1.1_CFHTLS

January 18, 2018

1 GAMA-09 master catalogue

1.1 Preparation of Canada France Hawaii Telescope Legacy Survey (CFHTLS) data

The catalogue is in `dmu0_CFHTLS`.

In the catalogue, we keep:

- The position;
- The stellarity (g band stellarity);
- The aperture magnitude (3 arcsec).
- The total magnitude (Kron like aperture magnitude).

We use the 2007 release, which we take as the date.

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

1.2 I - Column selection

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

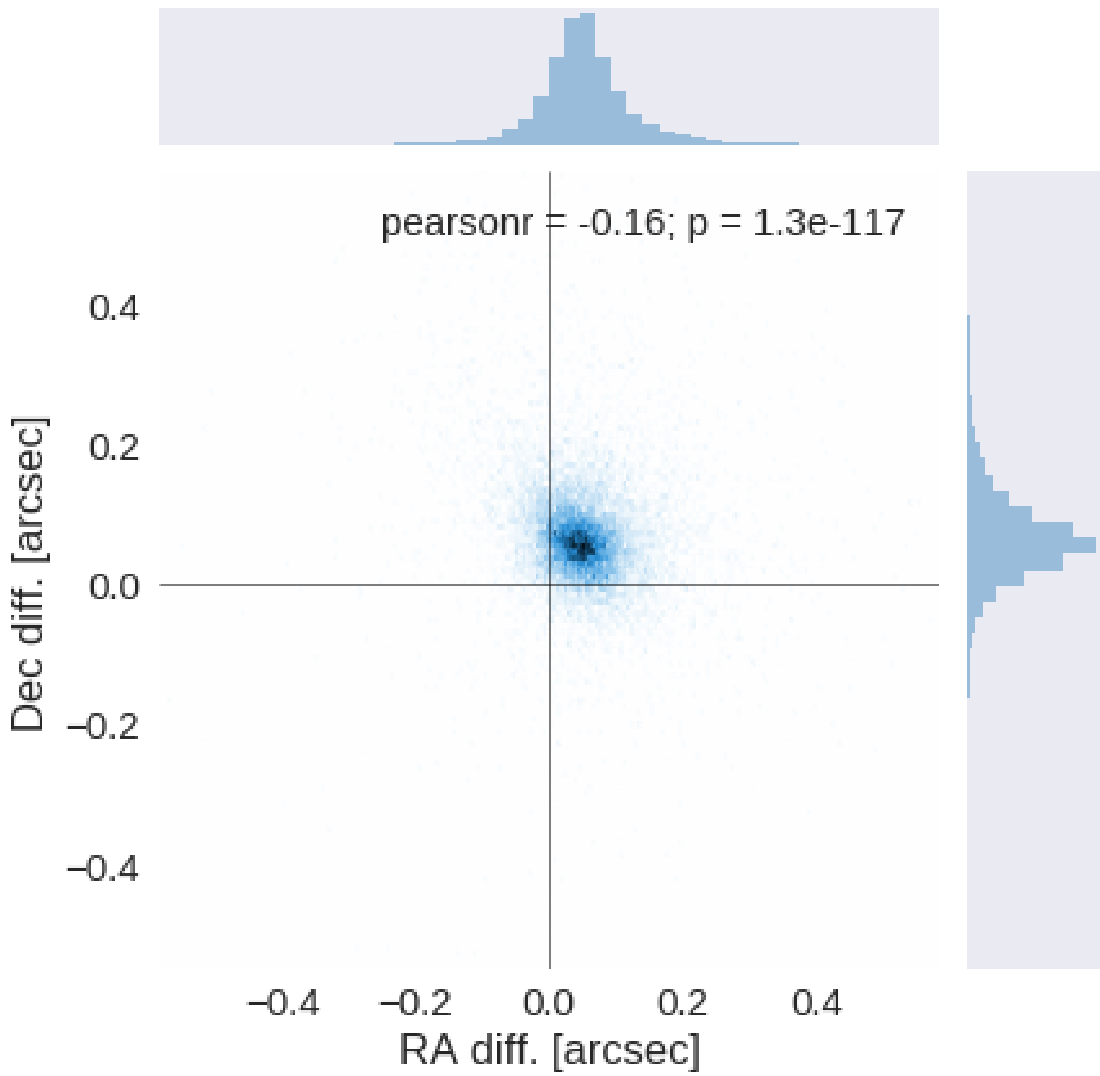
1.3 II - Removal of duplicated sources

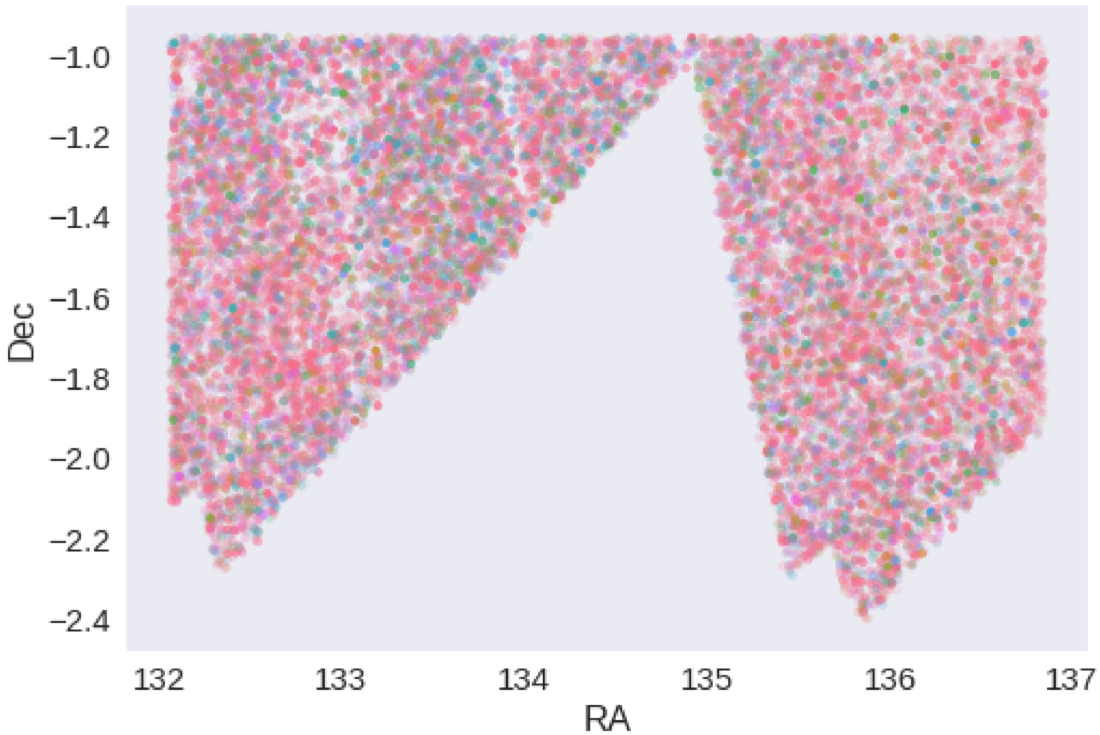
We remove duplicated objects from the input catalogues.

```
/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 1044973 sources.
The cleaned catalogue has 1044965 sources (8 removed).
The cleaned catalogue has 8 sources flagged as having been cleaned
```

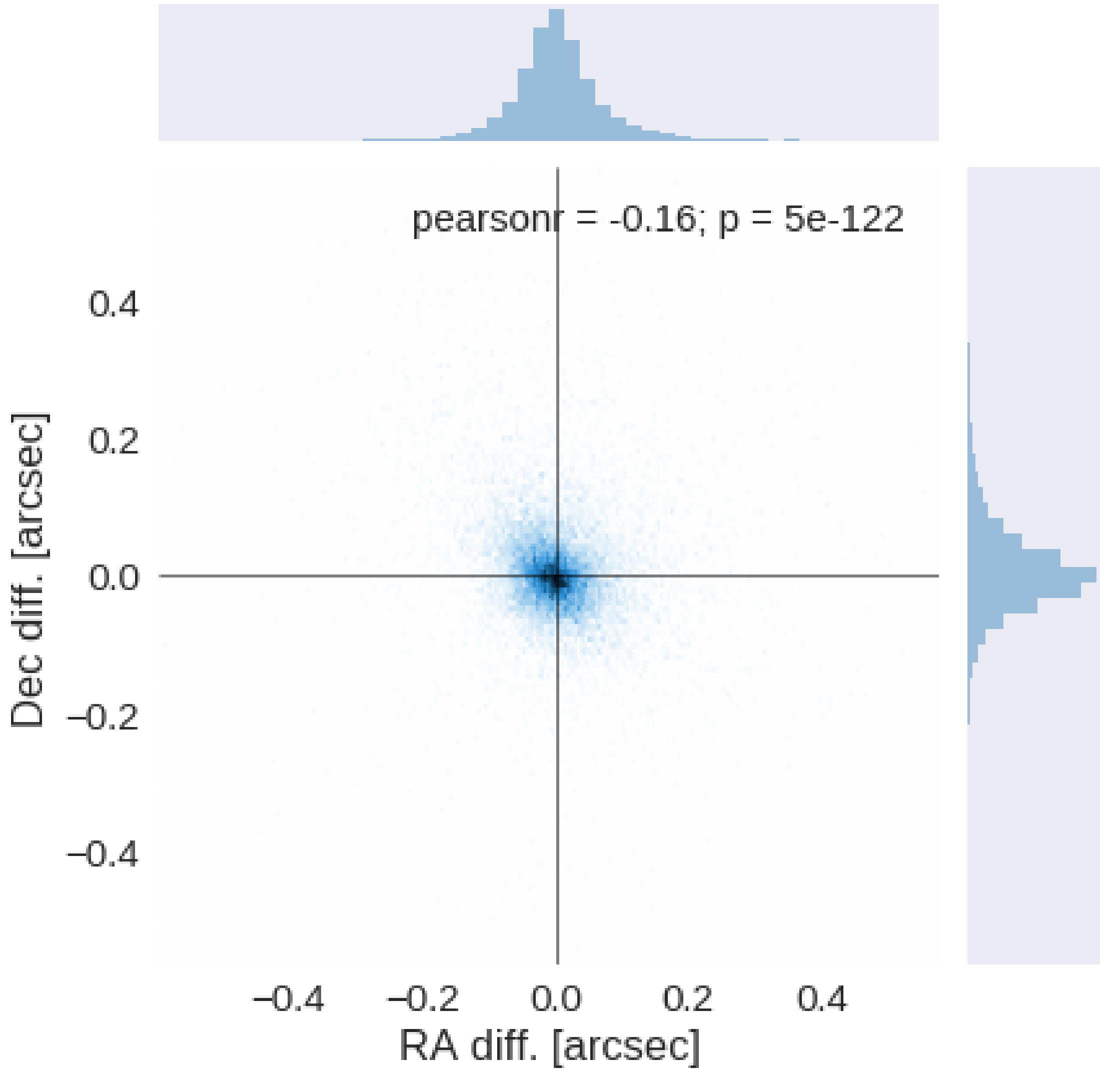
1.4 III - Astrometry correction

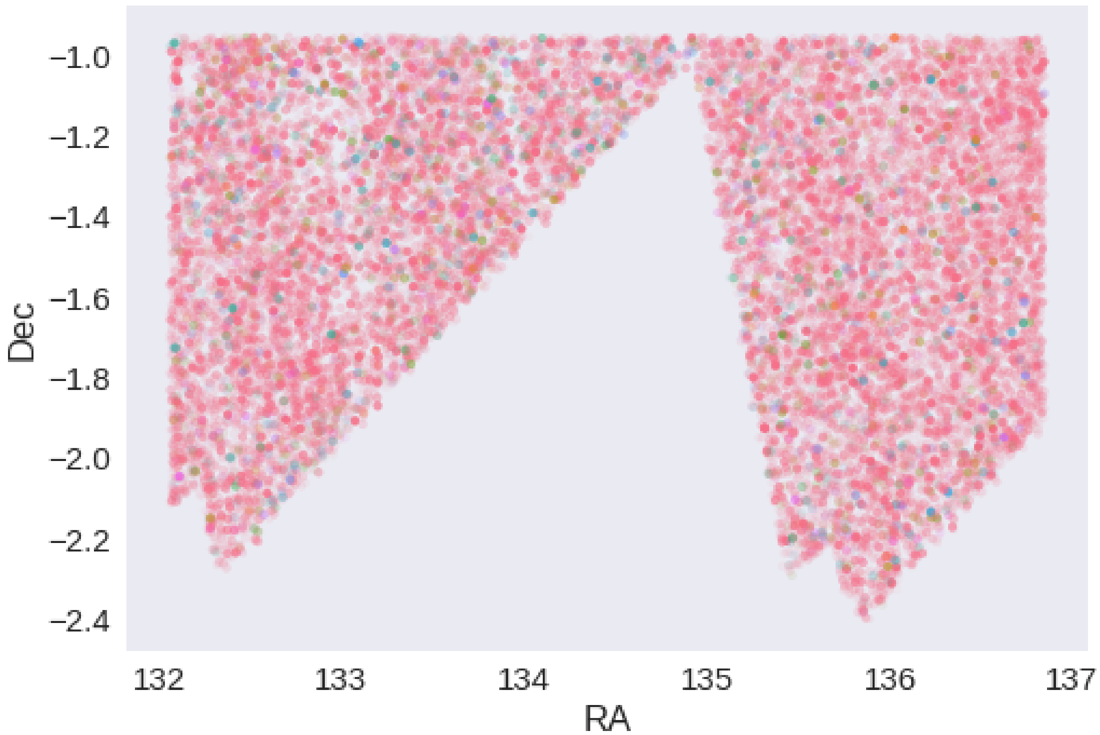
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.04861379154590395 arcsec
Dec correction: -0.06012614039372366 arcsec
```


pearsonr = -0.16; p = 5e-122
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

```
20482 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.2_CFHTLenS

January 18, 2018

1 GAMA-09 master catalogue

1.1 Preparation of Canada France Hawaii Telescope Lensing Survey (CFHTLenS) data

Isaac Newton Telescope / Wide Field Camera (INT/WFC) catalogue: the catalogue comes from `dmu0_CFHTLenS`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The kron magnitude, there doesn't appear to be aperture magnitudes. This may mean the survey is unusable.

We use the publication year 2012 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

```
/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/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:10:
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:11:
```

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

1.3 II - Removal of duplicated sources

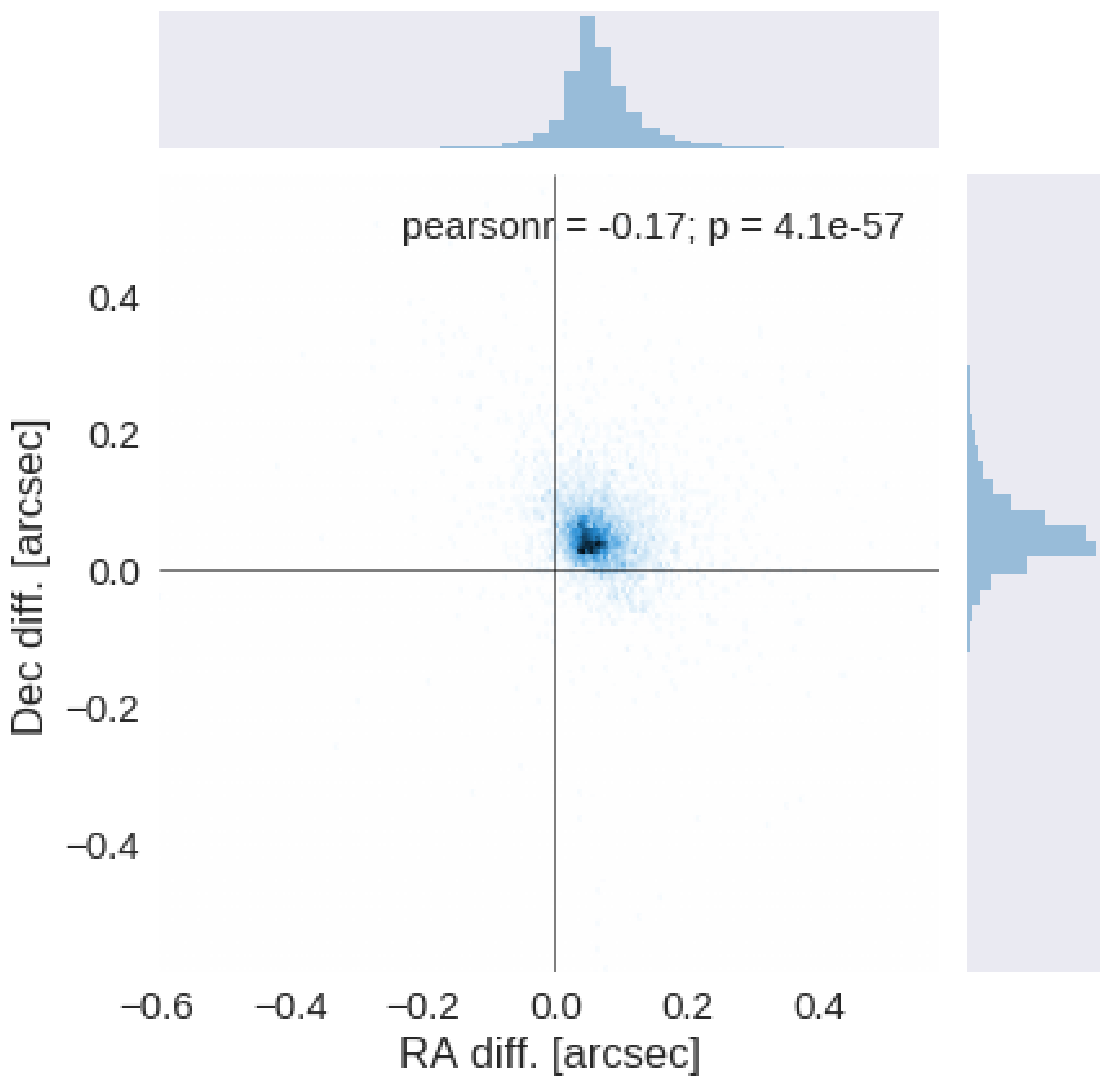
We remove duplicated objects from the input catalogues.

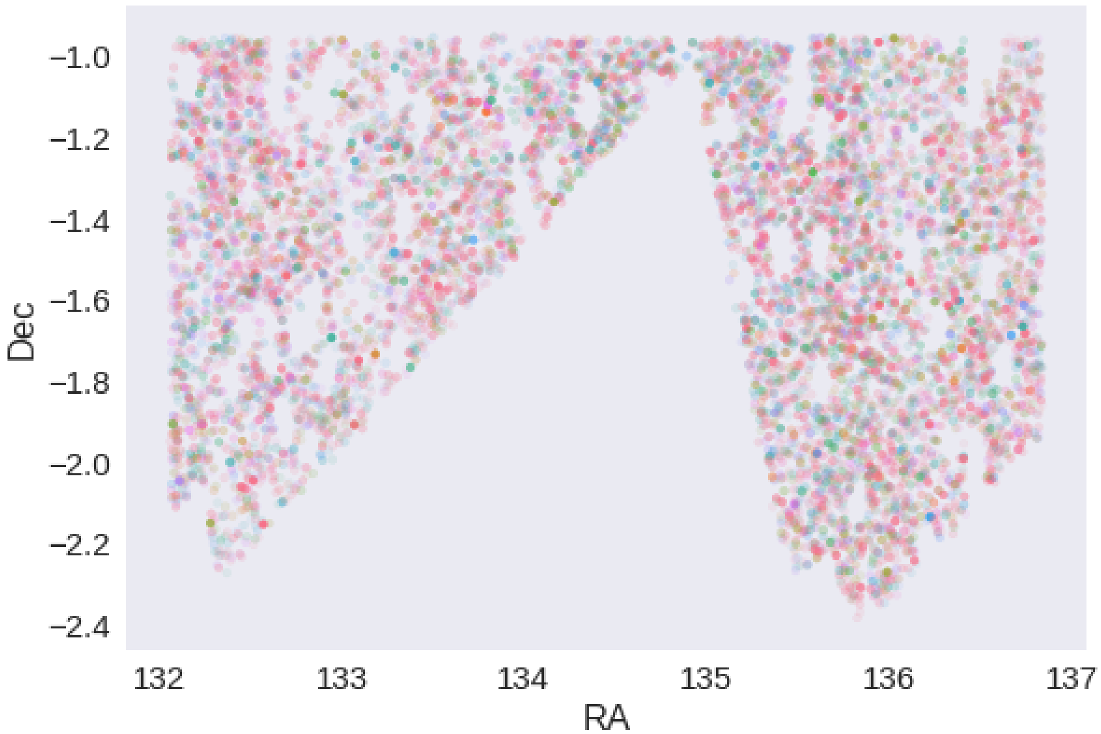
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 569071 sources.
The cleaned catalogue has 569066 sources (5 removed).
The cleaned catalogue has 5 sources flagged as having been cleaned
```

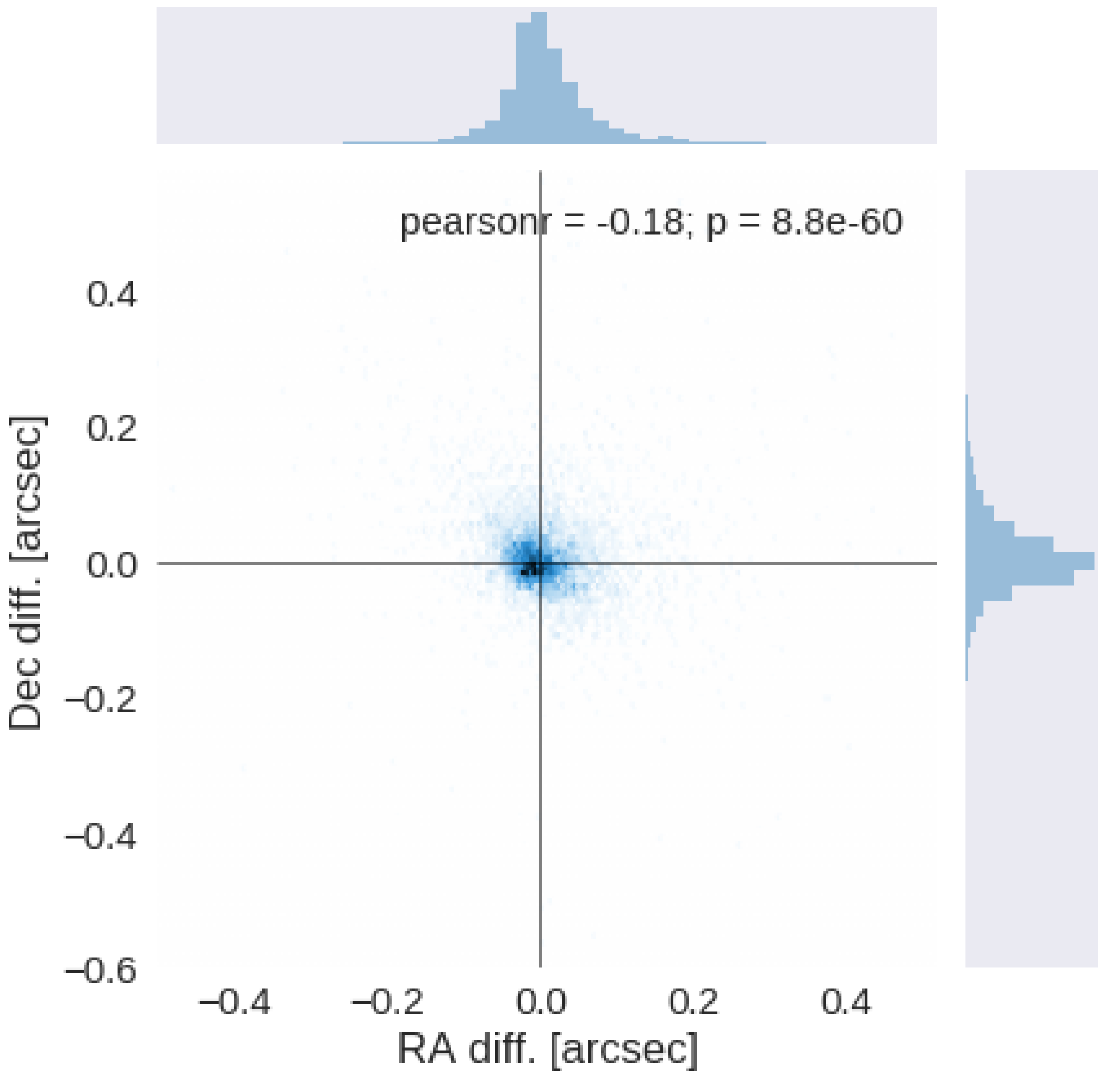
1.4 III - Astrometry correction

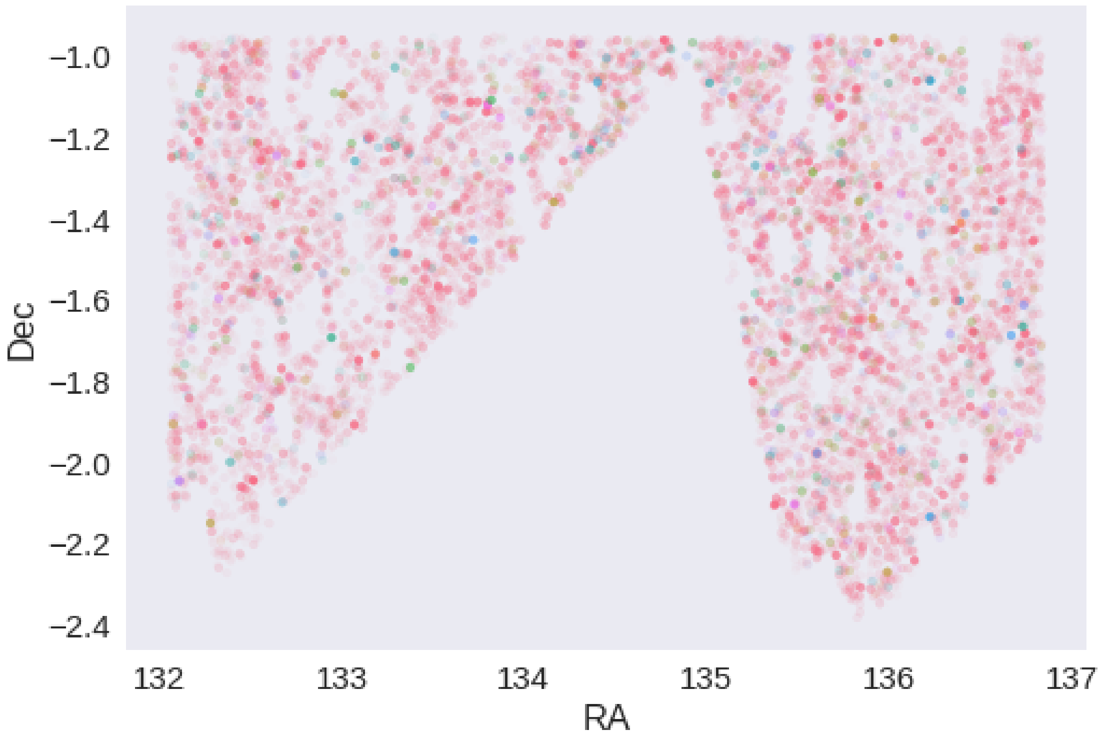
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.059877701926325244 arcsec
Dec correction: -0.04593033190820606 arcsec
```


pearsonr = -0.18; p = 8.8e-60
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

```
8602 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.3_DECaLS

January 18, 2018

1 GAMA-09 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).

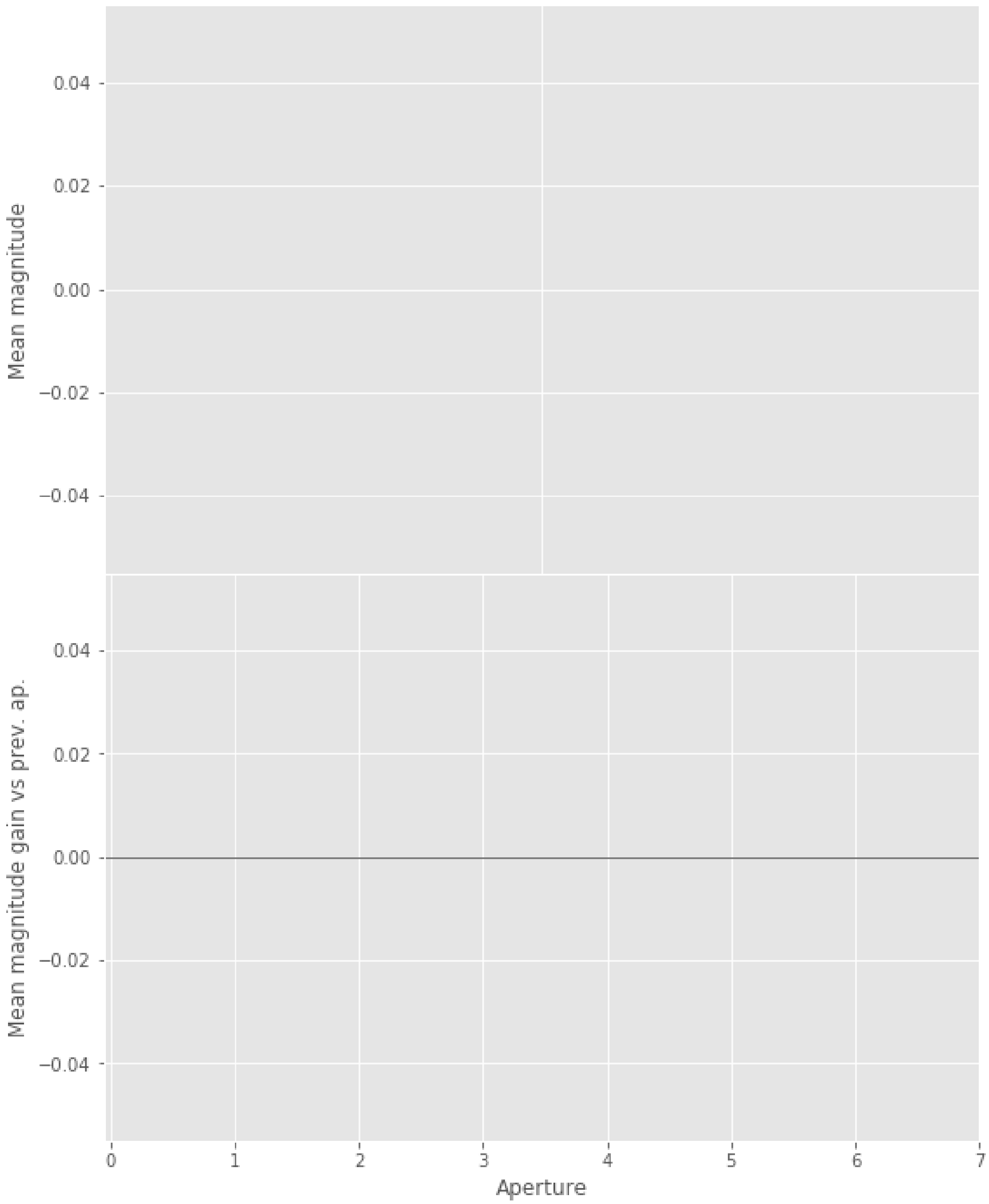
As target aperture, we should use the smallest (i.e. less noisy) aperture for which most of the flux is captures.

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
```

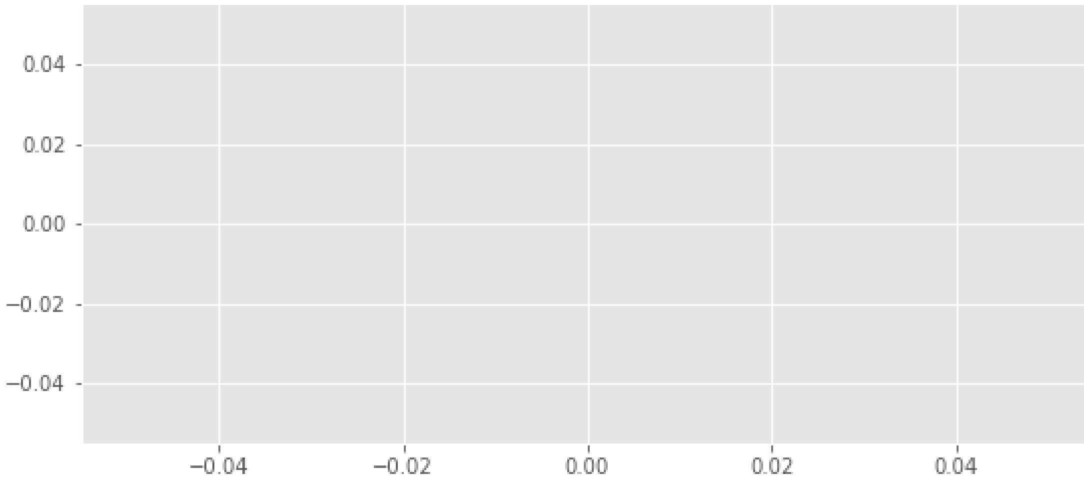
1.2.1 1.a u band

```
/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)
```



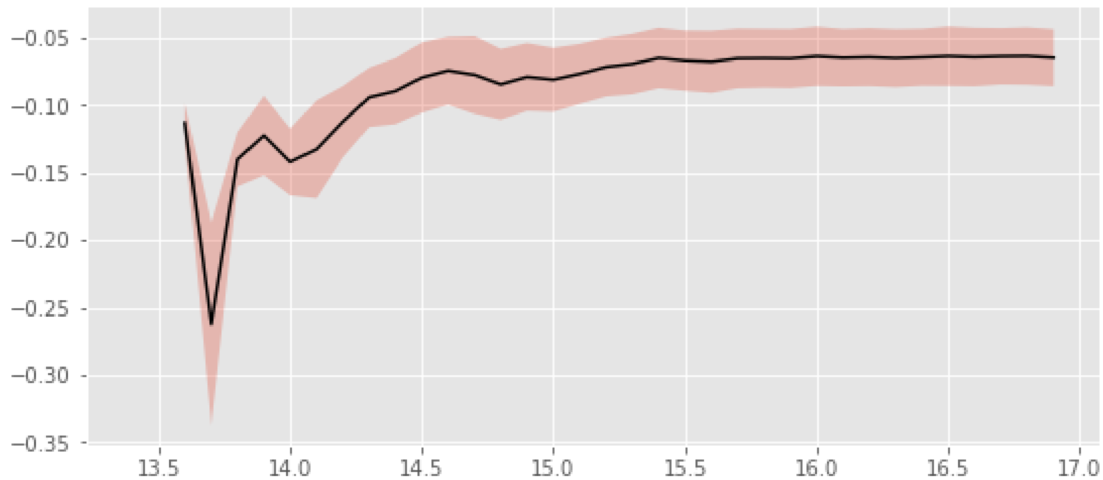
u band is all nan

```
/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

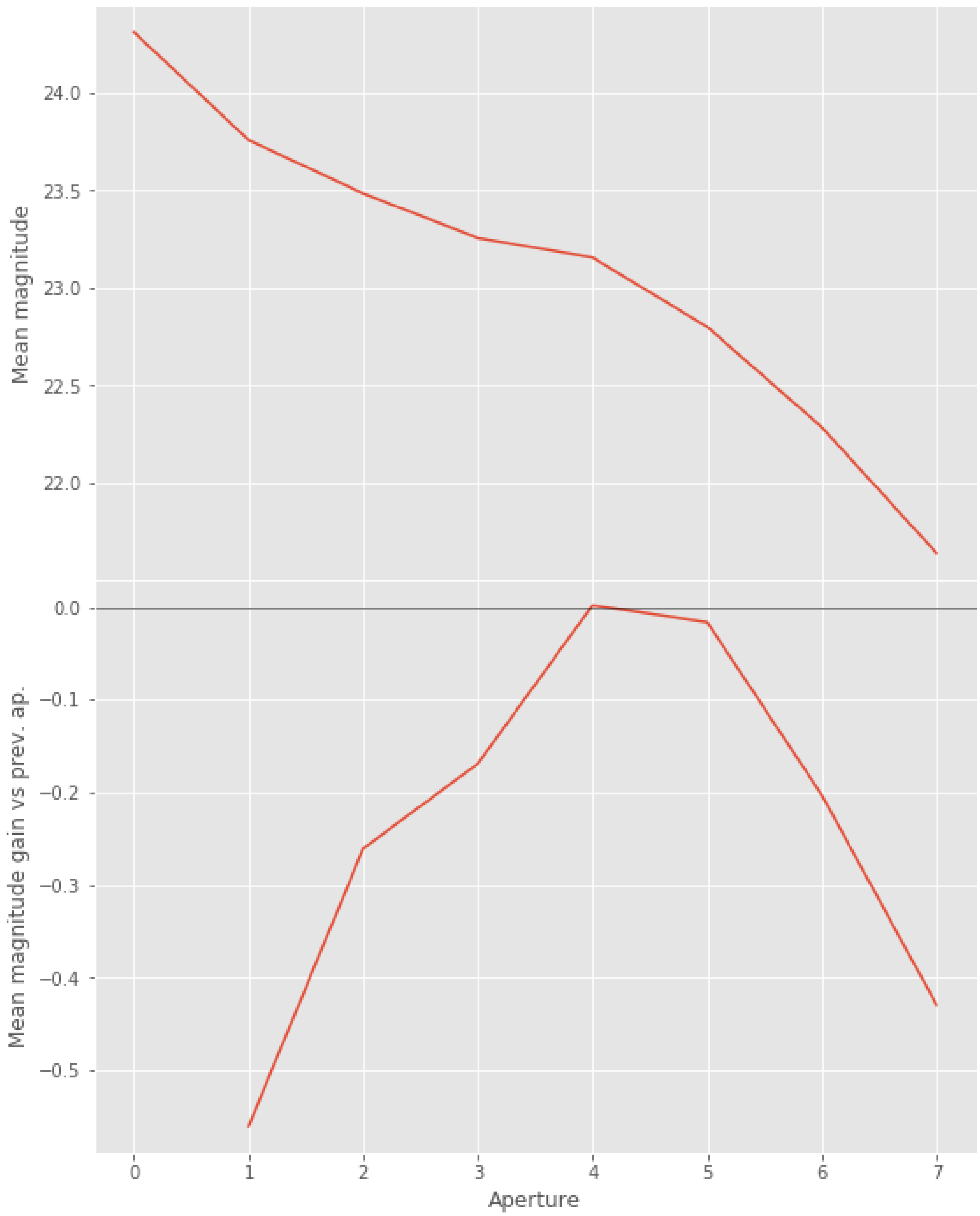
We will use aperture 5 as target.



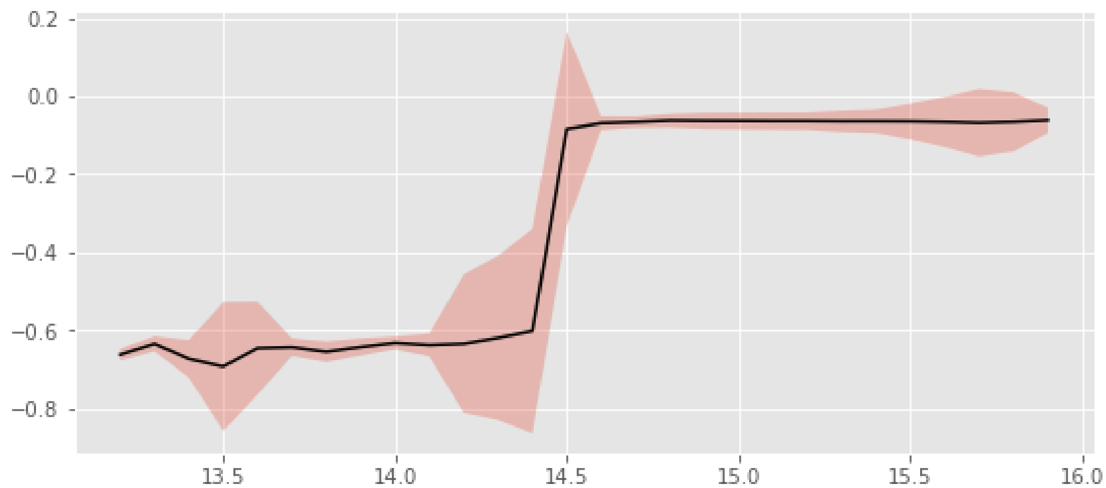
We will use magnitudes between 16.0 and 19.0

```
Aperture correction for g band:
Correction: -0.06364856635450167
Number of source used: 80580
RMS: 0.021638503175454352
```

1.2.3 I.b - r band



We will use aperture 5 as target.

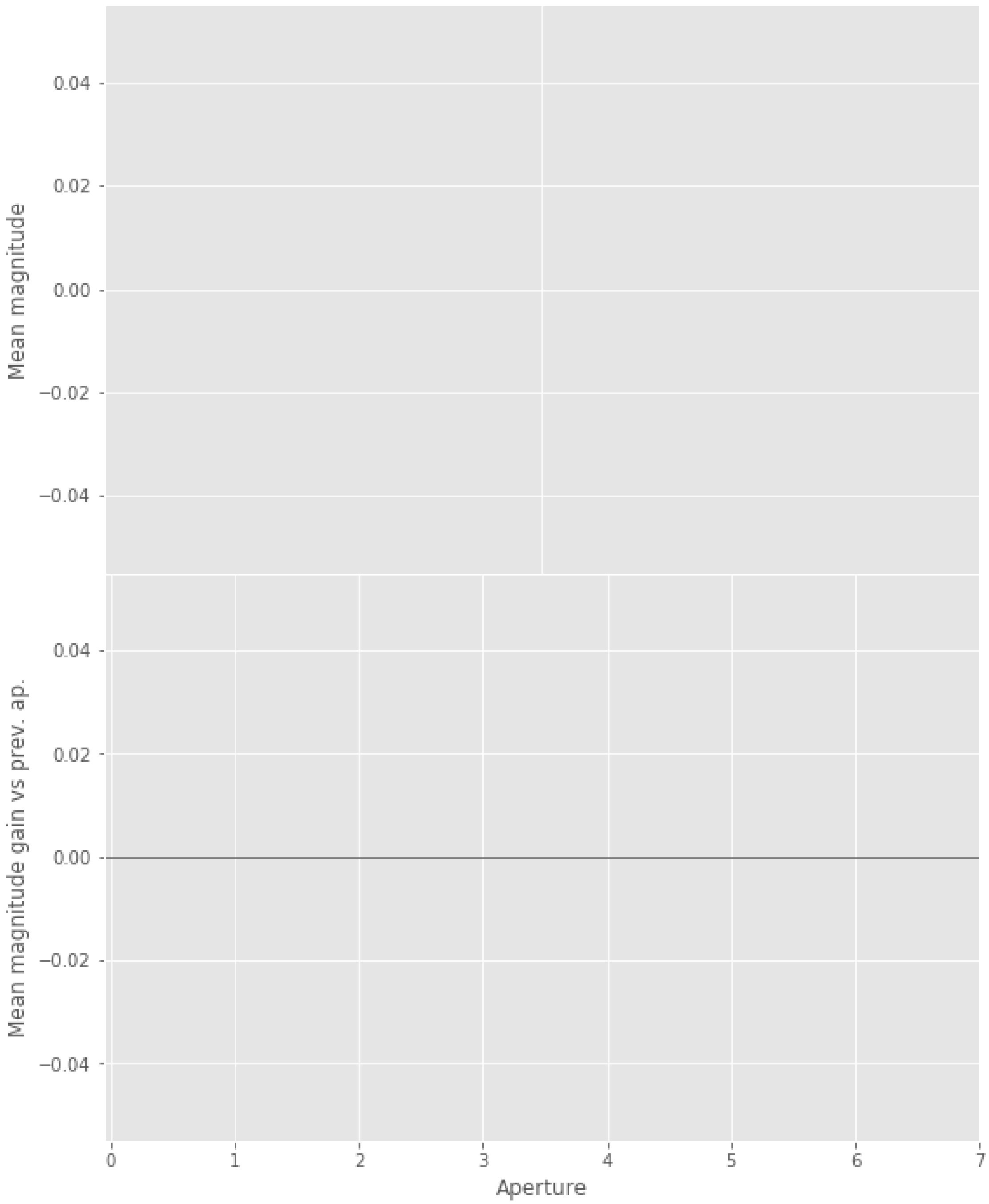


We use magnitudes between 16.0 and 18.0.

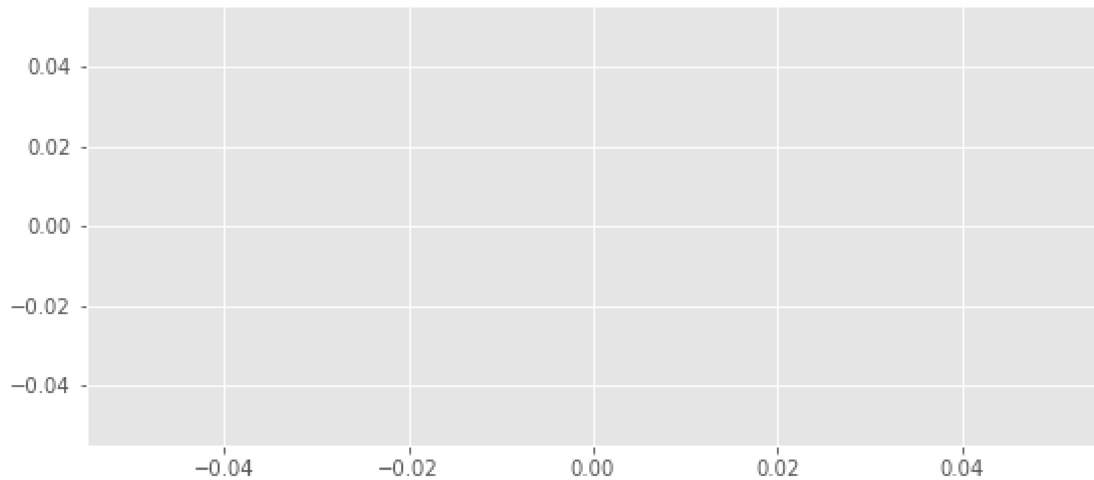
```
Aperture correction for r band:
Correction: -0.05840845867184896
Number of source used: 65026
RMS: 0.016524230909853454
```

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)
```

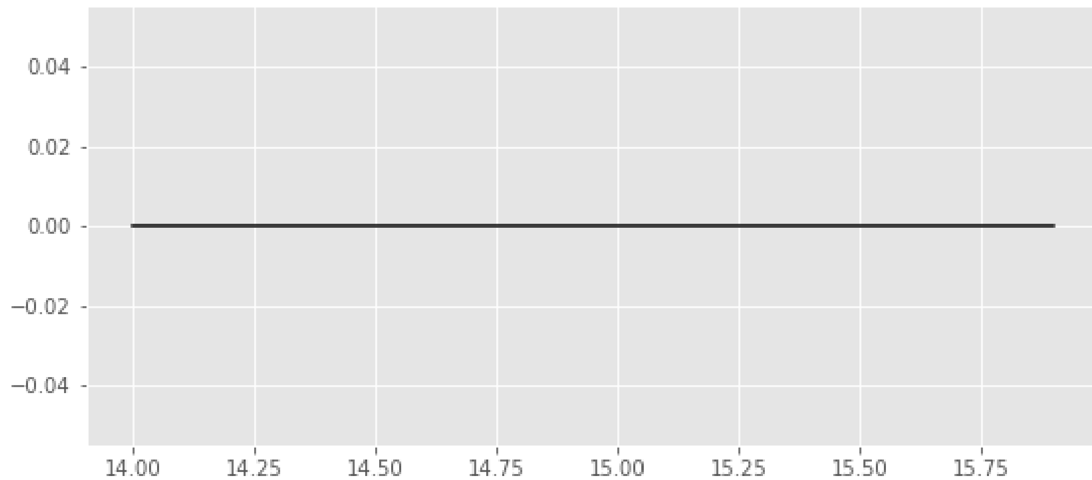



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```


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.

