1.1_DECaLS

March 8, 2018

1 GAMA-12 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:
44f1ae0 (Thu Nov 30 18:27:54 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).

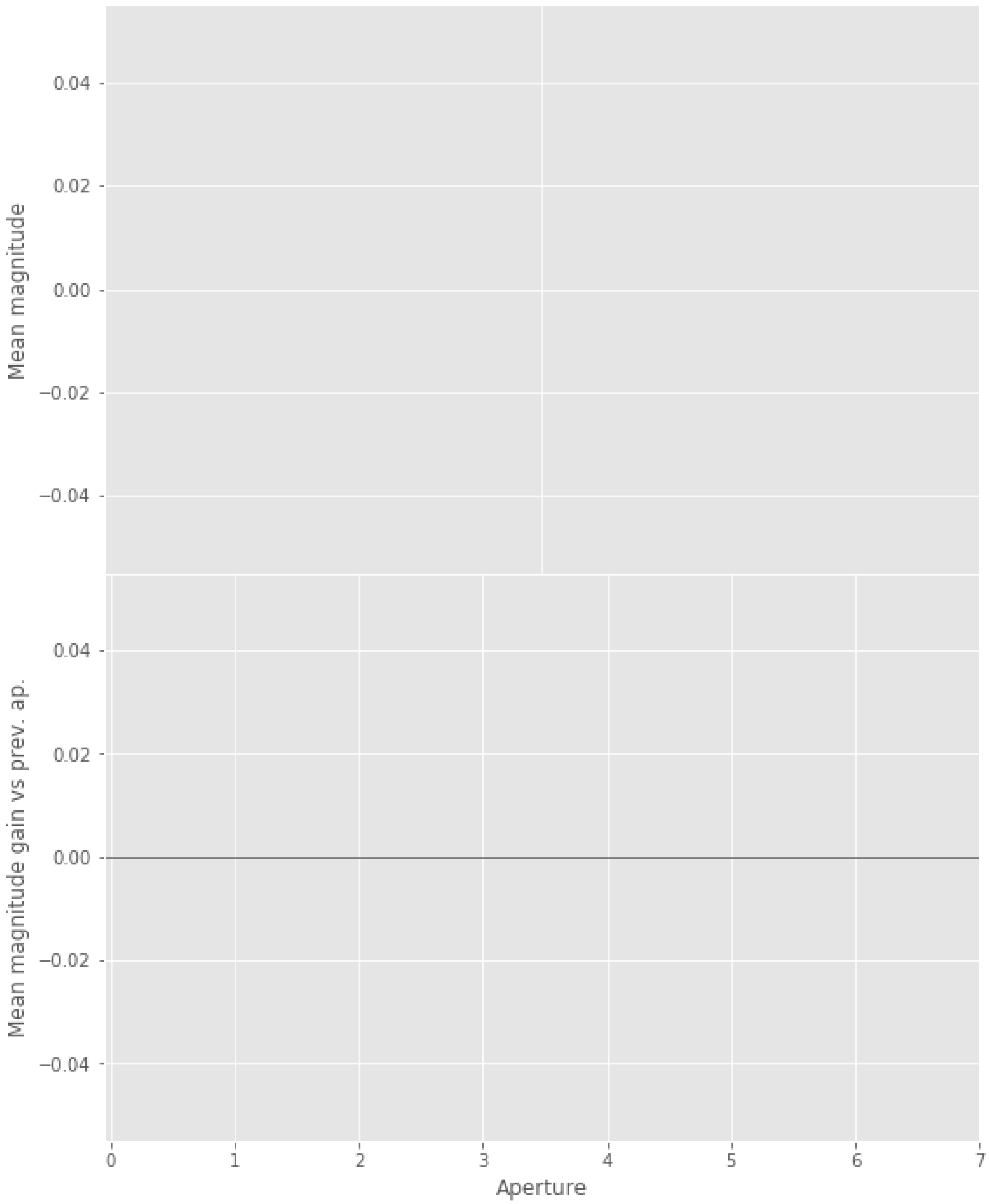
As target aperture, we should use the smallest (i.e. less noisy) aperture for which most of the flux is captures.

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
```

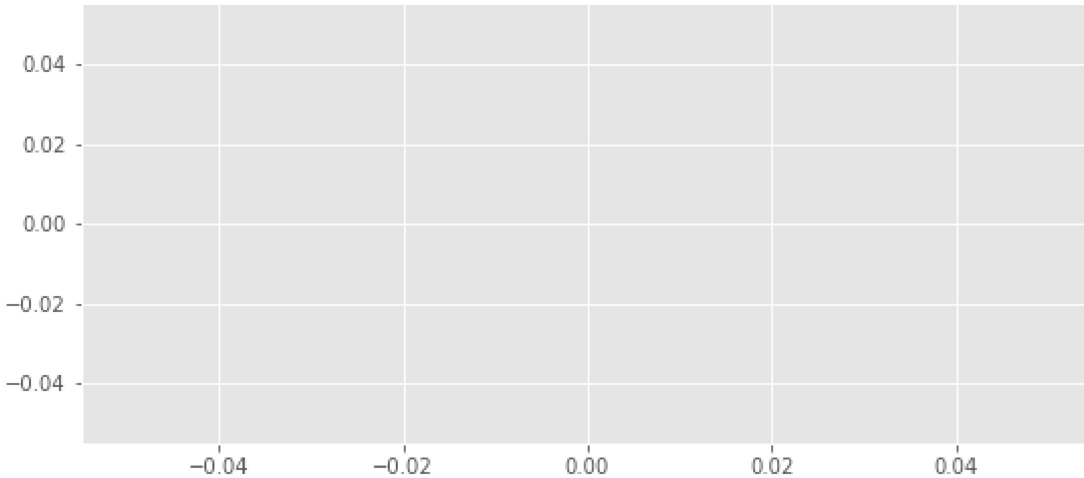
1.2.1 1.a u band

```
/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)
```

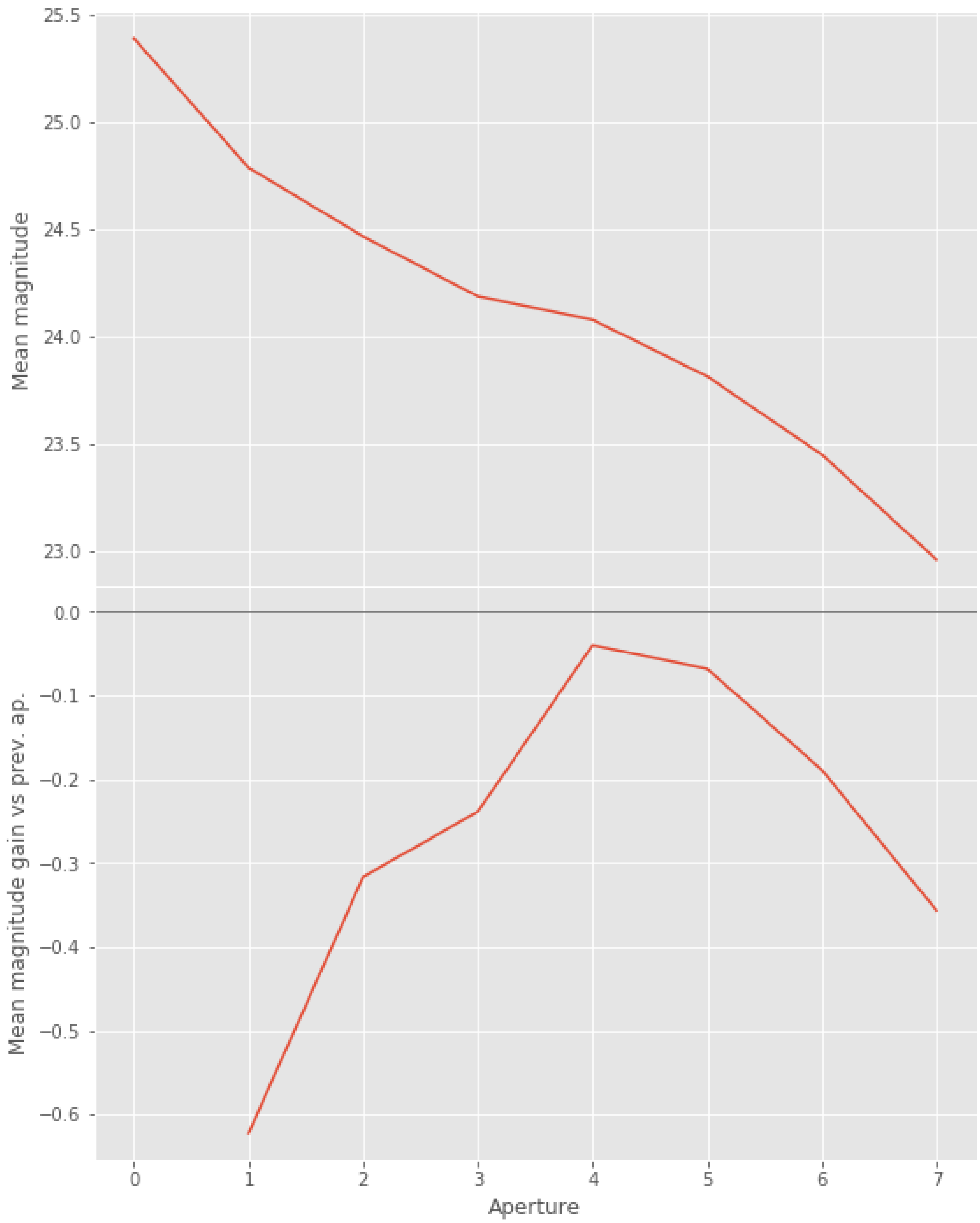


u band is all nan

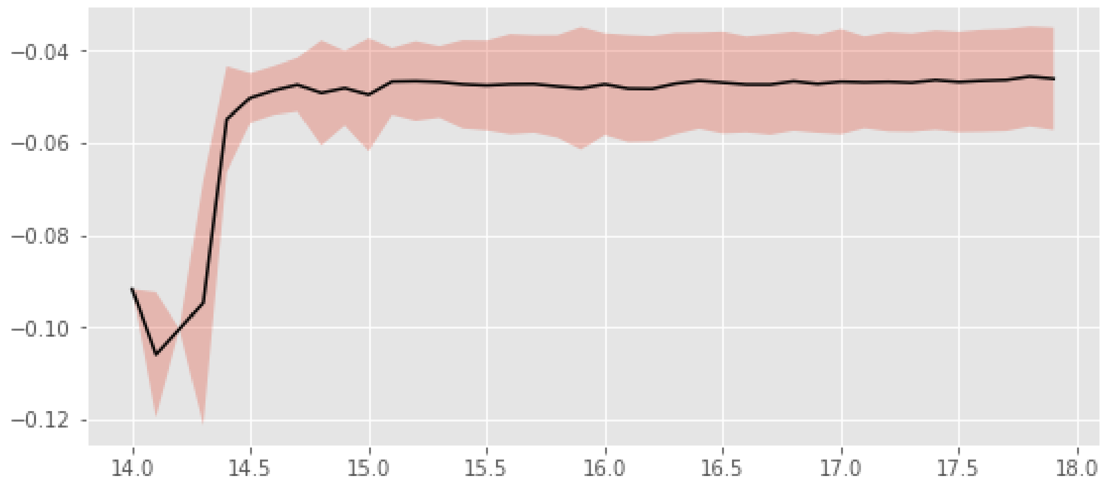
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```


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.

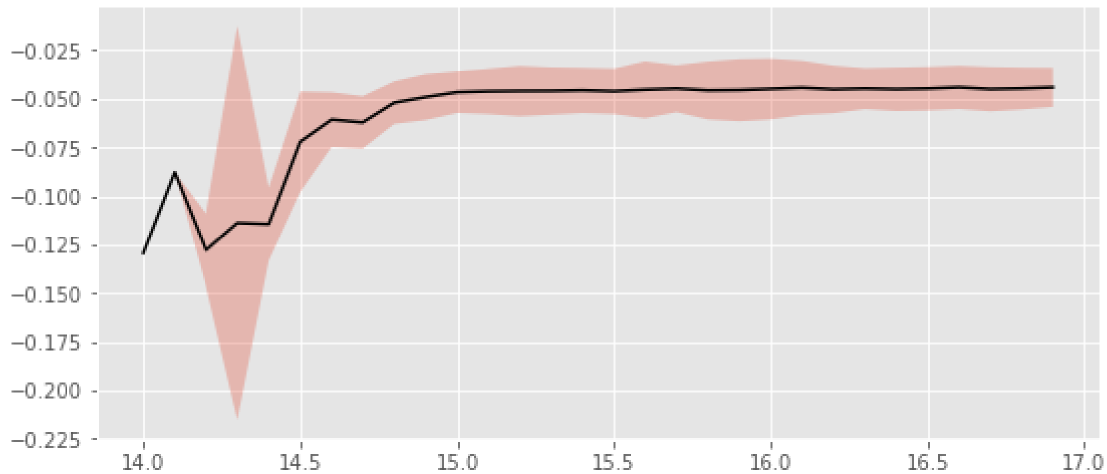


We will use magnitudes between 16.0 and 19.0

```
Aperture correction for g band:
Correction: -0.04667313830054809
Number of source used: 23717
RMS: 0.011444360751639541
```

1.2.3 I.b - r band

We will use aperture 5 as target.

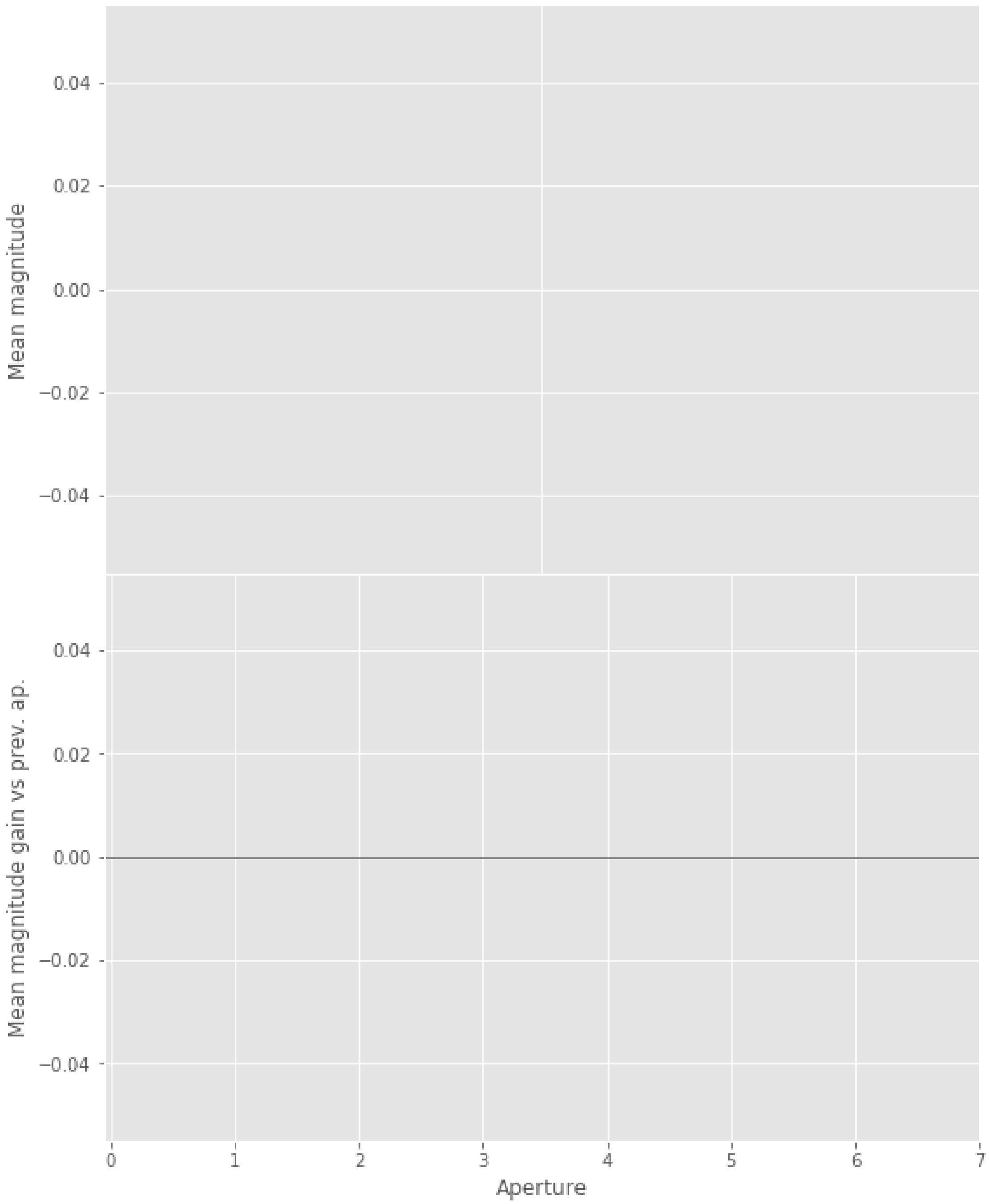


We use magnitudes between 16.0 and 18.0.

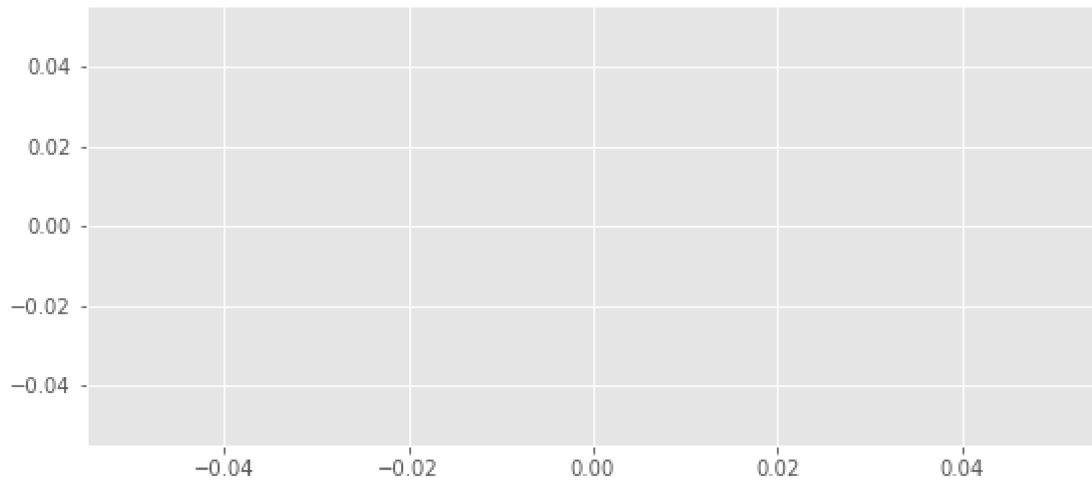
```
Aperture correction for r band:
Correction: -0.04464416991417153
Number of source used: 19270
RMS: 0.011583695530186974
```

1.2.4 I.d - i band

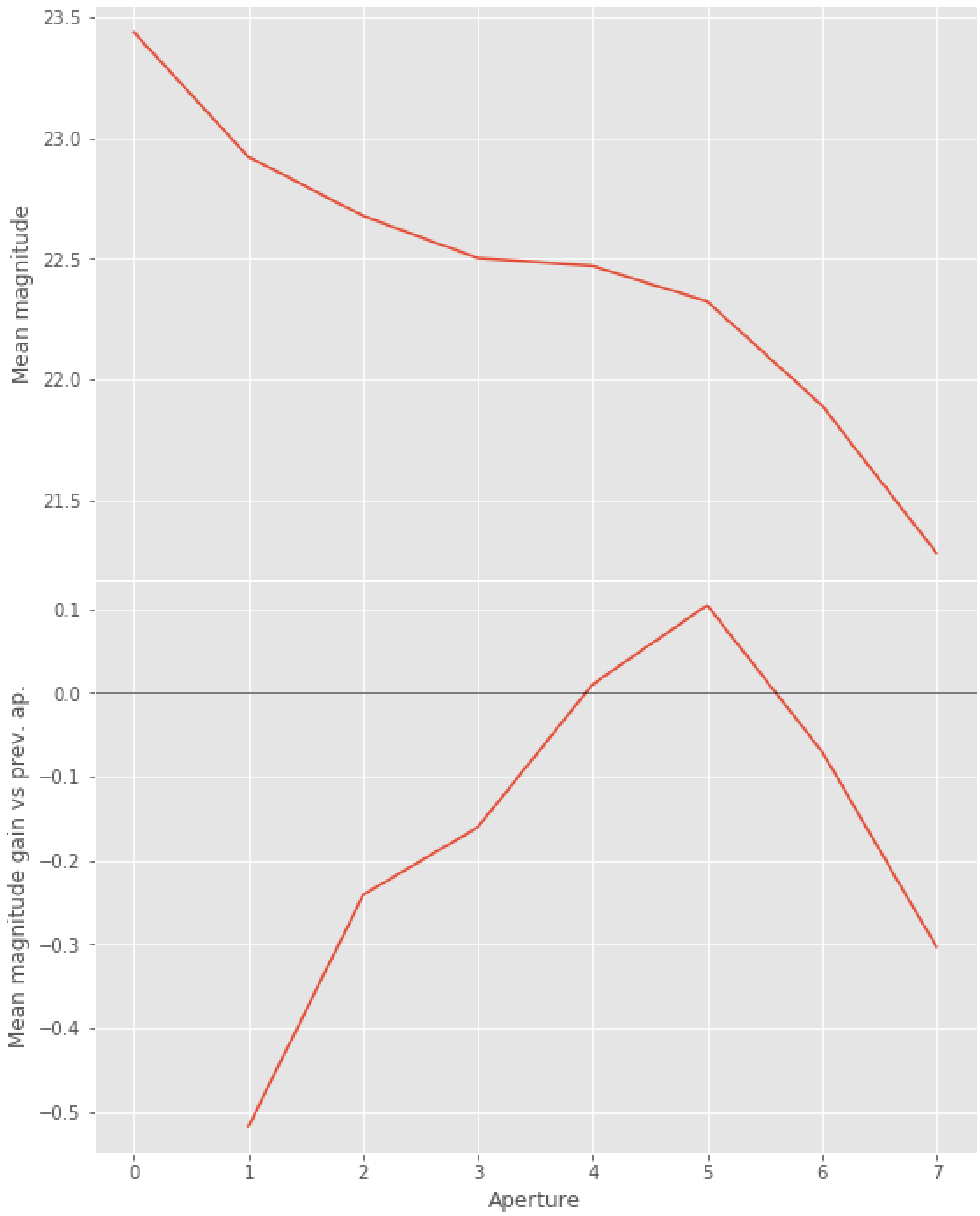
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:
  warnings.warn("Mean of empty slice", RuntimeWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:
  warnings.warn("Mean of empty slice", RuntimeWarning)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



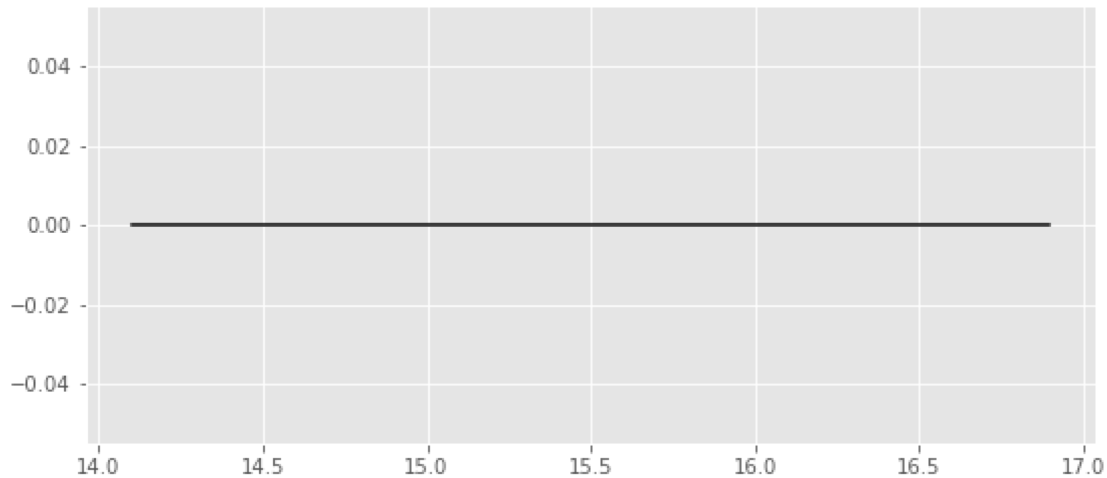

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```


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.

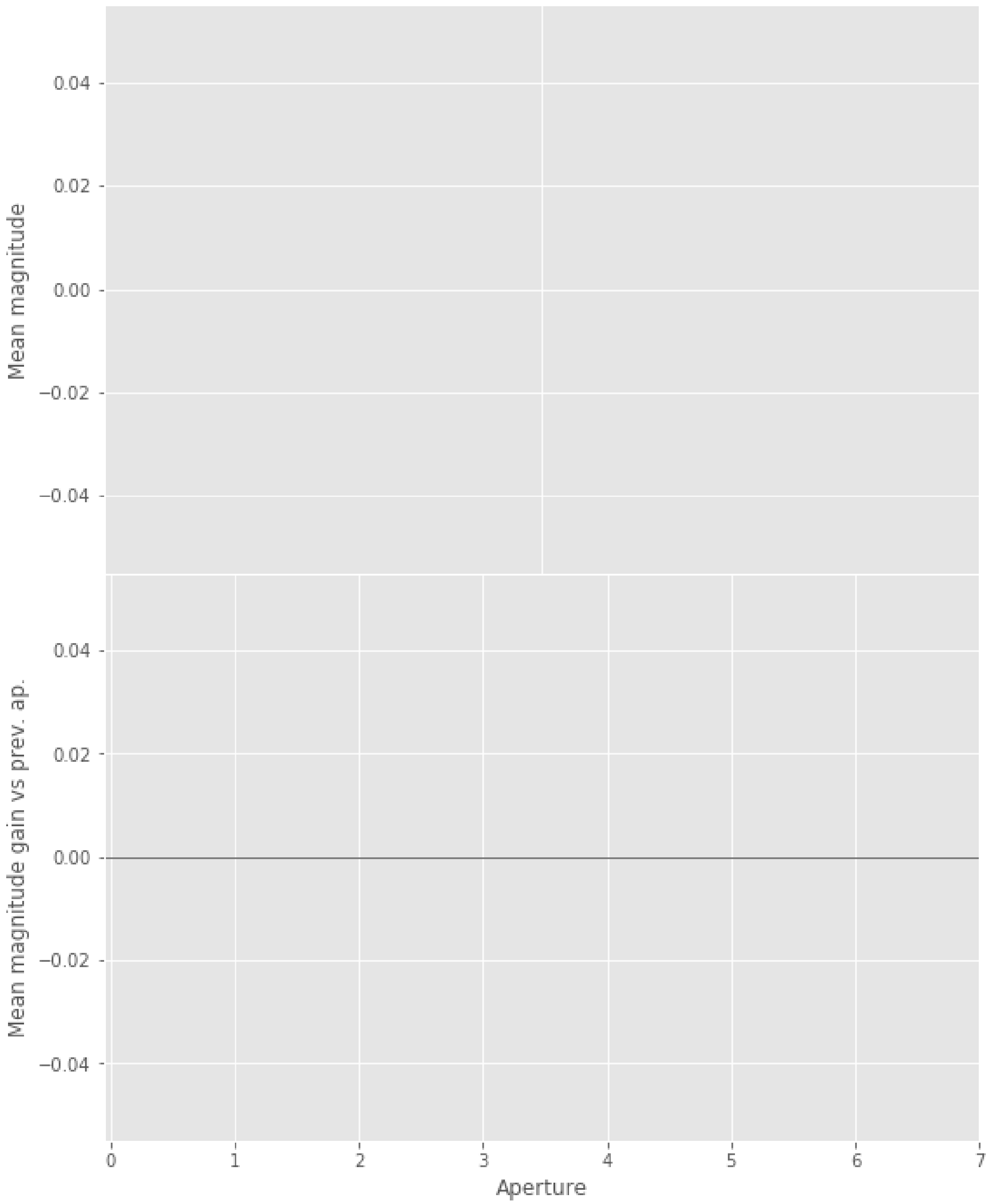


We use magnitudes between 16.0 and 17.5.

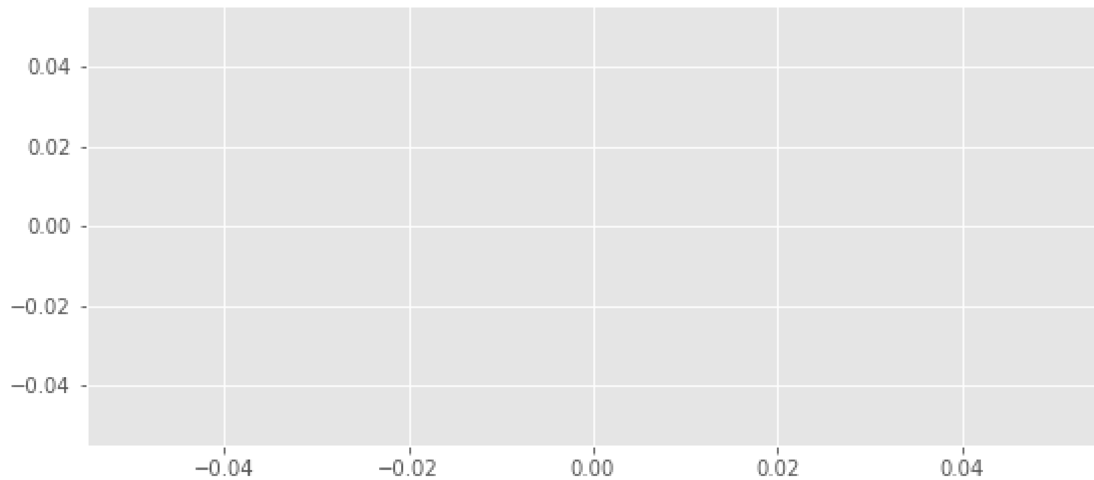
```
Aperture correction for z band:
Correction: -0.06427007912088101
Number of source used: 34963
RMS: 0.017483249006434255
```

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

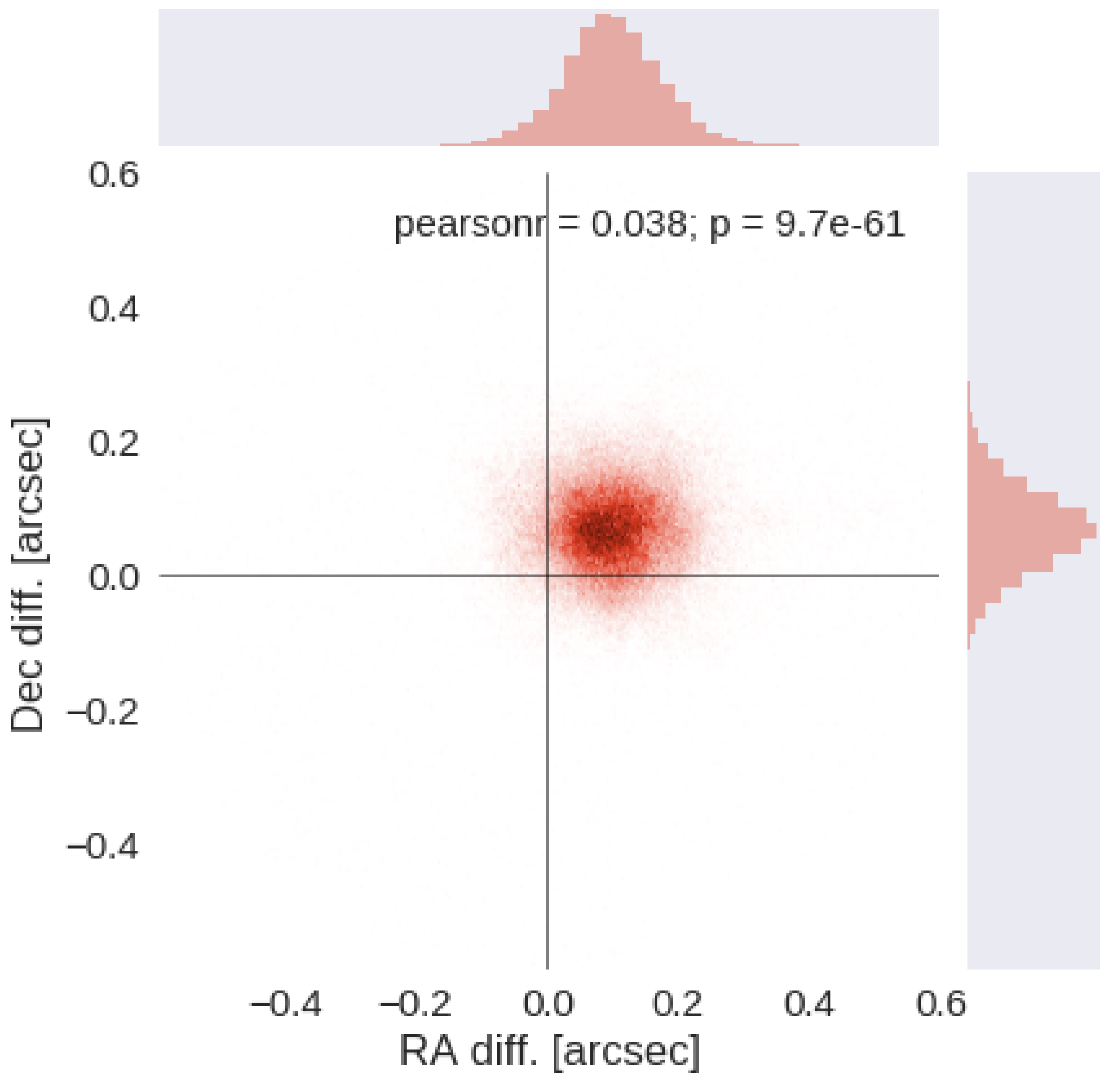
We remove duplicated objects from the input catalogues.

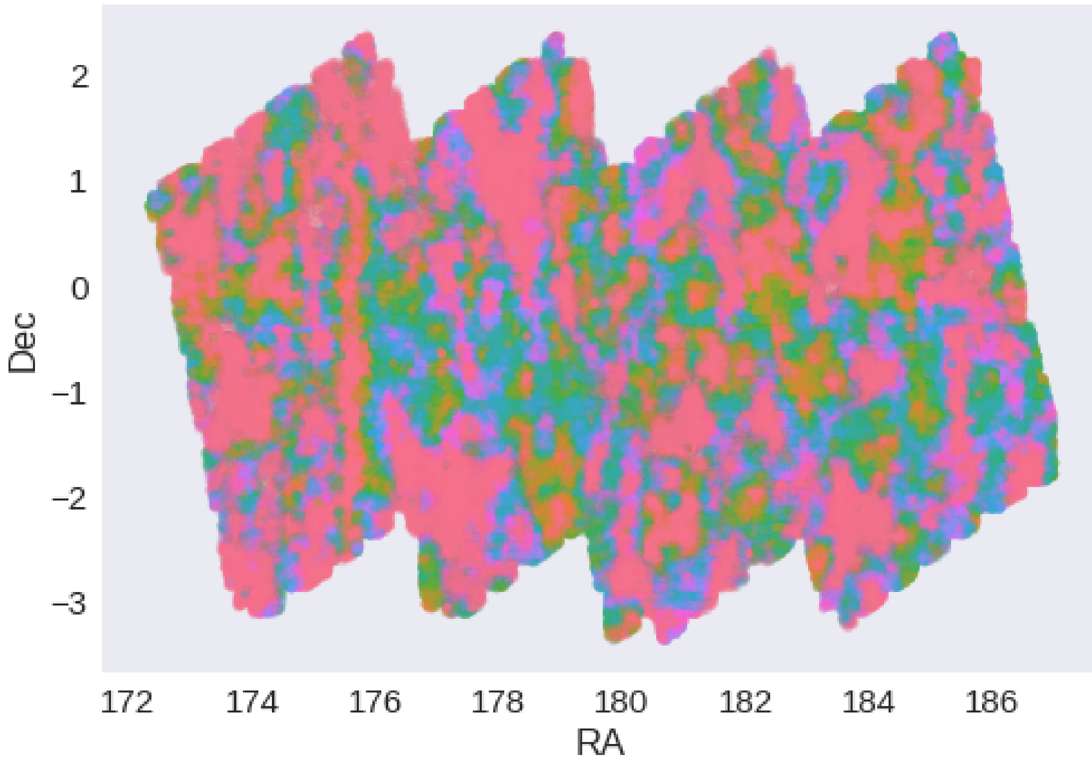
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)


The initial catalogue had 3844247 sources.
The cleaned catalogue has 3843655 sources (592 removed).
The cleaned catalogue has 591 sources flagged as having been cleaned
```

