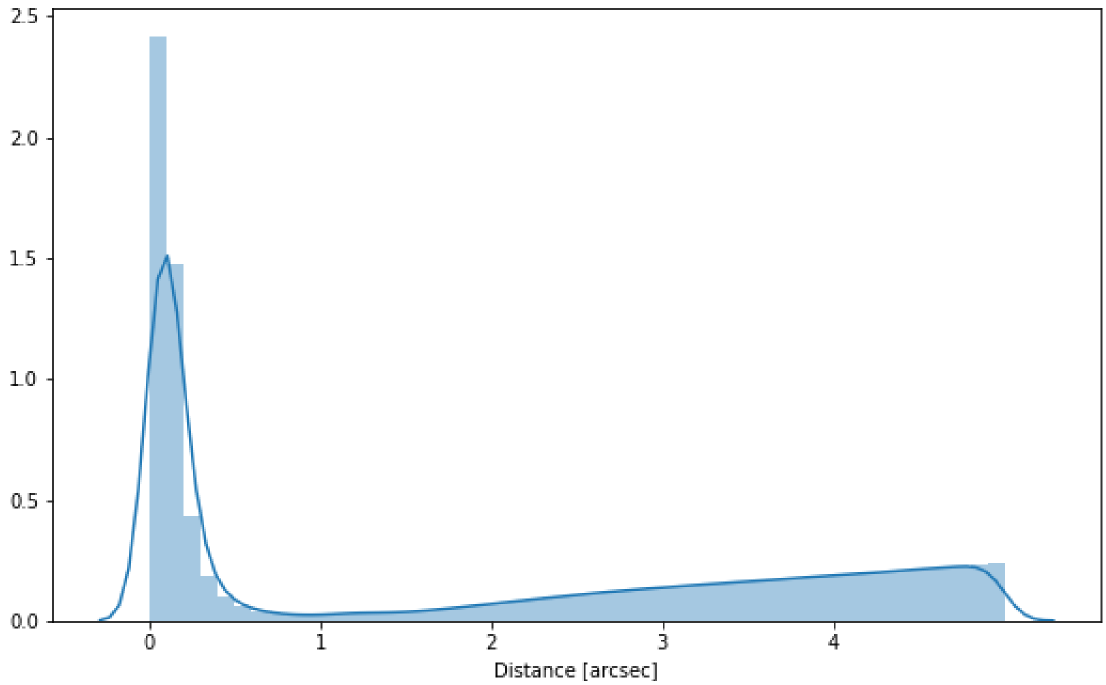
1.2.2 Add HSC-PSS



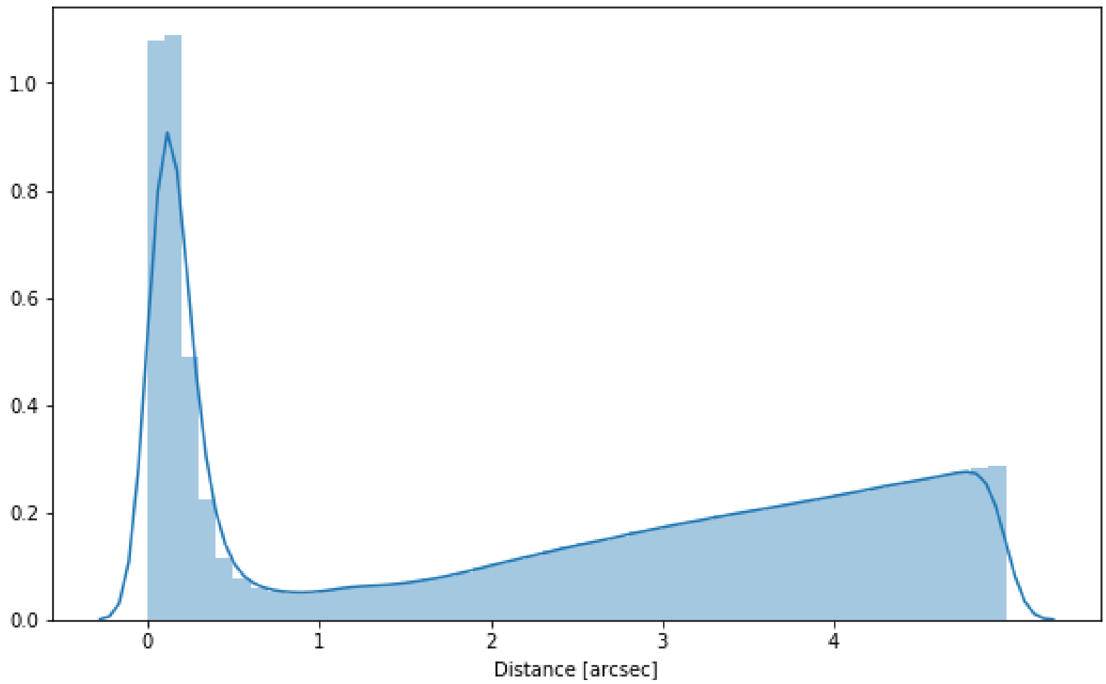
1.2.3 Add KIDS



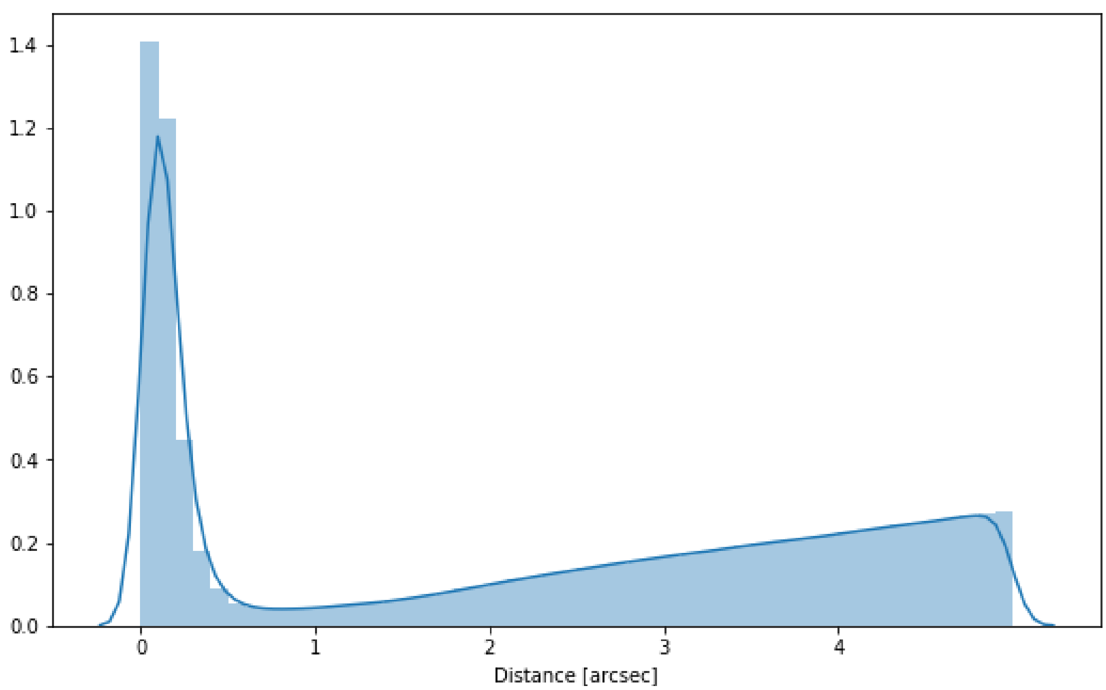
1.2.4 Add PanSTARRS



1.2.5 Add UKIDSS LAS



1.2.6 Add VIKING



1.2.7 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[17]: <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.

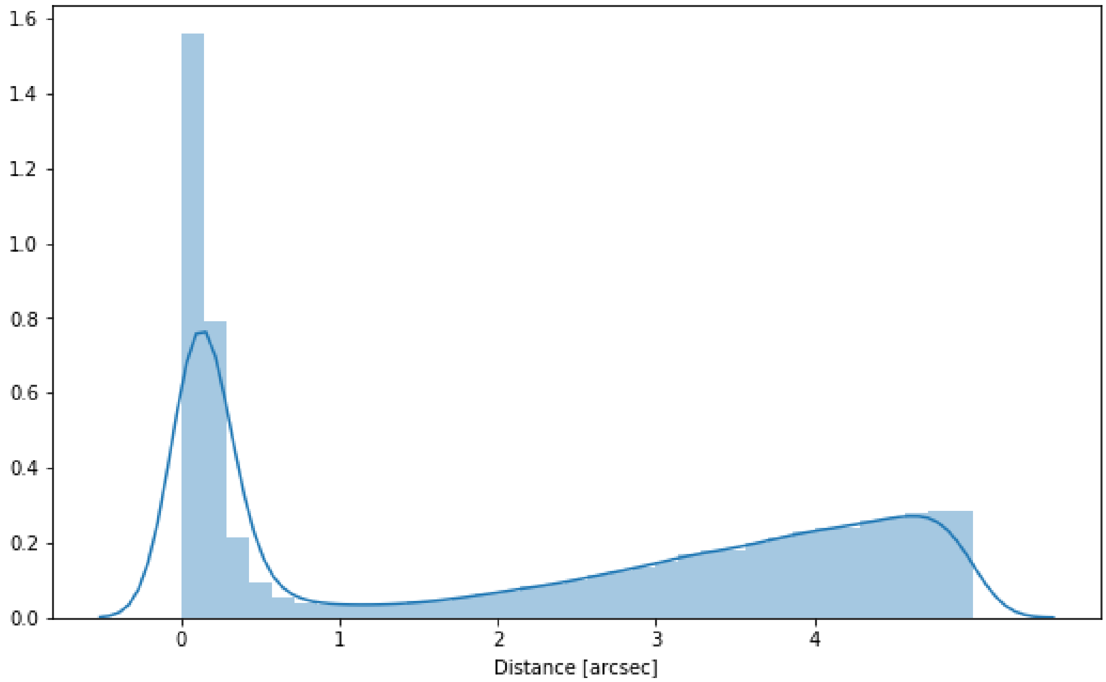
```
decals_stellarity, hsc_stellarity, kids_stellarity, las_stellarity, viking_stellarity
```

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

In GAMA-15 we don't have any pairs of surveys from the same instruments. All we need to do is rename some columns to the name of the camera

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 catalogue. This can be used to easily get additional information from them.

```
['decals_id', 'hsc_id', 'kids_id', 'ps1_id', 'las_id', 'viking_id', 'help_id', 'specz_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_Checks_and_diagnostics

March 8, 2018

1 GAMA-15 master catalogue

1.1 Checks and diagnostics

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