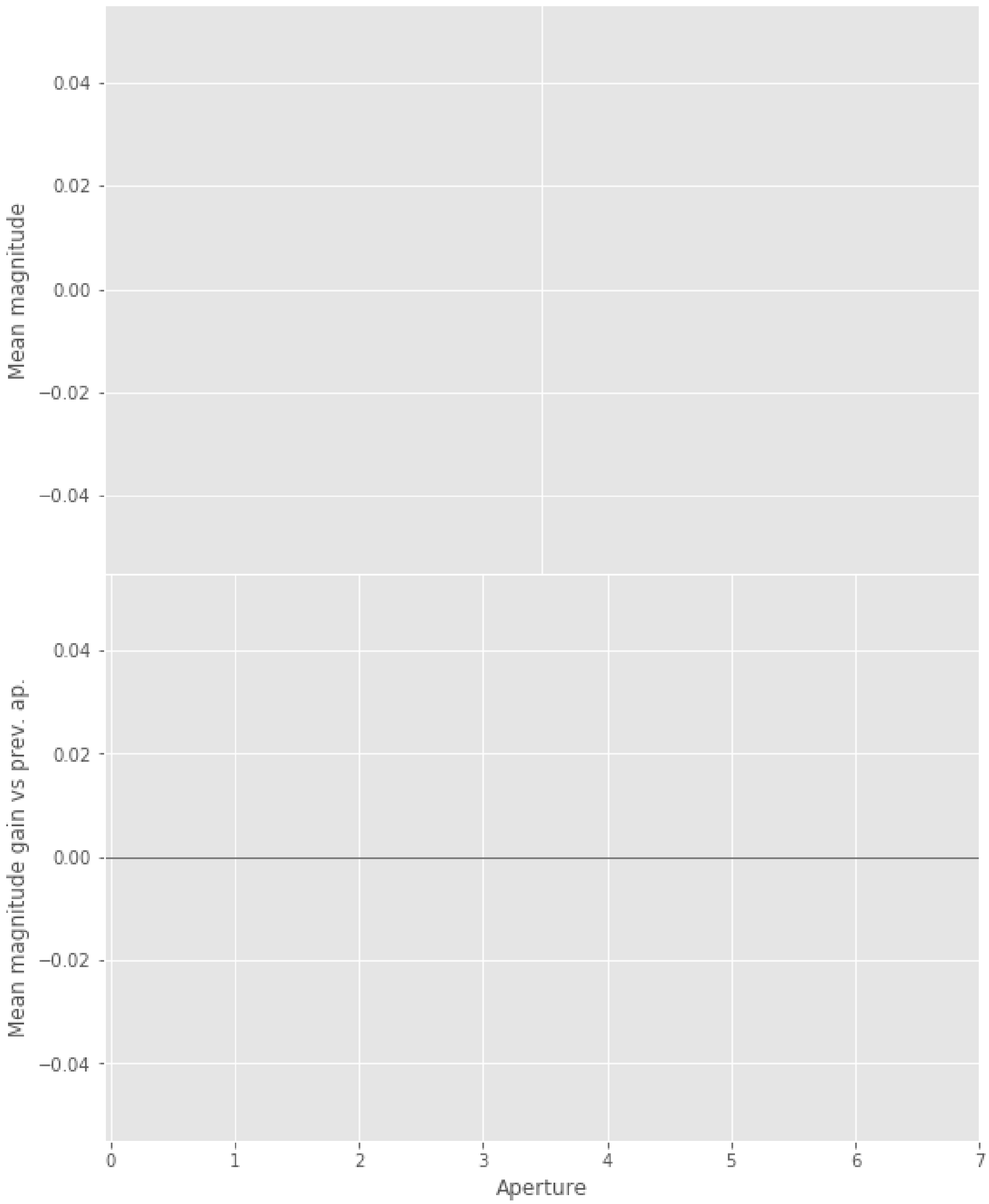


We use magnitudes between 16.0 and 17.5.

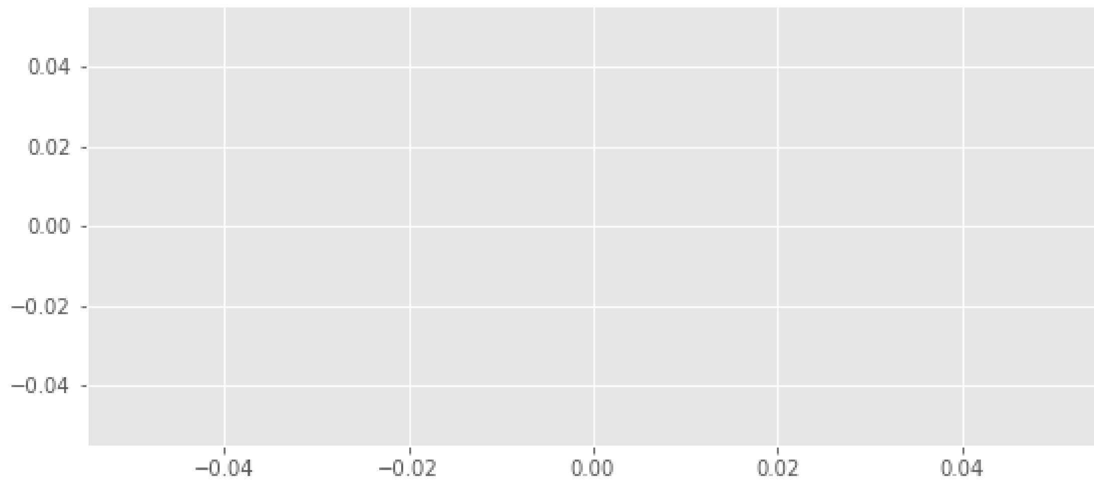
```
Aperture correction for z band:
Correction: -0.058563401863963804
Number of source used: 80697
RMS: 0.02760028468976214
```

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>
```

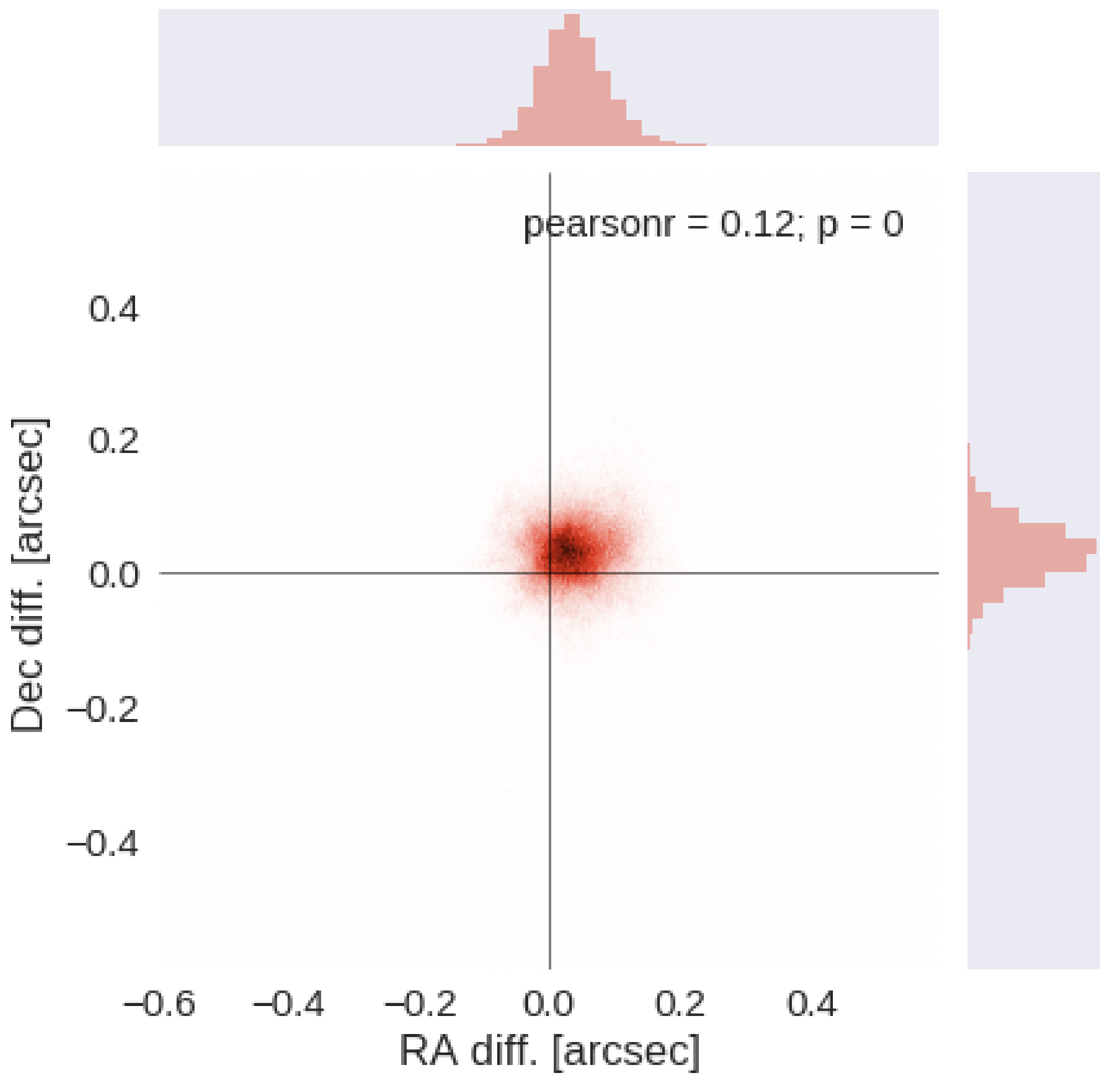
1.5 III - Removal of duplicated sources

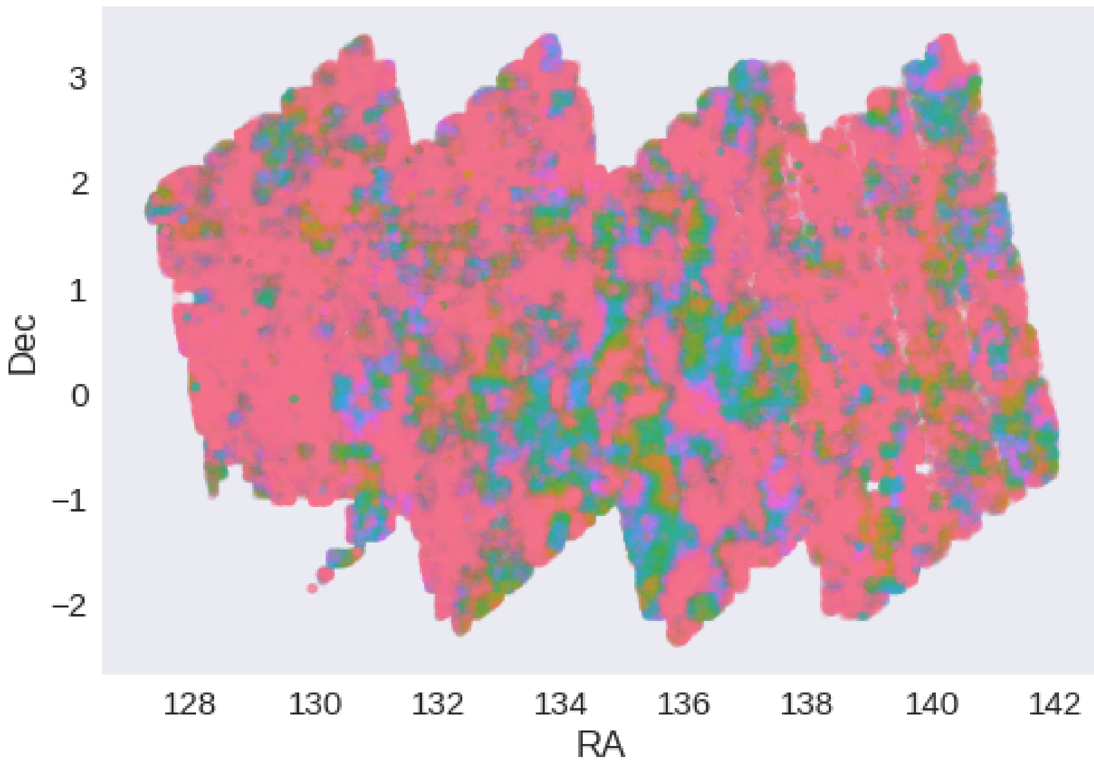
We remove duplicated objects from the input catalogues.

```
/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 4153642 sources.
The cleaned catalogue has 4151704 sources (1938 removed).
The cleaned catalogue has 1935 sources flagged as having been cleaned
```

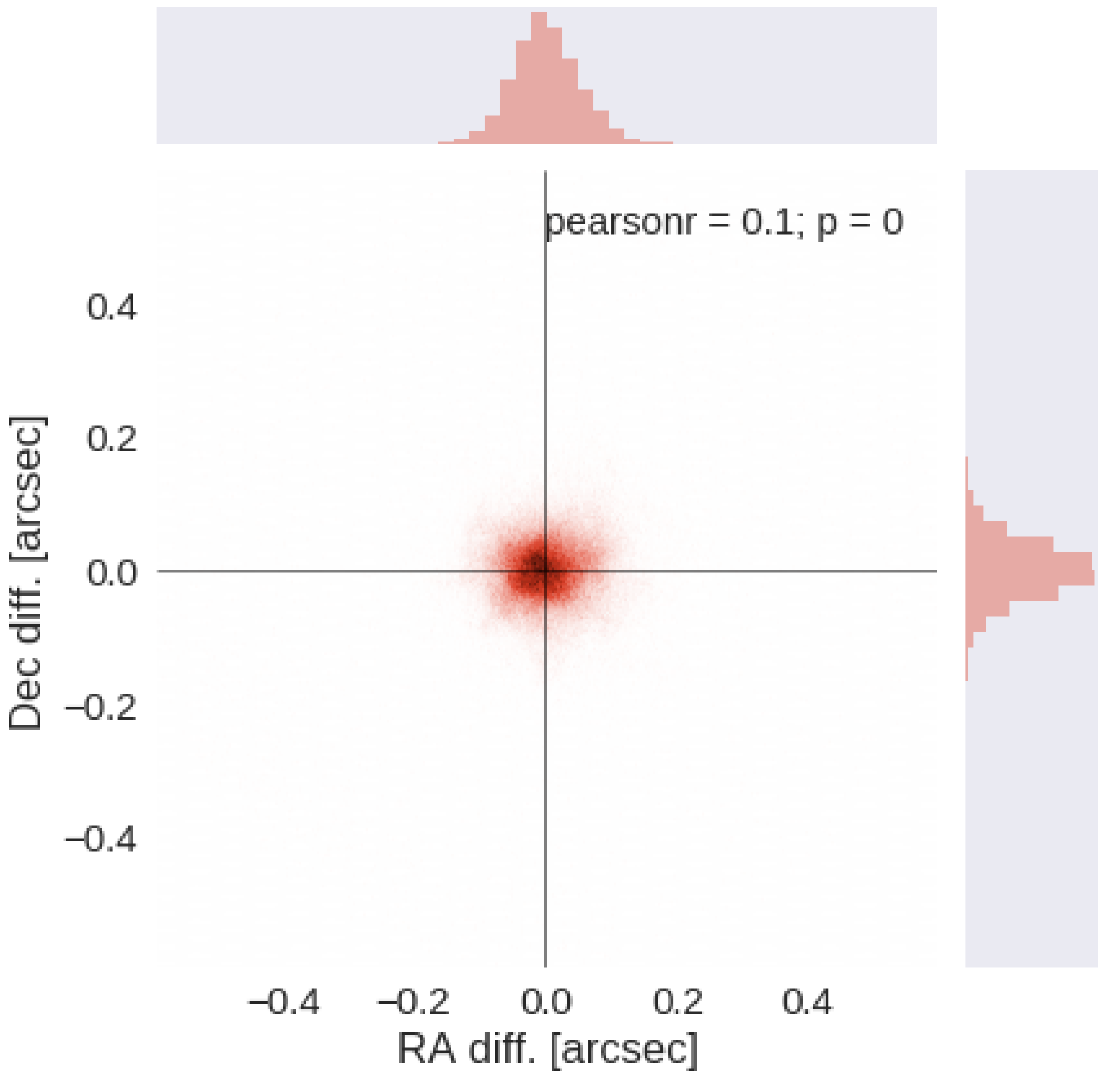
1.6 III - Astrometry correction

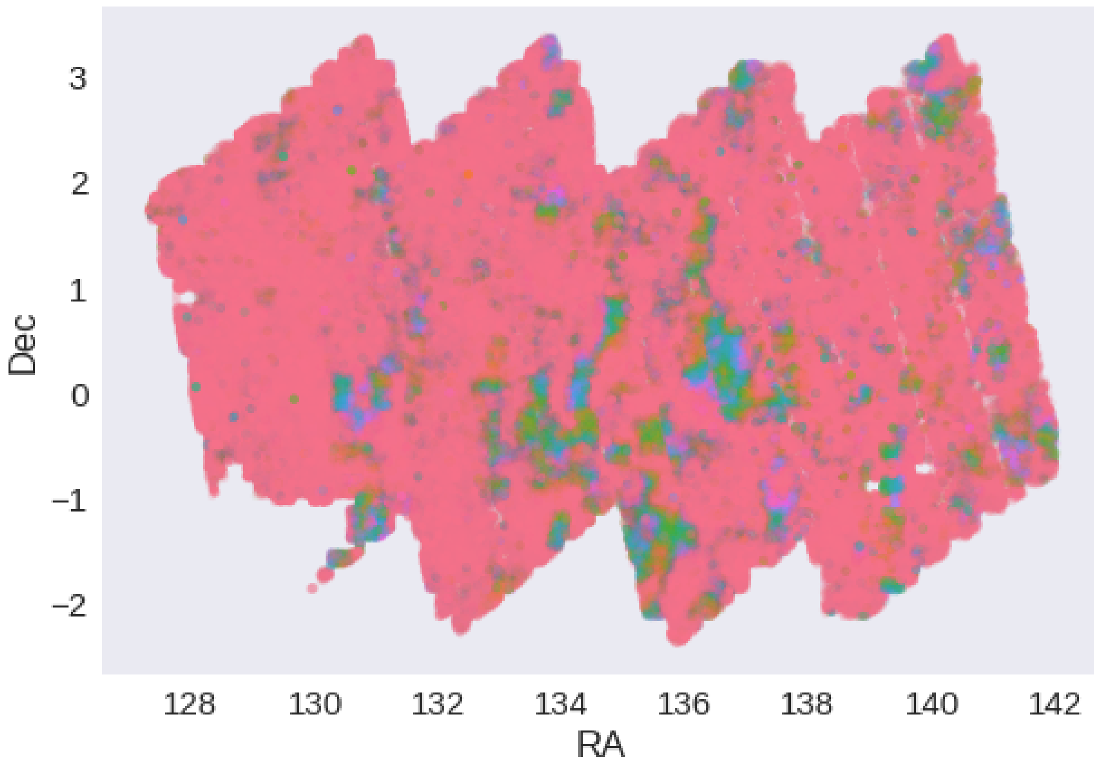
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = 0.12; p = 0
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]




```
RA correction: -0.03570928037106569 arcsec
Dec correction: -0.030769226409737768 arcsec
```


pearsonr = 0.1; 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]



1.7 IV - Flagging Gaia objects

```
265522 sources flagged.
```

2 V - Saving to disk

1.4_HSC-SSP

January 18, 2018

1 GAMA-09 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.

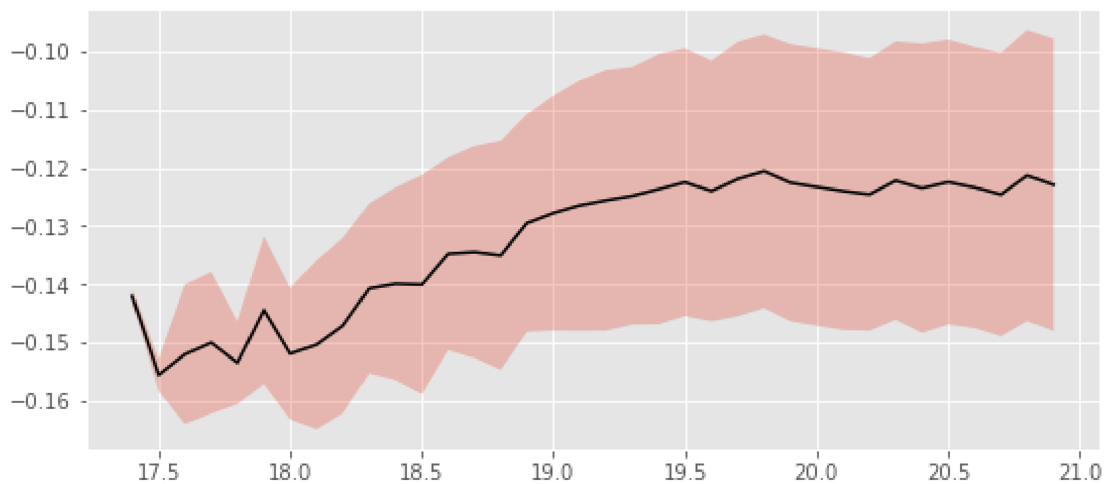
```
No error column for a y band aperture magnitude.
```

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: -0.12408447265625
Number of source used: 18461
RMS: 0.023483843404198672
```

```
/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)
```

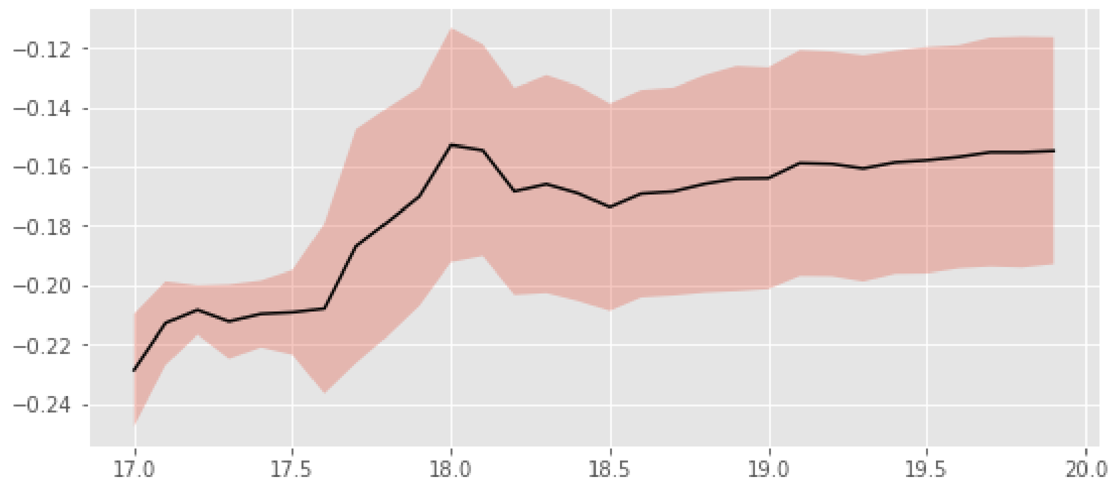
1.2.2 I.b - r band

```
/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: -0.16170883178710938
Number of source used: 14615
RMS: 0.0376657609667549
```

```
/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)
```

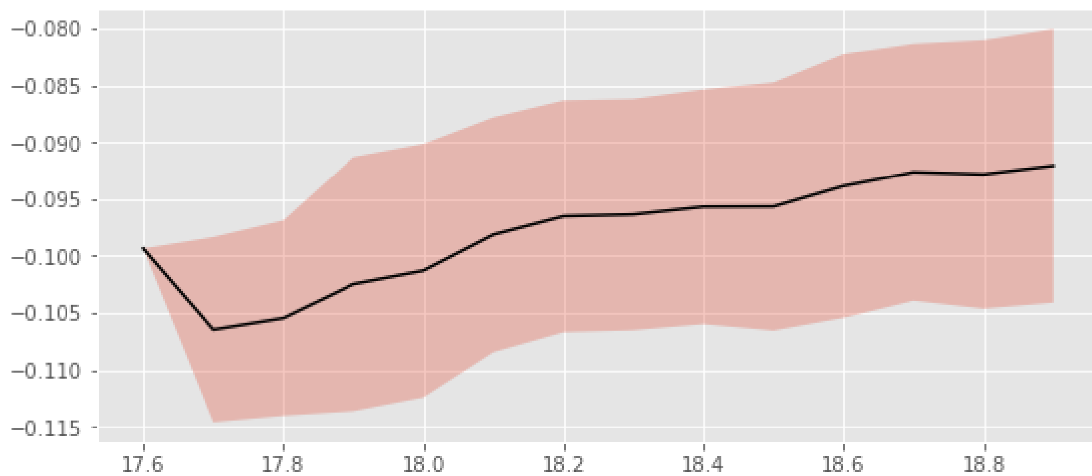
1.2.3 I.c - i band

```
/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)
```



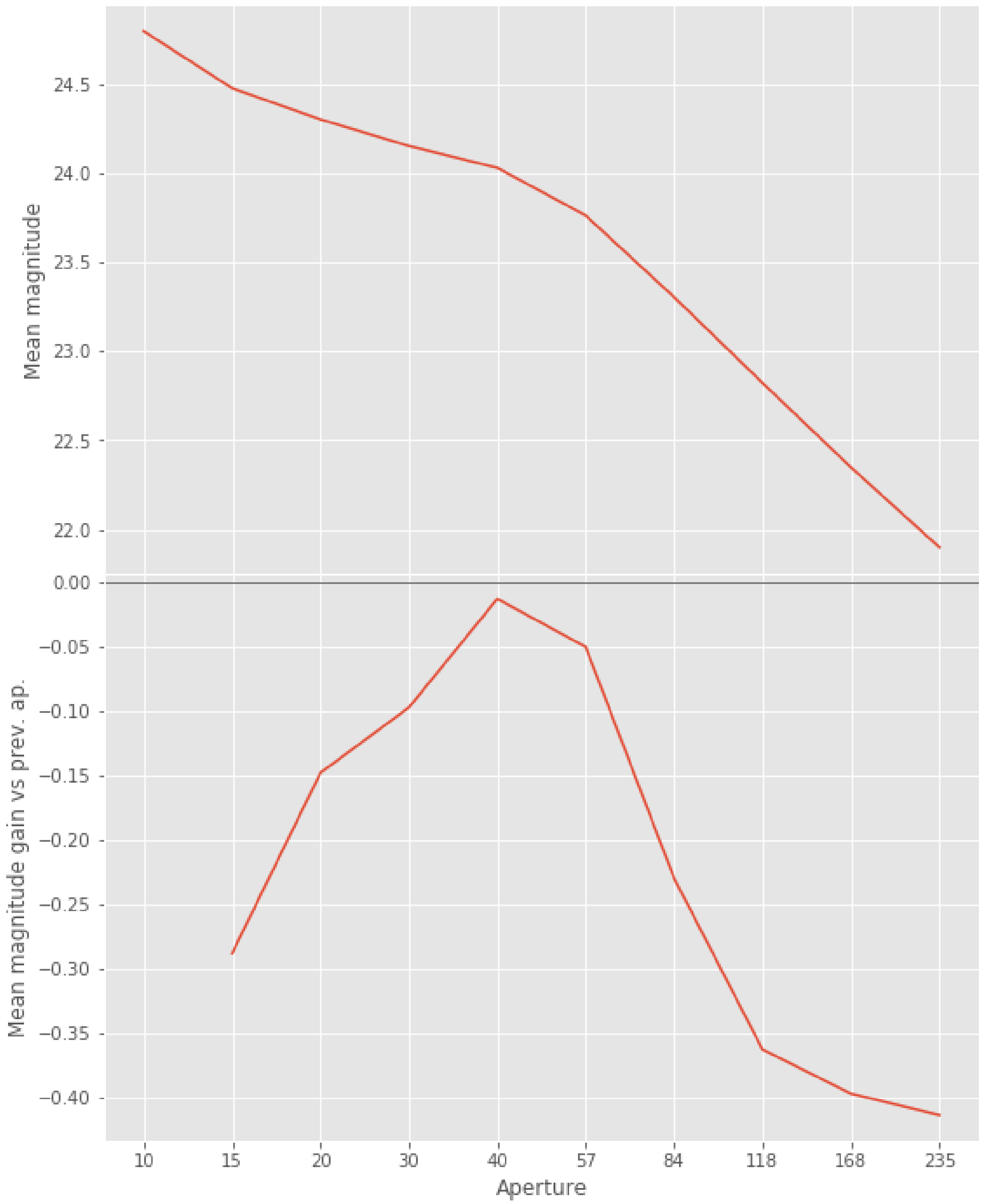
We use magnitudes between 18.5 and 19.8.

```
Aperture correction for i band:
Correction: -0.09254837036132812
Number of source used: 33192
RMS: 0.012256088927246552
```

```
/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

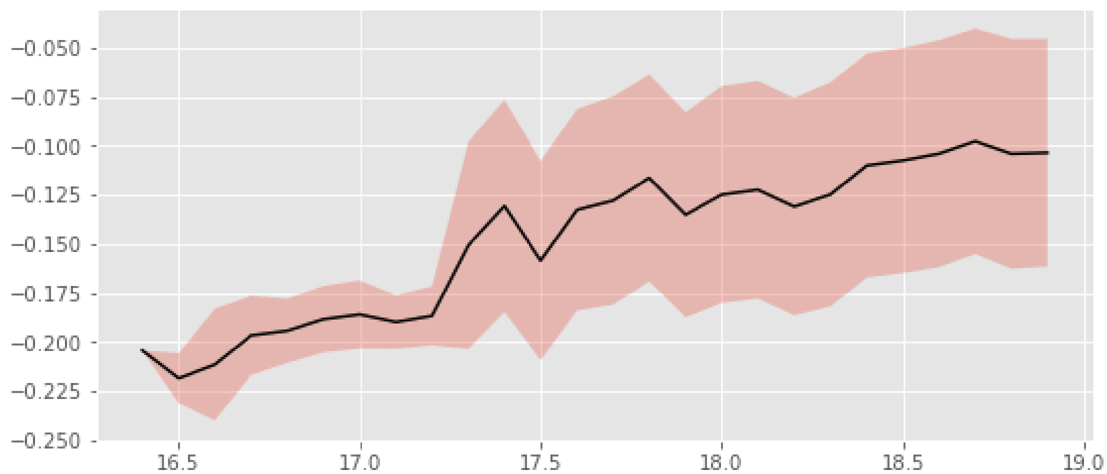
```
/opt/herschelhelp_internal/herschelhelp_internal/masterlist.py:850: RuntimeWarning: invalid valu
  mags = magnitudes[:, stellarity > stel_threshold].copy()
```



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: -0.10509109497070312
Number of source used: 51772
RMS: 0.05780501082757794
```

```
/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)
```

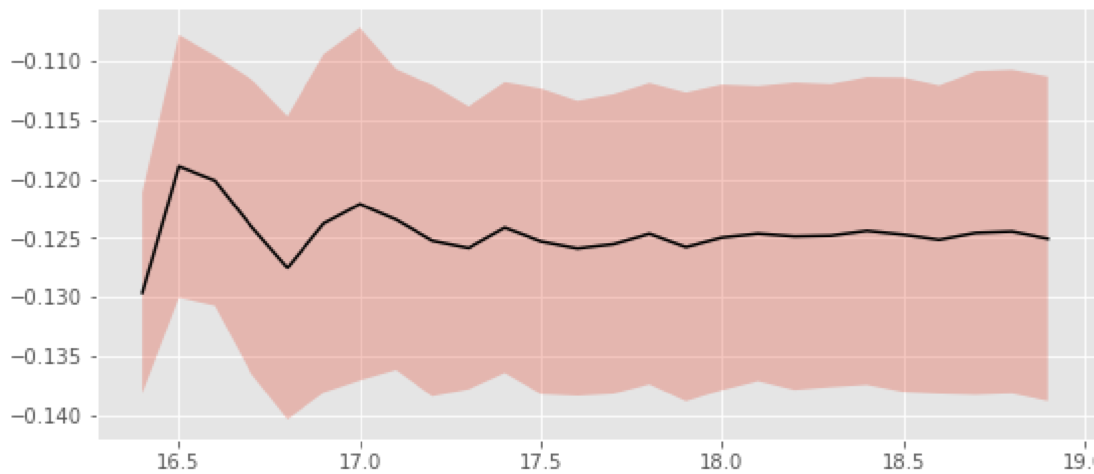
1.2.5 I.e - y band

```
/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: -0.12488555908203125
Number of source used: 19325
RMS: 0.012975513965416236
```

```
/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)
```

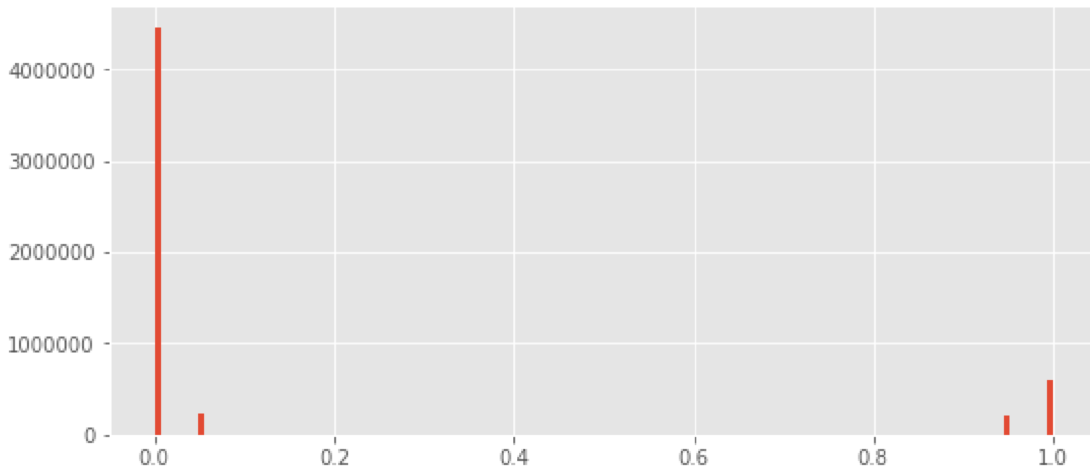
1.3 II - Stellarity

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>

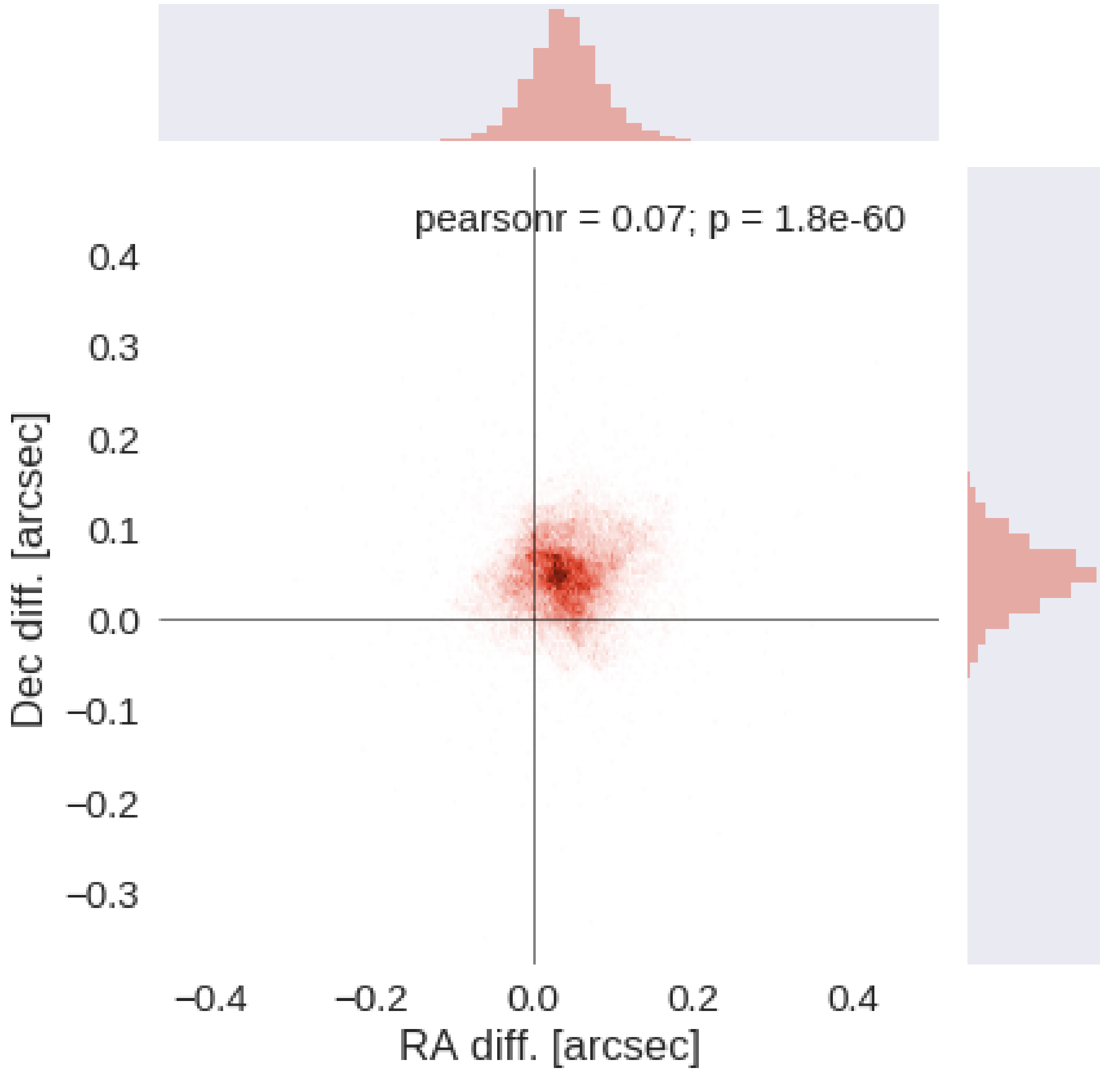
1.5 III - Removal of duplicated sources

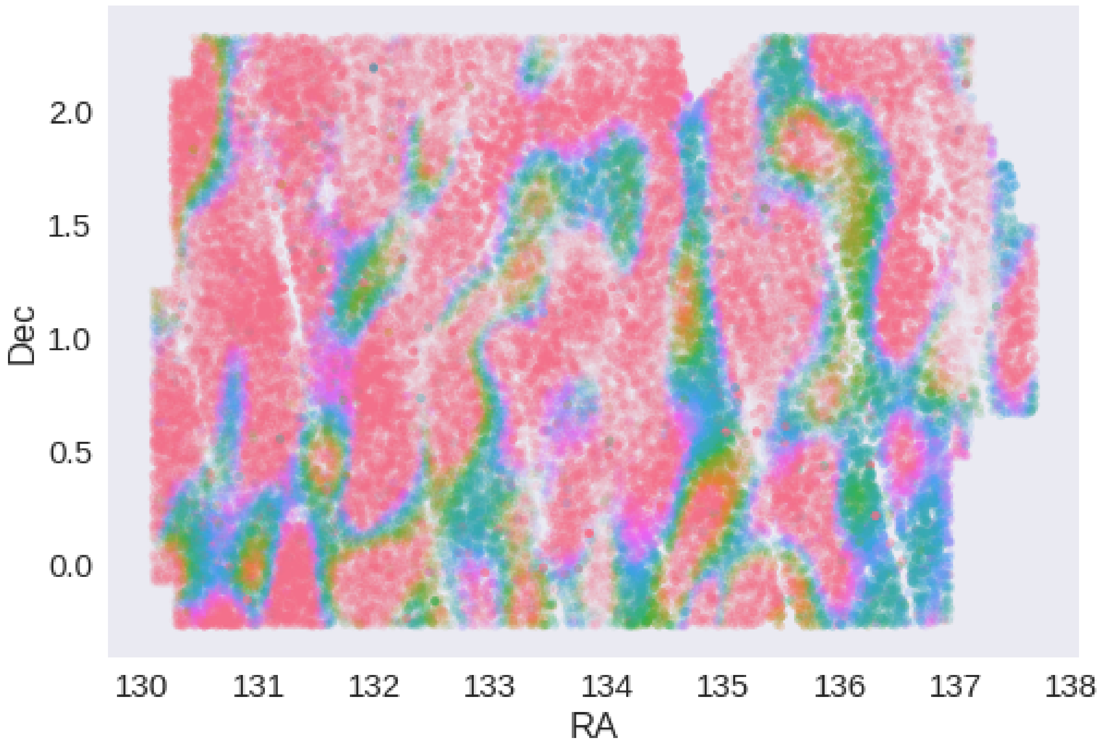
We remove duplicated objects from the input catalogues.

```
/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 5500445 sources.
The cleaned catalogue has 5500272 sources (173 removed).
The cleaned catalogue has 173 sources flagged as having been cleaned
```

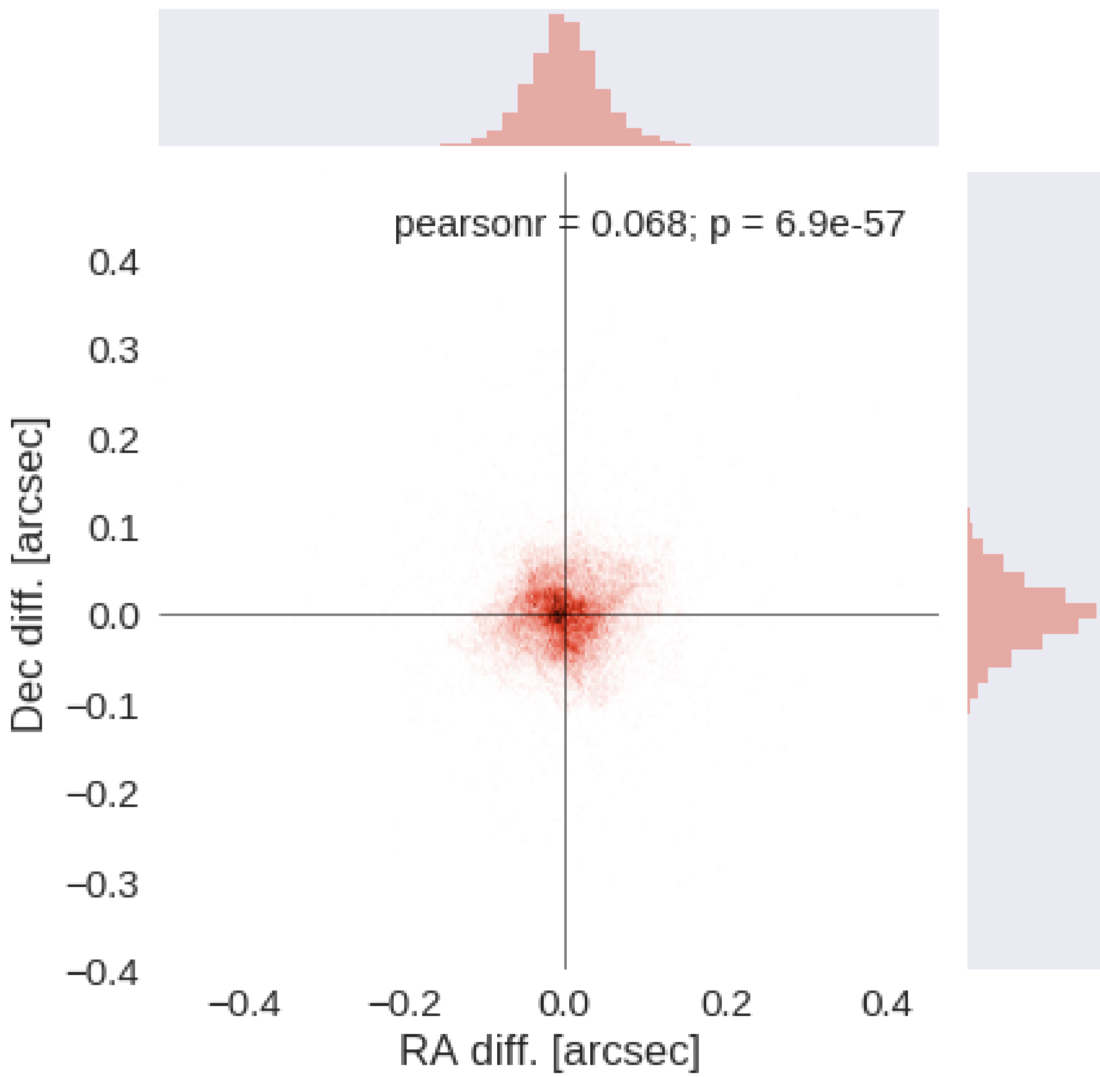
1.6 III - Astrometry correction

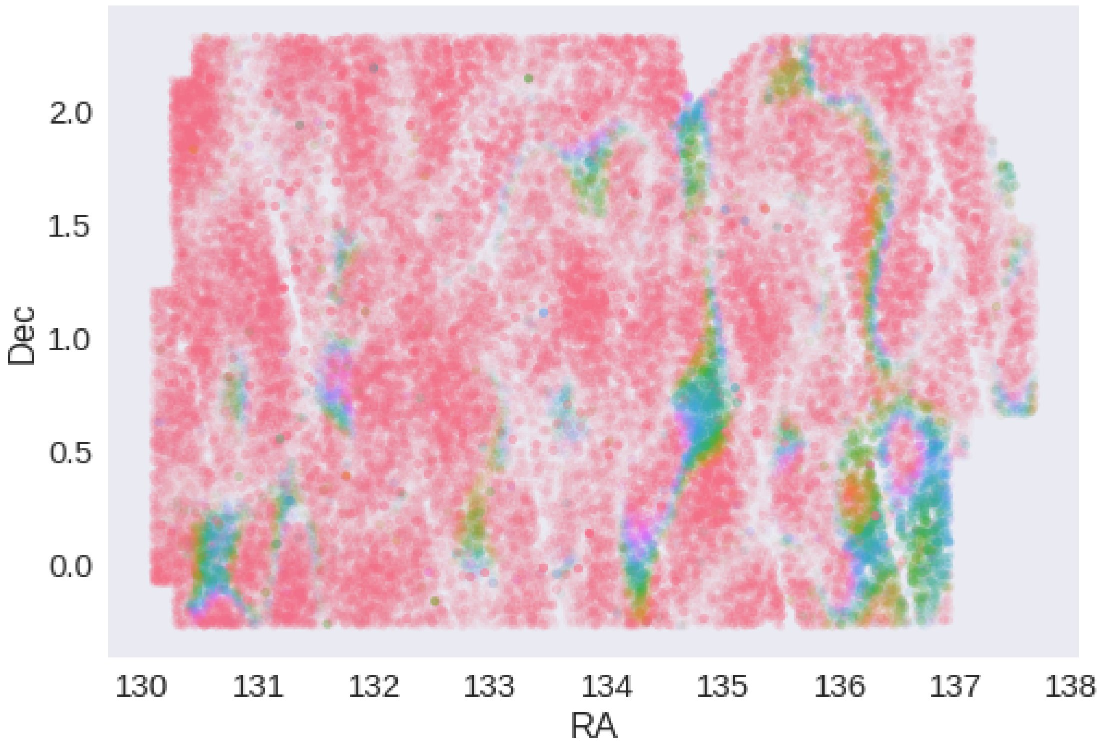
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = 0.07; p = 1.8e-60
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
Dec diff. [arcsec]
−0.4
−0.2
0.0
0.2
0.4
RA diff. [arcsec]




```
RA correction: -0.04088912146471557 arcsec
Dec correction: -0.048413513806411235 arcsec
```


pearsonr = 0.068; p = 6.9e-57
0.4
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

```
55457 sources flagged.
```

1.8 V - Flagging objects near bright stars

2 VI - Saving to disk

1.5_KIDS

January 18, 2018

1 GAMA-09 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

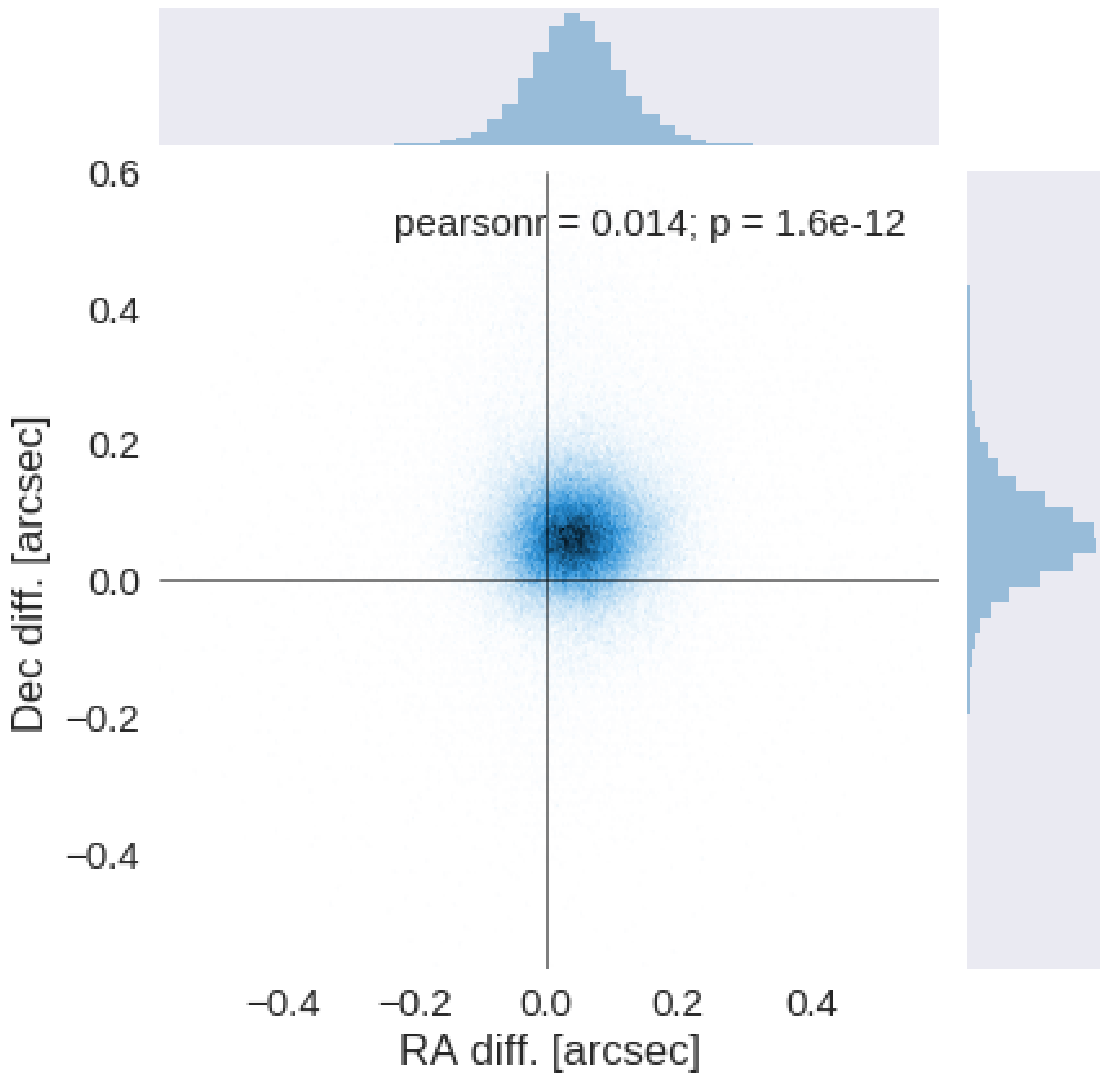
We remove duplicated objects from the input catalogues.