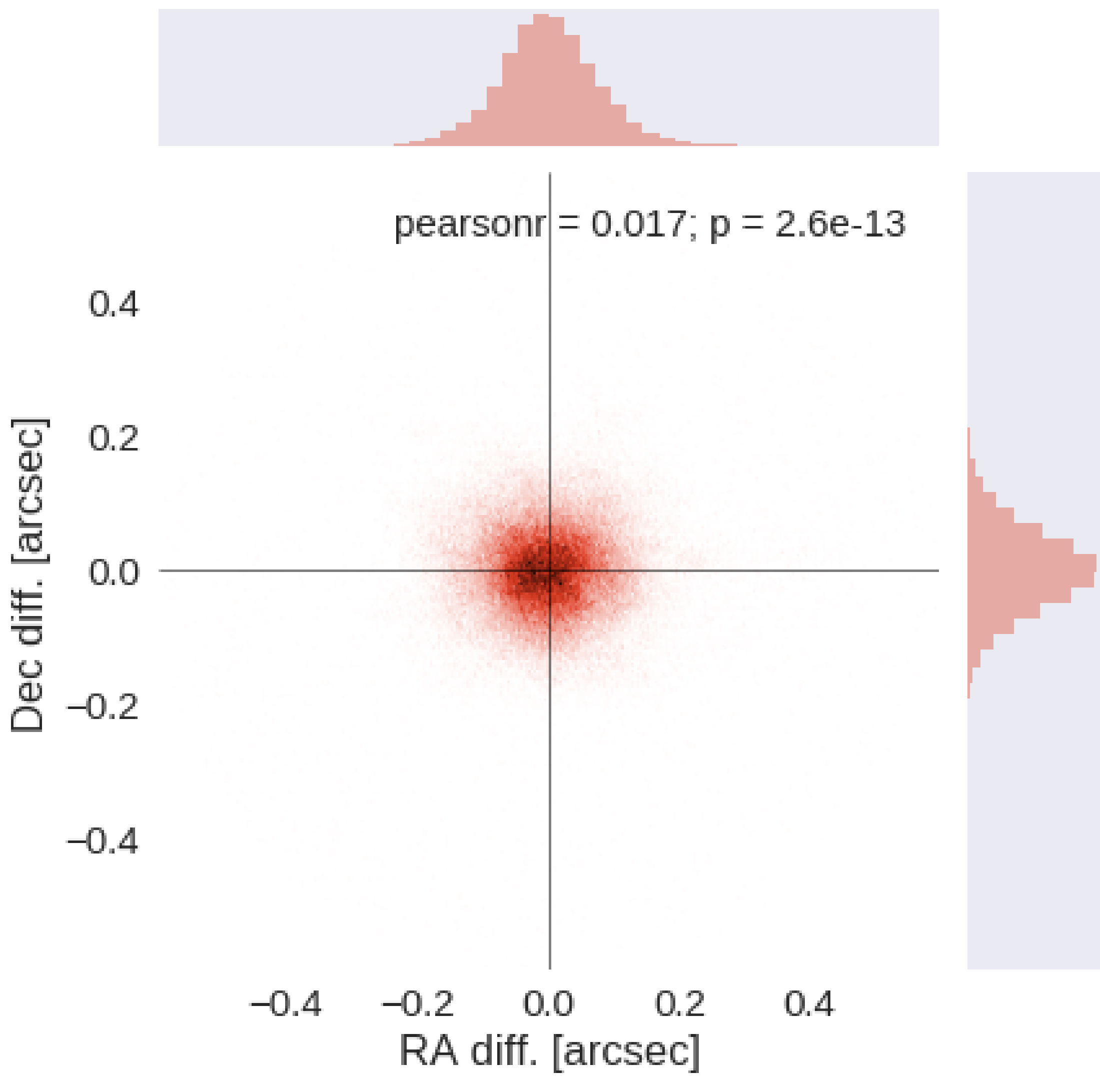
1.6 III - Astrometry correction

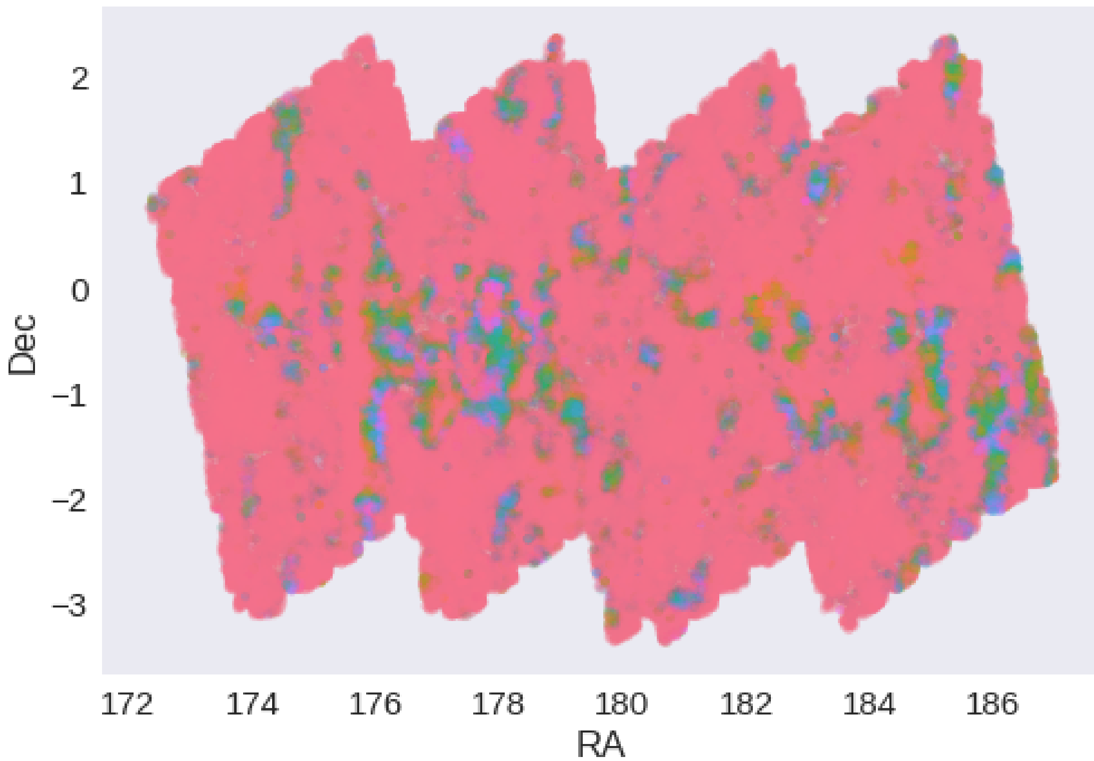
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = 0.038; p = 9.7e-61
Dec diff. [arcsec]
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.4
−0.2
0.0
0.2
0.4
0.6
RA diff. [arcsec]




```
RA correction: -0.09793402824698205 arcsec
Dec correction: -0.06714987024245556 arcsec
```


pearsonr = 0.017; p = 2.6e-13
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

```
191008 sources flagged.
```

2 V - Saving to disk

1.2_HSC-SSP

March 8, 2018

1 GAMA-12 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.

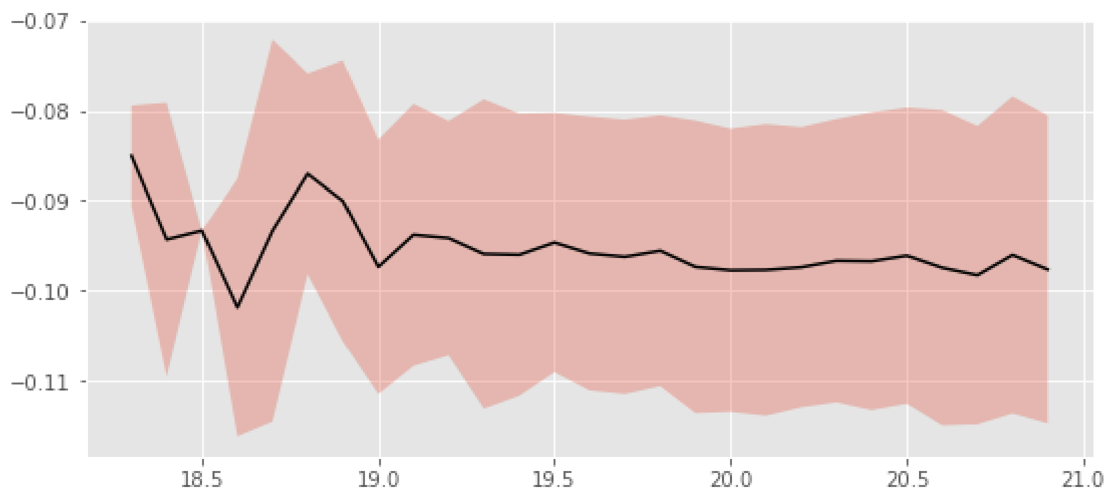
```
No error column for a y band aperture magnitude.
```

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: -0.09674453735351562
Number of source used: 6713
RMS: 0.016023767426012712
```

```
/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)
```

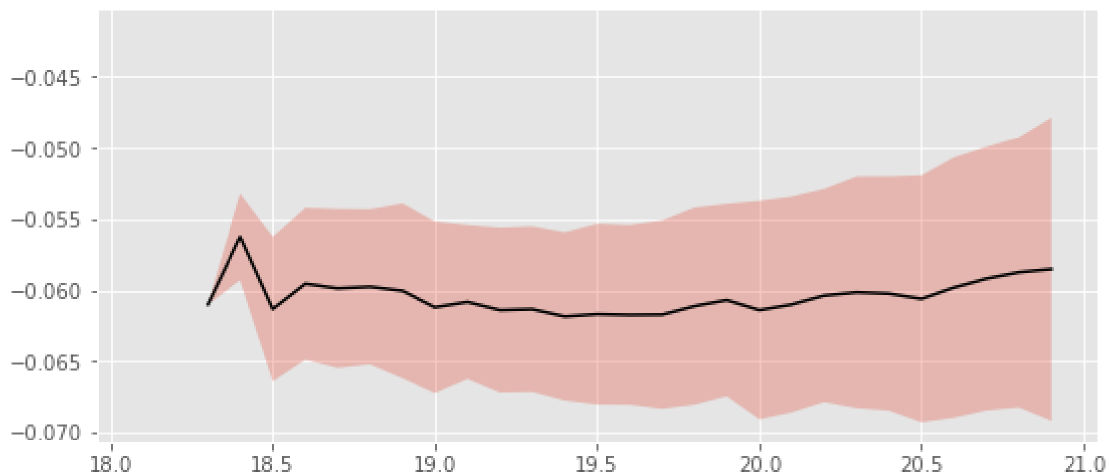
1.2.2 I.b - r band

```
/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: -0.06122016906738281
Number of source used: 3680
RMS: 0.00599616115561753
```

```
/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)
```

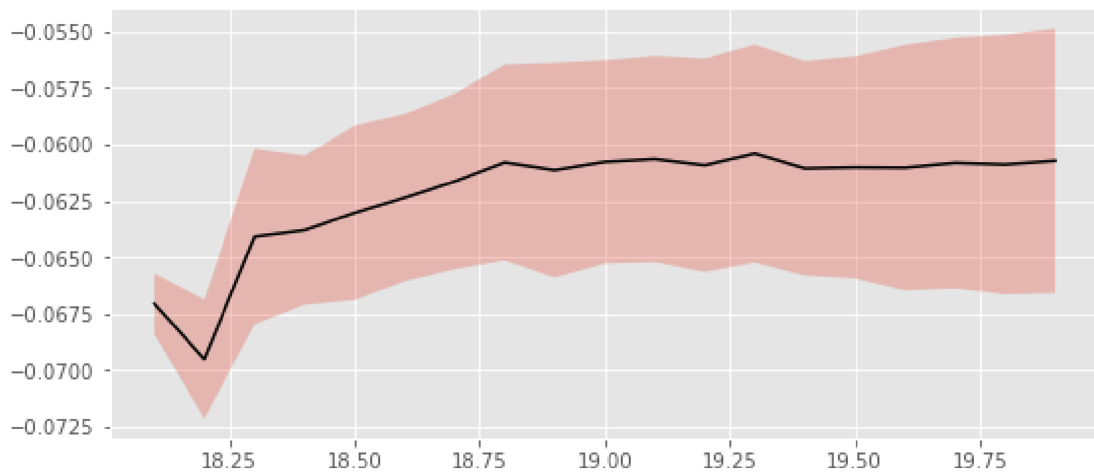
1.2.3 I.c - i band

```
/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)
```



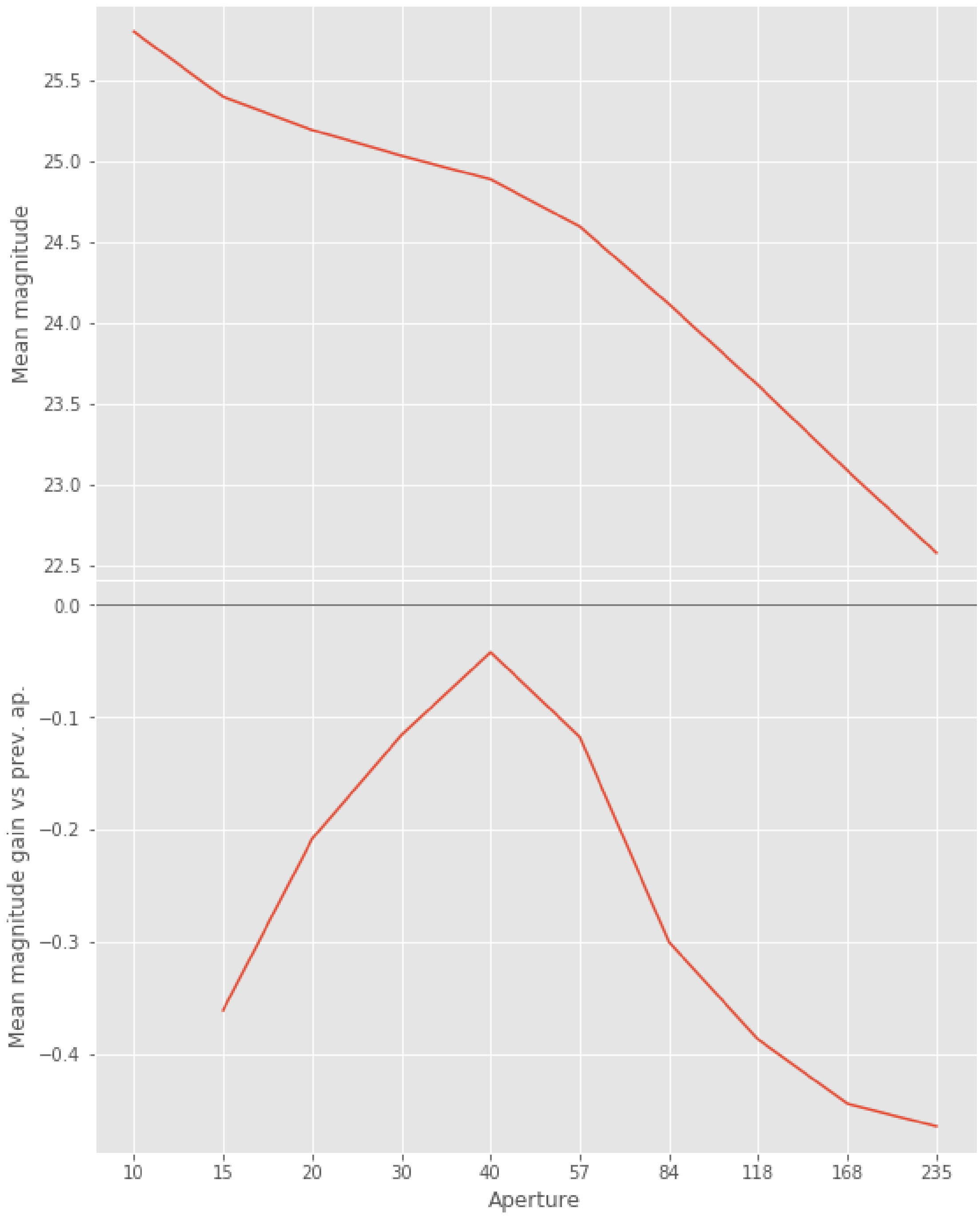
We use magnitudes between 18.5 and 19.8.

```
Aperture correction for i band:
Correction: -0.061016082763671875
Number of source used: 10687
RMS: 0.004784361518138592
```

```
/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

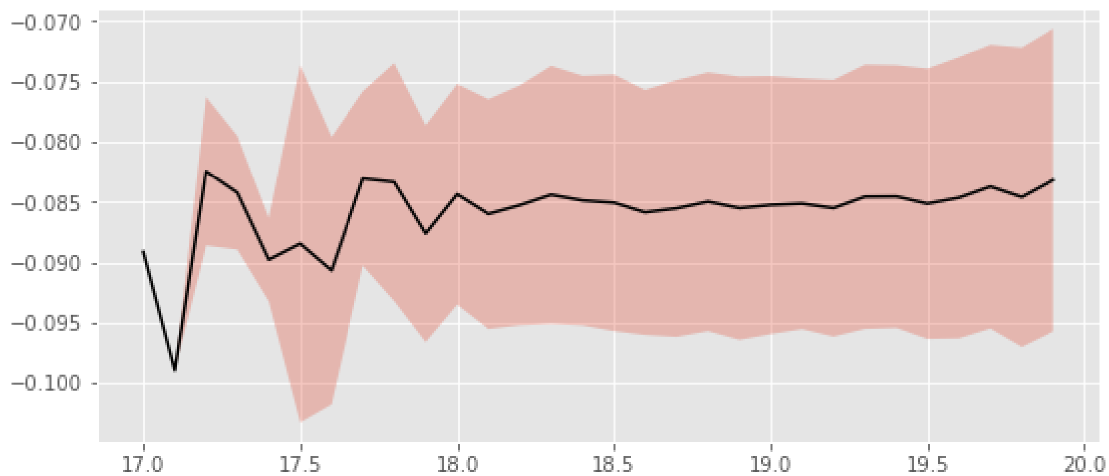
```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```



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: -0.08498001098632812
Number of source used: 15443
RMS: 0.010872531231867034
```

```
/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)
```

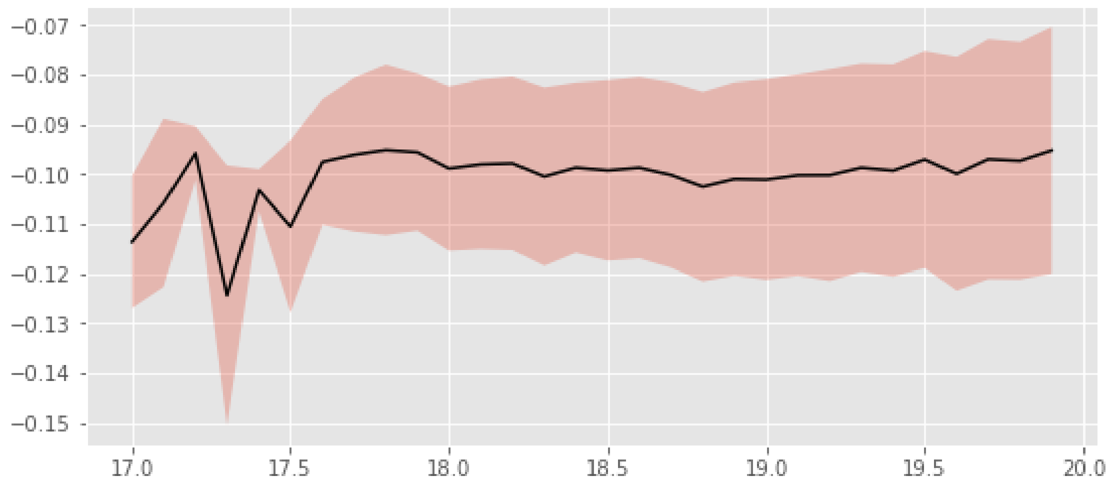
1.2.5 I.e - y band

```
/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: -0.098480224609375
Number of source used: 3877
RMS: 0.01754249850290026
```

```
/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)
```

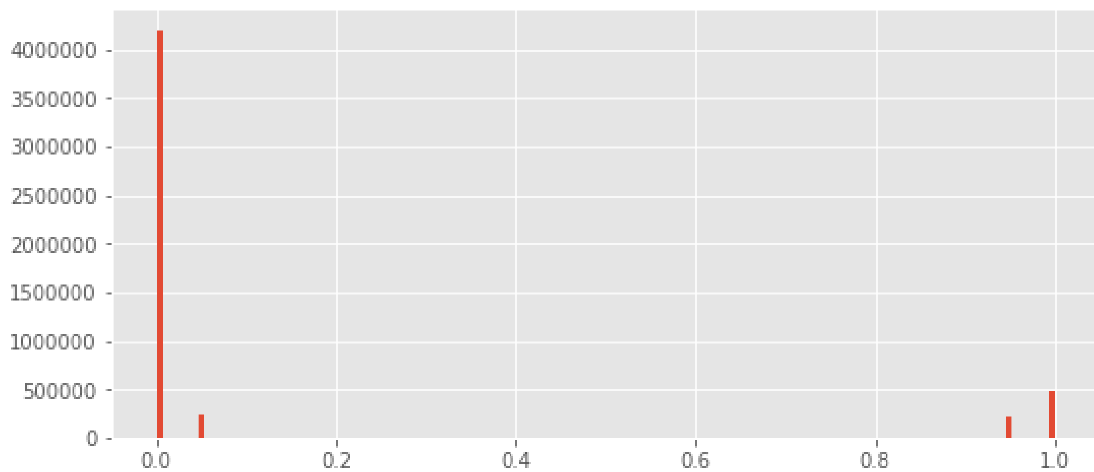
1.3 II - Stellarity

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

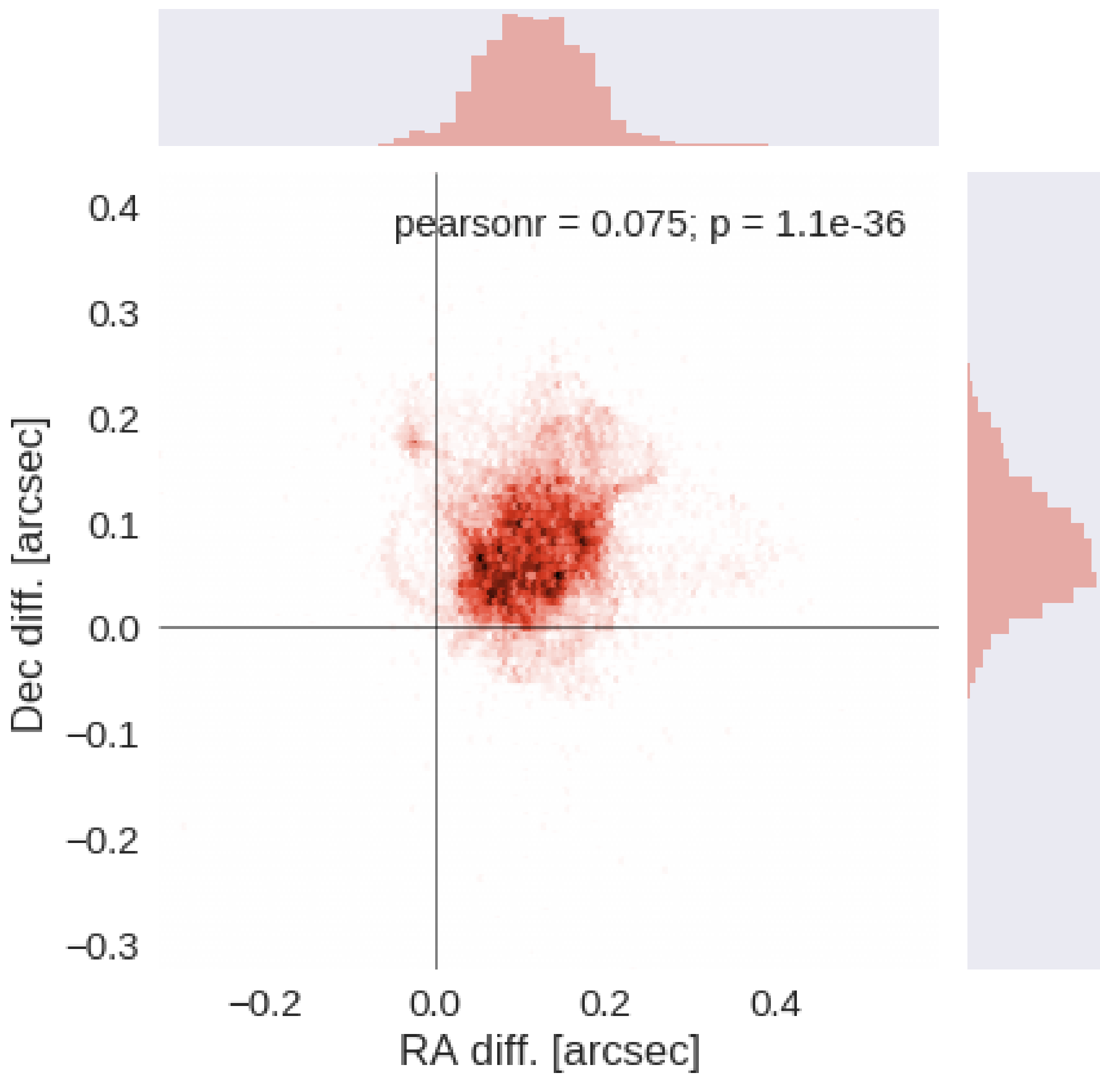
We remove duplicated objects from the input catalogues.

```
/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)

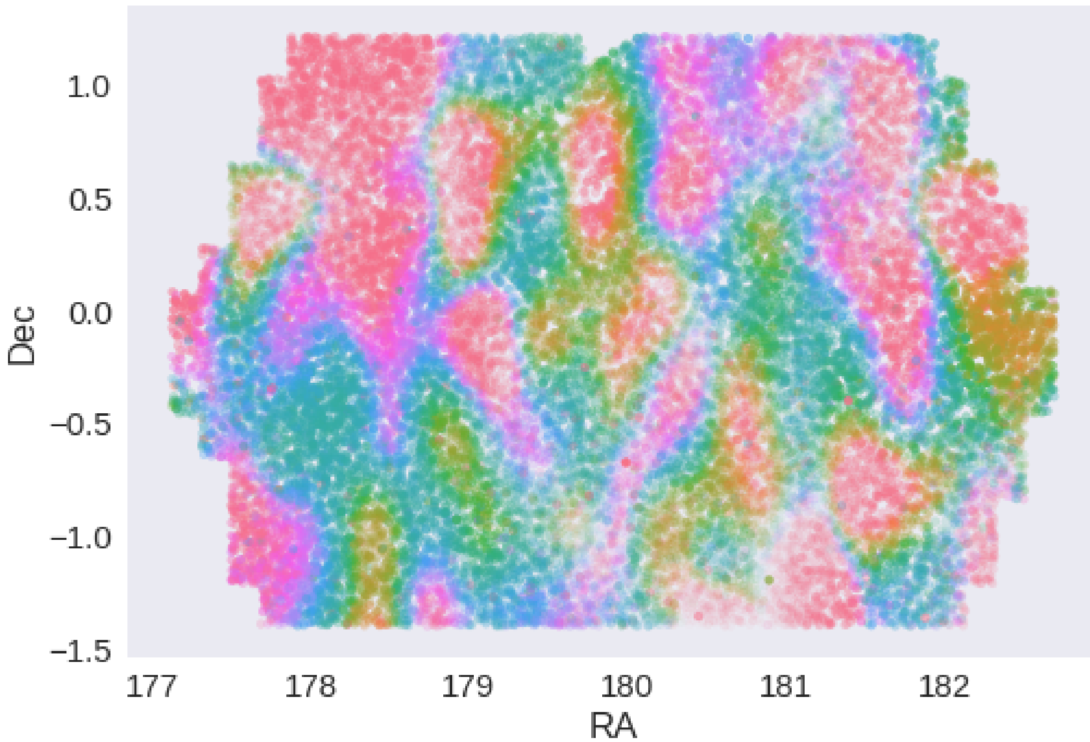

The initial catalogue had 5144451 sources.
The cleaned catalogue has 5144219 sources (232 removed).
The cleaned catalogue has 230 sources flagged as having been cleaned
```

1.6 III - Astrometry correction

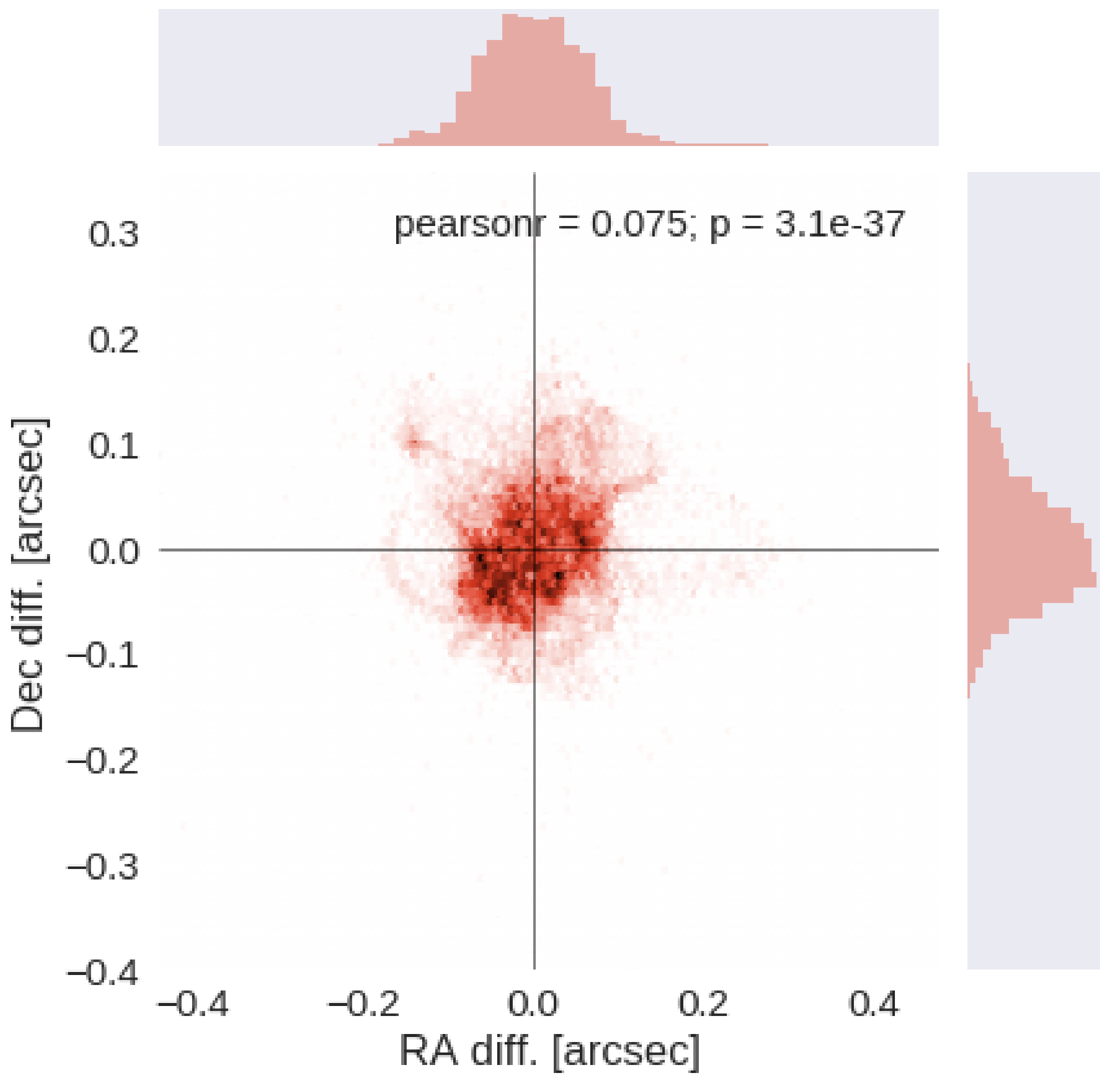
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

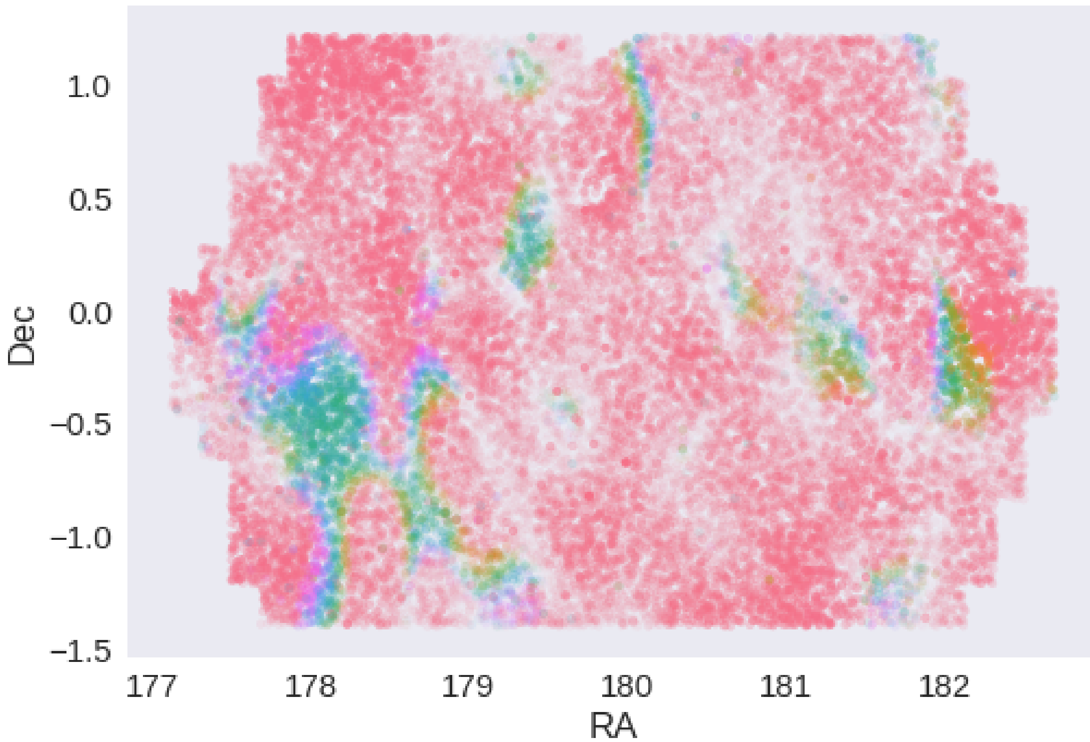


pearsonr = 0.075; p = 1.1e-36
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
Dec diff. [arcsec]
−0.2
0.0
0.2
0.4
RA diff. [arcsec]




```
RA correction: -0.1140621750266746 arcsec
Dec correction: -0.07552225386344702 arcsec
```


pearsonr = 0.075; p = 3.1e-37
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
RA diff. [arcsec]



1.7 IV - Flagging Gaia objects

```
31250 sources flagged.
```

1.8 V - Flagging objects near bright stars

2 VI - Saving to disk

1.3_KIDS

March 8, 2018

1 GAMA-12 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

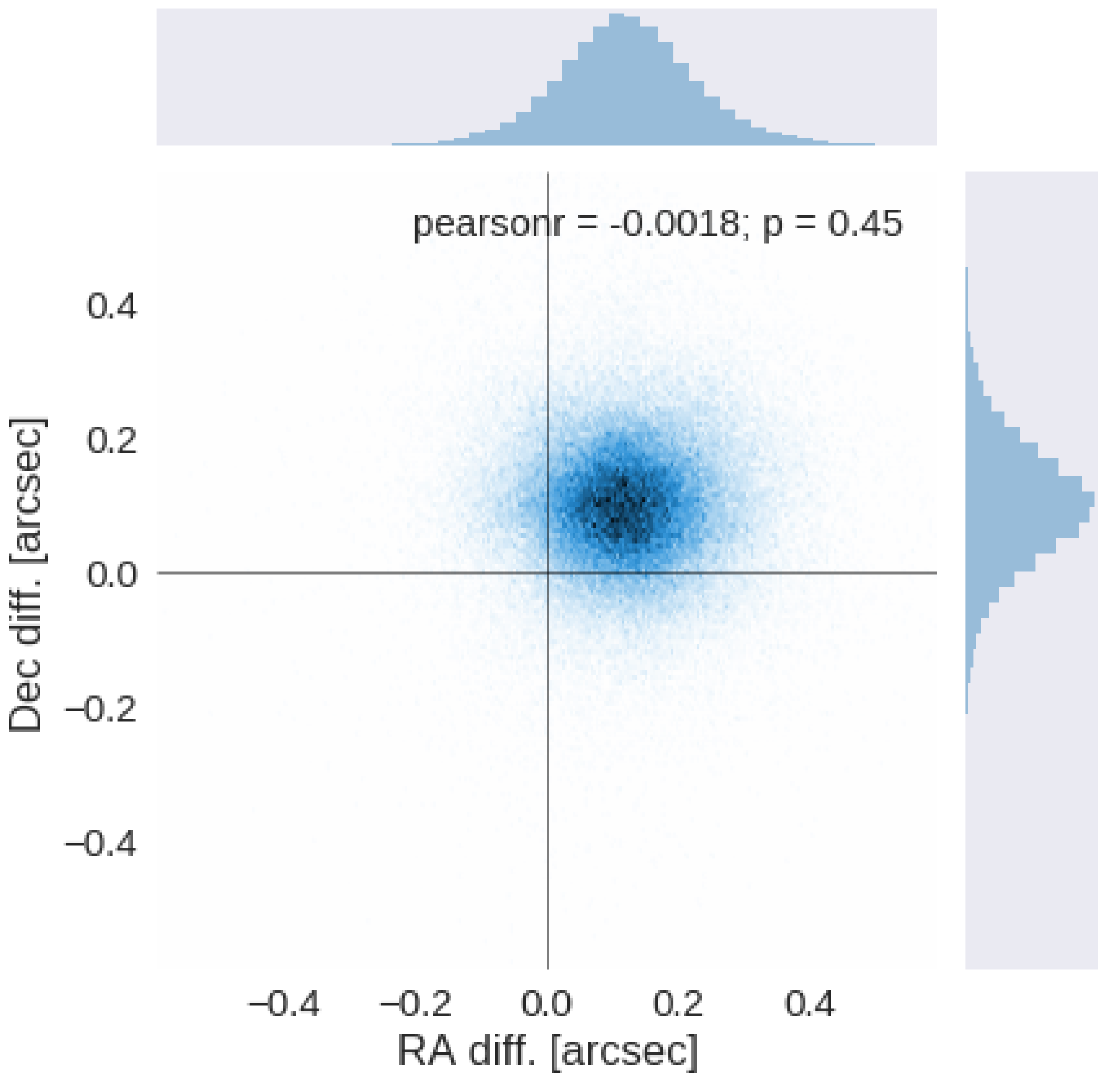
We remove duplicated objects from the input catalogues.