```
Diagnostics done using: master_catalogue_gama-15_20180129.fits
```

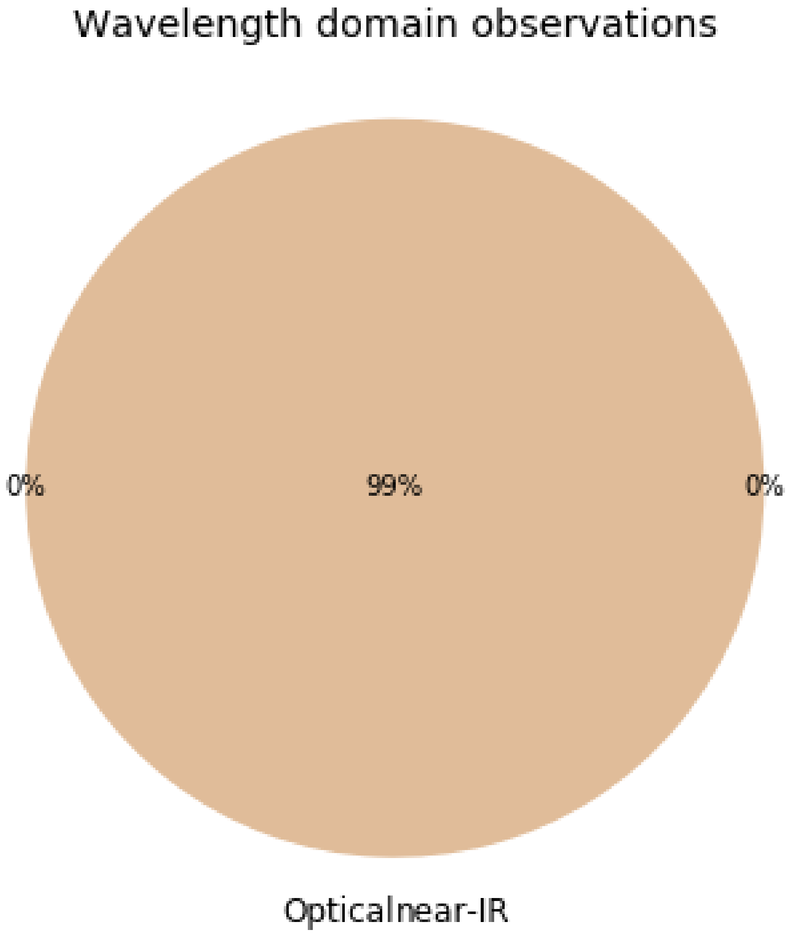
1.2 0 - Quick checks

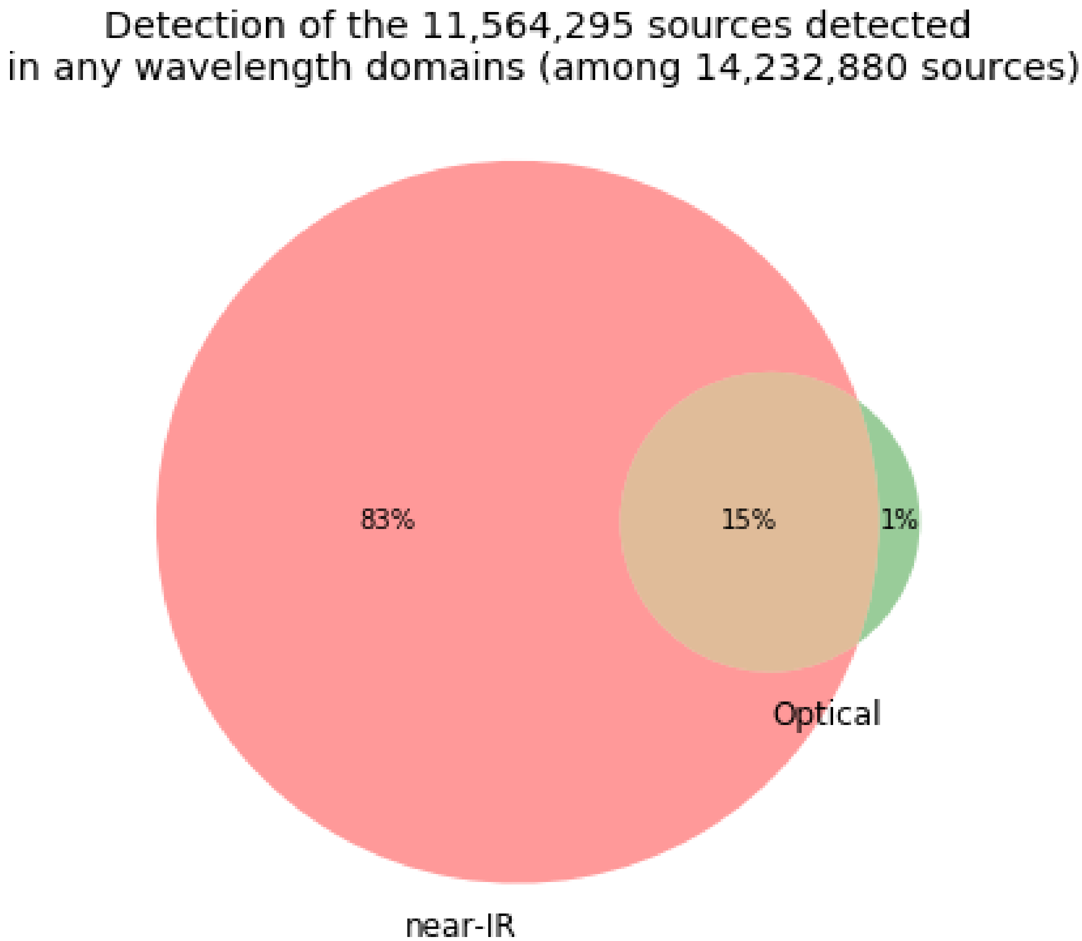
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype),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

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

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

1.3 I - Summary of wavelength domains



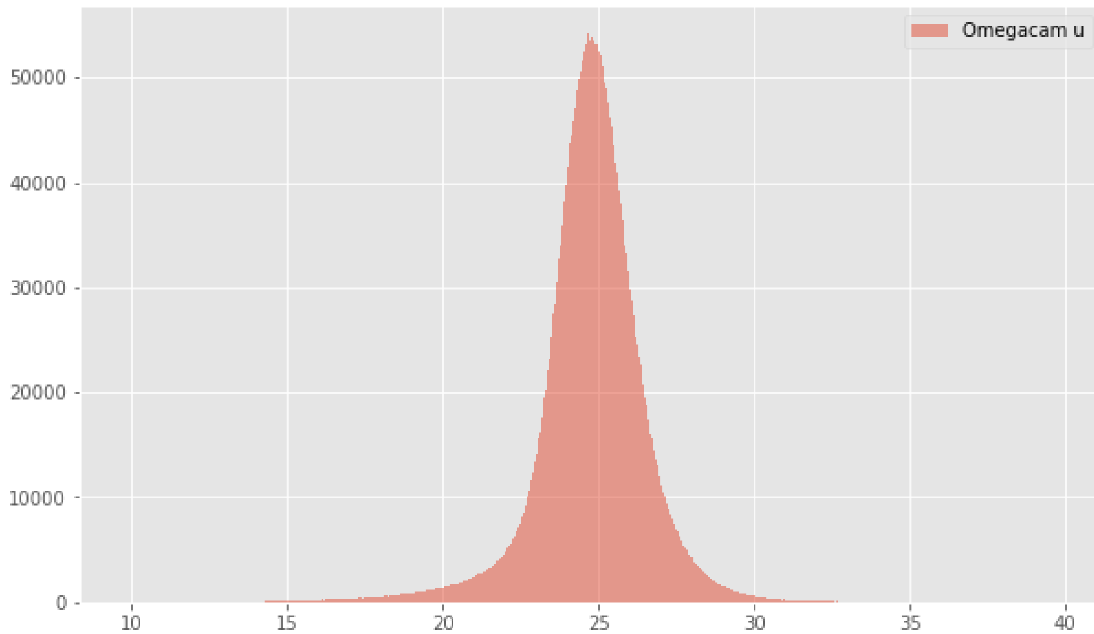


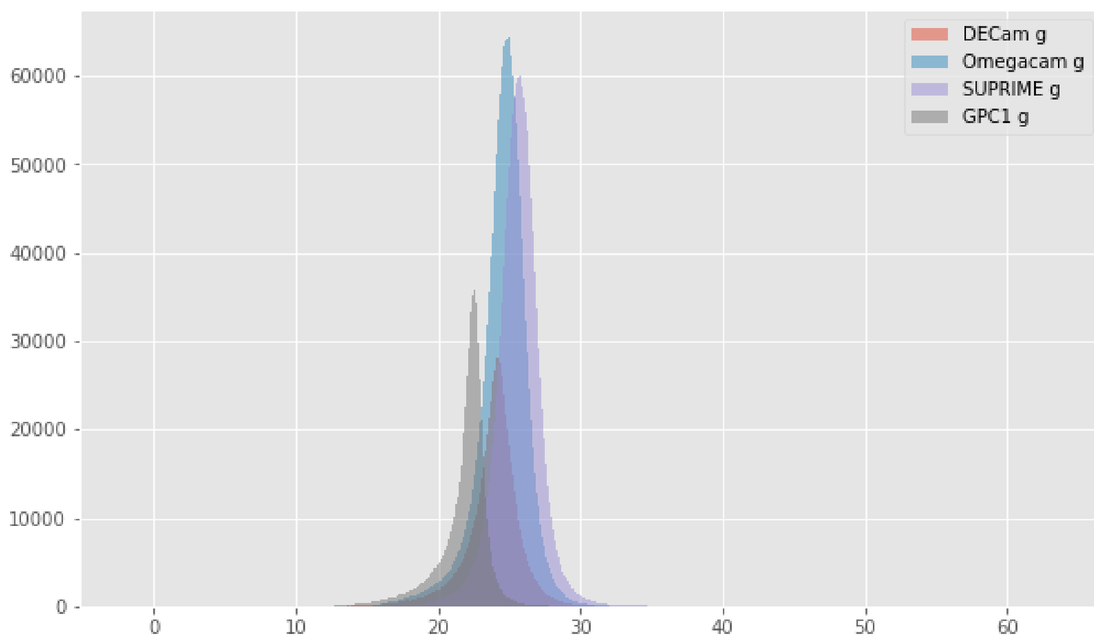
1.4 II - Comparing magnitudes in similar filters

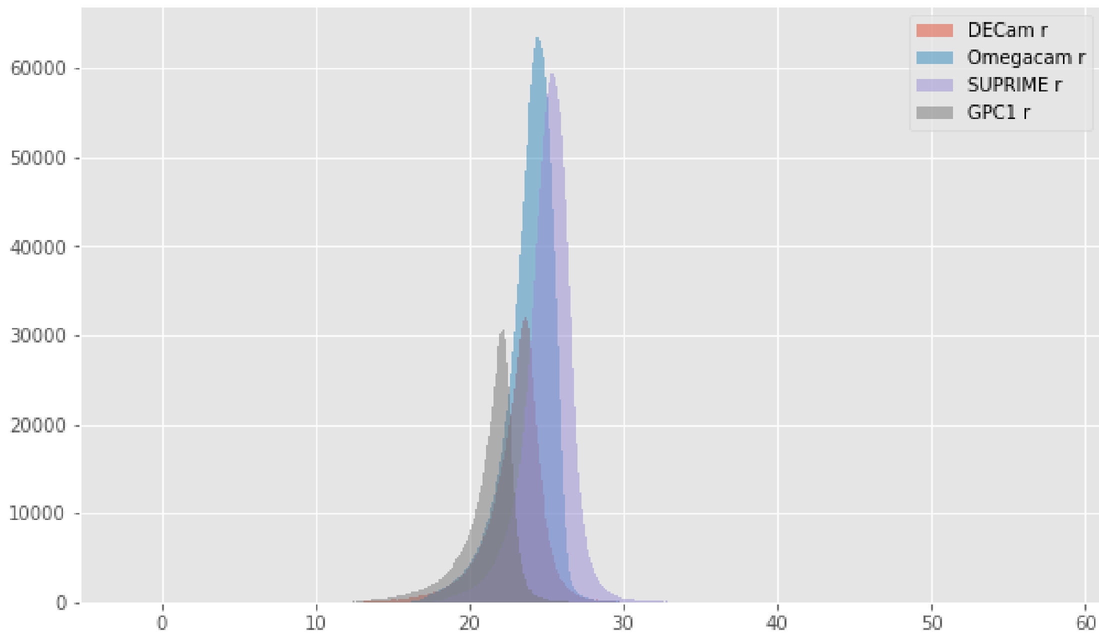
The master list if composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

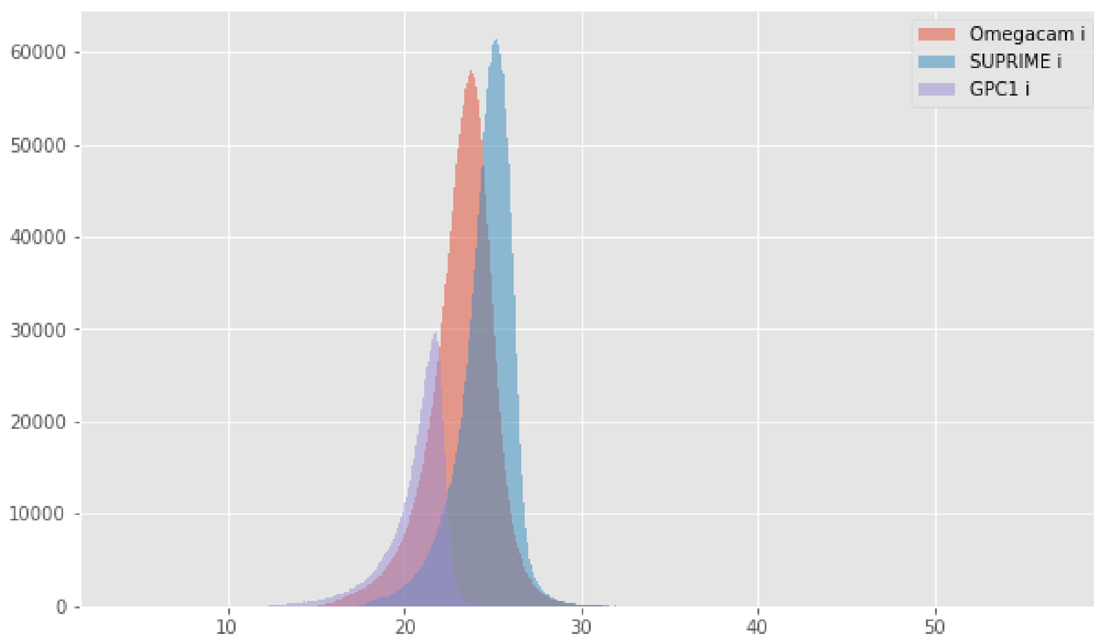
1.4.1 II.a - Comparing depths

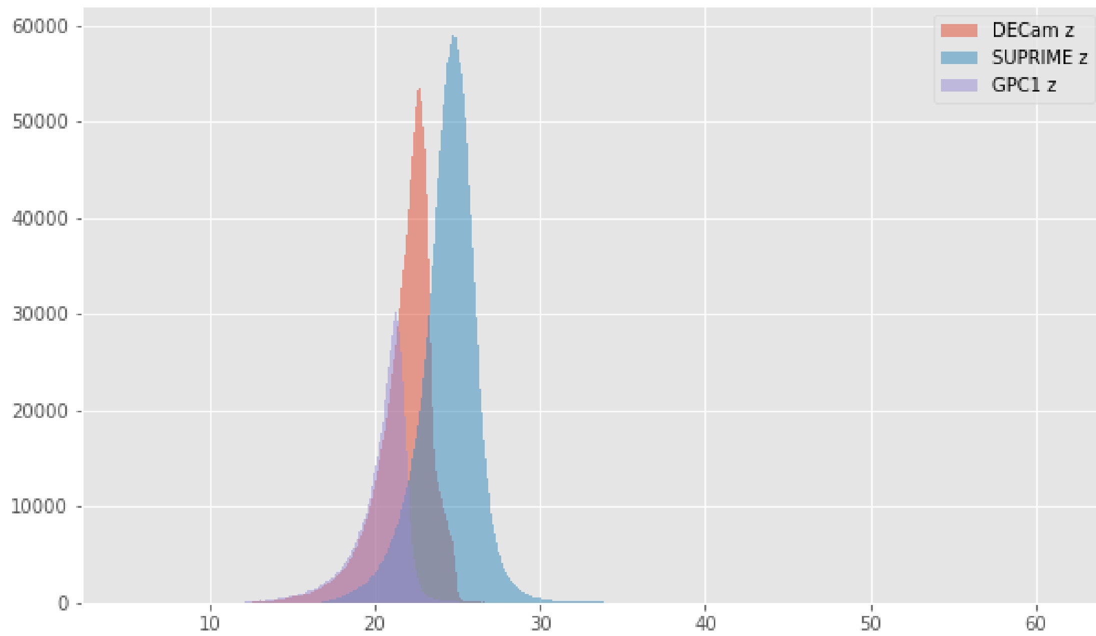
We compare the histograms of the total aperture magnitudes of similar bands.

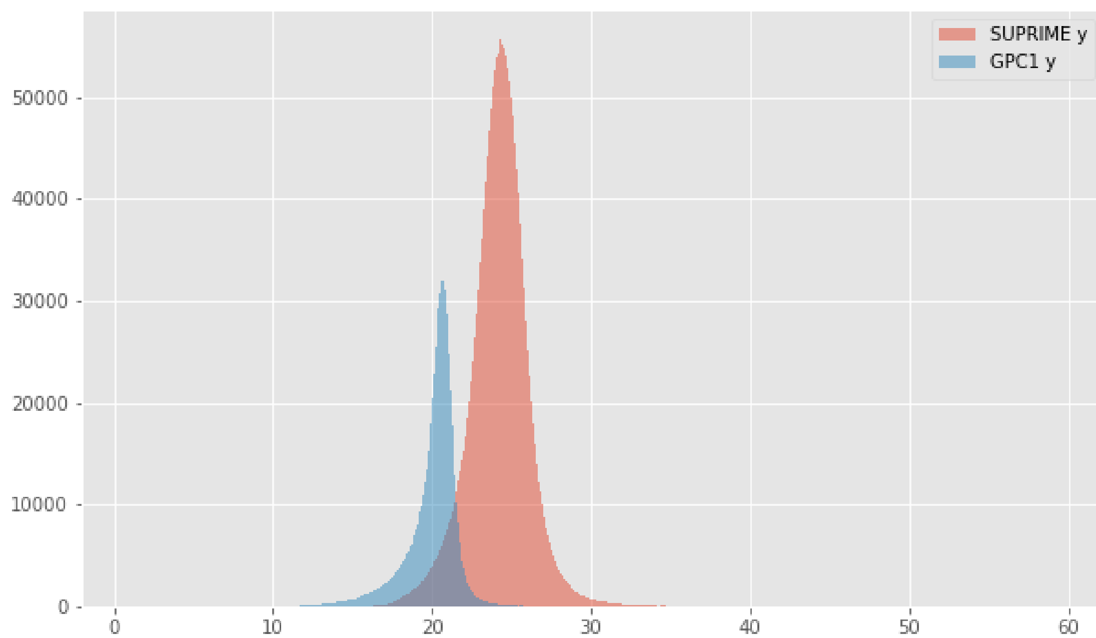

Omegacam u
50000
40000
30000
20000
10000
0
10
15
20
25
30
35
40


DECam g
Omegacam g
SUPRIME g
GPC1 g
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60


DECam r
Omegacam r
SUPRIME r
GPC1 r
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60


Omegacam i
SUPRIME i
GPC1 i
60000
50000
40000
30000
20000
10000
0
10
20
30
40
50

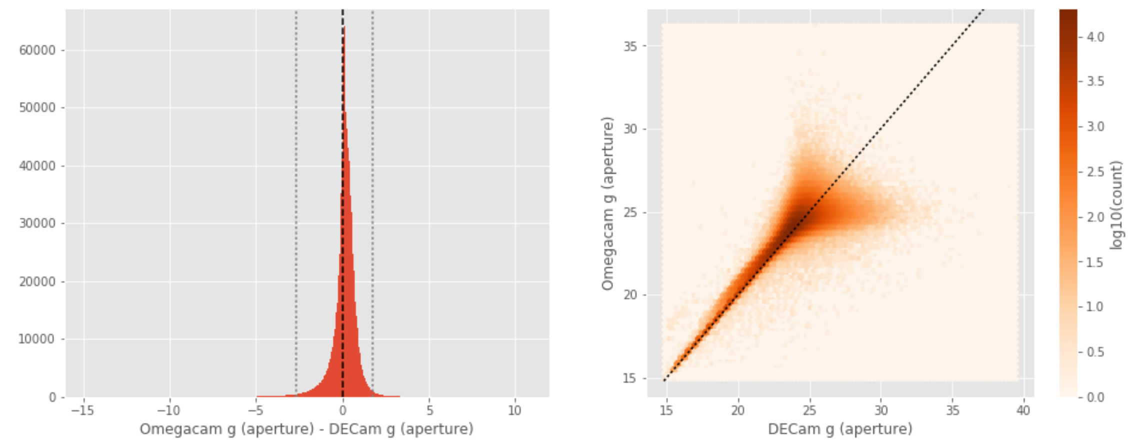




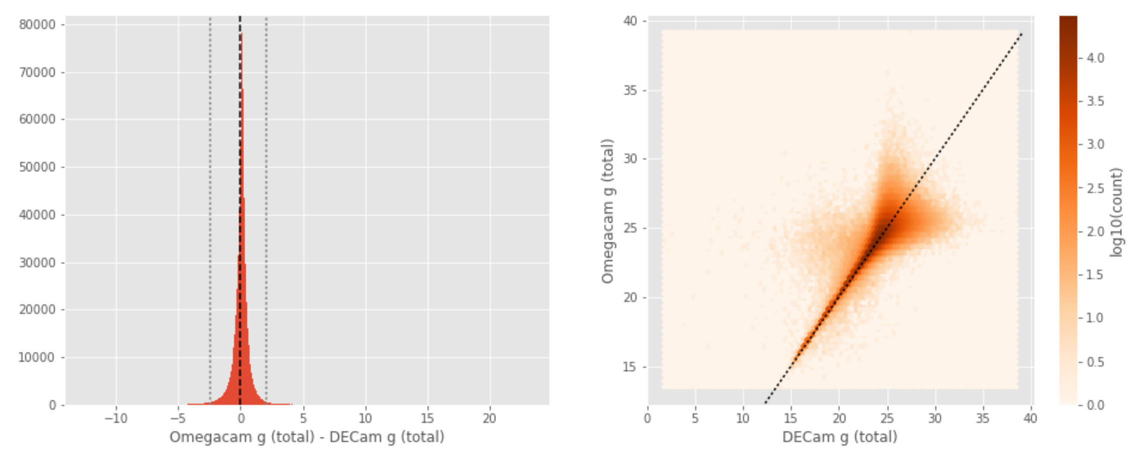
1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

Omegacam g (aperture) - DECam g (aperture):
- Median: 0.18
- Median Absolute Deviation: 0.28
- 1% percentile: -2.634096145629883
- 99% percentile: 1.733809585571289

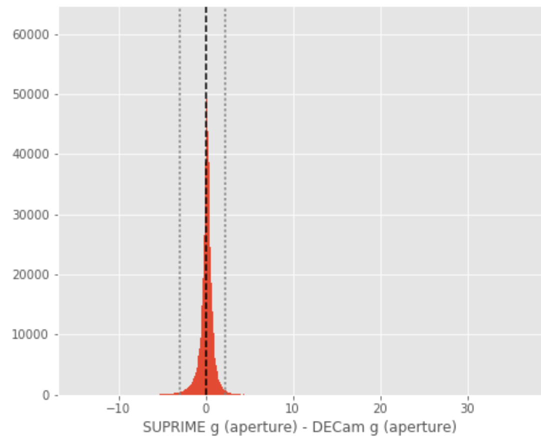


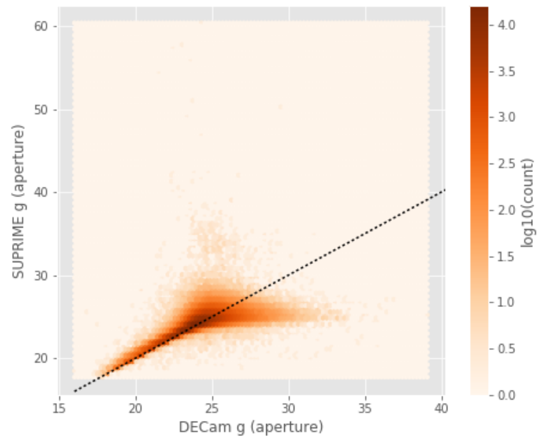
Omegacam g (total) - DECam g (total):
- Median: 0.09
- Median Absolute Deviation: 0.24
- 1% percentile: -2.4240271186828615
- 99% percentile: 2.0510866737365694



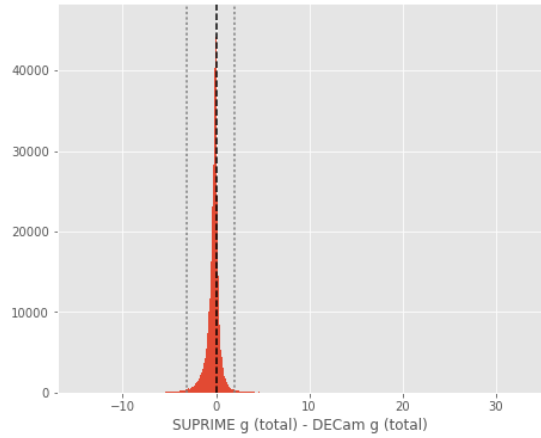
SUPRIME g (aperture) - DECam g (aperture):
- Median: 0.11

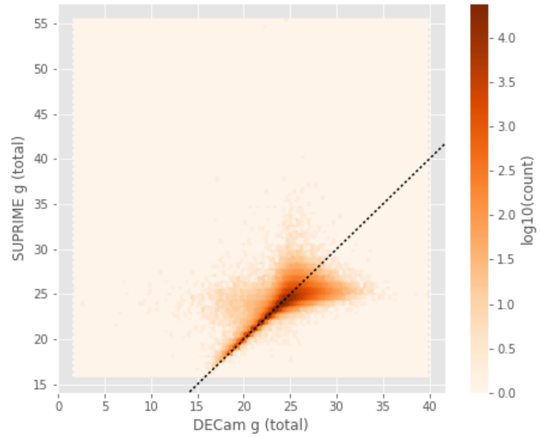
- Median Absolute Deviation: 0.31
- 1% percentile: -2.922472896575928
- 99% percentile: 2.2731615829467797





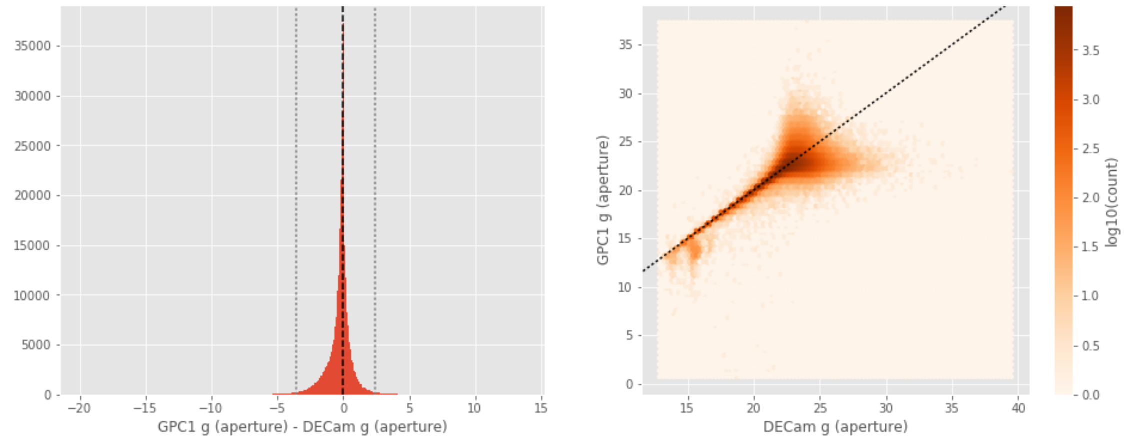
SUPRIME g (total) - DECam g (total):
- Median: -0.14
- Median Absolute Deviation: 0.26
- 1% percentile: -3.1349516105651856
- 99% percentile: 1.9637036705017081



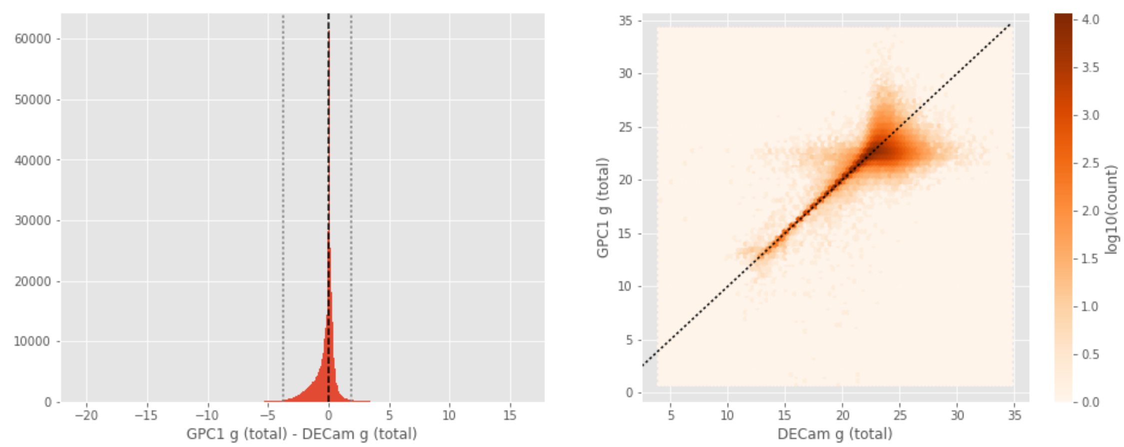


GPC1 g (aperture) - DECam g (aperture):
- Median: -0.11
- Median Absolute Deviation: 0.30
- 1% percentile: -3.582785797119141

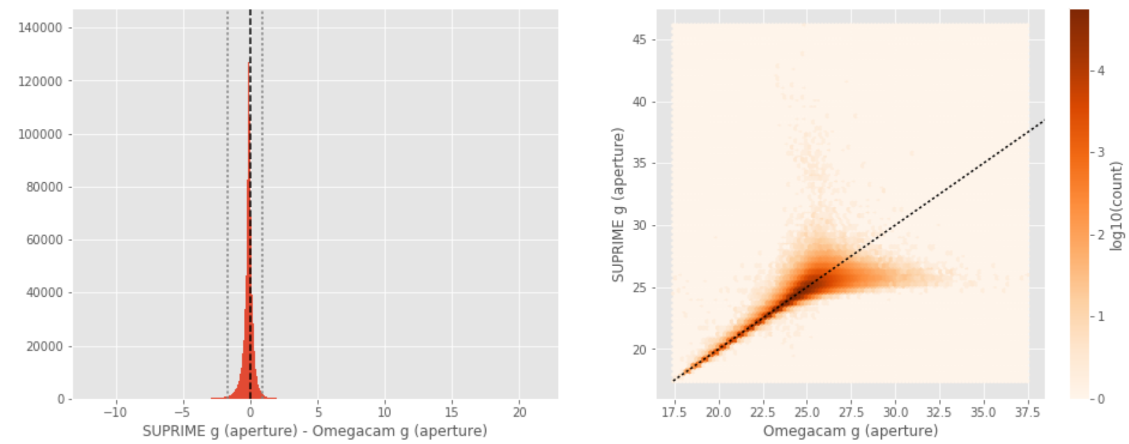
- 99% percentile: 2.3899072265624985



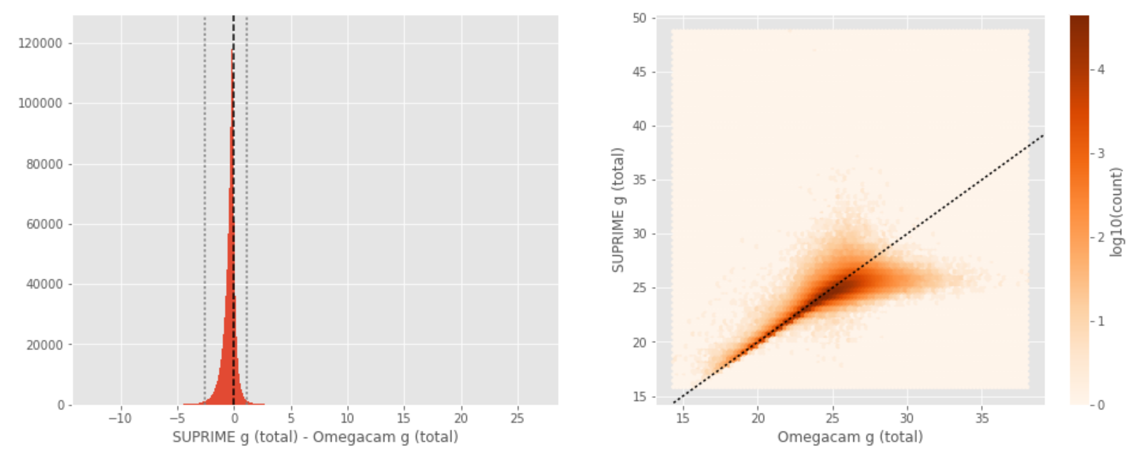
GPC1 g (total) - DECam g (total):
- Median: -0.00
- Median Absolute Deviation: 0.25
- 1% percentile: -3.7355956268310546
- 99% percentile: 1.9217100906371878



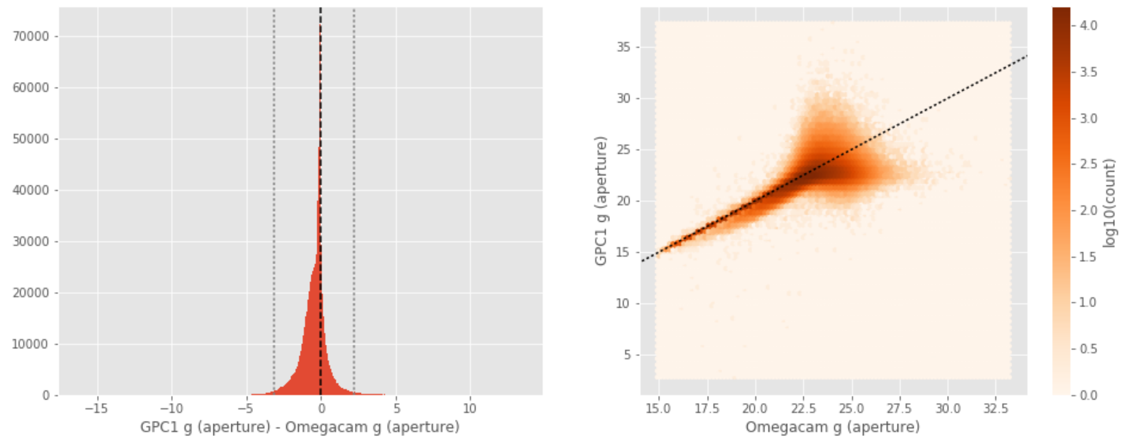
SUPRIME g (aperture) - Omegacam g (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.15
- 1% percentile: -1.639749526977539
- 99% percentile: 0.9492234992980966



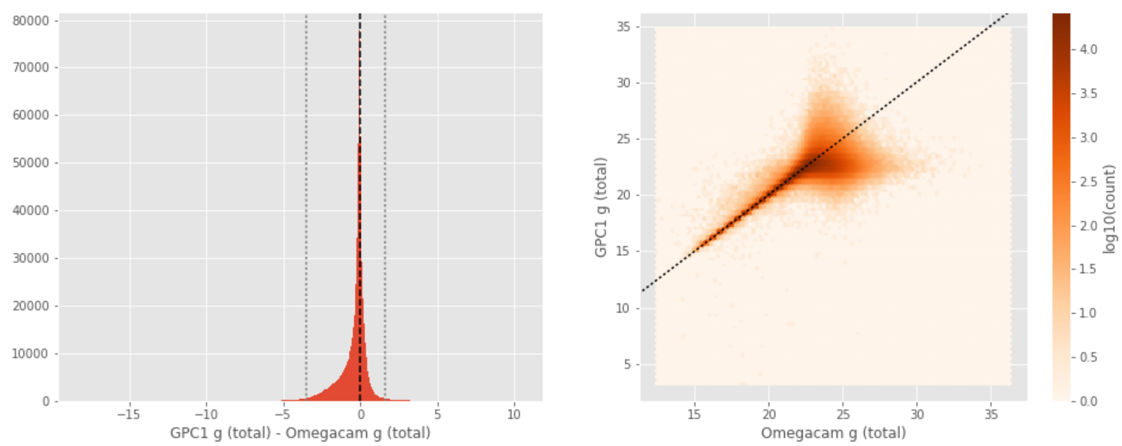
SUPRIME g (total) - Omegacam g (total):
- Median: -0.28
- Median Absolute Deviation: 0.25
- 1% percentile: -2.564059658050537
- 99% percentile: 1.128276958465567



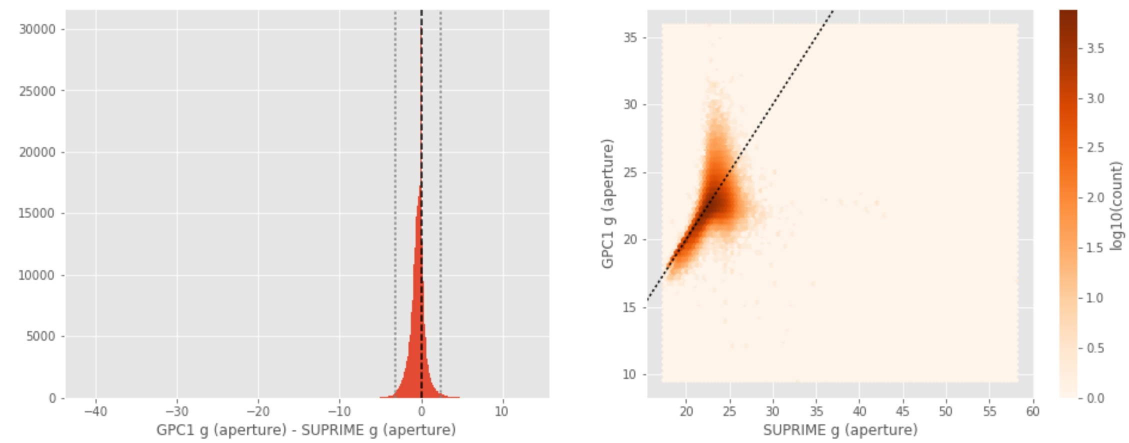
GPC1 g (aperture) - Omegacam g (aperture):
- Median: -0.31
- Median Absolute Deviation: 0.38
- 1% percentile: -3.1371237373352048
- 99% percentile: 2.213497180938726



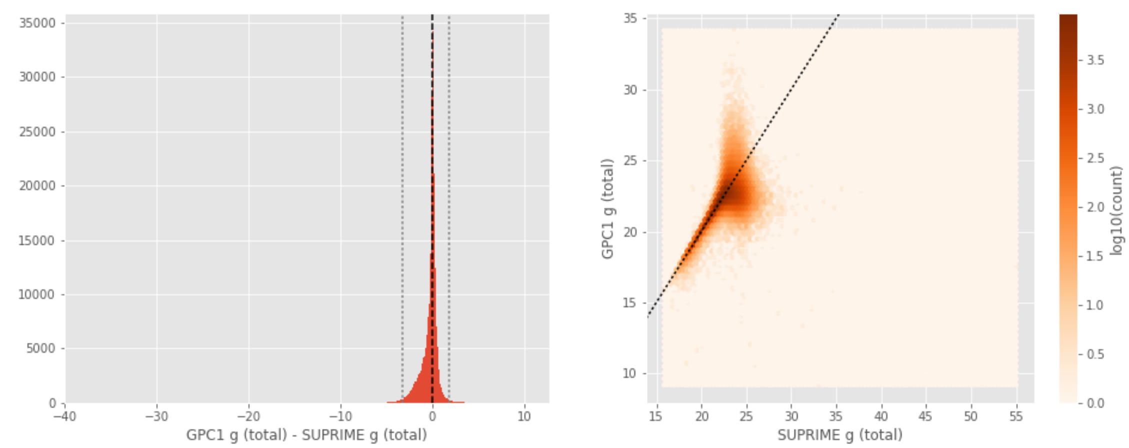
GPC1 g (total) - Omegacam g (total):
- Median: -0.12
- Median Absolute Deviation: 0.25
- 1% percentile: -3.543268051147461
- 99% percentile: 1.5813409042358293



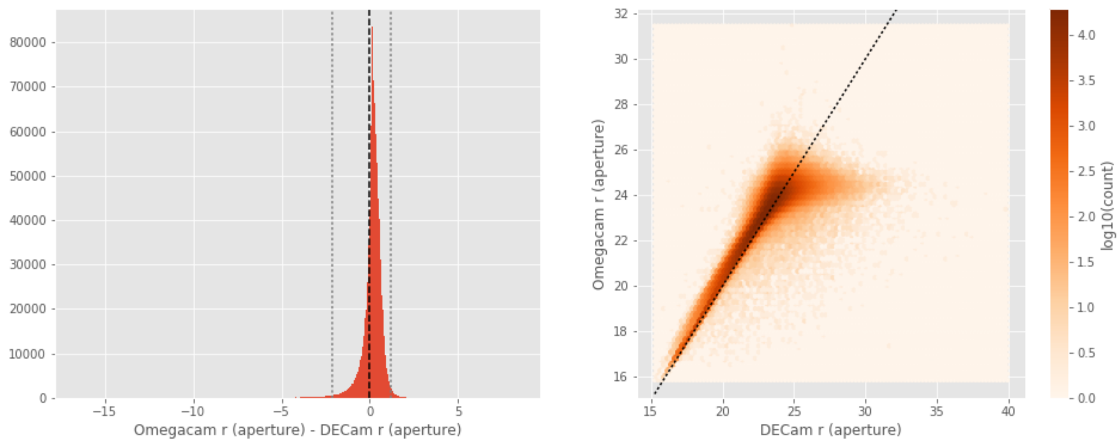
GPC1 g (aperture) - SUPRIME g (aperture):
- Median: -0.28
- Median Absolute Deviation: 0.43
- 1% percentile: -3.1680870056152344
- 99% percentile: 2.4179883003234885



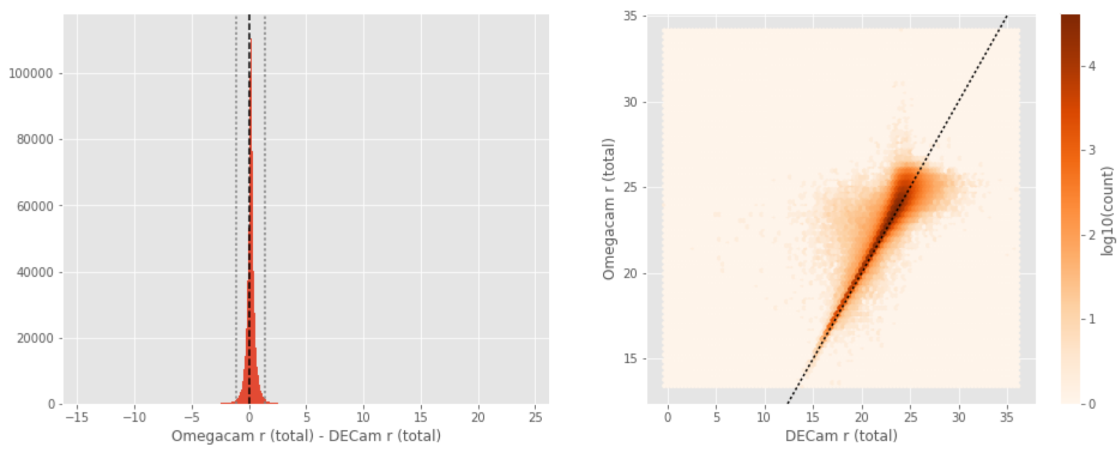
GPC1 g (total) - SUPRIME g (total):
- Median: -0.04
- Median Absolute Deviation: 0.30
- 1% percentile: -3.2857778167724607
- 99% percentile: 1.7586553955078141



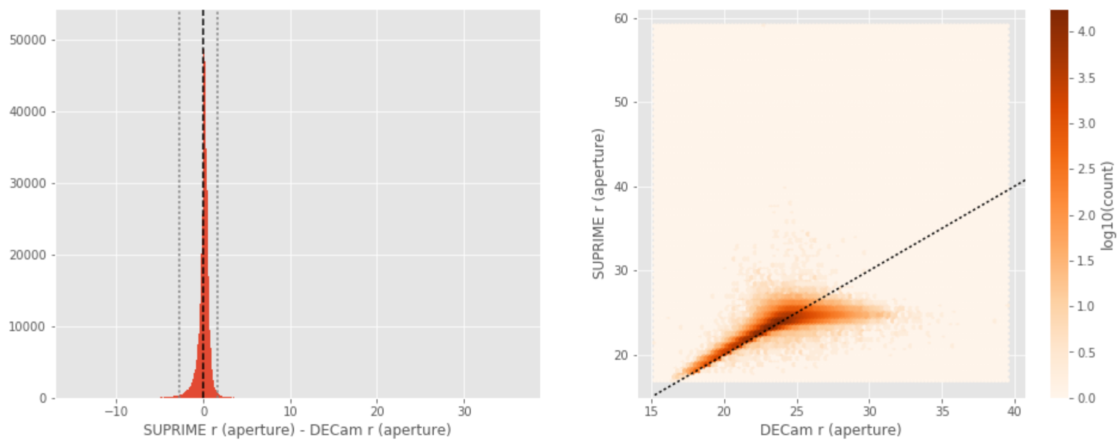
Omegacam r (aperture) - DECam r (aperture):
- Median: 0.20
- Median Absolute Deviation: 0.23
- 1% percentile: -2.137364654541016
- 99% percentile: 1.1862708282470713



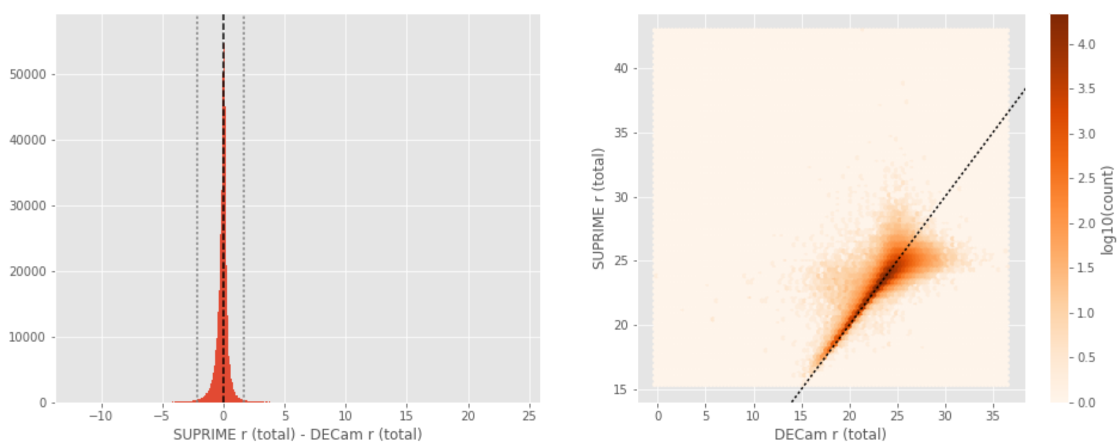
Omegacam r (total) - DECam r (total):
- Median: 0.17
- Median Absolute Deviation: 0.16
- 1% percentile: -1.1469199562072752
- 99% percentile: 1.4274457168579113



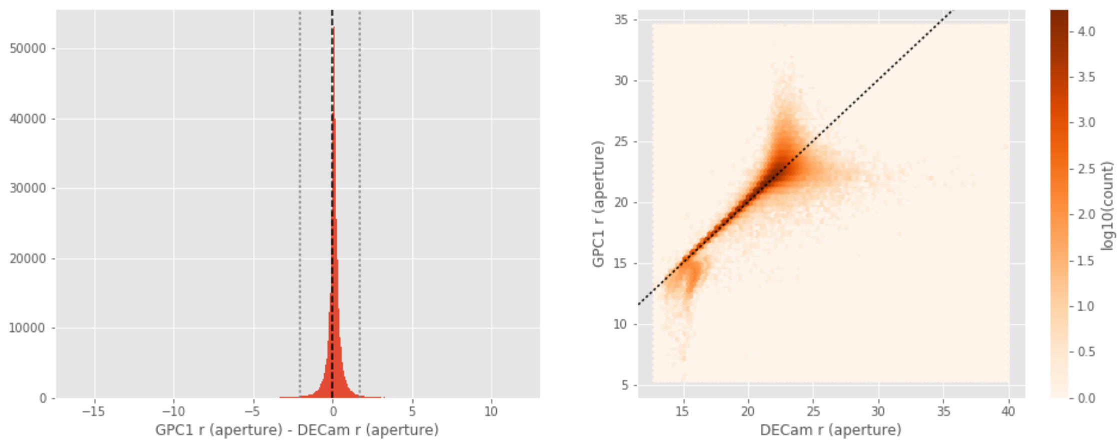
SUPRIME r (aperture) - DECam r (aperture):
- Median: 0.13
- Median Absolute Deviation: 0.26
- 1% percentile: -2.7111525154113774
- 99% percentile: 1.588455638885501



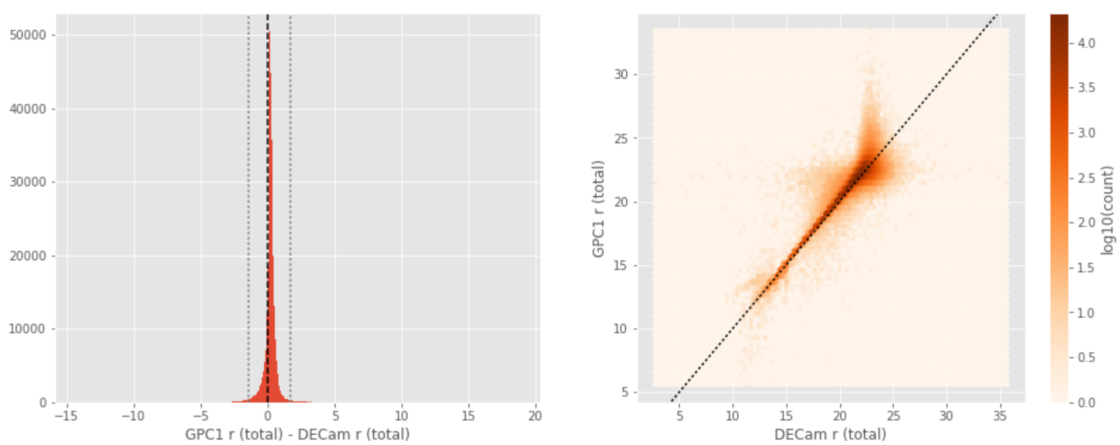
SUPRIME r (total) - DECam r (total):
- Median: -0.01
- Median Absolute Deviation: 0.19
- 1% percentile: -2.140242462158203
- 99% percentile: 1.6562129211425773



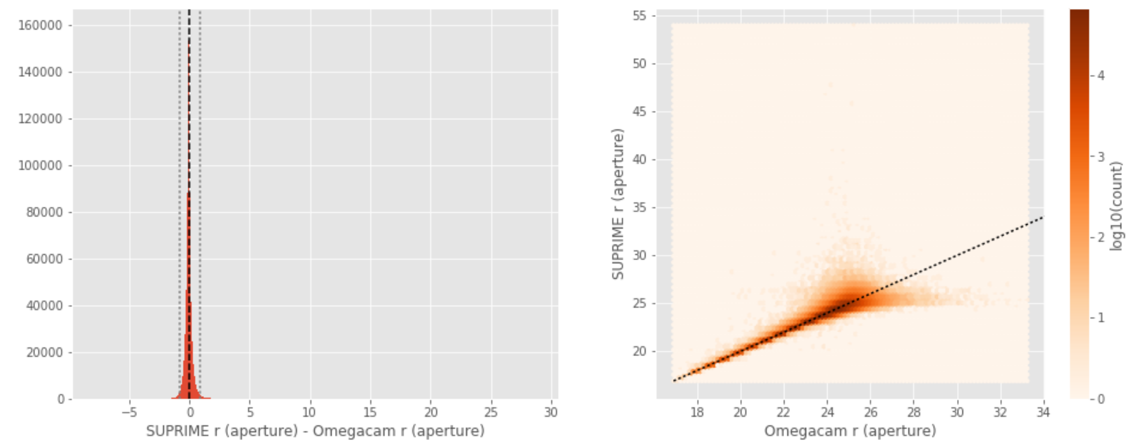
GPC1 r (aperture) - DECam r (aperture):
- Median: 0.10
- Median Absolute Deviation: 0.16
- 1% percentile: -2.022557506561279
- 99% percentile: 1.742434997558596



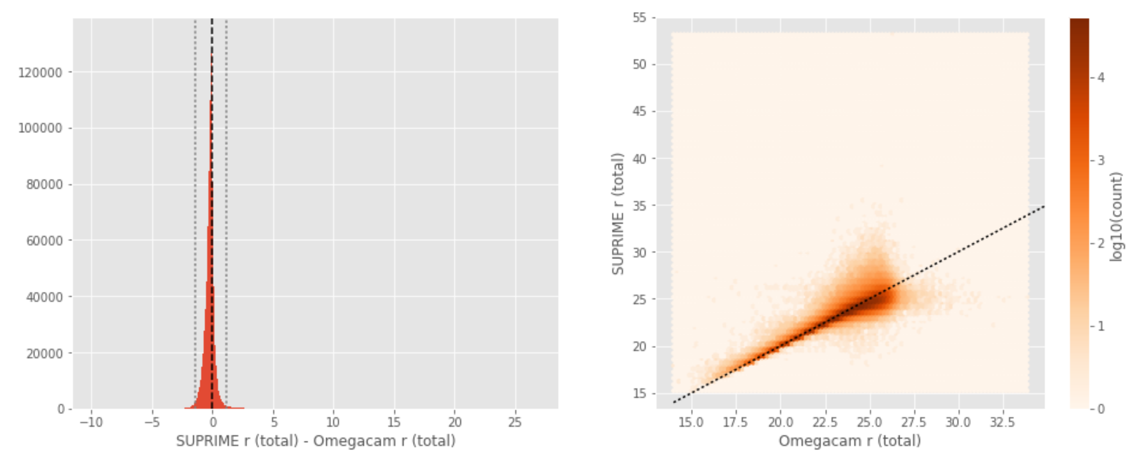
GPC1 r (total) - DECam r (total):
- Median: 0.21
- Median Absolute Deviation: 0.14
- 1% percentile: -1.4518033599853515
- 99% percentile: 1.7165108680725139



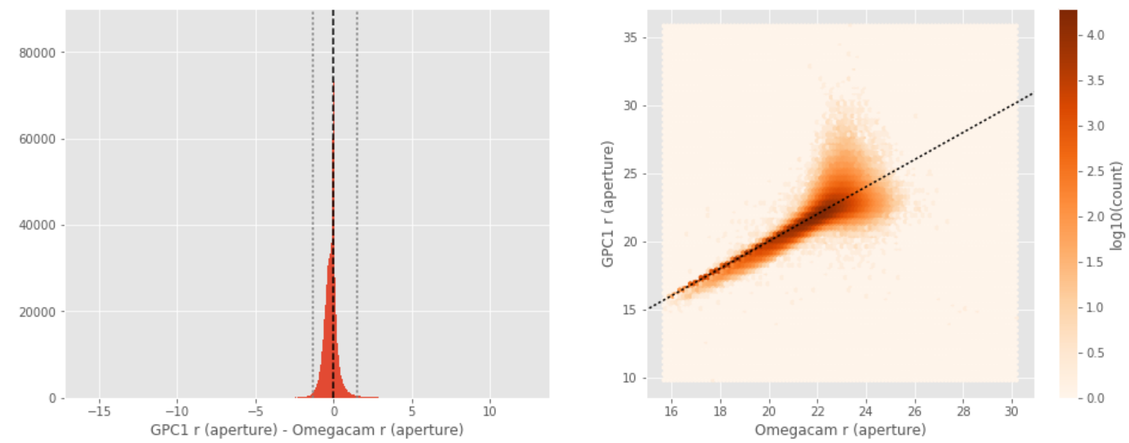
SUPRIME r (aperture) - Omegacam r (aperture):
- Median: -0.06
- Median Absolute Deviation: 0.11
- 1% percentile: -0.8526588439941406
- 99% percentile: 0.8960708618164048



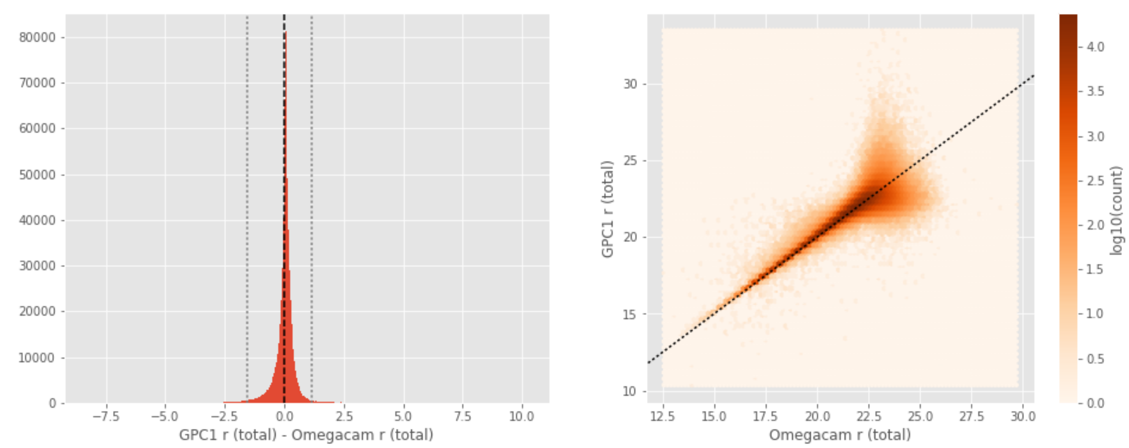
SUPRIME r (total) - Omegacam r (total):
- Median: -0.19
- Median Absolute Deviation: 0.18
- 1% percentile: -1.4241687393188478
- 99% percentile: 1.1404187583923342



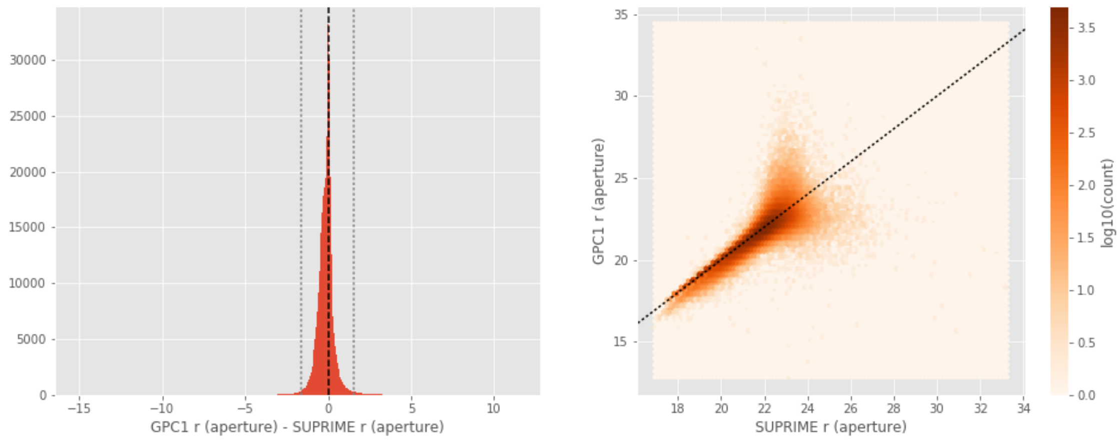
GPC1 r (aperture) - Omegacam r (aperture):
- Median: -0.11
- Median Absolute Deviation: 0.21
- 1% percentile: -1.3515098571777342
- 99% percentile: 1.496448478698733



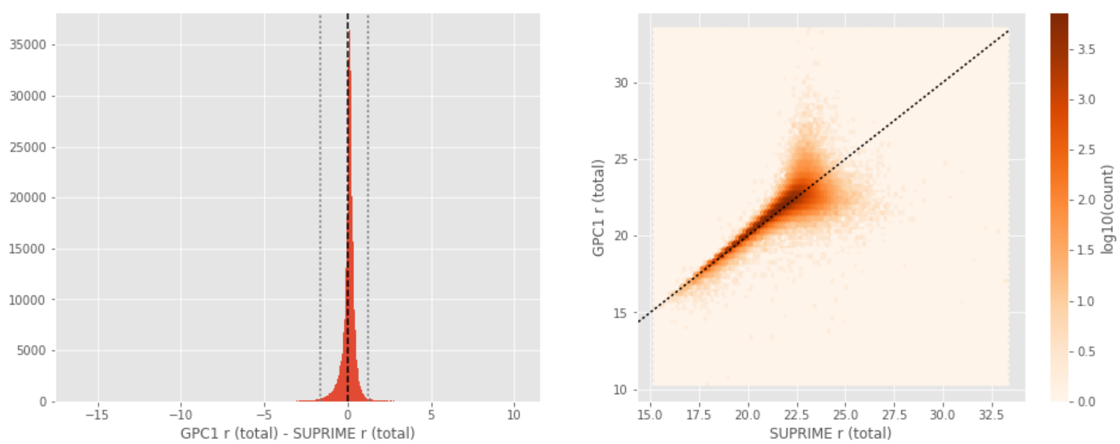
GPC1 r (total) - Omegacam r (total):
- Median: 0.05
- Median Absolute Deviation: 0.13
- 1% percentile: -1.5403206634521482
- 99% percentile: 1.1657170867919837



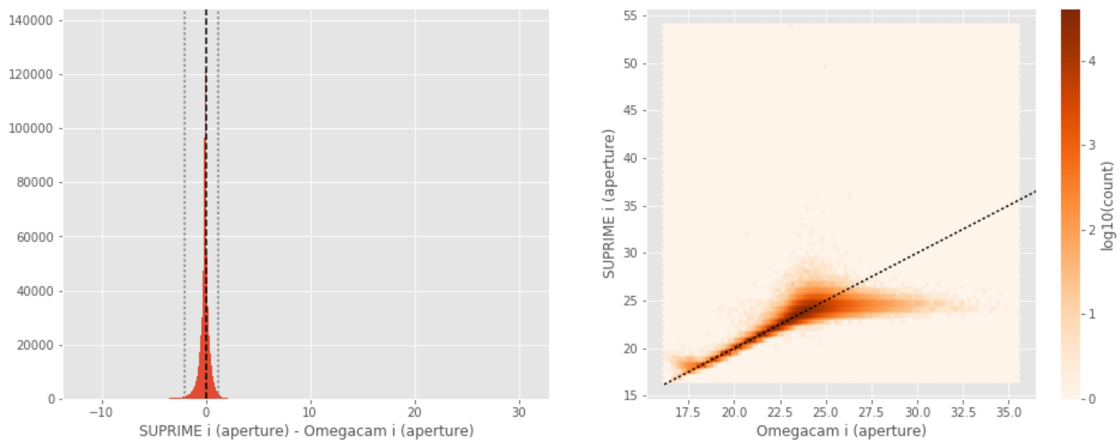
GPC1 r (aperture) - SUPRIME r (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.23
- 1% percentile: -1.5872383117675781
- 99% percentile: 1.525237350463859



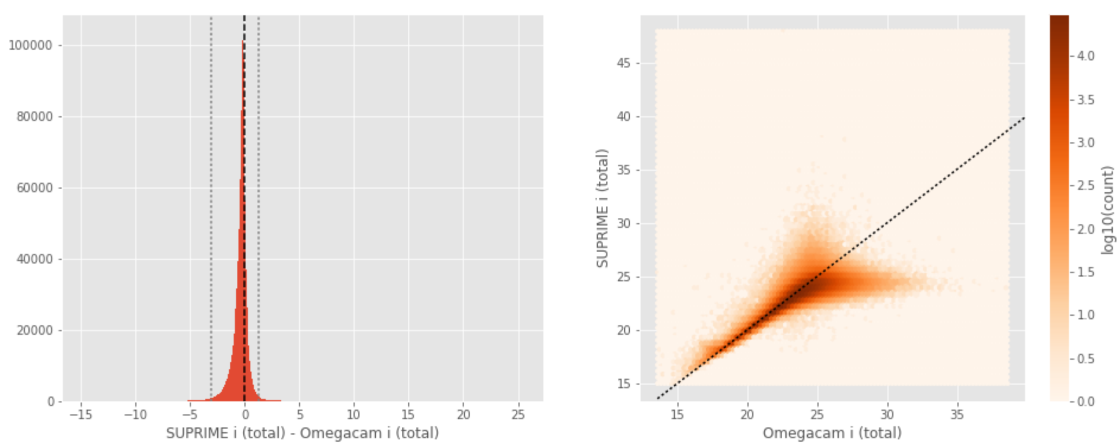
GPC1 r (total) - SUPRIME r (total):
- Median: 0.11
- Median Absolute Deviation: 0.15
- 1% percentile: -1.6637313461303709
- 99% percentile: 1.2613188362121595



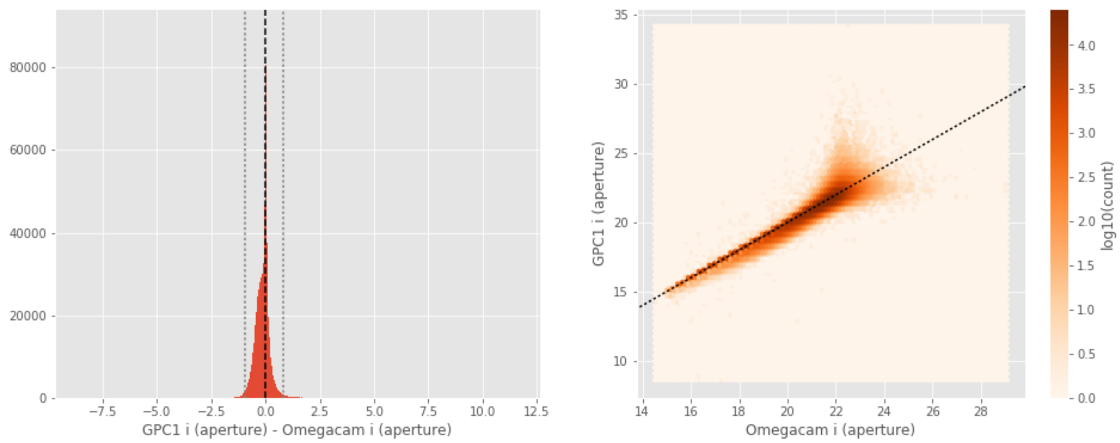
SUPRIME i (aperture) - Omegacam i (aperture):
- Median: -0.07
- Median Absolute Deviation: 0.18
- 1% percentile: -2.0469532012939453
- 99% percentile: 1.169138336181641



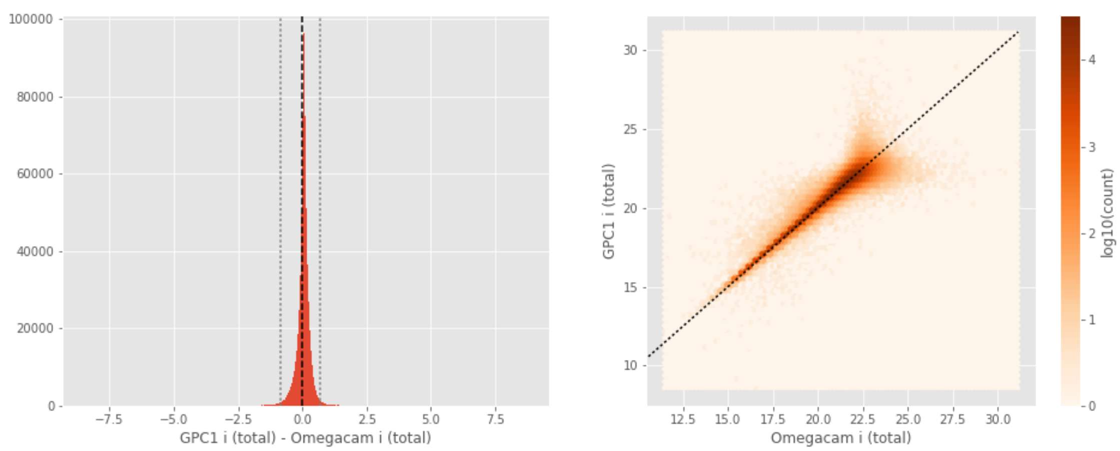
SUPRIME i (total) - Omegacam i (total):
- Median: -0.27
- Median Absolute Deviation: 0.27
- 1% percentile: -3.016033172607422
- 99% percentile: 1.297071933746338



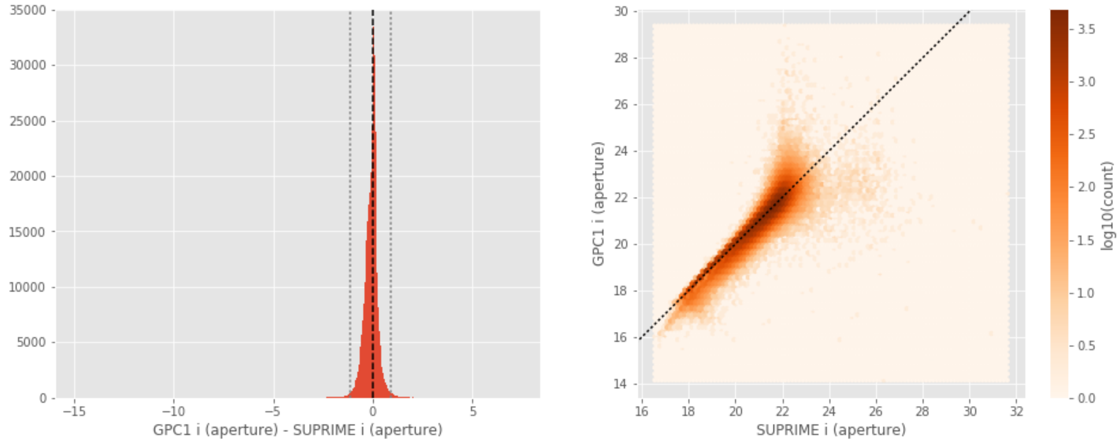
GPC1 i (aperture) - Omegacam i (aperture):
- Median: -0.08
- Median Absolute Deviation: 0.16
- 1% percentile: -0.9477043151855469
- 99% percentile: 0.8186016082763672



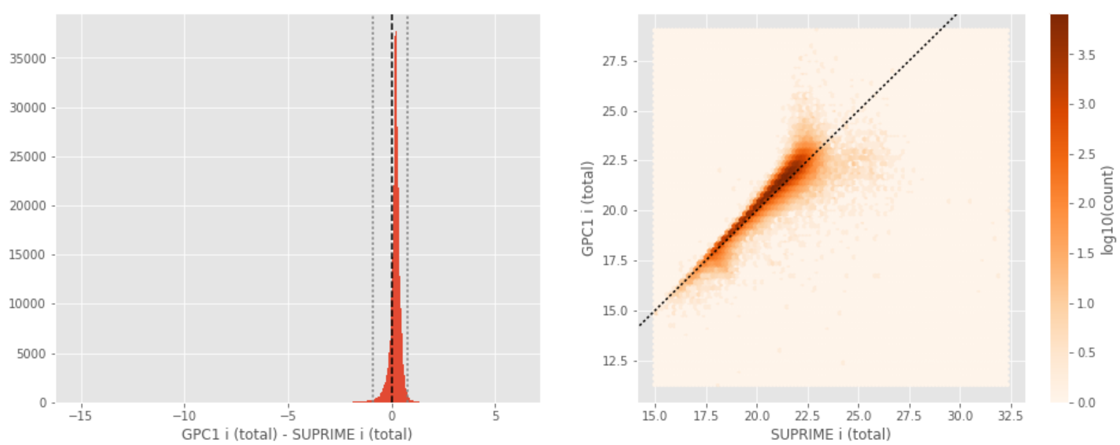
GPC1 i (total) - Omegacam i (total):
- Median: 0.05
- Median Absolute Deviation: 0.10
- 1% percentile: -0.8343009567260742
- 99% percentile: 0.6969107818603506



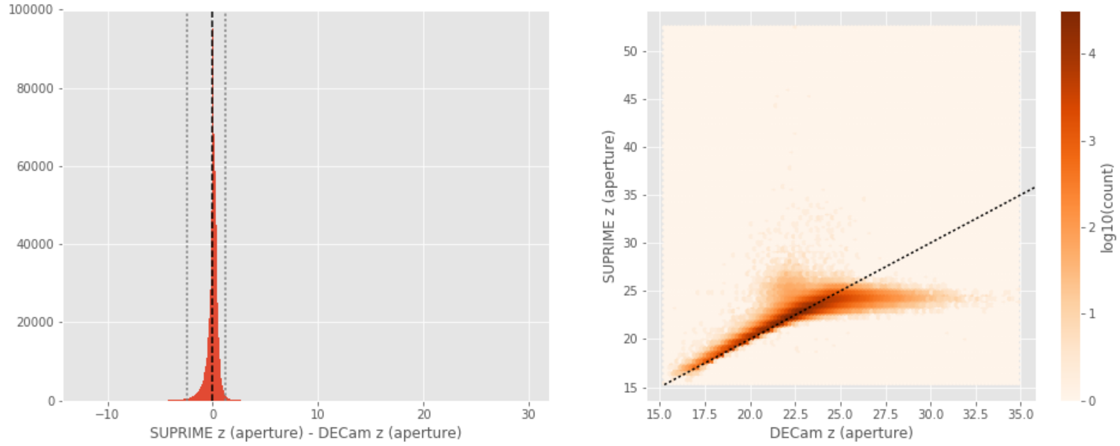
GPC1 i (aperture) - SUPRIME i (aperture):
- Median: -0.03
- Median Absolute Deviation: 0.18
- 1% percentile: -1.1367273139953613
- 99% percentile: 0.9213391876220709



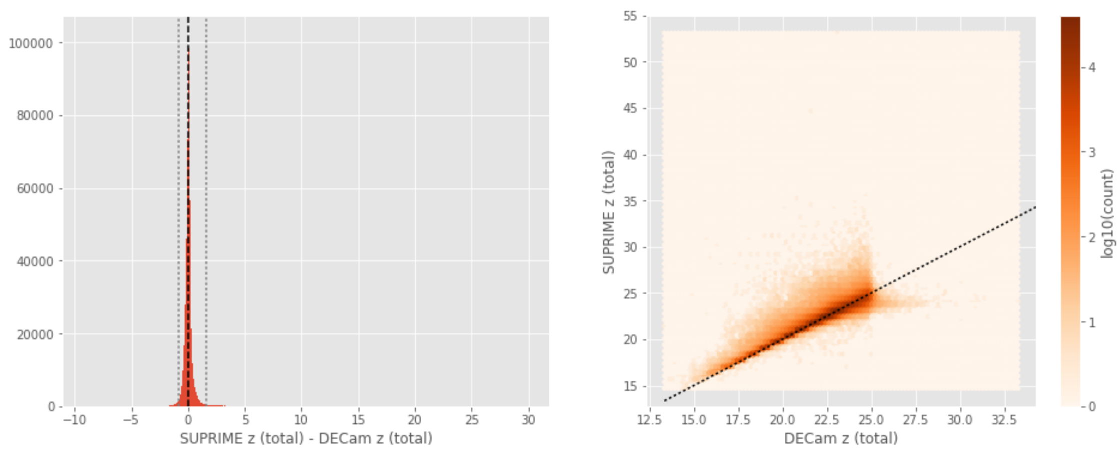
GPC1 i (total) - SUPRIME i (total):
- Median: 0.20
- Median Absolute Deviation: 0.11
- 1% percentile: -0.8914554595947265
- 99% percentile: 0.7686335754394538



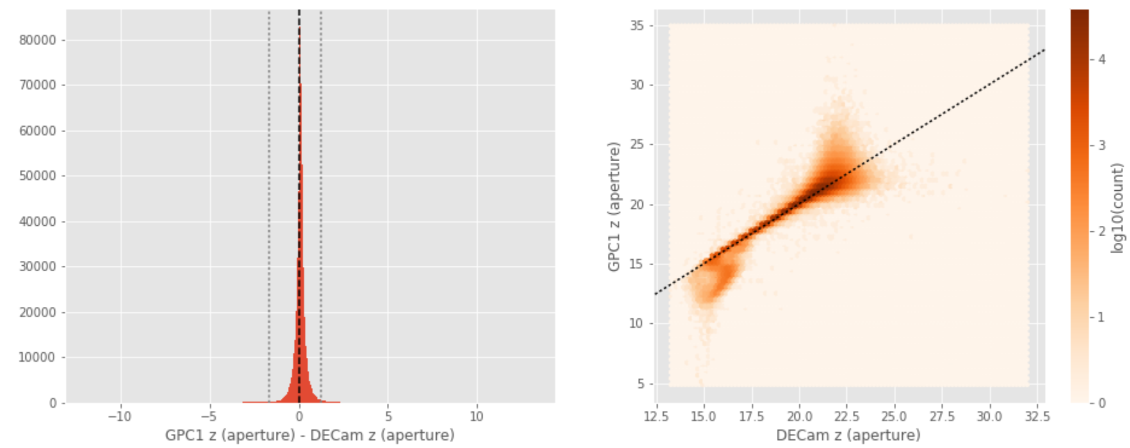
SUPRIME z (aperture) - DECam z (aperture):
- Median: 0.05
- Median Absolute Deviation: 0.22
- 1% percentile: -2.385577850341797
- 99% percentile: 1.2567932891845697



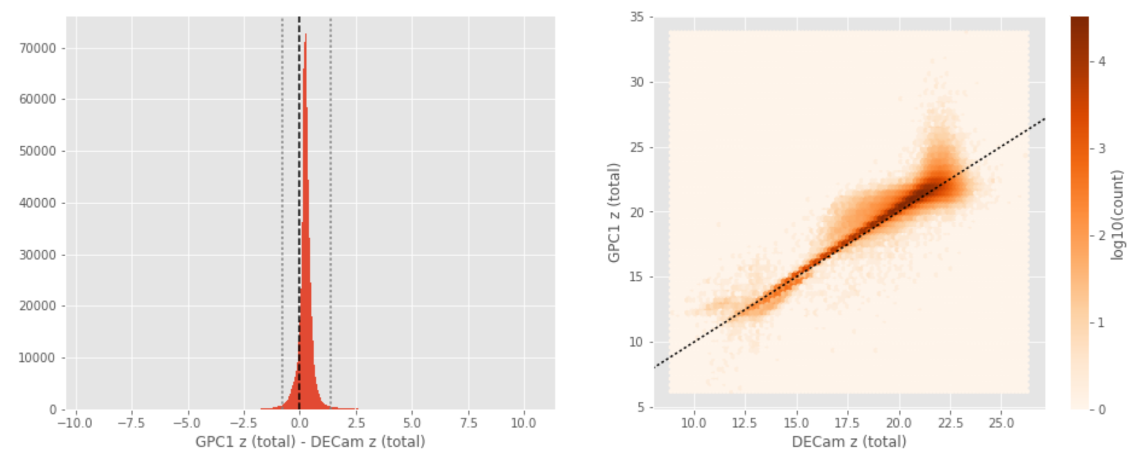
SUPRIME z (total) - DECam z (total):
- Median: 0.03
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8611987304687501
- 99% percentile: 1.6053555679321367



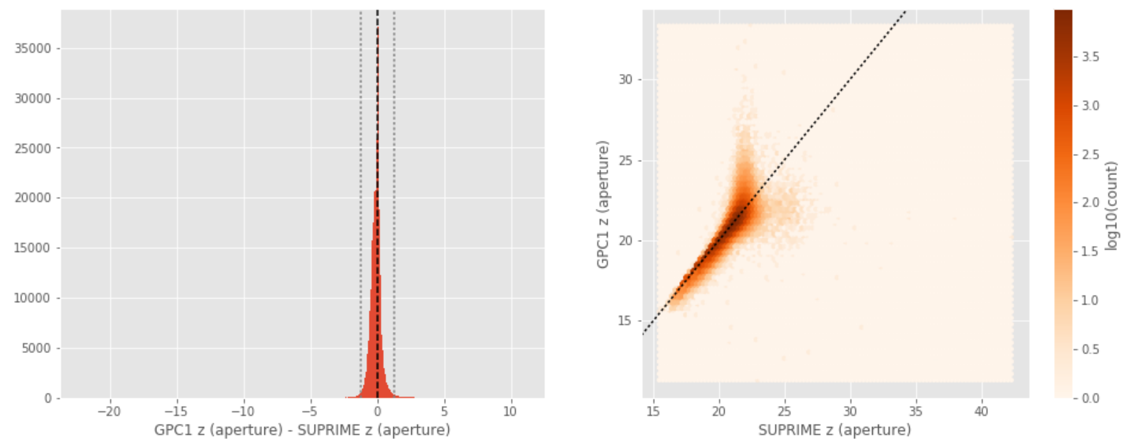
GPC1 z (aperture) - DECam z (aperture):
- Median: 0.09
- Median Absolute Deviation: 0.12
- 1% percentile: -1.6480256843566894
- 99% percentile: 1.2552158927917487



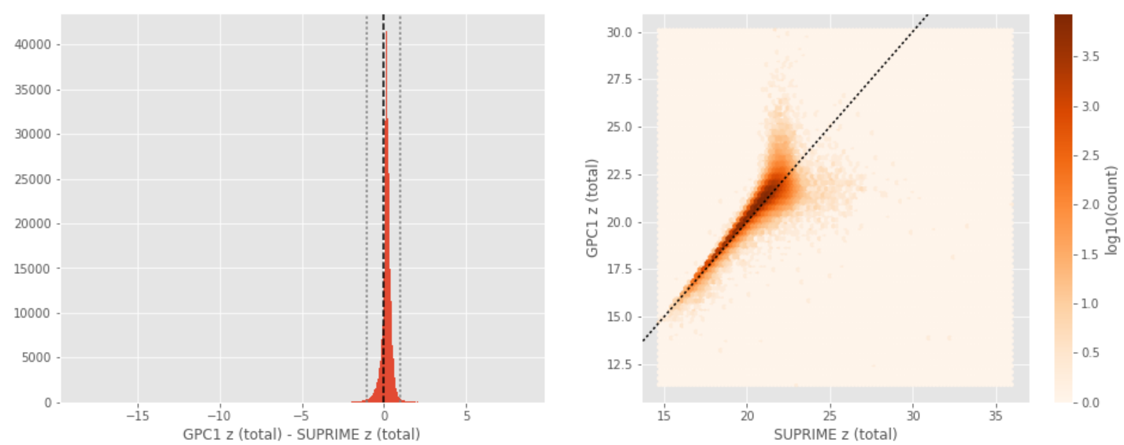
GPC1 z (total) - DECam z (total):
- Median: 0.26
- Median Absolute Deviation: 0.12
- 1% percentile: -0.7882545471191406
- 99% percentile: 1.373531684875486



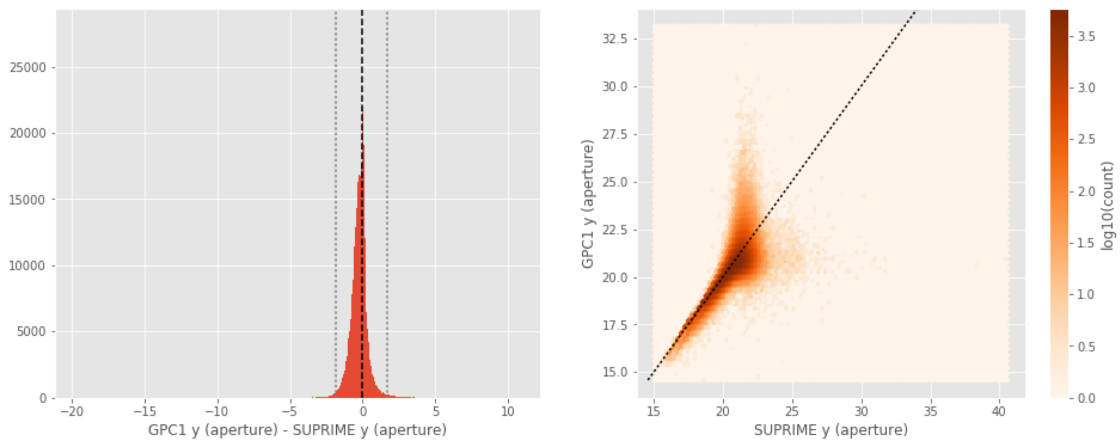
GPC1 z (aperture) - SUPRIME z (aperture):
- Median: -0.04
- Median Absolute Deviation: 0.20
- 1% percentile: -1.1917795181274413
- 99% percentile: 1.2728551101684569



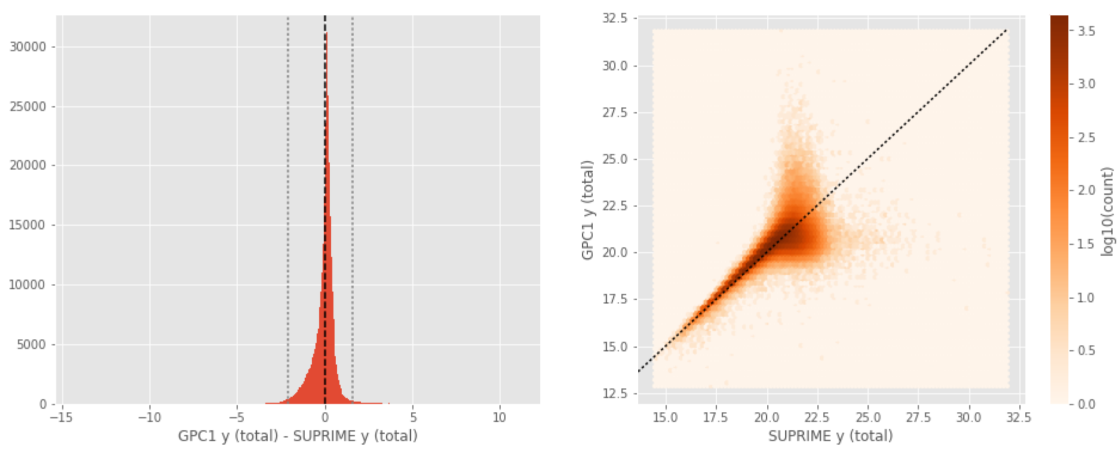
GPC1 z (total) - SUPRIME z (total):
- Median: 0.18
- Median Absolute Deviation: 0.12
- 1% percentile: -1.0532553100585937
- 99% percentile: 0.9818671417236327



GPC1 y (aperture) - SUPRIME y (aperture):
- Median: -0.19
- Median Absolute Deviation: 0.28
- 1% percentile: -1.8443033599853516
- 99% percentile: 1.679386215209945