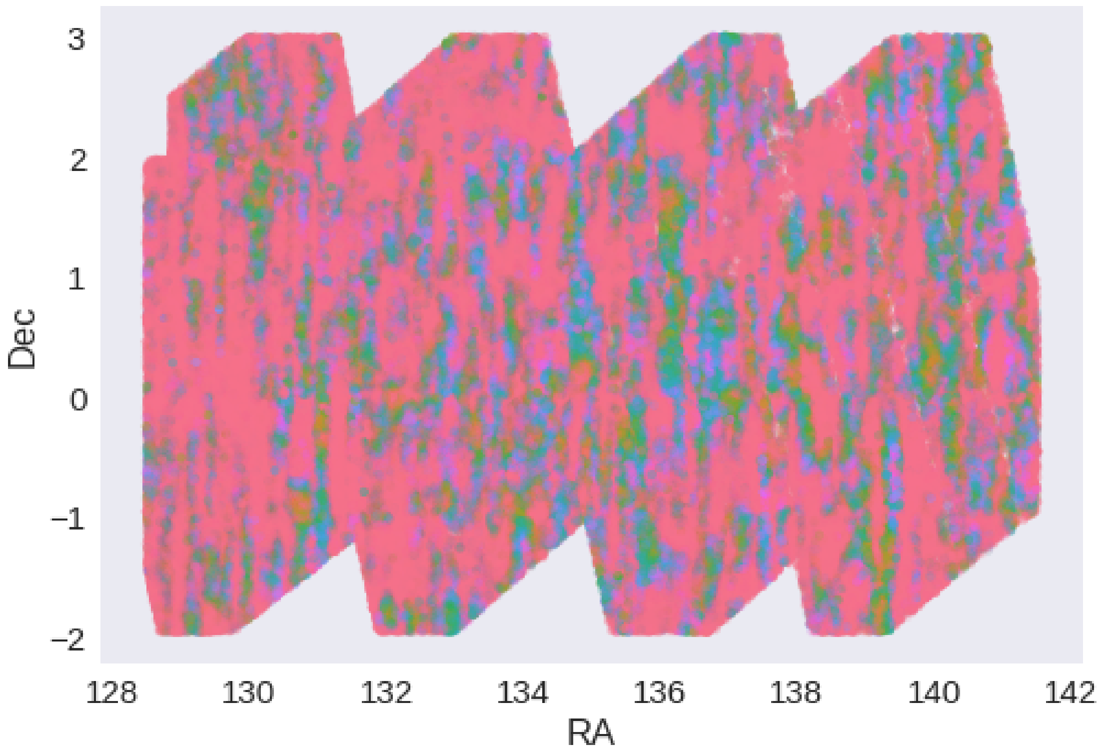
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 6002233 sources.
The cleaned catalogue has 6002146 sources (87 removed).
The cleaned catalogue has 87 sources flagged as having been cleaned
```

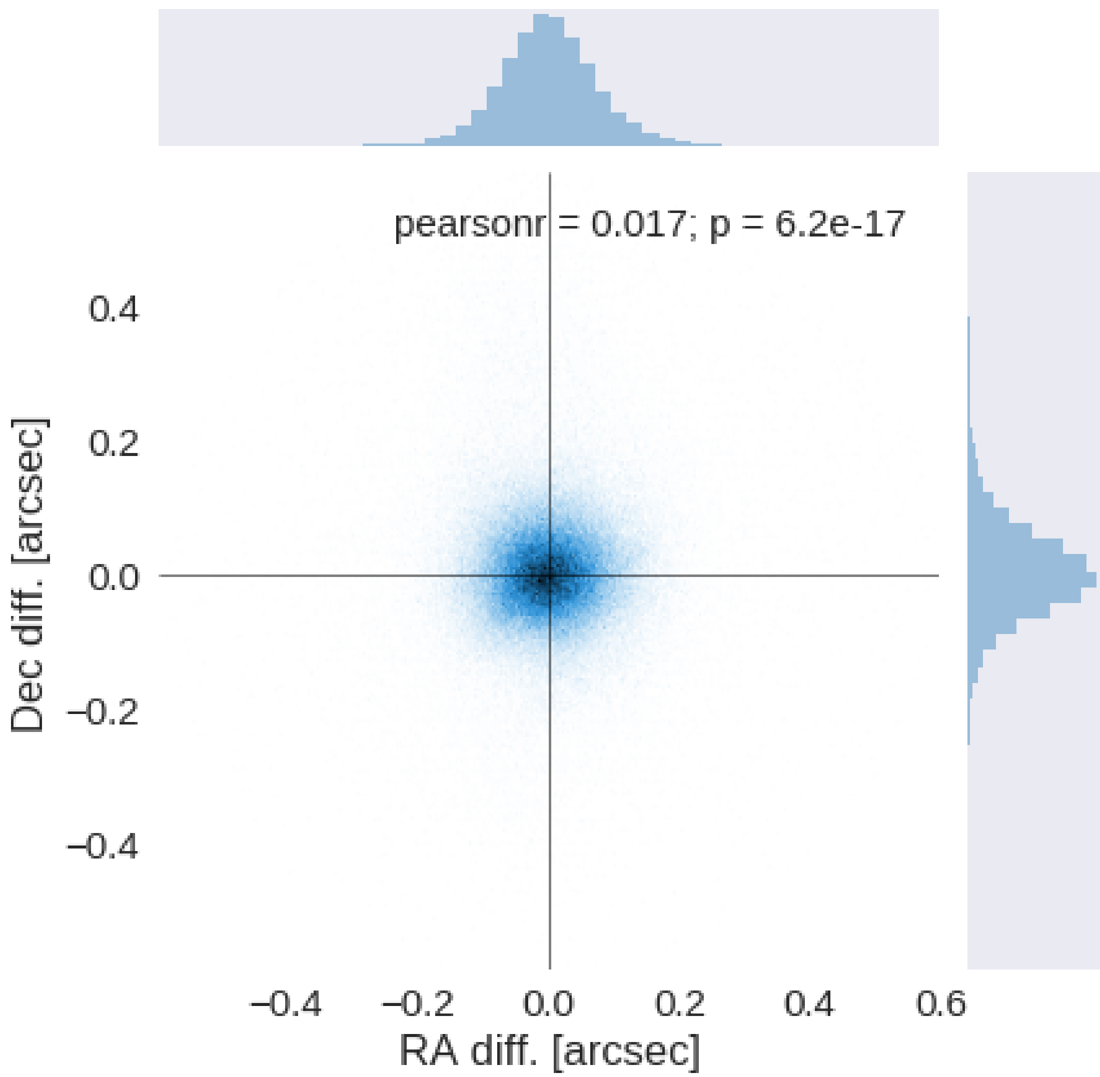
1.4 III - Astrometry correction

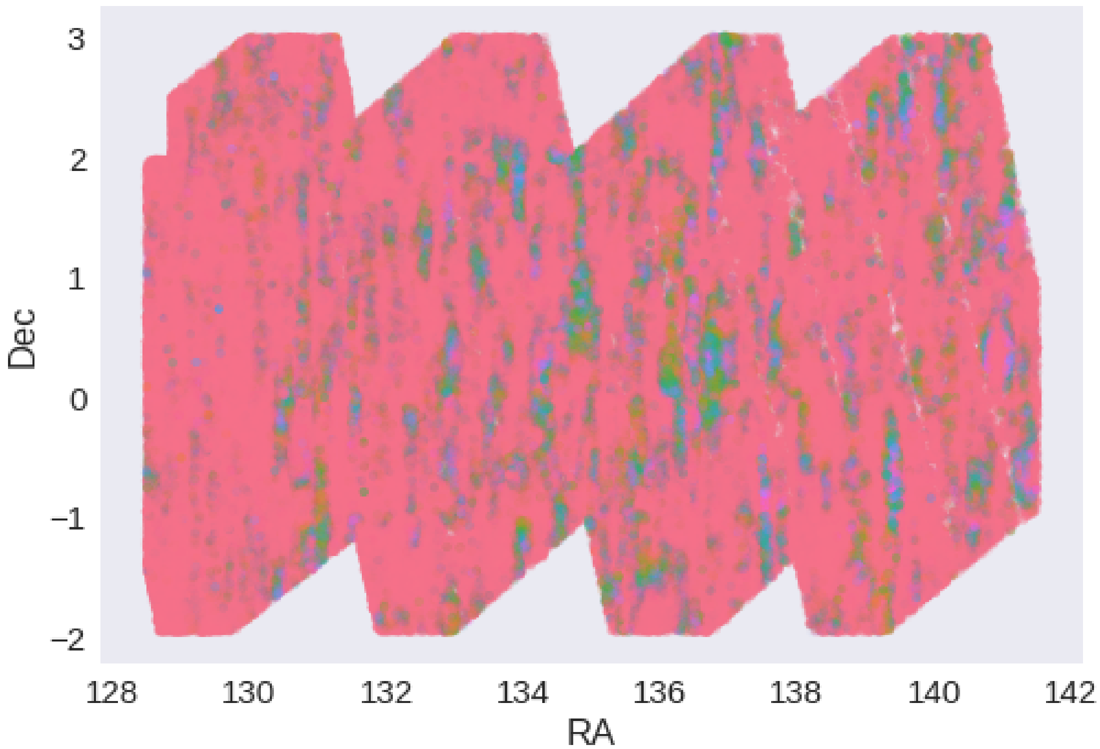
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.04423632481120876 arcsec
Dec correction: -0.06355399180684174 arcsec
```


pearsonr = 0.017; p = 6.2e-17
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

```
276907 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.6_PanSTARRS-3SS

January 18, 2018

1 GAMA-09 master catalogue

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

This catalogue comes from `dmu0_PanSTARRS1-3SS`.

In the catalogue, we keep:

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

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

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

```
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

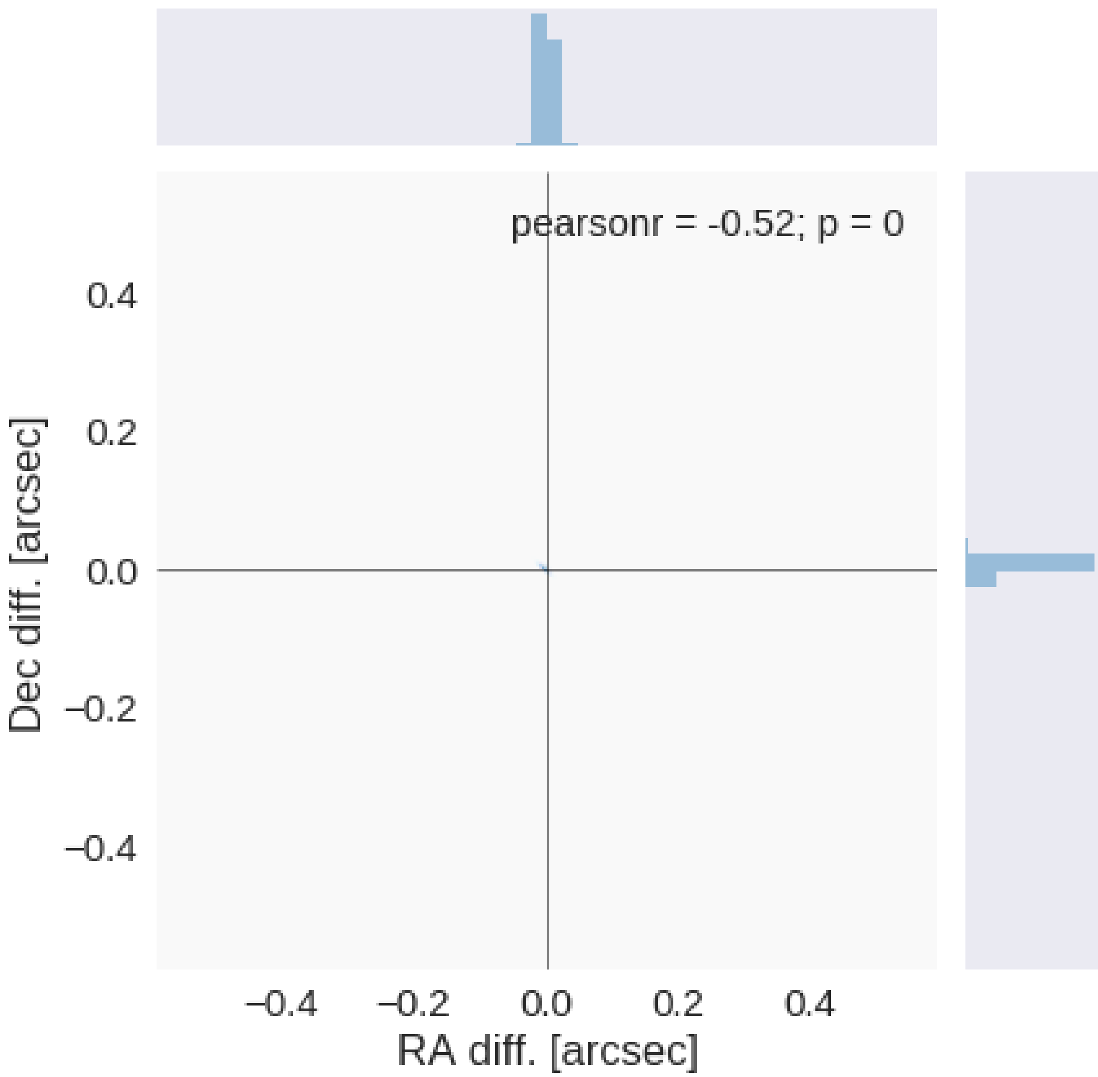
We remove duplicated objects from the input catalogues.

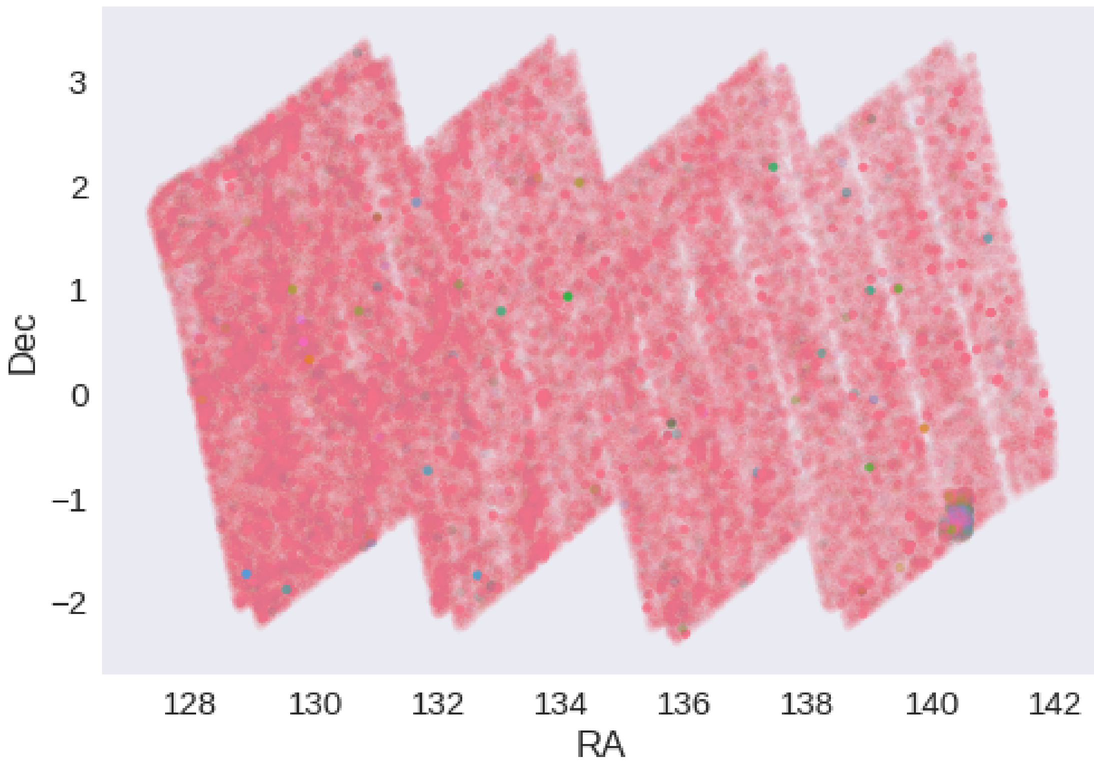
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

```
The initial catalogue had 1493855 sources.
The cleaned catalogue has 1493365 sources (490 removed).
The cleaned catalogue has 490 sources flagged as having been cleaned
```

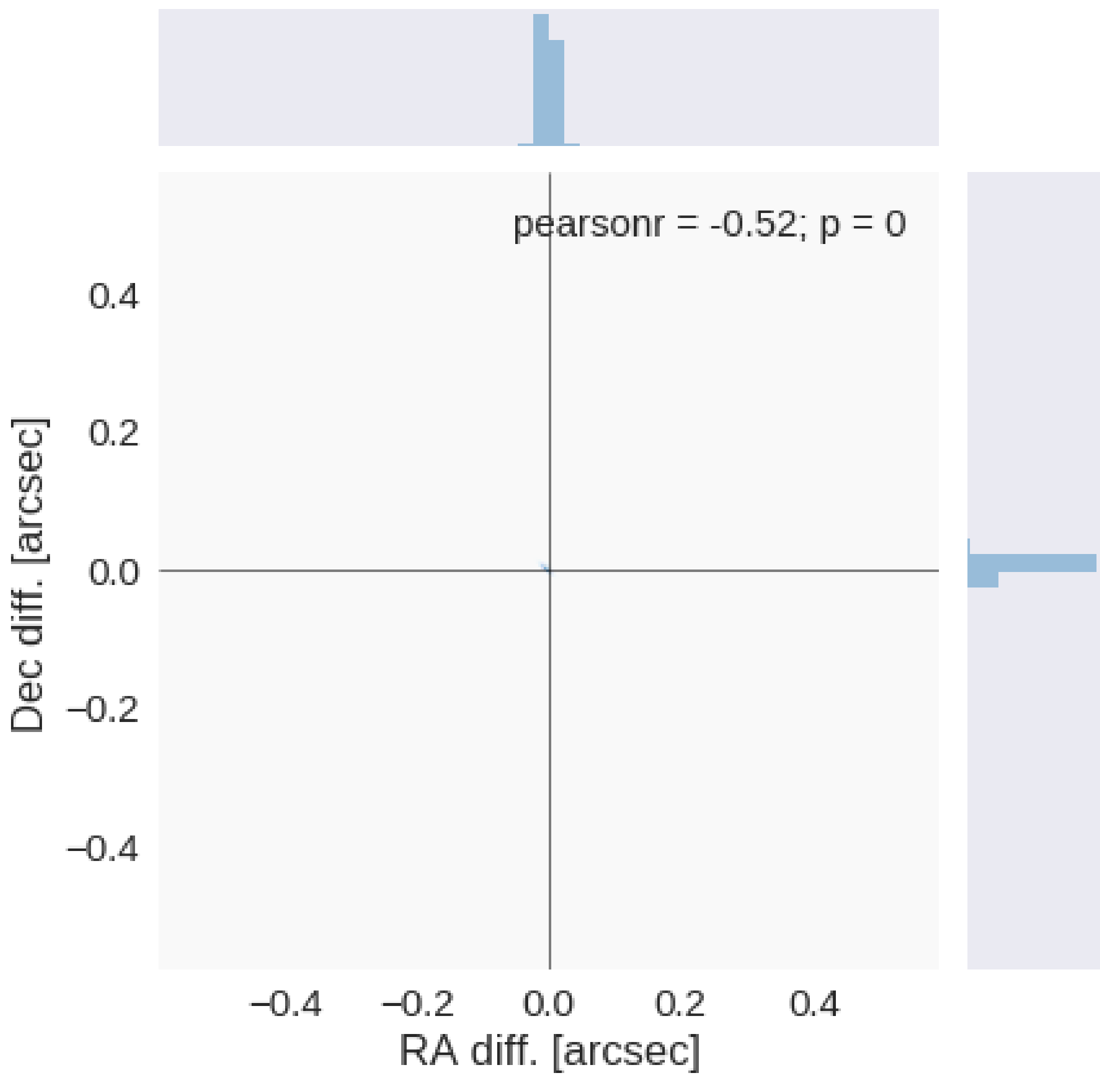
1.4 III - Astrometry correction

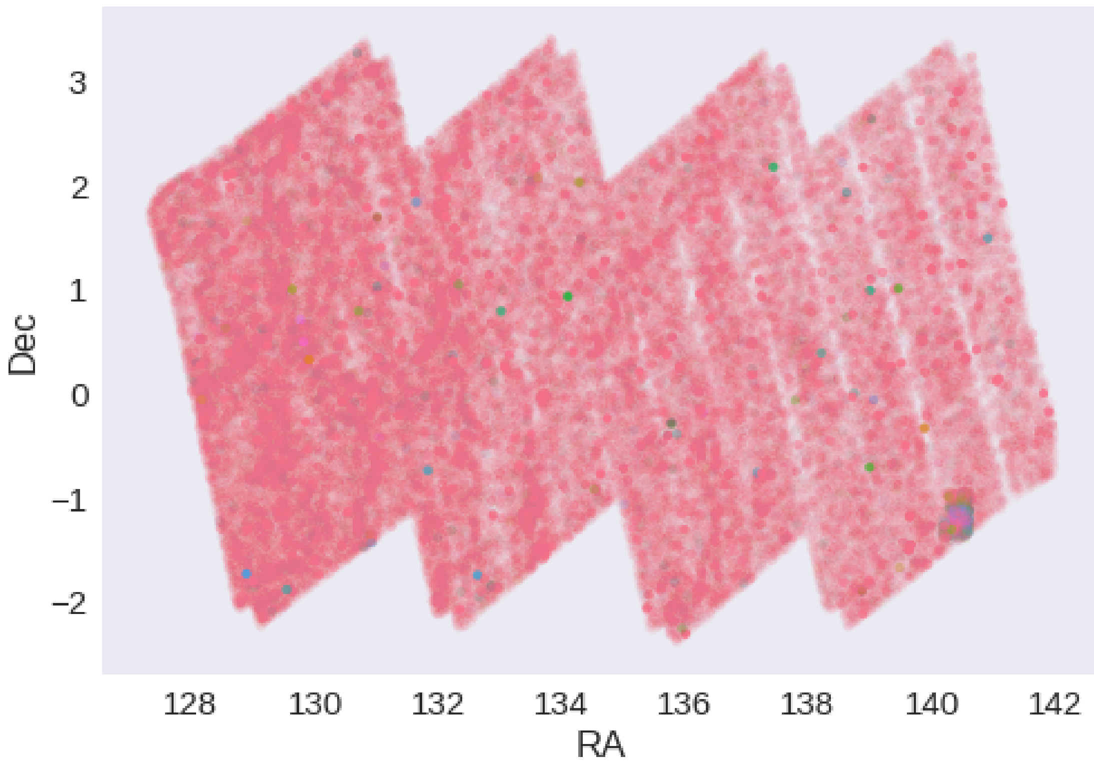
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.001187848795325408 arcsec
Dec correction: 3.903602401322814e-05 arcsec
```


pearsonr = -0.52; 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

```
287193 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.7_UKIDSS-LAS

January 18, 2018

1 GAMA-09 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>

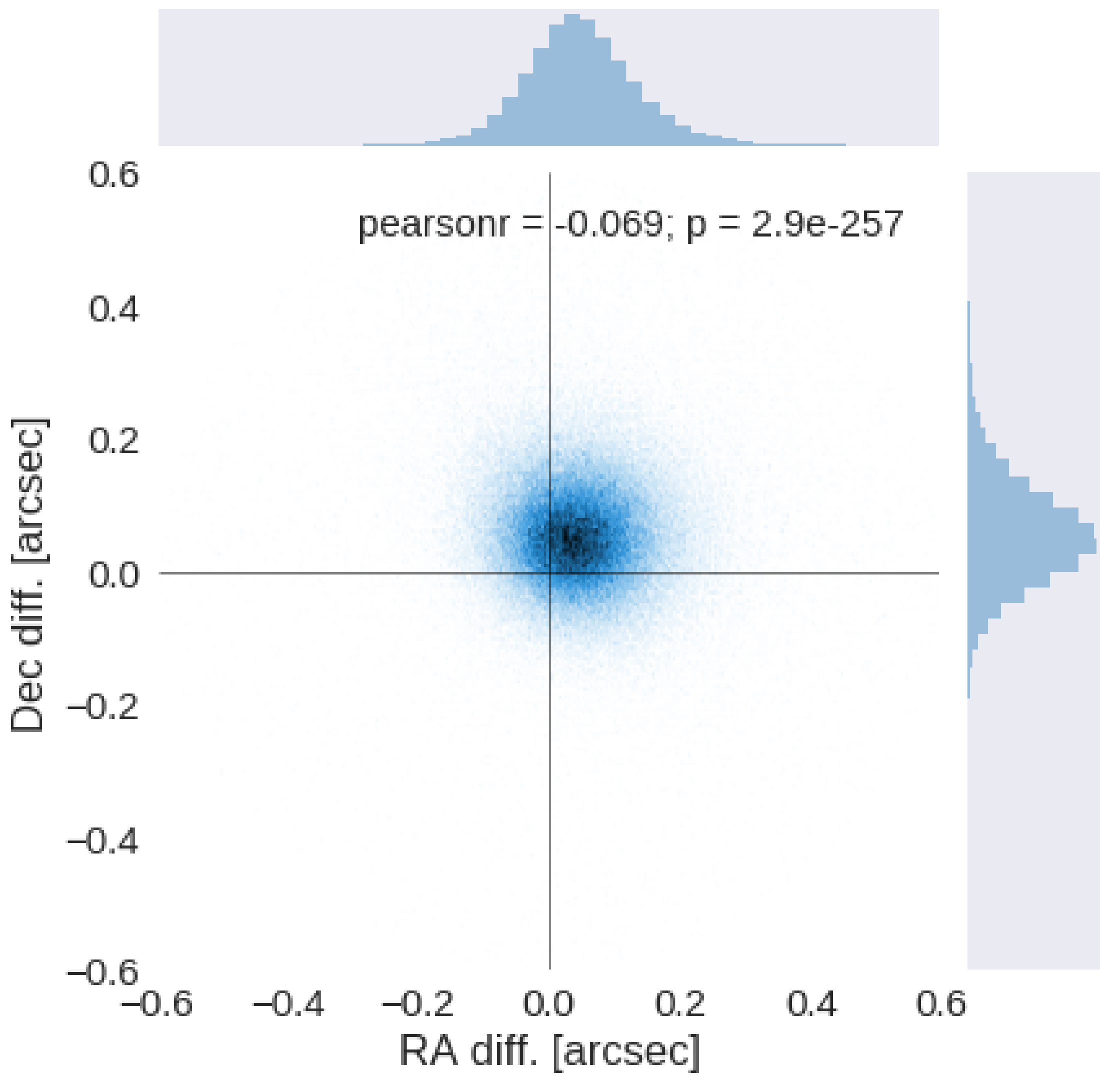
1.3 II - Removal of duplicated sources

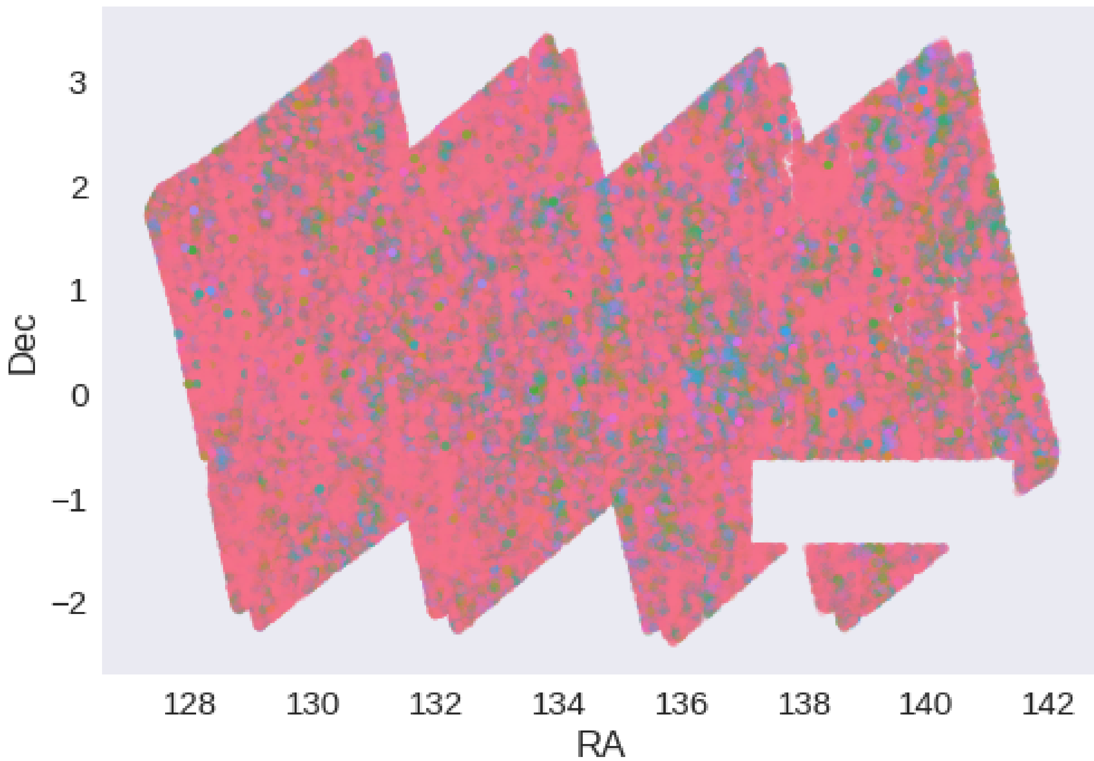
We remove duplicated objects from the input catalogues.

```
/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 1431772 sources.
The cleaned catalogue has 1430268 sources (1504 removed).
The cleaned catalogue has 1508 sources flagged as having been cleaned
```

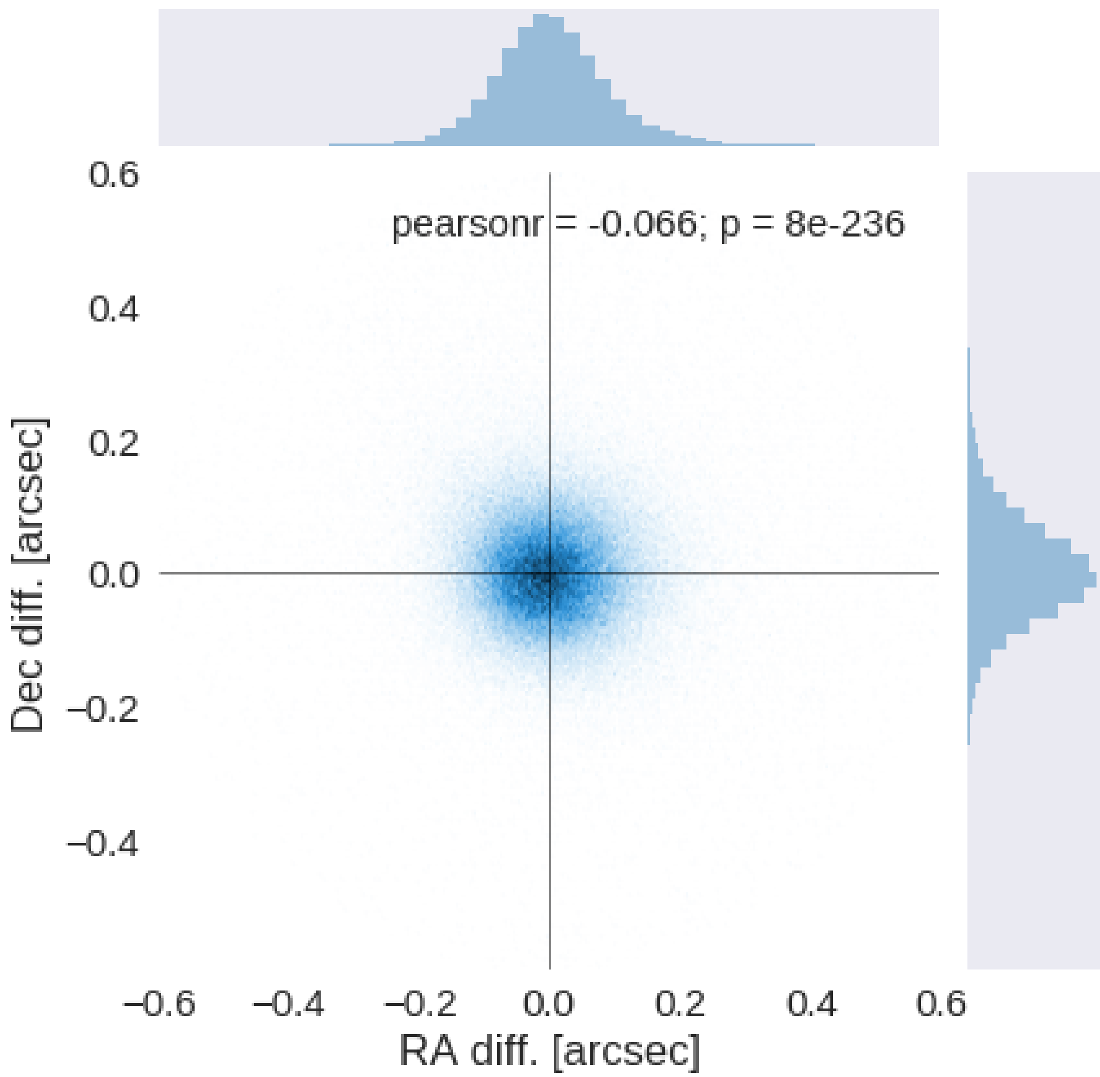
1.4 III - Astrometry correction

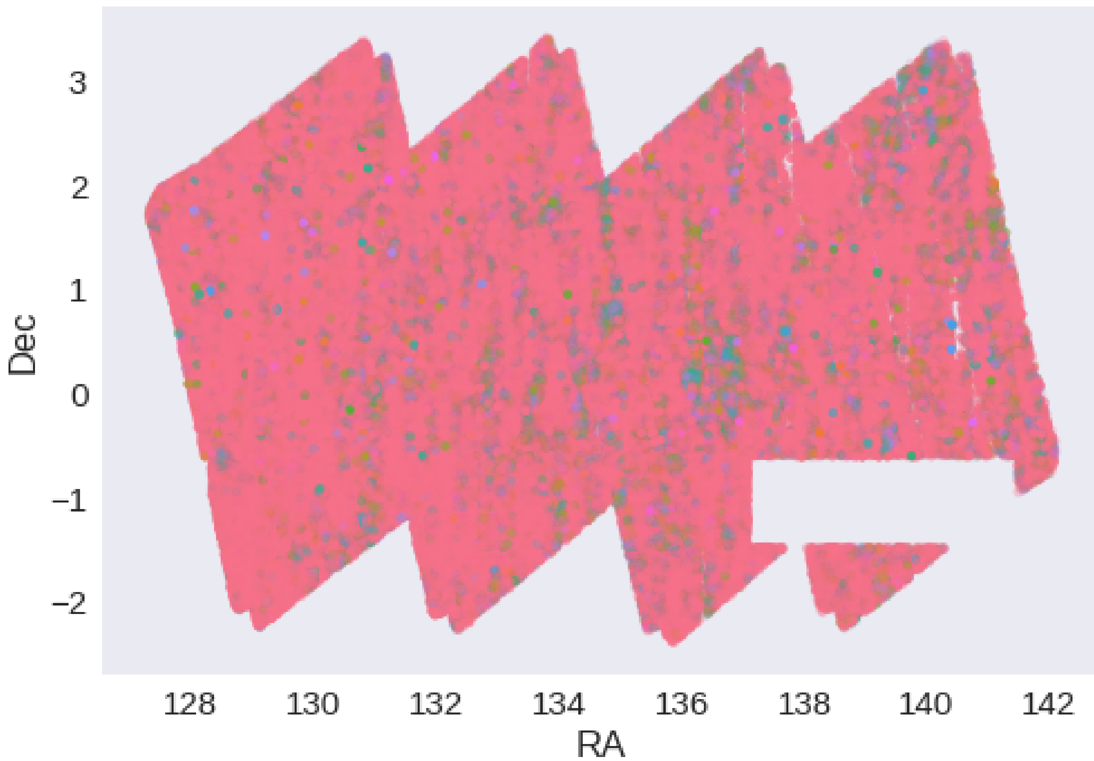
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.


pearsonr = -0.069; p = 2.9e-257
Dec diff. [arcsec]
RA diff. [arcsec]
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6




```
RA correction: -0.044649084838896579 arcsec
Dec correction: -0.051806019252376156 arcsec
```


pearsonr = -0.066; p = 8e-236
0.6
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]



1.5 IV - Flagging Gaia objects

```
254308 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.8_VISTA-VHS

January 18, 2018

1 GAMA-09 master catalogue

1.1 Preparation of VHS data

VISTA telescope/VHS catalogue: the catalogue comes from `dmu0_VHS`.

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>
```

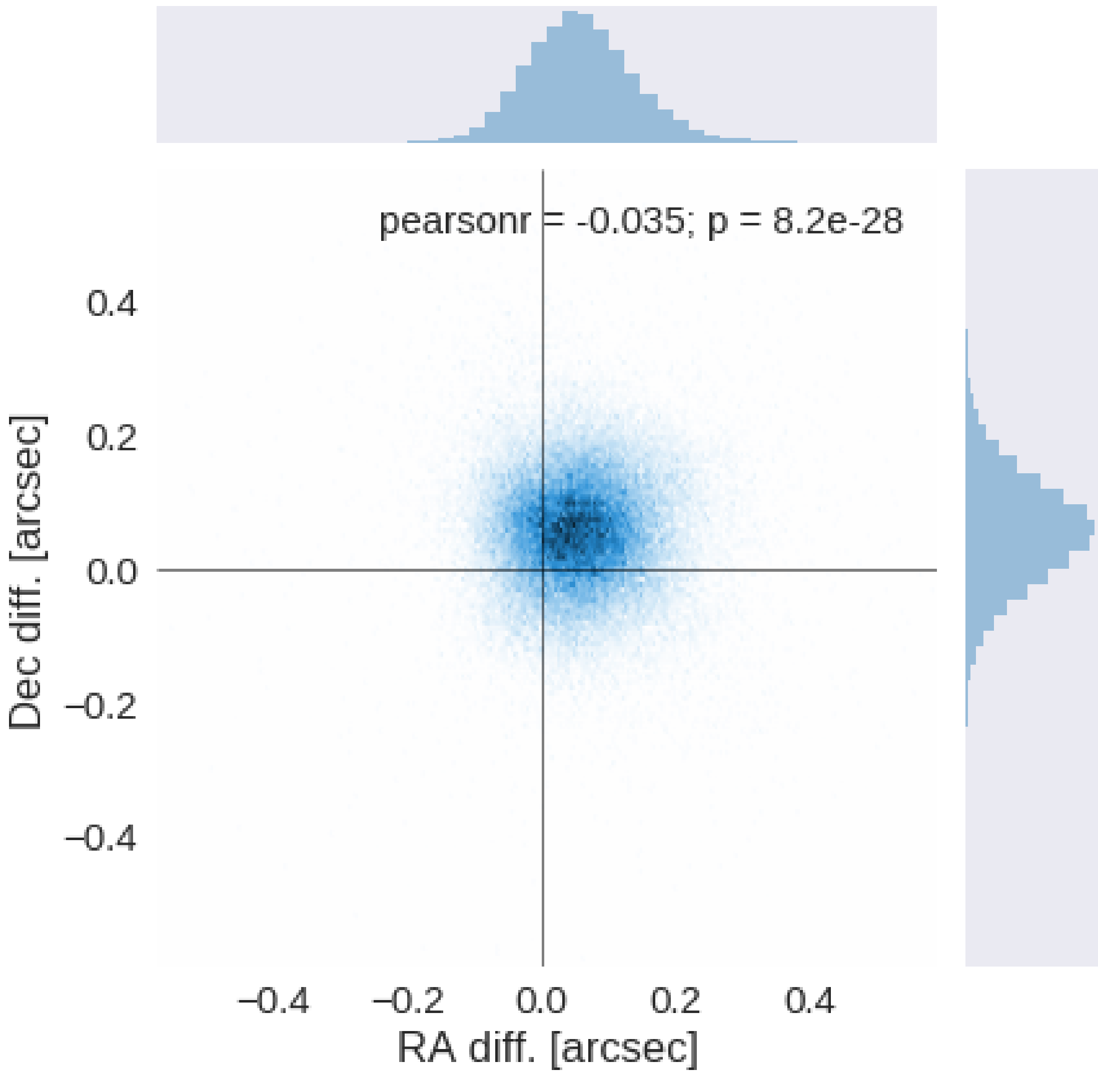
1.3 II - Removal of duplicated sources

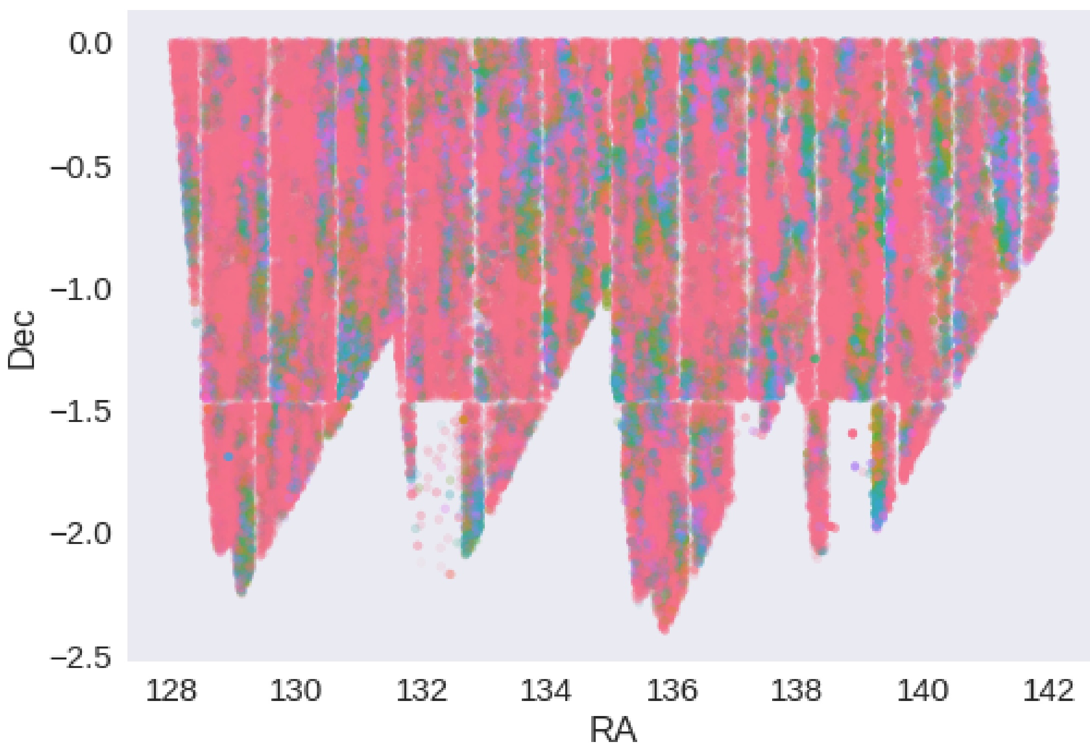
We remove duplicated objects from the input catalogues.

```
/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 532739 sources.
The cleaned catalogue has 532707 sources (32 removed).
The cleaned catalogue has 32 sources flagged as having been cleaned
```