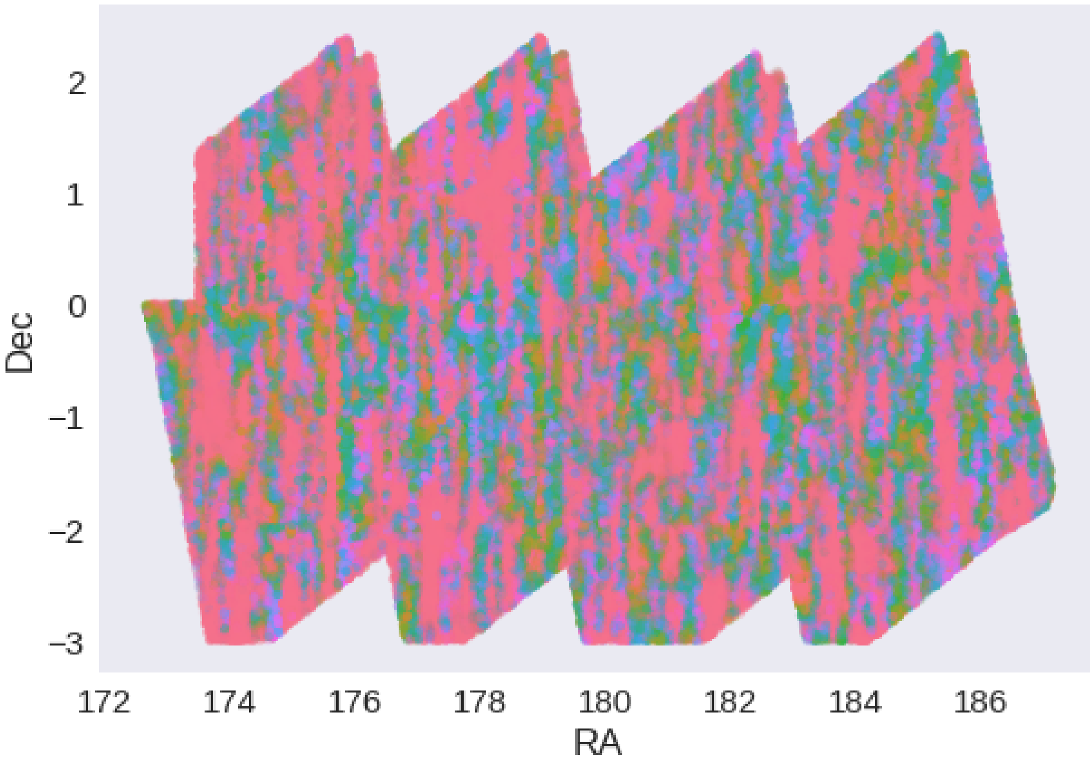
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 6582267 sources.
The cleaned catalogue has 6582157 sources (110 removed).
The cleaned catalogue has 110 sources flagged as having been cleaned
```

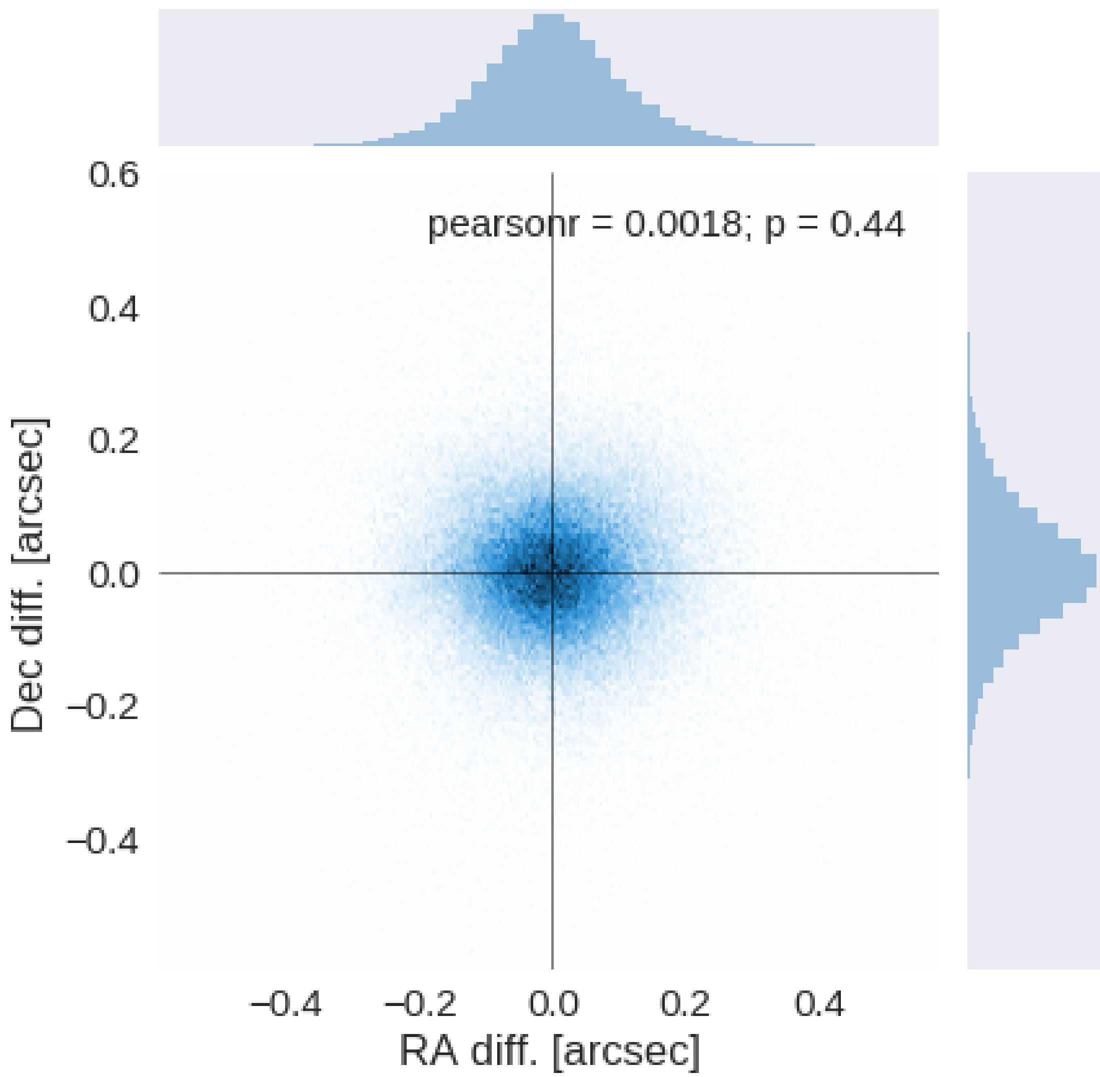
1.4 III - Astrometry correction

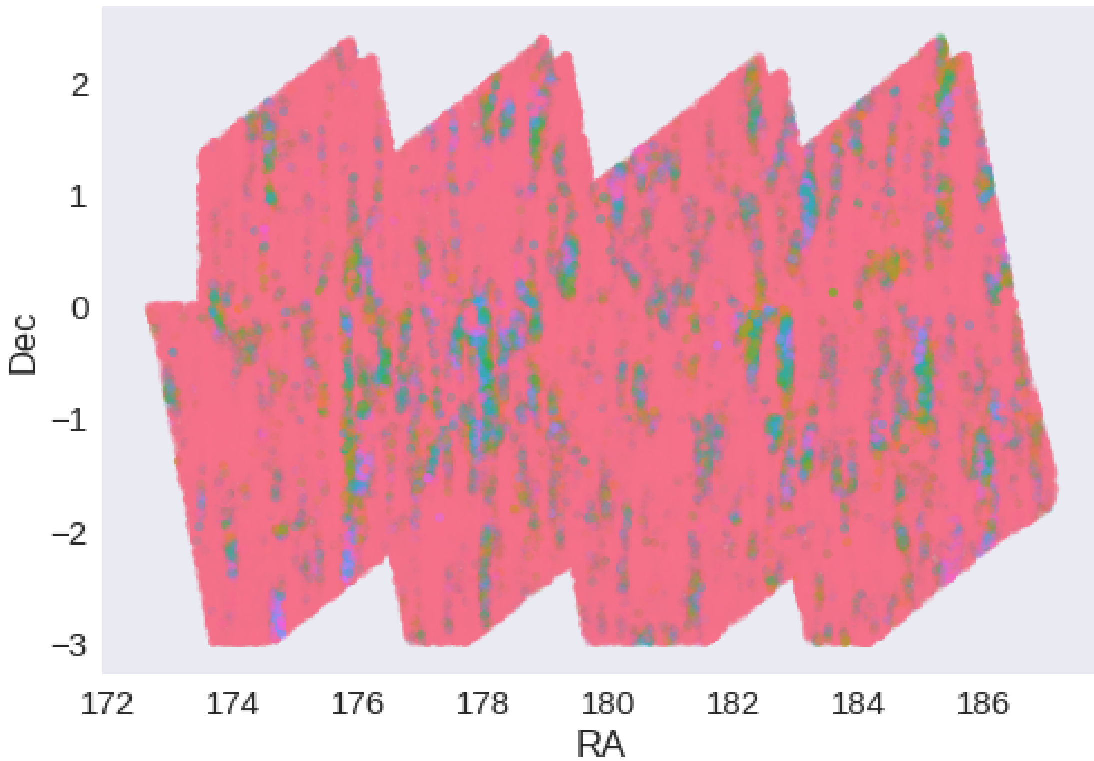
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.12011726085461305 arcsec
Dec correction: -0.10001507929536801 arcsec
```


pearsonr = 0.0018; p = 0.44
0.6
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]



1.5 IV - Flagging Gaia objects

```
196511 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.4_PanSTARRS

March 8, 2018

1 GAMA-12 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' above means we take the forced photometry from positions in the chi-squared image. We are alos using an updated catalogue which has significantly fewer duplicates.

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

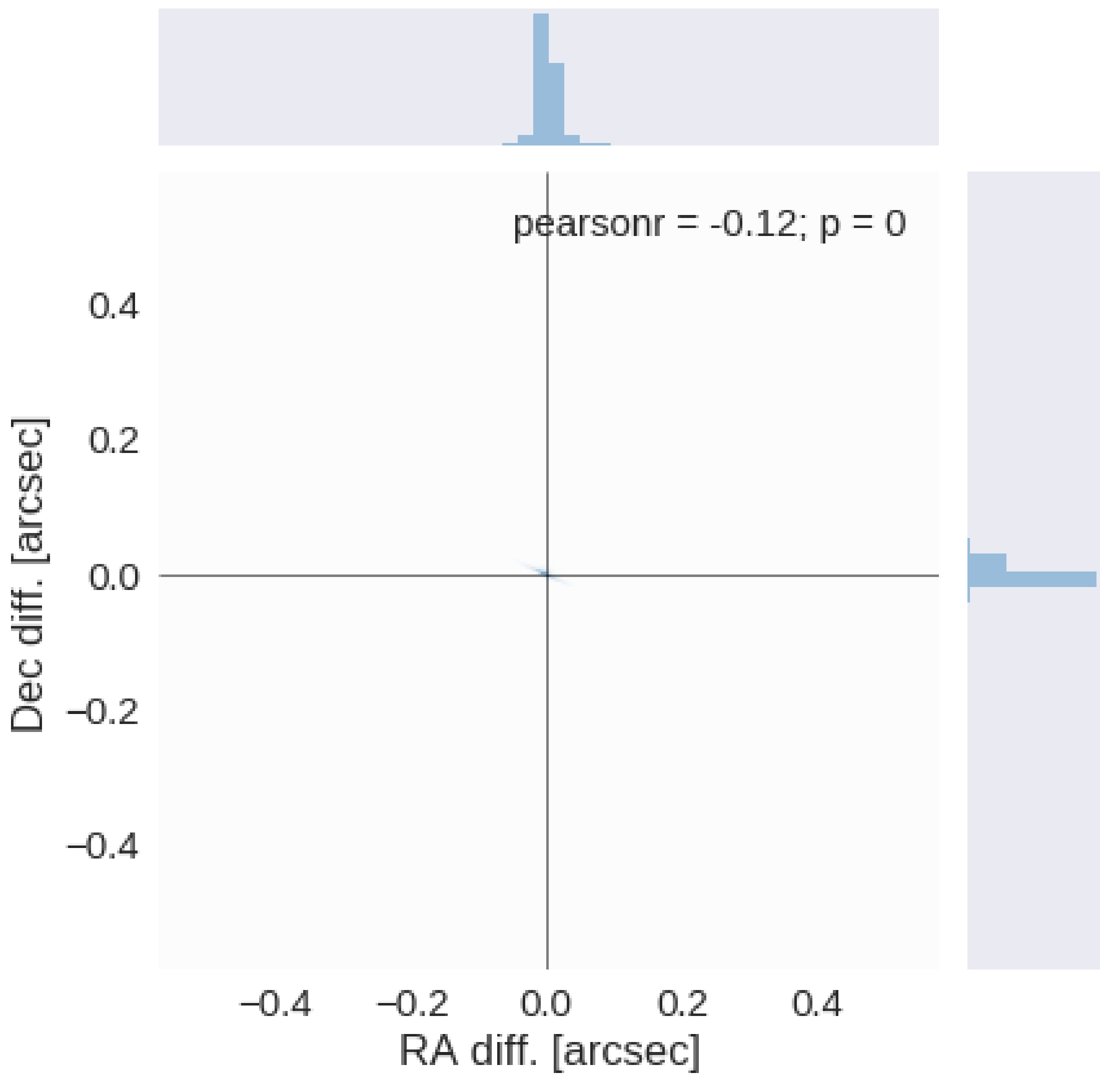
We remove duplicated objects from the input catalogues.

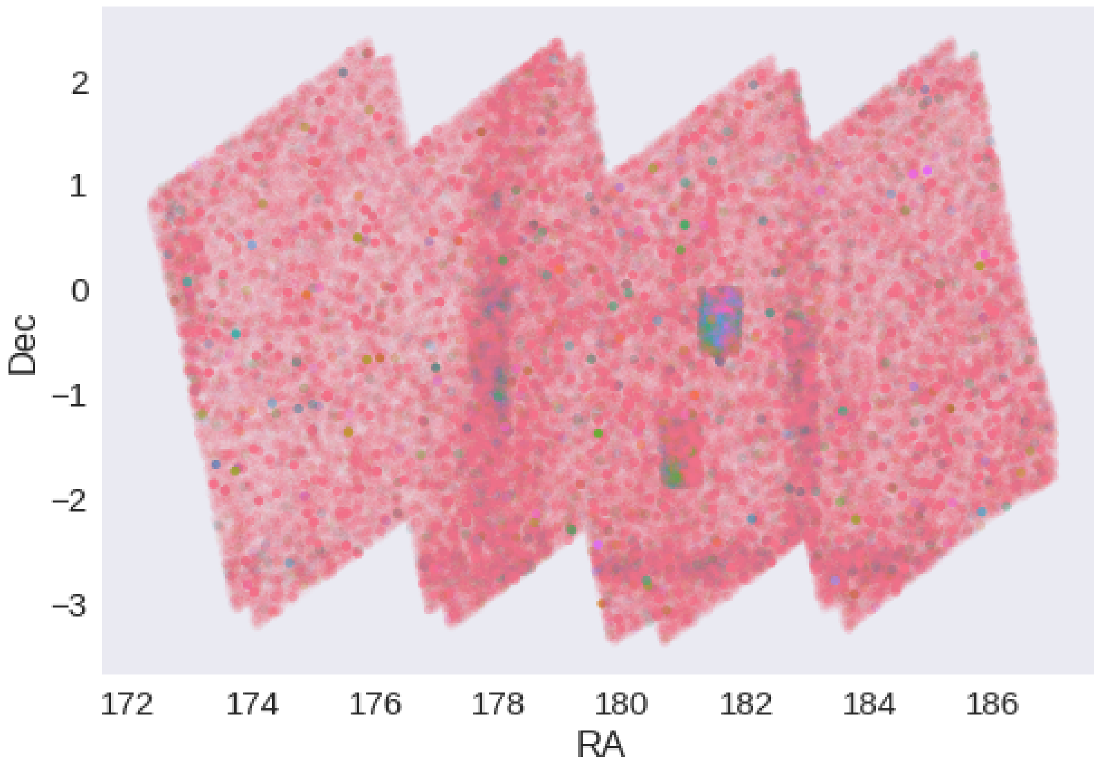
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 1281409 sources.
The cleaned catalogue has 1280946 sources (463 removed).
The cleaned catalogue has 463 sources flagged as having been cleaned
```

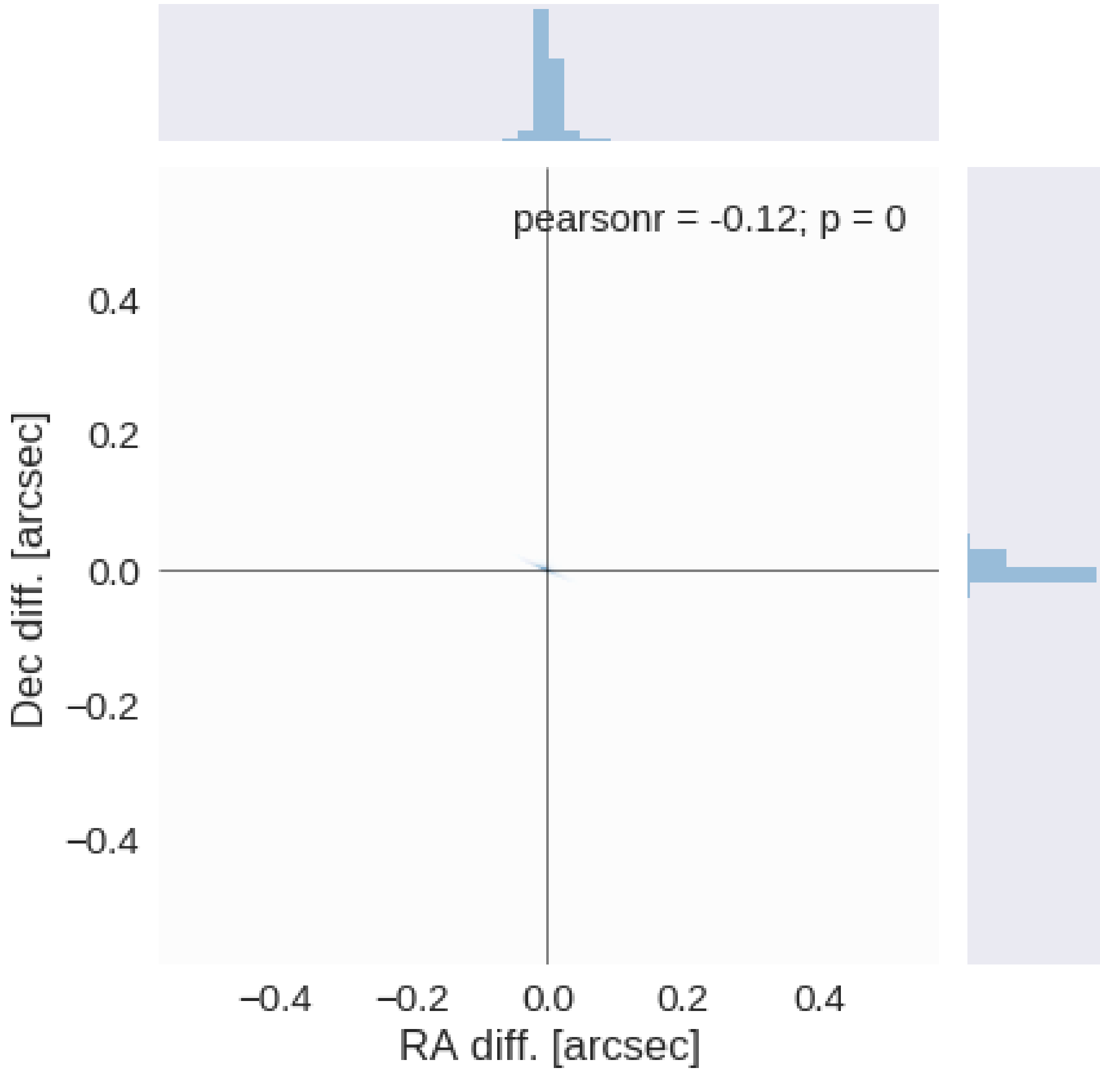
1.4 III - Astrometry correction

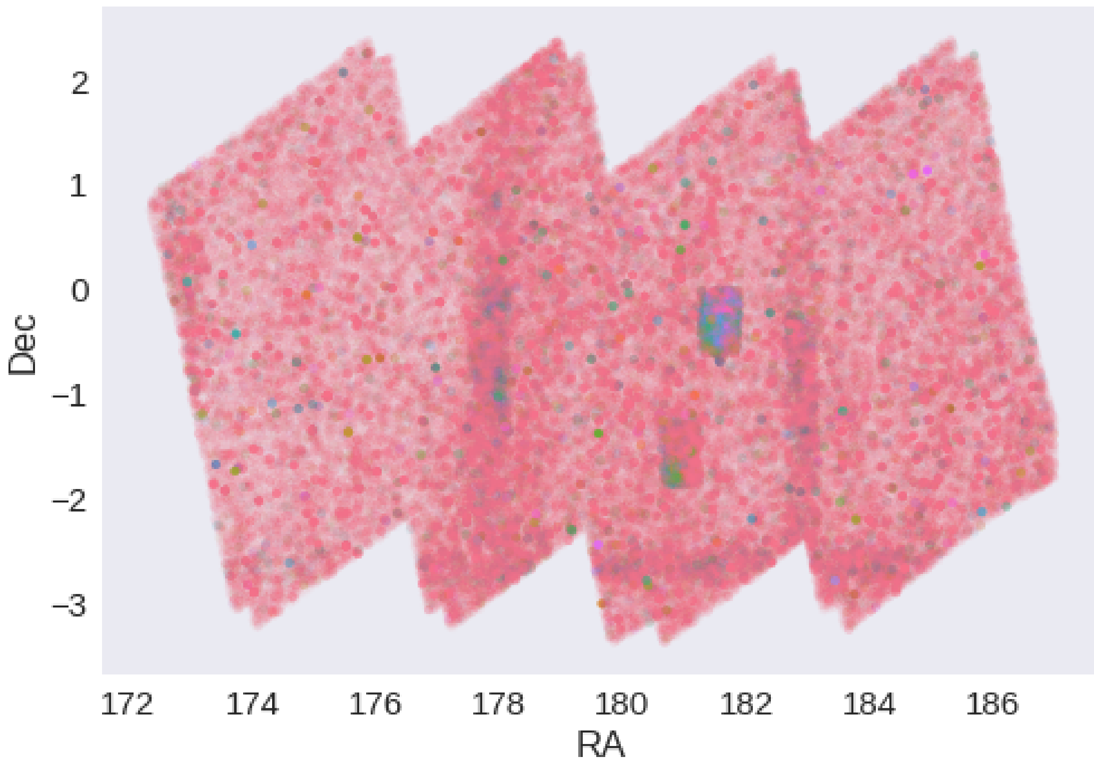
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.001237971645196012 arcsec
Dec correction: -0.0002818848545582675 arcsec
```


pearsonr = -0.12; p = 0
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]



1.5 IV - Flagging Gaia objects

```
193622 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.5_UKIDSS-LAS

March 8, 2018

1 GAMA-12 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

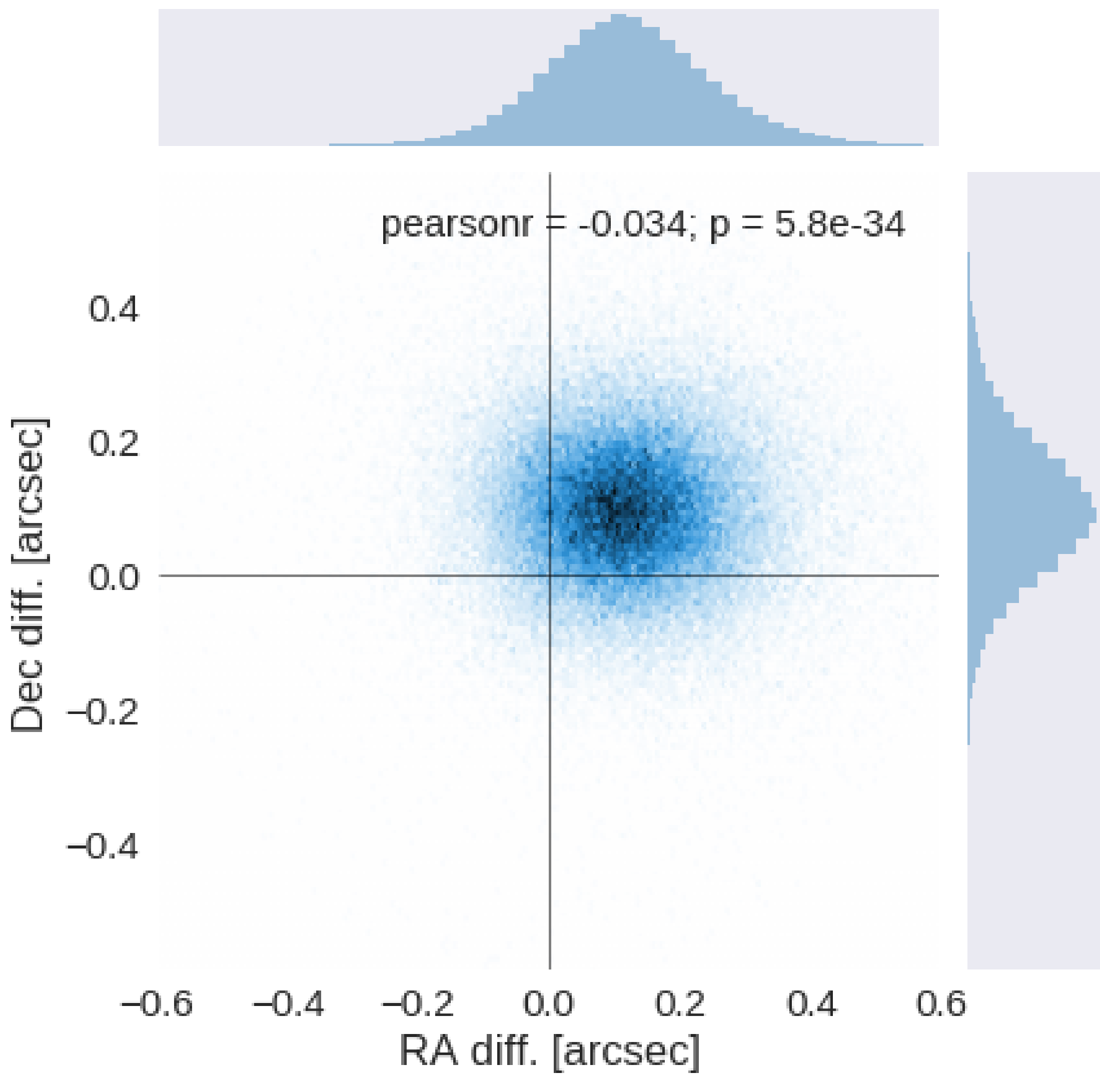
We remove duplicated objects from the input catalogues.

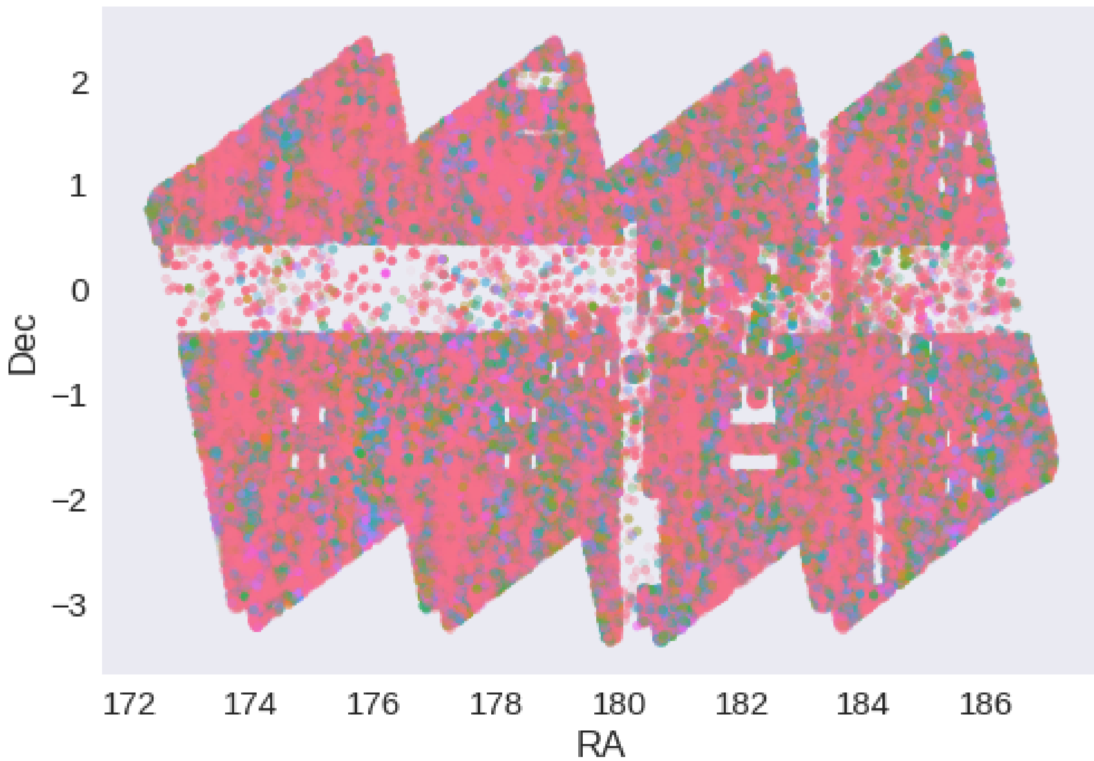
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)


The initial catalogue had 949148 sources.
The cleaned catalogue has 948556 sources (592 removed).
The cleaned catalogue has 589 sources flagged as having been cleaned
```

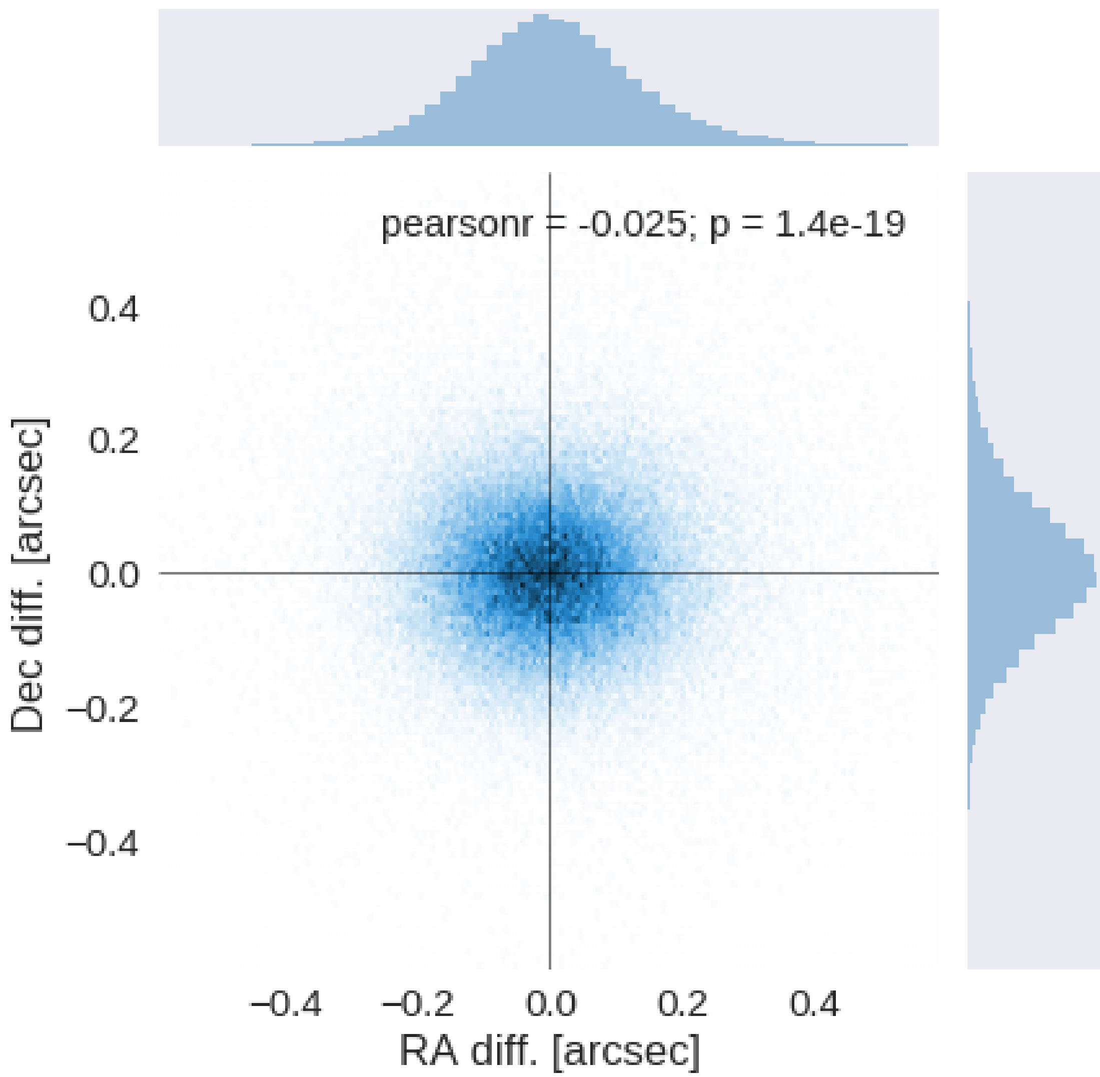
1.4 III - Astrometry correction

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.

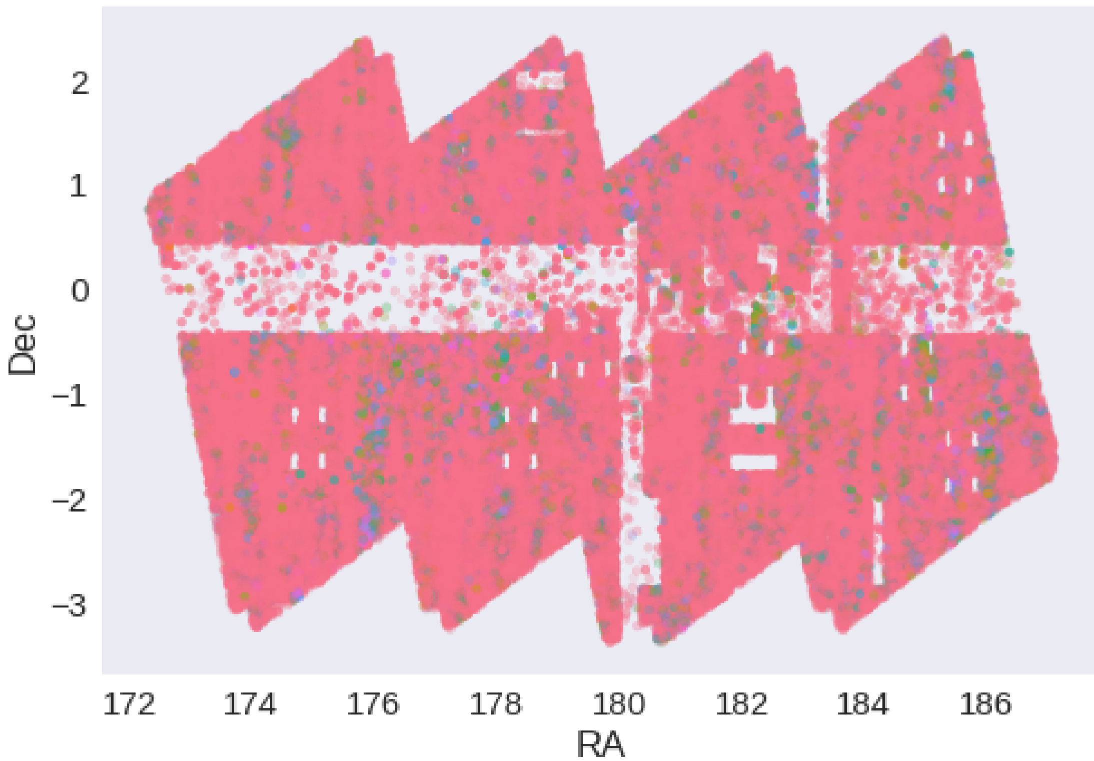

pearsonr = -0.034; p = 5.8e-34
0.4
0.2
0.0
−0.2
−0.4
Dec diff. [arcsec]
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
RA diff. [arcsec]




```
RA correction: -0.11539355086824798 arcsec
Dec correction: -0.09543808613279303 arcsec
```



pearsonr = -0.025; p = 1.4e-19
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]



1.5 IV - Flagging Gaia objects

```
135410 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.6_VISTA-VIKING

March 8, 2018

1 GAMA-12 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

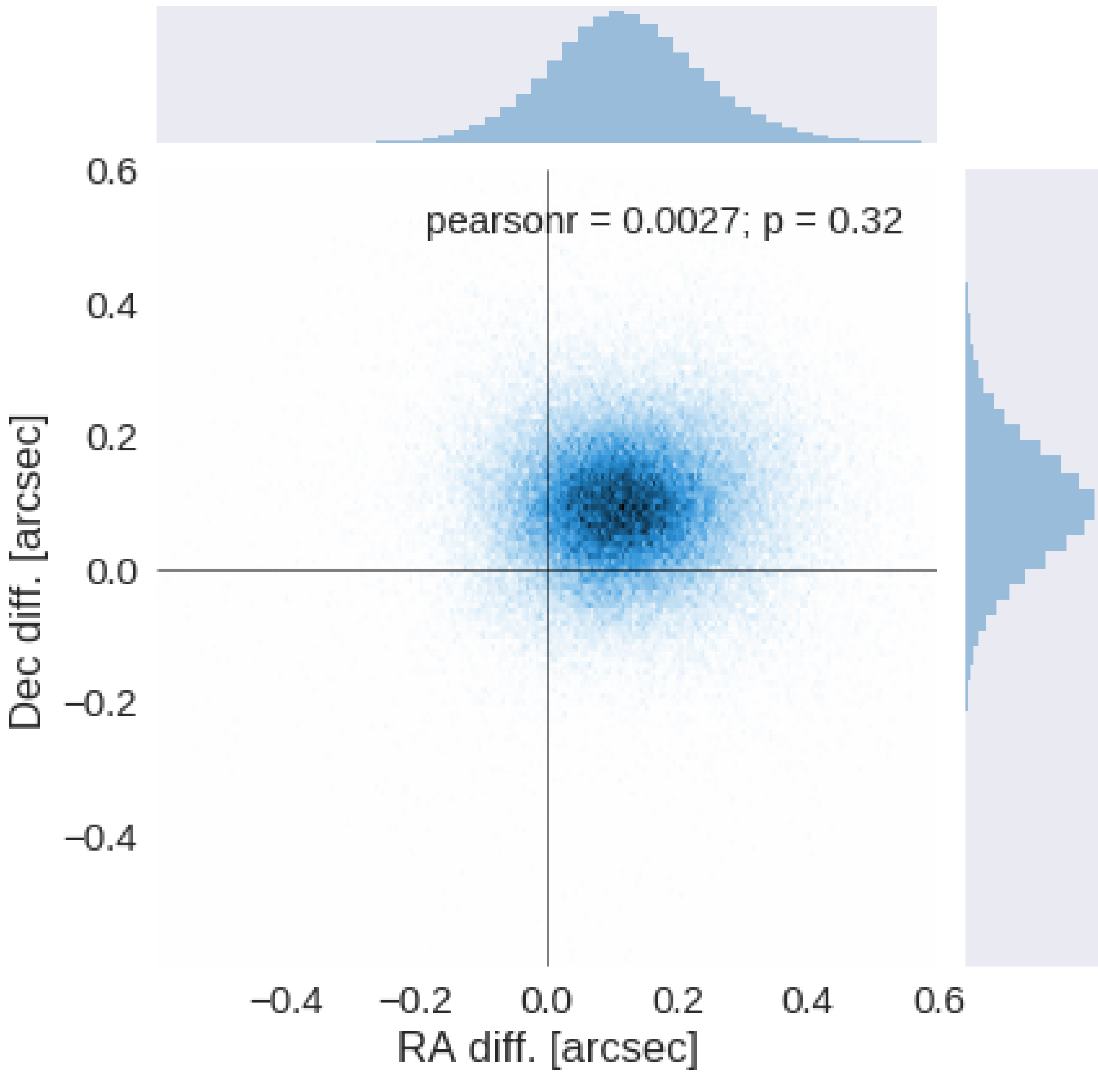
We remove duplicated objects from the input catalogues.