```
GPC1 y (total) - SUPRIME y (total):
- Median: 0.09
- Median Absolute Deviation: 0.23
- 1% percentile: -2.0898357391357423
- 99% percentile: 1.6052894592285112
```



1.5 III - Comparing magnitudes to reference bands

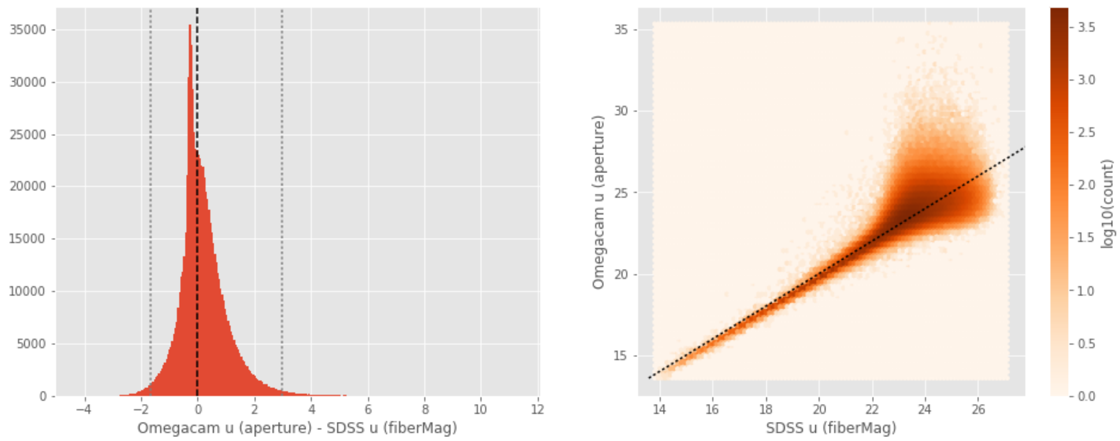
Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

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

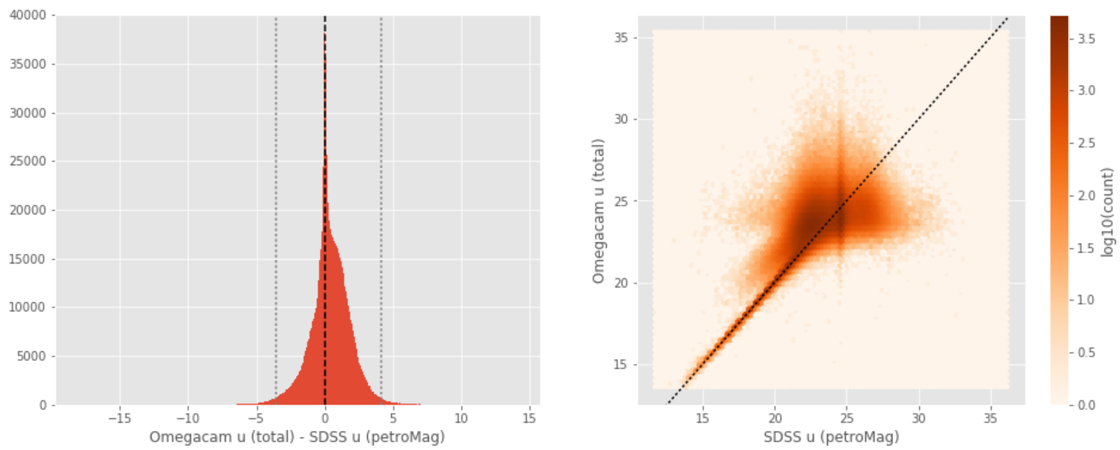
The catalogue is cross-matched to SDSS-DR13 withing 0.2 arcsecond.

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.