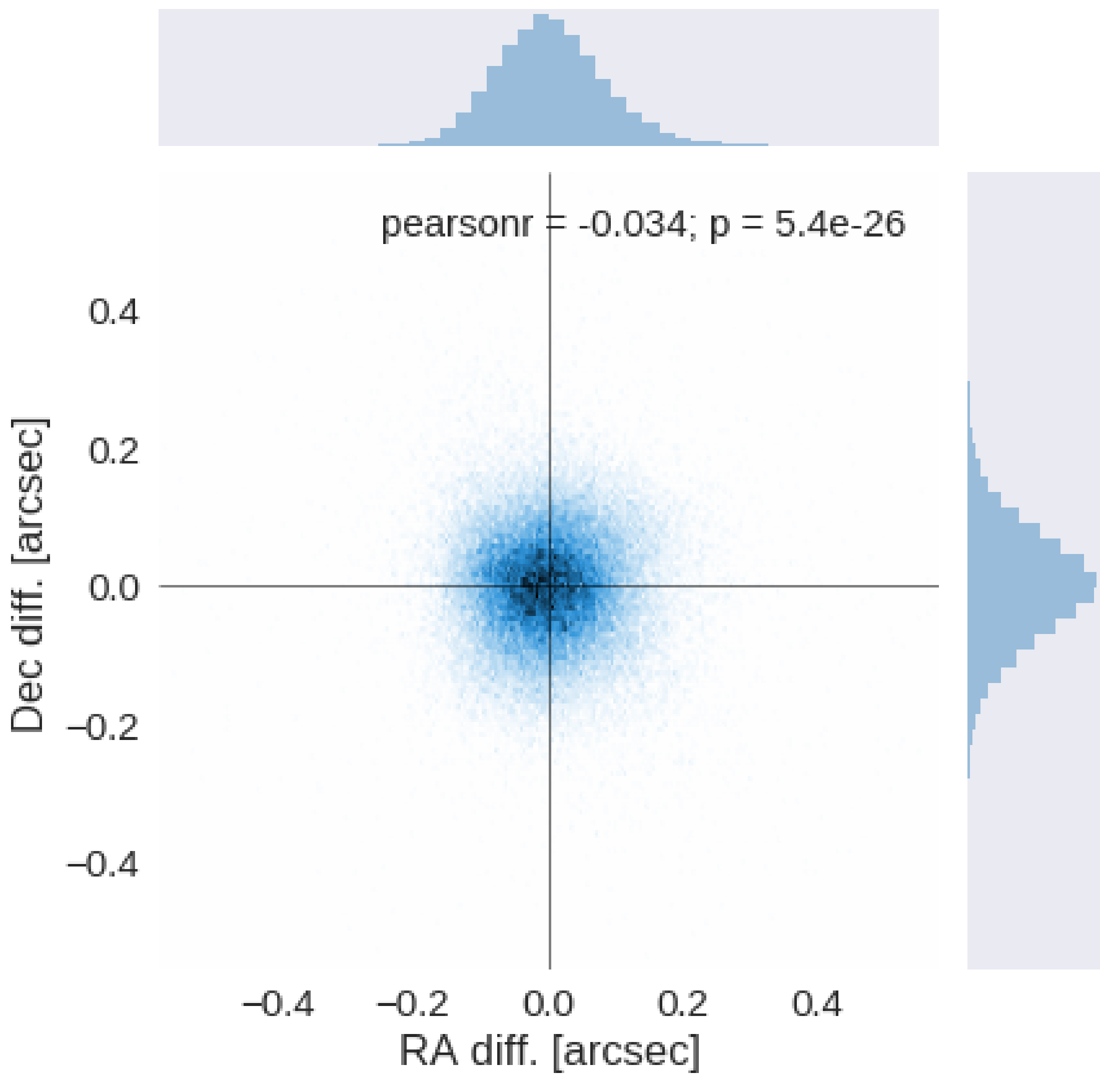
1.4 III - Astrometry correction

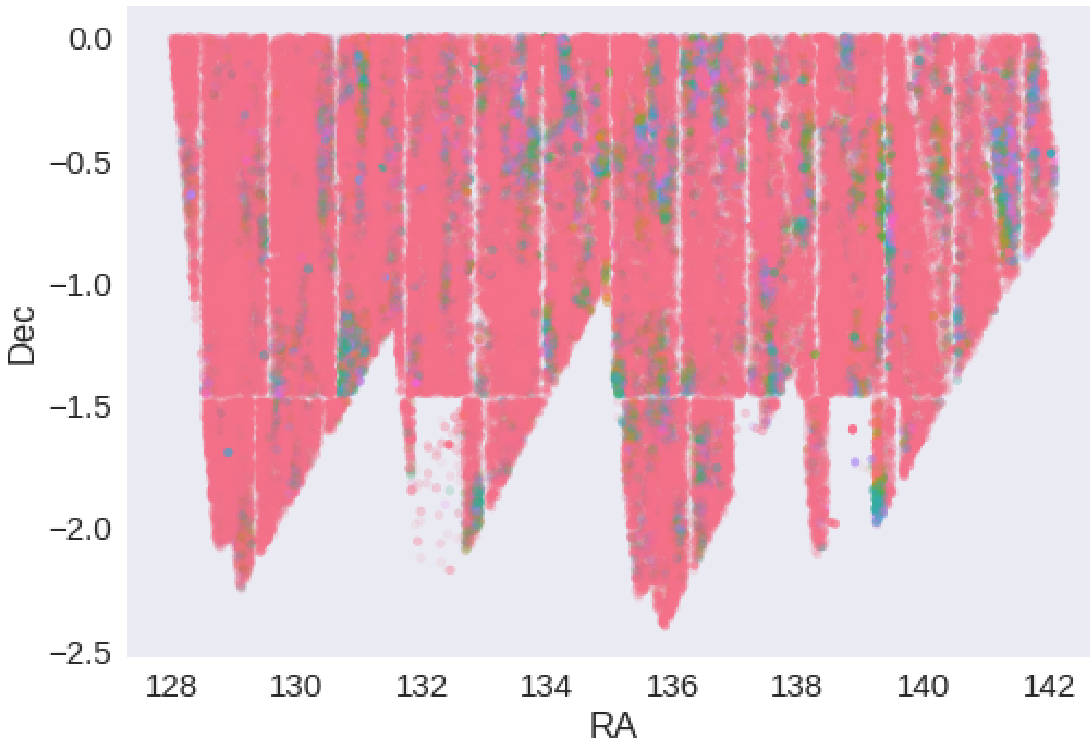
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.053860528453242296 arcsec
Dec correction: -0.055894050792959504 arcsec
```


pearsonr = -0.034; p = 5.4e-26
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

```
97043 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.9_VISTA-VIKING

January 18, 2018

1 GAMA-09 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>
```

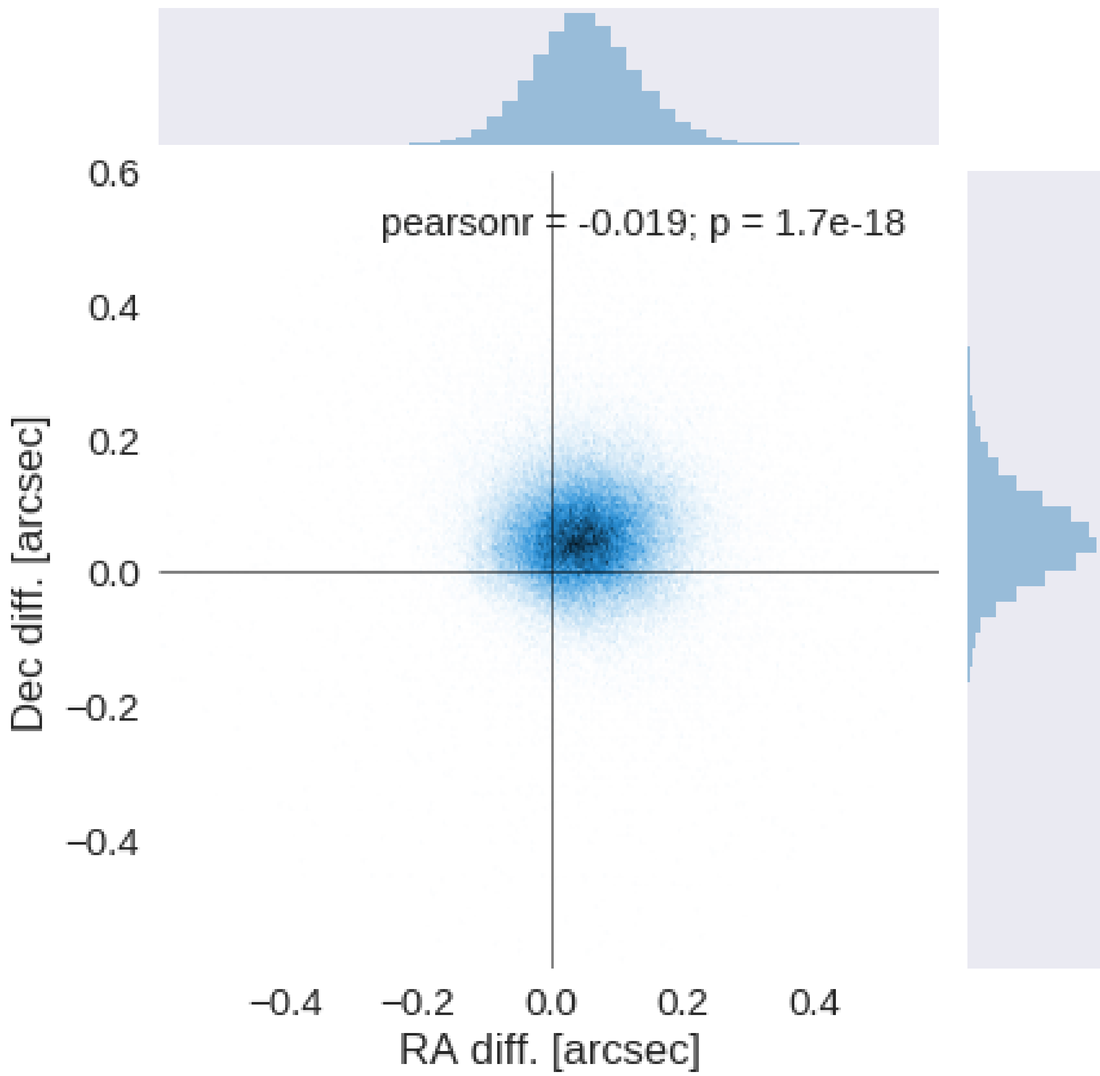
1.3 II - Removal of duplicated sources

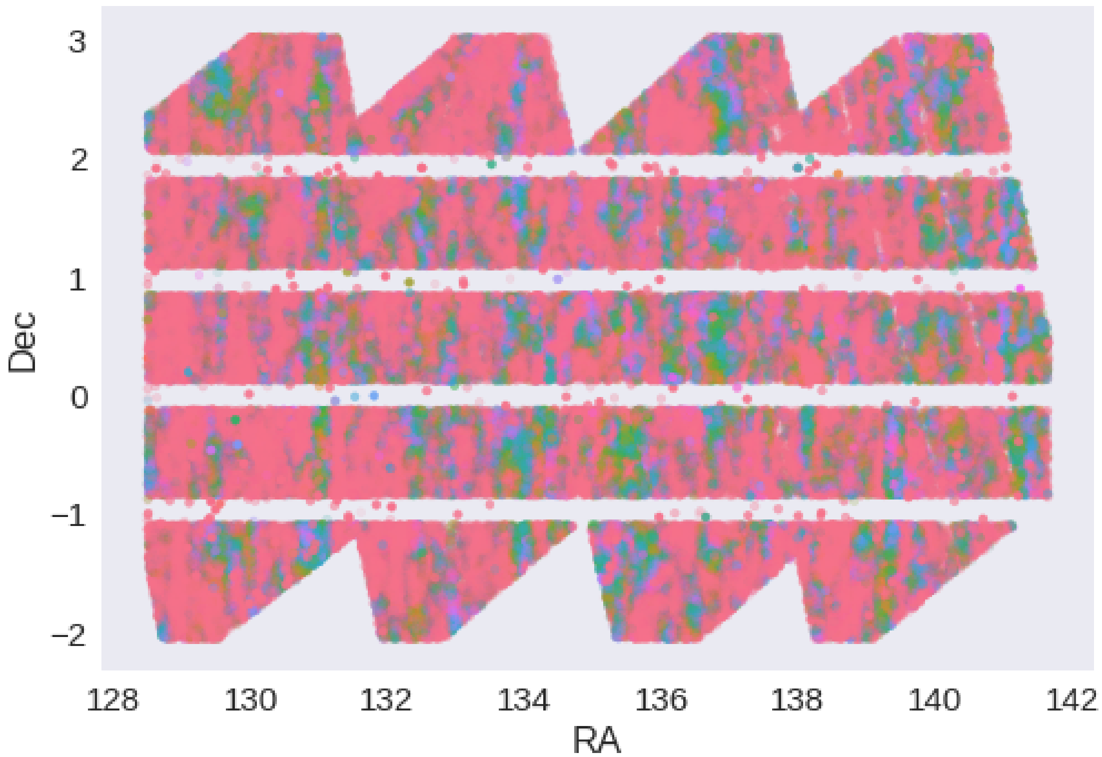
We remove duplicated objects from the input catalogues.

```
/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 3549363 sources.
The cleaned catalogue has 3547809 sources (1554 removed).
The cleaned catalogue has 1549 sources flagged as having been cleaned
```

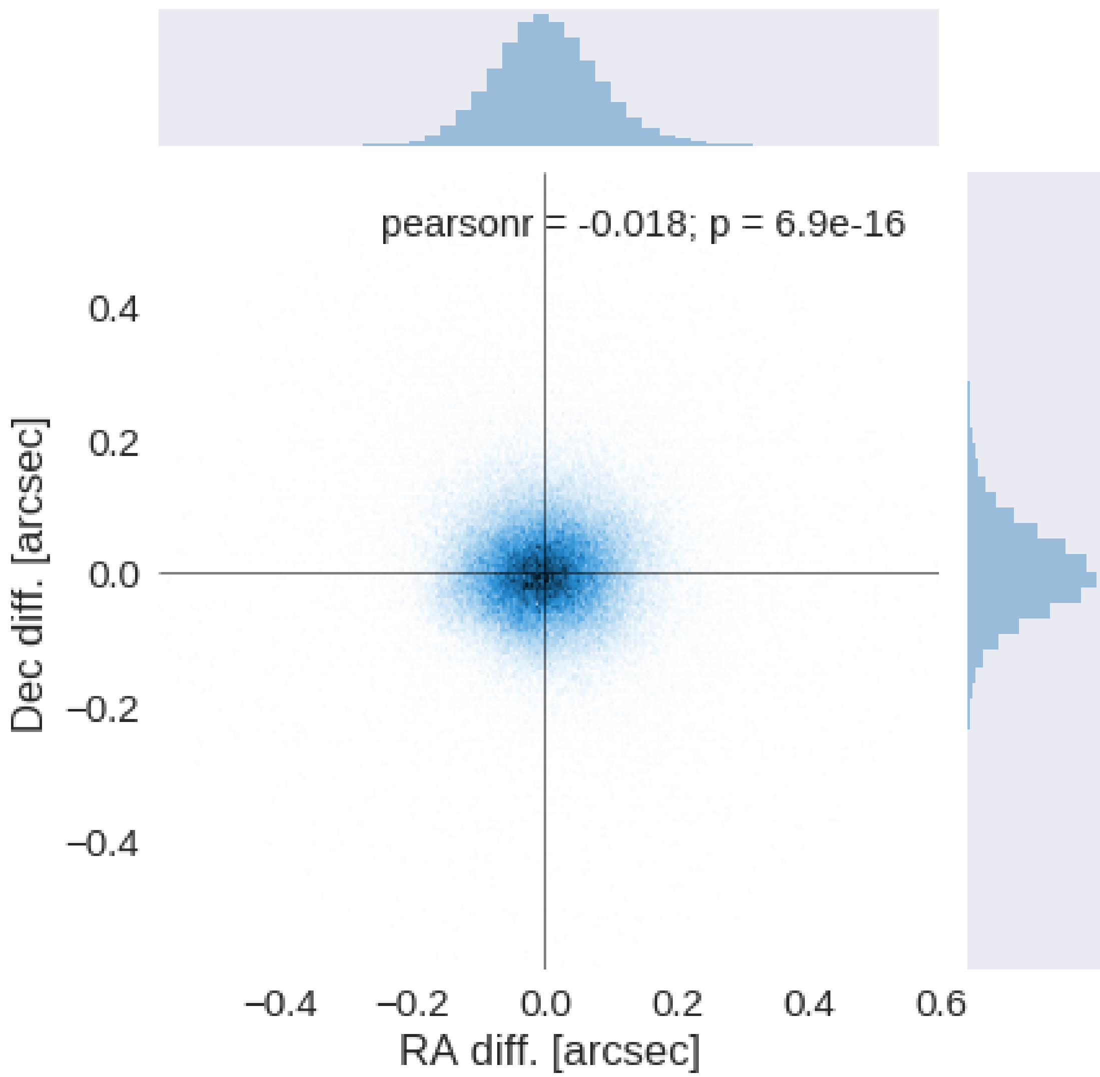
1.4 III - Astrometry correction

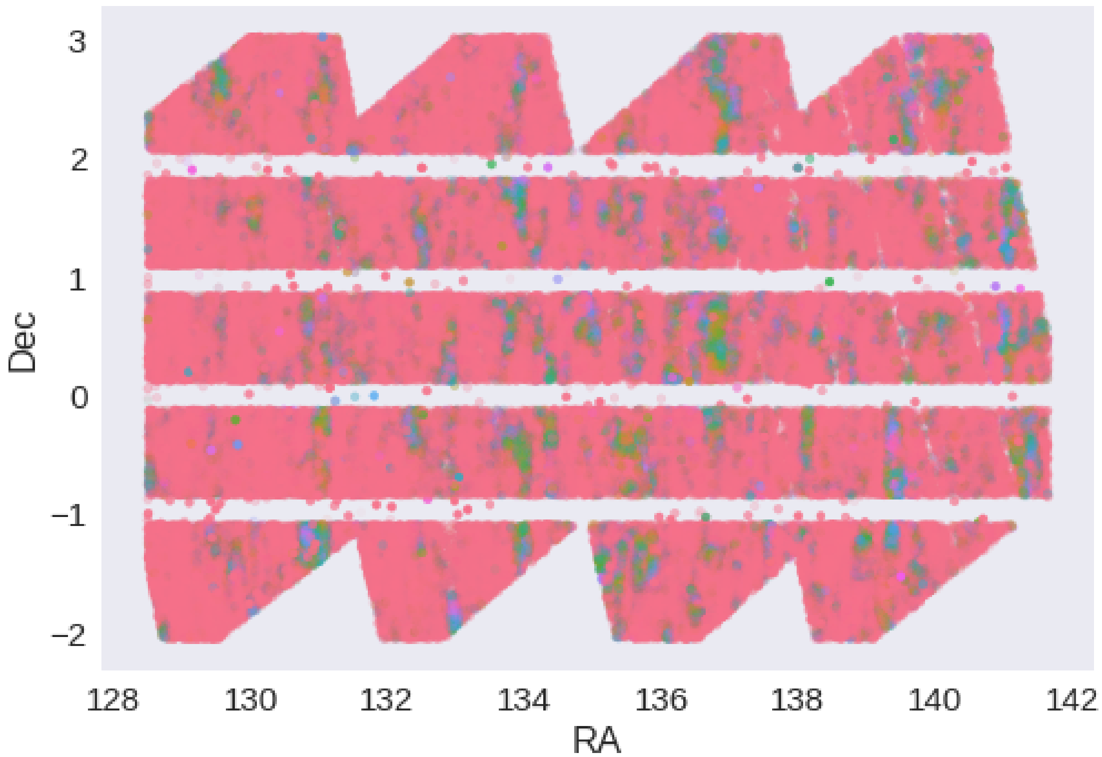
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.






```
RA correction: -0.051234650595688436 arcsec
Dec correction: -0.05147916371074368 arcsec
```


pearsonr = -0.018; p = 6.9e-16
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

```
210025 sources flagged.
```

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

2-out

January 18, 2018

1 GAMA-09 master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-09.

```
This notebook was run with herschelhelp_internal version:
970e176 (Mon Sep 11 16:26:40 2017 +0100)
```

```
/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6/site-pa
  warnings.warn(msg, UserWarning)
```

1.1 I - Reading the prepared pristine catalogues

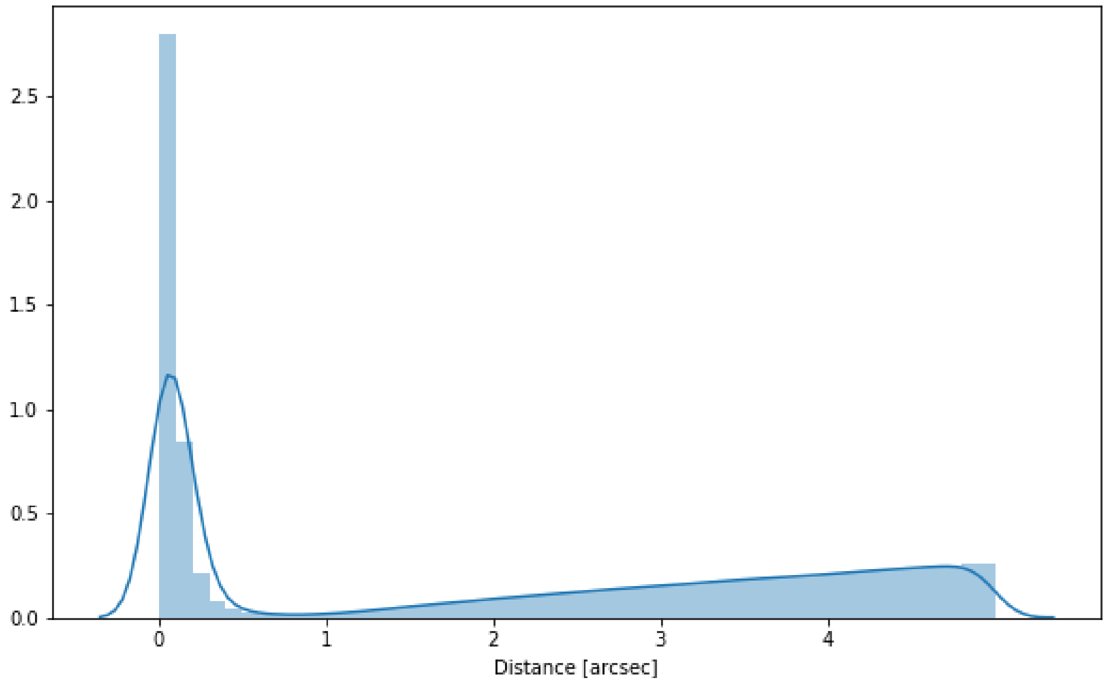
1.2 II - Merging tables

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

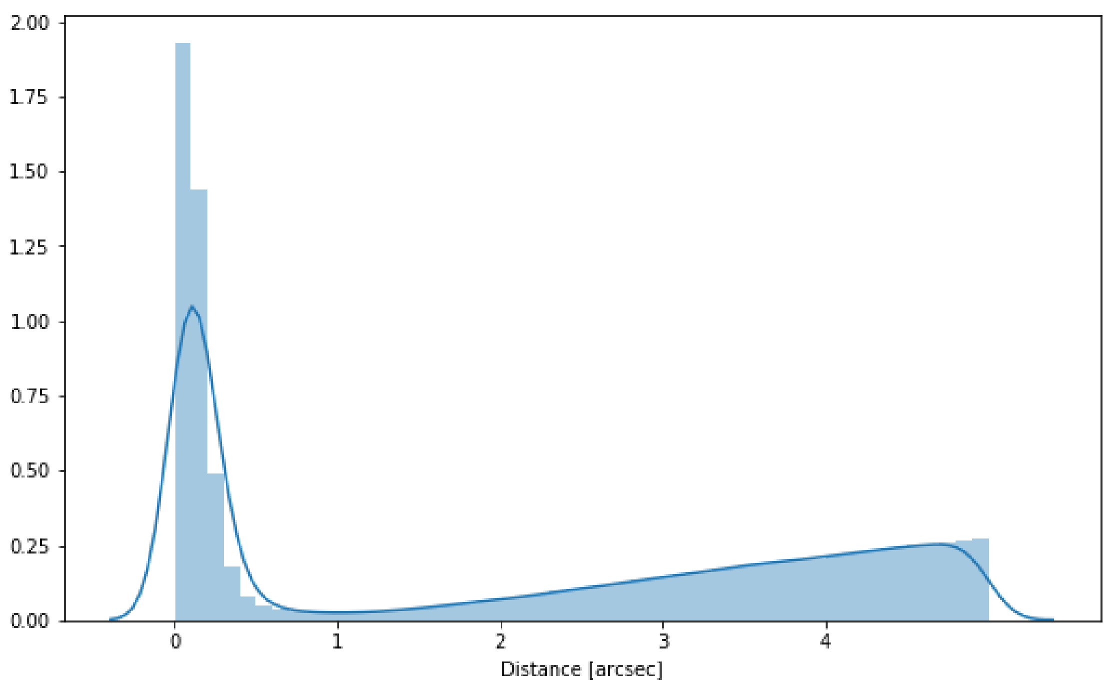
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 CFHTLenS

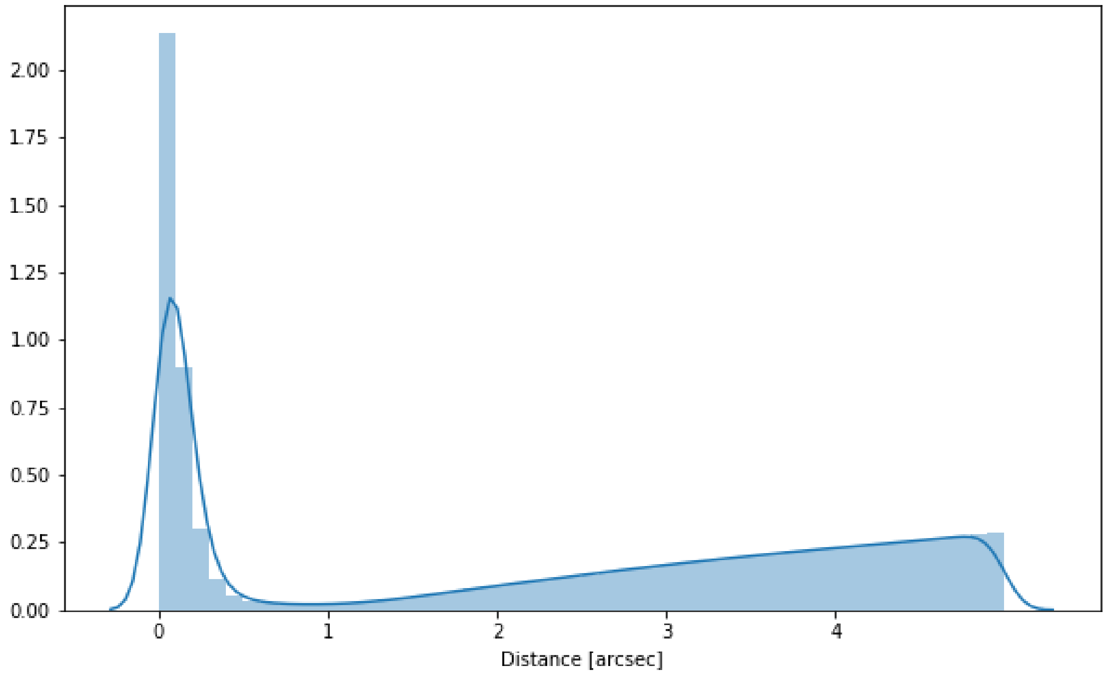
1.2.2 Add CFHTLS



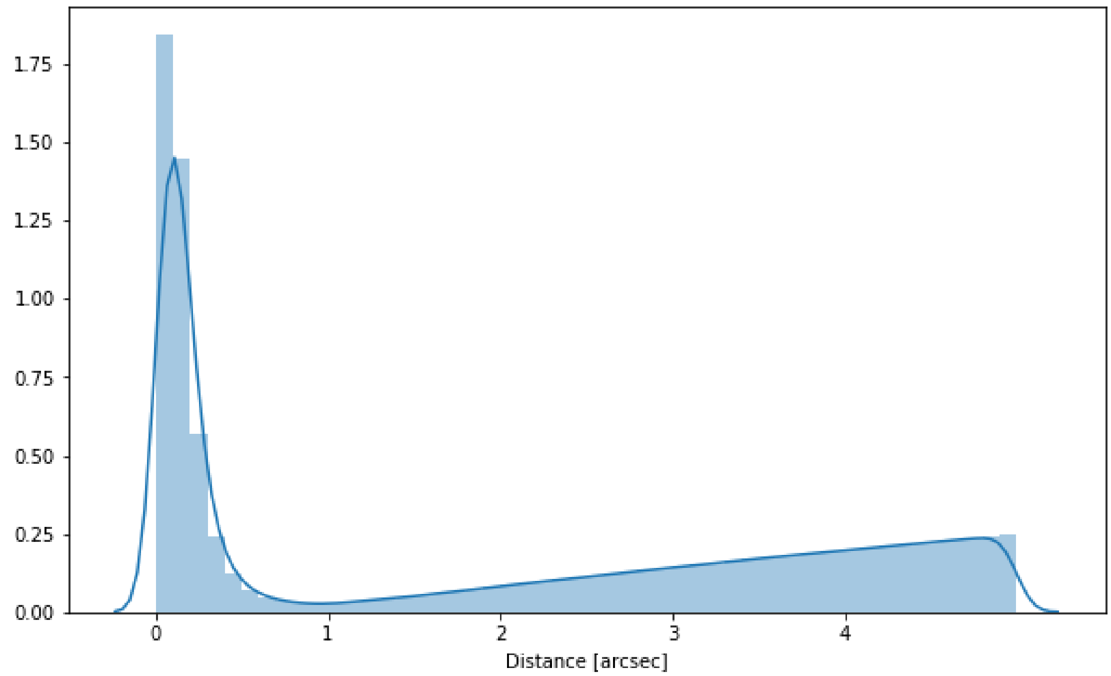
1.2.3 Add DECaLS



1.2.4 Add HSC-PSS



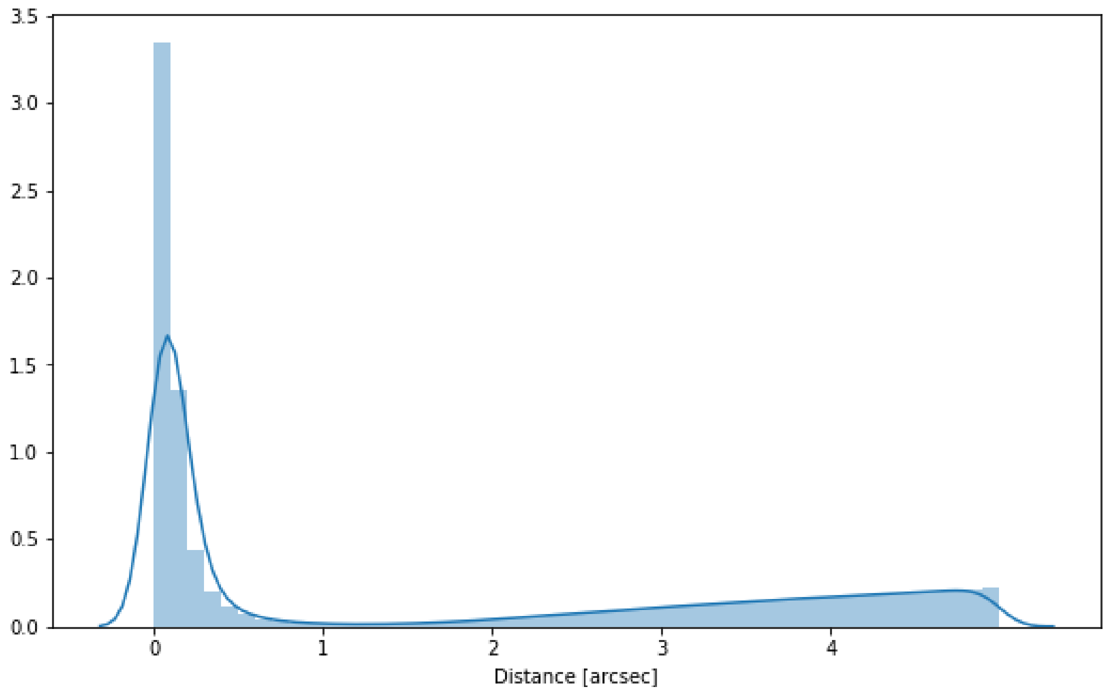
1.2.5 Add KIDS




```
---------------------------------------------------------------------------

MemoryError                               Traceback (most recent call last)

<ipython-input-14-ae91afa3fcf5> in <module>()
      1 # Given the graph above, we use 0.8 arc-second radius
----> 2 master_catalogue = merge_catalogues(master_catalogue, kids, "kids_ra", "kids_dec", r


/research/astro/fir/HELP/help_python/herschelhelp_internal/herschelhelp_internal/masterl
    382
    383     merged_catalogue = vstack([only_in_cat_1, both_in_cat_1_and_cat_2,
--> 384                                only_in_cat_2])
    385
    386     # When vertically stacking the catalogues, some values in the flag columns


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    188     col_name_map = OrderedDict()
    189
--> 190     out = _vstack(tables, join_type, col_name_map, metadata_conflicts)
    191
```

```
    192     # Merge table metadata


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    746                                       .format(col_cls.__name__))
    747         try:
--> 748             out[out_name] = col_cls.info.new_like(cols, n_rows, metadata_conflicts,
    749         except metadata.MergeConflictError as err:
    750             # Beautify the error message when we are trying to merge columns with in


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    181                                             ('meta', 'unit', 'format', 'description')
    182
--> 183         return self._parent_cls(length=length, **attrs)
    184
    185


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1080         self_data = BaseColumn(data, dtype=dtype, shape=shape, length=length, name=n
   1081                                unit=unit, format=format, description=description,
-> 1082                                meta=meta, copy=copy, copy_indices=copy_indices)
   1083         self = ma.MaskedArray.__new__(cls, data=self_data, mask=mask)
   1084


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    194         if data is None:
    195             dtype = (np.dtype(dtype).str, shape)
--> 196             self_data = np.zeros(length, dtype=dtype)
    197         elif isinstance(data, BaseColumn) and hasattr(data, '_name'):
    198             # When unpickling a MaskedColumn, ``data`` will be a bare


    MemoryError:
```

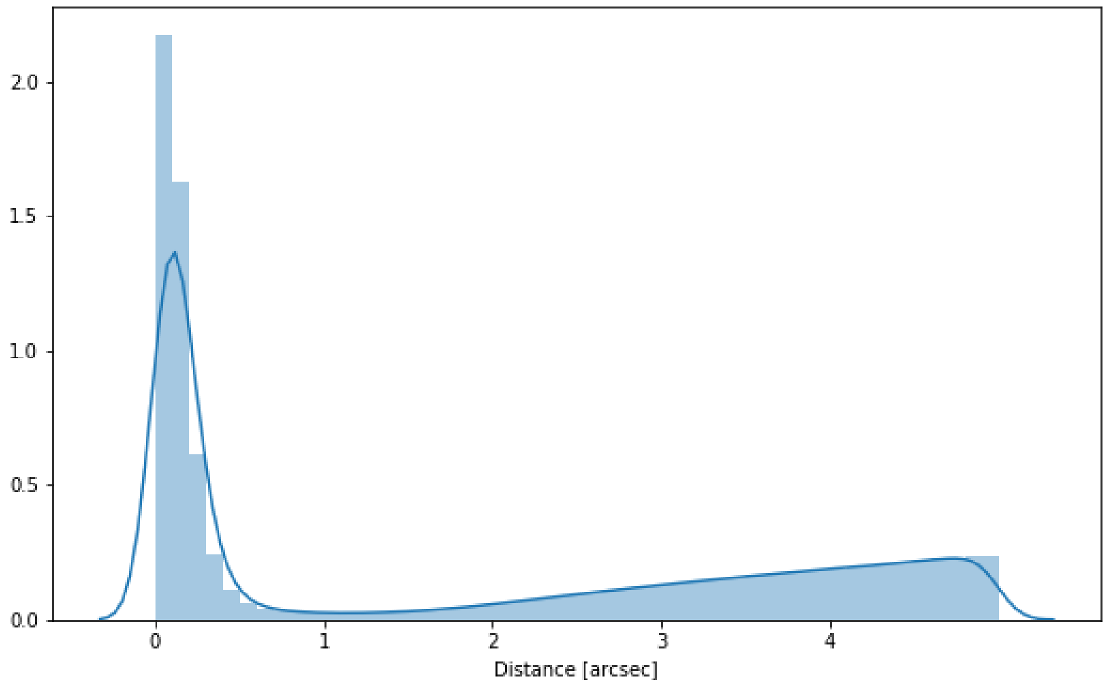
1.2.6 Add PanSTARRS




```
---------------------------------------------------------------------------

MemoryError                               Traceback (most recent call last)

<ipython-input-16-e76055589b43> in <module>()
  1 # Given the graph above, we use 0.8 arc-second radius
----> 2 master_catalogue = merge_catalogues(master_catalogue, ps1, "ps1_ra", "ps1_dec", radi


/research/astro/fir/HELP/help_python/herschelhelp_internal/herschelhelp_internal/masterl
382
383     merged_catalogue = vstack([only_in_cat_1, both_in_cat_1_and_cat_2,
--> 384                                only_in_cat_2])
385
386     # When vertically stacking the catalogues, some values in the flag columns


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
188     col_name_map = OrderedDict()
189
--> 190     out = _vstack(tables, join_type, col_name_map, metadata_conflicts)
191
```

```
    192     # Merge table metadata


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    746                                         .format(col_cls.__name__))
    747         try:
--> 748             out[out_name] = col_cls.info.new_like(cols, n_rows, metadata_conflicts,
    749         except metadata.MergeConflictError as err:
    750             # Beautify the error message when we are trying to merge columns with in


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    181                                              ('meta', 'unit', 'format', 'description')
    182
--> 183         return self._parent_cls(length=length, **attrs)
    184
    185


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1080         self_data = BaseColumn(data, dtype=dtype, shape=shape, length=length, name=n
   1081                                unit=unit, format=format, description=description,
-> 1082                                meta=meta, copy=copy, copy_indices=copy_indices)
   1083         self = ma.MaskedArray.__new__(cls, data=self_data, mask=mask)
   1084


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    194         if data is None:
    195             dtype = (np.dtype(dtype).str, shape)
--> 196             self_data = np.zeros(length, dtype=dtype)
    197         elif isinstance(data, BaseColumn) and hasattr(data, '_name'):
    198             # When unpickling a MaskedColumn, ``data`` will be a bare


    MemoryError:
```

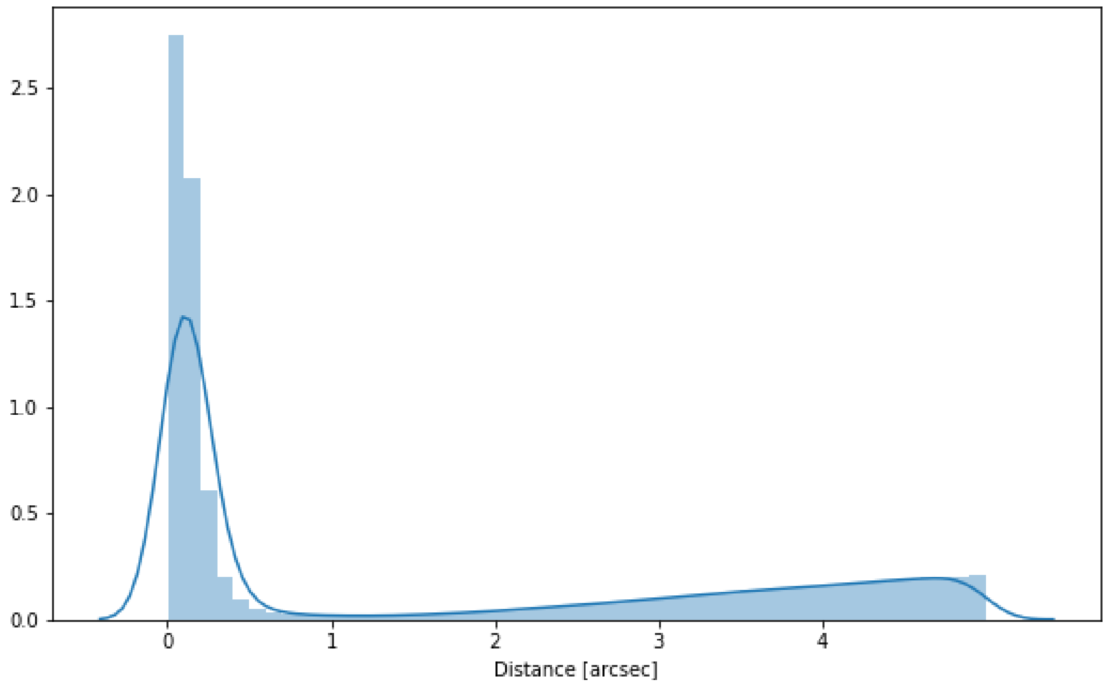
1.2.7 Add UKIDSS LAS




```
---------------------------------------------------------------------------

MemoryError                               Traceback (most recent call last)

<ipython-input-18-488beb5a5a93> in <module>()
      1 # Given the graph above, we use 0.8 arc-second radius
----> 2 master_catalogue = merge_catalogues(master_catalogue, las, "las_ra", "las_dec", radi


/research/astro/fir/HELP/help_python/herschelhelp_internal/herschelhelp_internal/masterl
    382
    383     merged_catalogue = vstack([only_in_cat_1, both_in_cat_1_and_cat_2,
--> 384                                only_in_cat_2])
    385
    386     # When vertically stacking the catalogues, some values in the flag columns


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    188     col_name_map = OrderedDict()
    189
--> 190     out = _vstack(tables, join_type, col_name_map, metadata_conflicts)
    191
```

```
    192     # Merge table metadata


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    746                                         .format(col_cls.__name__))
    747         try:
--> 748             out[out_name] = col_cls.info.new_like(cols, n_rows, metadata_conflicts,
    749         except metadata.MergeConflictError as err:
    750             # Beautify the error message when we are trying to merge columns with in


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    181                                                ('meta', 'unit', 'format', 'description')
    182
--> 183         return self._parent_cls(length=length, **attrs)
    184
    185


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1080         self_data = BaseColumn(data, dtype=dtype, shape=shape, length=length, name=n
   1081                                unit=unit, format=format, description=description,
-> 1082                                meta=meta, copy=copy, copy_indices=copy_indices)
   1083         self = ma.MaskedArray.__new__(cls, data=self_data, mask=mask)
   1084


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    194         if data is None:
    195             dtype = (np.dtype(dtype).str, shape)
--> 196             self_data = np.zeros(length, dtype=dtype)
    197         elif isinstance(data, BaseColumn) and hasattr(data, '_name'):
    198             # When unpickling a MaskedColumn, ``data`` will be a bare


    MemoryError:
```

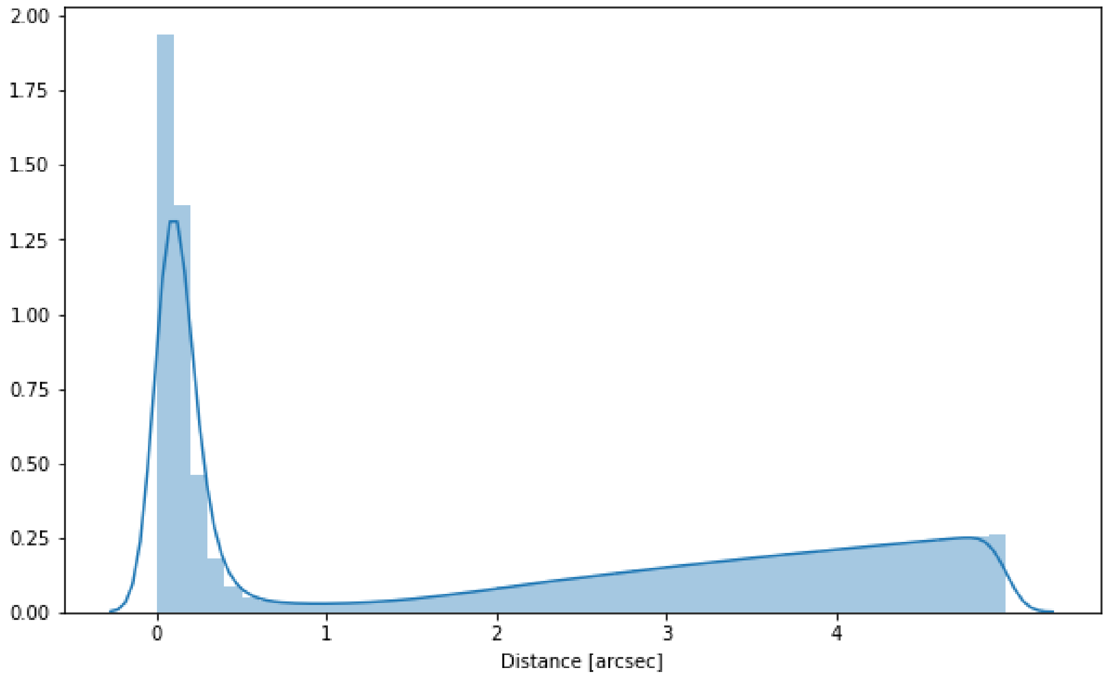
1.2.8 Add VHS




```
---------------------------------------------------------------------------

MemoryError                               Traceback (most recent call last)

<ipython-input-20-48f561eef423> in <module>()
  1 # Given the graph above, we use 1 arc-second radius
----> 2 master_catalogue = merge_catalogues(master_catalogue, vhs, "vhs_ra", "vhs_dec", radi


/research/astro/fir/HELP/help_python/herschelhelp_internal/herschelhelp_internal/masterl
382
383     merged_catalogue = vstack([only_in_cat_1, both_in_cat_1_and_cat_2,
--> 384                               only_in_cat_2])
385
386     # When vertically stacking the catalogues, some values in the flag columns


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
188     col_name_map = OrderedDict()
189
--> 190     out = _vstack(tables, join_type, col_name_map, metadata_conflicts)
191
```

```
    192     # Merge table metadata


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    746                                        .format(col_cls.__name__))
    747         try:
--> 748             out[out_name] = col_cls.info.new_like(cols, n_rows, metadata_conflicts,
    749         except metadata.MergeConflictError as err:
    750             # Beautify the error message when we are trying to merge columns with in


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    181                                              ('meta', 'unit', 'format', 'description')
    182
--> 183         return self._parent_cls(length=length, **attrs)
    184
    185


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1080         self_data = BaseColumn(data, dtype=dtype, shape=shape, length=length, name=n
   1081                                unit=unit, format=format, description=description,
-> 1082                                meta=meta, copy=copy, copy_indices=copy_indices)
   1083         self = ma.MaskedArray.__new__(cls, data=self_data, mask=mask)
   1084


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    194         if data is None:
    195             dtype = (np.dtype(dtype).str, shape)
--> 196             self_data = np.zeros(length, dtype=dtype)
    197         elif isinstance(data, BaseColumn) and hasattr(data, '_name'):
    198             # When unpickling a MaskedColumn, ``data`` will be a bare


    MemoryError:
```

1.2.9 Add VIKING




```
---------------------------------------------------------------------------

MemoryError                               Traceback (most recent call last)

<ipython-input-22-95e157d50877> in <module>()
      1 # Given the graph above, we use 1 arc-second radius
----> 2 master_catalogue = merge_catalogues(master_catalogue, viking, "viking_ra", "viking_d


/research/astro/fir/HELP/help_python/herschelhelp_internal/herschelhelp_internal/masterl
    382
    383     merged_catalogue = vstack([only_in_cat_1, both_in_cat_1_and_cat_2,
--> 384                                only_in_cat_2])
    385
    386     # When vertically stacking the catalogues, some values in the flag columns


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    188     col_name_map = OrderedDict()
    189
--> 190     out = _vstack(tables, join_type, col_name_map, metadata_conflicts)
    191
```

```
    192     # Merge table metadata


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    746                                        .format(col_cls.__name__))
    747         try:
--> 748             out[out_name] = col_cls.info.new_like(cols, n_rows, metadata_conflicts,
    749         except metadata.MergeConflictError as err:
    750             # Beautify the error message when we are trying to merge columns with in


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    181                                              ('meta', 'unit', 'format', 'description')
    182
--> 183         return self._parent_cls(length=length, **attrs)
    184
    185


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1080         self_data = BaseColumn(data, dtype=dtype, shape=shape, length=length, name=n
   1081                                unit=unit, format=format, description=description,
-> 1082                                meta=meta, copy=copy, copy_indices=copy_indices)
   1083         self = ma.MaskedArray.__new__(cls, data=self_data, mask=mask)
   1084


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    194         if data is None:
    195             dtype = (np.dtype(dtype).str, shape)
--> 196             self_data = np.zeros(length, dtype=dtype)
    197         elif isinstance(data, BaseColumn) and hasattr(data, '_name'):
    198             # When unpickling a MaskedColumn, ``data`` will be a bare


    MemoryError:
```

1.2.10 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.