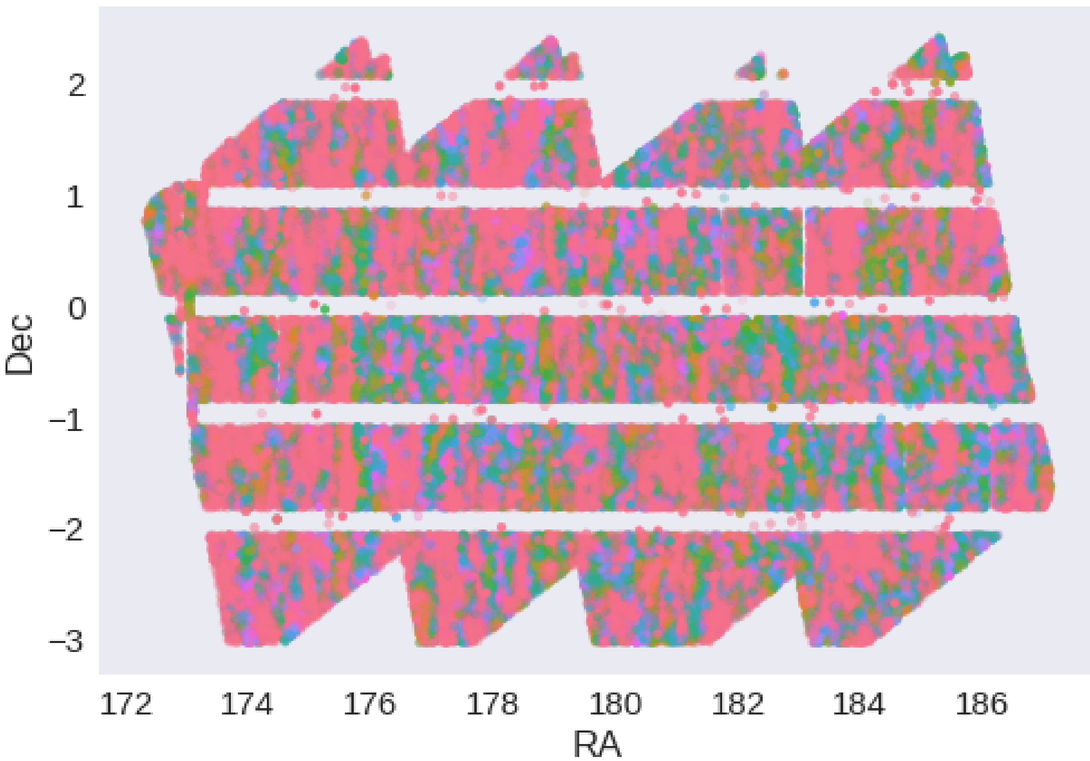
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 3045586 sources.
The cleaned catalogue has 3045013 sources (573 removed).
The cleaned catalogue has 572 sources flagged as having been cleaned
```

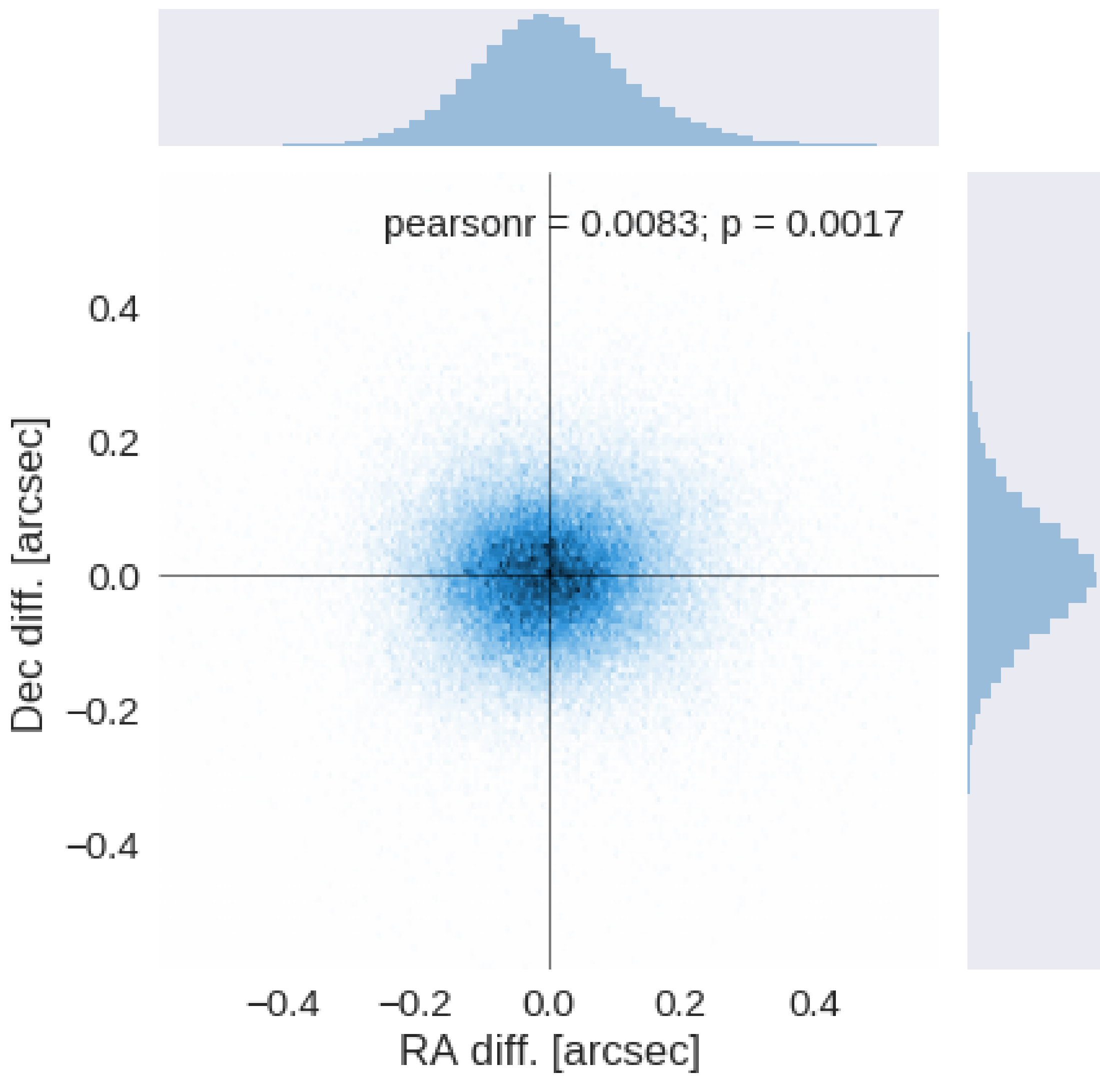
1.4 III - Astrometry correction

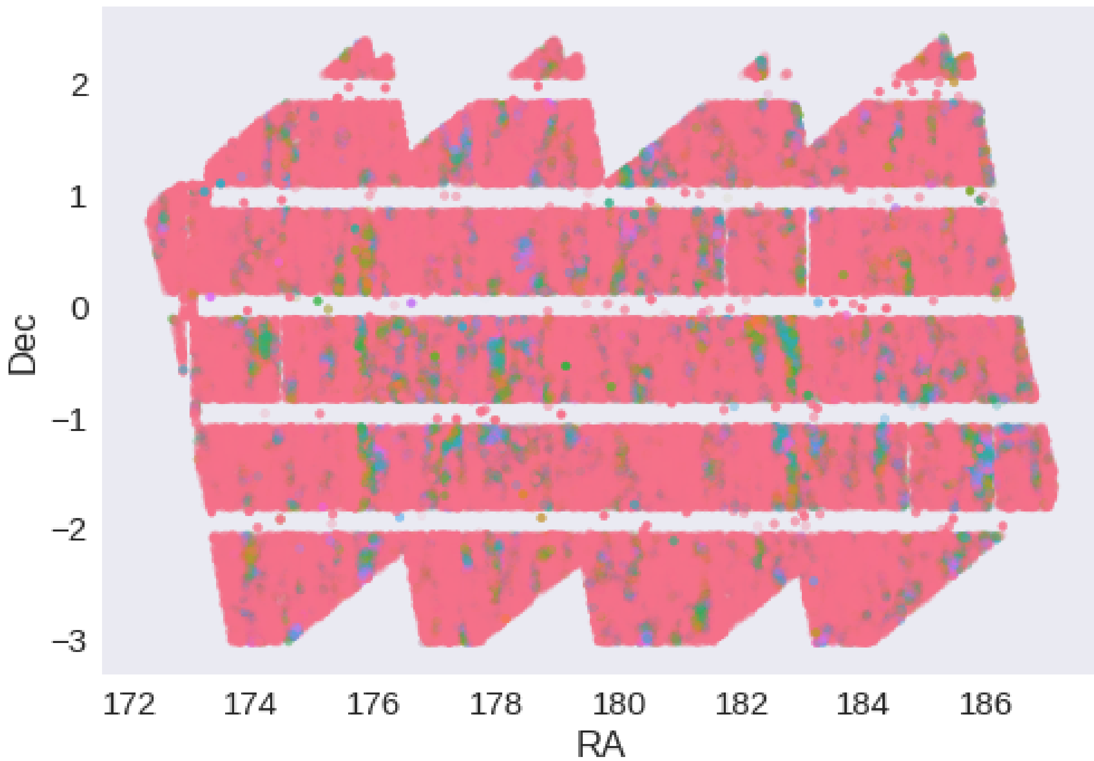
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.11862931214636774 arcsec
Dec correction: -0.09424492095163606 arcsec
```


pearsonr = 0.0083; p = 0.0017
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]



1.5 IV - Flagging Gaia objects

```
145807 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

2_Merging

March 8, 2018

1 GAMA-12 master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-12.

```
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 16:05:40.334315
```

1.1 I - Reading the prepared pristine catalogues

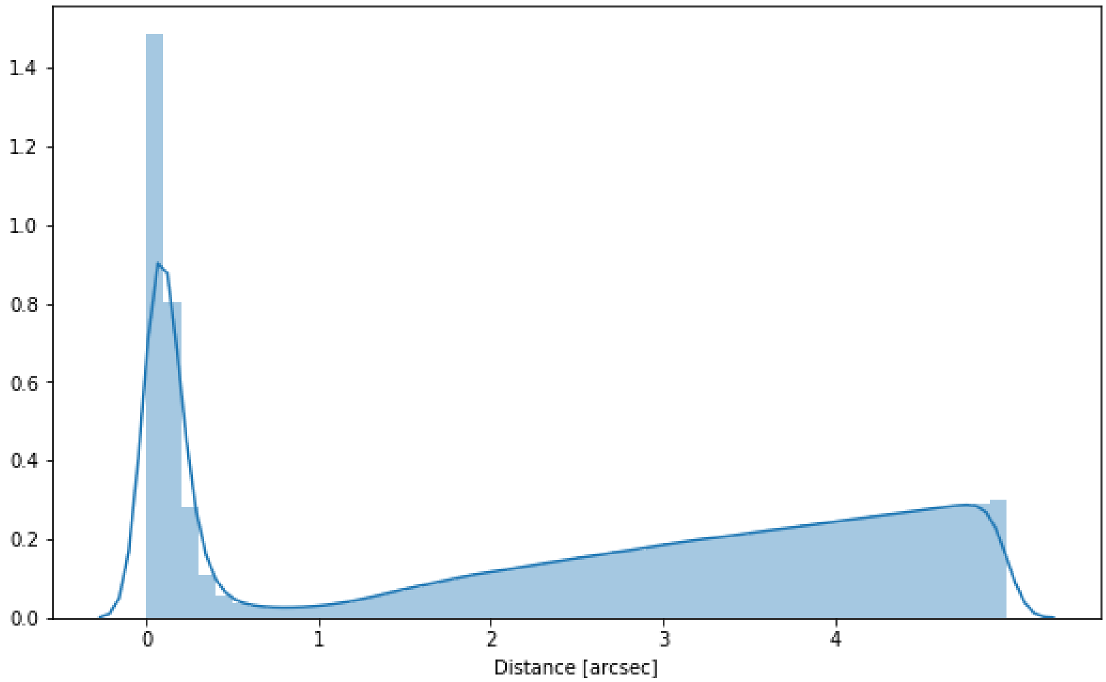
1.2 II - Merging tables

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

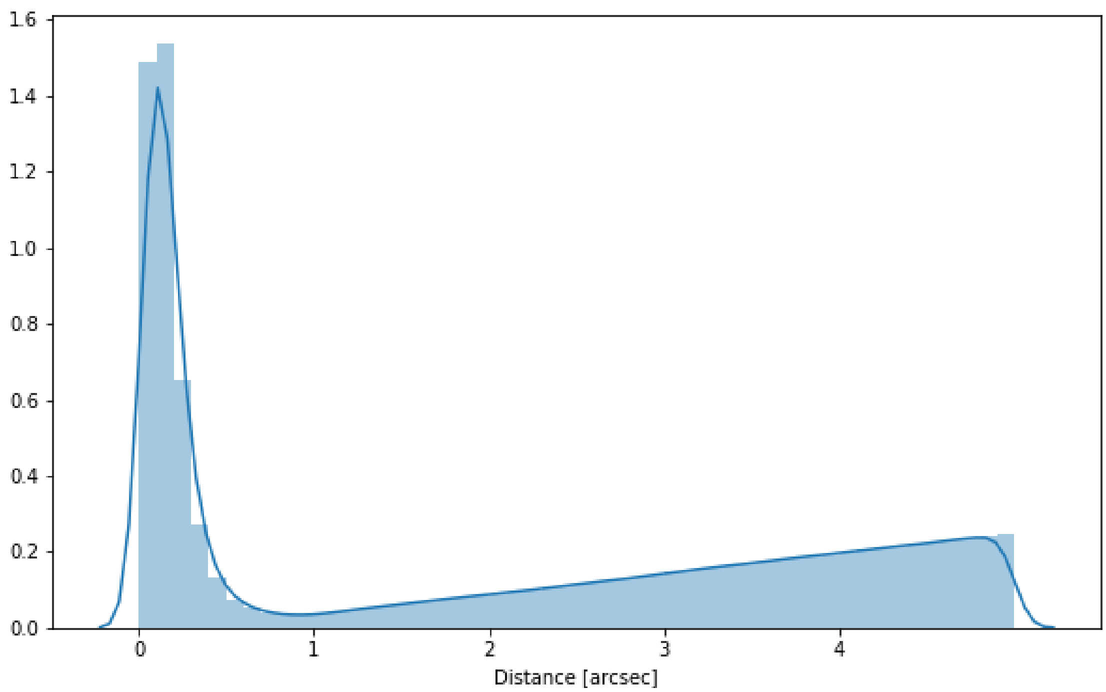
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 DECaLS

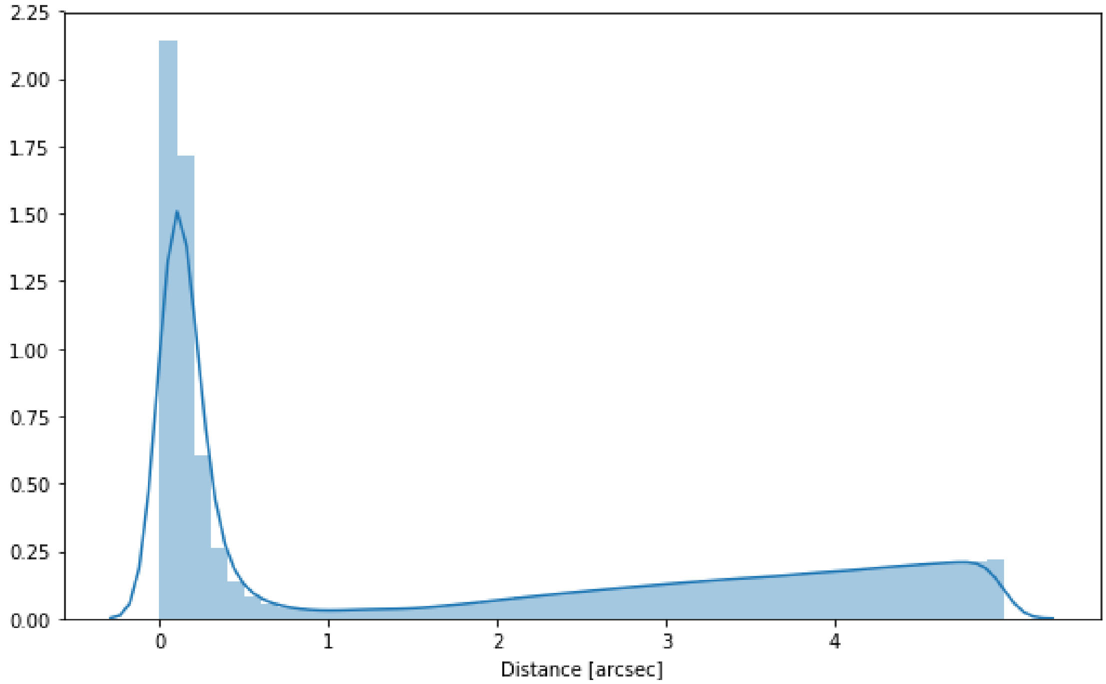
1.2.2 Add HSC-PSS



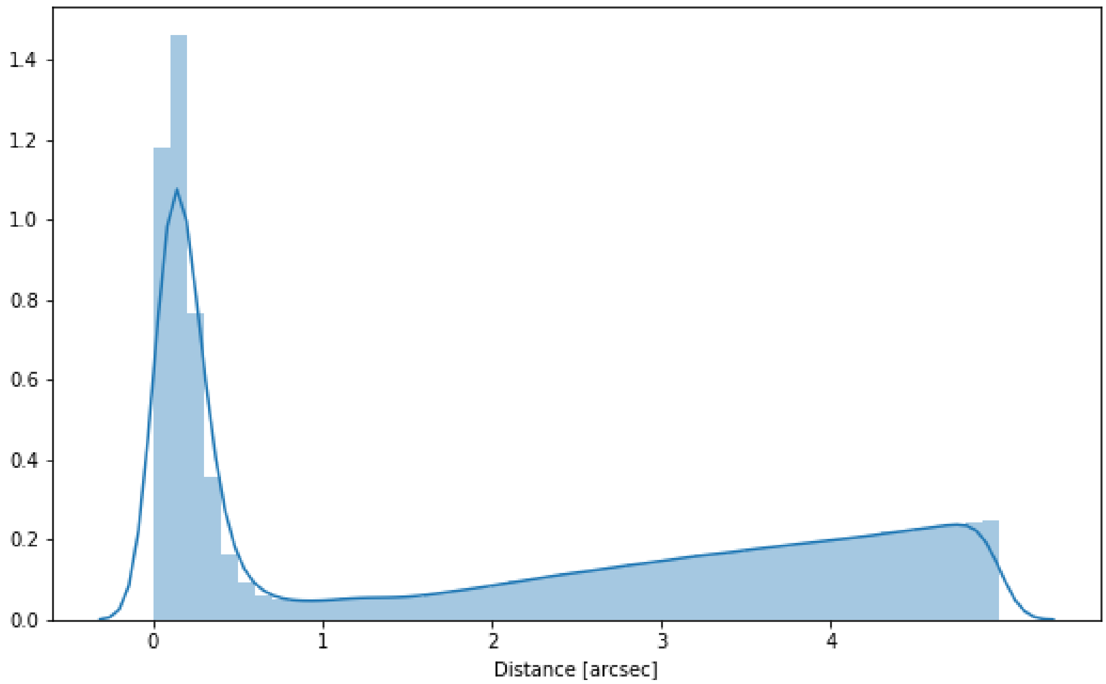
1.2.3 Add KIDS



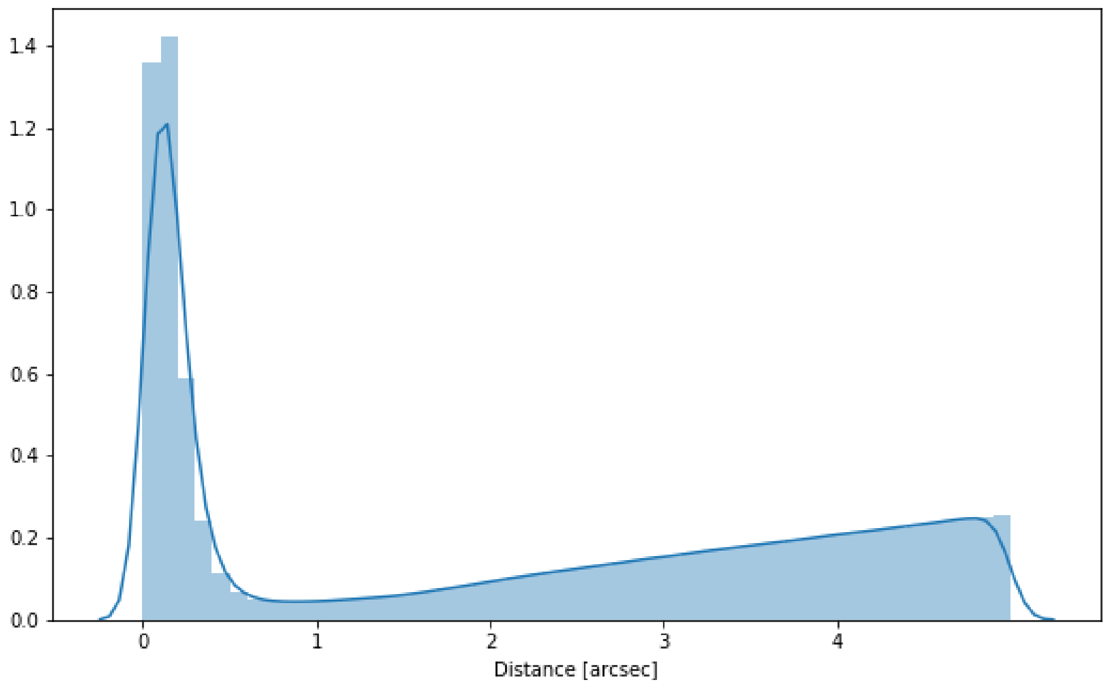
1.2.4 Add PanSTARRS



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
```

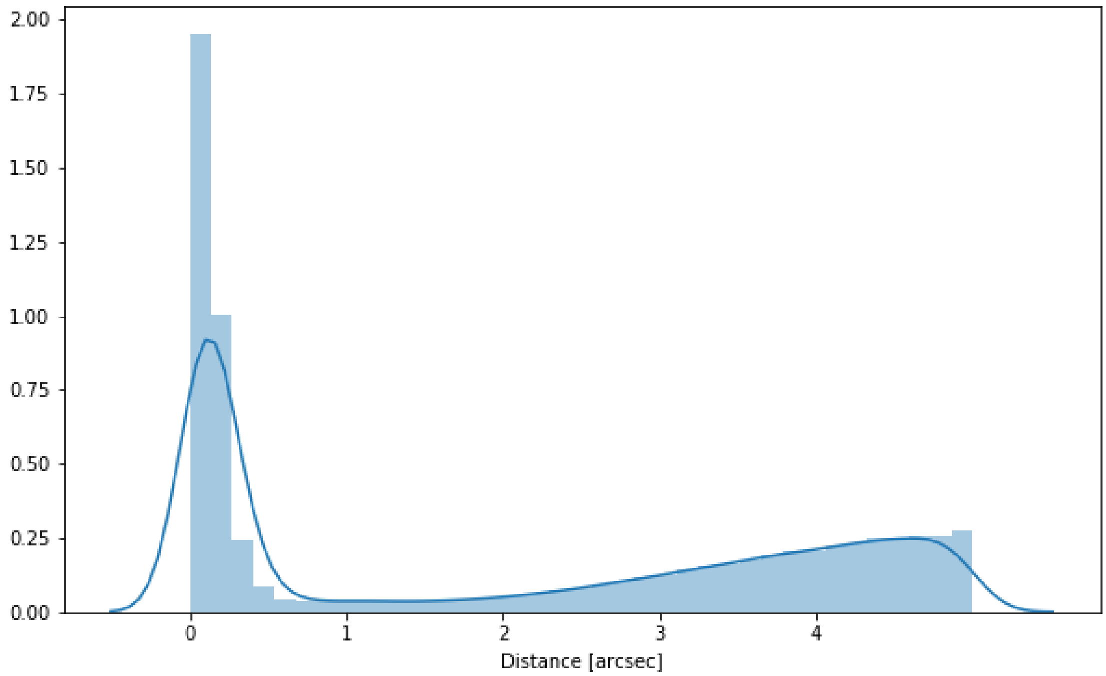
1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

```
OK!
```

1.6 VI - Cross-matching with spec-z catalogue

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



1.7 VII - Choosing between multiple values for the same filter

In GAMA-12 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.

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

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

```
['decals_id', 'hsc_id', 'kids_id', 'ps1_id', 'las_id', 'viking_id', 'help_id', 'specz_id', 'sdss
```

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

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

```
Diagnostics done using: master_catalogue_gama-12_20180218.fits
```

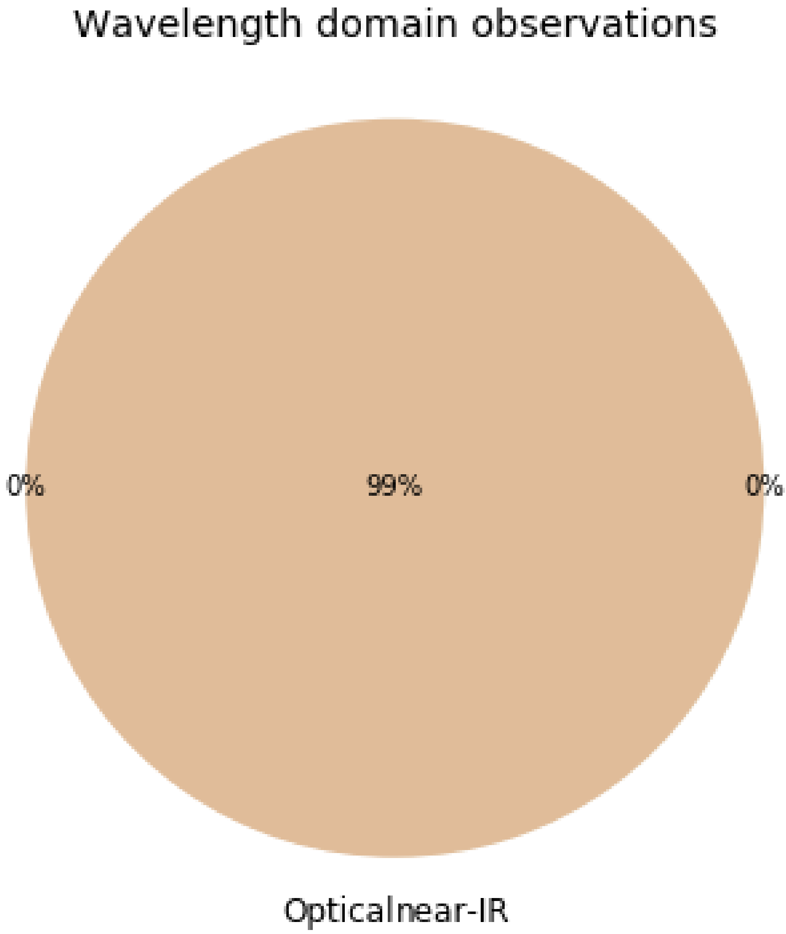
0.1 0 - Quick checks

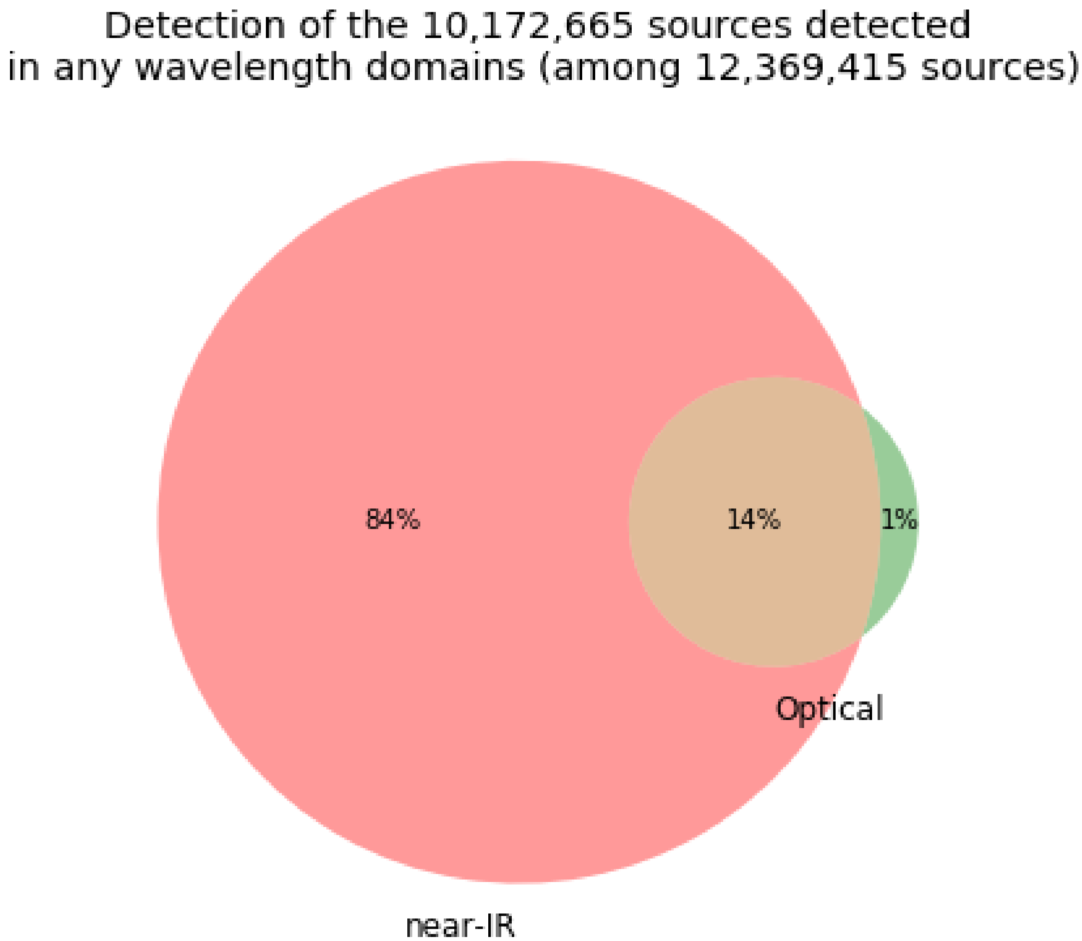
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype),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

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

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

0.2 I - Summary of wavelength domains





0.3 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.

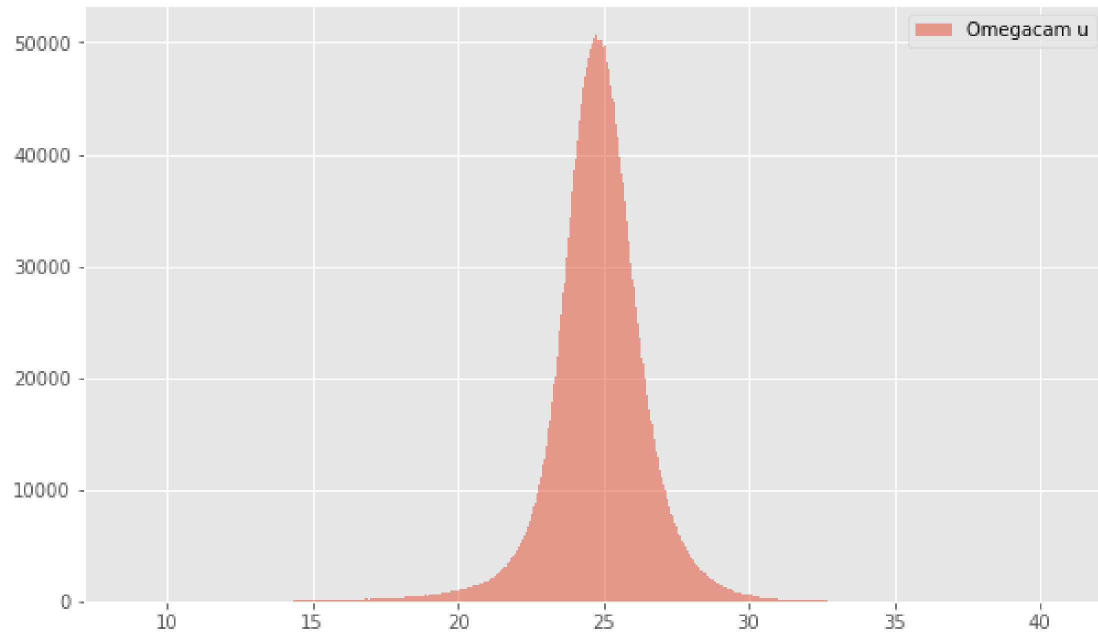
```
DECam g max: 39.3524
Omegacam g max: 43.5271
SUPRIME g max: nan
GPC1 g max: 34.7890014648


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

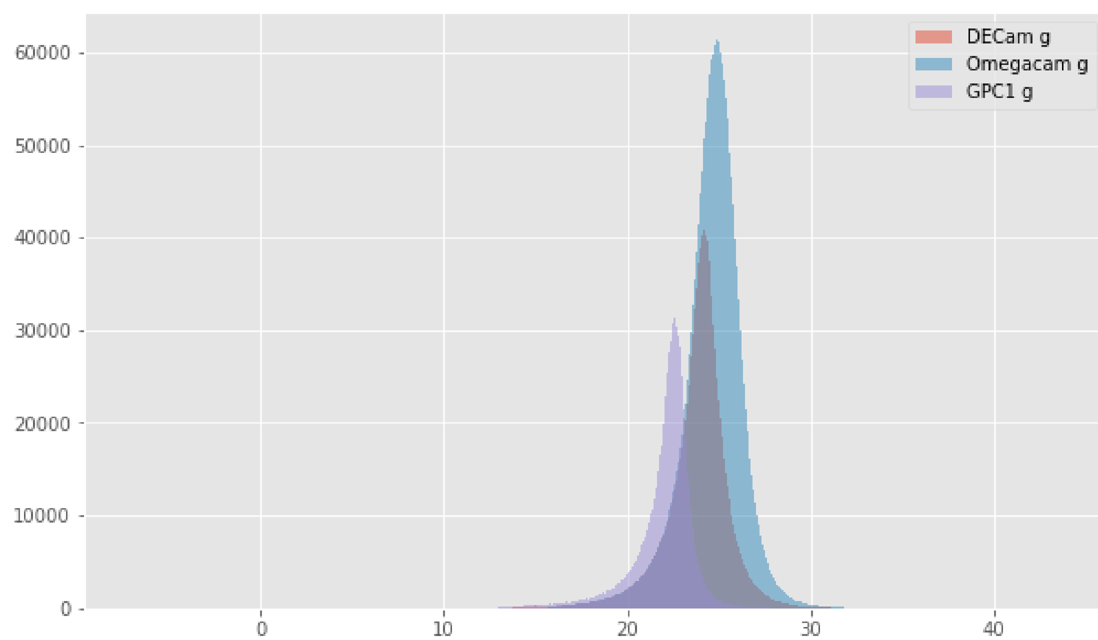
The Suprime g magnitudes are very wrong. They are almost all between 0 and 1.

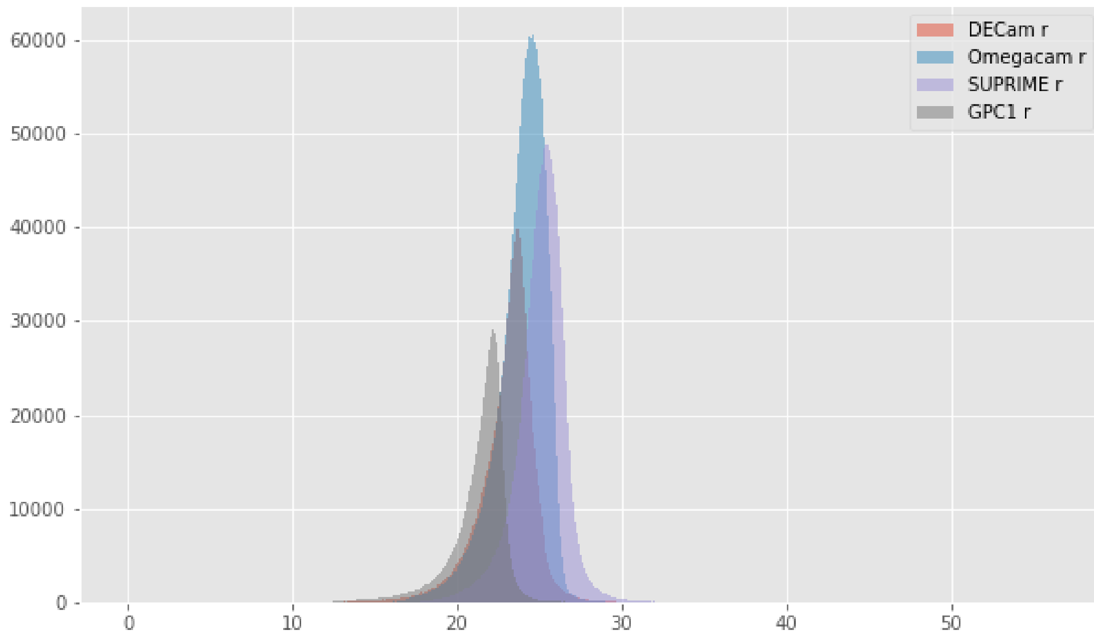
0.3.1 II.a - Comparing depths

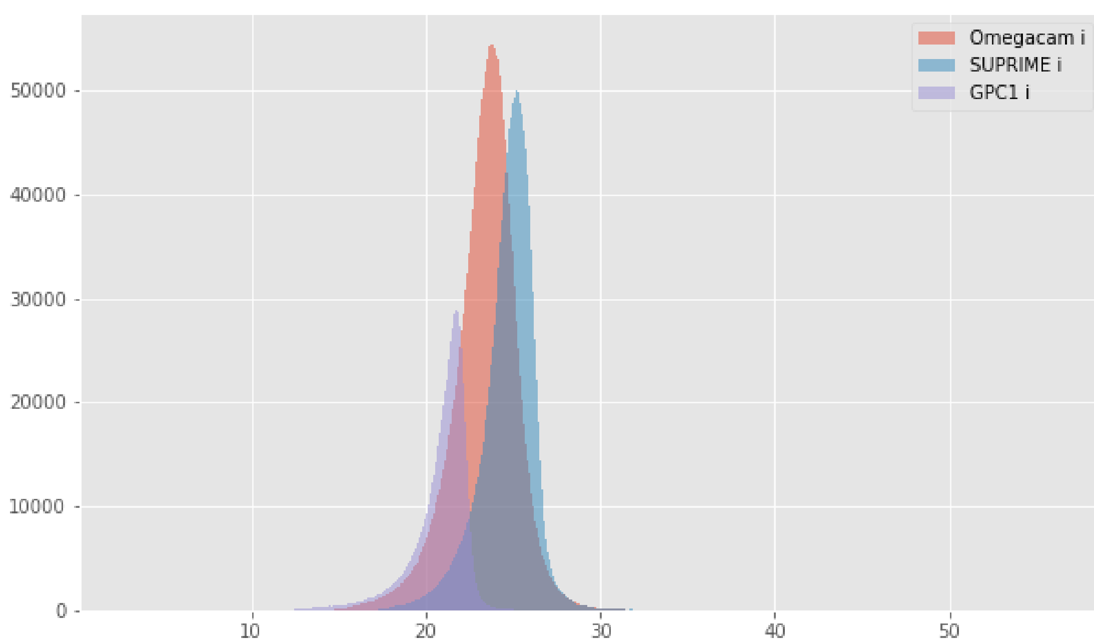
We compare the histograms of the total aperture magnitudes of similar bands.

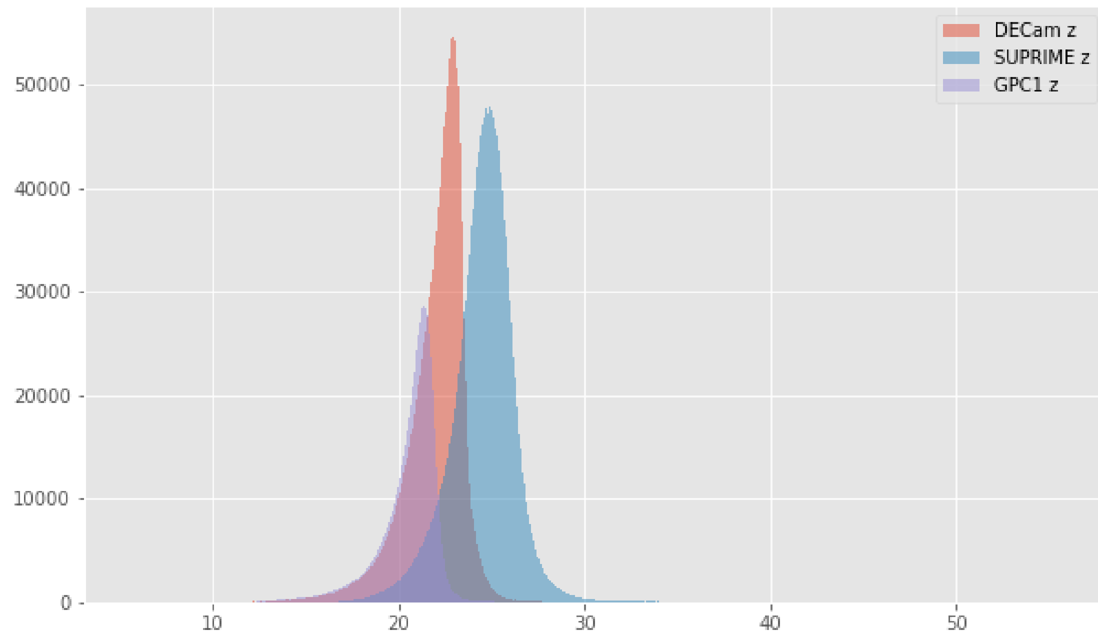


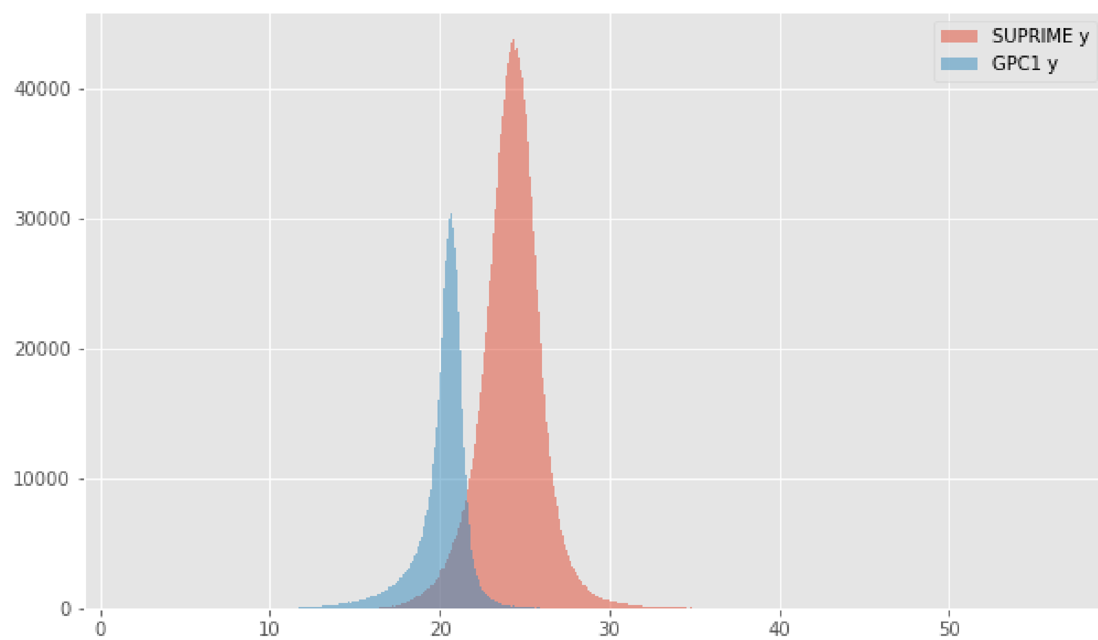