```
Omegacam u (aperture) - SDSS u (fiberMag):
- Median: 0.06
- Median Absolute Deviation: 0.42
- 1% percentile: -1.6777433204650878
- 99% percentile: 2.9605134963989226
```

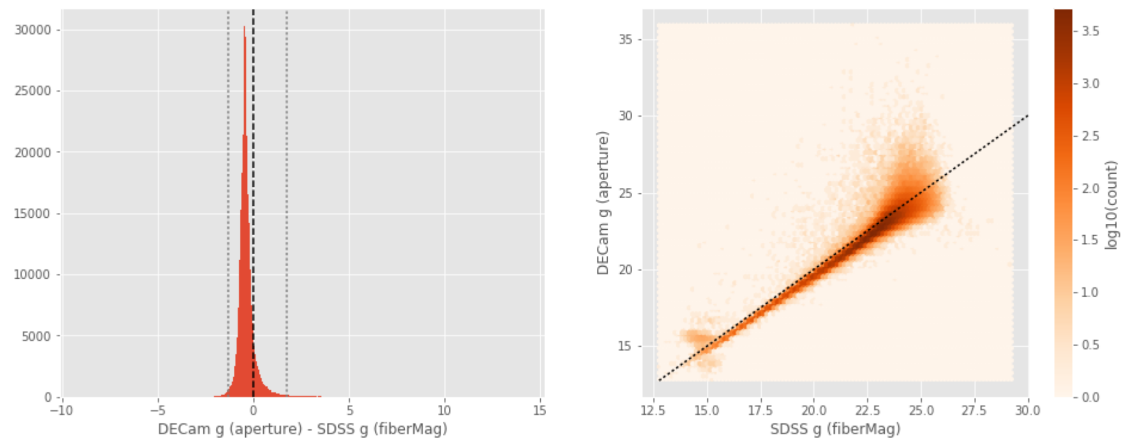