```
    ---------------------------------------------------------------------------
```

```
    MemoryError                               Traceback (most recent call last)

    <ipython-input-23-928c16644eda> in <module>()
      7         master_catalogue[col].fill_value = -1
      8
----> 9 master_catalogue = master_catalogue.filled()


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    472         """
    473         if self.masked:
--> 474             data = [col.filled(fill_value) for col in six.itervalues(self.columns)]
    475         else:
    476             data = self


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    472         """
    473         if self.masked:
--> 474             data = [col.filled(fill_value) for col in six.itervalues(self.columns)]
    475         else:
    476             data = self


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1153             fill_value = self.fill_value
   1154
-> 1155         data = super(MaskedColumn, self).filled(fill_value)
   1156         # Use parent table definition of Column if available
   1157         column_cls = self.parent_table.Column if (self.parent_table is not None) els


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   3677             return self._data
   3678         else:
-> 3679             result = self._data.copy('K')
   3680             try:
   3681                 np.copyto(result, fill_value, where=m)


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    294             data = self.data
    295             if copy_data:
--> 296                 data = data.copy(order)
    297
    298         out = data.view(self.__class__)
```

```
MemoryError:
```

Out[24]: <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.

```
---------------------------------------------------------------------------

ValueError                                Traceback (most recent call last)

<ipython-input-27-f844bca5fa8b> in <module>()
      3
      4 master_catalogue.add_column(Column(
----> 5     data=np.nanmax([master_catalogue[column] for column in stellarity_columns], axis
      6     name="stellarity"
      7 ))


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    339     if not isinstance(a, np.ndarray) or type(a) is np.ndarray:
    340         # Fast, but not safe for subclasses of ndarray
--> 341         res = np.fmax.reduce(a, axis=axis, out=out, **kwargs)
    342         if np.isnan(res).any():
    343             warnings.warn("All-NaN slice encountered", RuntimeWarning)


ValueError: zero-size array to reduction operation fmax which has no identity
```

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

```
OK!
```

1.6 VI - Choosing between multiple values for the same filter

Both CFHTLenS and CFHTLS, and VISTA-VIKING and VISTA-VHS have measurements from the same camera and filters. We wish to choose the superior measurement where both are present.

1.6.1 VI.a CFHTLenS and CFHTLS

CFHTLS is optimised for deep photometry so we take that for

```
For Megacam band u:
```

```
---------------------------------------------------------------------------

KeyError                                  Traceback (most recent call last)

<ipython-input-32-fa4b1a932fa3> in <module>()
      3     print('For Megacam band ' + band + ':')
      4     # Megacam total flux
----> 5     has_cfhtls = ~np.isnan(master_catalogue['f_cfhtls_' + band])
      6     has_cfhtlens = ~np.isnan(master_catalogue['f_cfhtlens_' + band])
      7     has_both = has_cfhtls & has_cfhtlens


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1222     def __getitem__(self, item):
   1223         if isinstance(item, six.string_types):
-> 1224             return self.columns[item]
   1225         elif isinstance(item, (int, np.integer)):
   1226             return self.Row(self, item)


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    107         """
    108         if isinstance(item, six.string_types):
--> 109             return OrderedDict.__getitem__(self, item)
    110         elif isinstance(item, (int, np.integer)):
    111             return self.values()[item]


KeyError: 'f_cfhtls_u'
```

```
---------------------------------------------------------------------------

KeyError                                  Traceback (most recent call last)

<ipython-input-33-af139769a528> in <module>()
      1 #Aperture flux only in CFHTLS
      2 for band in megacam_bands:
----> 3     master_catalogue['f_ap_cfhtls_' + band].name = 'f_ap_megacam_' + band
      4     master_catalogue['ferr_ap_cfhtls_' + band].name = 'ferr_ap_megacam_' + band
```

```
      5     master_catalogue['m_ap_cfhtls_' + band].name = 'm_ap_megacam_' + band


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1222     def __getitem__(self, item):
   1223         if isinstance(item, six.string_types):
-> 1224             return self.columns[item]
   1225         elif isinstance(item, (int, np.integer)):
   1226             return self.Row(self, item)


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    107         """
    108         if isinstance(item, six.string_types):
--> 109             return OrderedDict.__getitem__(self, item)
    110         elif isinstance(item, (int, np.integer)):
    111             return self.values()[item]


    KeyError: 'f_ap_cfhtls_u'
```

VI.b VISTA-VIKING and VISTA-VHS VIKING is deeper than VHS so we take the VIKING photometry if available.

```
For VISTA band y:



    ---------------------------------------------------------------------------

    KeyError                                  Traceback (most recent call last)

    <ipython-input-36-3dcd5f7bcf0c> in <module>()
      3     print('For VISTA band ' + band + ':')
      4     # VISTA total flux
----> 5     has_viking = ~np.isnan(master_catalogue['f_viking_' + band])
      6     has_vhs = ~np.isnan(master_catalogue['f_vhs_' + band])
      7     has_both = has_viking & has_vhs


    /research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1222     def __getitem__(self, item):
   1223         if isinstance(item, six.string_types):
-> 1224             return self.columns[item]
   1225         elif isinstance(item, (int, np.integer)):
   1226             return self.Row(self, item)
```

```
/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    107         """
    108         if isinstance(item, six.string_types):
--> 109             return OrderedDict.__getitem__(self, item)
    110         elif isinstance(item, (int, np.integer)):
    111             return self.values()[item]


KeyError: 'f_viking_y'
```

```
---------------------------------------------------------------------------

KeyError                                  Traceback (most recent call last)

<ipython-input-37-5b9911c91e44> in <module>()
      2 #Z band only in viking
      3
----> 4 master_catalogue['f_ap_viking_z'].name = 'f_ap_vista_z'
      5 master_catalogue['ferr_ap_viking_z'].name = 'ferr_ap_vista_z'
      6 master_catalogue['f_viking_z'].name = 'f_vista_z'


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1222     def __getitem__(self, item):
   1223         if isinstance(item, six.string_types):
-> 1224             return self.columns[item]
   1225         elif isinstance(item, (int, np.integer)):
   1226             return self.Row(self, item)


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    107         """
    108         if isinstance(item, six.string_types):
--> 109             return OrderedDict.__getitem__(self, item)
    110         elif isinstance(item, (int, np.integer)):
    111             return self.values()[item]


KeyError: 'f_ap_viking_z'
```

1.7 VII.a Wavelength domain coverage

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

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

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

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

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

1.8 VII.b Wavelenght domain detection

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

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

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

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

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

```
---------------------------------------------------------------------------

KeyError                                  Traceback (most recent call last)

<ipython-input-42-eef7db88fcfc> in <module>()
     25     1 * ~np.isnan(master_catalogue['f_kids_u']) +
     26     1 * ~np.isnan(master_catalogue['f_kids_g']) +
---> 27     1 * ~np.isnan(master_catalogue['f_kids_r']) +
     28     1 * ~np.isnan(master_catalogue['f_kids_i'])
     29 )


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1222     def __getitem__(self, item):
   1223         if isinstance(item, six.string_types):
-> 1224             return self.columns[item]
   1225         elif isinstance(item, (int, np.integer)):
   1226             return self.Row(self, item)
```

```
/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
    107         """
    108         if isinstance(item, six.string_types):
--> 109             return OrderedDict.__getitem__(self, item)
    110         elif isinstance(item, (int, np.integer)):
    111             return self.values()[item]


KeyError: 'f_megacam_u'
```

```
---------------------------------------------------------------------------

NameError                                 Traceback (most recent call last)

<ipython-input-43-badcad18dcc0> in <module>()
----> 1 has_optical_flux = nb_optical_flux >= 2
      2 has_nir_flux = nb_nir_flux >= 2
      3 has_mir_flux = nb_mir_flux >= 2
      4
      5 master_catalogue.add_column(


NameError: name 'nb_optical_flux' is not defined
```

1.9 VIII - Cross-identification table

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

```
---------------------------------------------------------------------------

ValueError                                Traceback (most recent call last)

<ipython-input-44-b7f6f3f75dc5> in <module>()
      9                  'las_id',
     10                  'vhs_id',
---> 11                  'viking_id'
     12                 ].write(
     13     "{}/master_list_cross_ident_gama-09{}.fits".format(OUT_DIR, SUFFIX))


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1232             if bad_names:
```

```
   1233                 raise ValueError('Slice name(s) {0} not valid column name(s)'
-> 1234                                  .format(', '.join(bad_names)))
   1235             out = self.__class__([self[x] for x in item],
   1236                                  meta=deepcopy(self.meta),
```

```
ValueError: Slice name(s) kids_id, ps1_id, las_id, vhs_id, viking_id not valid column na
```

1.10 IX - Adding HEALPix index

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

1.11 IX - Saving the catalogue

```
Missing columns: {'cfhtlens_id', 'cfhtls_id', 'hsc_id', 'decals_id'}
```

```
---------------------------------------------------------------------------

ValueError                                Traceback (most recent call last)

<ipython-input-48-0994321197c4> in <module>()
----> 1 master_catalogue[columns].write("{}/master_catalogue_gama-09{}.fits".format(OUT_DIR,


/research/astro/fir/HELP/help_python/miniconda3/envs/herschelhelp_internal/lib/python3.6
   1232             if bad_names:
   1233                 raise ValueError('Slice name(s) {0} not valid column name(s)'
-> 1234                                  .format(', '.join(bad_names)))
   1235             out = self.__class__([self[x] for x in item],
   1236                                  meta=deepcopy(self.meta),


ValueError: Slice name(s) stellarity, flag_optnir_det not valid column name(s)
```

2_Merging-half

January 18, 2018

1 GAMA-09 master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-09.

```
This notebook was run with herschelhelp_internal version:
56042ea (Thu Aug 3 18:51:31 2017 +0100) [with local modifications]
```

1.1 I - Reading the prepared pristine catalogues

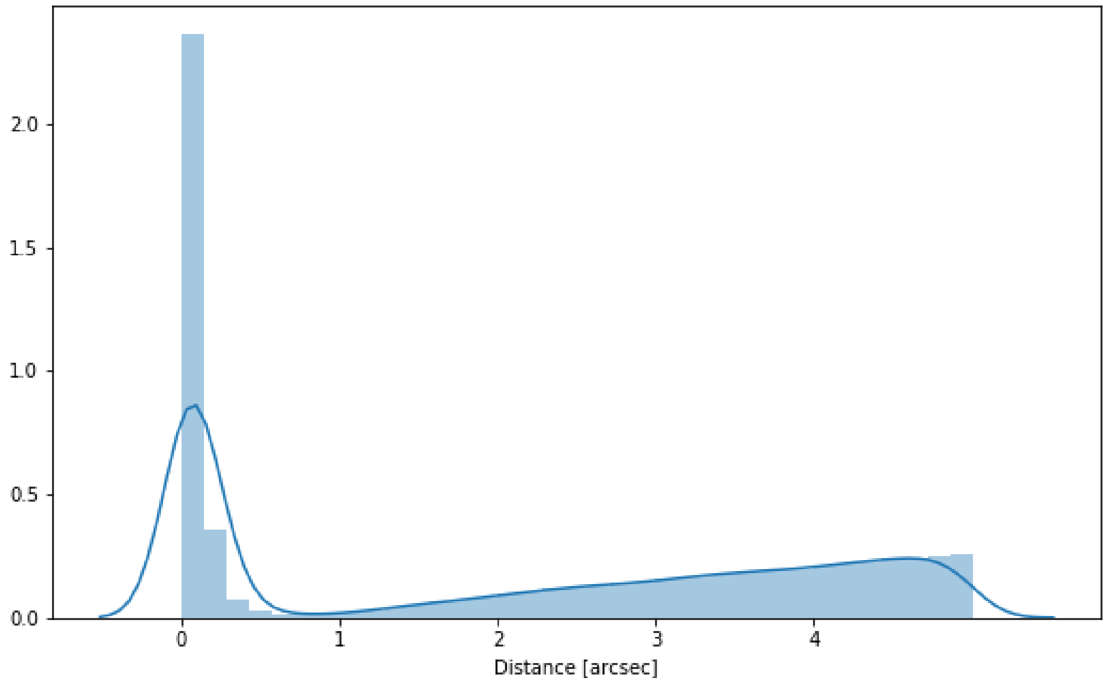
1.2 II - Merging tables

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

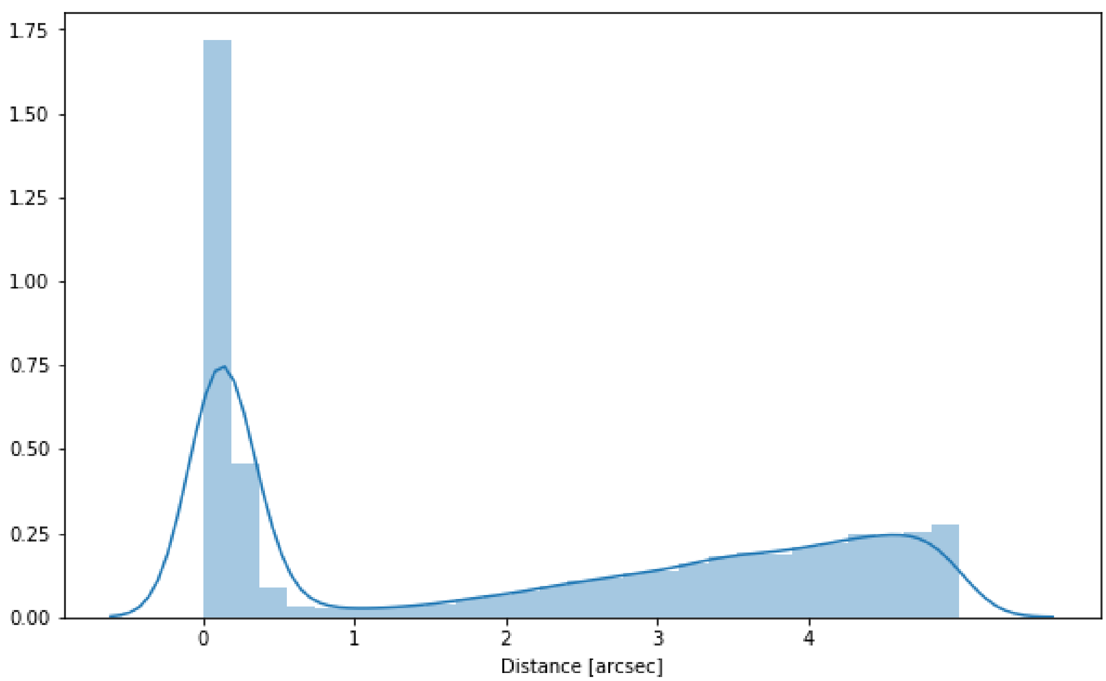
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 CFHTLenS

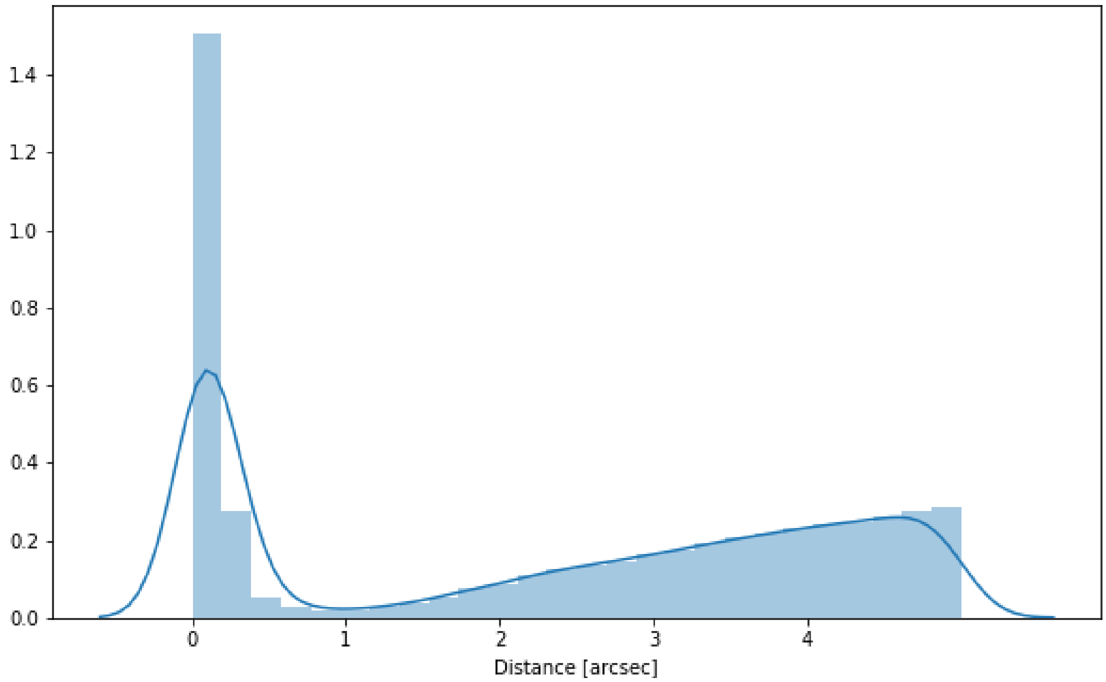
1.2.2 Add CFHTLS



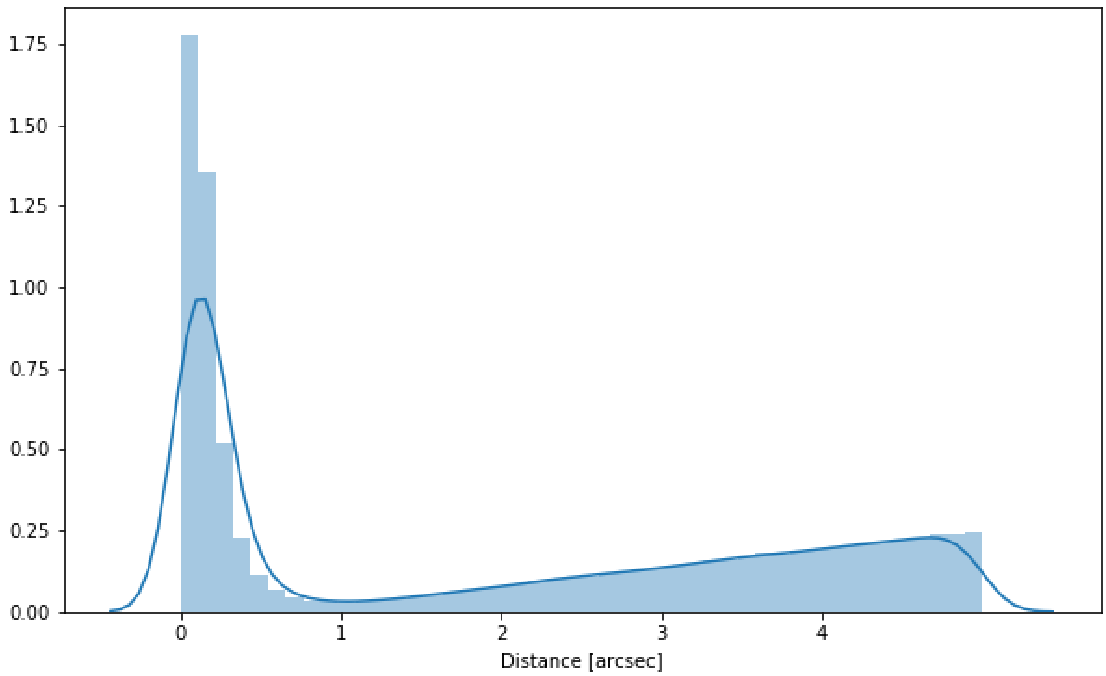
1.2.3 Add DECaLS



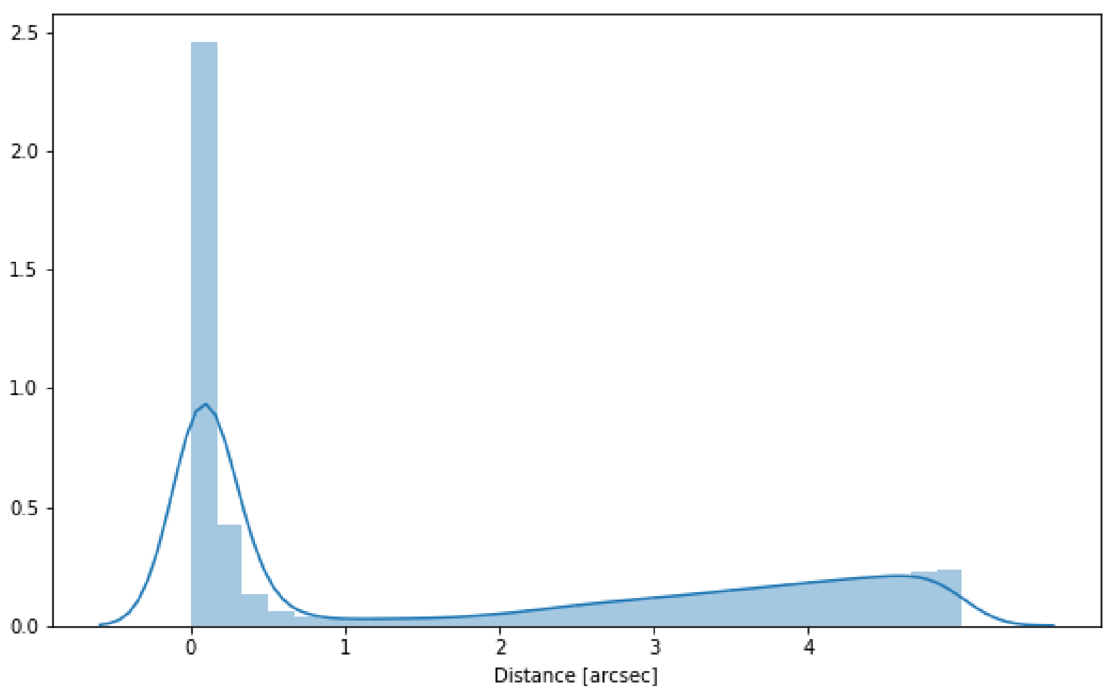
1.2.4 Add HSC-PSS



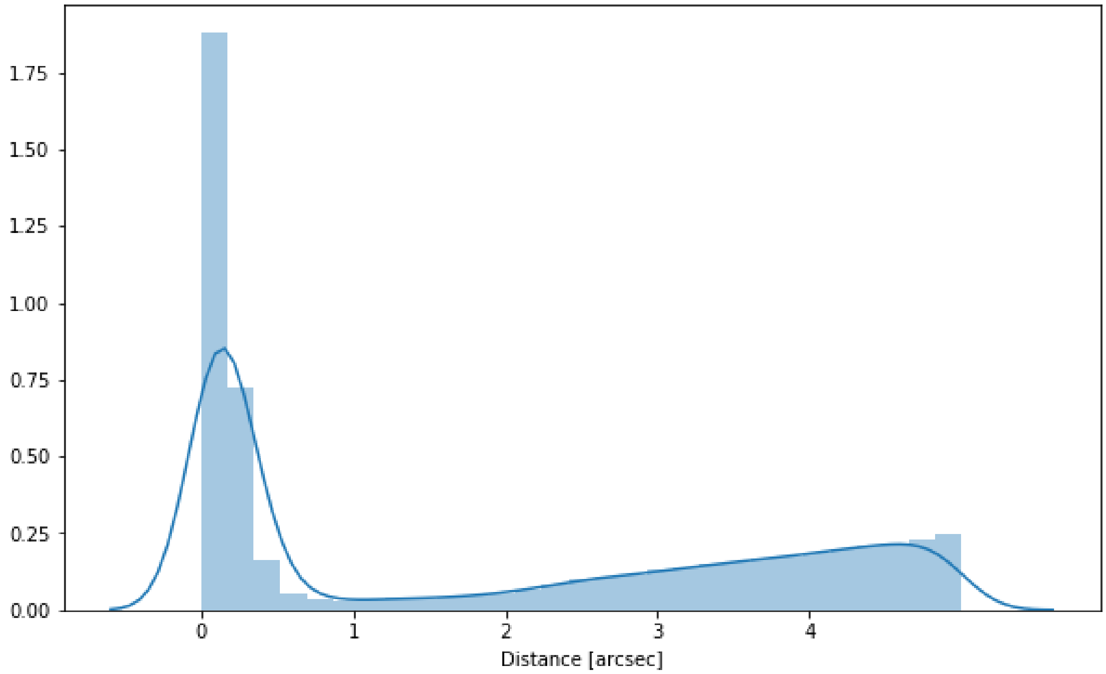
1.2.5 Add KIDS



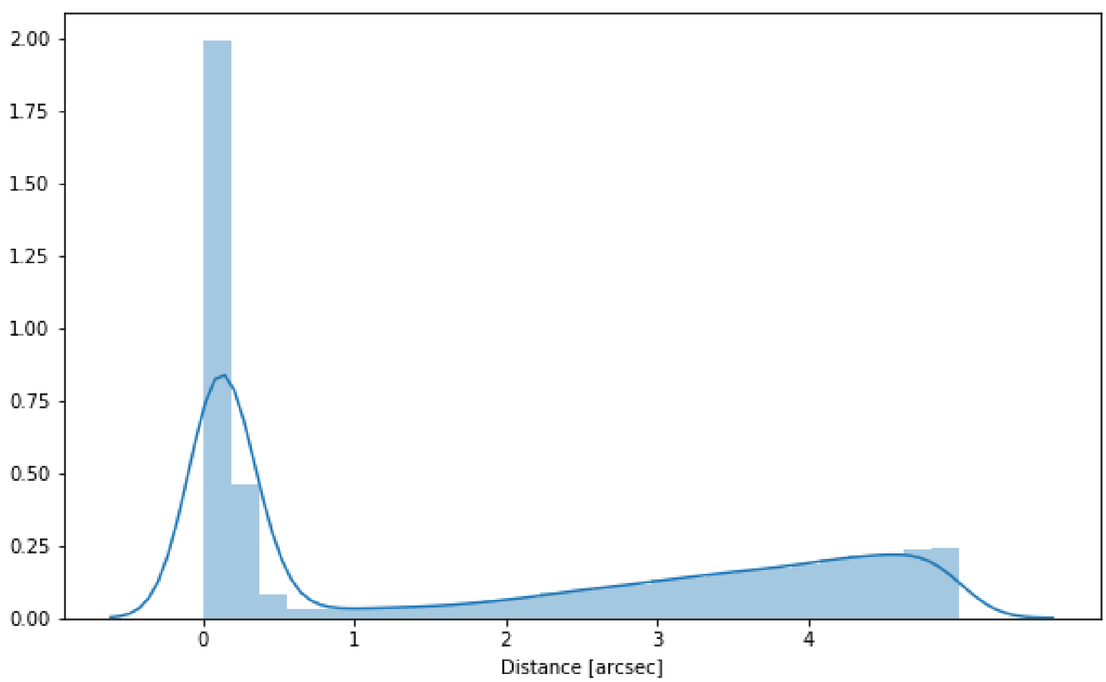
1.2.6 Add PanSTARRS



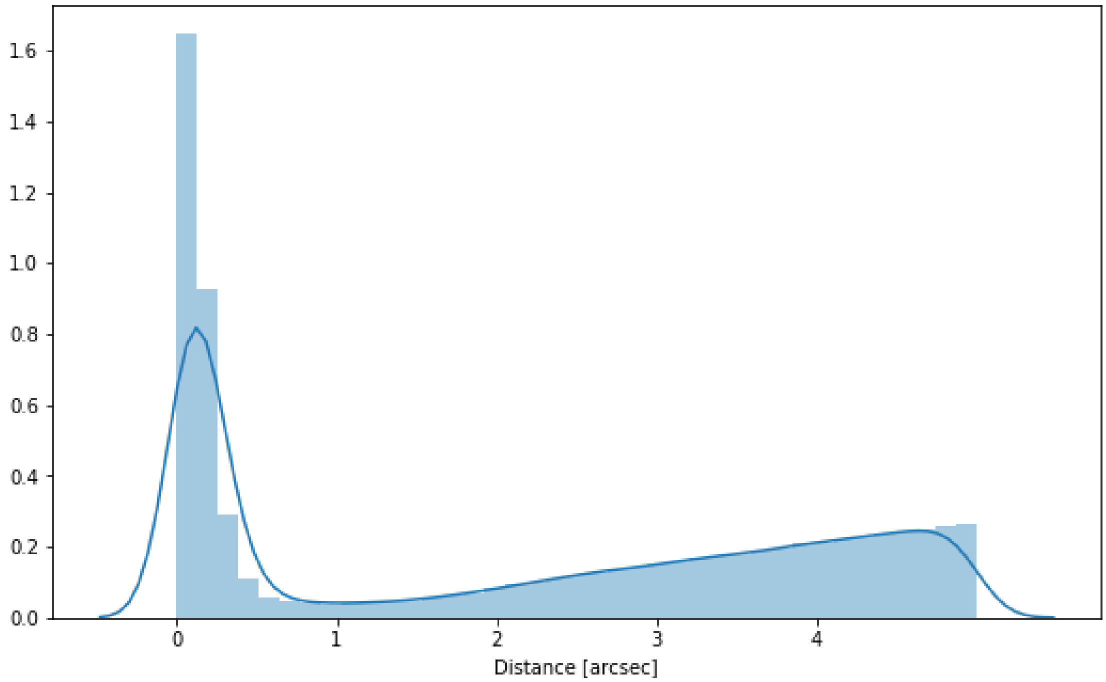
1.2.7 Add UKIDSS LAS



1.2.8 Add VHS



1.2.9 Add VIKING



1.2.10 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[23]: <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.

```
/Users/rs548/anaconda/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfuncti
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

```
OK!
```

1.6 VI - Choosing between multiple values for the same filter

Both CFHTLenS and CFHTLS, and VISTA-VIKING and VISTA-VHS have measurements from the same camera and filters. We wish to choose the superior measurement where both are present.

1.6.1 VI.a CFHTLenS and CFHTLS

CFHTLS is optimised for deep photometry so we take that for

```
For Megacam band u:
97540 sources with CFHTLS flux
46479 sources with CFHTLenS flux
44464 sources with CFHTLS and CFHTLenS flux
97540 sources for which we use CFHTLS
2015 sources for which we use CFHTLenS
For Megacam band g:
106621 sources with CFHTLS flux
58043 sources with CFHTLenS flux
55832 sources with CFHTLS and CFHTLenS flux
106621 sources for which we use CFHTLS
2211 sources for which we use CFHTLenS
For Megacam band r:
106301 sources with CFHTLS flux
58749 sources with CFHTLenS flux
56409 sources with CFHTLS and CFHTLenS flux
106301 sources for which we use CFHTLS
2340 sources for which we use CFHTLenS
For Megacam band i:
104738 sources with CFHTLS flux
62025 sources with CFHTLenS flux
58119 sources with CFHTLS and CFHTLenS flux
104738 sources for which we use CFHTLS
3906 sources for which we use CFHTLenS
For Megacam band z:
92404 sources with CFHTLS flux
47865 sources with CFHTLenS flux
45146 sources with CFHTLS and CFHTLenS flux
92404 sources for which we use CFHTLS
```

```
2719 sources for which we use CFHTLenS
```

VI.b VISTA-VIKING and VISTA-VHS VIKING is deeper than VHS so we take the VIKING photometry if available.

```
For VISTA band y:
37367 sources with VIKING flux
0 sources with VHS flux
0 sources with VIKING and VHS flux
37367 sources for which we use VIKING
0 sources for which we use VHS
37366 sources with VIKING aperture flux
0 sources with VHS aperture flux
0 sources with VIKING and VHS aperture flux
37366 sources for which we use VIKING aperture fluxes
0 sources for which we use VHS aperture fluxes
For VISTA band j:
51324 sources with VIKING flux
31223 sources with VHS flux
19898 sources with VIKING and VHS flux
51324 sources for which we use VIKING
11325 sources for which we use VHS
51321 sources with VIKING aperture flux
31220 sources with VHS aperture flux
19895 sources with VIKING and VHS aperture flux
51321 sources for which we use VIKING aperture fluxes
11325 sources for which we use VHS aperture fluxes
For VISTA band h:
40451 sources with VIKING flux
0 sources with VHS flux
0 sources with VIKING and VHS flux
40451 sources for which we use VIKING
0 sources for which we use VHS
40440 sources with VIKING aperture flux
0 sources with VHS aperture flux
0 sources with VIKING and VHS aperture flux
40440 sources for which we use VIKING aperture fluxes
0 sources for which we use VHS aperture fluxes
For VISTA band k:
44007 sources with VIKING flux
25359 sources with VHS flux
17615 sources with VIKING and VHS flux
44007 sources for which we use VIKING
7744 sources for which we use VHS
44000 sources with VIKING aperture flux
25354 sources with VHS aperture flux
17609 sources with VIKING and VHS aperture flux
```

```
44000 sources for which we use VIKING aperture fluxes
7745 sources for which we use VHS aperture fluxes
```

1.7 VII.a Wavelength domain coverage

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

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

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

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

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

1.8 VII.b Wavelenght domain detection

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

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

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

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

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

1.9 VIII - Cross-identification table

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

1.10 IX - Adding HEALPix index

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

1.11 IX - Saving the catalogue

```
Missing columns: set()
```

2_Merging-radeconly2

January 18, 2018

1 GAMA-09 master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-09.

```
This notebook was run with herschelhelp_internal version:
56042ea (Thu Aug 3 18:51:31 2017 +0100) [with local modifications]
```

1.1 I - Reading the prepared pristine catalogues

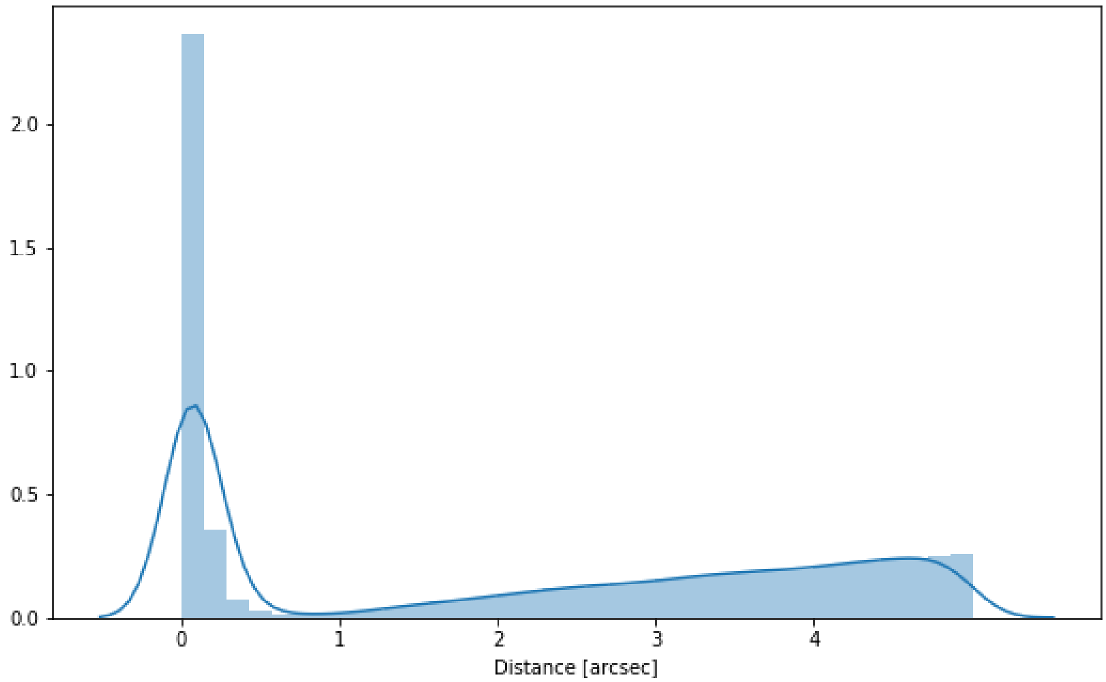
1.2 II - Merging tables

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

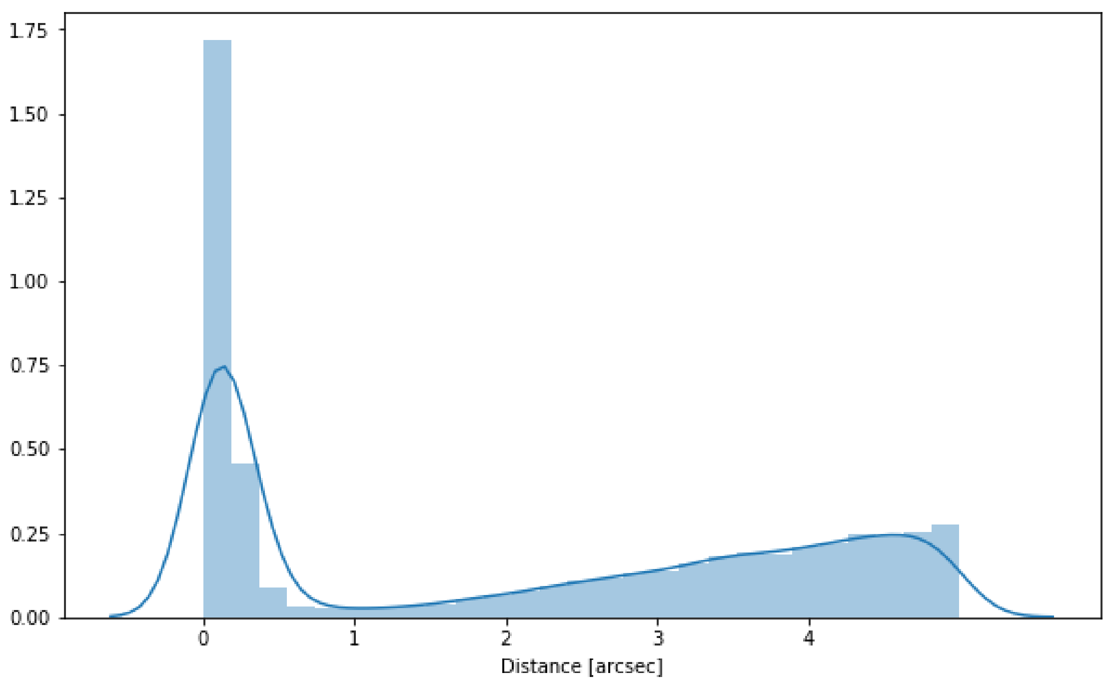
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 CFHTLenS