```
HELP warning: the column m_suprime_g (SUPRIME g) is empty.
```




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


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

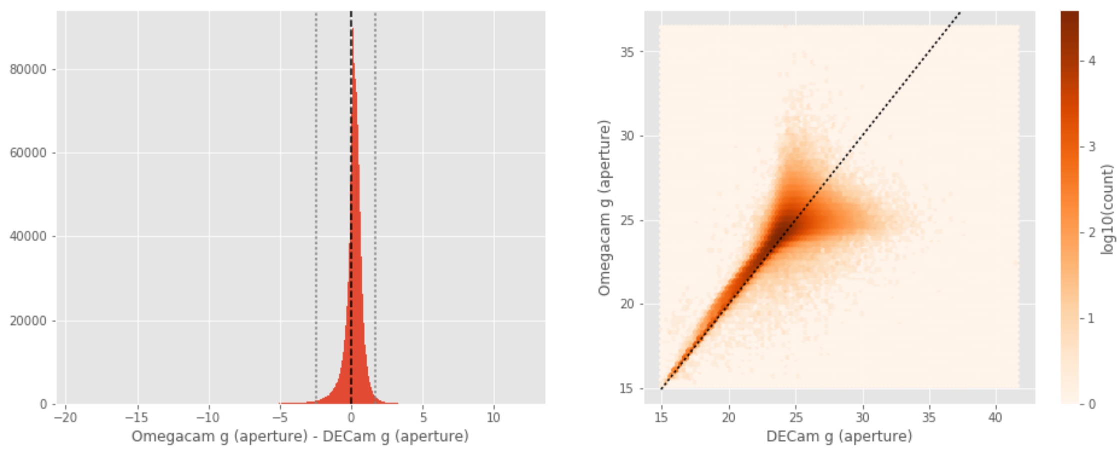




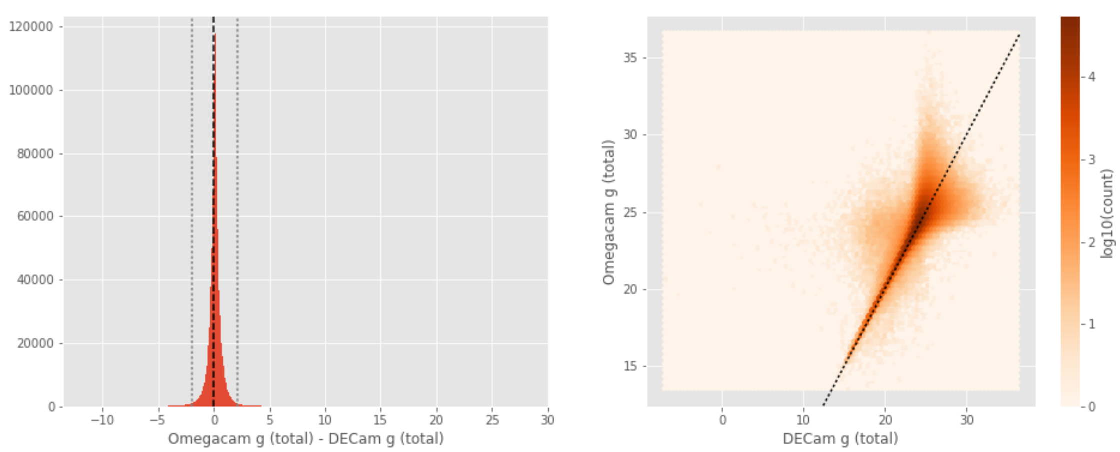
0.3.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

```
Omegacam g (aperture) - DECam g (aperture):
- Median: 0.24
- Median Absolute Deviation: 0.28
- 1% percentile: -2.421456756591797
- 99% percentile: 1.7177793884277346
```

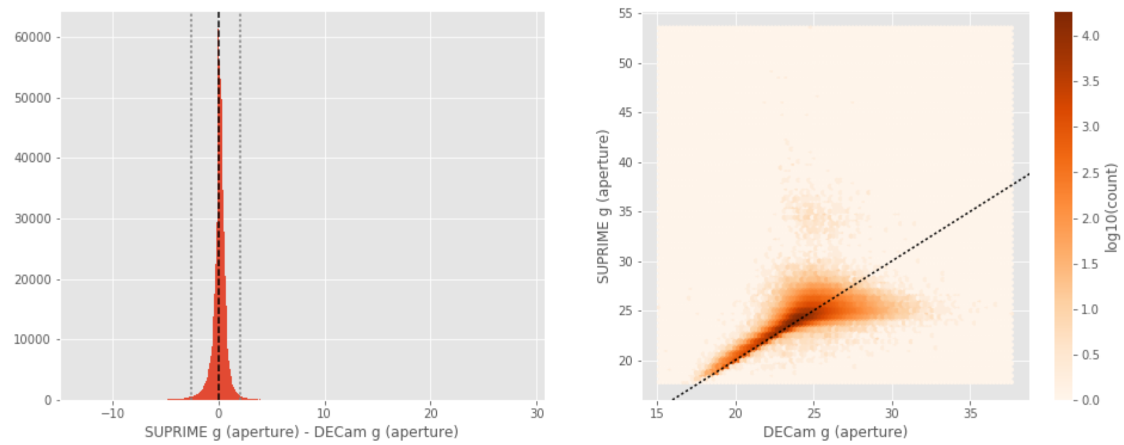



```
Omegacam g (total) - DECam g (total):
- Median: 0.12
- Median Absolute Deviation: 0.24
- 1% percentile: -1.9983771514892579
- 99% percentile: 2.143661956787107
```

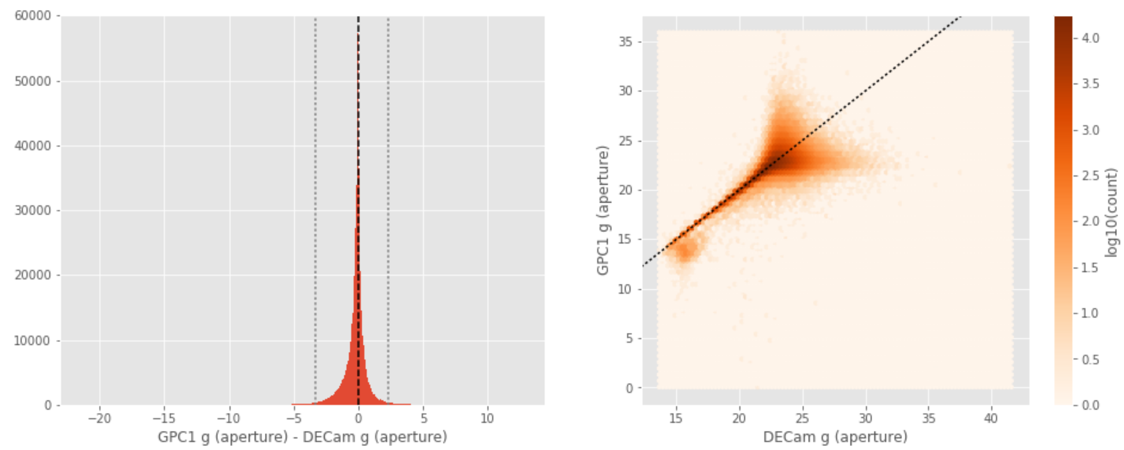