```
Omegacam u (total) - SDSS u (petroMag):
- Median: 0.32
- Median Absolute Deviation: 0.79
- 1% percentile: -3.572389373779297
- 99% percentile: 4.141102294921889
```

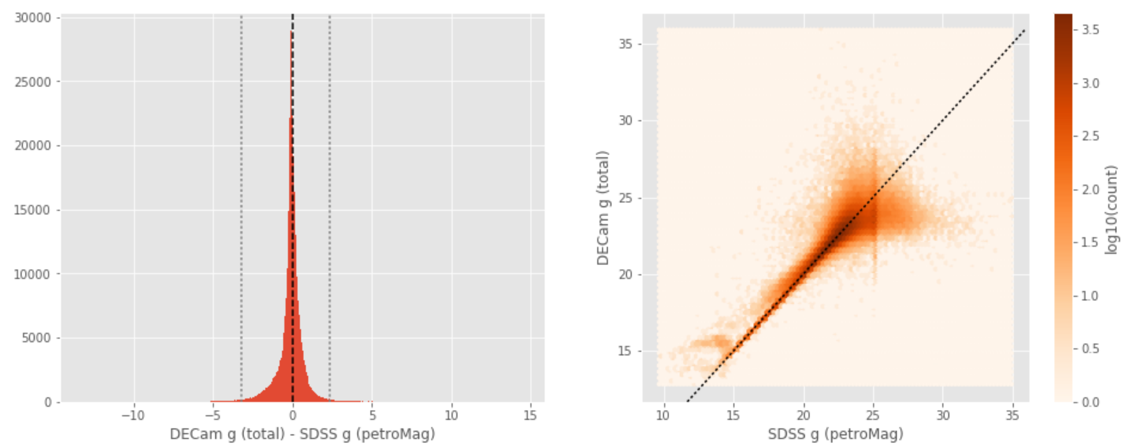



```
DECam g (aperture) - SDSS g (fiberMag):
- Median: -0.42
```

- Median Absolute Deviation: 0.17
- 1% percentile: -1.287907028198242
- 99% percentile: 1.732054214477536

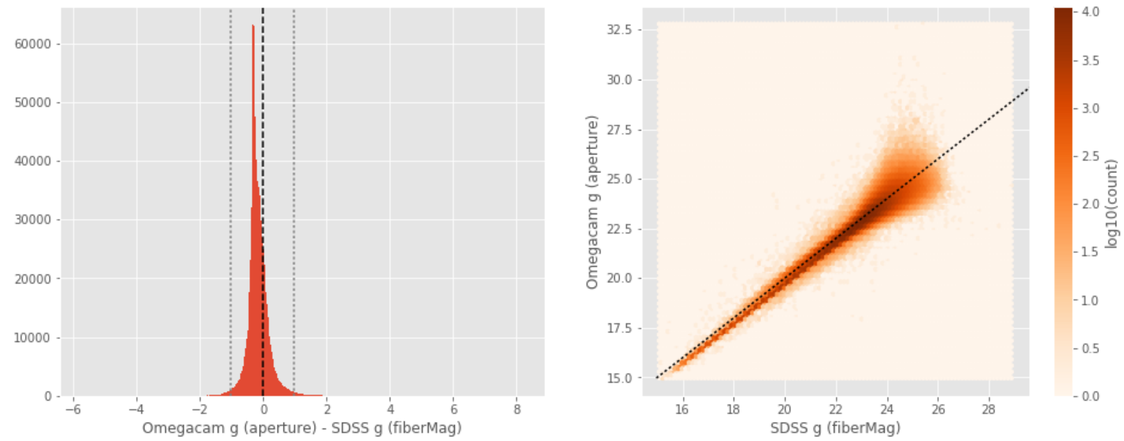


DECam g (total) - SDSS g (petroMag):
- Median: -0.07
- Median Absolute Deviation: 0.27
- 1% percentile: -3.2379779624938965
- 99% percentile: 2.3154718208312697

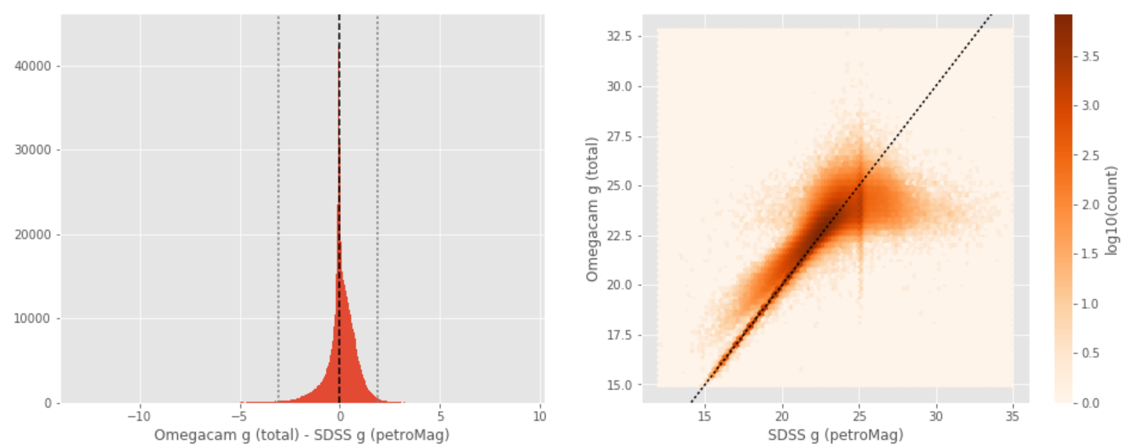



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:11:
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:12:
```

Omegacam g (aperture) - SDSS g (fiberMag):
- Median: -0.21
- Median Absolute Deviation: 0.15
- 1% percentile: -1.0146925735473633
- 99% percentile: 0.9640124511718753

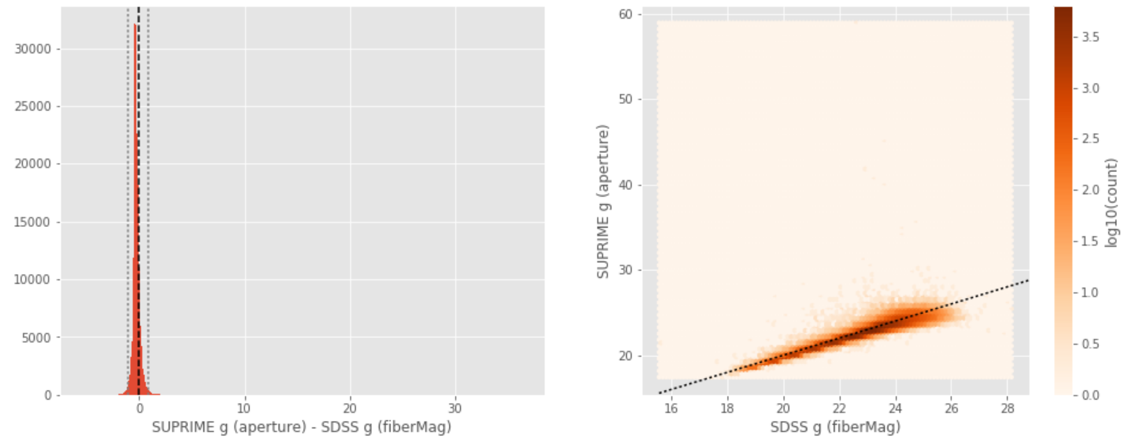


Omegacam g (total) - SDSS g (petroMag):
- Median: 0.04
- Median Absolute Deviation: 0.33
- 1% percentile: -3.0399436950683594
- 99% percentile: 1.910231590270996

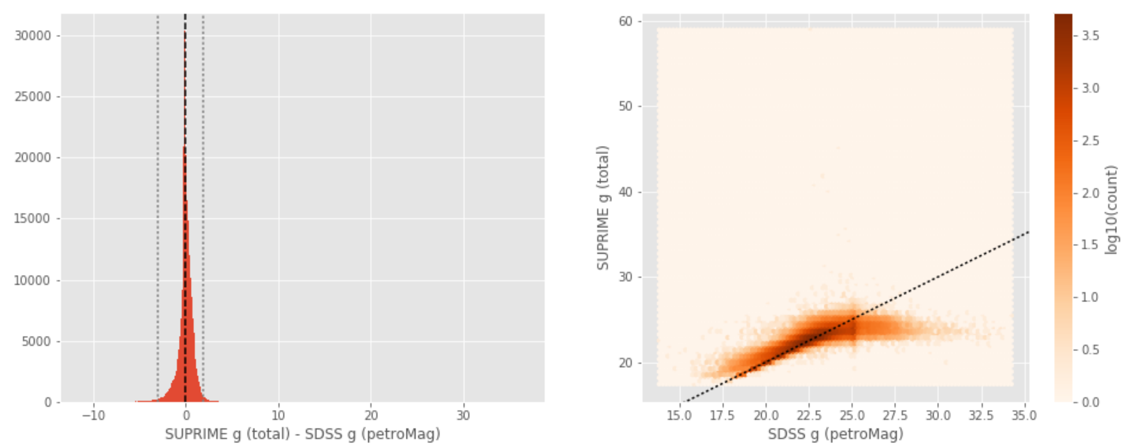


SUPRIME g (aperture) - SDSS g (fiberMag):
- Median: -0.29

- Median Absolute Deviation: 0.16
- 1% percentile: -1.10162353515625
- 99% percentile: 0.9030033111572264

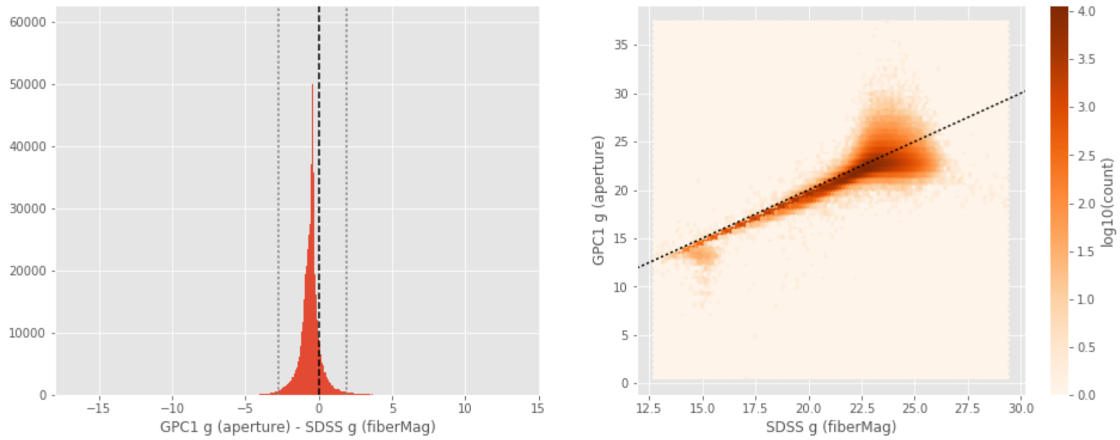


SUPRIME g (total) - SDSS g (petroMag):
- Median: -0.02
- Median Absolute Deviation: 0.35
- 1% percentile: -3.0725487899780273
- 99% percentile: 1.8739874267578123

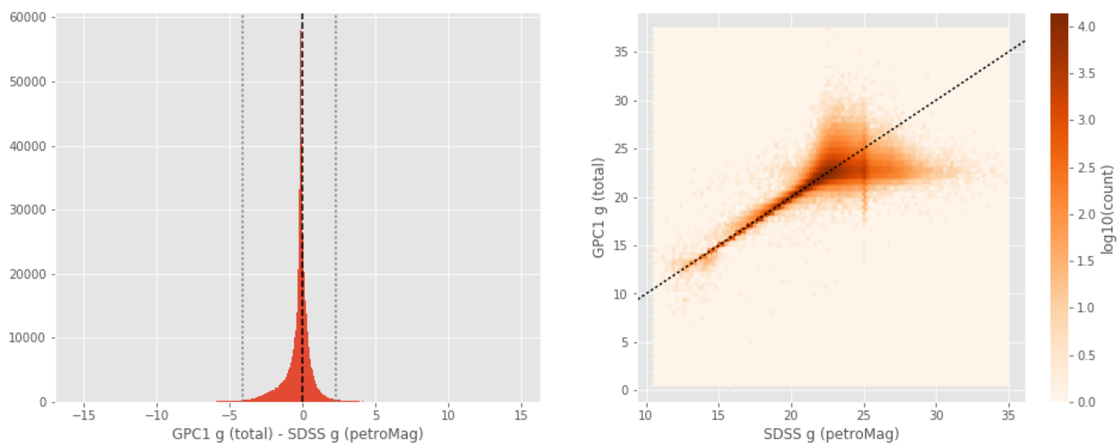


GPC1 g (aperture) - SDSS g (fiberMag):
- Median: -0.50
- Median Absolute Deviation: 0.29
- 1% percentile: -2.7221376419067385

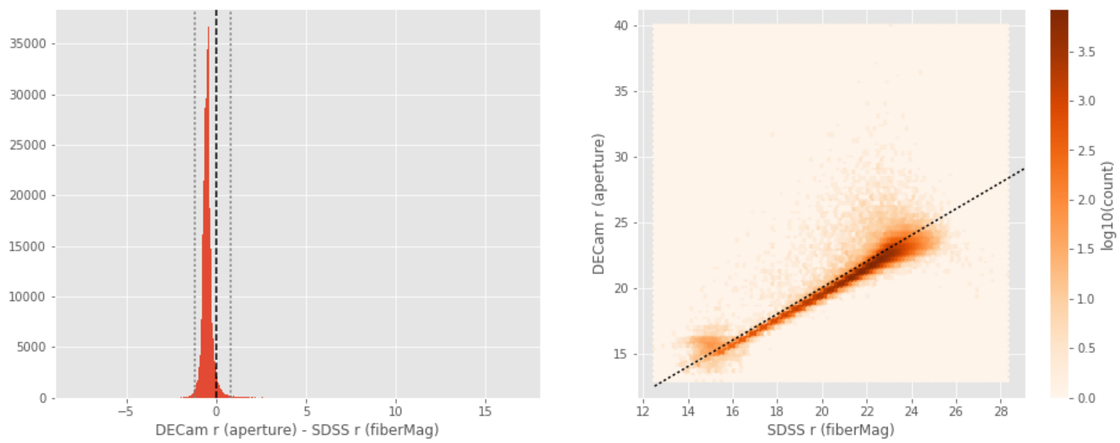
- 99% percentile: 1.9057595252990729



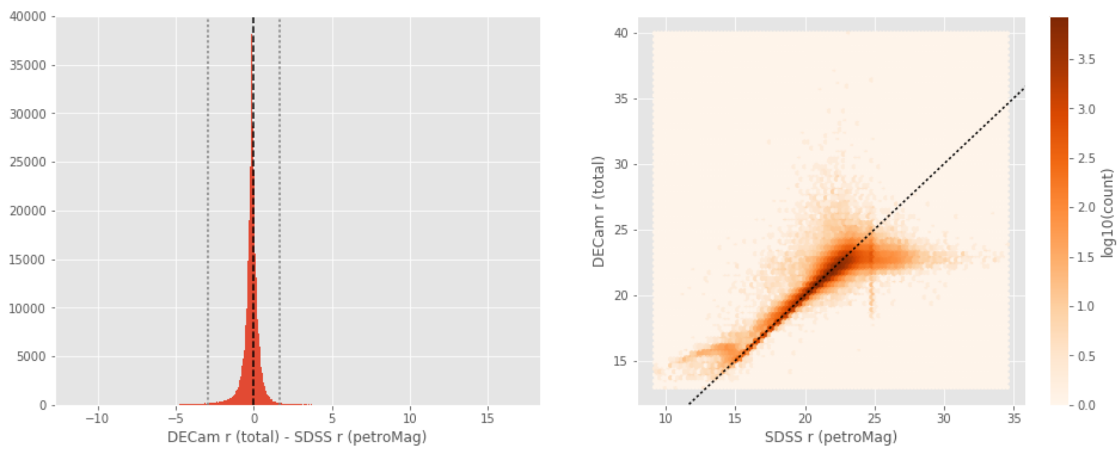
GPC1 g (total) - SDSS g (petroMag):
- Median: -0.12
- Median Absolute Deviation: 0.30
- 1% percentile: -4.07849645614624
- 99% percentile: 2.268861007690436



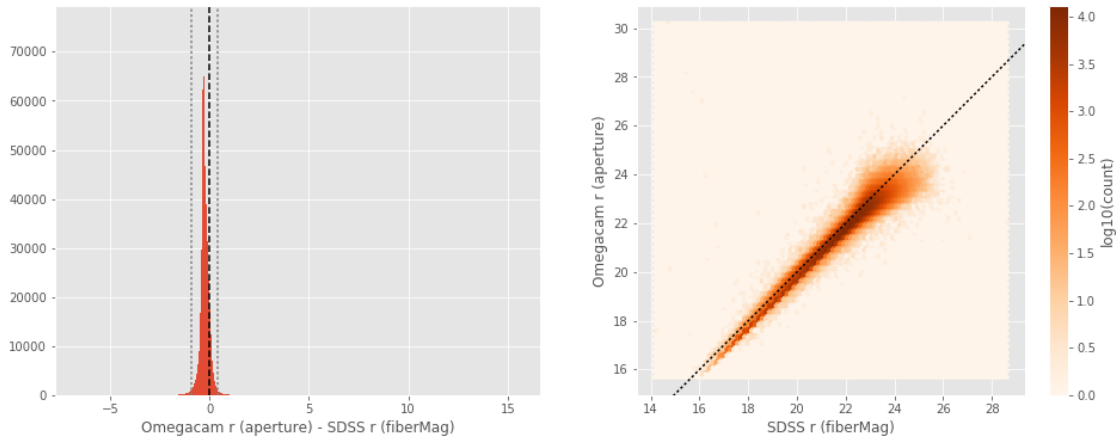
DECam r (aperture) - SDSS r (fiberMag):
- Median: -0.50
- Median Absolute Deviation: 0.13
- 1% percentile: -1.2138477325439452
- 99% percentile: 0.8274073028564413