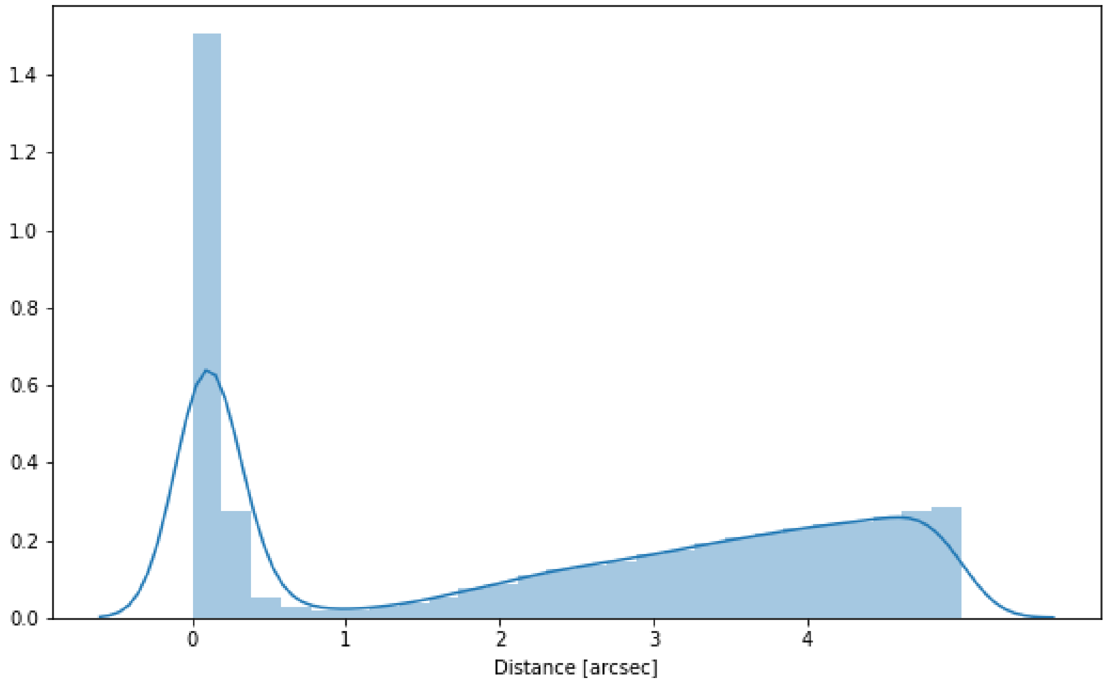
1.2.2 Add CFHTLS



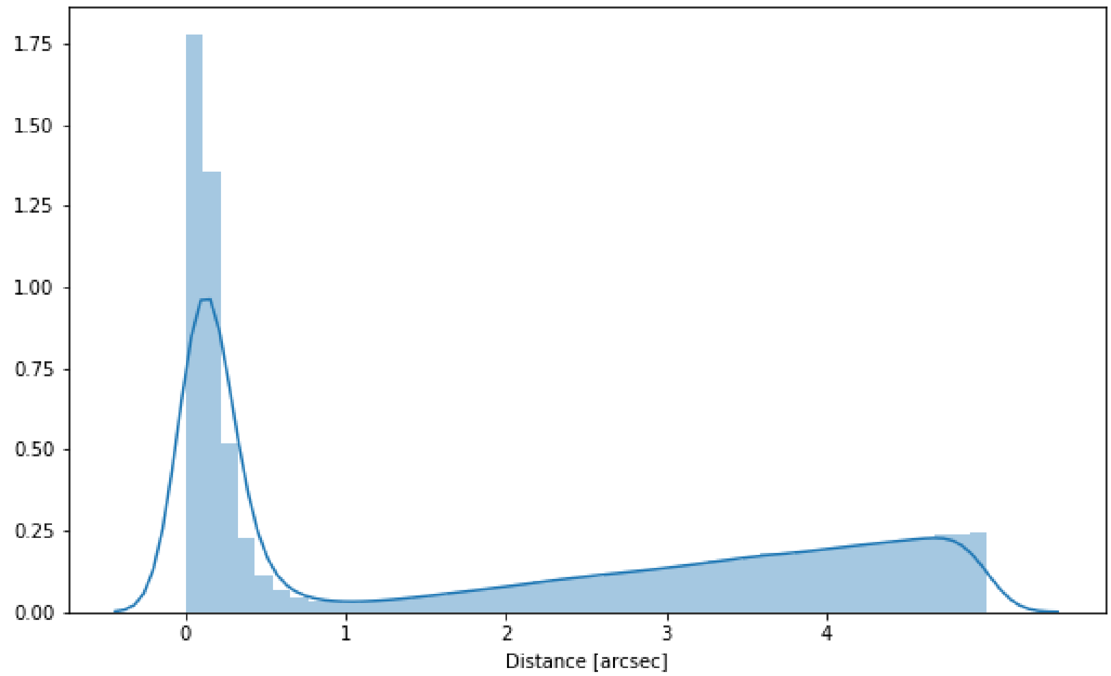
1.2.3 Add DECaLS



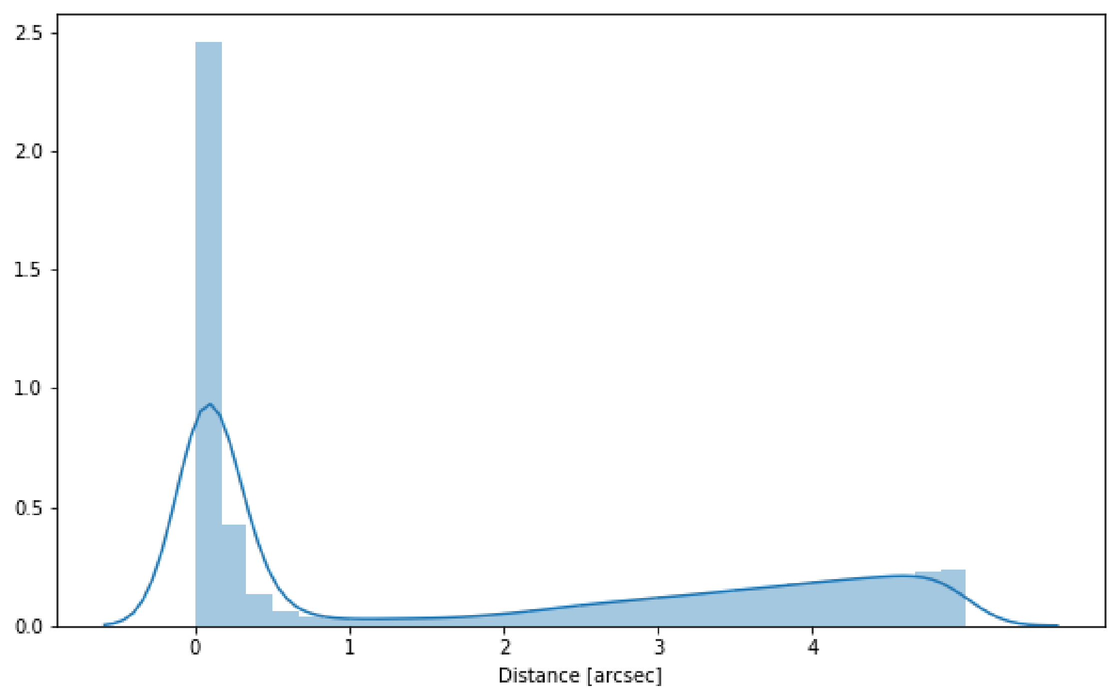
1.2.4 Add HSC-PSS



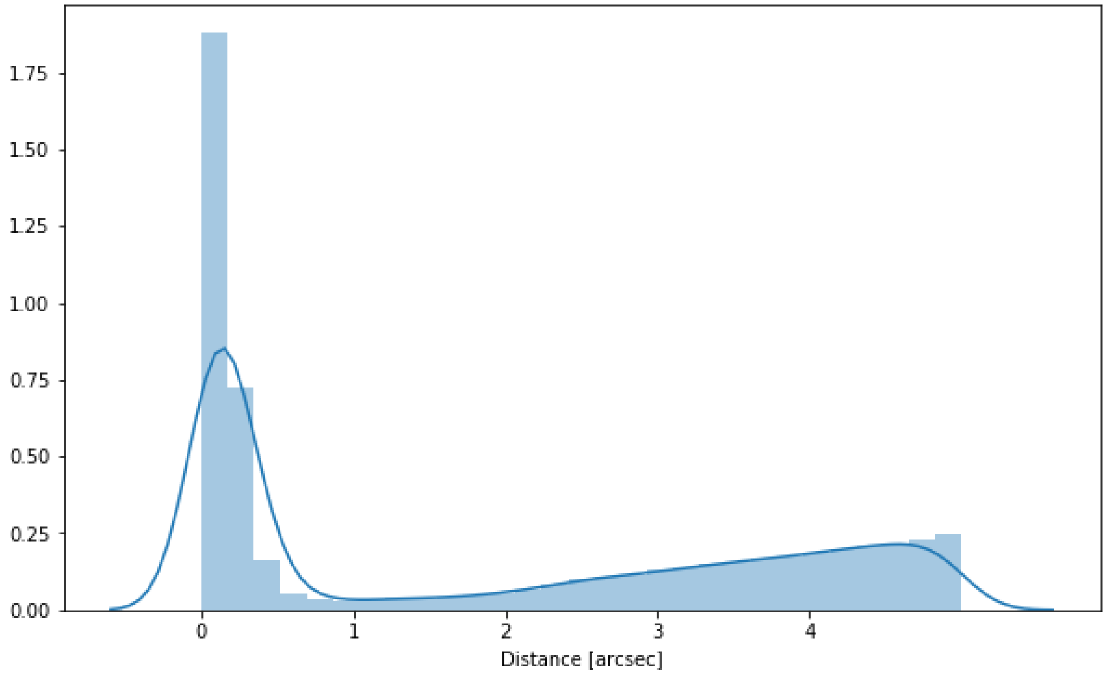
1.2.5 Add KIDS



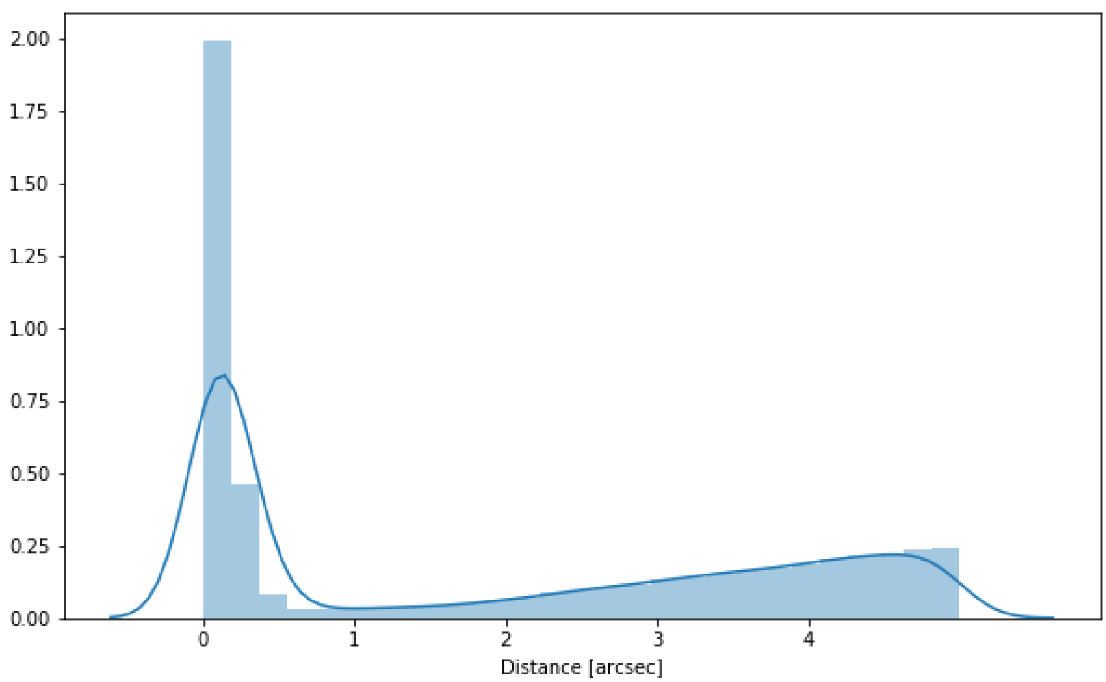
1.2.6 Add PanSTARRS



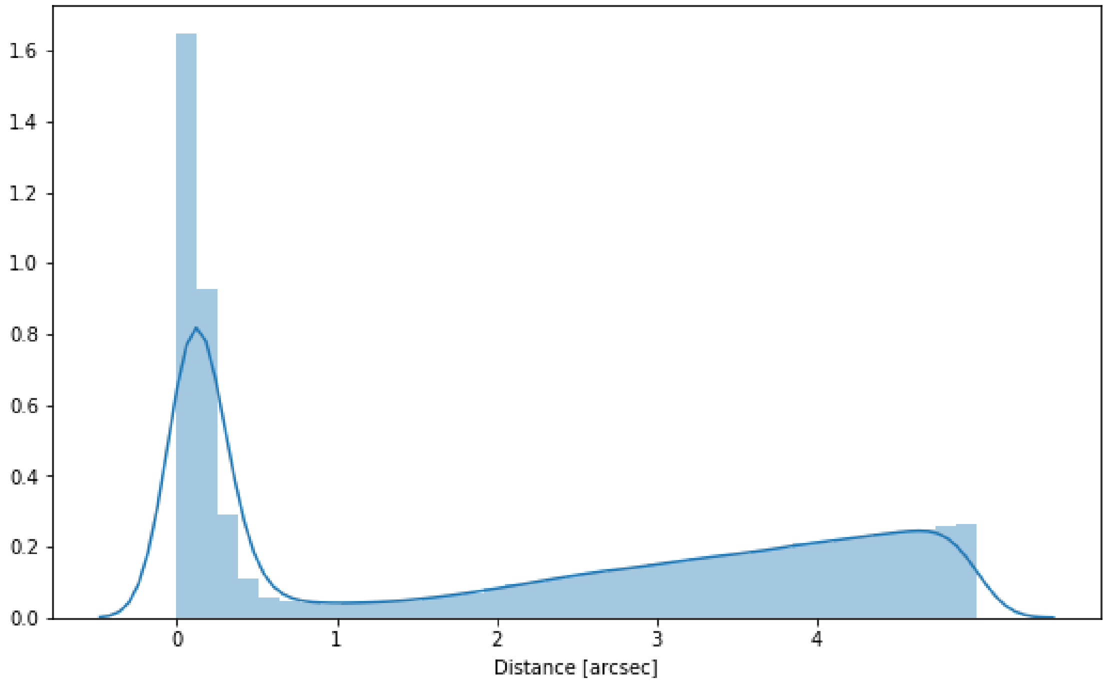
1.2.7 Add UKIDSS LAS



1.2.8 Add VHS



1.2.9 Add VIKING



1.2.10 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[23]: <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.

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```
/Users/rs548/anaconda/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfuncti
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

```
OK!
```

1.6 VI - Choosing between multiple values for the same filter

Both CFHTLenS and CFHTLS, and VISTA-VIKING and VISTA-VHS have measurements from the same camera and filters. We wish to choose the superior measurement where both are present.

1.6.1 VI.a CFHTLenS and CFHTLS

CFHTLS is optimised for deep photometry so we take that for

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For Megacam band u:
97540 sources with CFHTLS flux
46479 sources with CFHTLenS flux
44464 sources with CFHTLS and CFHTLenS flux
97540 sources for which we use CFHTLS
2015 sources for which we use CFHTLenS
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106621 sources with CFHTLS flux
58043 sources with CFHTLenS flux
55832 sources with CFHTLS and CFHTLenS flux
106621 sources for which we use CFHTLS
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For Megacam band r:
106301 sources with CFHTLS flux
58749 sources with CFHTLenS flux
56409 sources with CFHTLS and CFHTLenS flux
106301 sources for which we use CFHTLS
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For Megacam band i:
104738 sources with CFHTLS flux
62025 sources with CFHTLenS flux
58119 sources with CFHTLS and CFHTLenS flux
104738 sources for which we use CFHTLS
3906 sources for which we use CFHTLenS
For Megacam band z:
92404 sources with CFHTLS flux
47865 sources with CFHTLenS flux
45146 sources with CFHTLS and CFHTLenS flux
92404 sources for which we use CFHTLS
```

```
2719 sources for which we use CFHTLenS
```

VI.b VISTA-VIKING and VISTA-VHS VIKING is deeper than VHS so we take the VIKING photometry if available.

```
For VISTA band y:
37367 sources with VIKING flux
0 sources with VHS flux
0 sources with VIKING and VHS flux
37367 sources for which we use VIKING
0 sources for which we use VHS
37366 sources with VIKING aperture flux
0 sources with VHS aperture flux
0 sources with VIKING and VHS aperture flux
37366 sources for which we use VIKING aperture fluxes
0 sources for which we use VHS aperture fluxes
For VISTA band j:
51324 sources with VIKING flux
31223 sources with VHS flux
19898 sources with VIKING and VHS flux
51324 sources for which we use VIKING
11325 sources for which we use VHS
51321 sources with VIKING aperture flux
31220 sources with VHS aperture flux
19895 sources with VIKING and VHS aperture flux
51321 sources for which we use VIKING aperture fluxes
11325 sources for which we use VHS aperture fluxes
For VISTA band h:
40451 sources with VIKING flux
0 sources with VHS flux
0 sources with VIKING and VHS flux
40451 sources for which we use VIKING
0 sources for which we use VHS
40440 sources with VIKING aperture flux
0 sources with VHS aperture flux
0 sources with VIKING and VHS aperture flux
40440 sources for which we use VIKING aperture fluxes
0 sources for which we use VHS aperture fluxes
For VISTA band k:
44007 sources with VIKING flux
25359 sources with VHS flux
17615 sources with VIKING and VHS flux
44007 sources for which we use VIKING
7744 sources for which we use VHS
44000 sources with VIKING aperture flux
25354 sources with VHS aperture flux
17609 sources with VIKING and VHS aperture flux
```

```
44000 sources for which we use VIKING aperture fluxes
7745 sources for which we use VHS aperture fluxes
```

1.7 VII.a Wavelength domain coverage

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

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

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

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

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

1.8 VII.b Wavelenght domain detection

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

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

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

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

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

1.9 VIII - Cross-identification table

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

1.10 IX - Adding HEALPix index

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

1.11 IX - Saving the catalogue

```
Missing columns: set()
```

2_Merging-tiled

January 18, 2018

1 GAMA-09 master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-09.

```
This notebook was run with herschelhelp_internal version:
56042ea (Thu Aug 3 18:51:31 2017 +0100) [with local modifications]
```

1.1 I - Reading the prepared pristine catalogues

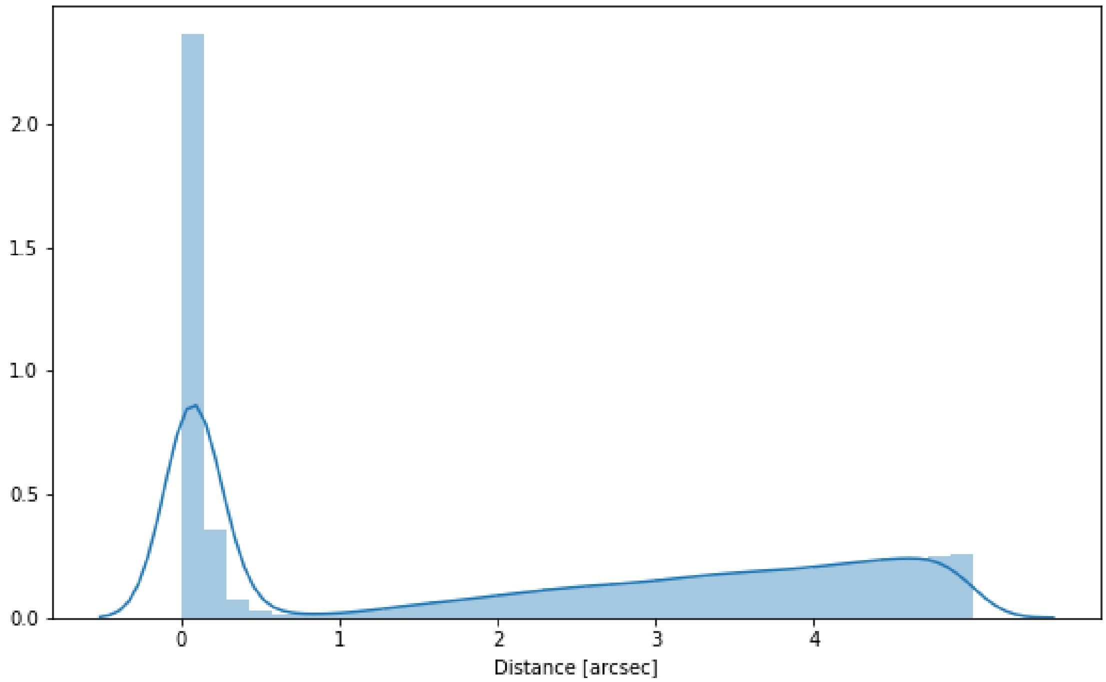
1.2 II - Merging tables

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

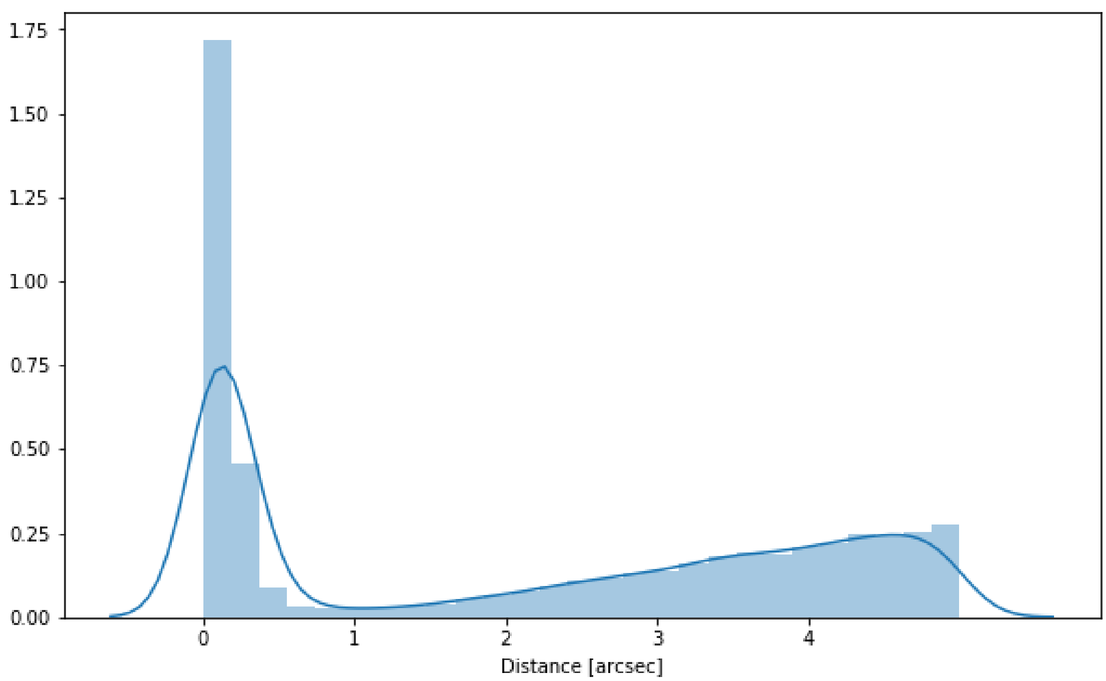
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 CFHTLenS

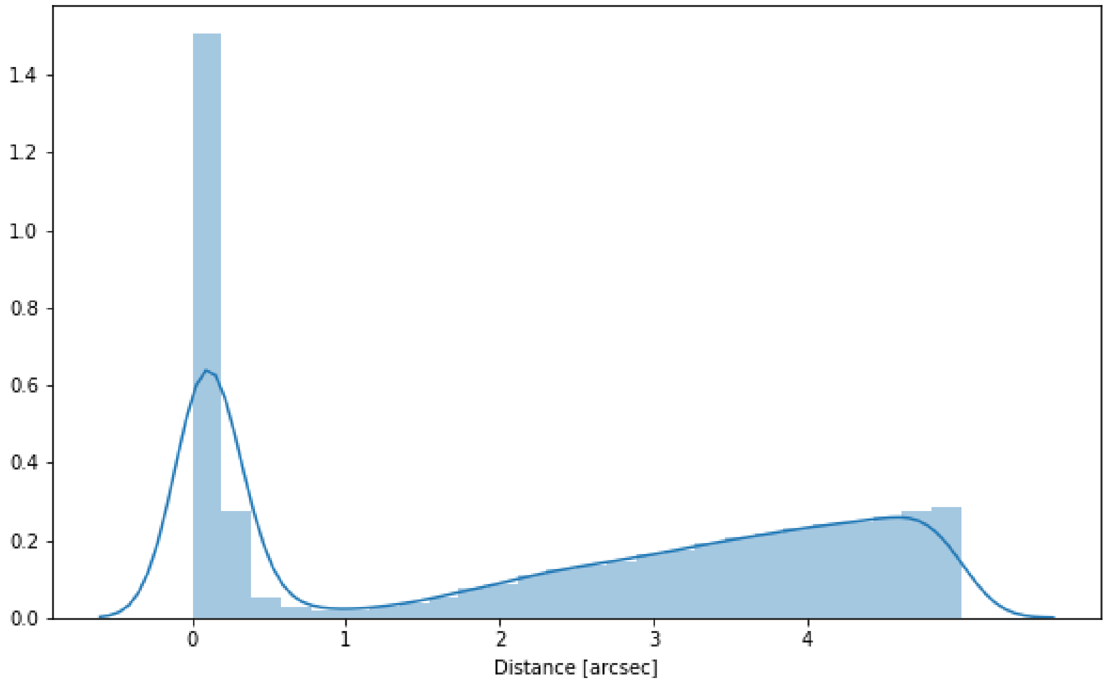
1.2.2 Add CFHTLS



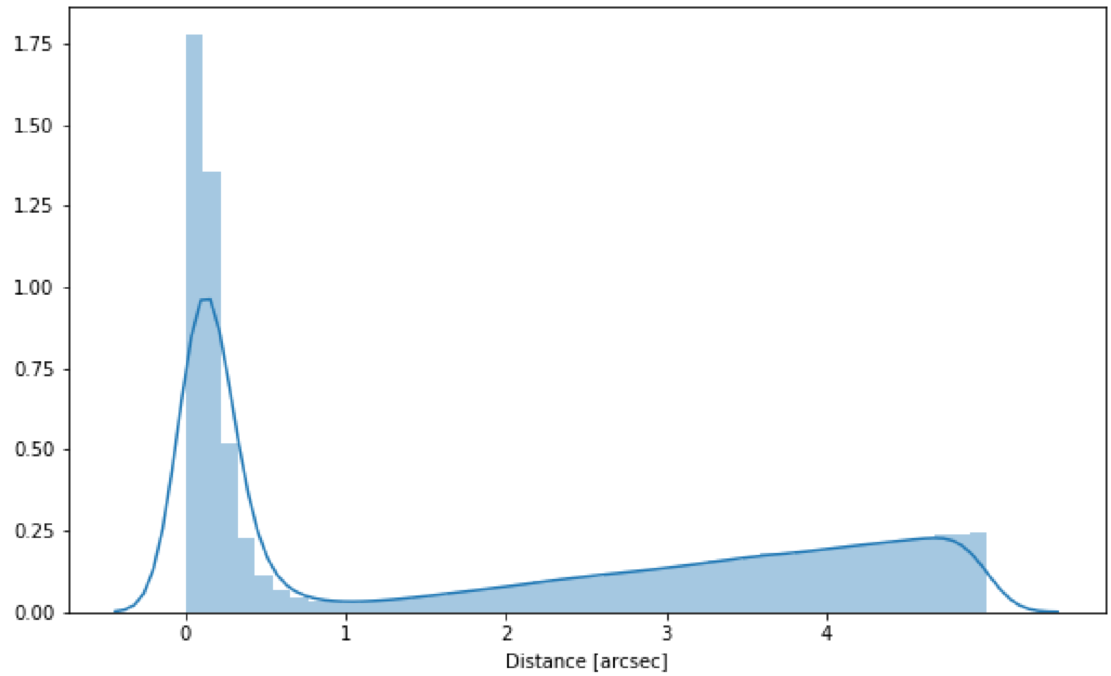
1.2.3 Add DECaLS



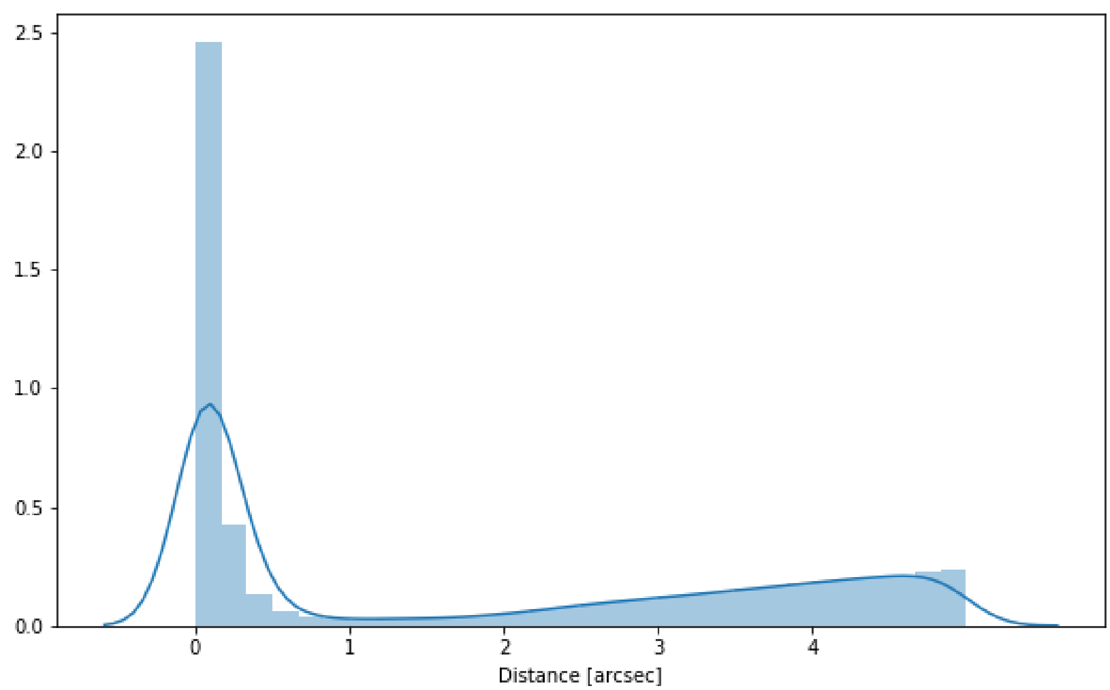
1.2.4 Add HSC-PSS



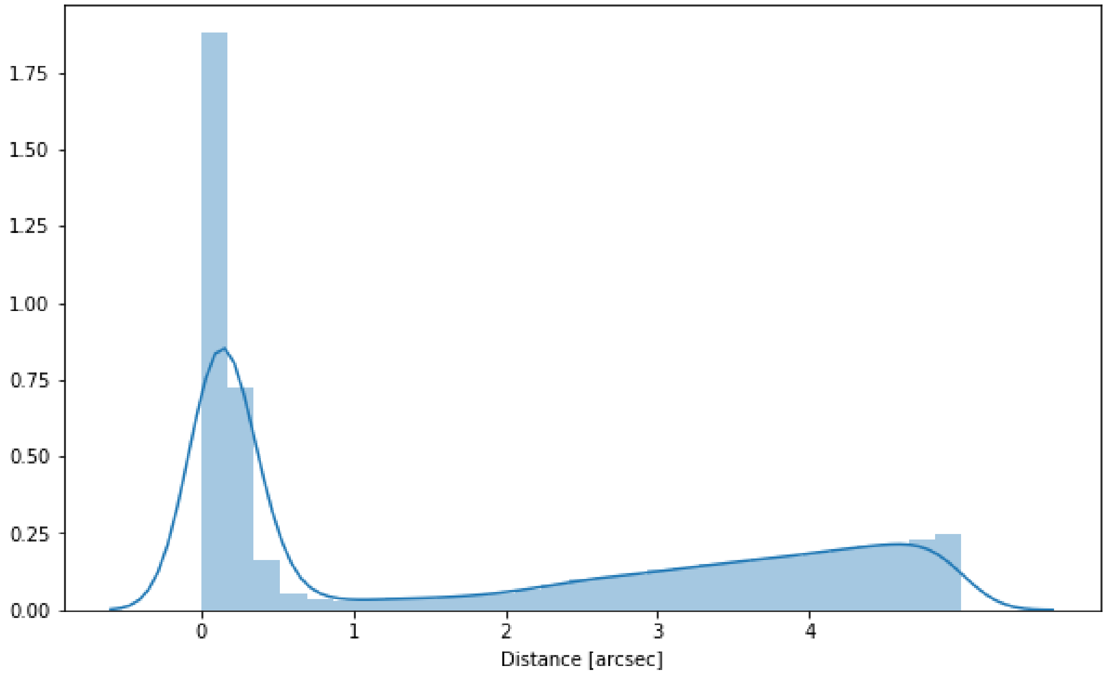
1.2.5 Add KIDS



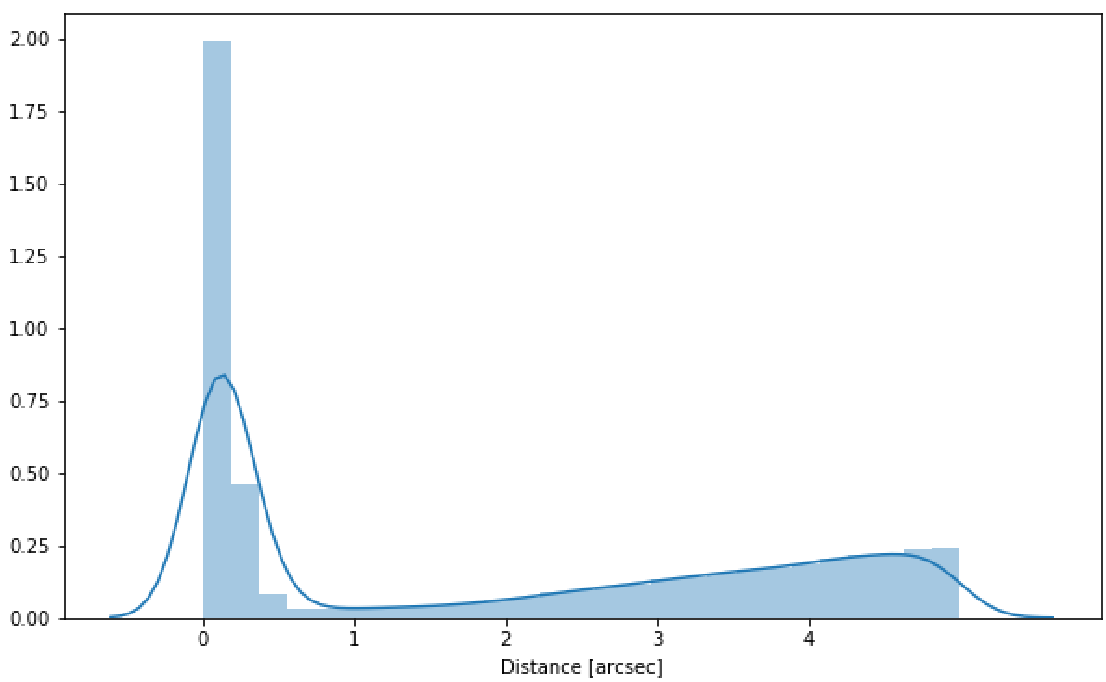
1.2.6 Add PanSTARRS



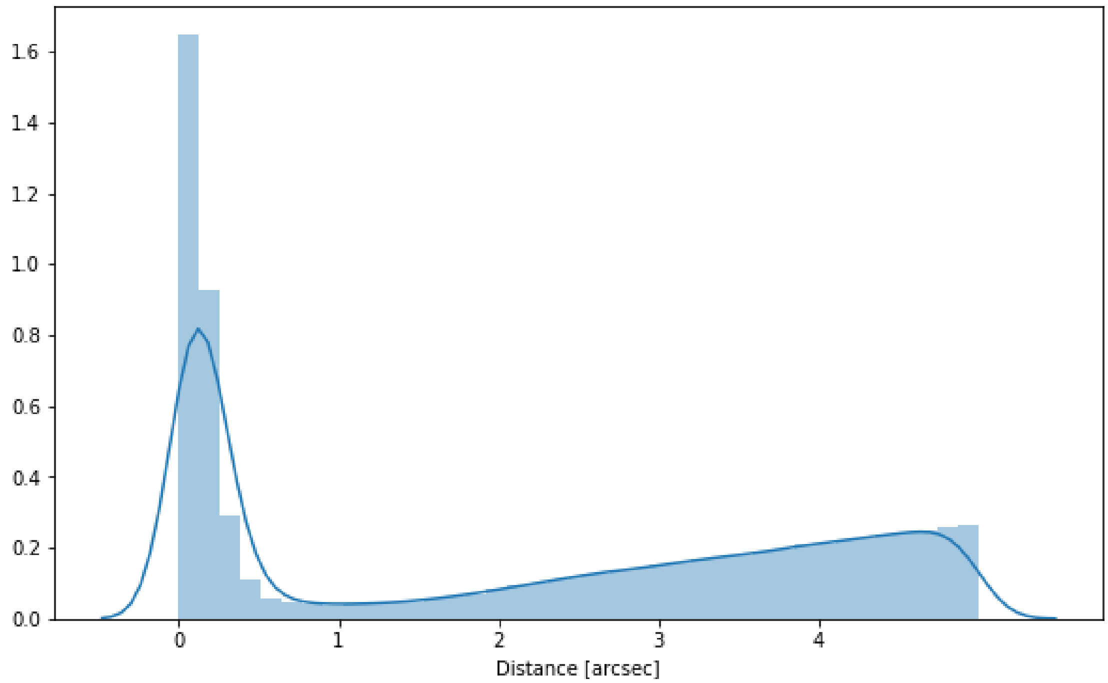
1.2.7 Add UKIDSS LAS



1.2.8 Add VHS



1.2.9 Add VIKING



1.2.10 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[23]: <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.

```
/Users/rs548/anaconda/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfuncti
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

```
OK!
```

1.6 VI - Choosing between multiple values for the same filter

Both CFHTLenS and CFHTLS, and VISTA-VIKING and VISTA-VHS have measurements from the same camera and filters. We wish to choose the superior measurement where both are present.

1.6.1 VI.a CFHTLenS and CFHTLS

CFHTLS is optimised for deep photometry so we take that for

```
For Megacam band u:
97540 sources with CFHTLS flux
46479 sources with CFHTLenS flux
44464 sources with CFHTLS and CFHTLenS flux
97540 sources for which we use CFHTLS
2015 sources for which we use CFHTLenS
For Megacam band g:
106621 sources with CFHTLS flux
58043 sources with CFHTLenS flux
55832 sources with CFHTLS and CFHTLenS flux
106621 sources for which we use CFHTLS
2211 sources for which we use CFHTLenS
For Megacam band r:
106301 sources with CFHTLS flux
58749 sources with CFHTLenS flux
56409 sources with CFHTLS and CFHTLenS flux
106301 sources for which we use CFHTLS
2340 sources for which we use CFHTLenS
For Megacam band i:
104738 sources with CFHTLS flux
62025 sources with CFHTLenS flux
58119 sources with CFHTLS and CFHTLenS flux
104738 sources for which we use CFHTLS
3906 sources for which we use CFHTLenS
For Megacam band z:
92404 sources with CFHTLS flux
47865 sources with CFHTLenS flux
45146 sources with CFHTLS and CFHTLenS flux
92404 sources for which we use CFHTLS
```

```
2719 sources for which we use CFHTLenS
```

VI.b VISTA-VIKING and VISTA-VHS VIKING is deeper than VHS so we take the VIKING photometry if available.

```
For VISTA band y:
37367 sources with VIKING flux
0 sources with VHS flux
0 sources with VIKING and VHS flux
37367 sources for which we use VIKING
0 sources for which we use VHS
37366 sources with VIKING aperture flux
0 sources with VHS aperture flux
0 sources with VIKING and VHS aperture flux
37366 sources for which we use VIKING aperture fluxes
0 sources for which we use VHS aperture fluxes
For VISTA band j:
51324 sources with VIKING flux
31223 sources with VHS flux
19898 sources with VIKING and VHS flux
51324 sources for which we use VIKING
11325 sources for which we use VHS
51321 sources with VIKING aperture flux
31220 sources with VHS aperture flux
19895 sources with VIKING and VHS aperture flux
51321 sources for which we use VIKING aperture fluxes
11325 sources for which we use VHS aperture fluxes
For VISTA band h:
40451 sources with VIKING flux
0 sources with VHS flux
0 sources with VIKING and VHS flux
40451 sources for which we use VIKING
0 sources for which we use VHS
40440 sources with VIKING aperture flux
0 sources with VHS aperture flux
0 sources with VIKING and VHS aperture flux
40440 sources for which we use VIKING aperture fluxes
0 sources for which we use VHS aperture fluxes
For VISTA band k:
44007 sources with VIKING flux
25359 sources with VHS flux
17615 sources with VIKING and VHS flux
44007 sources for which we use VIKING
7744 sources for which we use VHS
44000 sources with VIKING aperture flux
25354 sources with VHS aperture flux
17609 sources with VIKING and VHS aperture flux
```

```
44000 sources for which we use VIKING aperture fluxes
7745 sources for which we use VHS aperture fluxes
```

1.7 VII.a Wavelength domain coverage

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

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

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

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

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

1.8 VII.b Wavelenght domain detection

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

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

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

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

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

1.9 VIII - Cross-identification table

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

1.10 IX - Adding HEALPix index

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

1.11 IX - Saving the catalogue

```
Missing columns: set()
```

2_Merging

January 18, 2018

1 GAMA-09 master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP mater catalogue on GAMA-09.

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

1.1 I - Reading the prepared pristine catalogues

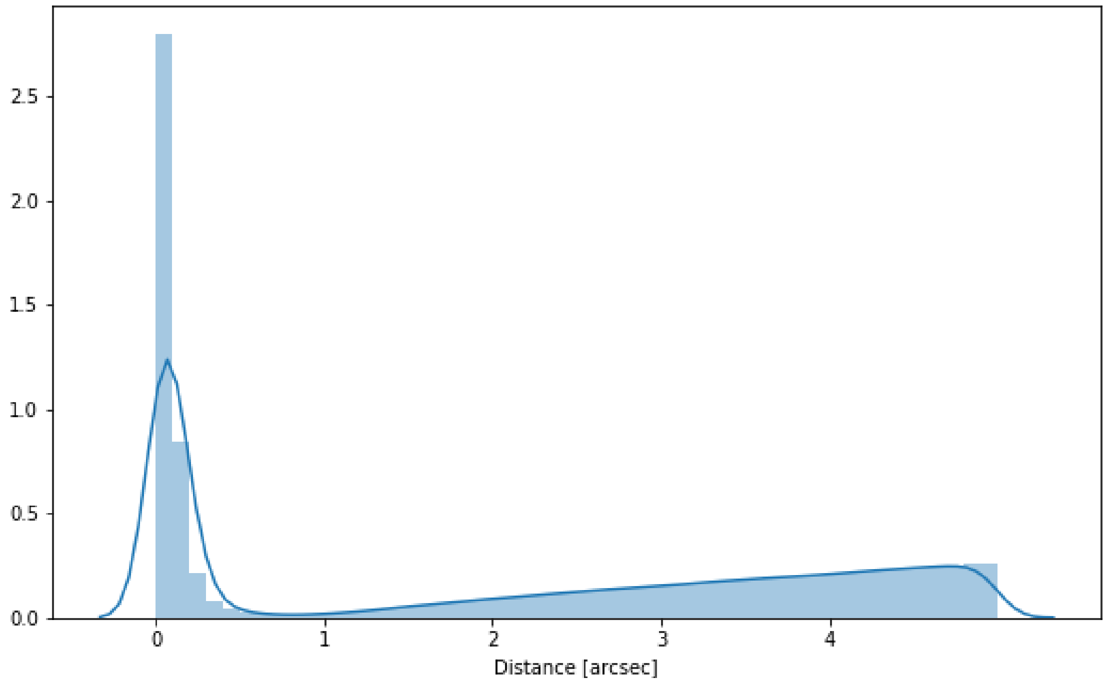
1.2 II - Merging tables

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

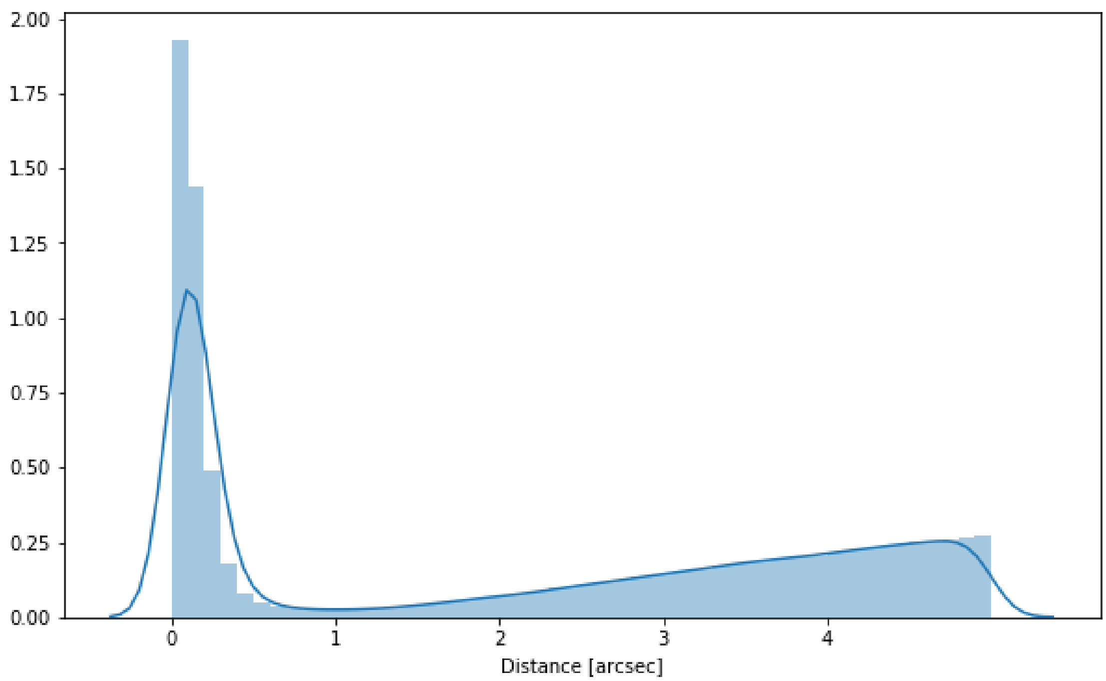
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 CFHTLenS