```
SUPRIME g (aperture) - DECam g (aperture):
- Median: 0.11
```

- Median Absolute Deviation: 0.28
- 1% percentile: -2.5734726333618165
- 99% percentile: 1.9980712890625032

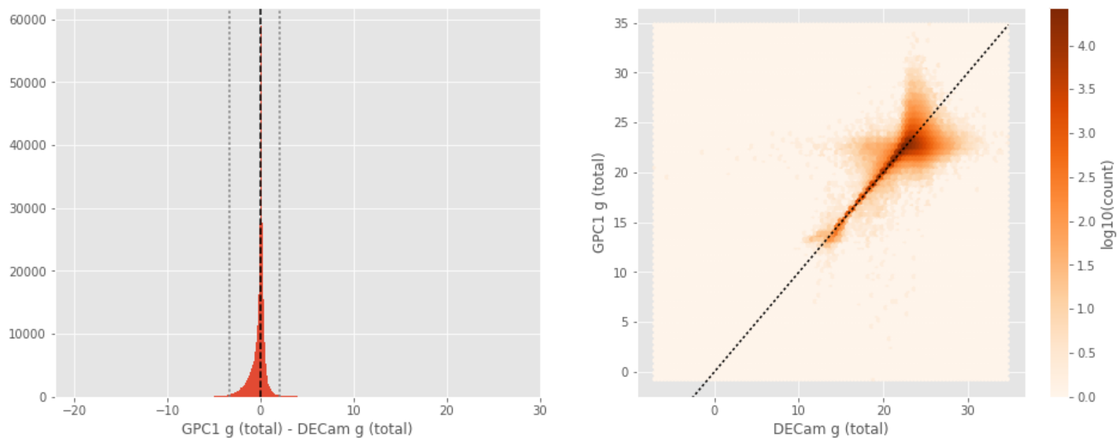


No sources have both DECam g (total) and SUPRIME g (total) values.
GPC1 g (aperture) - DECam g (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.28
- 1% percentile: -3.323600387573242
- 99% percentile: 2.2757487106323264

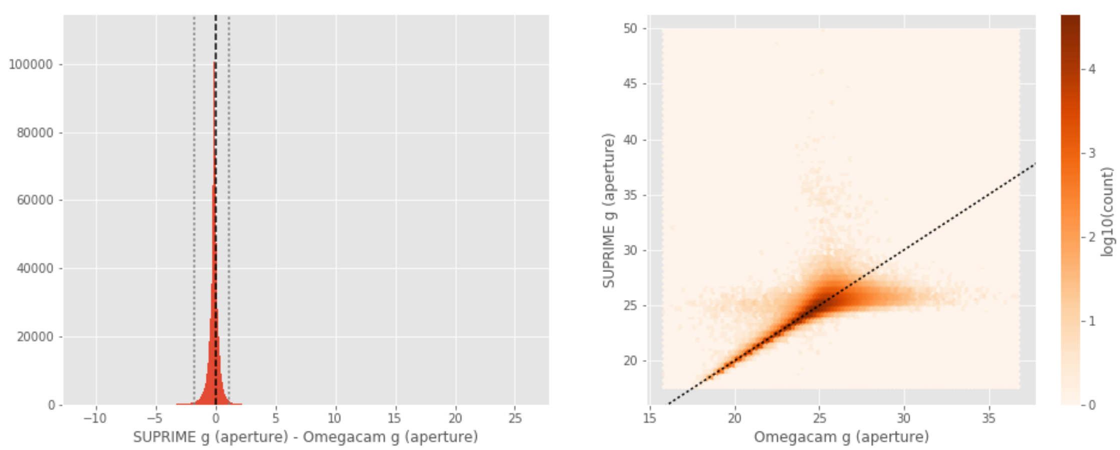


GPC1 g (total) - DECam g (total):
- Median: -0.00
- Median Absolute Deviation: 0.26

- 1% percentile: -3.400665760040283
- 99% percentile: 2.0117679786682143

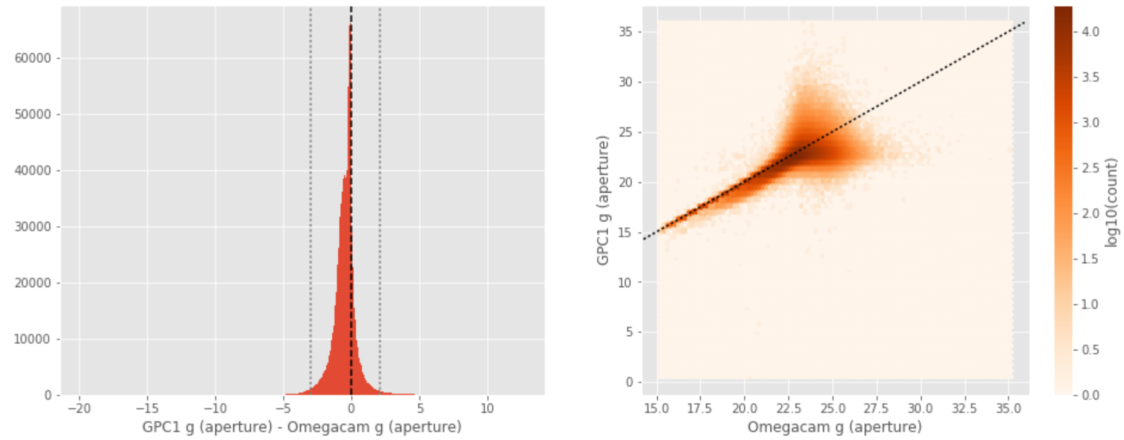


SUPRIME g (aperture) - Omegacam g (aperture):
- Median: -0.10
- Median Absolute Deviation: 0.17
- 1% percentile: -1.7694091796874998
- 99% percentile: 1.1416382789611785

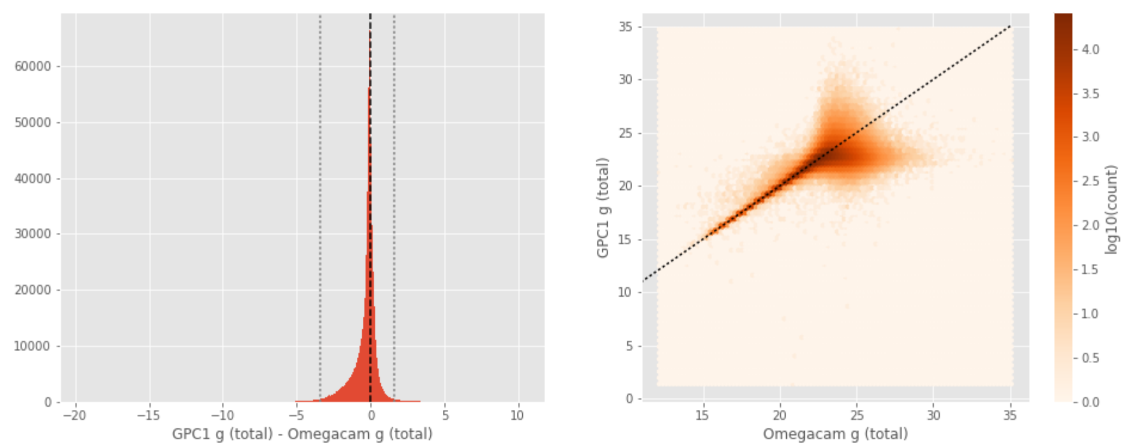


No sources have both Omegacam g (total) and SUPRIME g (total) values.
GPC1 g (aperture) - Omegacam g (aperture):
- Median: -0.40
- Median Absolute Deviation: 0.38
- 1% percentile: -2.9983723831176756

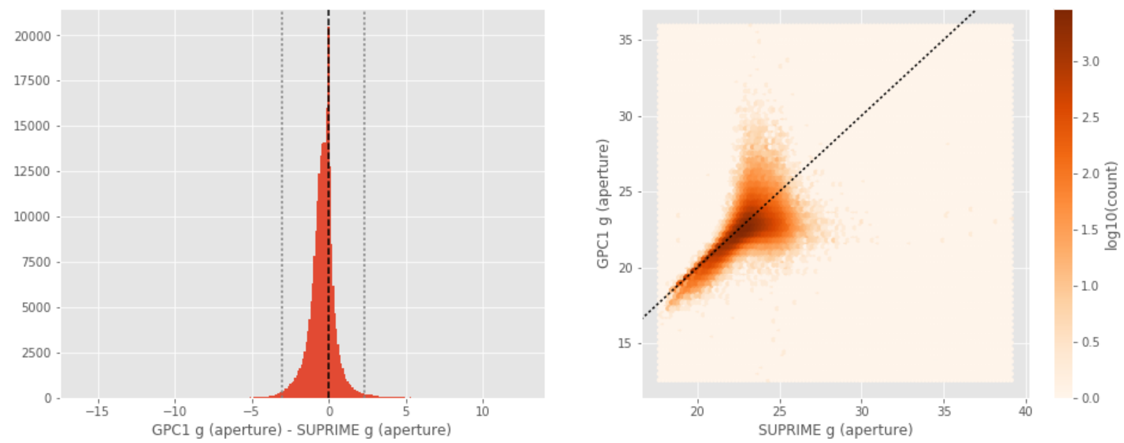
- 99% percentile: 2.0907281112671225



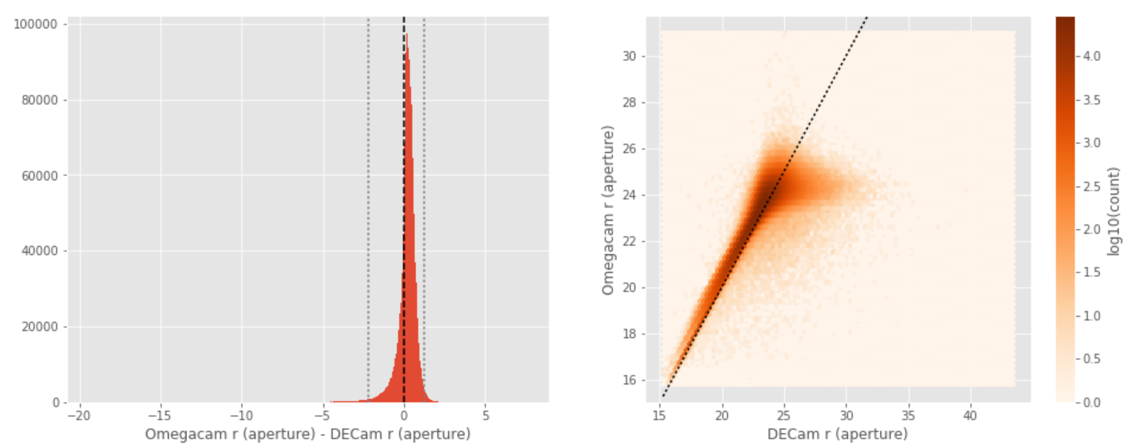
GPC1 g (total) - Omegacam g (total):
- Median: -0.12
- Median Absolute Deviation: 0.25
- 1% percentile: -3.3798369407653808
- 99% percentile: 1.5962666130065895



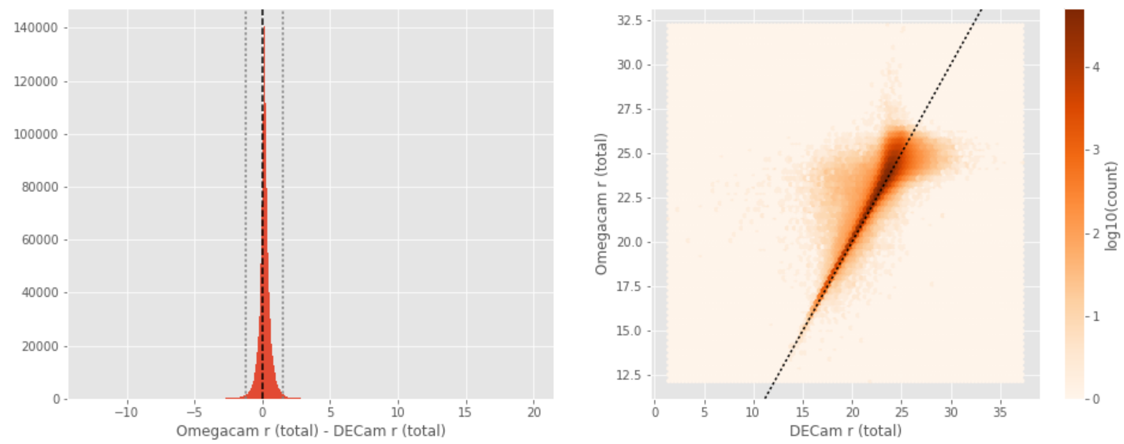
GPC1 g (aperture) - SUPRIME g (aperture):
- Median: -0.33
- Median Absolute Deviation: 0.40
- 1% percentile: -3.0280526733398436
- 99% percentile: 2.2830573272705097



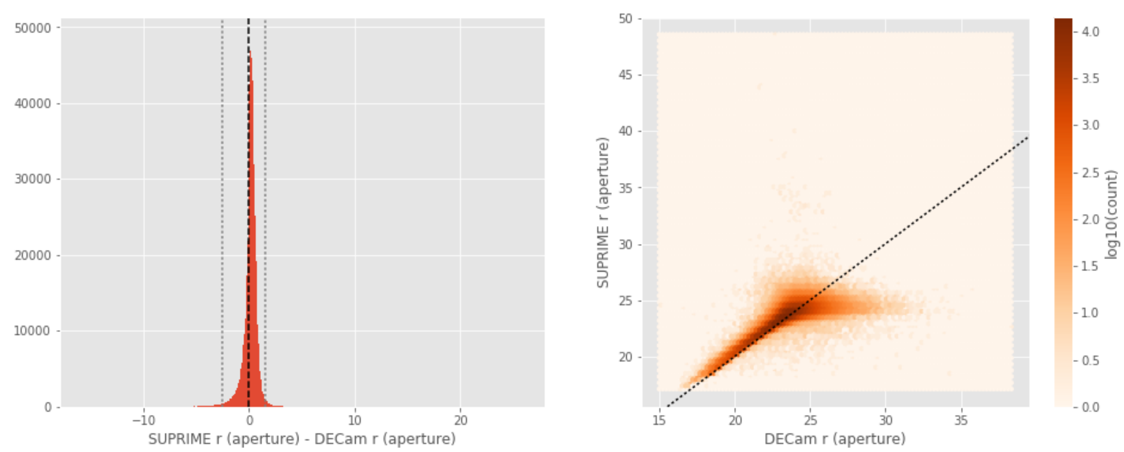
No sources have both SUPRIME g (total) and GPC1 g (total) values.
Omegacam r (aperture) - DECam r (aperture):
- Median: 0.25
- Median Absolute Deviation: 0.24
- 1% percentile: -2.223689575195312
- 99% percentile: 1.2501894378662115



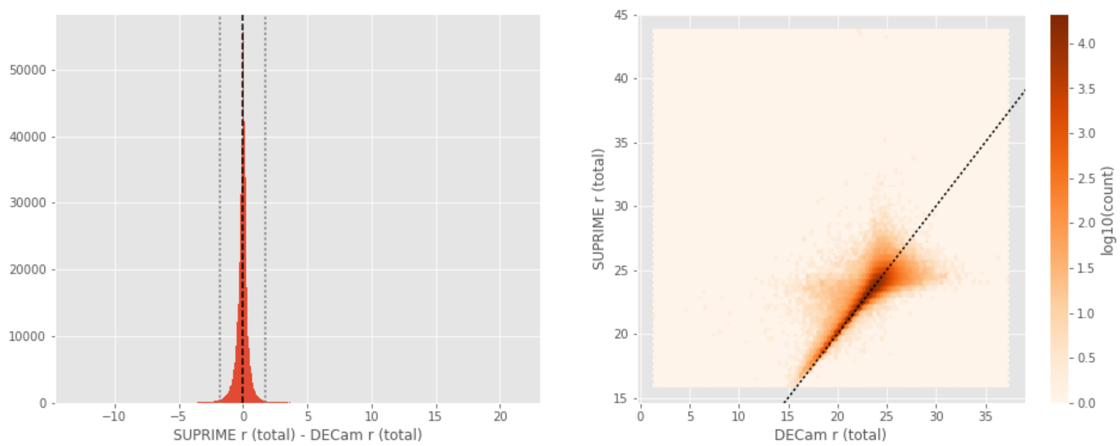
Omegacam r (total) - DECam r (total):
- Median: 0.17
- Median Absolute Deviation: 0.18
- 1% percentile: -1.2137767791748046
- 99% percentile: 1.5382007598877045



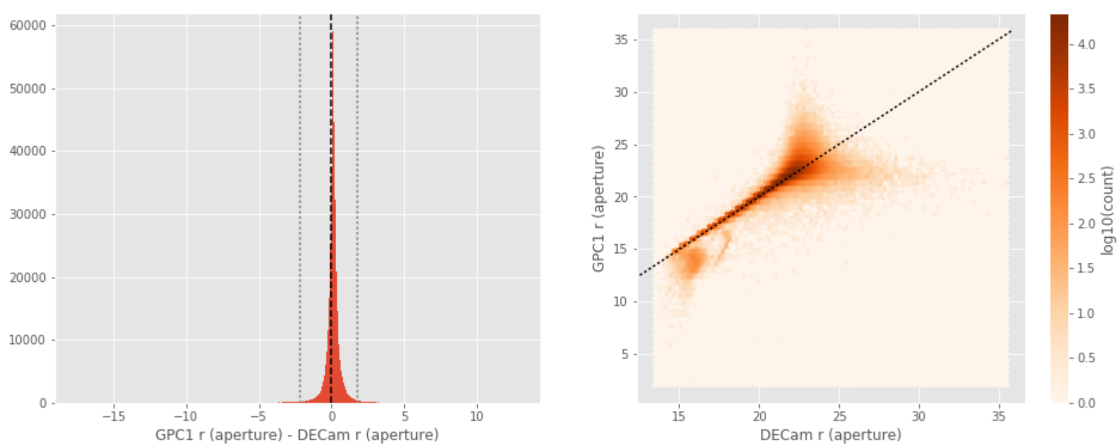
SUPRIME r (aperture) - DECam r (aperture):
- Median: 0.19
- Median Absolute Deviation: 0.26
- 1% percentile: -2.5148622894287107
- 99% percentile: 1.5698329162597655



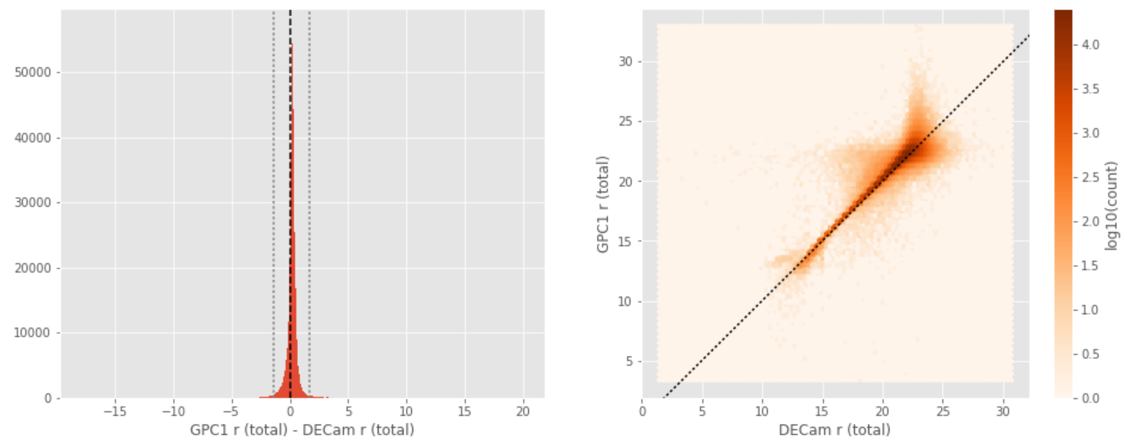
SUPRIME r (total) - DECam r (total):
- Median: -0.00
- Median Absolute Deviation: 0.19
- 1% percentile: -1.8438291549682617
- 99% percentile: 1.7042064666748047



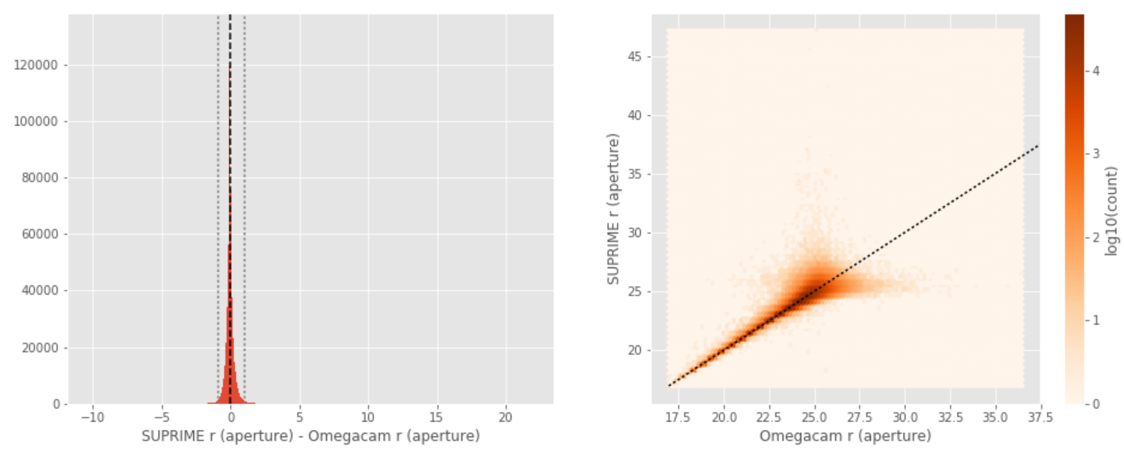
GPC1 r (aperture) - DECam r (aperture):
- Median: 0.10
- Median Absolute Deviation: 0.17
- 1% percentile: -2.1499901390075684
- 99% percentile: 1.7801751708984375



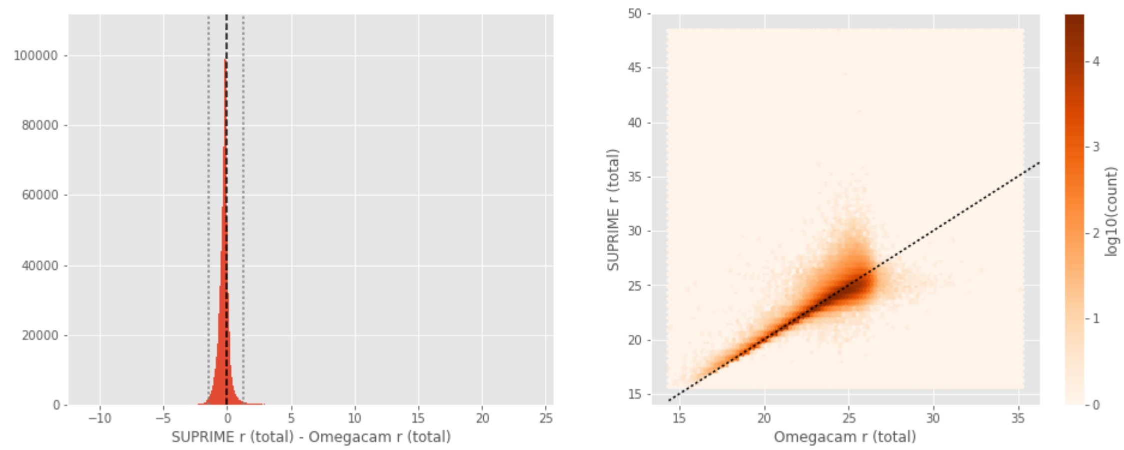
GPC1 r (total) - DECam r (total):
- Median: 0.21
- Median Absolute Deviation: 0.15
- 1% percentile: -1.3948646545410157
- 99% percentile: 1.6864162445068303



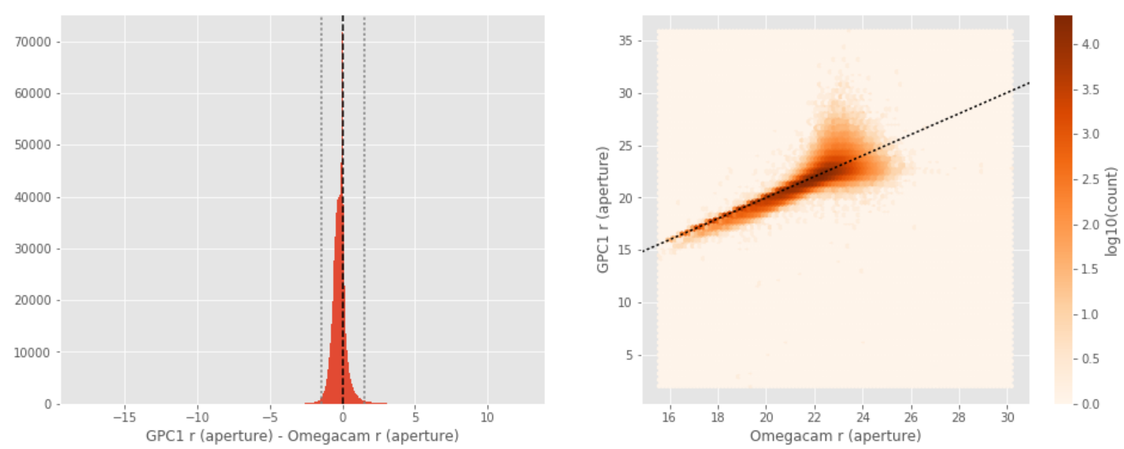
SUPRIME r (aperture) - Omegacam r (aperture):
- Median: -0.04
- Median Absolute Deviation: 0.11
- 1% percentile: -0.8898246765136719
- 99% percentile: 0.9822139739990225



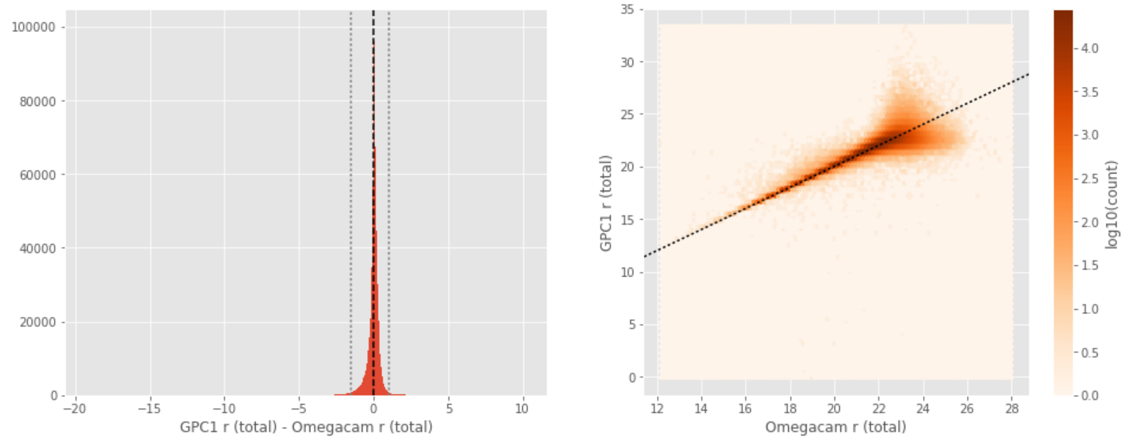
SUPRIME r (total) - Omegacam r (total):
- Median: -0.21
- Median Absolute Deviation: 0.19
- 1% percentile: -1.4218847274780273
- 99% percentile: 1.2361030578613281



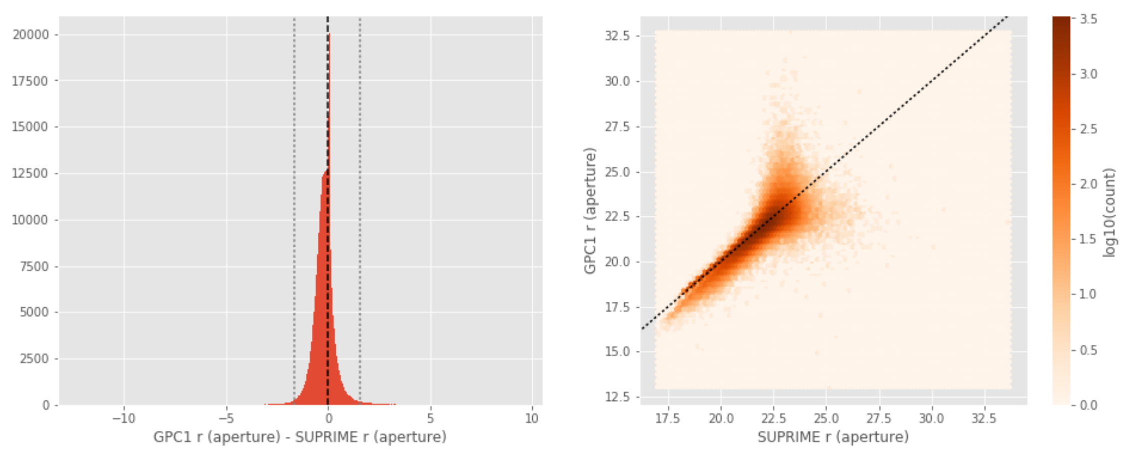
GPC1 r (aperture) - Omegacam r (aperture):
- Median: -0.19
- Median Absolute Deviation: 0.24
- 1% percentile: -1.4279033660888671
- 99% percentile: 1.5094874382019094



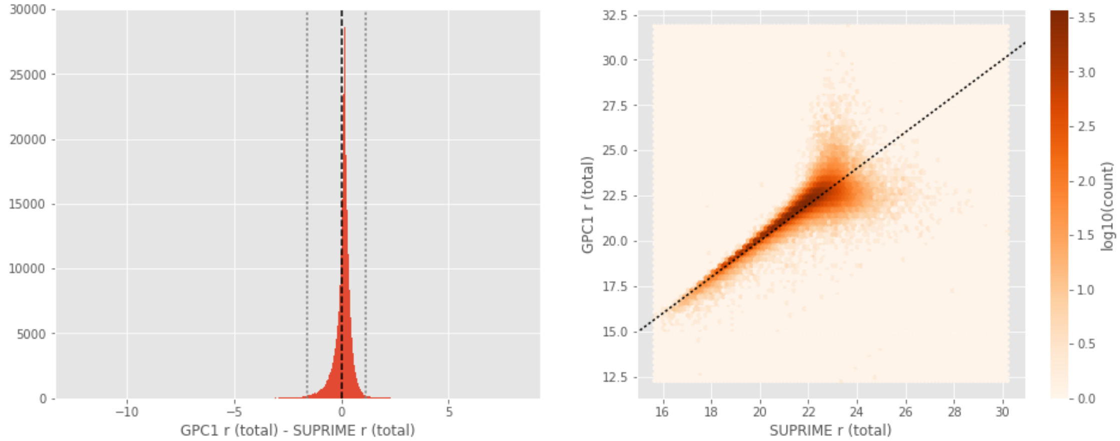
GPC1 r (total) - Omegacam r (total):
- Median: 0.05
- Median Absolute Deviation: 0.13
- 1% percentile: -1.5332369995117188
- 99% percentile: 1.0504807281494113



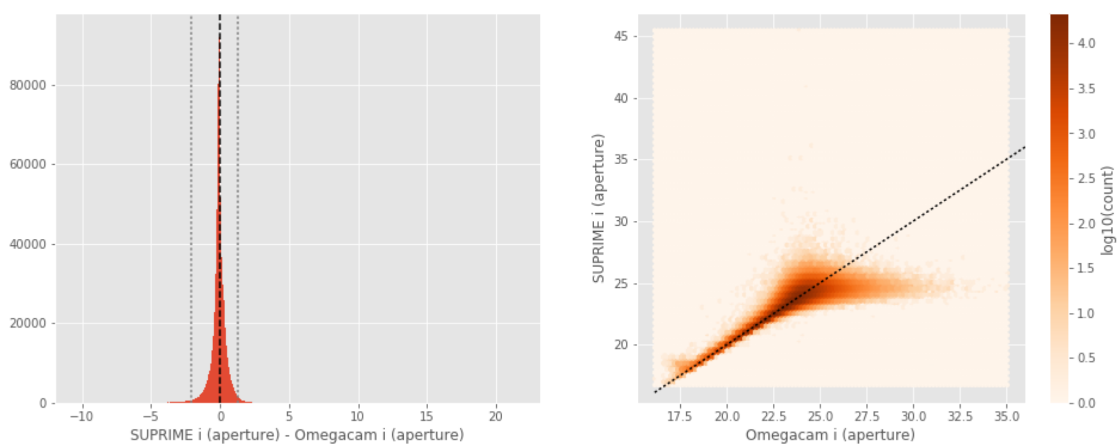
GPC1 r (aperture) - SUPRIME r (aperture):
- Median: -0.16
- Median Absolute Deviation: 0.25
- 1% percentile: -1.6482121086120607
- 99% percentile: 1.5769341278076159



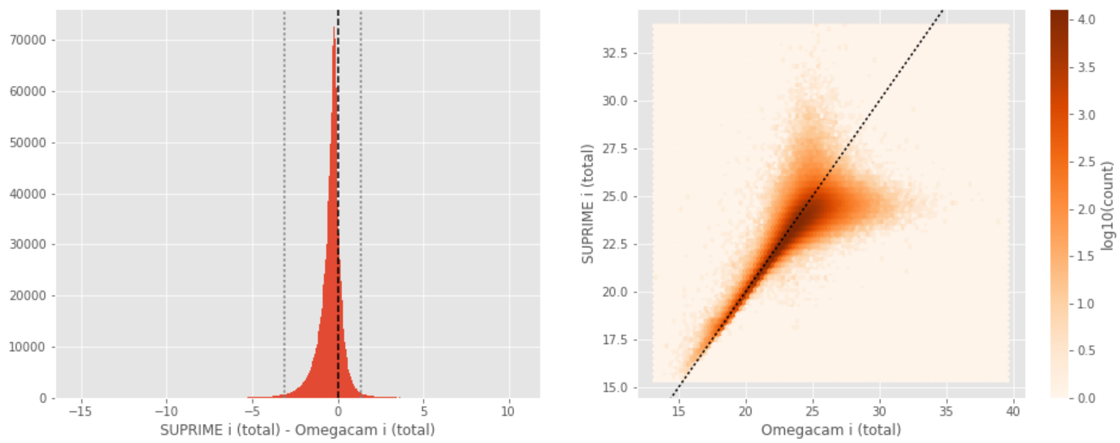
GPC1 r (total) - SUPRIME r (total):
- Median: 0.14
- Median Absolute Deviation: 0.15
- 1% percentile: -1.601072483062744
- 99% percentile: 1.1306134033203126



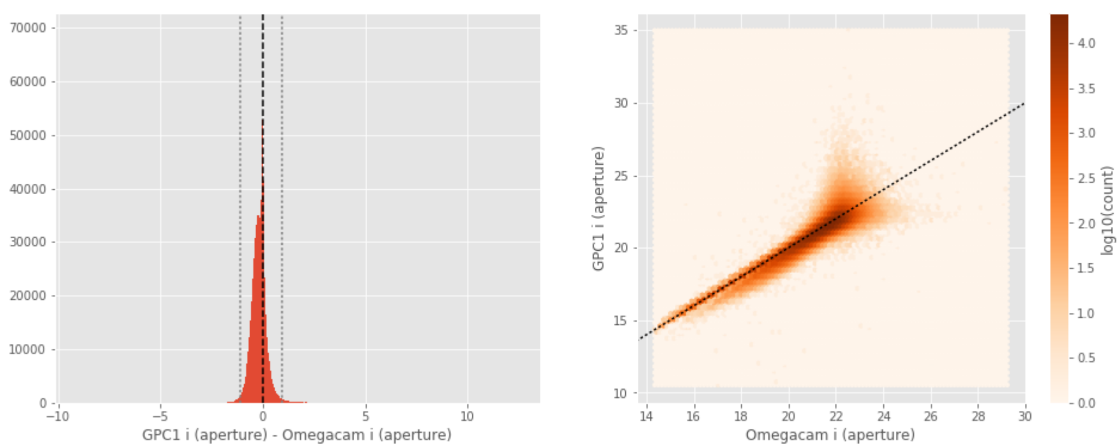
SUPRIME i (aperture) - Omegacam i (aperture):
- Median: -0.08
- Median Absolute Deviation: 0.21
- 1% percentile: -2.0993301010131837
- 99% percentile: 1.3187004470825237



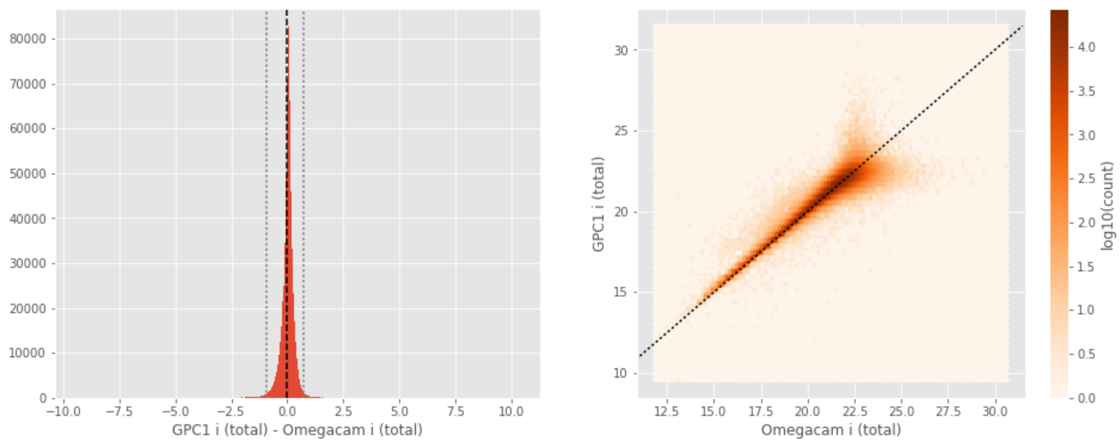
SUPRIME i (total) - Omegacam i (total):
- Median: -0.30
- Median Absolute Deviation: 0.30
- 1% percentile: -3.1144363403320314
- 99% percentile: 1.3730266189575193



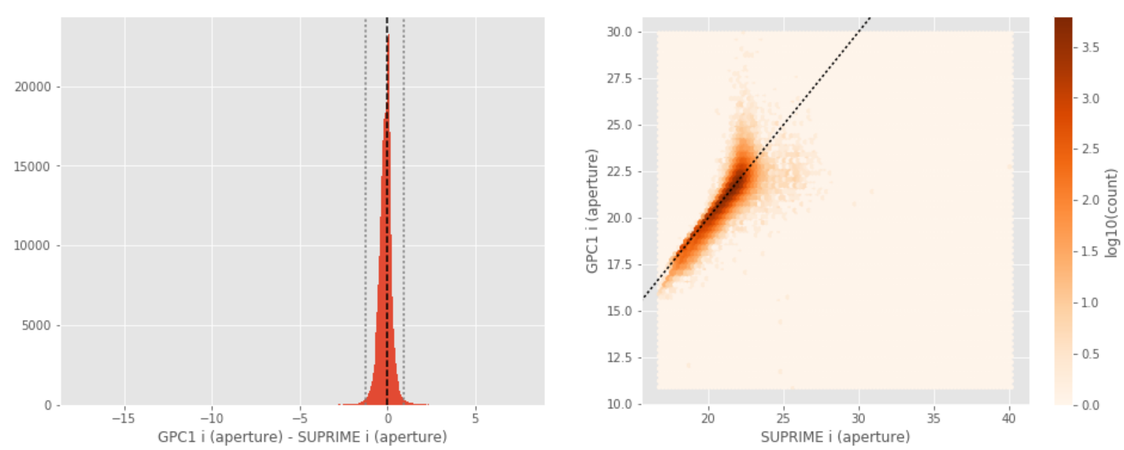
GPC1 i (aperture) - Omegacam i (aperture):
- Median: -0.15
- Median Absolute Deviation: 0.19
- 1% percentile: -1.0921630859375
- 99% percentile: 0.942601203918457



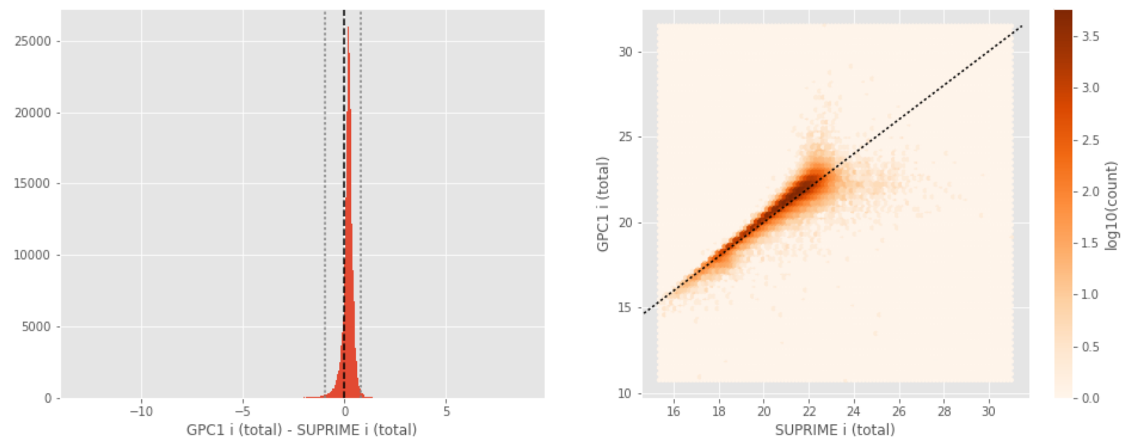
GPC1 i (total) - Omegacam i (total):
- Median: 0.04
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9394100379943848
- 99% percentile: 0.7289270019531244



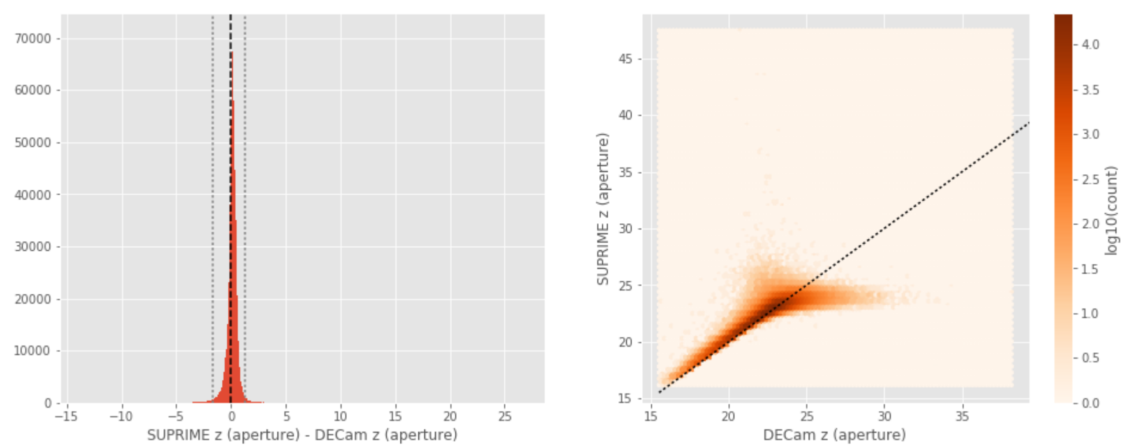
GPC1 i (aperture) - SUPRIME i (aperture):
- Median: -0.09
- Median Absolute Deviation: 0.20
- 1% percentile: -1.2597021865844726
- 99% percentile: 0.9451037597656242



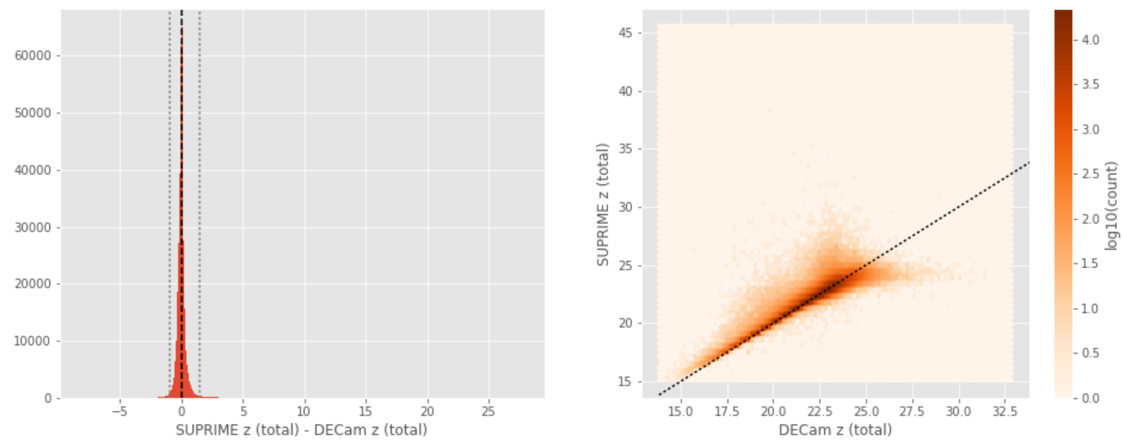
GPC1 i (total) - SUPRIME i (total):
- Median: 0.20
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9388385772705078
- 99% percentile: 0.7898092269897459



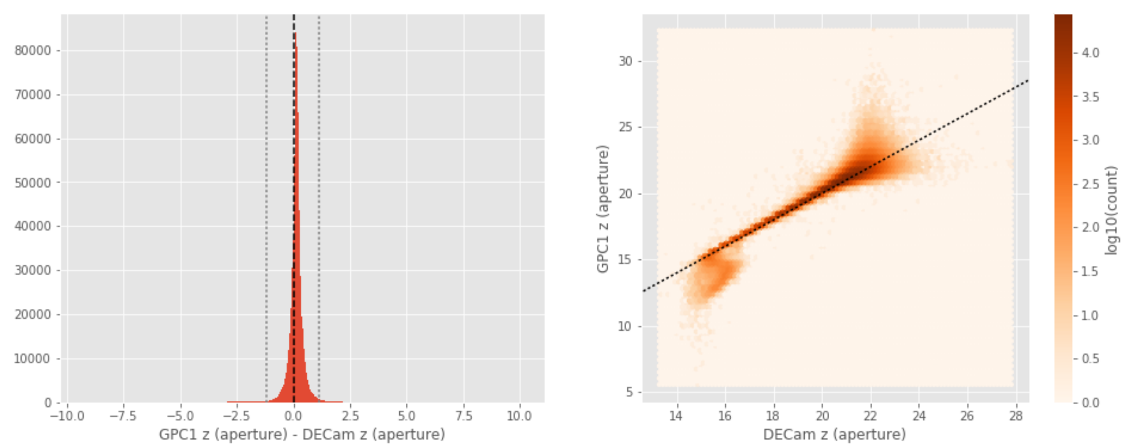
SUPRIME z (aperture) - DECam z (aperture):
- Median: 0.14
- Median Absolute Deviation: 0.20
- 1% percentile: -1.7197685241699219
- 99% percentile: 1.3337068557739267



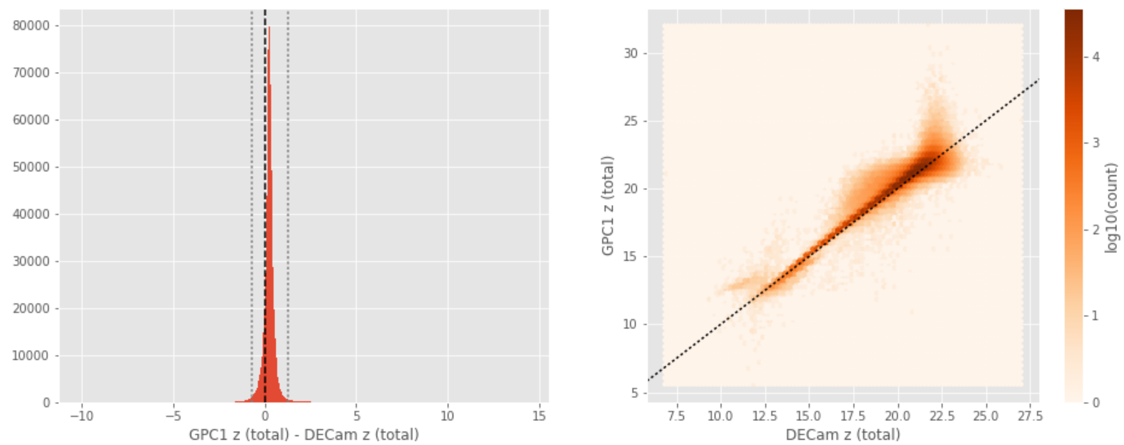
SUPRIME z (total) - DECam z (total):
- Median: 0.02
- Median Absolute Deviation: 0.14
- 1% percentile: -0.8981622886657715
- 99% percentile: 1.4719318771362397



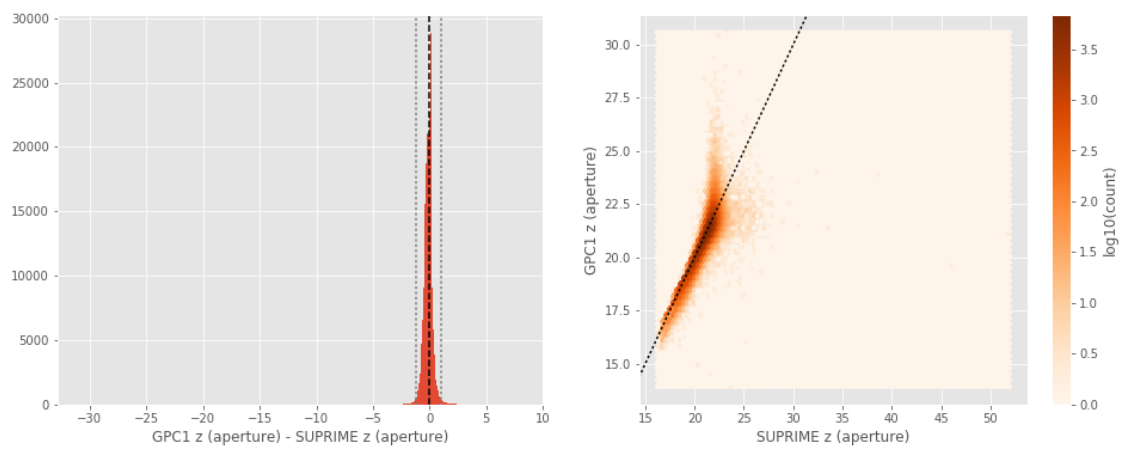
GPC1 z (aperture) - DECam z (aperture):
- Median: 0.13
- Median Absolute Deviation: 0.12
- 1% percentile: -1.197961082458496
- 99% percentile: 1.1379787445068388



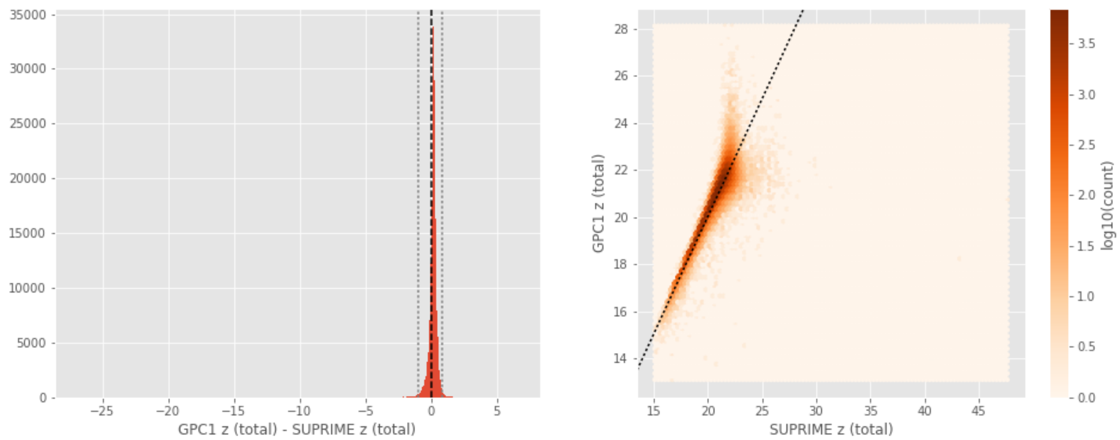
GPC1 z (total) - DECam z (total):
- Median: 0.25
- Median Absolute Deviation: 0.12
- 1% percentile: -0.7122621345520018
- 99% percentile: 1.3096992492675792



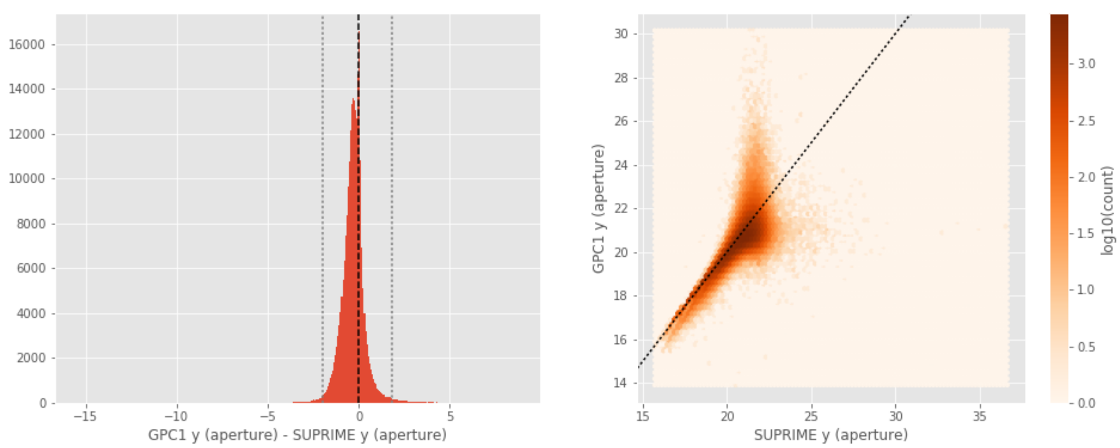
GPC1 z (aperture) - SUPRIME z (aperture):
- Median: -0.11
- Median Absolute Deviation: 0.21
- 1% percentile: -1.1804688262939453
- 99% percentile: 1.0268697357177732



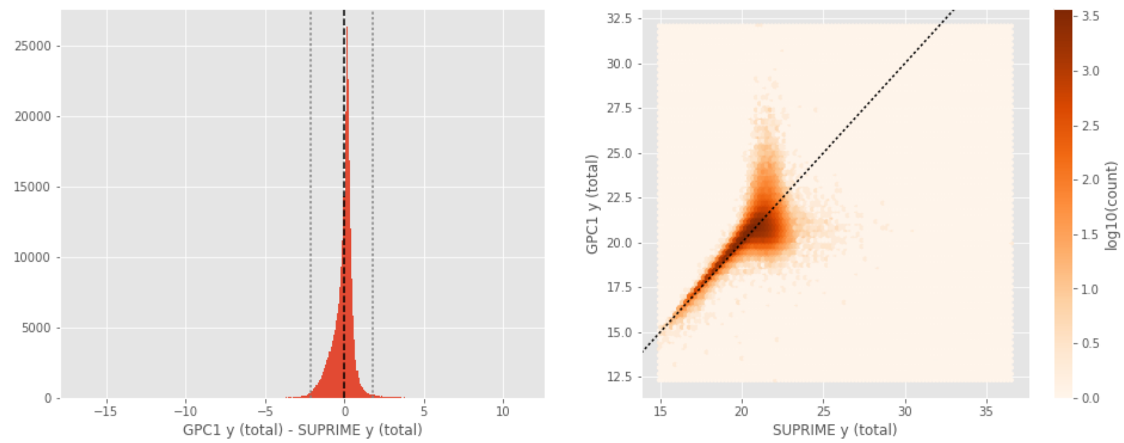
GPC1 z (total) - SUPRIME z (total):
- Median: 0.17
- Median Absolute Deviation: 0.13
- 1% percentile: -0.9890042114257812
- 99% percentile: 0.8573753738403318



GPC1 y (aperture) - SUPRIME y (aperture):
- Median: -0.27
- Median Absolute Deviation: 0.32
- 1% percentile: -1.9547522544860838
- 99% percentile: 1.80585403442383



GPC1 y (total) - SUPRIME y (total):
- Median: 0.07
- Median Absolute Deviation: 0.27
- 1% percentile: -2.1251942443847653
- 99% percentile: 1.7523292541503808



0.4 III - Comparing magnitudes to reference bands

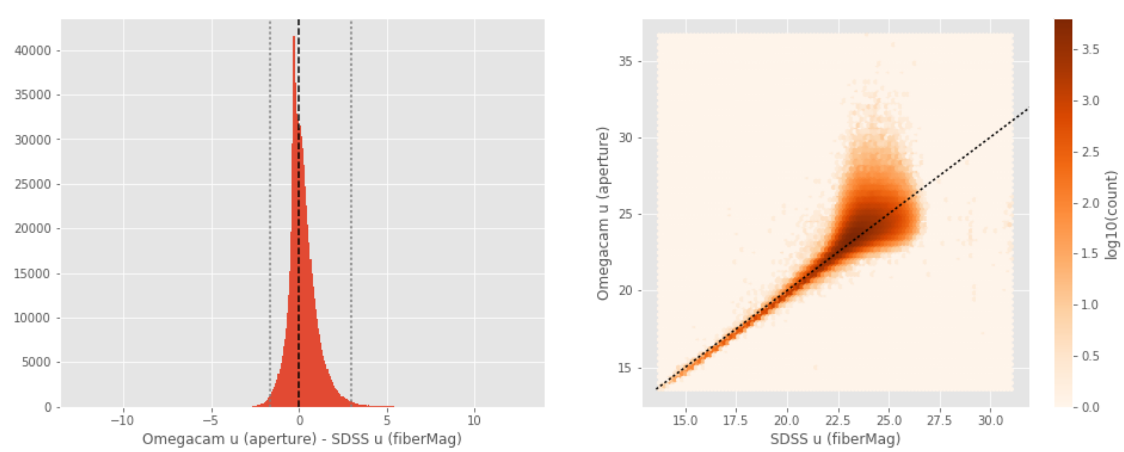
Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

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

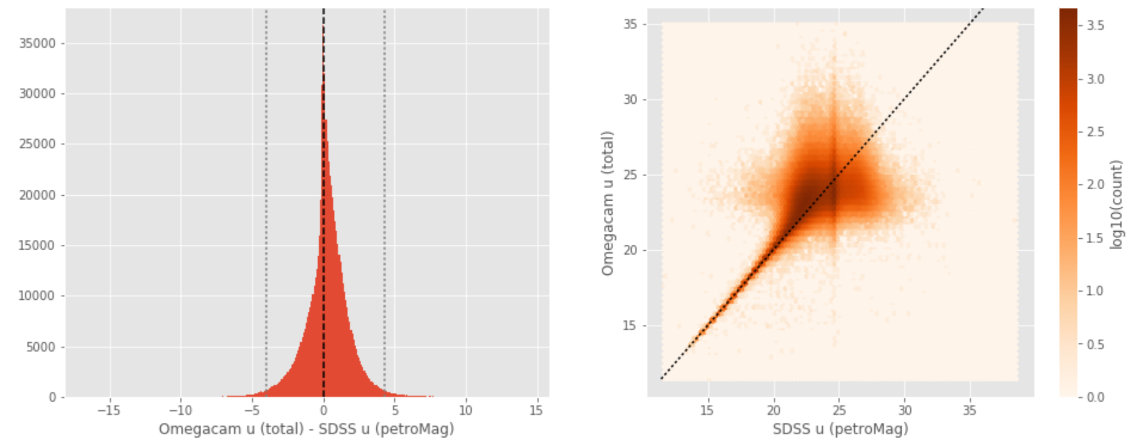
The catalogue is cross-matched to SDSS-DR13 withing 0.2 arcsecond.

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.

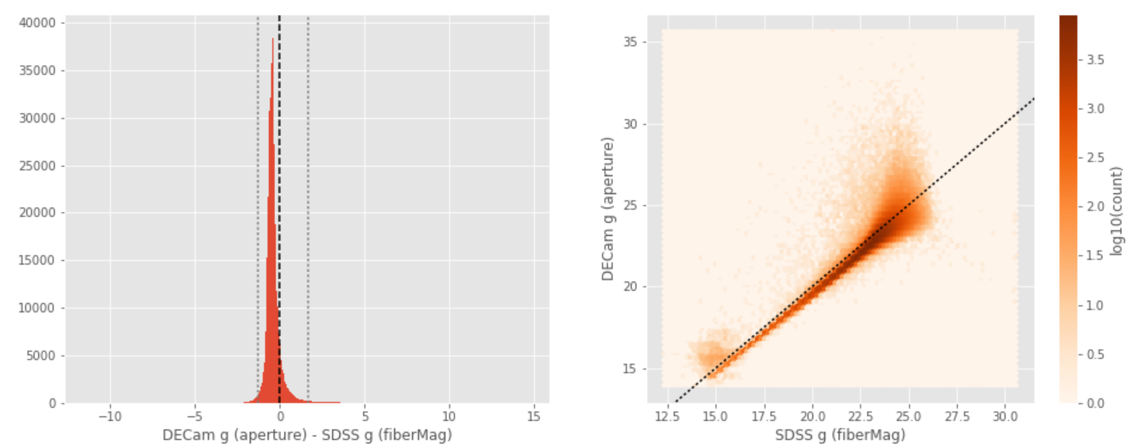
```
Omegacam u (aperture) - SDSS u (fiberMag):
- Median: 0.10
- Median Absolute Deviation: 0.42
- 1% percentile: -1.6068706512451172
- 99% percentile: 2.9546961784362793
```



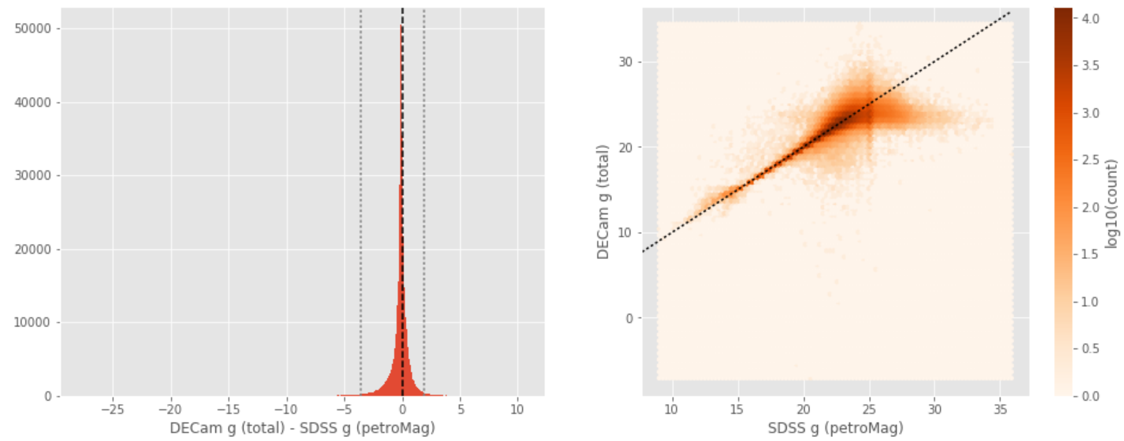
Omegacam u (total) - SDSS u (petroMag):
- Median: 0.24
- Median Absolute Deviation: 0.74
- 1% percentile: -4.01983835220337
- 99% percentile: 4.290471172332764



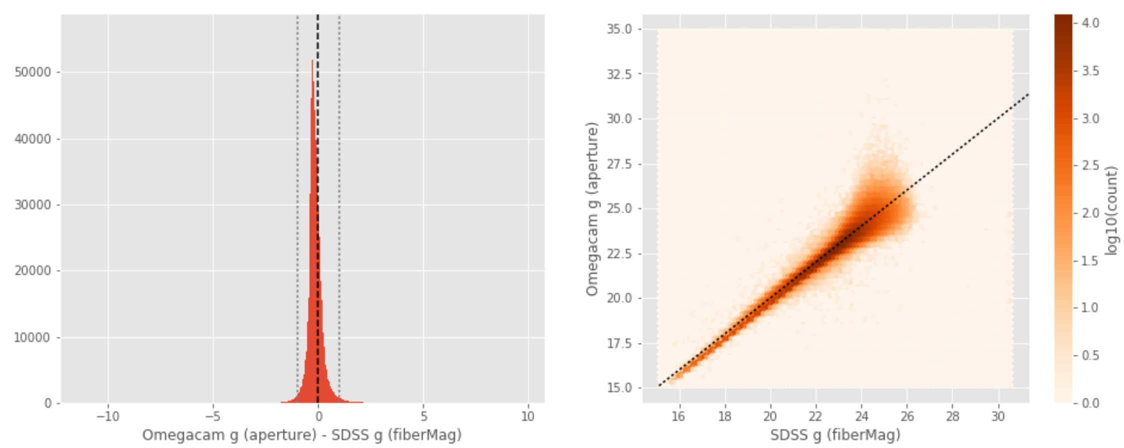
DECam g (aperture) - SDSS g (fiberMag):
- Median: -0.44
- Median Absolute Deviation: 0.16
- 1% percentile: -1.2985469055175782
- 99% percentile: 1.6975757598876973



```
DECam g (total) - SDSS g (petroMag):
- Median: -0.09
- Median Absolute Deviation: 0.24
- 1% percentile: -3.5824387550354
- 99% percentile: 1.9483854293823195
```

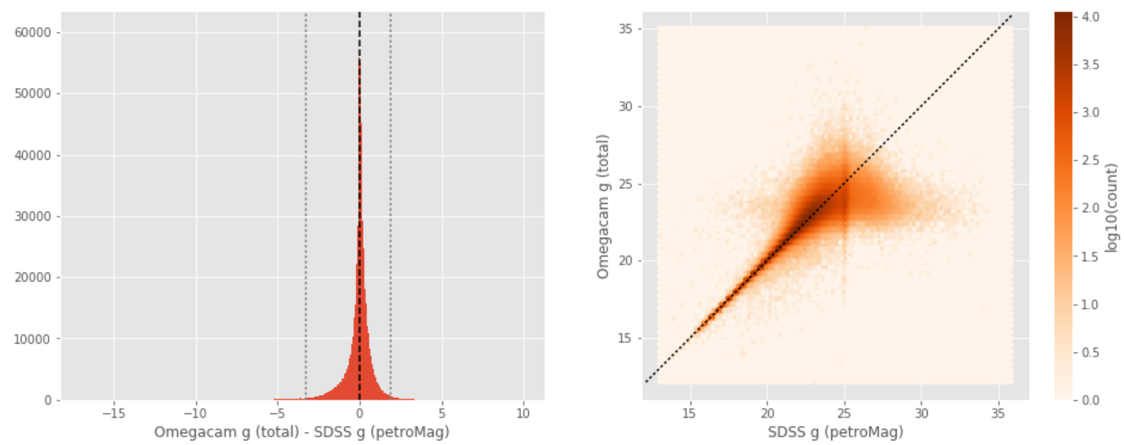



```
Omegacam g (aperture) - SDSS g (fiberMag):
- Median: -0.17
- Median Absolute Deviation: 0.16
- 1% percentile: -0.989033203125
- 99% percentile: 1.033982009887696
```

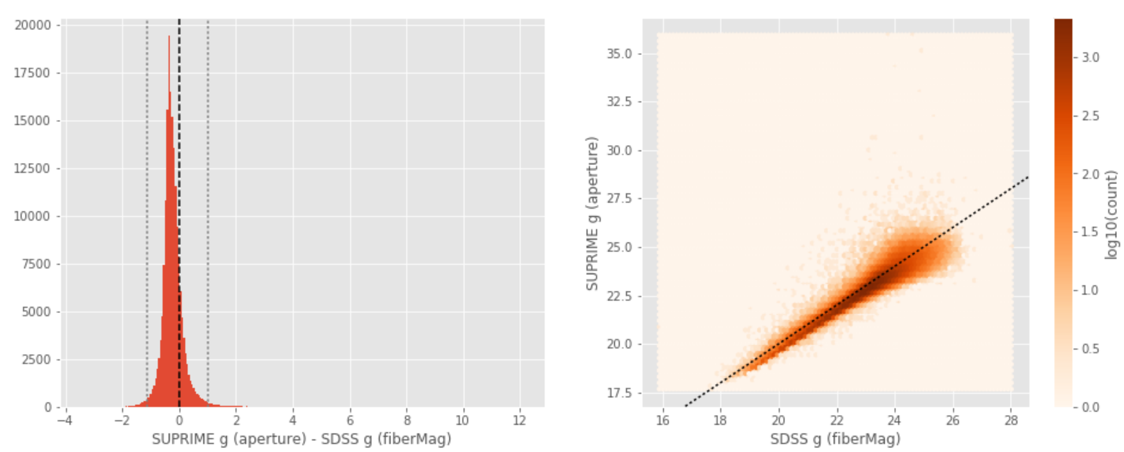