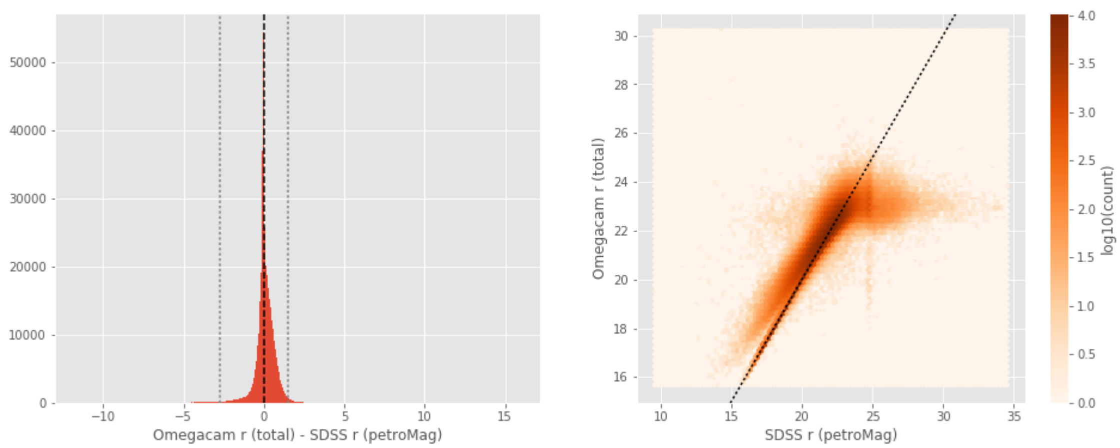
DECam r (total) - SDSS r (petroMag):
- Median: -0.14
- Median Absolute Deviation: 0.20
- 1% percentile: -2.9501192474365237
- 99% percentile: 1.6291219329834012



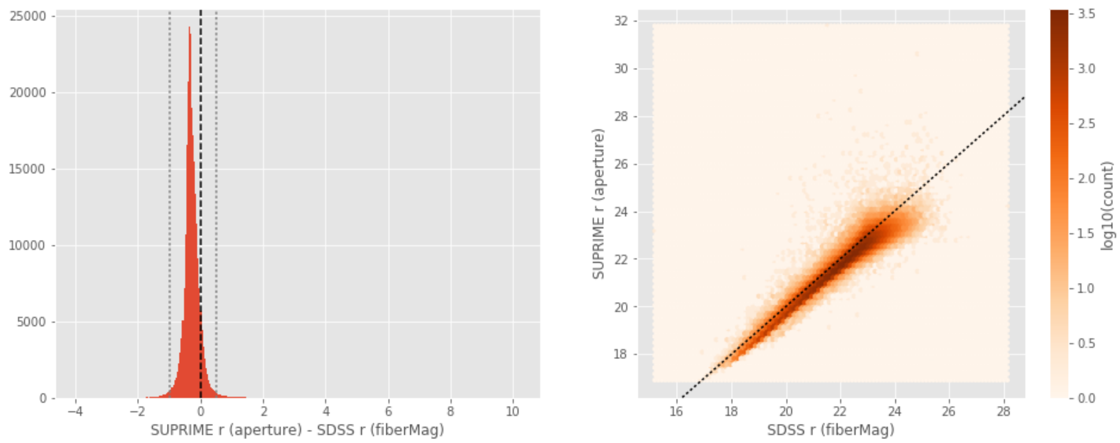
Omegacam r (aperture) - SDSS r (fiberMag):
- Median: -0.26
- Median Absolute Deviation: 0.11
- 1% percentile: -0.9293511772155763
- 99% percentile: 0.38018566131591847



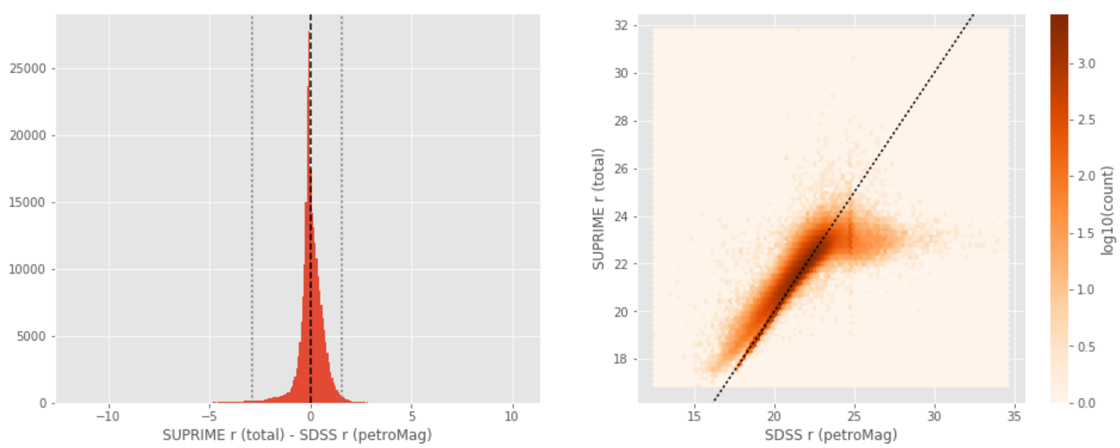
Omegacam r (total) - SDSS r (petroMag):
- Median: 0.03
- Median Absolute Deviation: 0.25
- 1% percentile: -2.7229127883911133
- 99% percentile: 1.5044150352478027



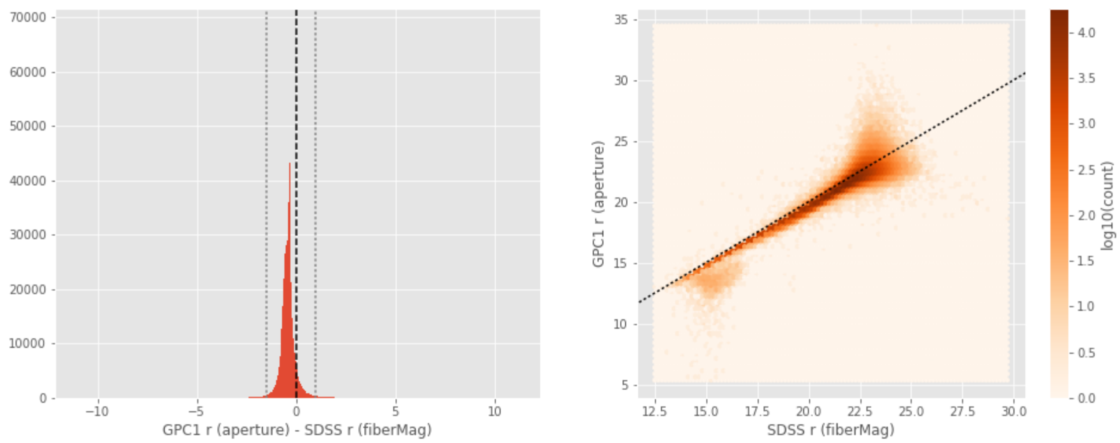
SUPRIME r (aperture) - SDSS r (fiberMag):
- Median: -0.31
- Median Absolute Deviation: 0.13
- 1% percentile: -0.9976661682128906
- 99% percentile: 0.5201660156250011



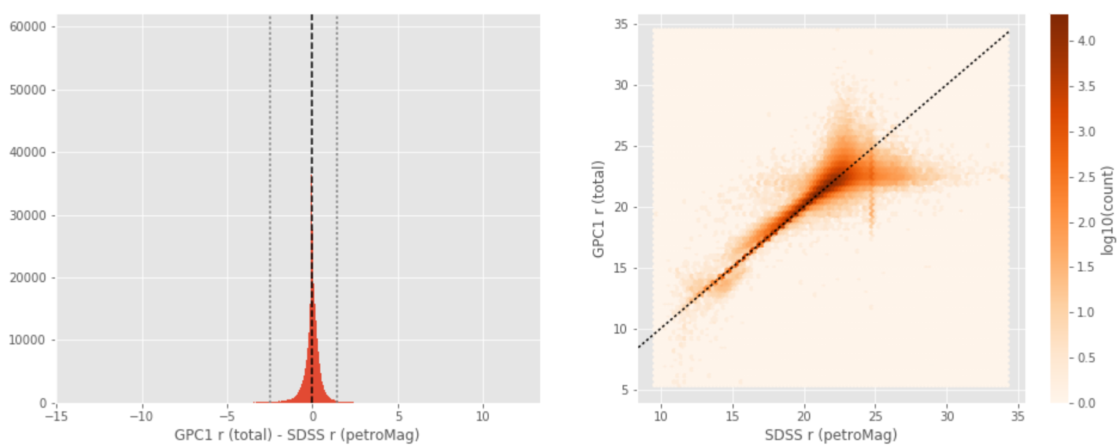
SUPRIME r (total) - SDSS r (petroMag):
- Median: -0.01
- Median Absolute Deviation: 0.27
- 1% percentile: -2.855342388153076
- 99% percentile: 1.5391726684570313



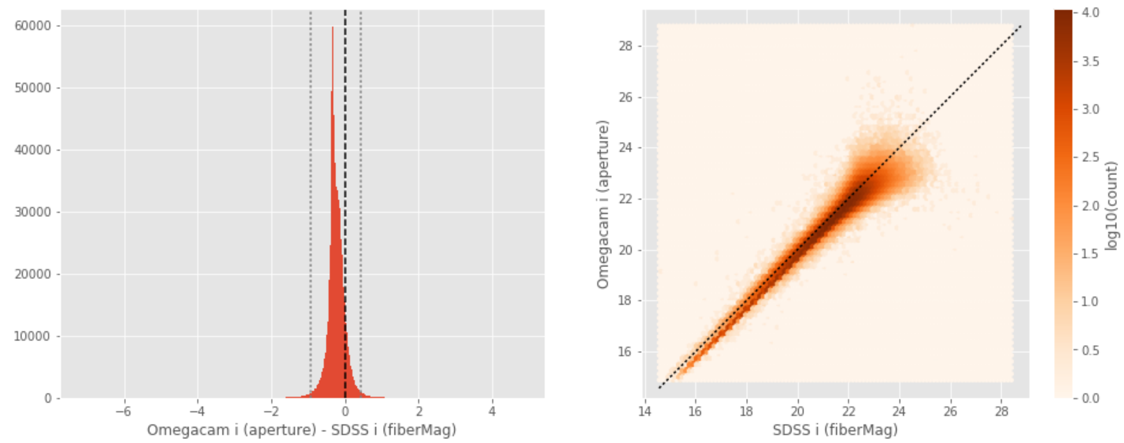
GPC1 r (aperture) - SDSS r (fiberMag):
- Median: -0.38
- Median Absolute Deviation: 0.15
- 1% percentile: -1.4833755493164062
- 99% percentile: 0.9636192321777344



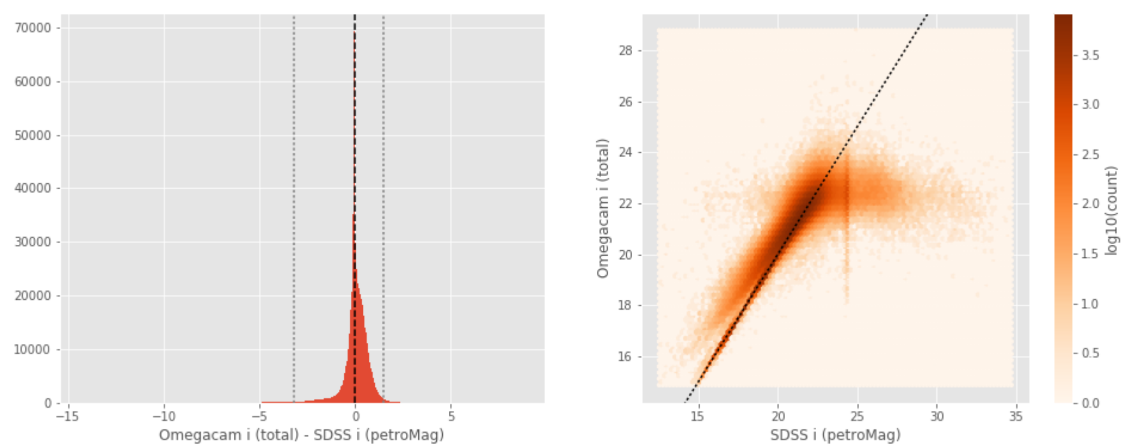
GPC1 r (total) - SDSS r (petroMag):
- Median: -0.03
- Median Absolute Deviation: 0.18
- 1% percentile: -2.4769830322265625
- 99% percentile: 1.4538796806335426



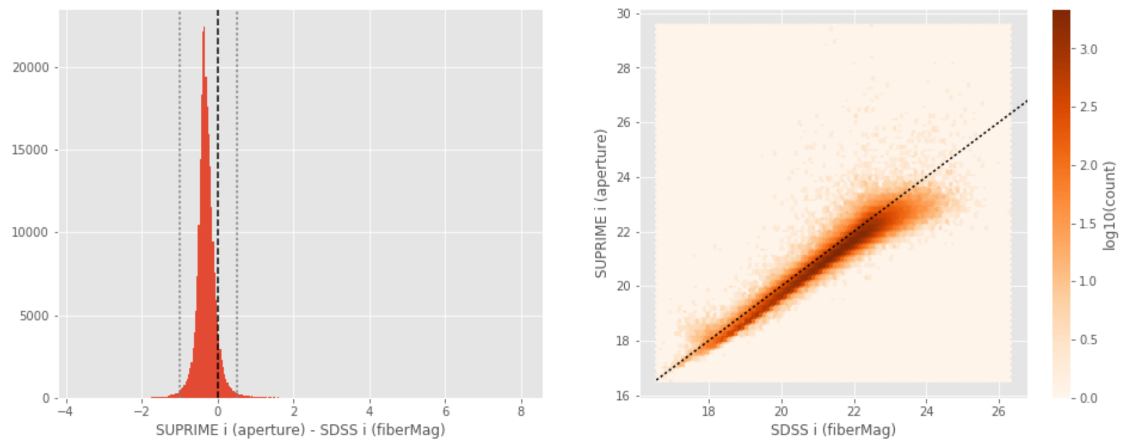
Omegacam i (aperture) - SDSS i (fiberMag):
- Median: -0.26
- Median Absolute Deviation: 0.11
- 1% percentile: -0.9333876609802246
- 99% percentile: 0.4504387855529779



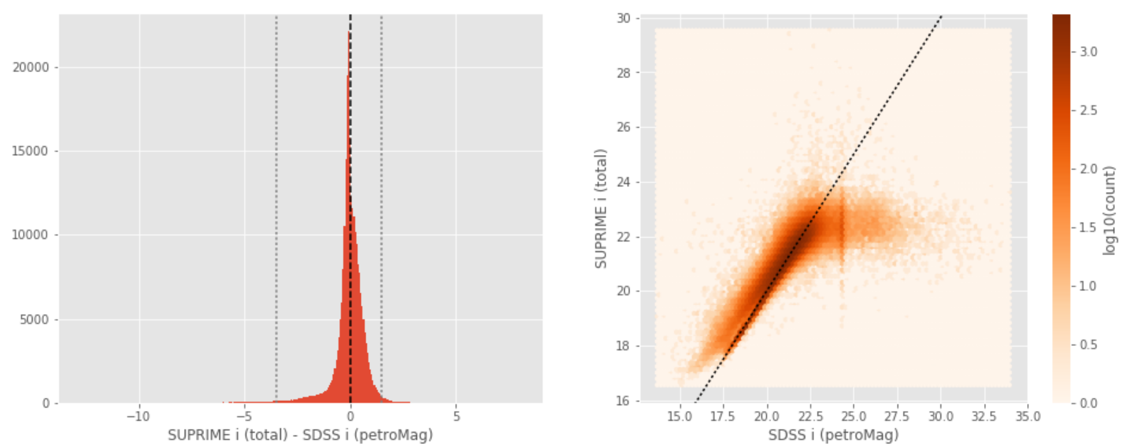
Omegacam i (total) - SDSS i (petroMag):
- Median: 0.02
- Median Absolute Deviation: 0.25
- 1% percentile: -3.2204542160034184
- 99% percentile: 1.4668953704833978



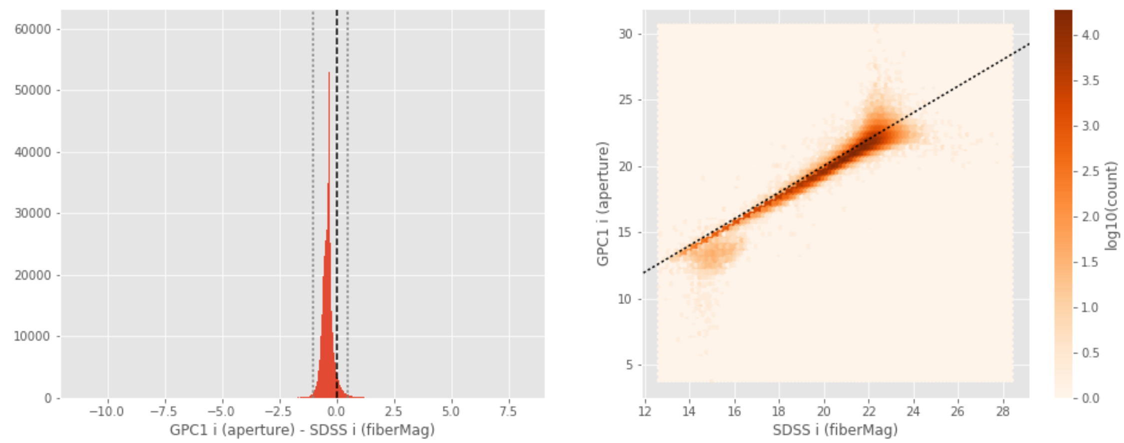
SUPRIME i (aperture) - SDSS i (fiberMag):
- Median: -0.32
- Median Absolute Deviation: 0.12
- 1% percentile: -1.0100884246826172
- 99% percentile: 0.52162536621094



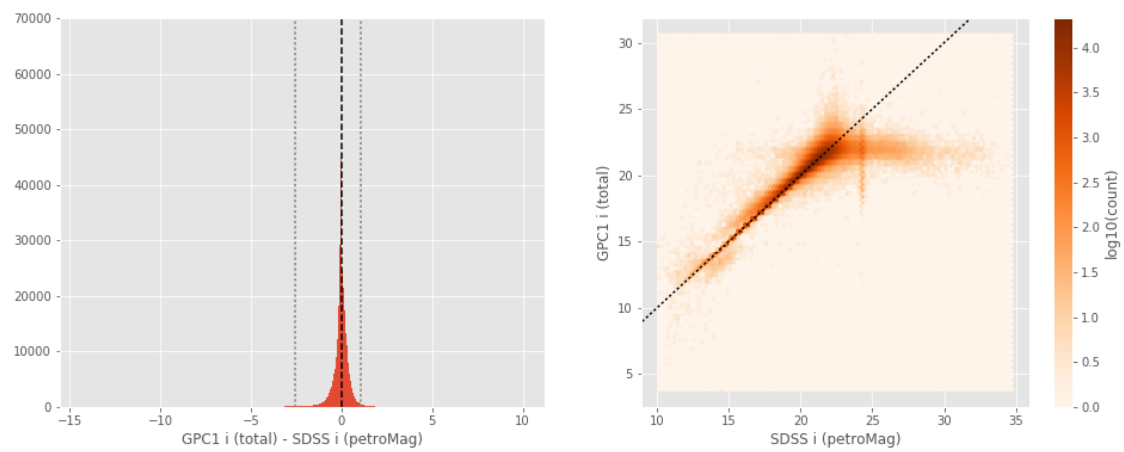
SUPRIME i (total) - SDSS i (petroMag):
- Median: -0.02
- Median Absolute Deviation: 0.27
- 1% percentile: -3.4856629371643066
- 99% percentile: 1.4867892265319824



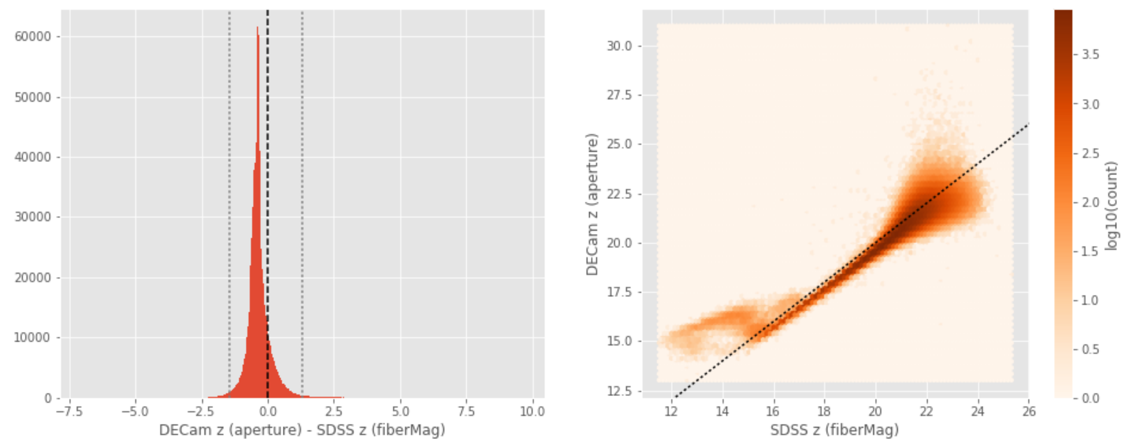
GPC1 i (aperture) - SDSS i (fiberMag):
- Median: -0.36
- Median Absolute Deviation: 0.12
- 1% percentile: -1.0263816833496096
- 99% percentile: 0.4693404197692874



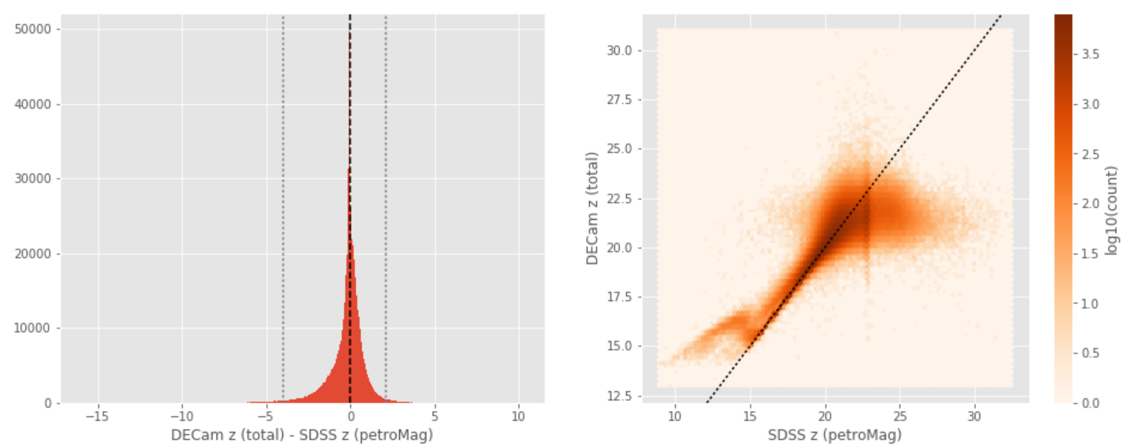
GPC1 i (total) - SDSS i (petroMag):
- Median: -0.02
- Median Absolute Deviation: 0.16
- 1% percentile: -2.5398798942565914
- 99% percentile: 1.065571212768555



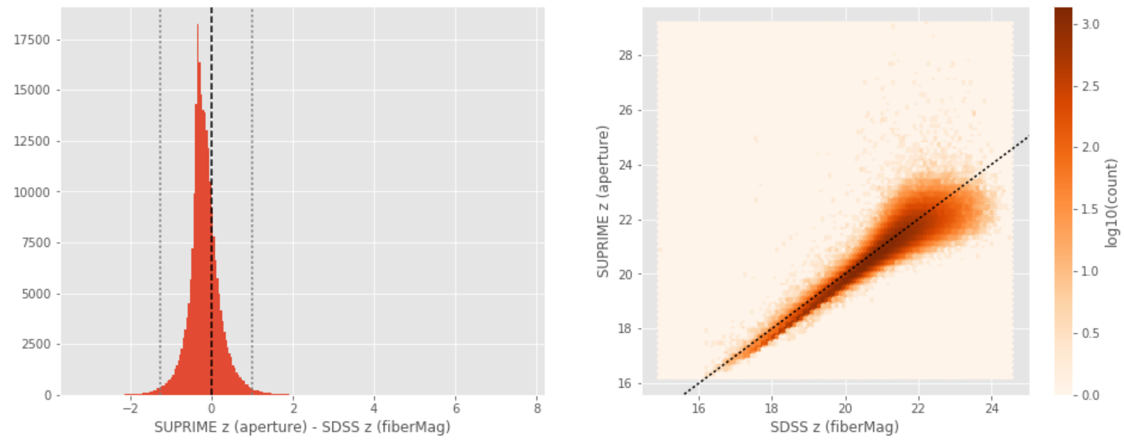
DECam z (aperture) - SDSS z (fiberMag):
- Median: -0.37
- Median Absolute Deviation: 0.18
- 1% percentile: -1.4442152404785156
- 99% percentile: 1.3228296661376957