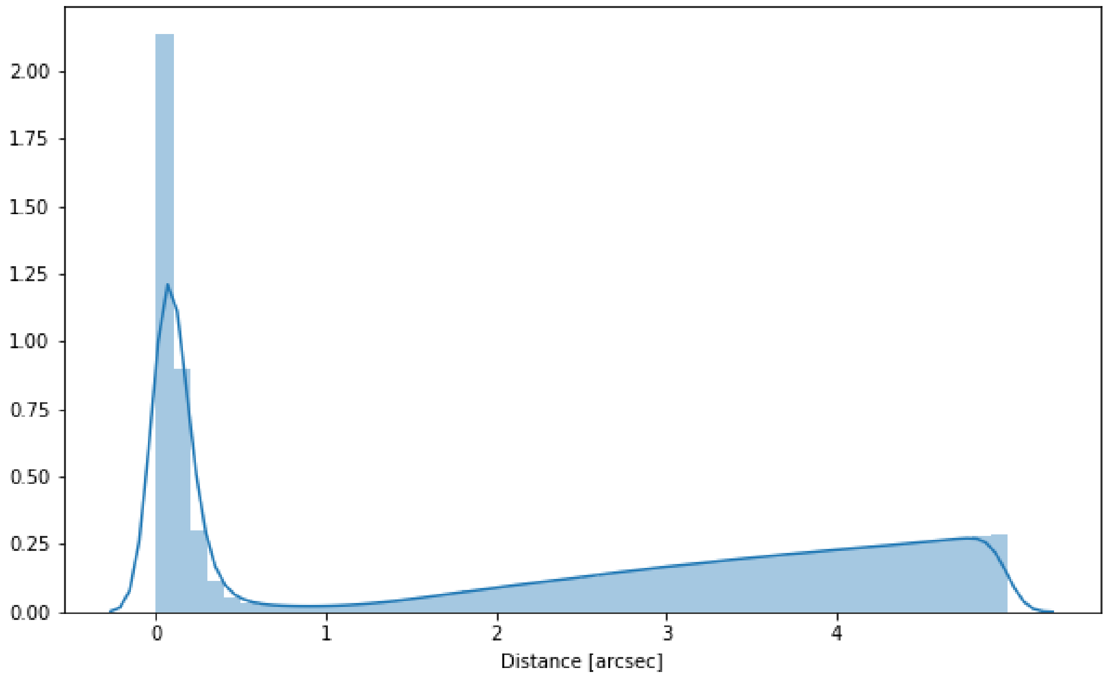
1.2.2 Add CFHTLS



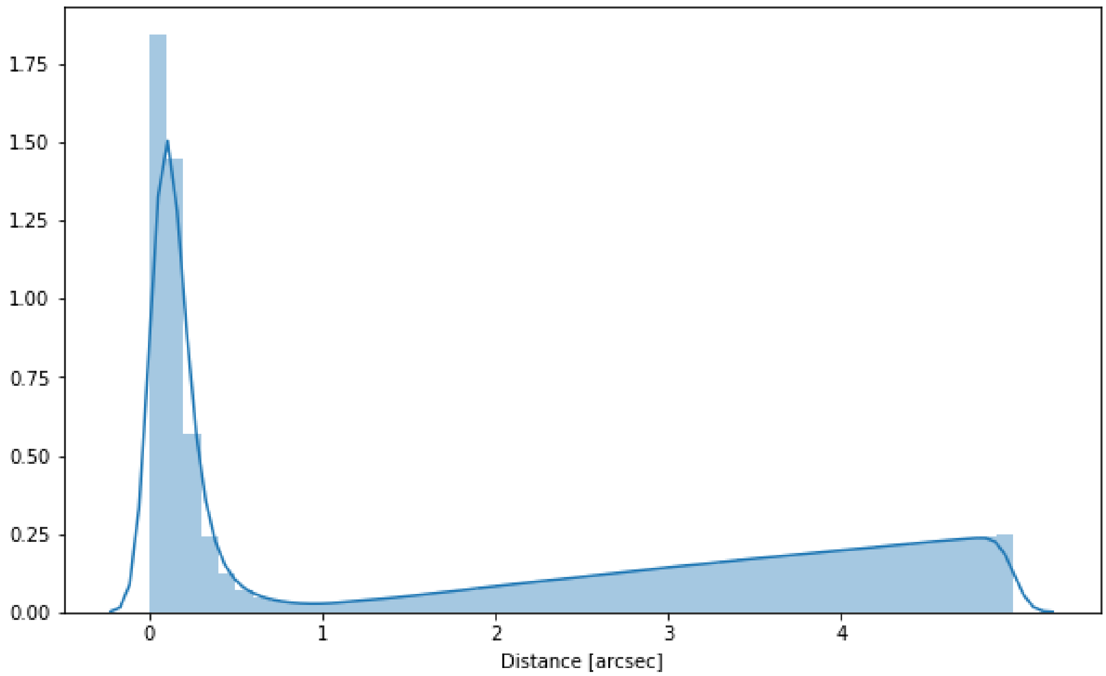
1.2.3 Add DECaLS



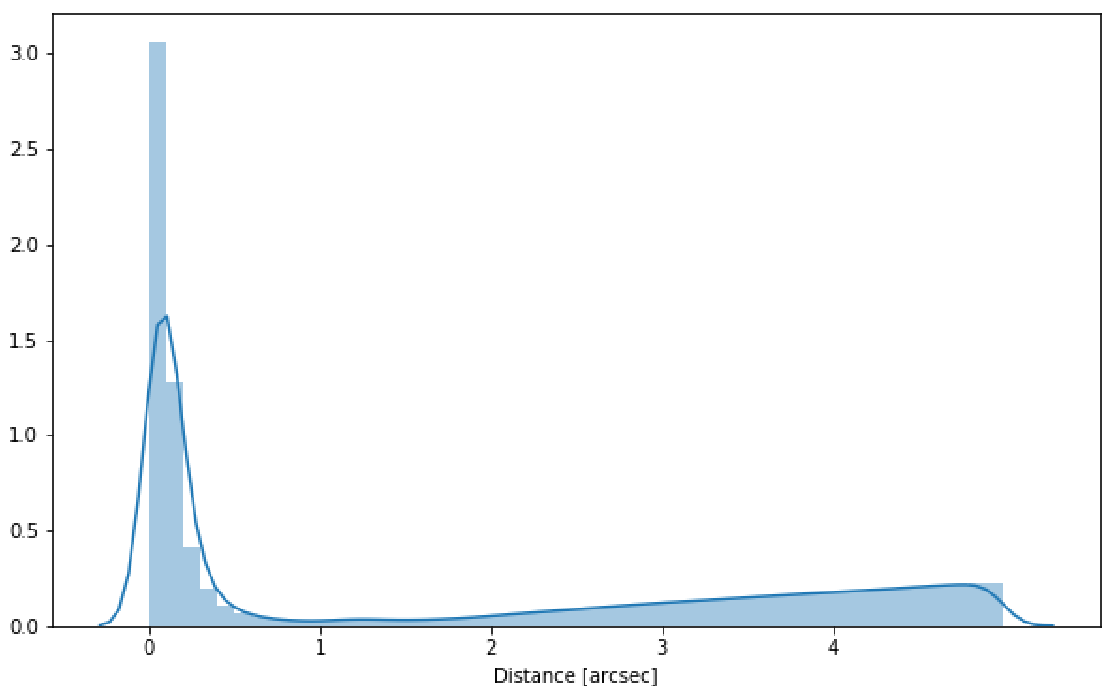
1.2.4 Add HSC-PSS



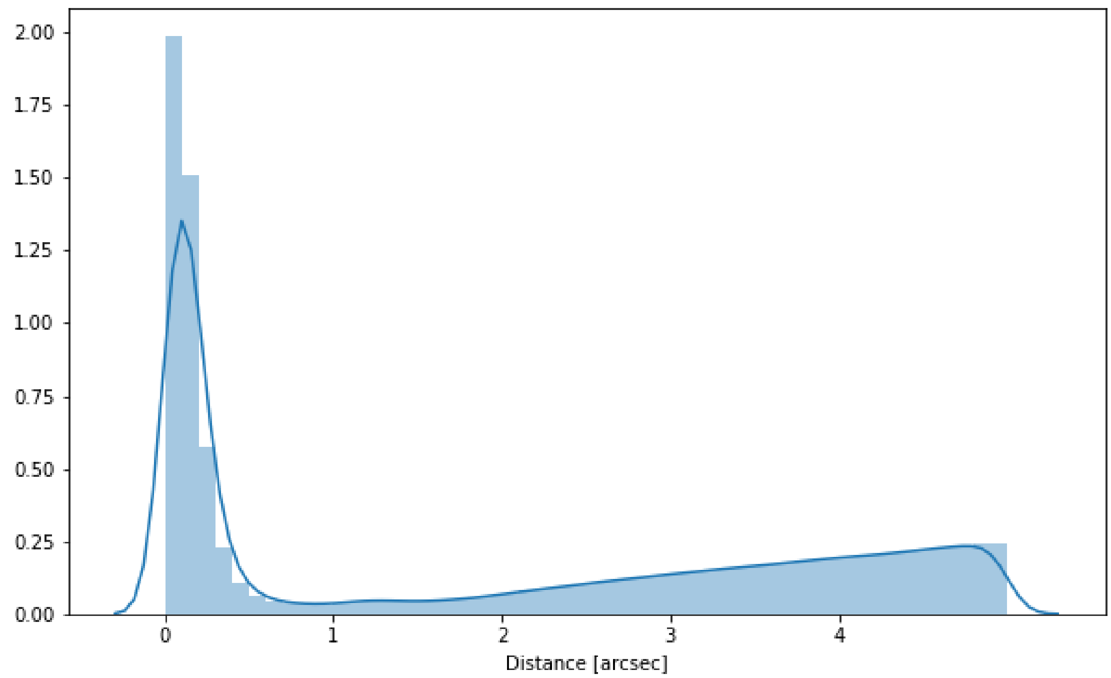
1.2.5 Add KIDS



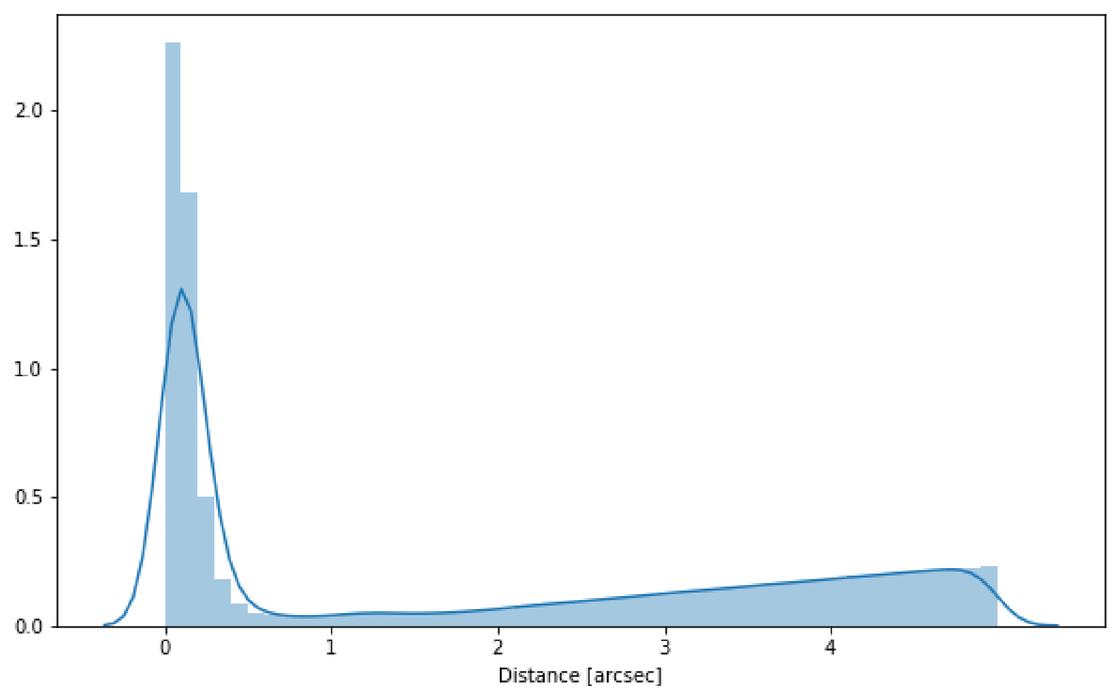
1.2.6 Add PanSTARRS



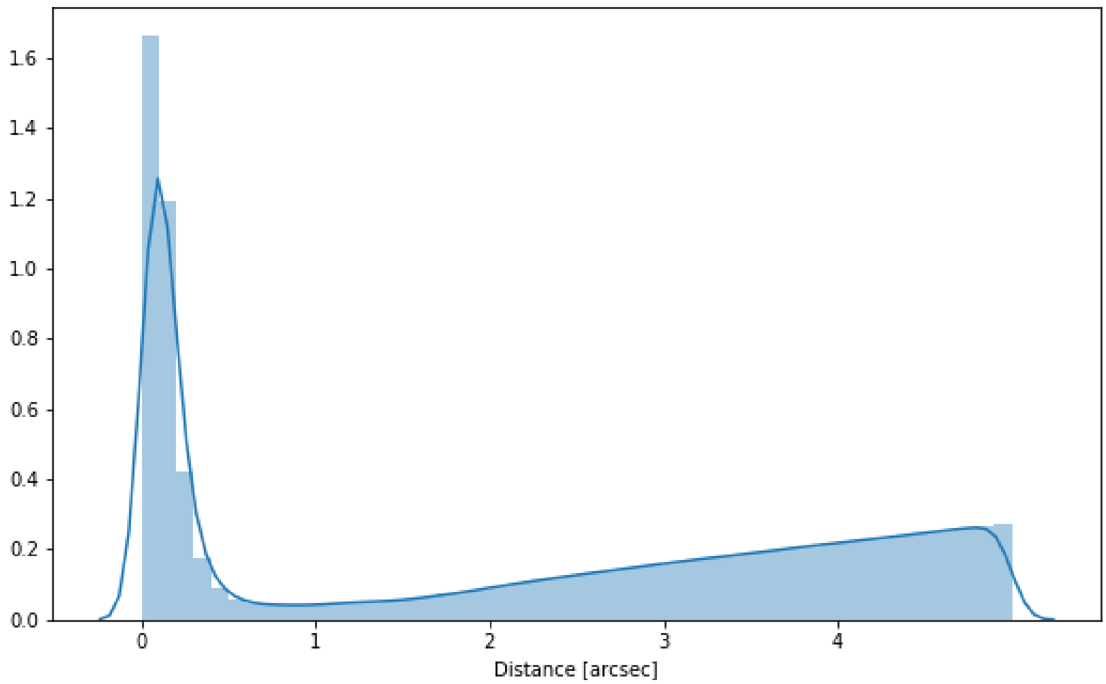
1.2.7 Add UKIDSS LAS



1.2.8 Add VHS



1.2.9 Add VIKING



1.2.10 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[23]: <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.

```
cfhtlens_stellarity, cfhtls_stellarity, decals_stellarity, hsc_stellarity, kids_stellarity, las_
```

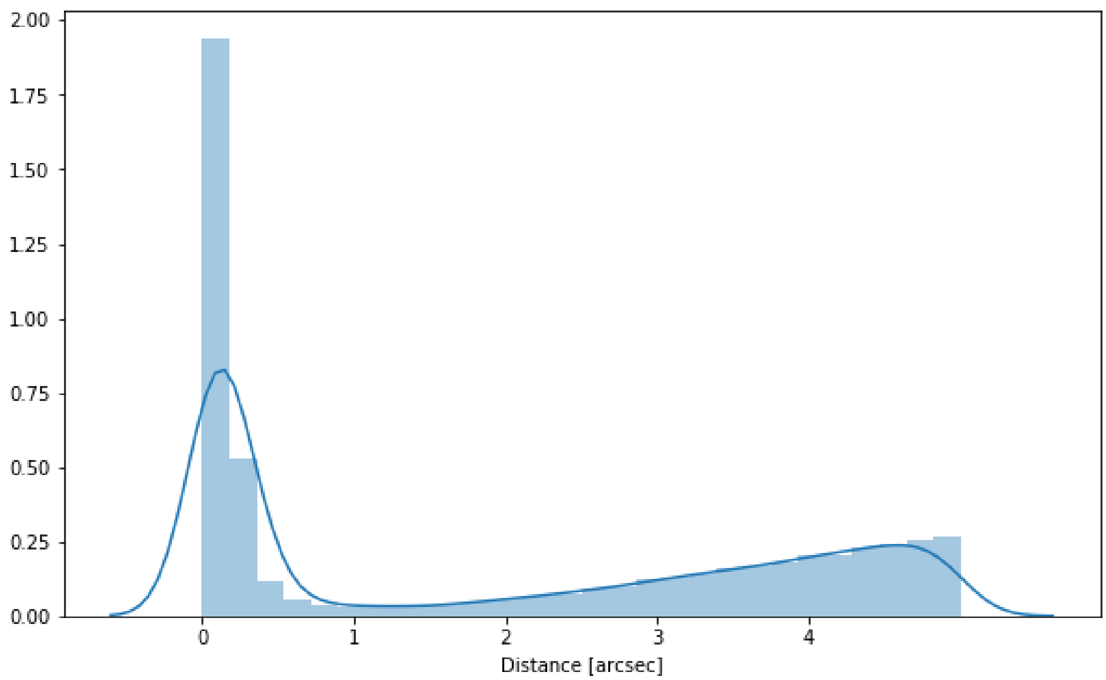
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/lib/nanfunctions.py:
  warnings.warn("All-NaN slice encountered", RuntimeWarning)
```

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 the spec-z catalogue



1.7 VII - Choosing between multiple values for the same filter

Both CFHTLenS and CFHTLS, and VISTA-VIKING and VISTA-VHS have measurements from the same camera and filters. We wish to choose the superior measurement where both are present.

1.7.1 VII.a CFHTLenS and CFHTLS

CFHTLS is optimised for deep photometry so we take that for

```
For Megacam band u:
898336 sources with CFHTLS flux
403760 sources with CFHTLenS flux
386292 sources with CFHTLS and CFHTLenS flux
```

```
898336 sources for which we use CFHTLS
17468 sources for which we use CFHTLenS
For Megacam band g:
968859 sources with CFHTLS flux
506111 sources with CFHTLenS flux
486700 sources with CFHTLS and CFHTLenS flux
968859 sources for which we use CFHTLS
19411 sources for which we use CFHTLenS
For Megacam band r:
984214 sources with CFHTLS flux
509786 sources with CFHTLenS flux
489579 sources with CFHTLS and CFHTLenS flux
984214 sources for which we use CFHTLS
20207 sources for which we use CFHTLenS
For Megacam band i:
959749 sources with CFHTLS flux
529203 sources with CFHTLenS flux
498878 sources with CFHTLS and CFHTLenS flux
959749 sources for which we use CFHTLS
30325 sources for which we use CFHTLenS
For Megacam band z:
846472 sources with CFHTLS flux
421512 sources with CFHTLenS flux
396727 sources with CFHTLS and CFHTLenS flux
846472 sources for which we use CFHTLS
24785 sources for which we use CFHTLenS
```

VII.b VISTA-VIKING and VISTA-VHS VIKING is deeper than VHS so we take the VIKING photometry if available.

```
For VISTA band y:
1386617 sources with VIKING flux
157730 sources with VHS flux
65293 sources with VIKING and VHS flux
1386617 sources for which we use VIKING
92437 sources for which we use VHS
1386533 sources with VIKING aperture flux
157725 sources with VHS aperture flux
65293 sources with VIKING and VHS aperture flux
1386533 sources for which we use VIKING aperture fluxes
92432 sources for which we use VHS aperture fluxes
For VISTA band j:
1614888 sources with VIKING flux
431419 sources with VHS flux
278769 sources with VIKING and VHS flux
1614888 sources for which we use VIKING
152650 sources for which we use VHS
```

```
1614759 sources with VIKING aperture flux
431399 sources with VHS aperture flux
278747 sources with VIKING and VHS aperture flux
1614759 sources for which we use VIKING aperture fluxes
152652 sources for which we use VHS aperture fluxes
For VISTA band h:
1616502 sources with VIKING flux
122508 sources with VHS flux
77750 sources with VIKING and VHS flux
1616502 sources for which we use VIKING
44758 sources for which we use VHS
1610310 sources with VIKING aperture flux
122497 sources with VHS aperture flux
77727 sources with VIKING and VHS aperture flux
1610310 sources for which we use VIKING aperture fluxes
44770 sources for which we use VHS aperture fluxes
For VISTA band k:
1364692 sources with VIKING flux
307880 sources with VHS flux
204046 sources with VIKING and VHS flux
1364692 sources for which we use VIKING
103834 sources for which we use VHS
1364254 sources with VIKING aperture flux
307839 sources with VHS aperture flux
203983 sources with VIKING and VHS aperture flux
1364254 sources for which we use VIKING aperture fluxes
103856 sources for which we use VHS aperture fluxes
```

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?**

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

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 - Renaming some columns

1.13 XI - Saving the catalogue

```
Missing columns: set()
```

3_Checks_and_diagnostics

January 18, 2018

1 GAMA-09 master catalogue

1.1 Checks and diagnostics

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

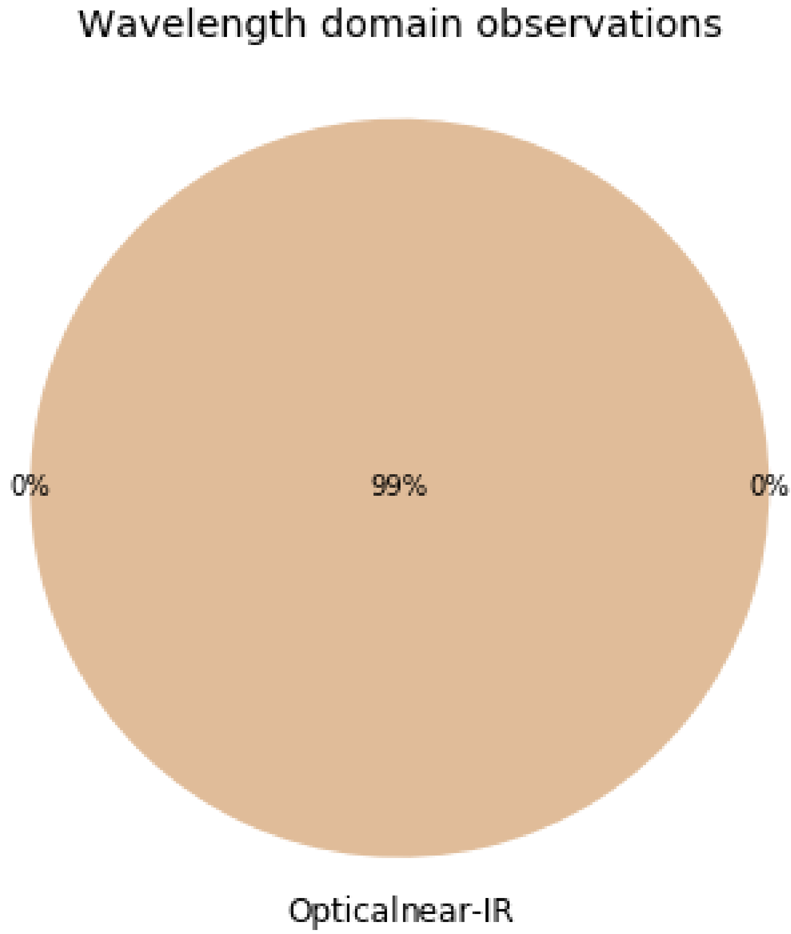
1.2 0 - Quick checks

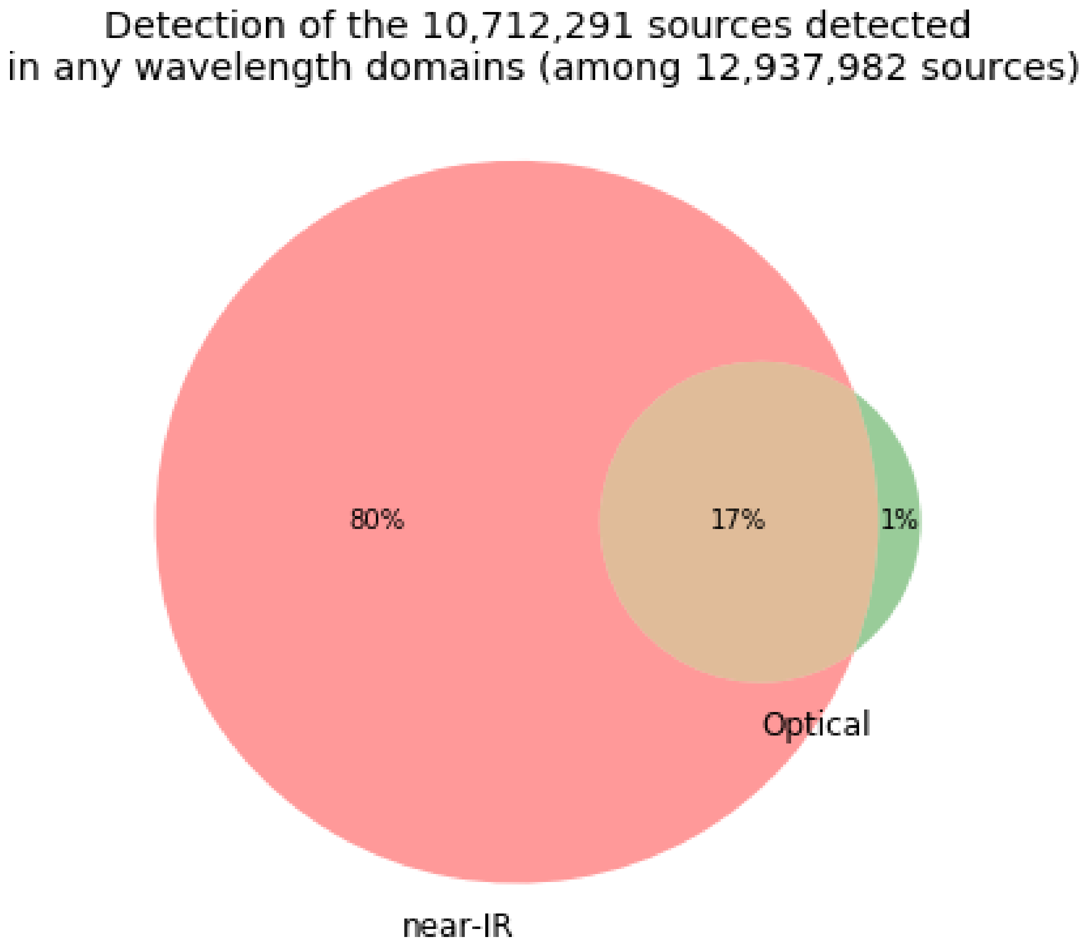
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype), FutureWarning)
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/numpy/core/numeric.py:301:
  format(shape, fill_value, array(fill_value).dtype),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

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

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

1.3 I - Summary of wavelength domains





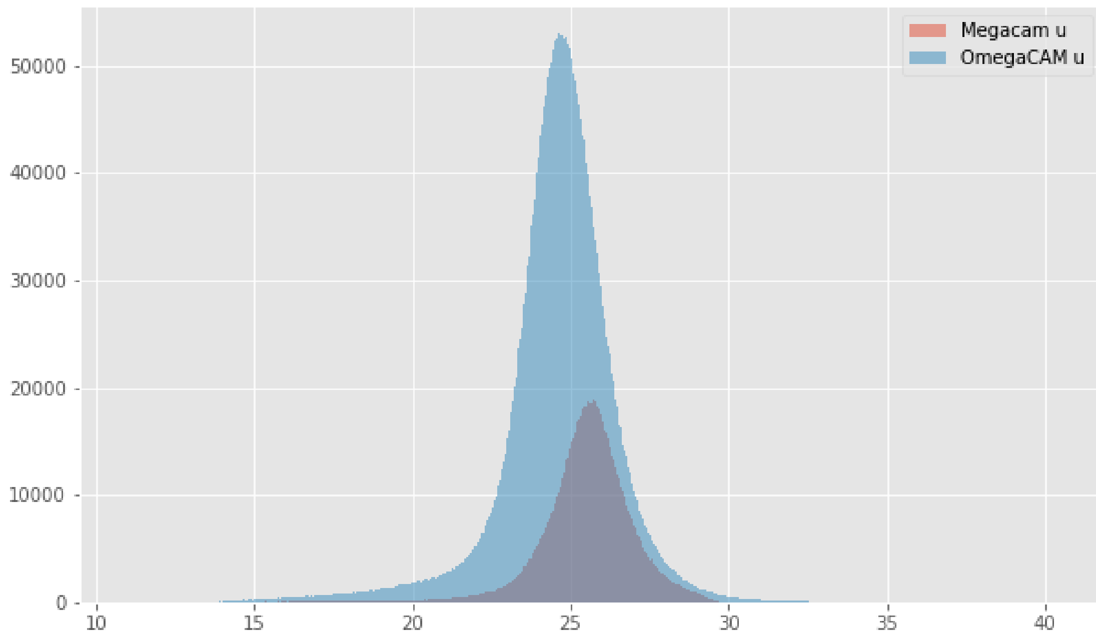
1.4 II - Comparing magnitudes in similar filters

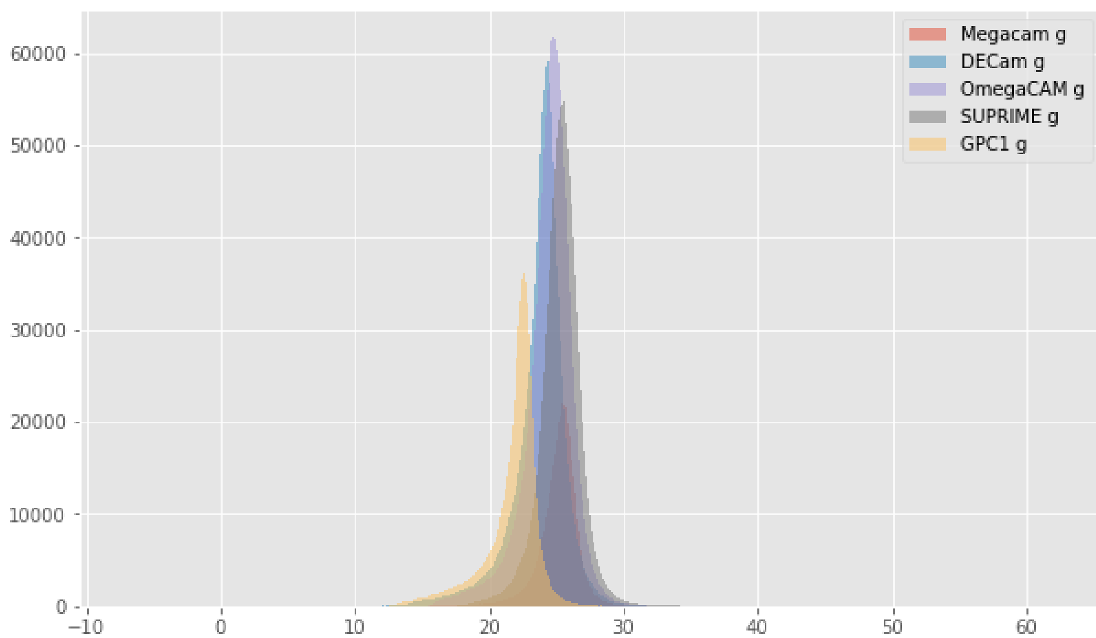
The master list if composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

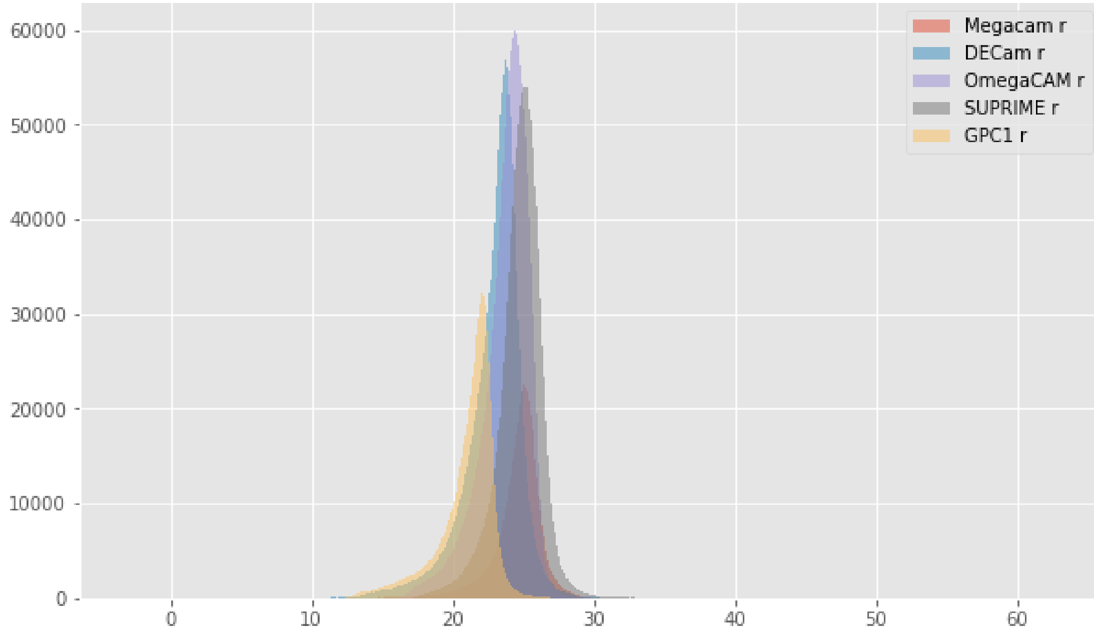
```
Megacam g max: 29.9969997406
DECam g max: 53.2943
OmegaCAM g max: 42.6942
SUPRIME g max: inf
GPC1 g max: 35.0805015564
```

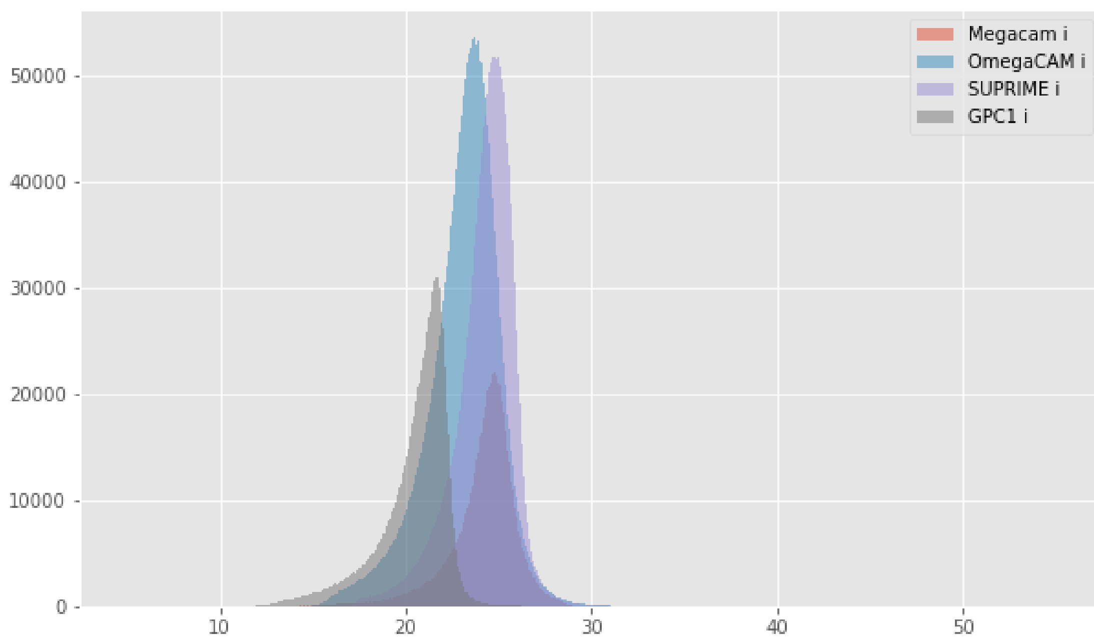
1.4.1 II.a - Comparing depths

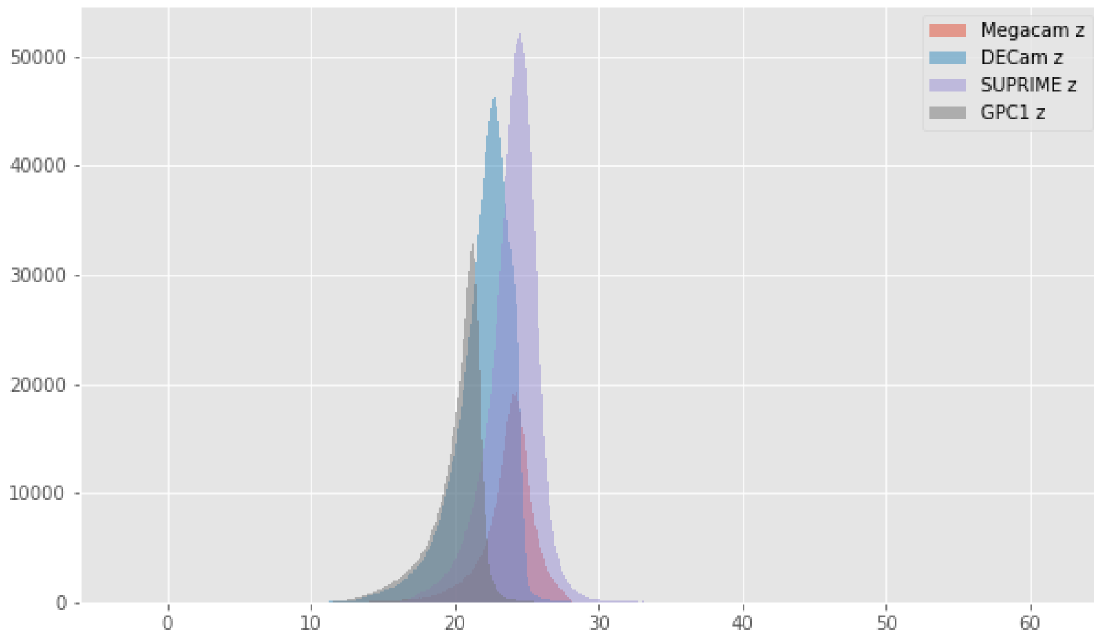
We compare the histograms of the total aperture magnitudes of similar bands.

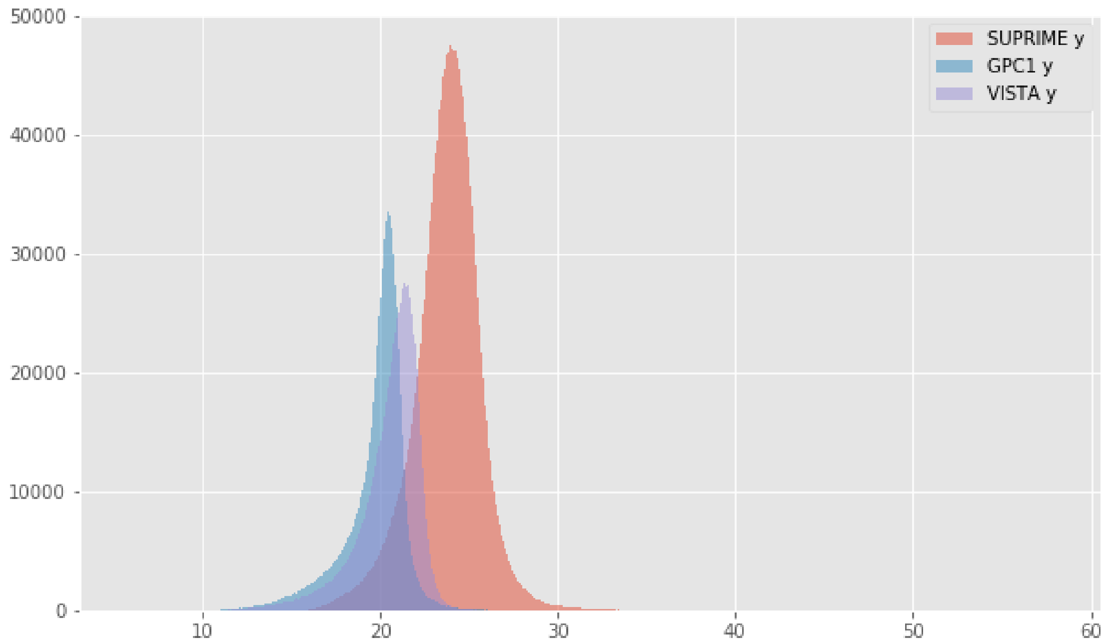

Megacam u
OmegaCAM u
50000
40000
30000
20000
10000
0
10
15
20
25
30
35
40


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


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


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

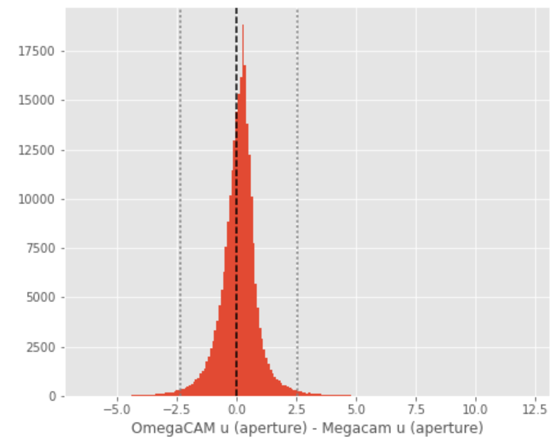


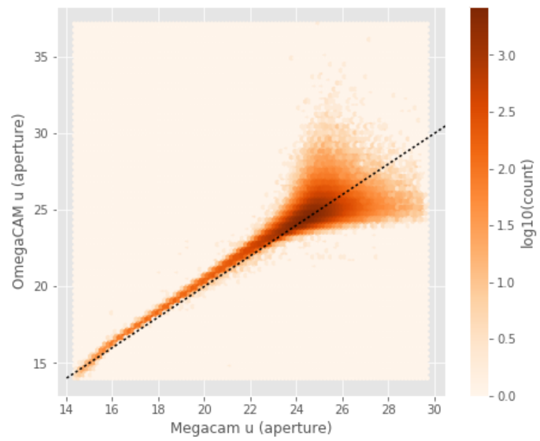


1.4.2 II.b - Comparing magnitudes

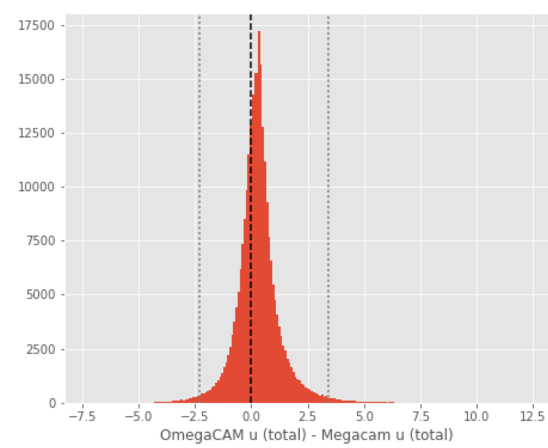
We compare one to one each magnitude in similar bands.

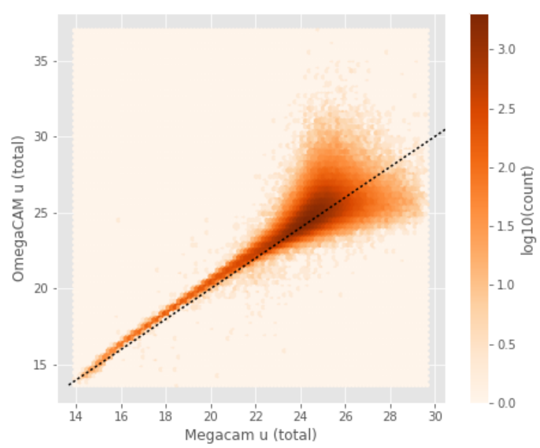
OmegaCAM u (aperture) - Megacam u (aperture):
- Median: 0.16
- Median Absolute Deviation: 0.38
- 1% percentile: -2.3490675354003905
- 99% percentile: 2.532443161010736





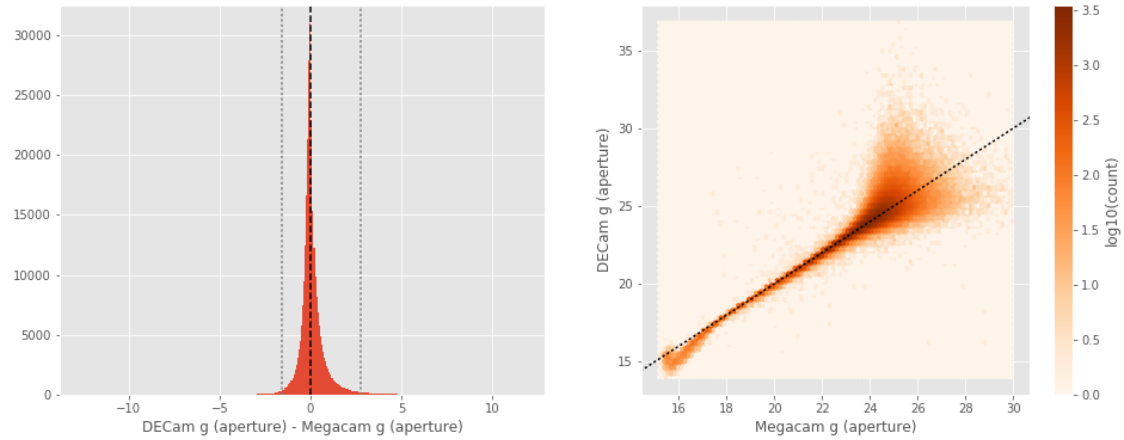
OmegaCAM u (total) - Megacam u (total):
- Median: 0.26
- Median Absolute Deviation: 0.43
- 1% percentile: -2.302859649658203
- 99% percentile: 3.4061350631713845



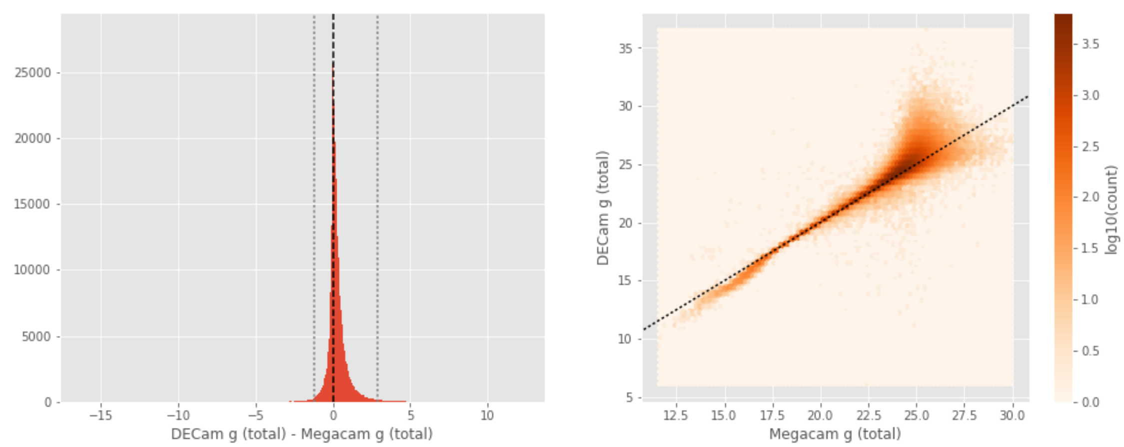


DECam g (aperture) - Megacam g (aperture):
- Median: -0.01

- Median Absolute Deviation: 0.23
- 1% percentile: -1.5602592468261718
- 99% percentile: 2.7763988494873053

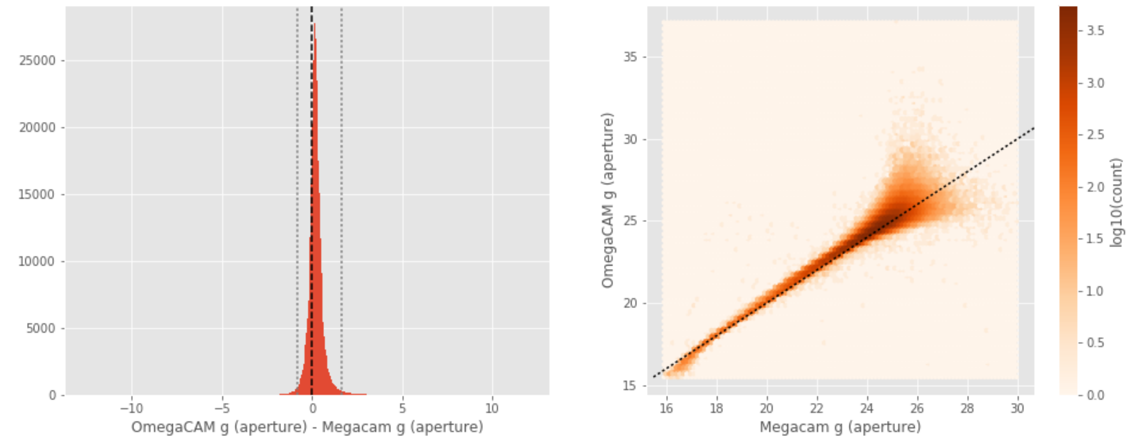


DECam g (total) - Megacam g (total):
- Median: 0.14
- Median Absolute Deviation: 0.20
- 1% percentile: -1.220804977416992
- 99% percentile: 2.8561179351806576

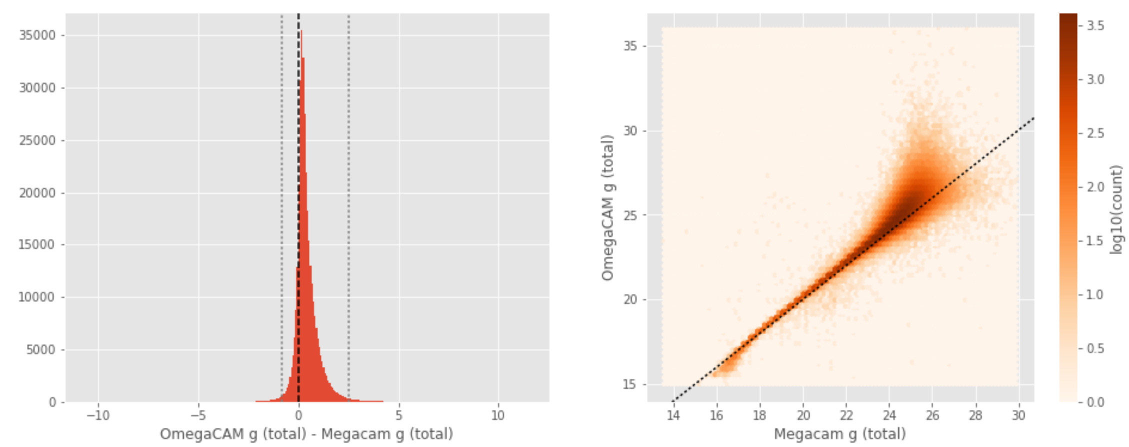


OmegaCAM g (aperture) - Megacam g (aperture):
- Median: 0.17
- Median Absolute Deviation: 0.18
- 1% percentile: -0.8424013137817382

- 99% percentile: 1.606662597656257

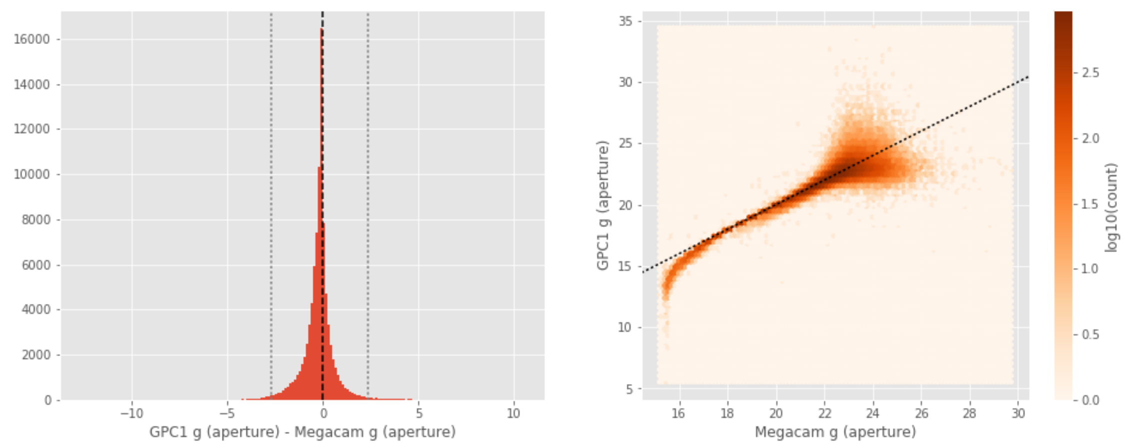


OmegaCAM g (total) - Megacam g (total):
- Median: 0.29
- Median Absolute Deviation: 0.23
- 1% percentile: -0.8038003158569336
- 99% percentile: 2.5004053497314445

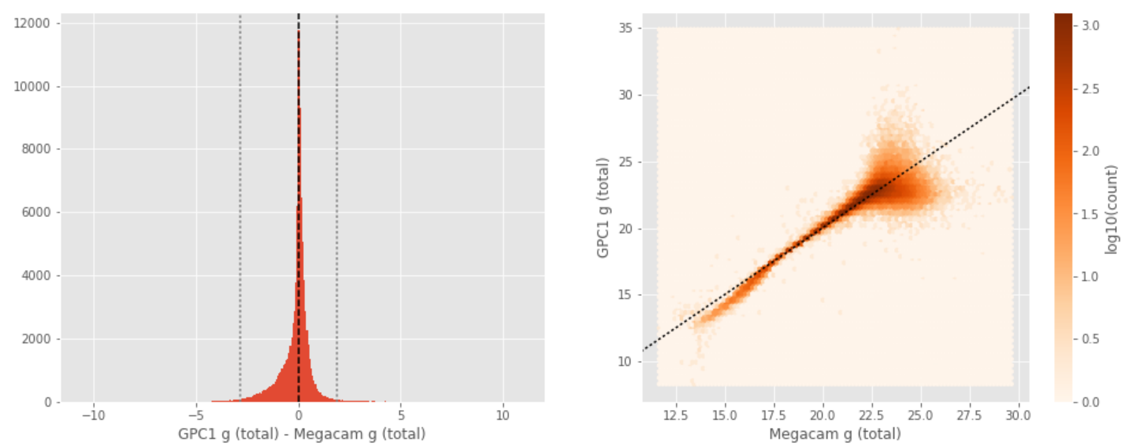


No sources have both Megacam g (aperture) and SUPRIME g (aperture) values.
No sources have both Megacam g (total) and SUPRIME g (total) values.
GPC1 g (aperture) - Megacam g (aperture):
- Median: -0.13
- Median Absolute Deviation: 0.28
- 1% percentile: -2.7002618026733396

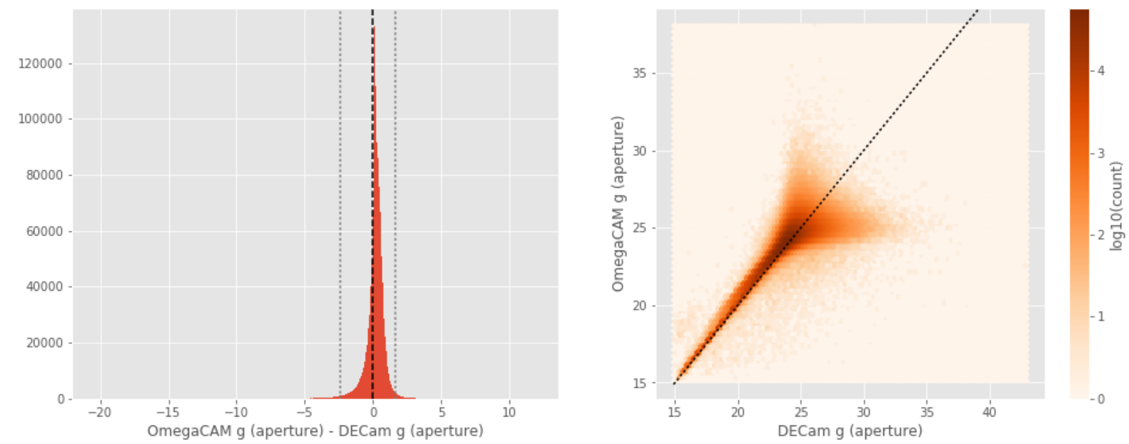
- 99% percentile: 2.371592845916747



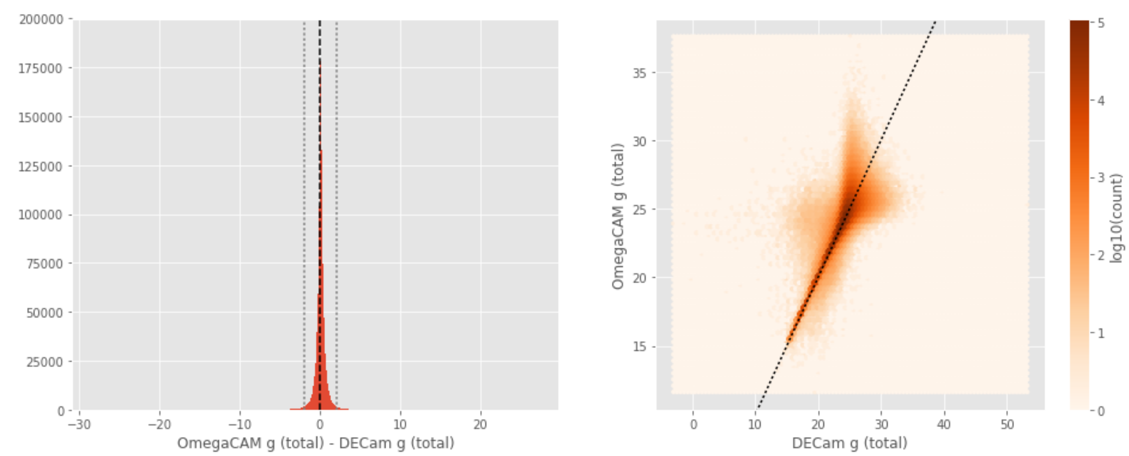
GPC1 g (total) - Megacam g (total):
- Median: 0.03
- Median Absolute Deviation: 0.23
- 1% percentile: -2.84140754699707
- 99% percentile: 1.9041188049316418



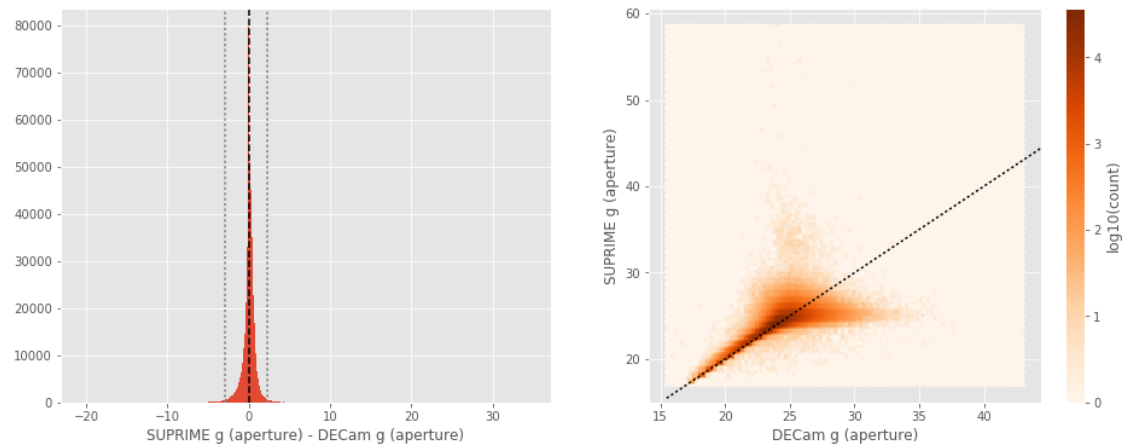
OmegaCAM g (aperture) - DECam g (aperture):
- Median: 0.20
- Median Absolute Deviation: 0.26
- 1% percentile: -2.423225708007813
- 99% percentile: 1.6479495239257815



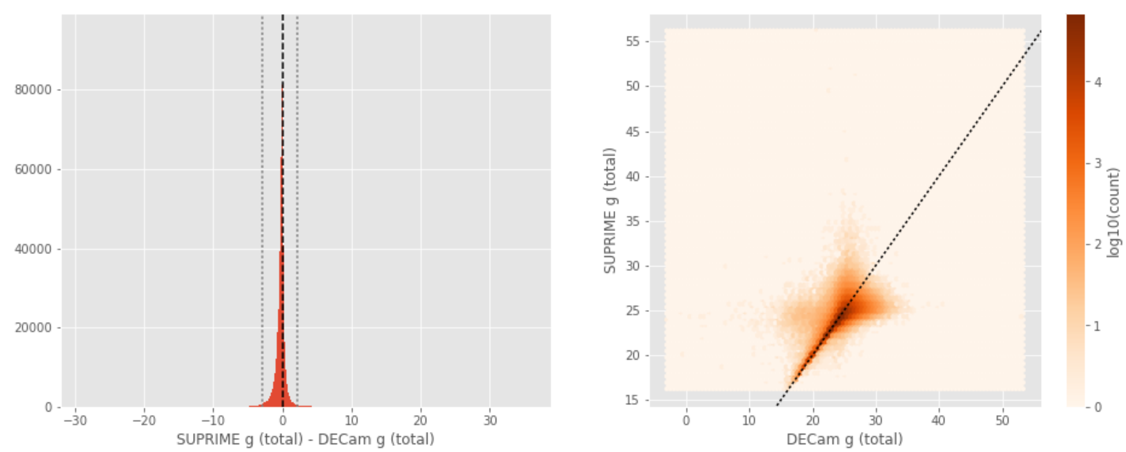
OmegaCAM g (total) - DECam g (total):
- Median: 0.11
- Median Absolute Deviation: 0.22
- 1% percentile: -1.9924044799804685
- 99% percentile: 2.0453008651733393



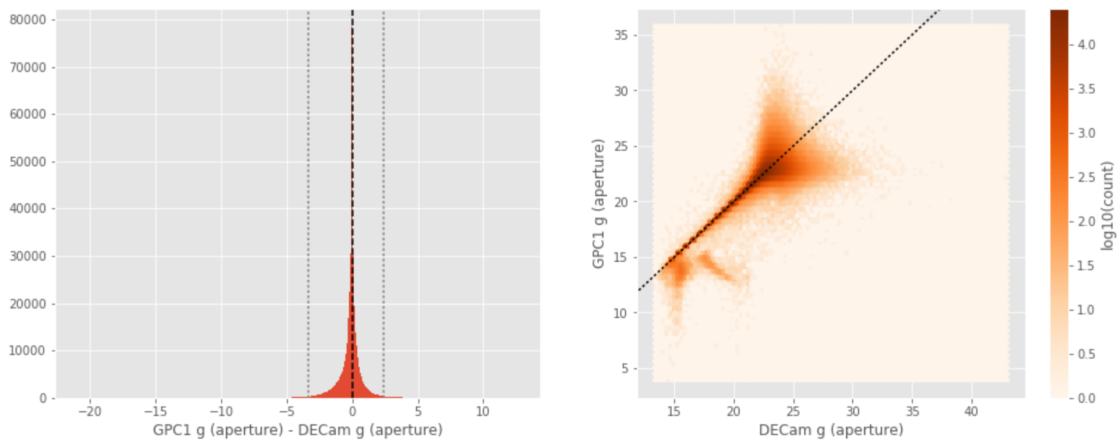
SUPRIME g (aperture) - DECam g (aperture):
- Median: 0.08
- Median Absolute Deviation: 0.31
- 1% percentile: -2.909161434173584
- 99% percentile: 2.240386371612546



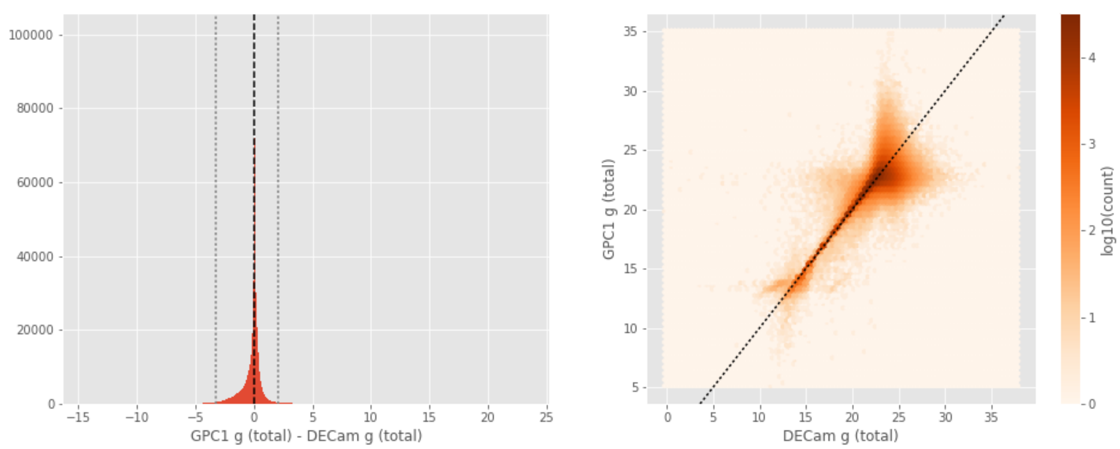
SUPRIME g (total) - DECam g (total):
- Median: -0.15
- Median Absolute Deviation: 0.24
- 1% percentile: -2.9536027908325195
- 99% percentile: 2.1289112472534177



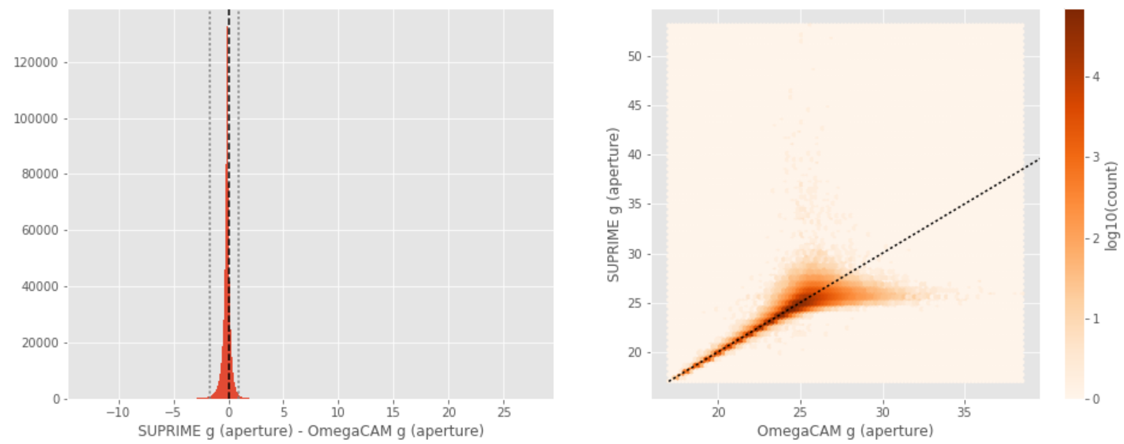
GPC1 g (aperture) - DECam g (aperture):
- Median: -0.04
- Median Absolute Deviation: 0.24
- 1% percentile: -3.3220154953002927
- 99% percentile: 2.4130214500427165



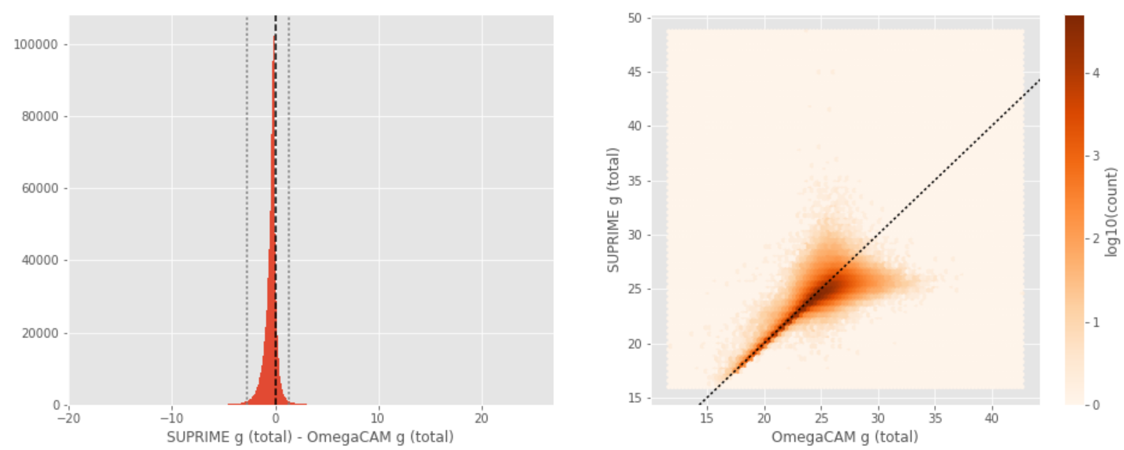
GPC1 g (total) - DECam g (total):
- Median: 0.03
- Median Absolute Deviation: 0.22
- 1% percentile: -3.2655200958251953
- 99% percentile: 2.05049629211426



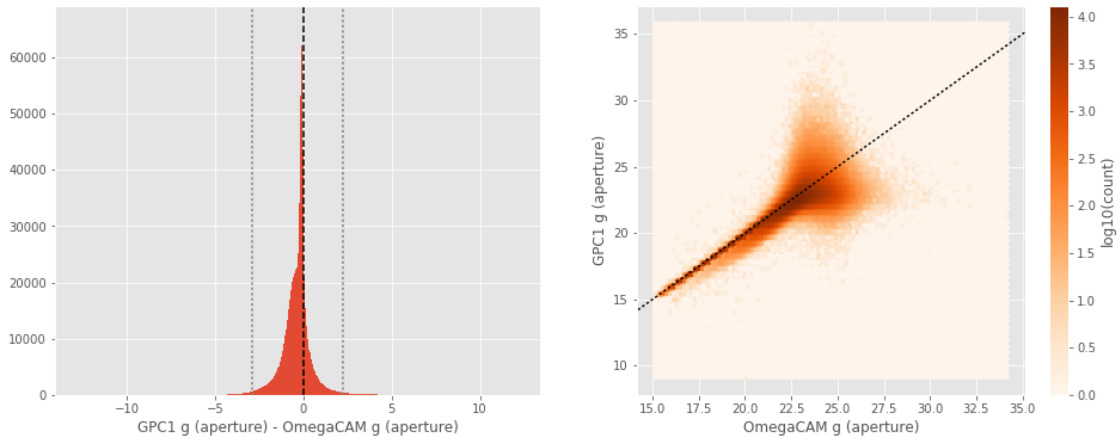
SUPRIME g (aperture) - OmegaCAM g (aperture):
- Median: -0.12
- Median Absolute Deviation: 0.15
- 1% percentile: -1.6483201026916503
- 99% percentile: 0.9457317352294936



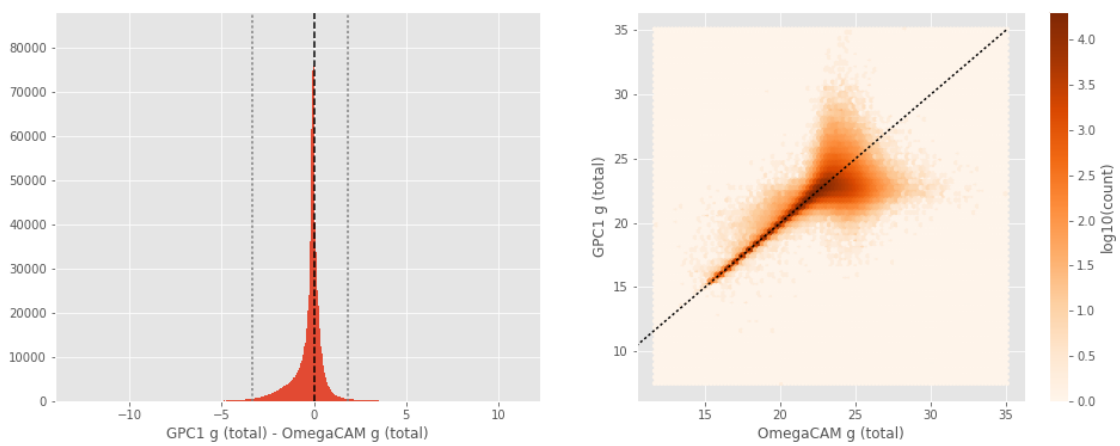