```
Omegacam g (total) - SDSS g (petroMag):
- Median: 0.02
```

- Median Absolute Deviation: 0.24
- 1% percentile: -3.2796149826049805
- 99% percentile: 1.9078044891357422

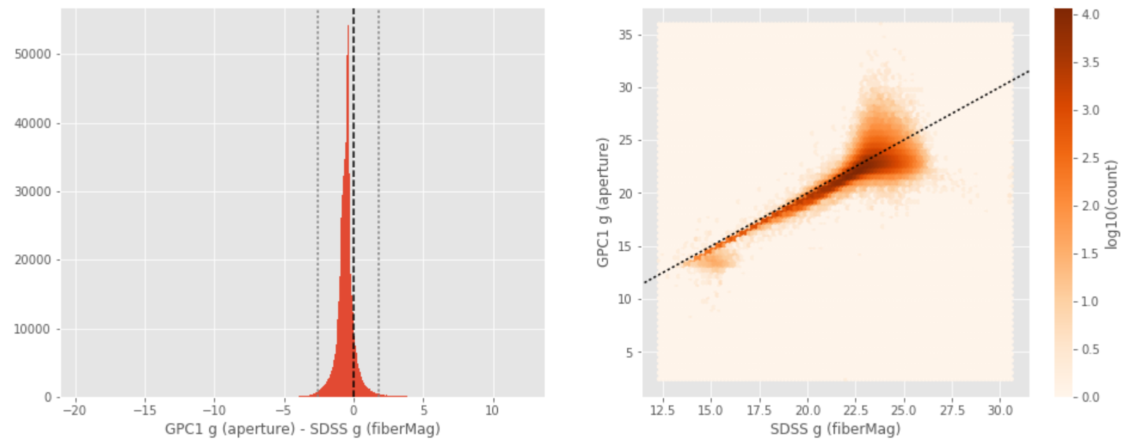


SUPRIME g (aperture) - SDSS g (fiberMag):
- Median: -0.27
- Median Absolute Deviation: 0.17
- 1% percentile: -1.121074981689453
- 99% percentile: 1.001533355712892

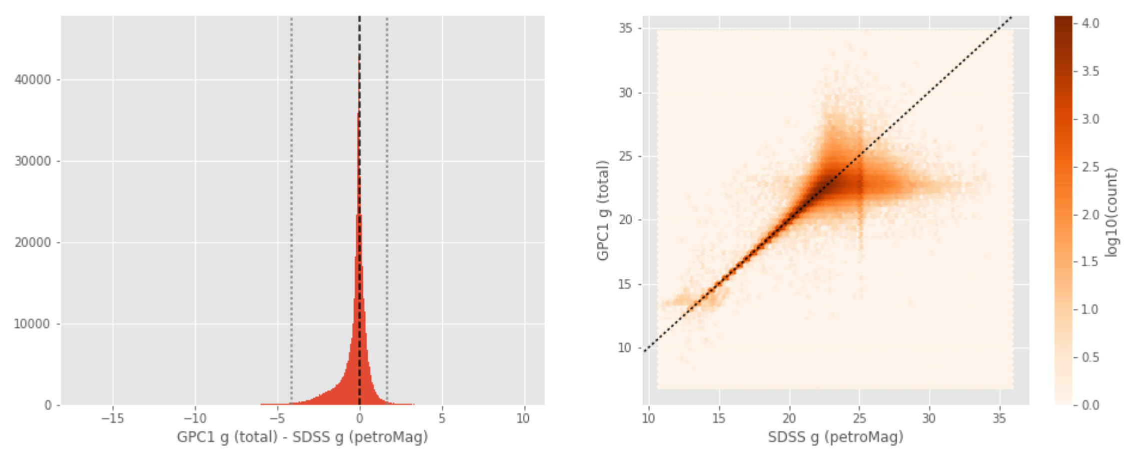


No sources have both SDSS g (petroMag) and SUPRIME g (total) values.
GPC1 g (aperture) - SDSS g (fiberMag):
- Median: -0.53
- Median Absolute Deviation: 0.27

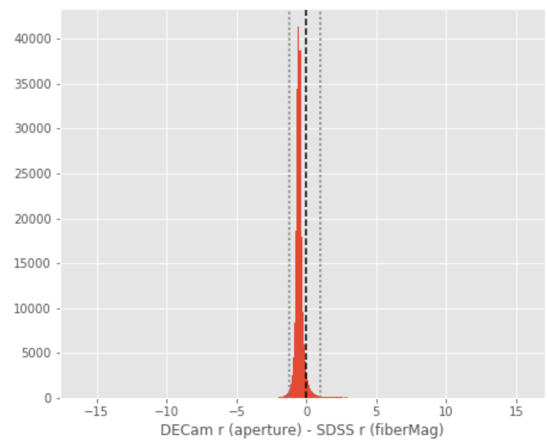
- 1% percentile: -2.5304904174804688
- 99% percentile: 1.800501060485837

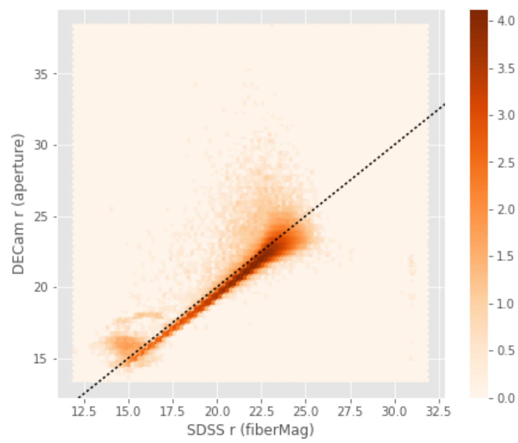


GPC1 g (total) - SDSS g (petroMag):
- Median: -0.08
- Median Absolute Deviation: 0.26
- 1% percentile: -4.119427013397217
- 99% percentile: 1.6508738517761201

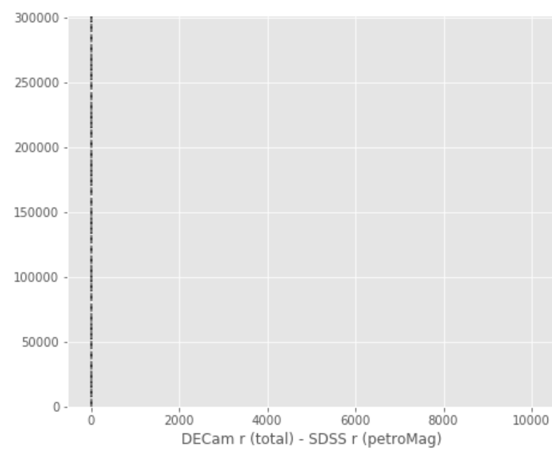


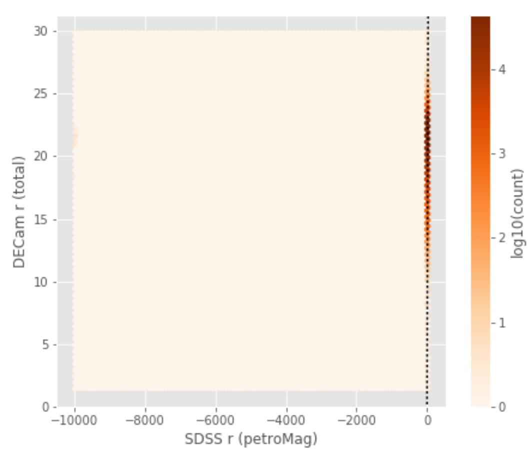
DECam r (aperture) - SDSS r (fiberMag):
- Median: -0.53
- Median Absolute Deviation: 0.13
- 1% percentile: -1.2202922821044921
- 99% percentile: 0.988734893798829





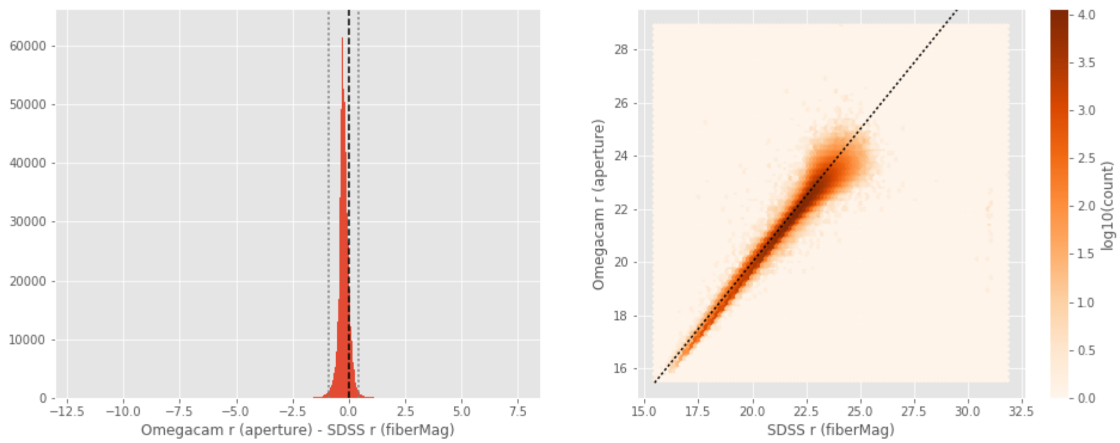

```
DECam r (total) - SDSS r (petroMag):
- Median: -0.16
- Median Absolute Deviation: 0.17
- 1% percentile: -3.014034652709961
- 99% percentile: 1.0932461166381828
```



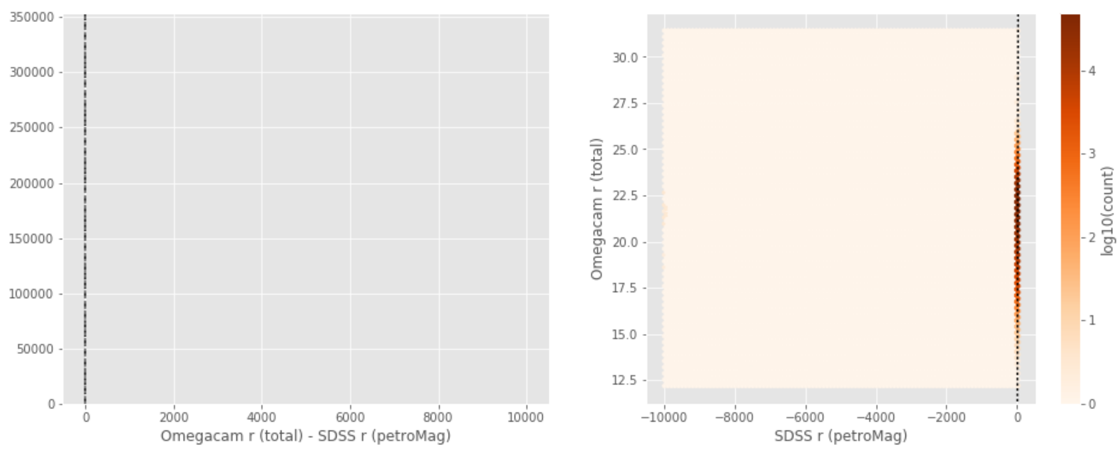



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:8: R

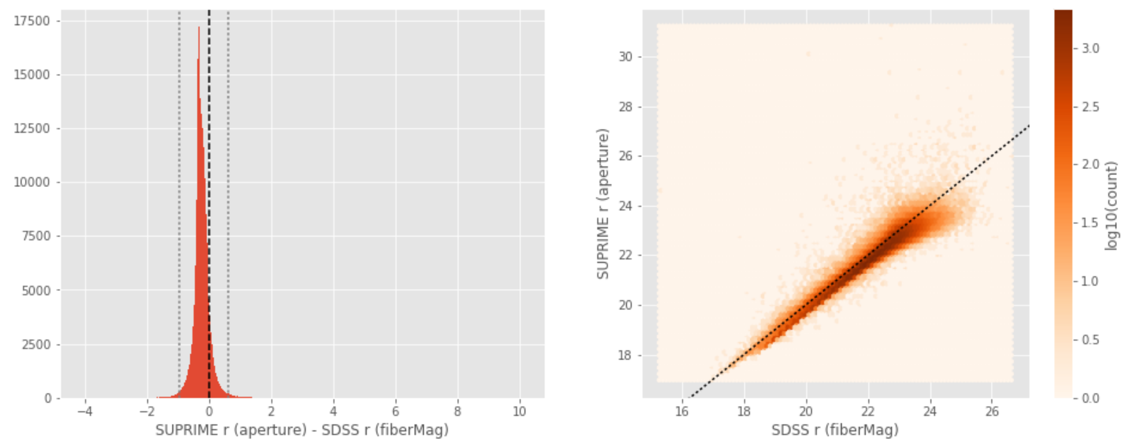
Omegacam r (aperture) - SDSS r (fiberMag):
- Median: -0.23
- Median Absolute Deviation: 0.12
- 1% percentile: -0.8954694747924804
- 99% percentile: 0.42119455337524436
```



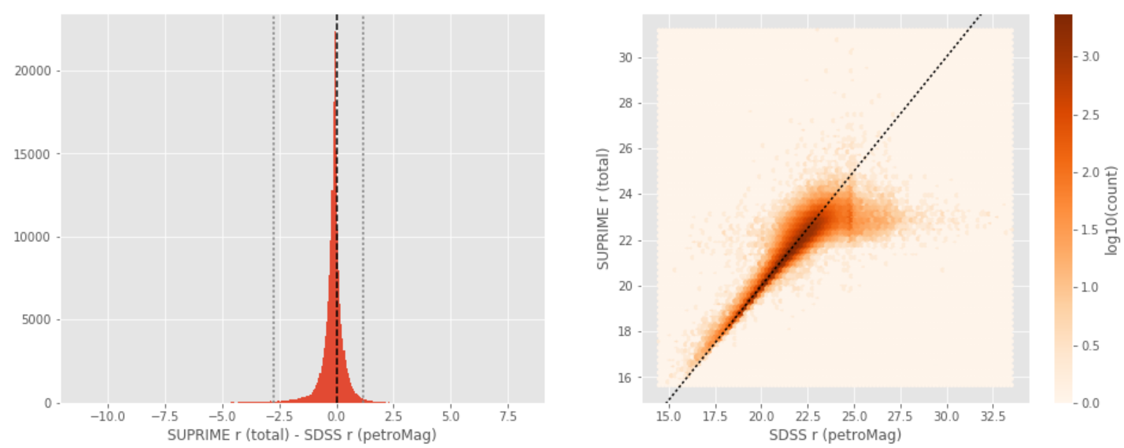
Omegacam r (total) - SDSS r (petroMag):
- Median: -0.01
- Median Absolute Deviation: 0.15
- 1% percentile: -2.604570159912109
- 99% percentile: 1.2320273399353003



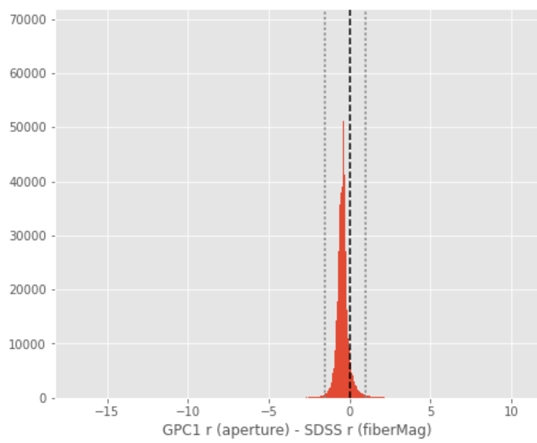
SUPRIME r (aperture) - SDSS r (fiberMag):
- Median: -0.26
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9513585090637208
- 99% percentile: 0.6181533622741703

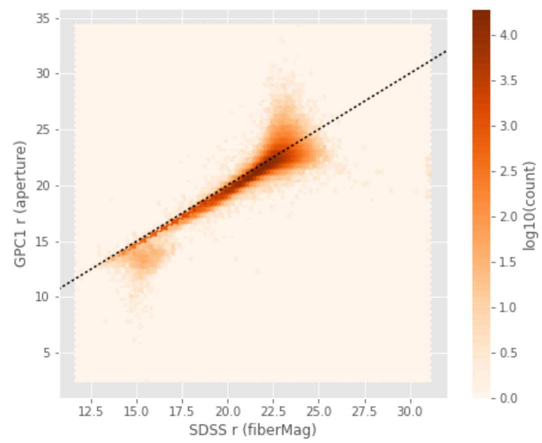


SUPRIME r (total) - SDSS r (petroMag):
- Median: -0.09
- Median Absolute Deviation: 0.17
- 1% percentile: -2.7216490936279296
- 99% percentile: 1.199208831787109

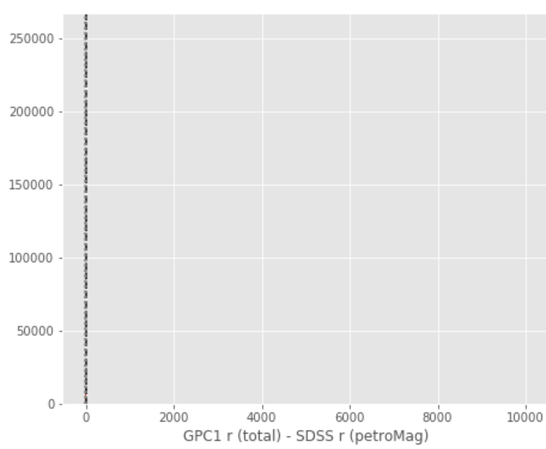


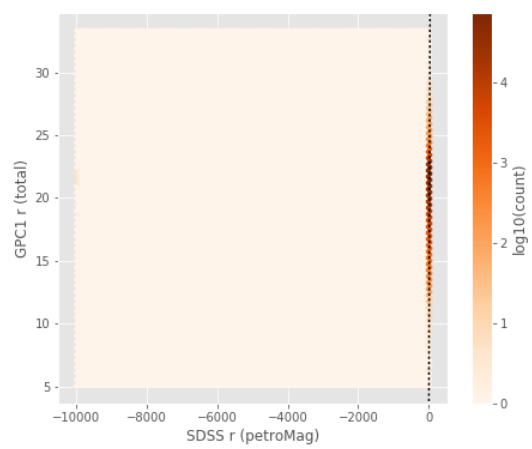
GPC1 r (aperture) - SDSS r (fiberMag):
- Median: -0.41
- Median Absolute Deviation: 0.17
- 1% percentile: -1.506801357269287
- 99% percentile: 1.0024491882324256



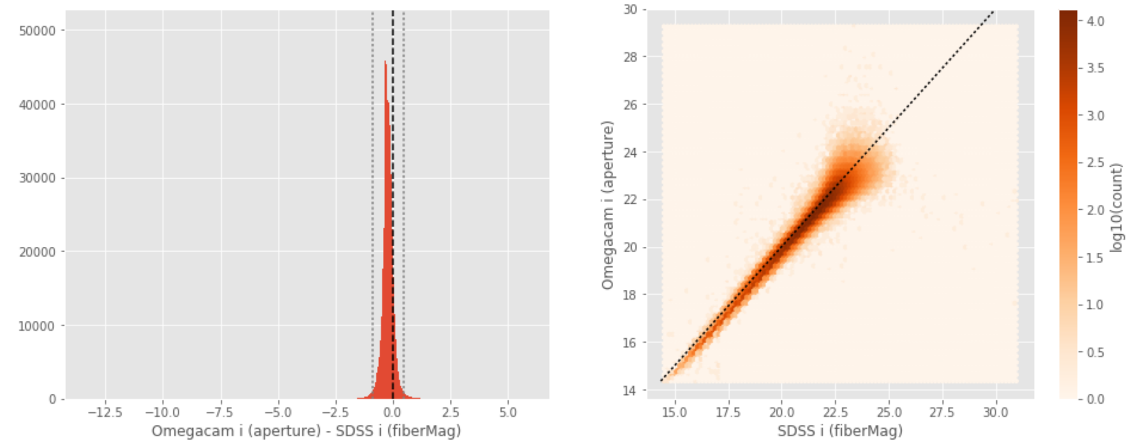


GPC1 r (total) - SDSS r (petroMag):
- Median: 0.05
- Median Absolute Deviation: 0.15
- 1% percentile: -2.472001113891601
- 99% percentile: 1.208791007995603

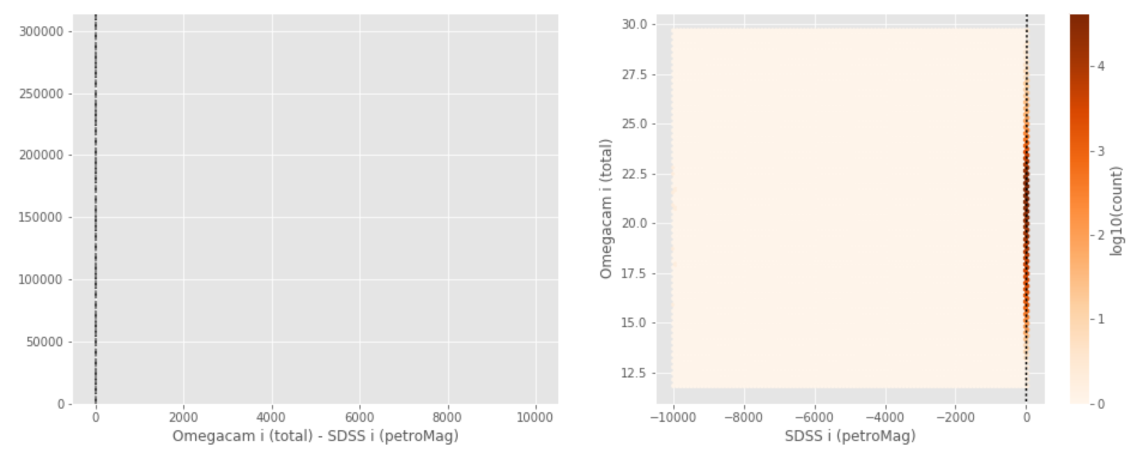




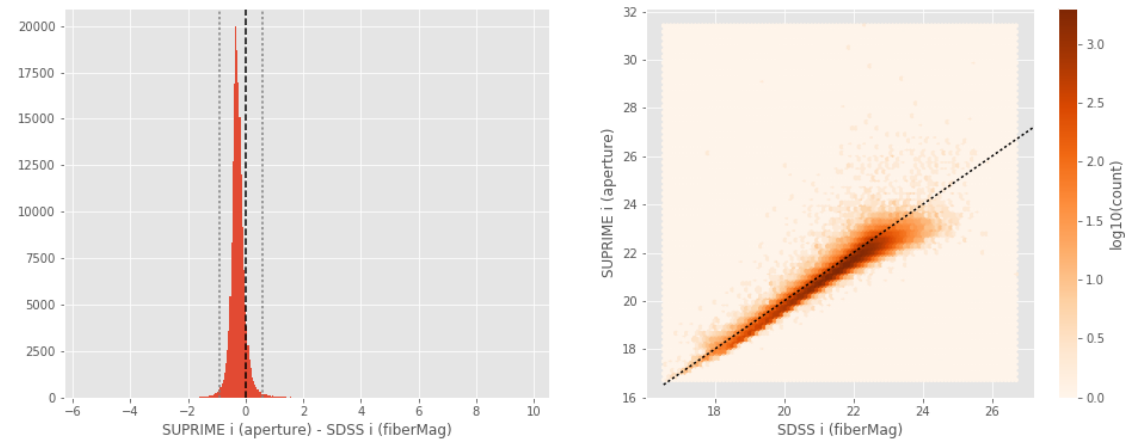
Omegacam i (aperture) - SDSS i (fiberMag):
- Median: -0.22
- Median Absolute Deviation: 0.12
- 1% percentile: -0.8867022514343261
- 99% percentile: 0.4903226852416962



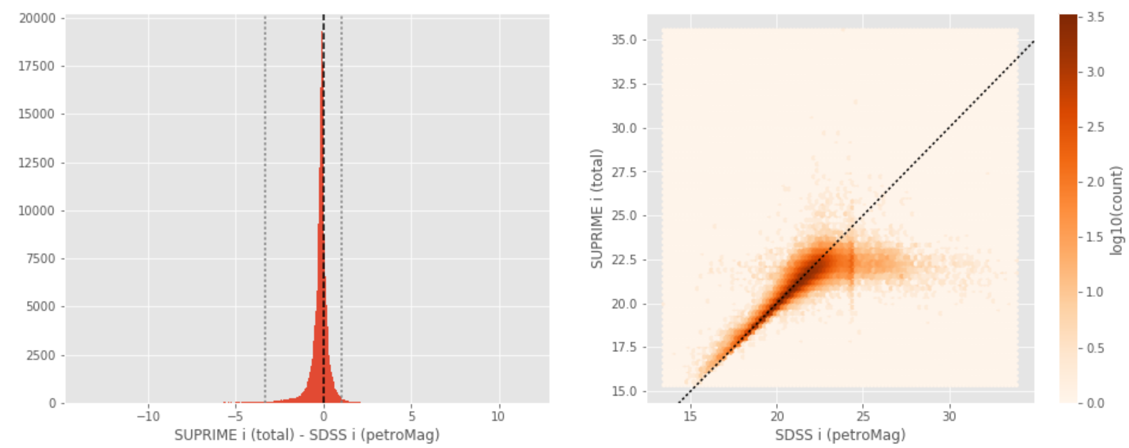
Omegacam i (total) - SDSS i (petroMag):
- Median: 0.01
- Median Absolute Deviation: 0.17
- 1% percentile: -3.094964065551758
- 99% percentile: 1.3094437789917004



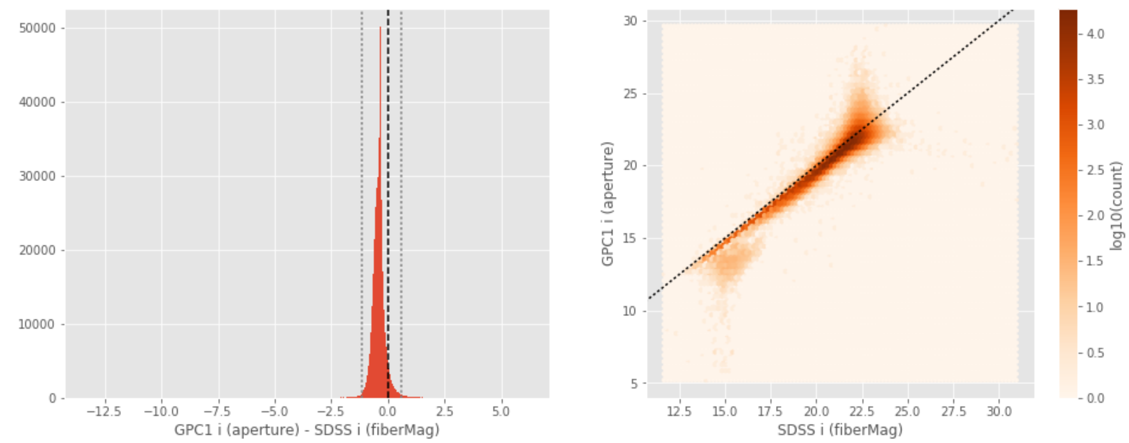
SUPRIME i (aperture) - SDSS i (fiberMag):
- Median: -0.29
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9200061035156251
- 99% percentile: 0.5815077590942384



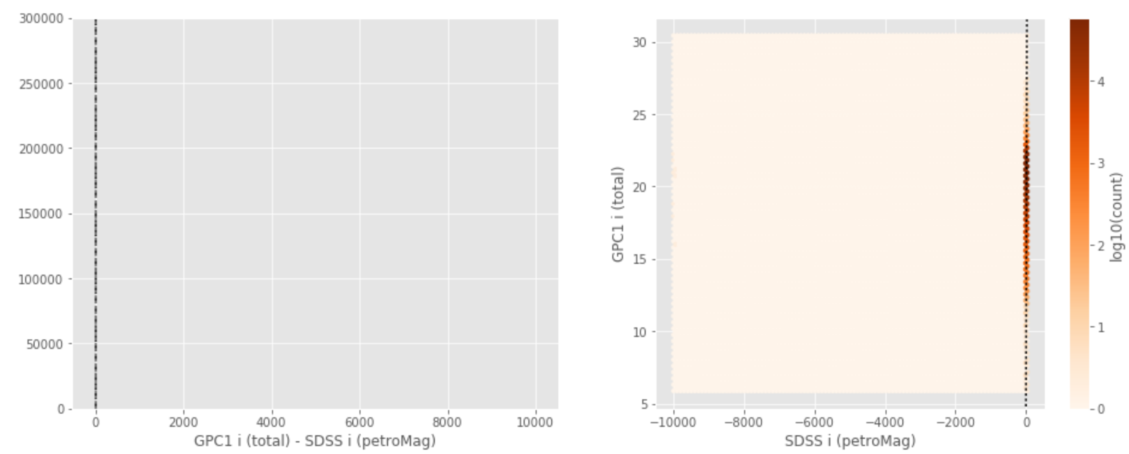
SUPRIME i (total) - SDSS i (petroMag):
- Median: -0.12
- Median Absolute Deviation: 0.17
- 1% percentile: -3.2976397705078124
- 99% percentile: 1.0475211334228498



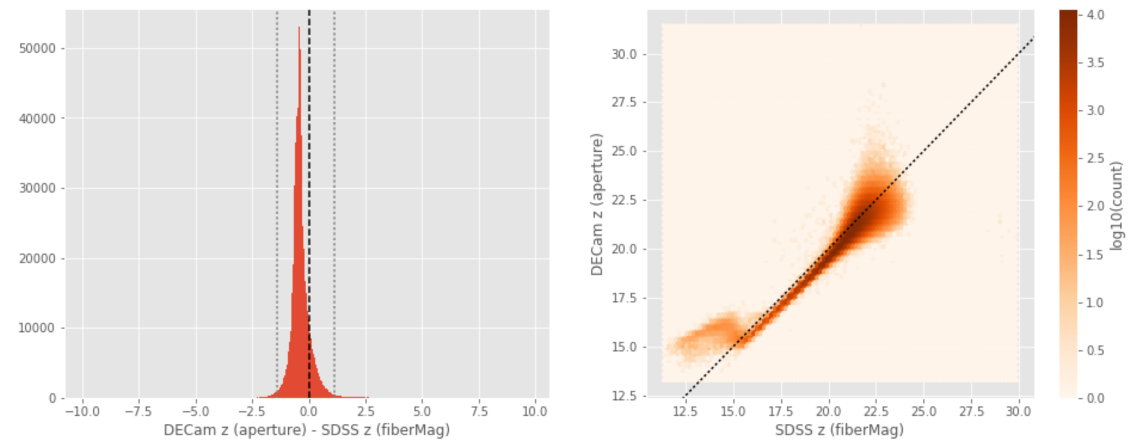
GPC1 i (aperture) - SDSS i (fiberMag):
- Median: -0.39
- Median Absolute Deviation: 0.14
- 1% percentile: -1.1198129272460937
- 99% percentile: 0.5794070434570271



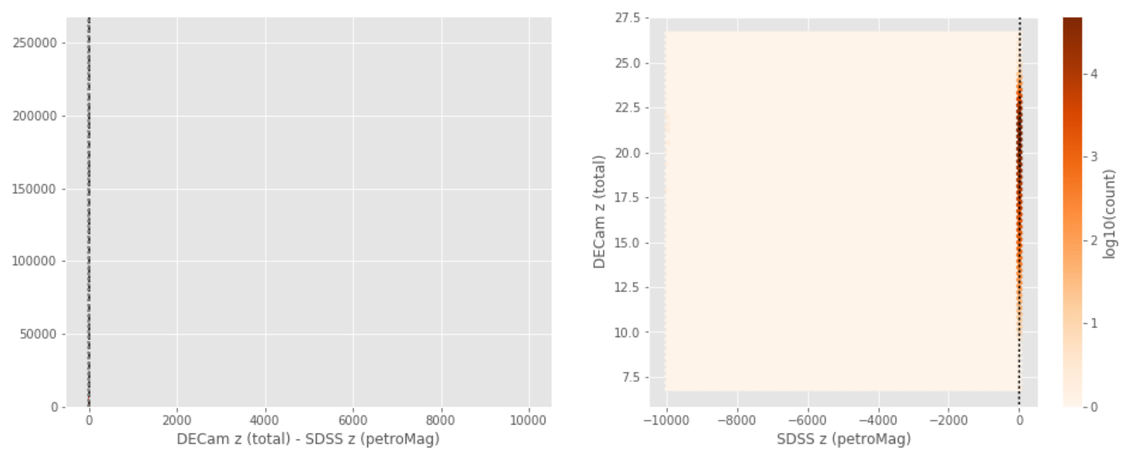
GPC1 i (total) - SDSS i (petroMag):
- Median: 0.06
- Median Absolute Deviation: 0.14
- 1% percentile: -2.520841598510742
- 99% percentile: 0.9990177154540998



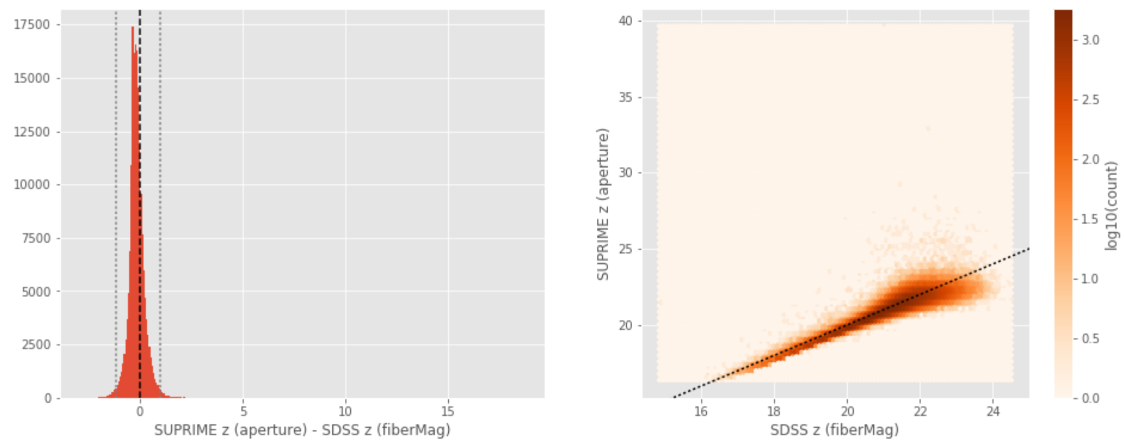
DECam z (aperture) - SDSS z (fiberMag):
- Median: -0.42
- Median Absolute Deviation: 0.18
- 1% percentile: -1.3981916618347168
- 99% percentile: 1.1099197769164975



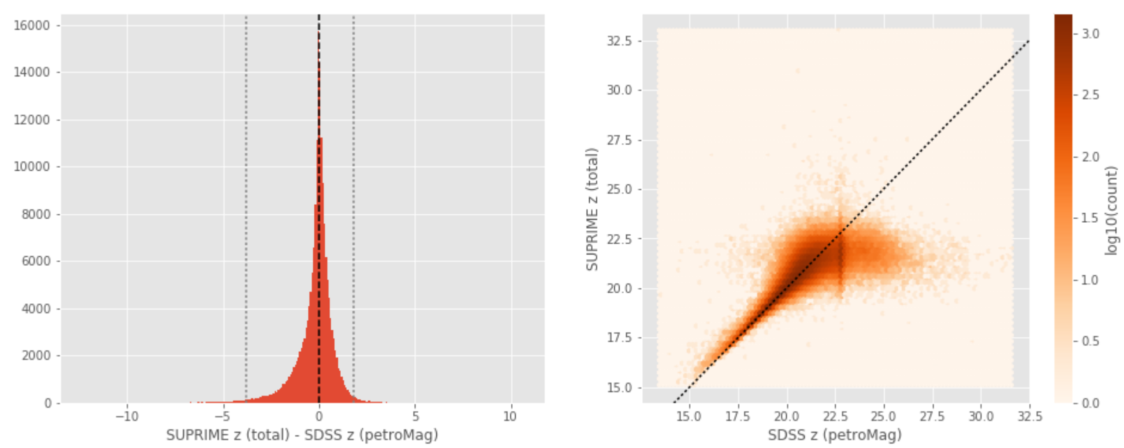
DECam z (total) - SDSS z (petroMag):
- Median: -0.11
- Median Absolute Deviation: 0.34
- 1% percentile: -4.015387382507324
- 99% percentile: 1.7345678901672361



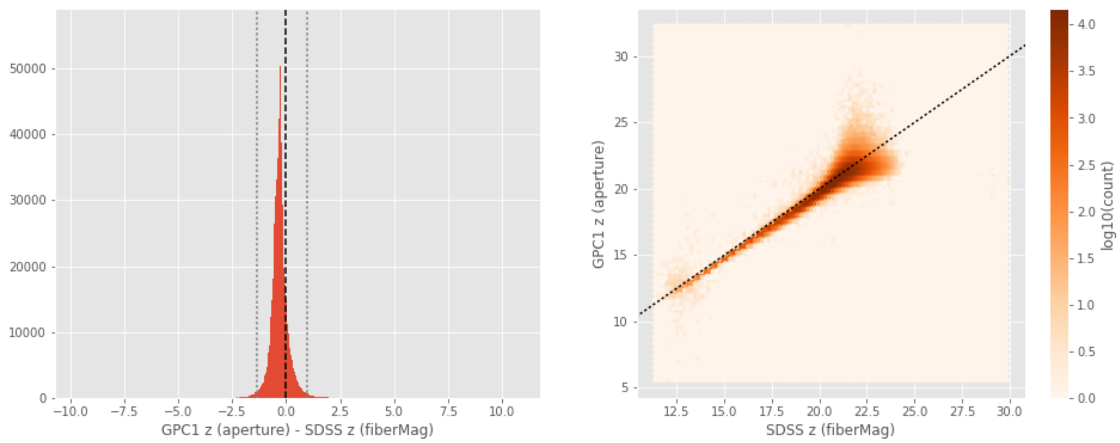
SUPRIME z (aperture) - SDSS z (fiberMag):
- Median: -0.17
- Median Absolute Deviation: 0.19
- 1% percentile: -1.1570728683471678
- 99% percentile: 1.0003003501892096



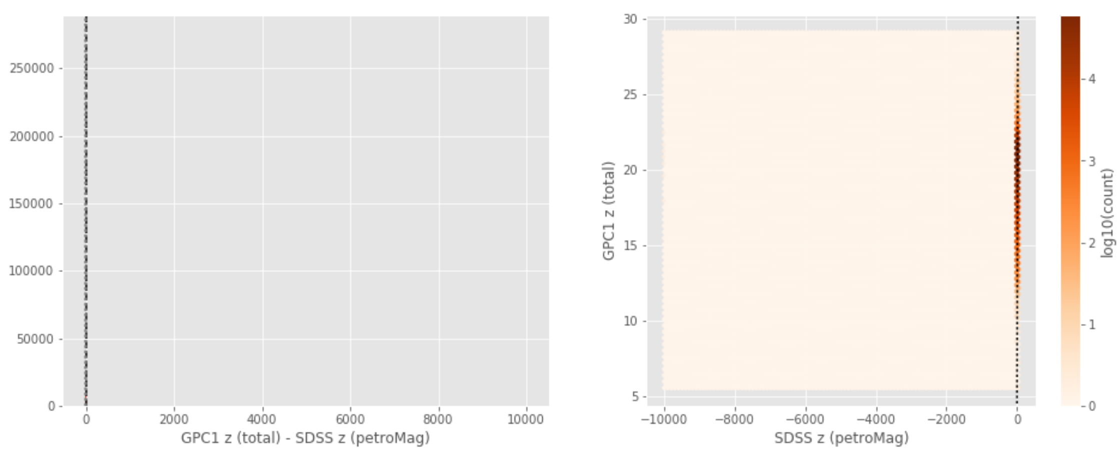
SUPRIME z (total) - SDSS z (petroMag):
- Median: -0.03
- Median Absolute Deviation: 0.35
- 1% percentile: -3.8091509246826174
- 99% percentile: 1.8075714111328063



GPC1 z (aperture) - SDSS z (fiberMag):
- Median: -0.31
- Median Absolute Deviation: 0.18
- 1% percentile: -1.3754301261901856
- 99% percentile: 0.9457995605468756




```
GPC1 z (total) - SDSS z (petroMag):
- Median: 0.11
- Median Absolute Deviation: 0.30
- 1% percentile: -3.7913813781738277
- 99% percentile: 1.6743761825561518
```



0.4.2 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.