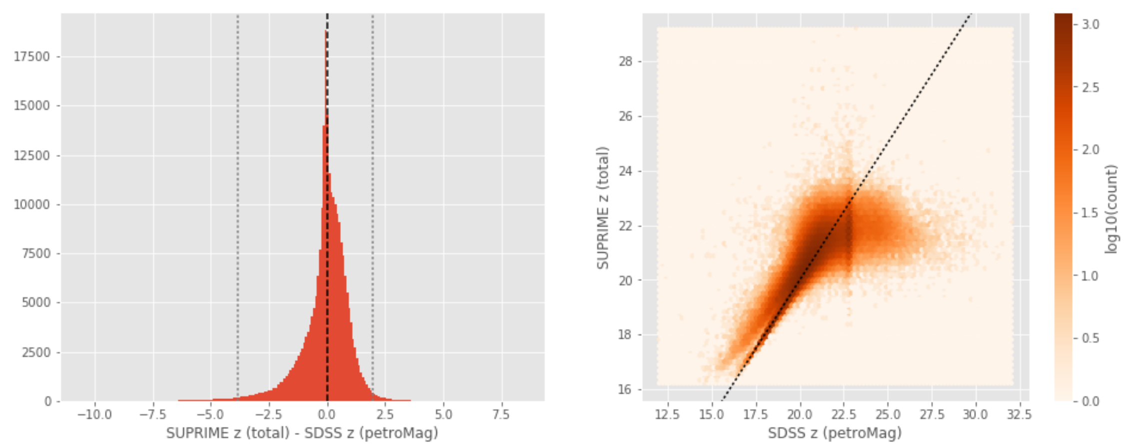
DECam z (total) - SDSS z (petroMag):
- Median: -0.05
- Median Absolute Deviation: 0.37
- 1% percentile: -4.001471099853516
- 99% percentile: 2.1159516525268556



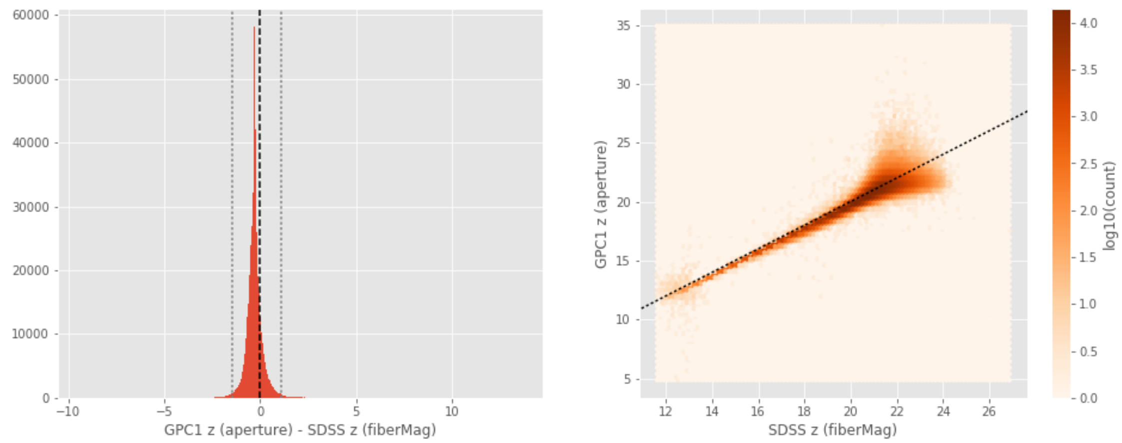
SUPRIME z (aperture) - SDSS z (fiberMag):
- Median: -0.21
- Median Absolute Deviation: 0.19
- 1% percentile: -1.2618062973022461
- 99% percentile: 0.9837664794921865



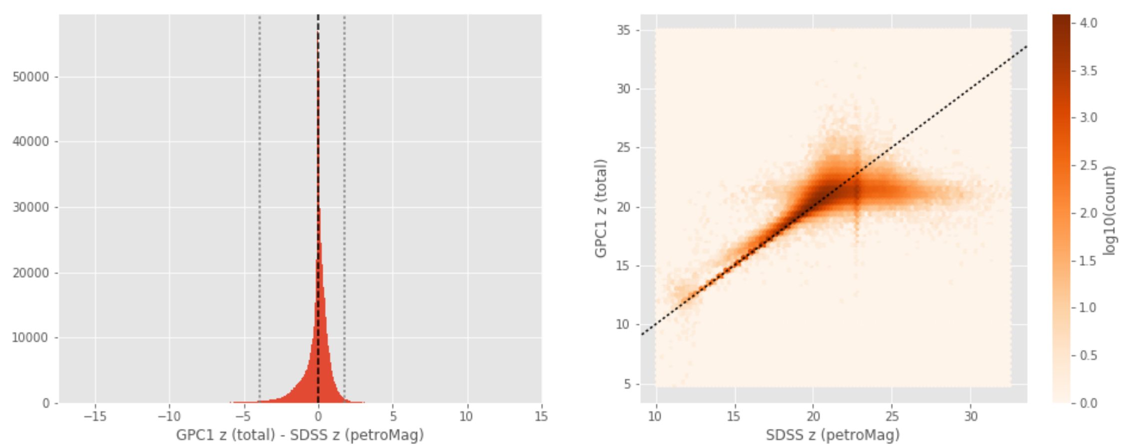

```
SUPRIME z (total) - SDSS z (petroMag):
- Median: 0.02
- Median Absolute Deviation: 0.46
- 1% percentile: -3.8373863220214846
- 99% percentile: 1.963347625732422
```




```
GPC1 z (aperture) - SDSS z (fiberMag):
- Median: -0.30
- Median Absolute Deviation: 0.18
- 1% percentile: -1.4636097908020018
- 99% percentile: 1.100358905792238
```




```
GPC1 z (total) - SDSS z (petroMag):
- Median: 0.02
- Median Absolute Deviation: 0.32
- 1% percentile: -3.900031566619873
- 99% percentile: 1.7810024833679203
```



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.

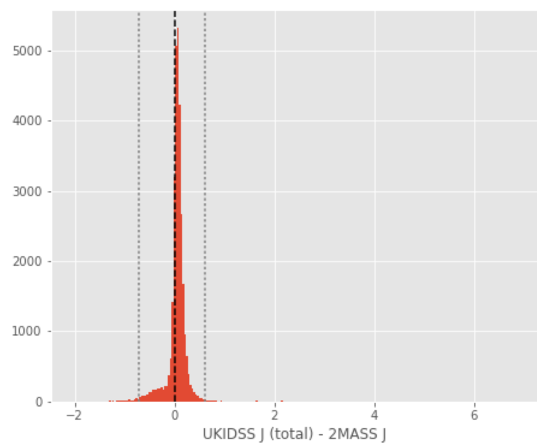
The 2MASS magnitudes are "*Vega-like*" and we have to convert them to AB magnitudes using the zero points provided on this page:

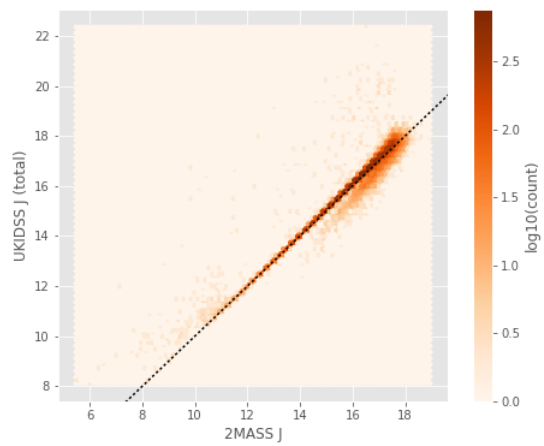
Band	F - 0 mag (Jy)
J	1594
H	1024
Ks	666.7

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:

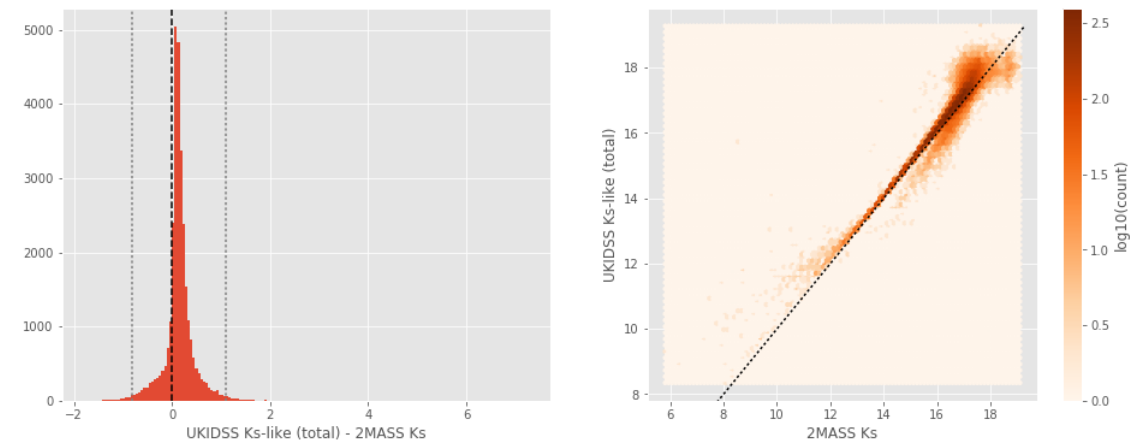
$$K_{s(2MASS)} = K_{UKIRT} + 0.003 + 0.004 * (JK)_{UKIRT}$$

```
UKIDSS J (total) - 2MASS J:
- Median: 0.06
- Median Absolute Deviation: 0.06
- 1% percentile: -0.7037645471097779
- 99% percentile: 0.6007539929292832
```

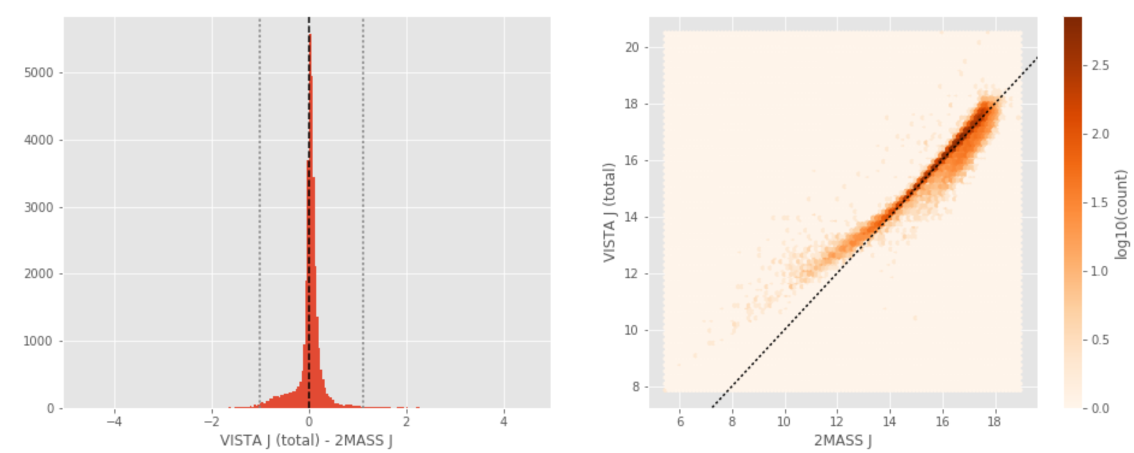





```
UKIDSS Ks-like (total) - 2MASS Ks:
- Median: 0.13
- Median Absolute Deviation: 0.09
- 1% percentile: -0.8042154709490332
- 99% percentile: 1.106456388792177
```

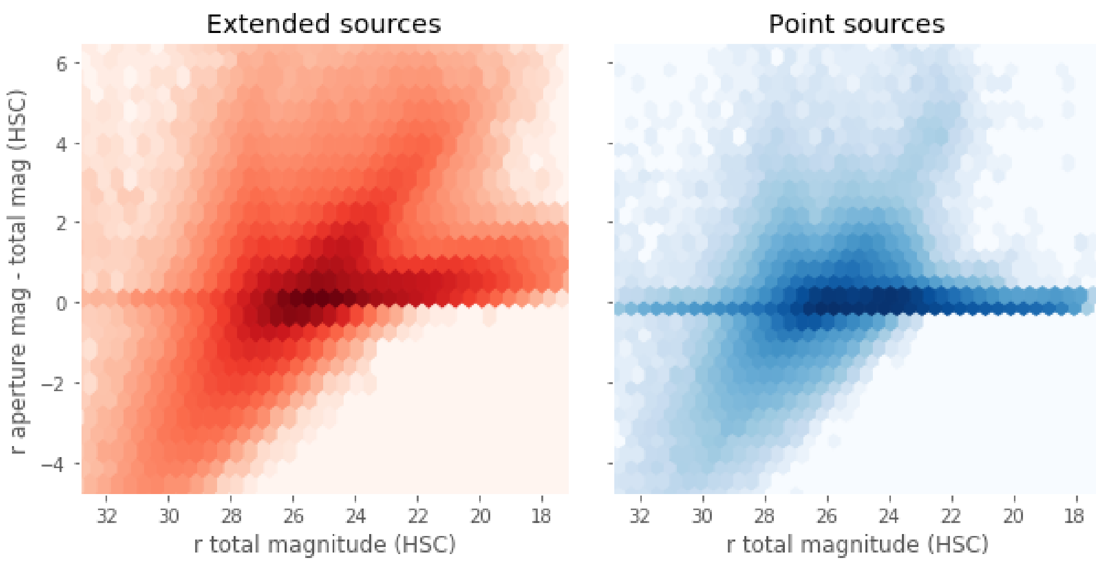


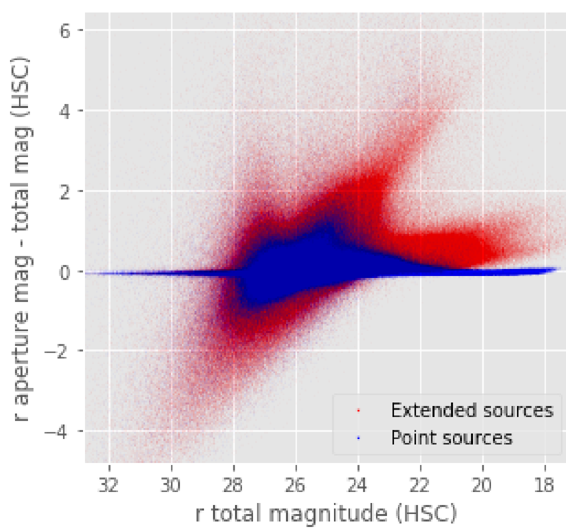
VISTA J (total) - 2MASS J:
- Median: 0.04
- Median Absolute Deviation: 0.07
- 1% percentile: -1.0072400489713493
- 99% percentile: 1.1234433082674224



1.6 IV - Comparing aperture magnitudes to total ones.

Number of source used: 5937538 / 14232880 (41.72%)

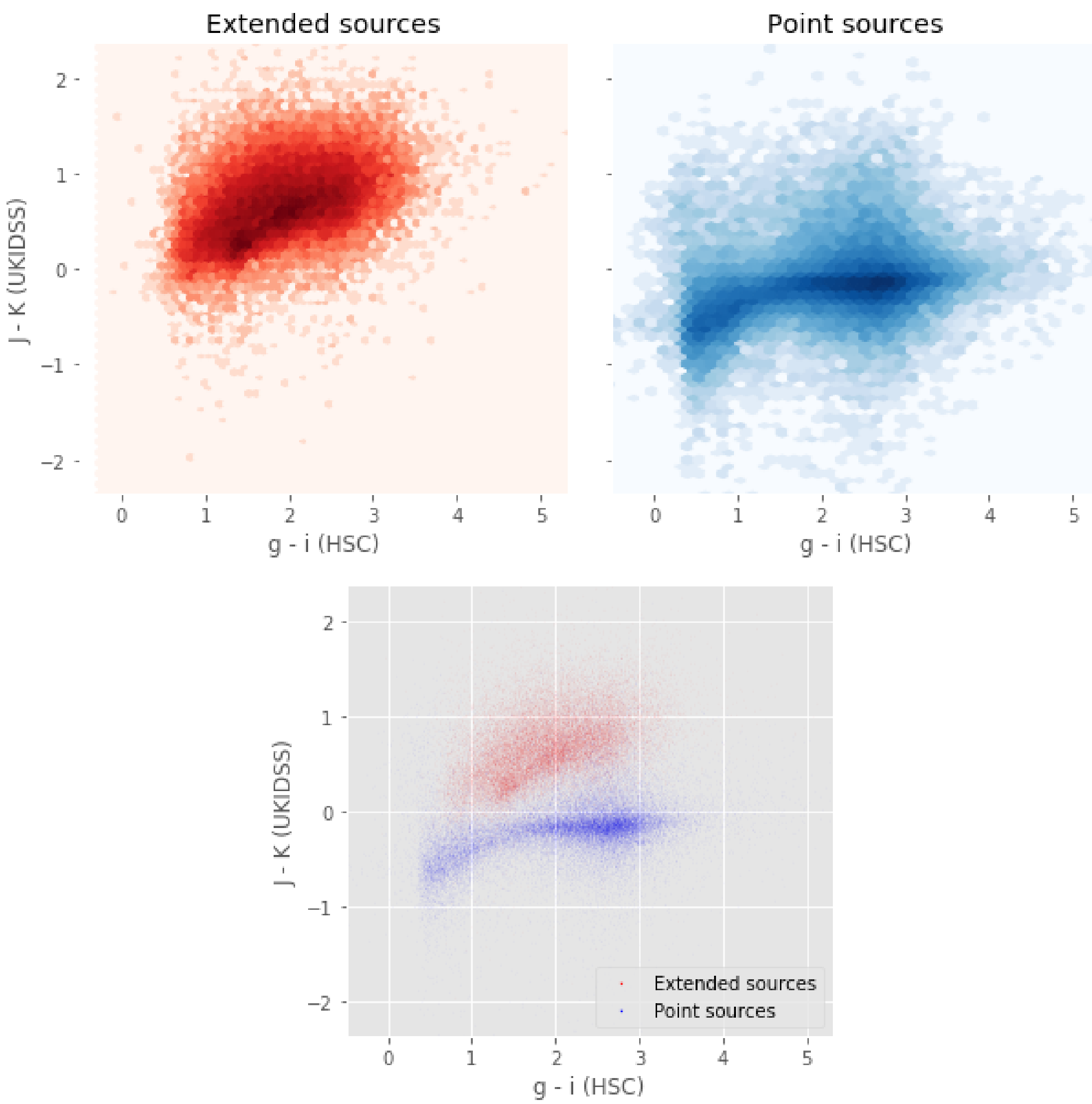




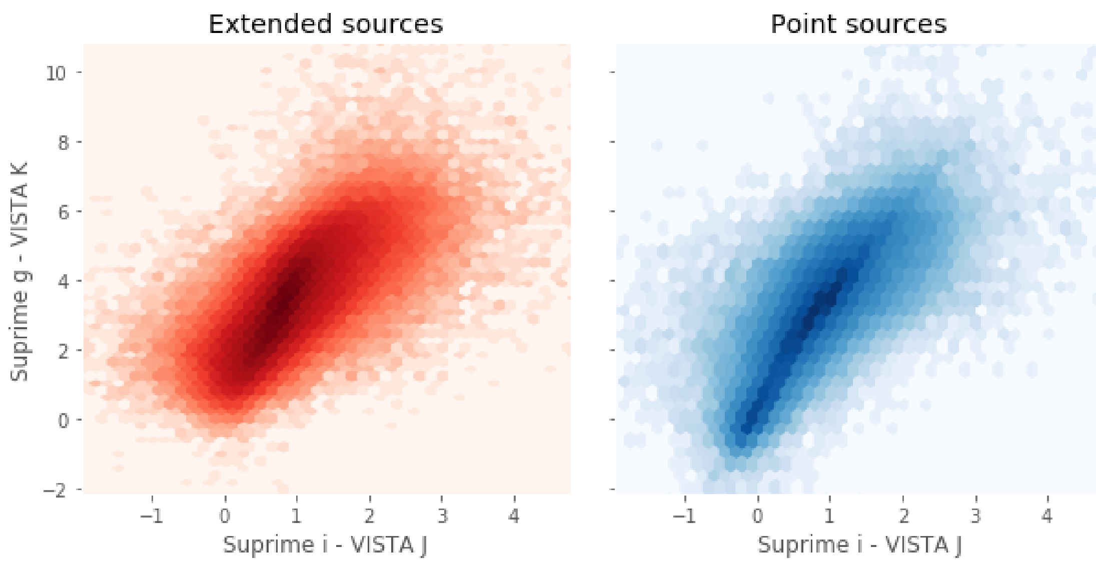
1.7 V - Color-color and magnitude-color plots

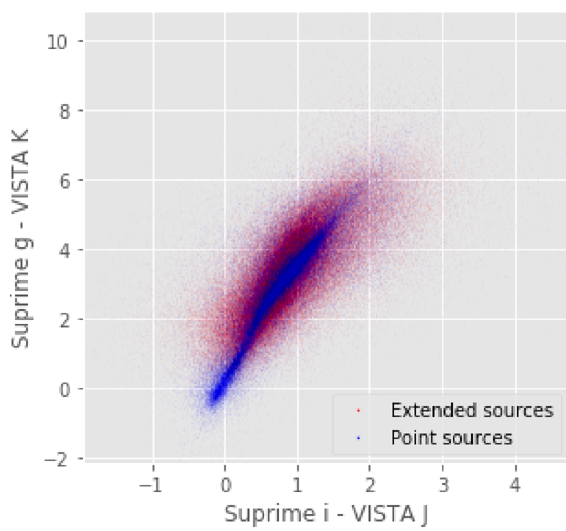
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:2: R
  from ipykernel import kernelapp as app
```