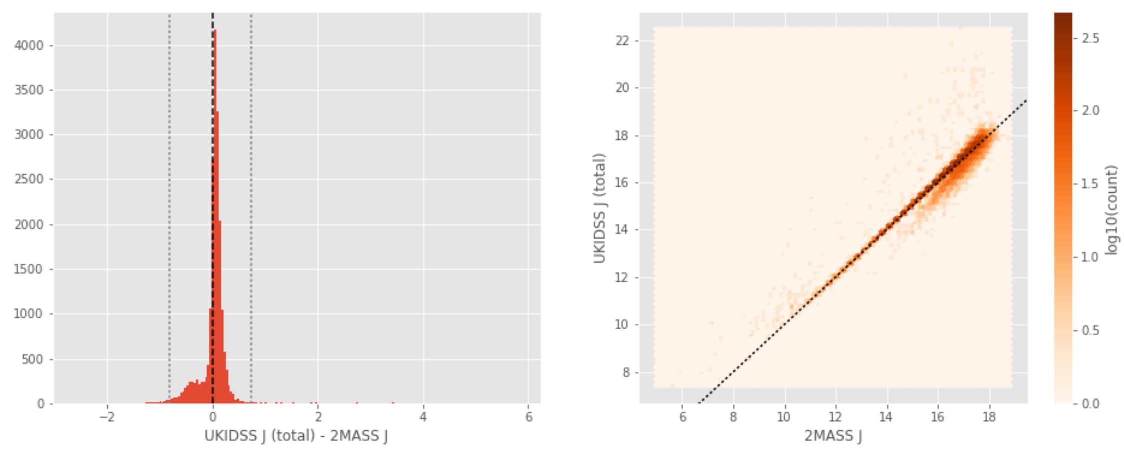
The 2MASS magnitudes are "*Vega-like*" and we have to convert them to AB magnitudes using the zero points provided on this page:

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

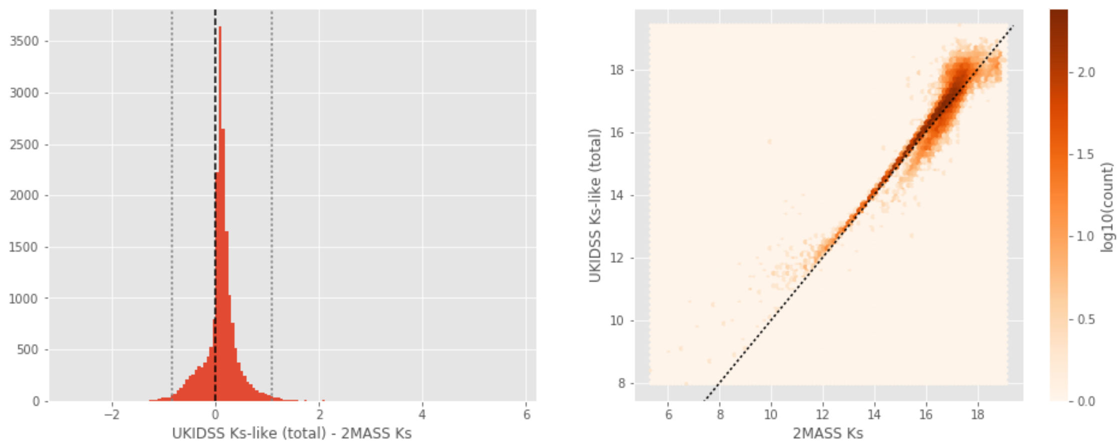
In addition, UKIDSS uses a K band whereas 2MASS uses a Ks ("short") band, this page give a correction to convert the K band in a Ks band with the formula:

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

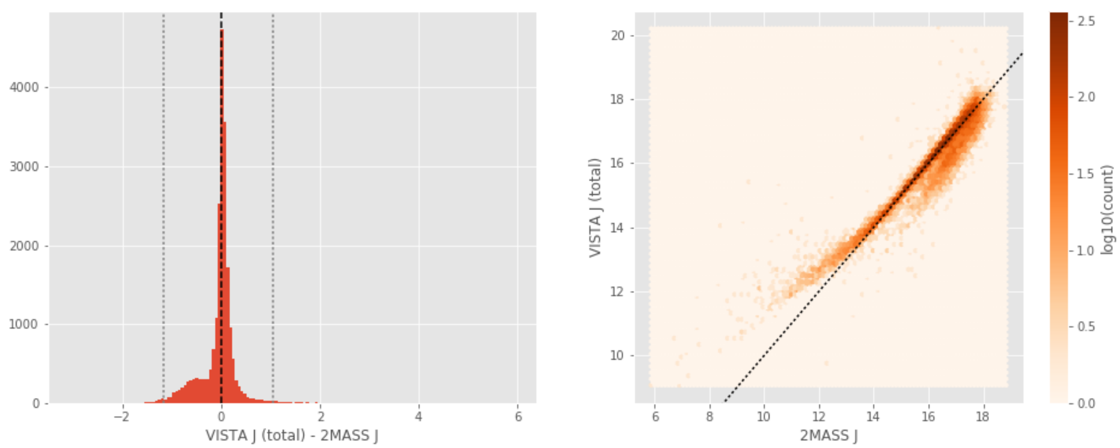
```
UKIDSS J (total) - 2MASS J:
- Median: 0.06
- Median Absolute Deviation: 0.06
- 1% percentile: -0.82272788390177
- 99% percentile: 0.7281288665865127
```



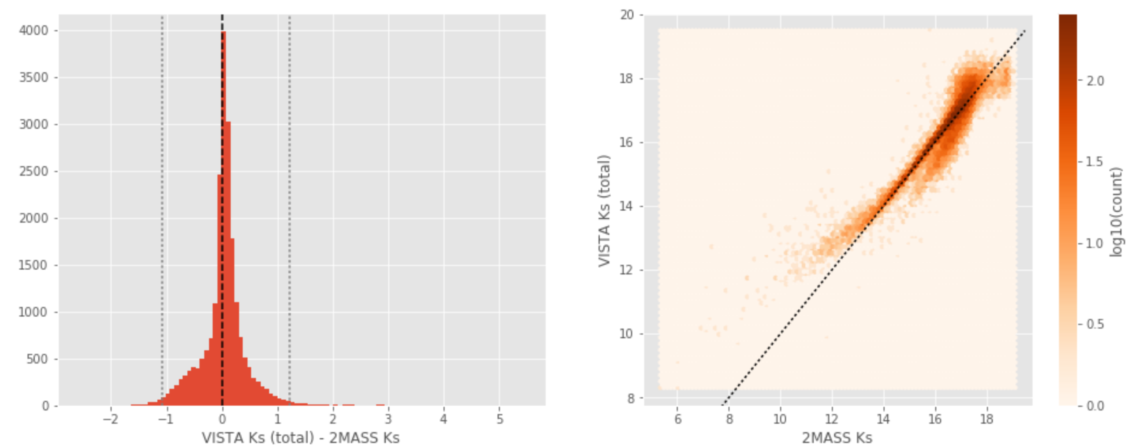

```
UKIDSS Ks-like (total) - 2MASS Ks:
- Median: 0.11
- Median Absolute Deviation: 0.10
- 1% percentile: -0.8383912190111664
- 99% percentile: 1.1027035285321665
```



VISTA J (total) - 2MASS J:
- Median: 0.02
- Median Absolute Deviation: 0.08
- 1% percentile: -1.160277298498327
- 99% percentile: 1.0473052539156118

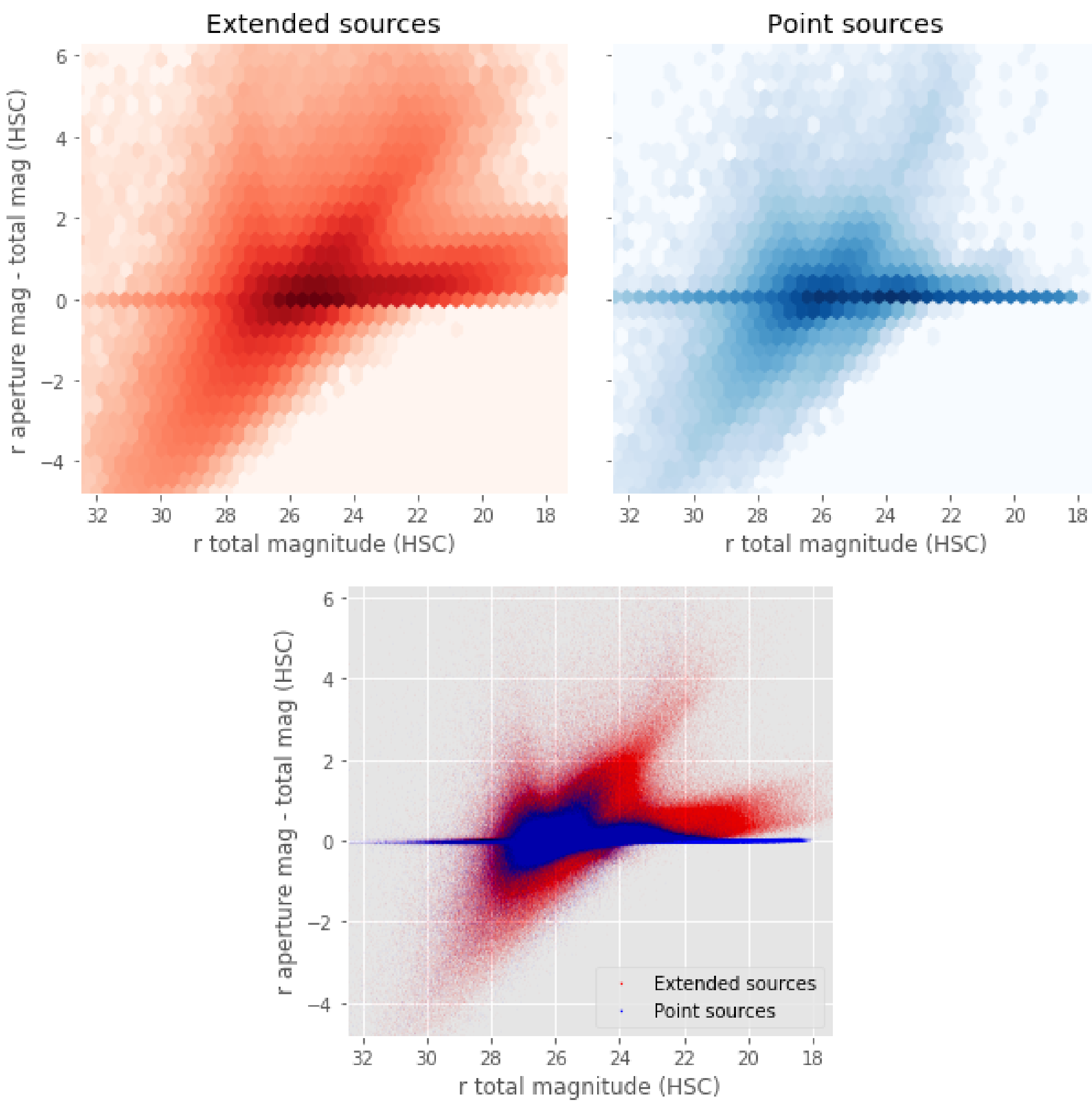


VISTA Ks (total) - 2MASS Ks:
- Median: 0.05
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0731860493334318
- 99% percentile: 1.219176158231873



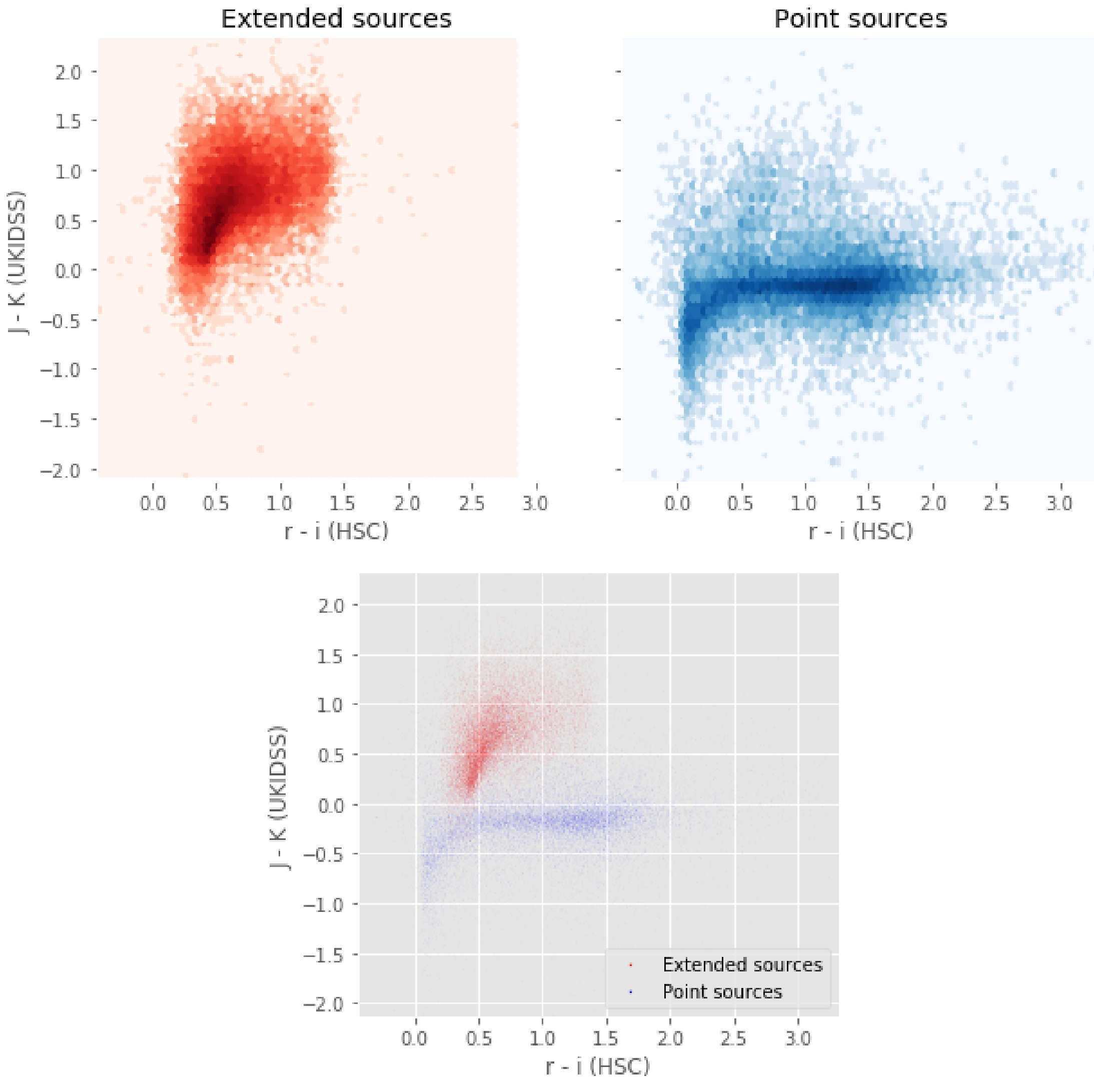
0.5 IV - Comparing aperture magnitudes to total ones.

```
Number of source used: 4366603 / 12369415 (35.30%)
```

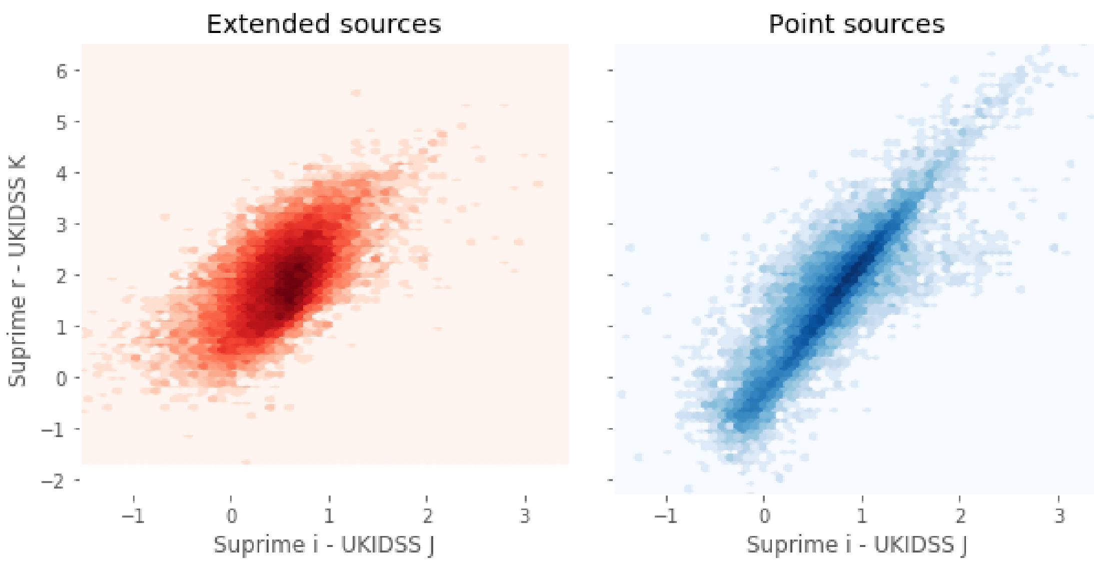


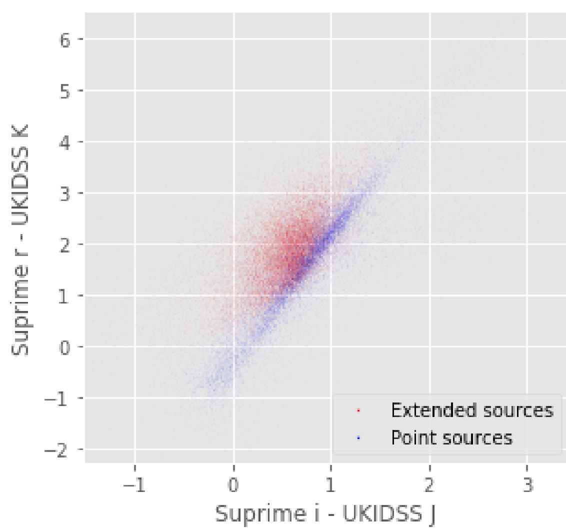
0.6 V - Color-color and magnitude-color plots

```
Number of source used: 37754 / 12369415 (0.31%)
```

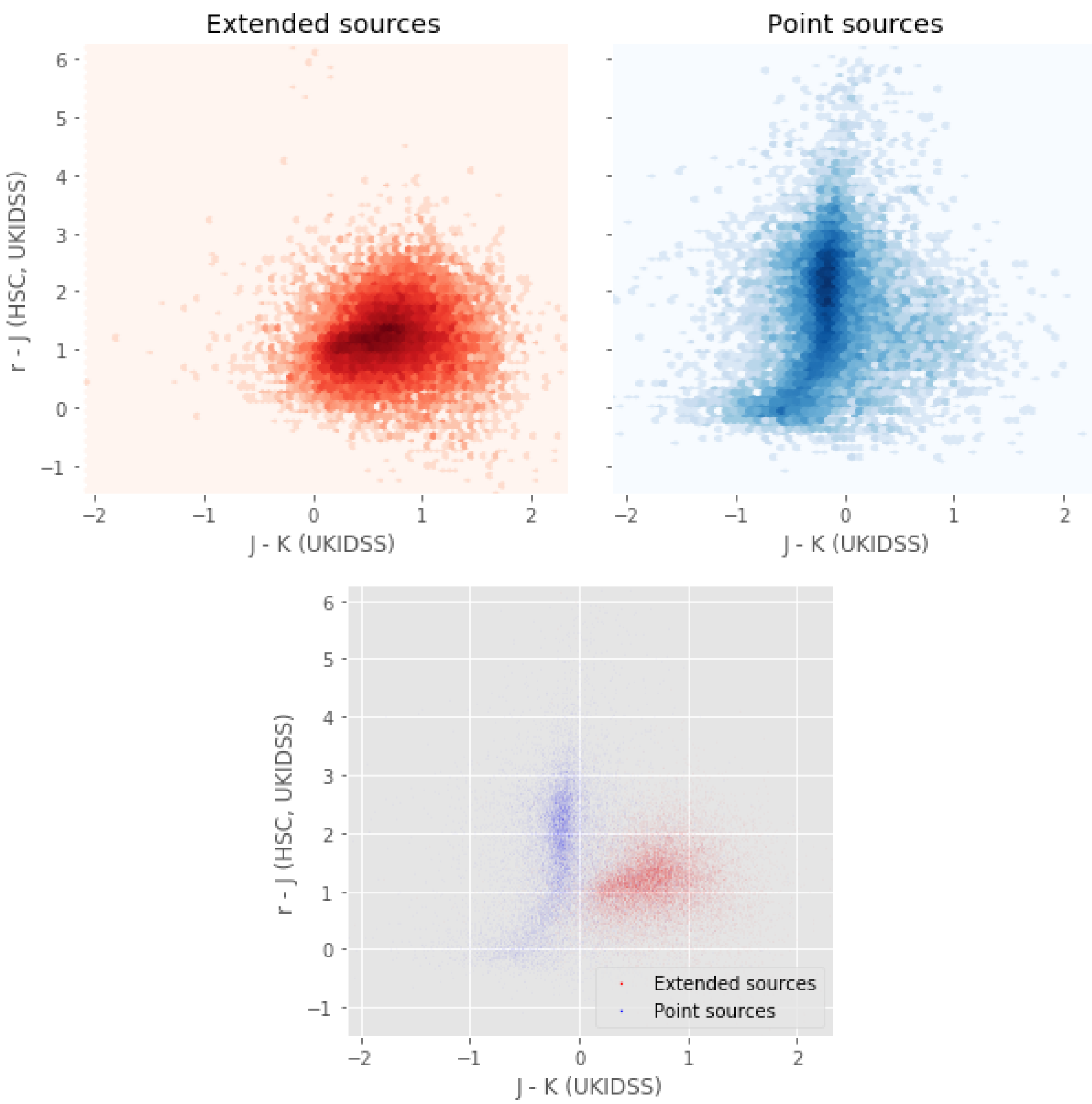


Number of source used: 37754 / 12369415 (0.31%)





Number of source used: 37757 / 12369415 (0.31%)



Extended sources
Point sources
r - J (HSC, UKIDSS)
J - K (UKIDSS)
Extended sources
Point sources

4_Selection_function

March 8, 2018

1 GAMA-12 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 21:34:07.936594
```

```
Depth maps produced using: master_catalogue_gama-12_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

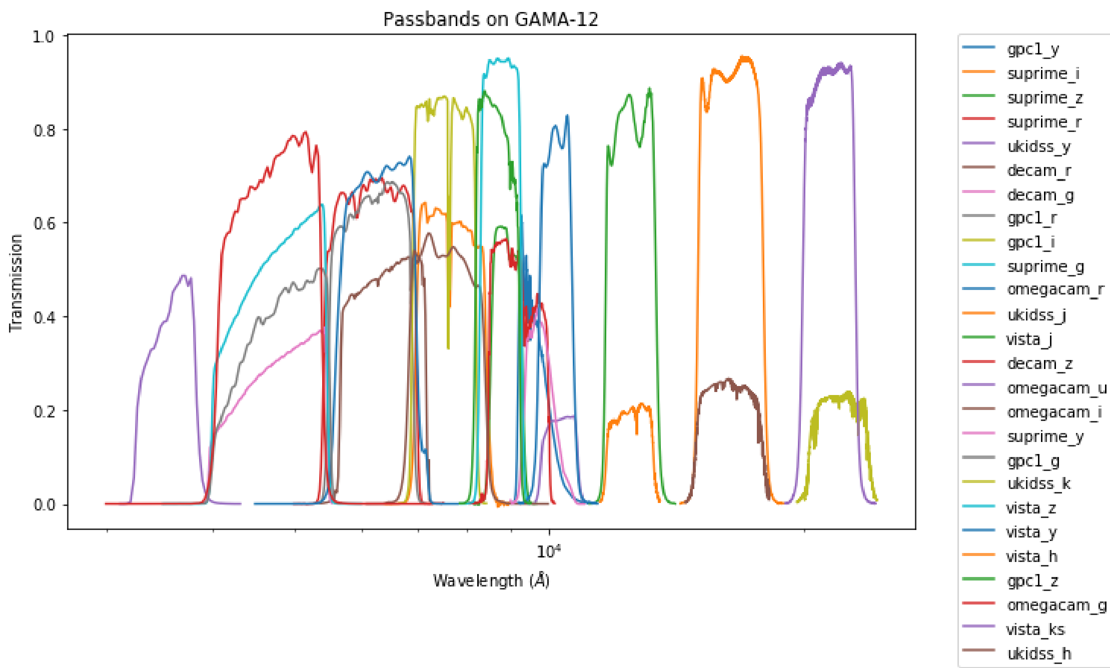
1.5 IV - Overview plots

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]: {'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 0x7f882fcdf5f8>
```



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: 3.133824577616906e-07, 3sigma in AB mag (Aperture): 38.967010157522616
decam_r: mean flux error: 4.977192133992503e-07, 3sigma in AB mag (Aperture): 38.464735847978254
decam_z: mean flux error: 5.6746068821667e-07, 3sigma in AB mag (Aperture): 38.32235741211476
suprime_g: mean flux error: 0.02343025989830494, 3sigma in AB mag (Aperture): 26.78275409819866
suprime_r: mean flux error: 0.03227318078279495, 3sigma in AB mag (Aperture): 26.43509243633968
suprime_i: mean flux error: inf, 3sigma in AB mag (Aperture): -inf
suprime_z: mean flux error: 0.071795254945755, 3sigma in AB mag (Aperture): 25.56695750813035
suprime_y: mean flux error: 0.1720176488161087, 3sigma in AB mag (Aperture): 24.618264344911104
omegacam_u: mean flux error: 0.2216183841228485, 3sigma in AB mag (Aperture): 24.343182403204928
omegacam_g: mean flux error: 0.09668917208909988, 3sigma in AB mag (Aperture): 25.24375225930807
omegacam_r: mean flux error: 0.1044473797082901, 3sigma in AB mag (Aperture): 25.159952990143502
omegacam_i: mean flux error: 0.3822774589061737, 3sigma in AB mag (Aperture): 23.751250136995004
gpc1_g: mean flux error: 6704.7258110498915, 3sigma in AB mag (Aperture): 13.141244307874544
gpc1_r: mean flux error: 5384.690589581968, 3sigma in AB mag (Aperture): 13.379294979955112
gpc1_i: mean flux error: 111.80530644936583, 3sigma in AB mag (Aperture): 17.586040822415434
gpc1_z: mean flux error: 9.621673940412125, 3sigma in AB mag (Aperture): 20.249070274623584
gpc1_y: mean flux error: 4511.997384885032, 3sigma in AB mag (Aperture): 13.571274765045835
ukidss_y: mean flux error: 4.085323333740234, 3sigma in AB mag (Aperture): 21.179130776817892
ukidss_j: mean flux error: 5.472280979156494, 3sigma in AB mag (Aperture): 20.861775891893863
ukidss_h: mean flux error: 5.633155345916748, 3sigma in AB mag (Aperture): 20.830317543276784
ukidss_k: mean flux error: 6.442551136016846, 3sigma in AB mag (Aperture): 20.684552177370186
```

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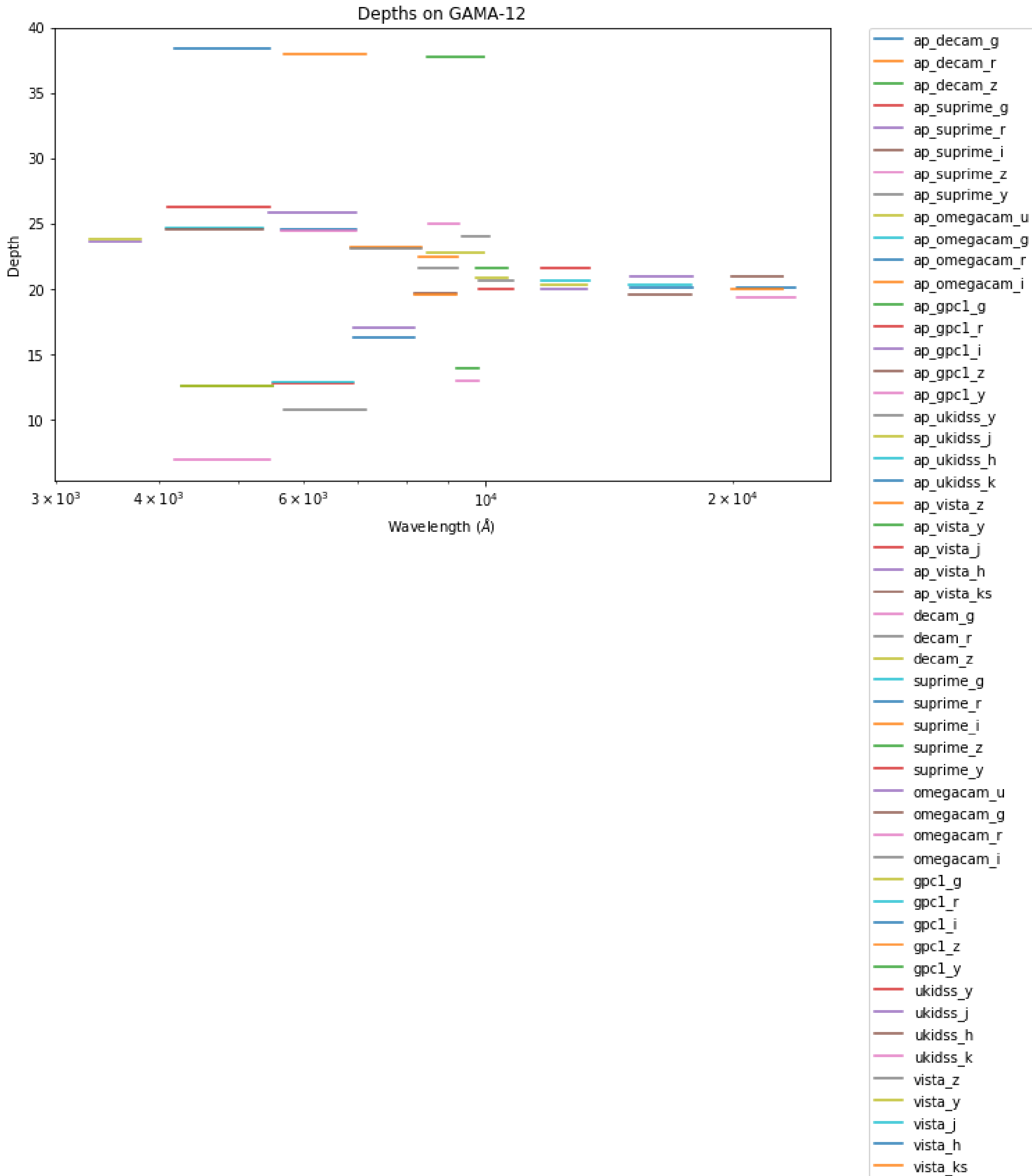
vista_z: mean flux error: 0.780605673789978, 3sigma in AB mag (Aperture): 22.976117604194407
vista_y: mean flux error: 1.652562141418457, 3sigma in AB mag (Aperture): 22.161802365018865
vista_j: mean flux error: 1.7444220781326294, 3sigma in AB mag (Aperture): 22.103067926580643
vista_h: mean flux error: 2.9306135177612305, 3sigma in AB mag (Aperture): 21.539800491934848
vista_ks: mean flux error: 3.031589984893799, 3sigma in AB mag (Aperture): 21.503020704029005
decam_g: mean flux error: 1203598.875, 3sigma in AB mag (Total): 7.505992430364401
decam_r: mean flux error: 35169.640625, 3sigma in AB mag (Total): 11.34177703676282
decam_z: mean flux error: 0.560624897480011, 3sigma in AB mag (Total): 23.335515910776103
suprime_g: mean flux error: nan, 3sigma in AB mag (Total): nan
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: 0.25768688321113586, 3sigma in AB mag (Total): 24.17946608160826
omegacam_g: mean flux error: 0.1110009253025055, 3sigma in AB mag (Total): 25.09388036551129
omegacam_r: mean flux error: 0.12315485626459122, 3sigma in AB mag (Total): 24.981068008972294
omegacam_i: mean flux error: 0.44612014293670654, 3sigma in AB mag (Total): 23.583567281510348
gpc1_g: mean flux error: 6815.626550409485, 3sigma in AB mag (Total): 13.123432398072033
gpc1_r: mean flux error: 5042.6099886664, 3sigma in AB mag (Total): 13.450558413812367
gpc1_i: mean flux error: 214.62734619081073, 3sigma in AB mag (Total): 16.8779842240288
gpc1_z: mean flux error: 10.357250393287158, 3sigma in AB mag (Total): 20.16908567388551
gpc1_y: mean flux error: 1903.789326835587, 3sigma in AB mag (Total): 14.508149643908183
ukidss_y: mean flux error: 7.0550150871276855, 3sigma in AB mag (Total): 20.585951996128962
ukidss_j: mean flux error: 7.297461032867432, 3sigma in AB mag (Total): 20.549267401671763
ukidss_h: mean flux error: 10.874505996704102, 3sigma in AB mag (Total): 20.116173020462533
ukidss_k: mean flux error: 12.705564498901367, 3sigma in AB mag (Total): 19.947211950200888
vista_z: mean flux error: 1.6978071928024292, 3sigma in AB mag (Total): 22.132475940327915
vista_y: mean flux error: 3.4150447845458984, 3sigma in AB mag (Total): 21.37370585483074
vista_j: mean flux error: 3.9011924266815186, 3sigma in AB mag (Total): 21.229203432060636
vista_h: mean flux error: 6.704754829406738, 3sigma in AB mag (Total): 20.641239608769276
vista_ks: mean flux error: 7.0718536376953125, 3sigma in AB mag (Total): 20.583363703846906


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)
```

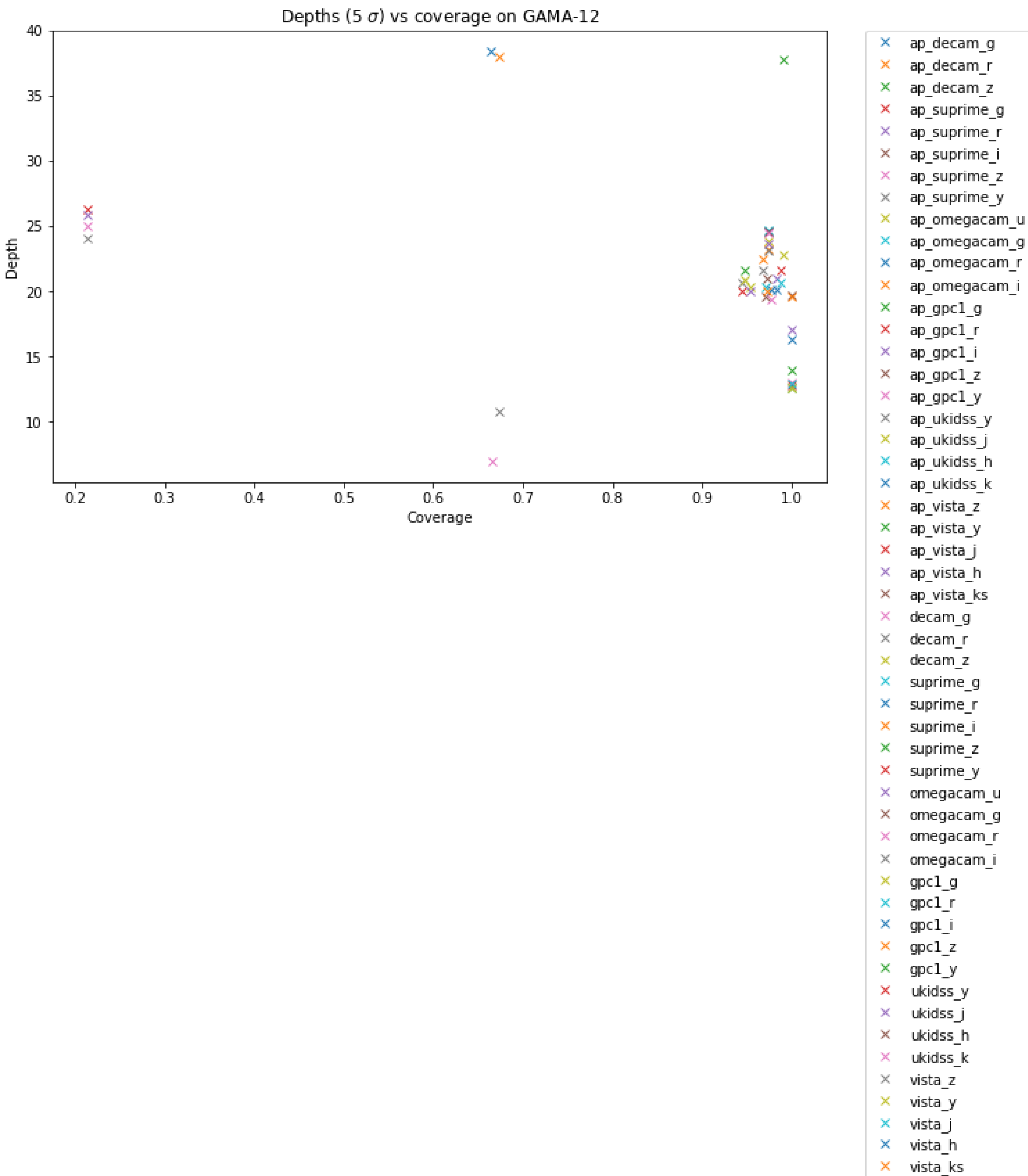
```
Out[20]: <matplotlib.text.Text at 0x7f84c17d9fd0>
```



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 0x7f84c0345a90>
```



Depths (5 σ) vs coverage on GAMA-12
Depth
Coverage
40
35
30
25
20
15
10
0.2
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