```
Number of source used: 68178 / 14232880 (0.48%)
```

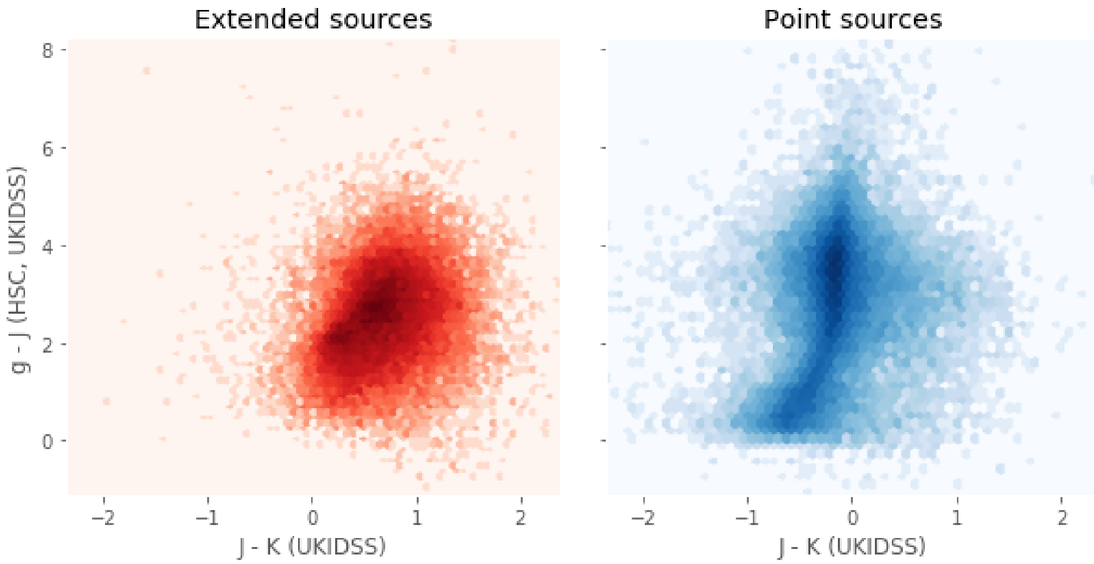


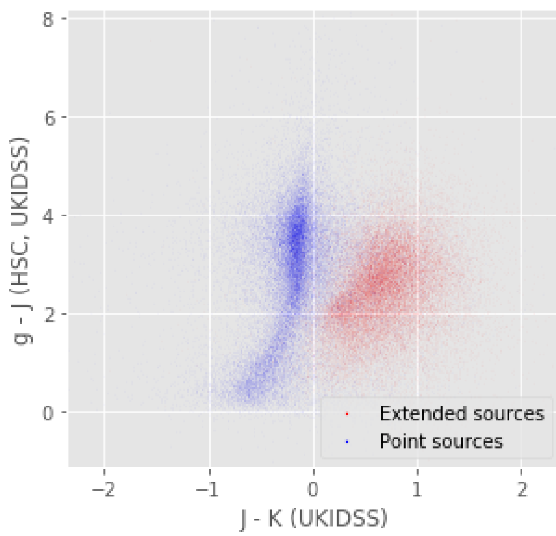
Number of source used: 279701 / 14232880 (1.97%)





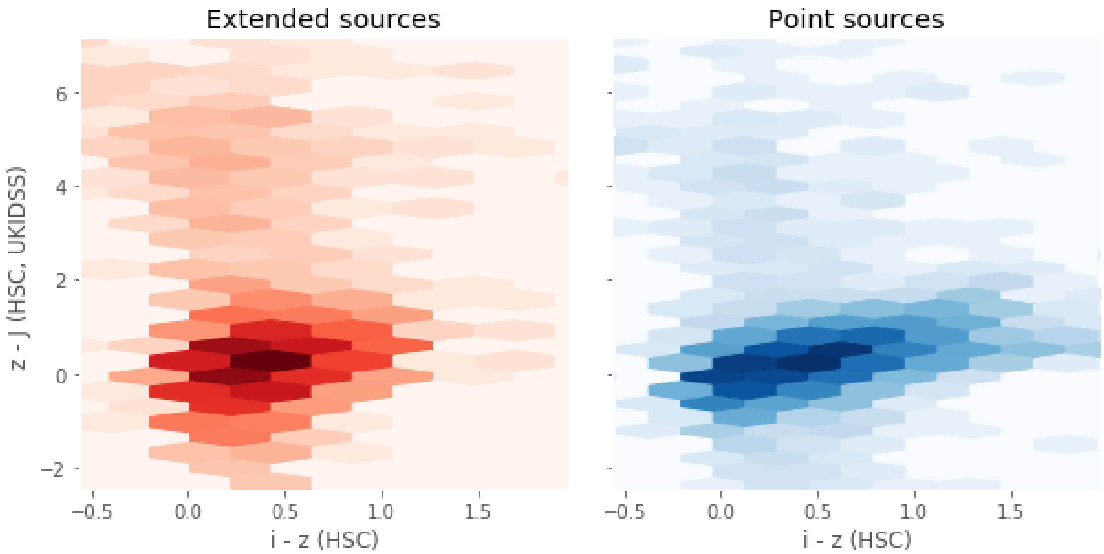

```
Number of source used: 68180 / 14232880 (0.48%)
```

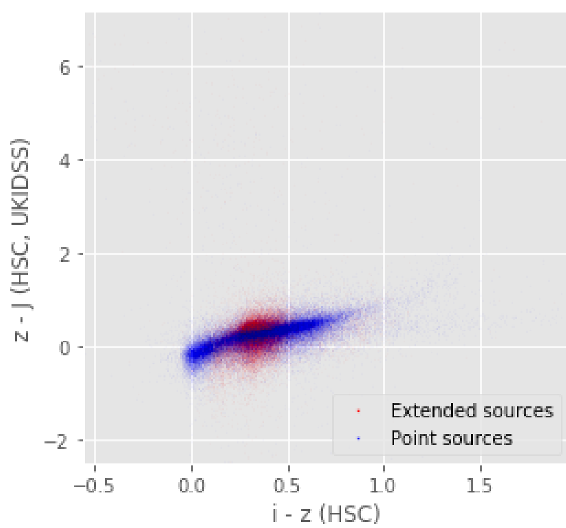





```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:2: R
  from ipykernel import kernelapp as app
```

```
Number of source used: 84746 / 14232880 (0.60%)
```


Extended sources
Point sources
z - J (HSC, UKIDSS)
i - z (HSC)
6
4
2
0
−2
−0.5
0.0
0.5
1.0
1.5


z - J (HSC, UKIDSS)
i - z (HSC)
Extended sources
Point sources
6
4
2
0
−2
−0.5
0.0
0.5
1.0
1.5

4_Selection_function

March 8, 2018

1 GAMA-15 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 21:56:24.322792
```

```
Depth maps produced using: master_catalogue_gama-15_20180213.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

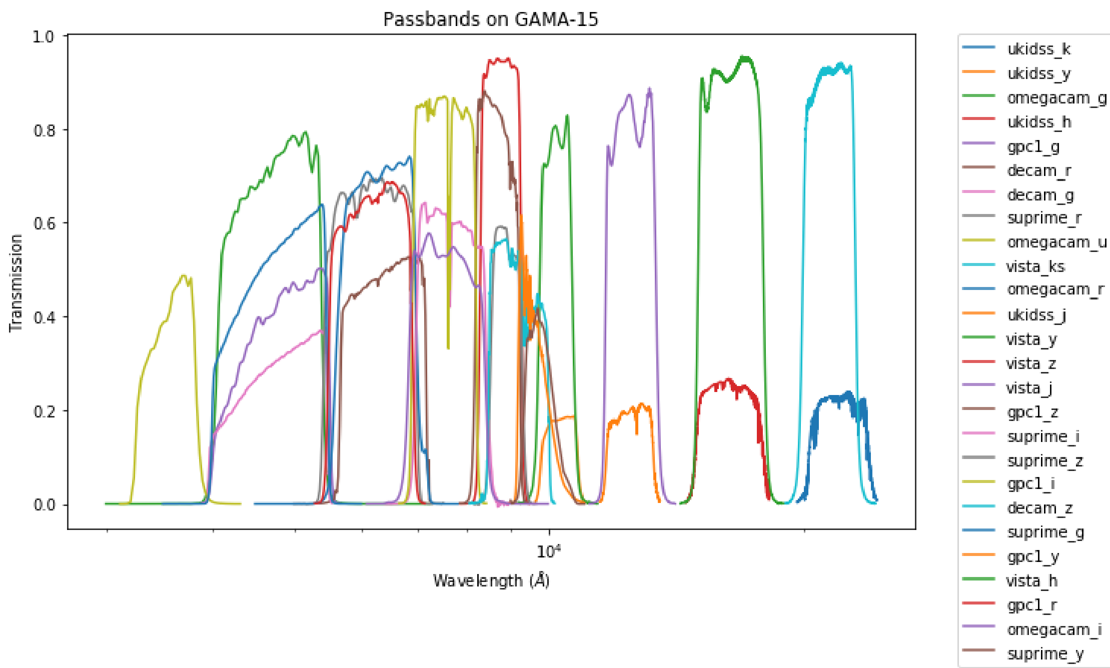
1.5 IV - Overview plots

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]: {'decam_g',
          'decam_r',
          'decam_z',
          'gpc1_g',
          'gpc1_i',
          'gpc1_r',
          'gpc1_y',
          'gpc1_z',
          'omegacam_g',
          'omegacam_i',
          'omegacam_r',
          'omegacam_u',
          'suprime_g',
          'suprime_i',
          'suprime_r',
          'suprime_y',
          'suprime_z',
          'ukidss_h',
          'ukidss_j',
          'ukidss_k',
          'ukidss_y',
          'vista_h',
          'vista_j',
          'vista_ks',
          'vista_y',
          'vista_z'}
```

```
Out[15]: <matplotlib.text.Text at 0x7fc257e4e748>
```



1.5.2 IV.a - Depth overview

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

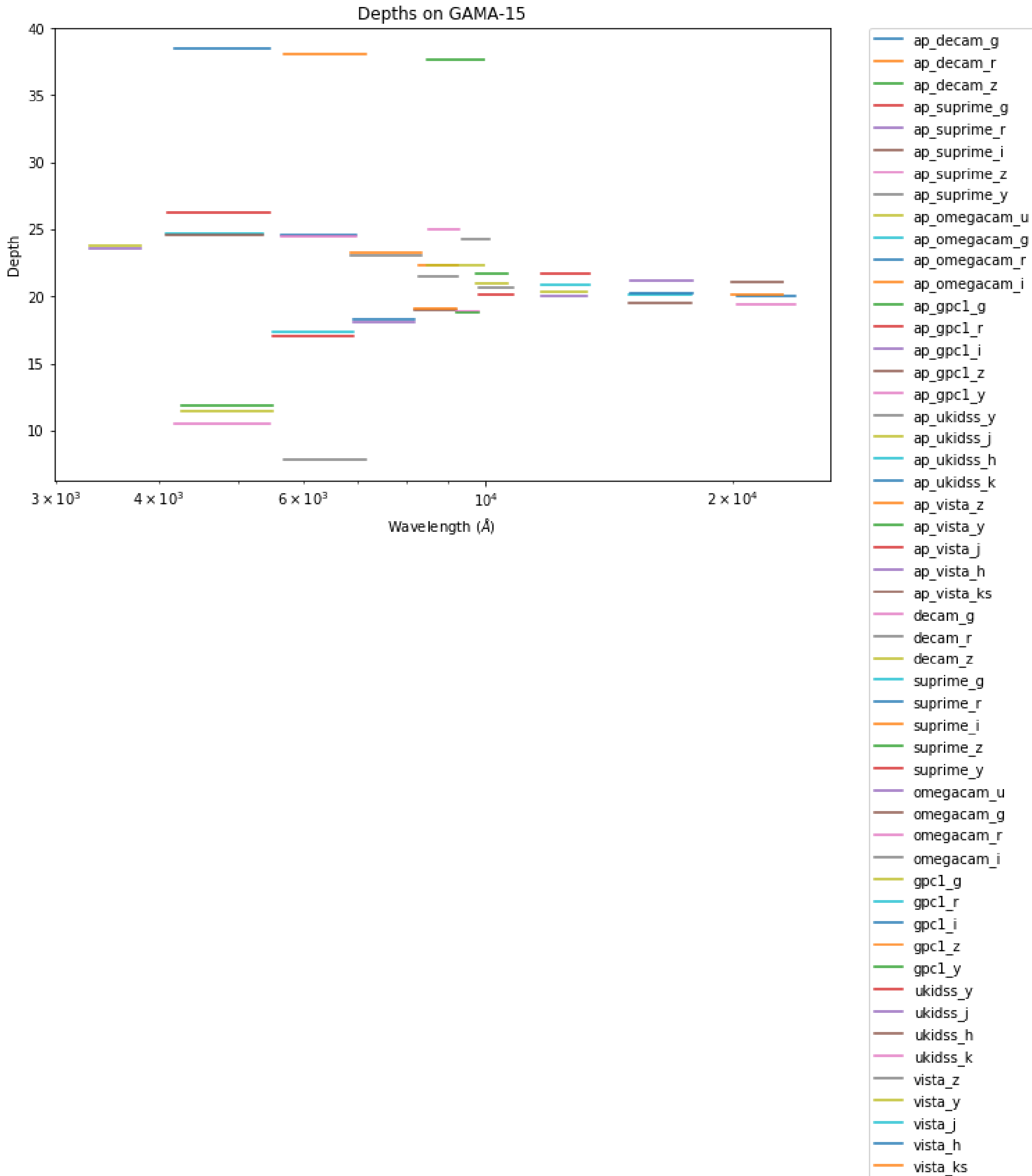
```
decam_g: mean flux error: 2.88053456642956e-07, 3sigma in AB mag (Aperture): 39.05851413537629
decam_r: mean flux error: 4.2927786125801504e-07, 3sigma in AB mag (Aperture): 38.625350634207
decam_z: mean flux error: 6.371932386173285e-07, 3sigma in AB mag (Aperture): 38.1965189662772
suprime_g: mean flux error: 0.022909177467226982, 3sigma in AB mag (Aperture): 26.80717312187916
suprime_r: mean flux error: inf, 3sigma in AB mag (Aperture): -inf
suprime_i: mean flux error: inf, 3sigma in AB mag (Aperture): -inf
suprime_z: mean flux error: 0.07355961948633194, 3sigma in AB mag (Aperture): 25.5405981781334
suprime_y: mean flux error: 0.14851710200309753, 3sigma in AB mag (Aperture): 24.777755697452868
omegacam_u: mean flux error: 0.2312910407781601, 3sigma in AB mag (Aperture): 24.29679983721858
omegacam_g: mean flux error: 0.09859927743673325, 3sigma in AB mag (Aperture): 25.22251253239927
omegacam_r: mean flux error: 0.10404875129461288, 3sigma in AB mag (Aperture): 25.16410468184406
omegacam_i: mean flux error: 0.37481188774108887, 3sigma in AB mag (Aperture): 23.77266347130554
gpc1_g: mean flux error: 13026.197196781804, 3sigma in AB mag (Aperture): 12.420152742089108
gpc1_r: mean flux error: 112.89824380099222, 3sigma in AB mag (Aperture): 17.575478897526388
gpc1_i: mean flux error: 44.05491301858491, 3sigma in AB mag (Aperture): 18.597210992915173
gpc1_z: mean flux error: 18.388773423543103, 3sigma in AB mag (Aperture): 19.545814958968144
gpc1_y: mean flux error: 19.538612671281303, 3sigma in AB mag (Aperture): 19.479962554124334
ukidss_y: mean flux error: 3.989213466644287, 3sigma in AB mag (Aperture): 21.204978672084543
ukidss_j: mean flux error: 5.380292892456055, 3sigma in AB mag (Aperture): 20.880182067104066
ukidss_h: mean flux error: 6.253326892852783, 3sigma in AB mag (Aperture): 20.716919033122643
ukidss_k: mean flux error: 6.797661781311035, 3sigma in AB mag (Aperture): 20.62629798220828
```

```
vista_z: mean flux error: 0.8404678702354431, 3sigma in AB mag (Aperture): 22.895894073955937
vista_y: mean flux error: 1.5430628061294556, 3sigma in AB mag (Aperture): 22.236237855236205
vista_j: mean flux error: 1.5670613050460815, 3sigma in AB mag (Aperture): 22.219481896084197
vista_h: mean flux error: 2.568079710006714, 3sigma in AB mag (Aperture): 21.683175614281602
vista_ks: mean flux error: 2.7992947101593018, 3sigma in AB mag (Aperture): 21.589575304550387
decam_g: mean flux error: 45585.32421875, 3sigma in AB mag (Total): 11.060134243199151
decam_r: mean flux error: 547971.8125, 3sigma in AB mag (Total): 8.360301315486986
decam_z: mean flux error: 0.8432648181915283, 3sigma in AB mag (Total): 22.892286909382996
suprime_g: mean flux error: inf, 3sigma in AB mag (Total): -inf
suprime_r: mean flux error: inf, 3sigma in AB mag (Total): -inf
suprime_i: mean flux error: inf, 3sigma in AB mag (Total): -inf
suprime_z: mean flux error: inf, 3sigma in AB mag (Total): -inf
suprime_y: mean flux error: inf, 3sigma in AB mag (Total): -inf
omegacam_u: mean flux error: 0.27011412382125854, 3sigma in AB mag (Total): 24.1283286298956
omegacam_g: mean flux error: 0.11004792153835297, 3sigma in AB mag (Total): 25.10324225195081
omegacam_r: mean flux error: 0.12321536988019943, 3sigma in AB mag (Total): 24.980534650492295
omegacam_i: mean flux error: 0.45526695251464844, 3sigma in AB mag (Total): 23.56153154734377
gpc1_g: mean flux error: 19043.864071544813, 3sigma in AB mag (Total): 12.007809180773094
gpc1_r: mean flux error: 83.51014723371986, 3sigma in AB mag (Total): 17.902848739765425
gpc1_i: mean flux error: 34.33598851874481, 3sigma in AB mag (Total): 18.867822975534217
gpc1_z: mean flux error: 16.218760640248636, 3sigma in AB mag (Total): 19.68215270208662
gpc1_y: mean flux error: 22.431917744420783, 3sigma in AB mag (Total): 19.33003085376226
ukidss_y: mean flux error: 6.6747846603393555, 3sigma in AB mag (Total): 20.646103715201043
ukidss_j: mean flux error: 7.230424880981445, 3sigma in AB mag (Total): 20.559287317044713
ukidss_h: mean flux error: 11.535013198852539, 3sigma in AB mag (Total): 20.05215162371183
ukidss_k: mean flux error: 12.777152061462402, 3sigma in AB mag (Total): 19.941111704744934
vista_z: mean flux error: 1.7923126220703125, 3sigma in AB mag (Total): 22.07366245507726
vista_y: mean flux error: 3.1276822090148926, 3sigma in AB mag (Total): 21.469140313838217
vista_j: mean flux error: 3.434054136276245, 3sigma in AB mag (Total): 21.367679019874238
vista_h: mean flux error: 5.768631935119629, 3sigma in AB mag (Total): 20.804514788489634
vista_ks: mean flux error: 6.45589017868042, 3sigma in AB mag (Total): 20.68230652824618


ap_decam_g (4180.0, 5470.0, 1290.0)
ap_decam_r (5680.0, 7150.0, 1470.0)
ap_decam_z (8490.0, 9960.0, 1470.0)
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_omegacam_u (3296.7, 3807.8999, 511.19995)
ap_omegacam_g (4077.8999, 5369.7002, 1291.8003)
ap_omegacam_r (5640.7002, 6962.7998, 1322.0996)
ap_omegacam_i (6841.5, 8373.7998, 1532.2998)
ap_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_y (9790.0, 10820.0, 1030.0)
ap_ukidss_j (11695.0, 13280.0, 1585.0)
ap_ukidss_h (14925.0, 17840.0, 2915.0)
ap_ukidss_k (20290.0, 23820.0, 3530.0)
ap_vista_z (8300.0, 9260.0, 960.0)
ap_vista_y (9740.0, 10660.0, 920.0)
ap_vista_j (11670.0, 13380.0, 1710.0)
ap_vista_h (15000.0, 17900.0, 2900.0)
ap_vista_ks (19930.0, 23010.0, 3080.0)
decam_g (4180.0, 5470.0, 1290.0)
decam_r (5680.0, 7150.0, 1470.0)
decam_z (8490.0, 9960.0, 1470.0)
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)
omegacam_u (3296.7, 3807.8999, 511.19995)
omegacam_g (4077.8999, 5369.7002, 1291.8003)
omegacam_r (5640.7002, 6962.7998, 1322.0996)
omegacam_i (6841.5, 8373.7998, 1532.2998)
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_y (9790.0, 10820.0, 1030.0)
ukidss_j (11695.0, 13280.0, 1585.0)
ukidss_h (14925.0, 17840.0, 2915.0)
ukidss_k (20290.0, 23820.0, 3530.0)
vista_z (8300.0, 9260.0, 960.0)
vista_y (9740.0, 10660.0, 920.0)
vista_j (11670.0, 13380.0, 1710.0)
vista_h (15000.0, 17900.0, 2900.0)
vista_ks (19930.0, 23010.0, 3080.0)
```

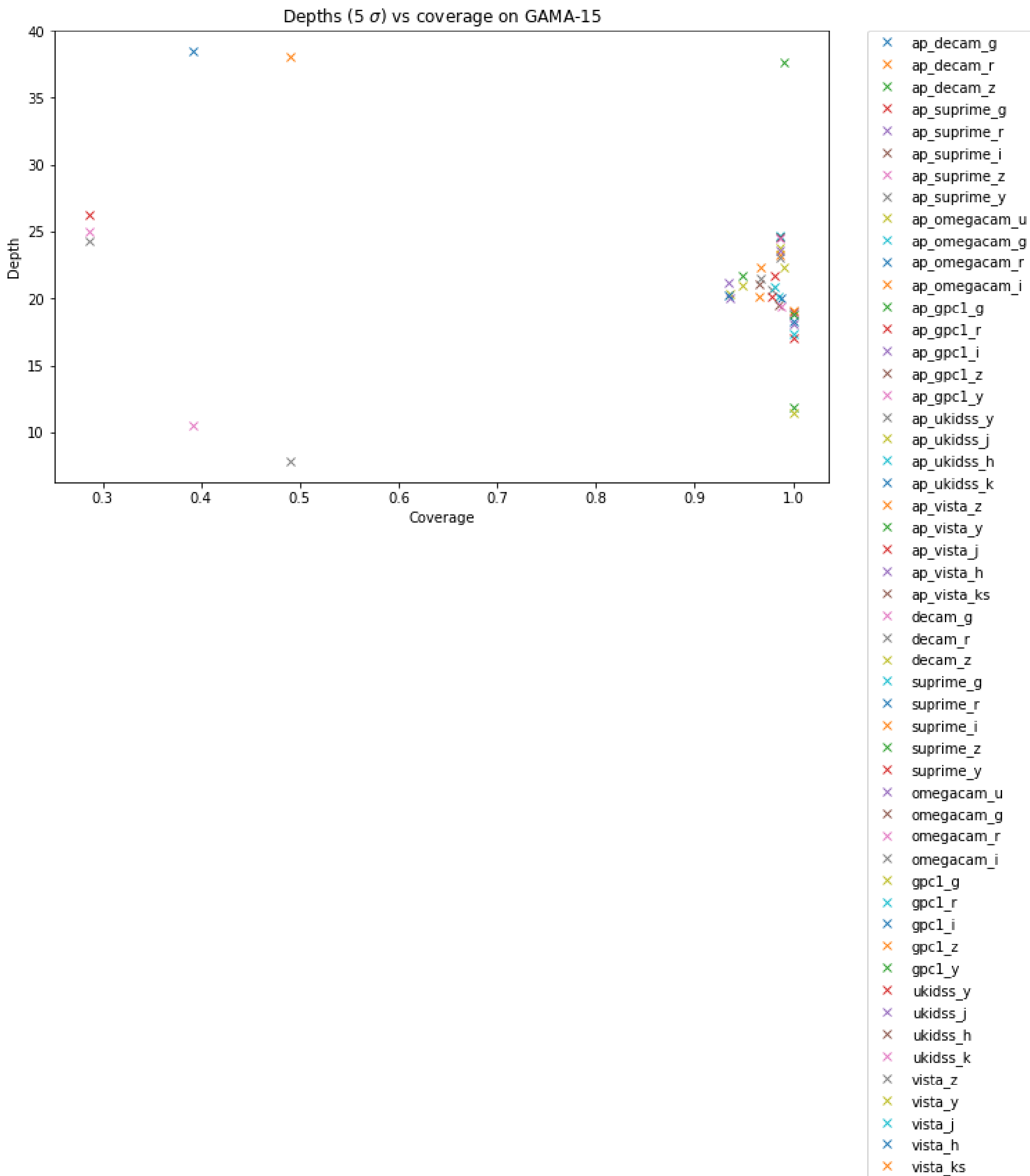
```
Out[20]: <matplotlib.text.Text at 0x7fc2647bdcf8>
```



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 0x7fc2643d13c8>
```



Depths (5 σ) vs coverage on GAMA-15
Depth
Coverage
40
35
30
25
20
15
10
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
ap_decam_g
ap_decam_r
ap_decam_z
ap_suprime_g
ap_suprime_r
ap_suprime_i
ap_suprime_z
ap_suprime_y
ap_omegacam_u
ap_omegacam_g
ap_omegacam_r
ap_omegacam_i
ap_gpc1_g
ap_gpc1_r
ap_gpc1_i
ap_gpc1_z
ap_gpc1_y
ap_ukidss_y
ap_ukidss_j
ap_ukidss_h
ap_ukidss_k
ap_vista_z
ap_vista_y
ap_vista_j
ap_vista_h
ap_vista_ks
decam_g
decam_r
decam_z
suprime_g
suprime_r
suprime_i
suprime_z
suprime_y
omegacam_u
omegacam_g
omegacam_r
omegacam_i
gpc1_g
gpc1_r
gpc1_i
gpc1_z
gpc1_y
ukidss_y
ukidss_j
ukidss_h
ukidss_k
vista_z
vista_y
vista_j
vista_h
vista_ks