```
SUPRIME g (total) - OmegaCAM g (total):
- Median: -0.30
- Median Absolute Deviation: 0.26
- 1% percentile: -2.7267112350463867
- 99% percentile: 1.2997833633422795
```



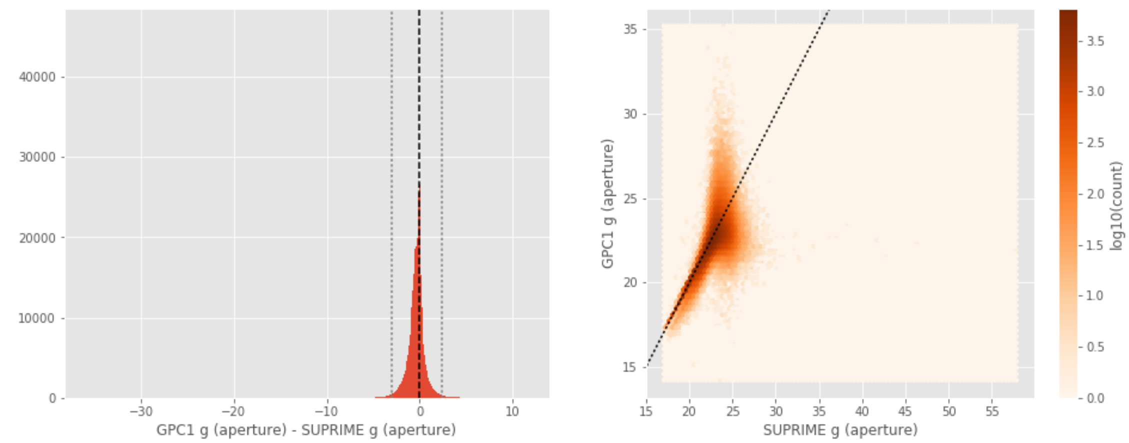

```
GPC1 g (aperture) - OmegaCAM g (aperture):
- Median: -0.26
- Median Absolute Deviation: 0.33
- 1% percentile: -2.8887551498413084
- 99% percentile: 2.226985321044925
```



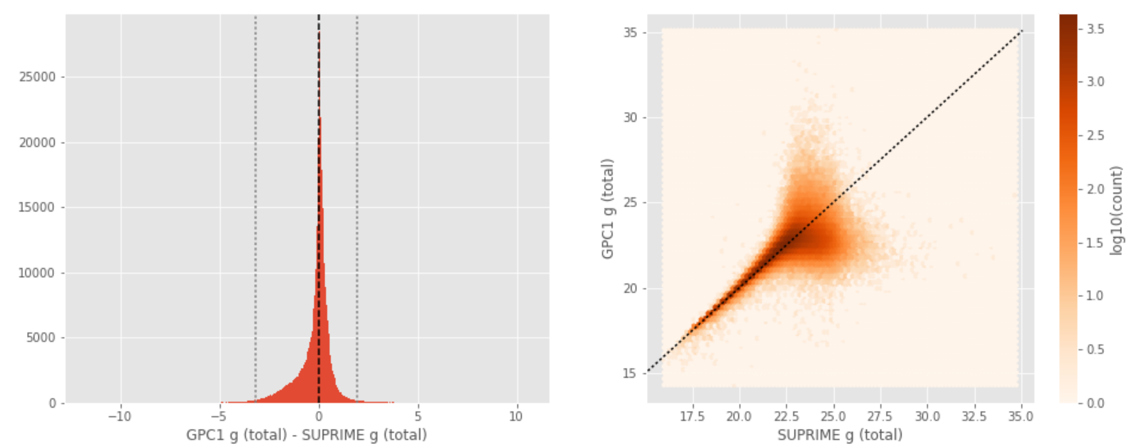
GPC1 g (total) - OmegaCAM g (total):
- Median: -0.08
- Median Absolute Deviation: 0.23
- 1% percentile: -3.3247805786132814
- 99% percentile: 1.855332870483399



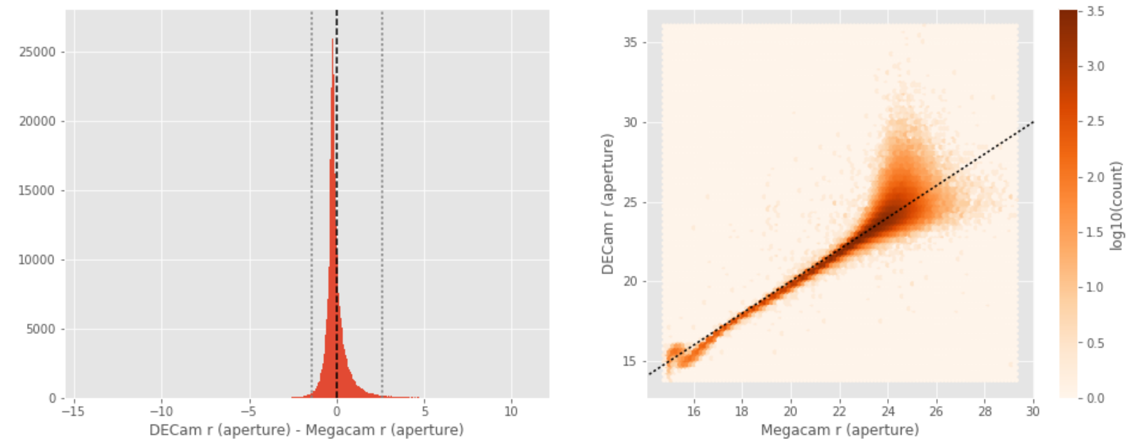
GPC1 g (aperture) - SUPRIME g (aperture):
- Median: -0.18
- Median Absolute Deviation: 0.36
- 1% percentile: -3.0022562408447264
- 99% percentile: 2.367362213134781



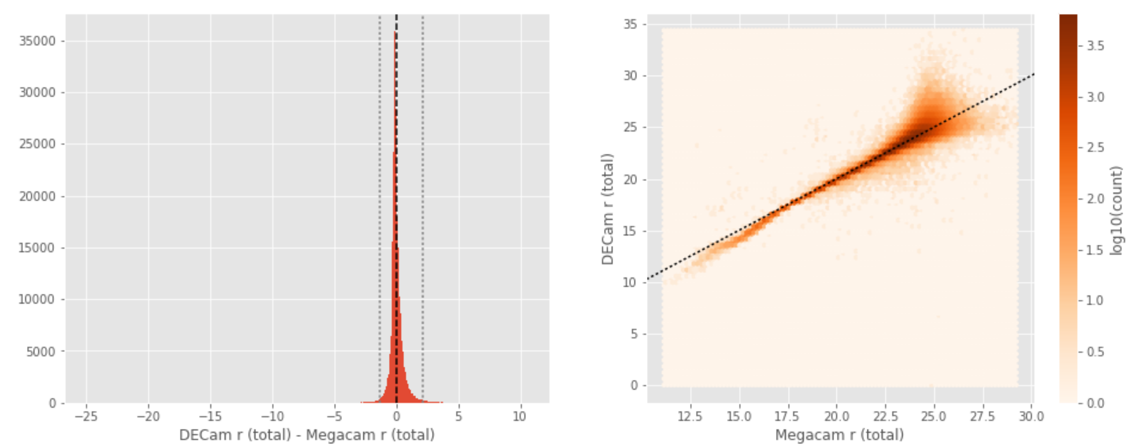
GPC1 g (total) - SUPRIME g (total):
- Median: 0.02
- Median Absolute Deviation: 0.26
- 1% percentile: -3.1486471557617186
- 99% percentile: 1.938578186035161



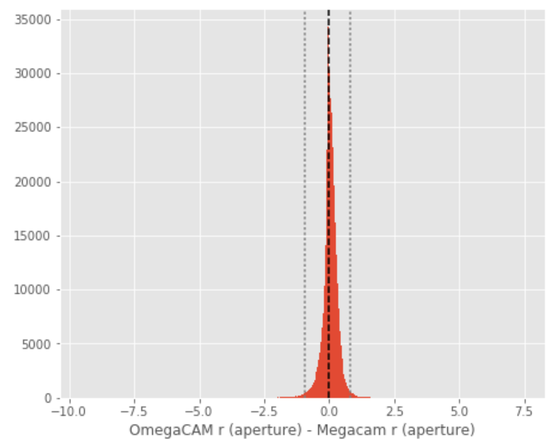
DECam r (aperture) - Megacam r (aperture):
- Median: -0.17
- Median Absolute Deviation: 0.20
- 1% percentile: -1.3899271011352539
- 99% percentile: 2.6179219055175738

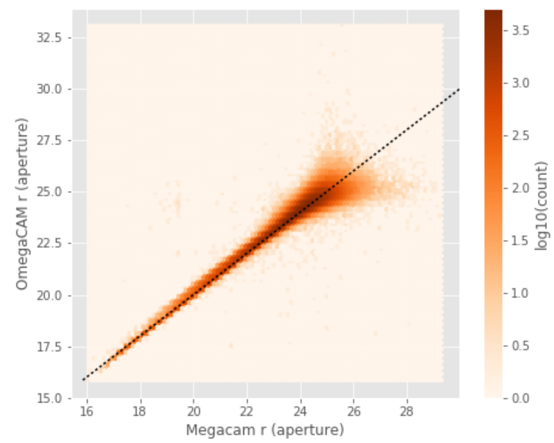


DECam r (total) - Megacam r (total):
- Median: -0.07
- Median Absolute Deviation: 0.19
- 1% percentile: -1.312962532043457
- 99% percentile: 2.1376333236694336

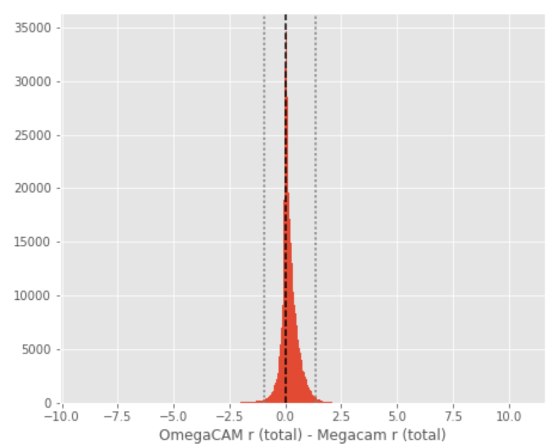


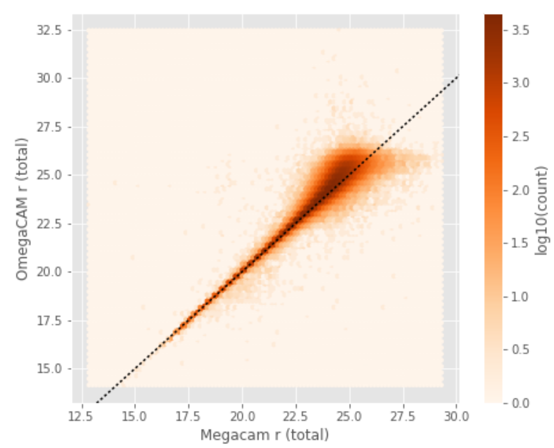
OmegaCAM r (aperture) - Megacam r (aperture):
- Median: 0.04
- Median Absolute Deviation: 0.13
- 1% percentile: -0.9313429069519044
- 99% percentile: 0.7994451522827124






```
OmegaCAM r (total) - Megacam r (total):
- Median: 0.11
- Median Absolute Deviation: 0.16
- 1% percentile: -0.9327923774719238
- 99% percentile: 1.341959476470949
```



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No sources have both Megacam r (aperture) and SUPRIME r (aperture) values.
No sources have both Megacam r (total) and SUPRIME r (total) values.
GPC1 r (aperture) - Megacam r (aperture):
- Median: -0.09
- Median Absolute Deviation: 0.18
- 1% percentile: -1.6790094757080076
- 99% percentile: 1.734747695922838
```
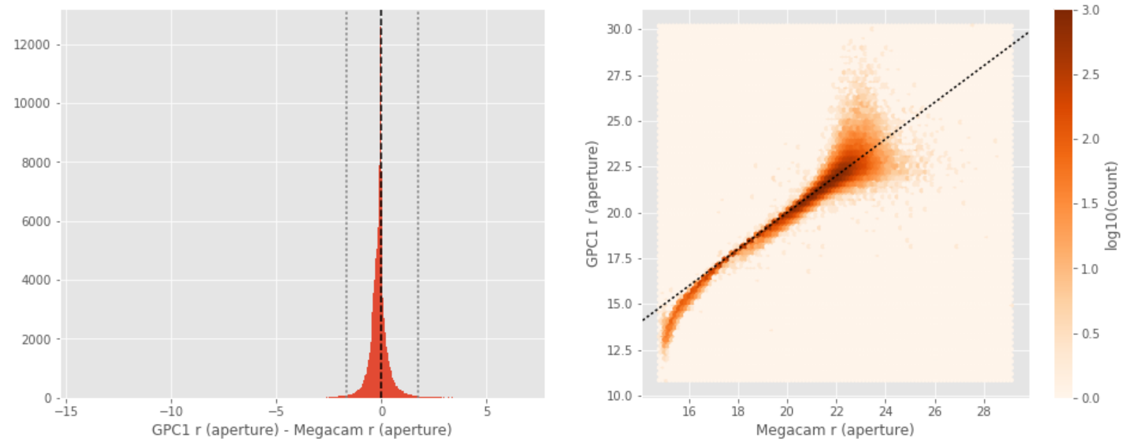
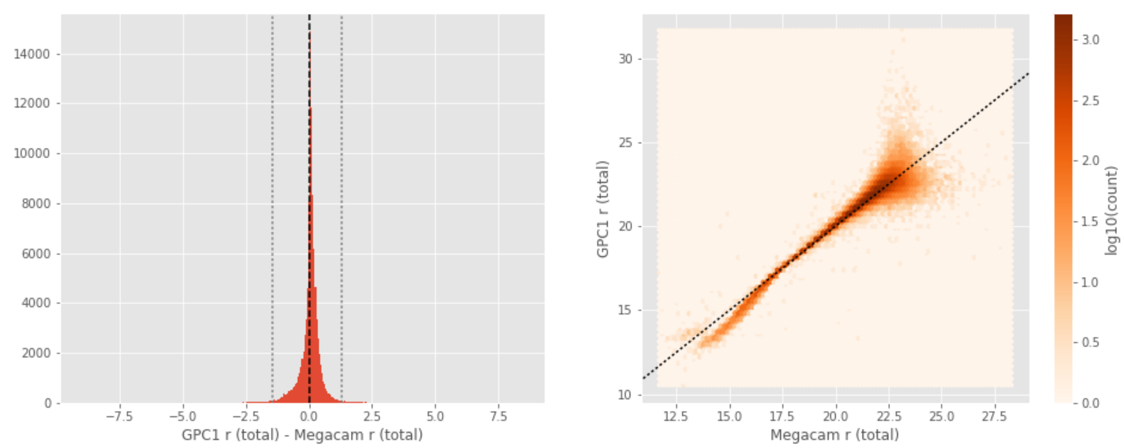
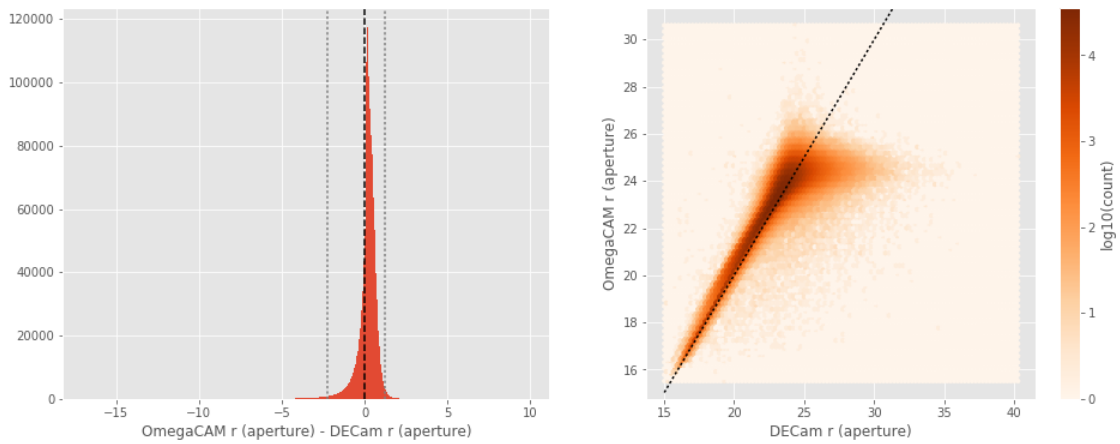



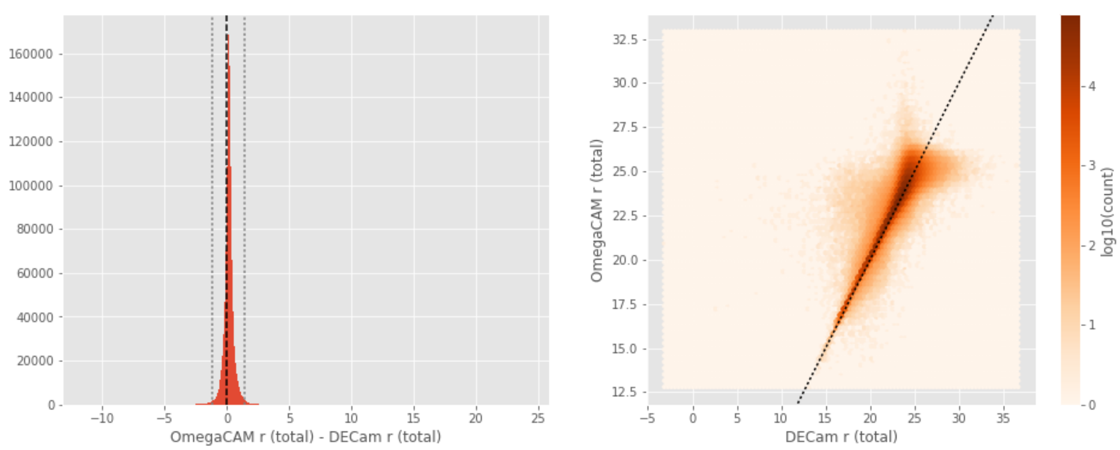
GPC1 r (total) - Megacam r (total):
- Median: 0.07
- Median Absolute Deviation: 0.13
- 1% percentile: -1.462839126586914
- 99% percentile: 1.2953002929687485



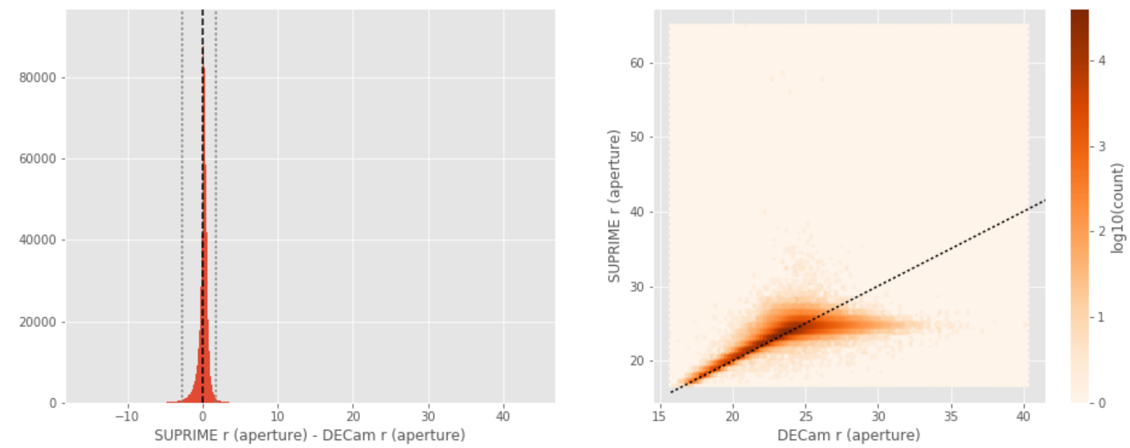
OmegaCAM r (aperture) - DECam r (aperture):
- Median: 0.23
- Median Absolute Deviation: 0.23
- 1% percentile: -2.2294609832763674
- 99% percentile: 1.208233489990235



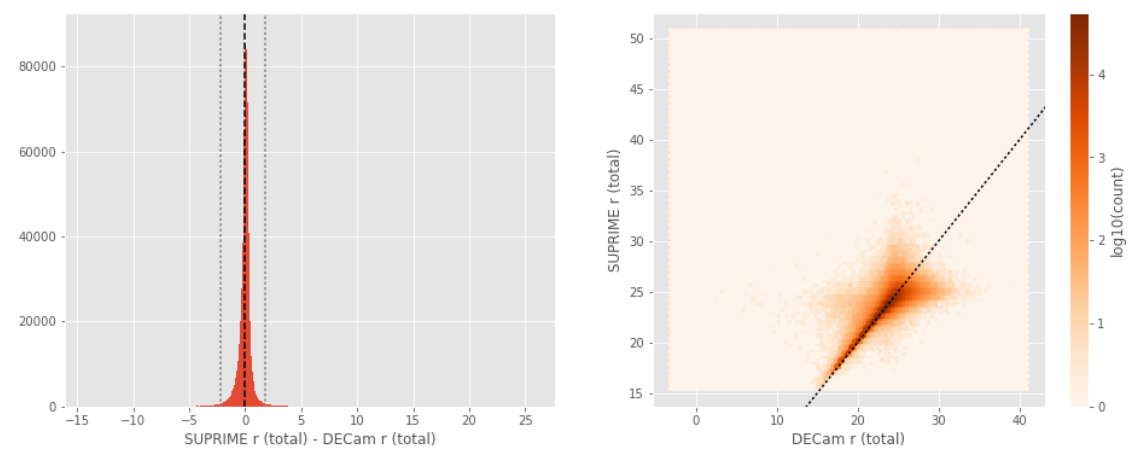
OmegaCAM r (total) - DECam r (total):
- Median: 0.17
- Median Absolute Deviation: 0.17
- 1% percentile: -1.1735394287109375
- 99% percentile: 1.4403925323486328



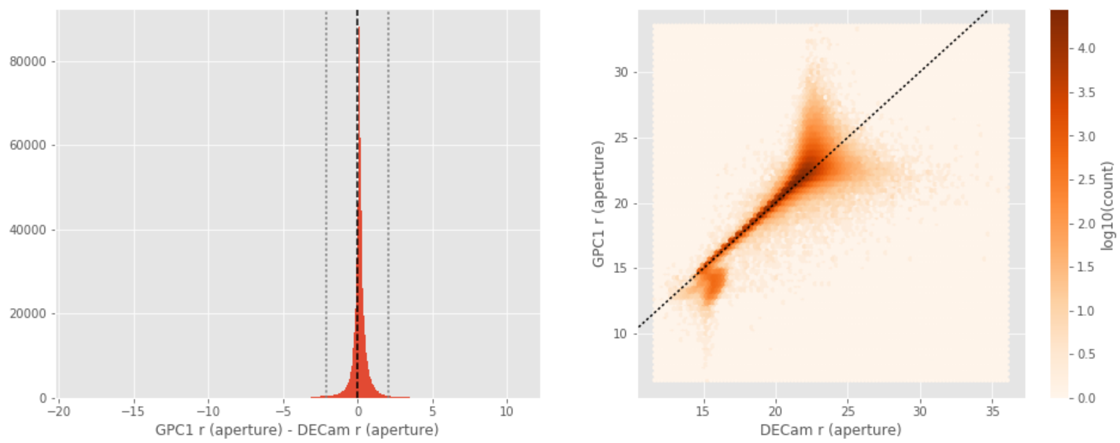
SUPRIME r (aperture) - DECam r (aperture):
- Median: 0.17
- Median Absolute Deviation: 0.26
- 1% percentile: -2.7013166046142576
- 99% percentile: 1.7273321533203125



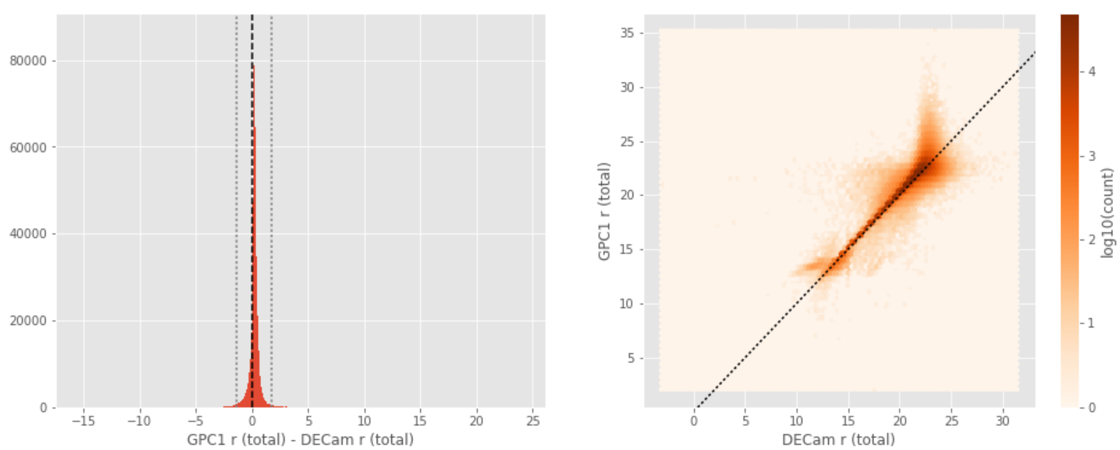
SUPRIME r (total) - DECam r (total):
- Median: 0.03
- Median Absolute Deviation: 0.21
- 1% percentile: -2.1892138671875
- 99% percentile: 1.8311728858947687



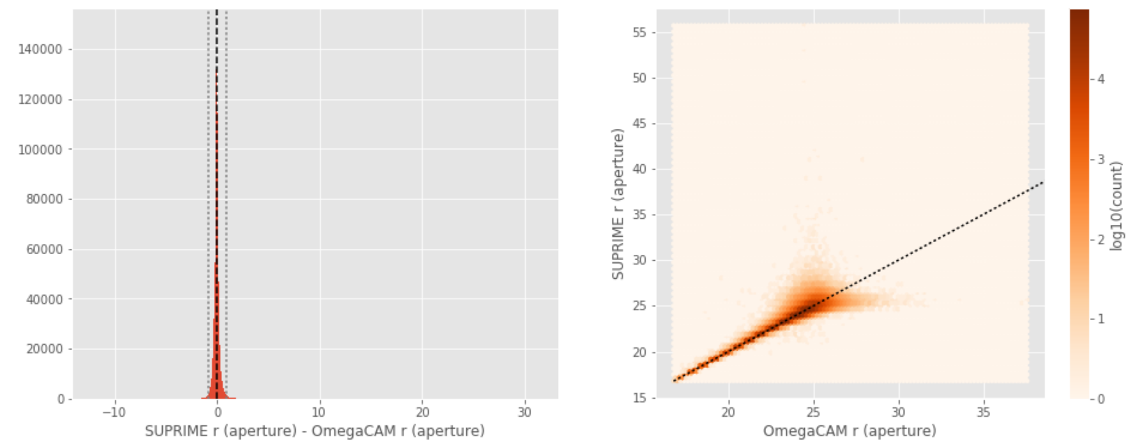
GPC1 r (aperture) - DECam r (aperture):
- Median: 0.12
- Median Absolute Deviation: 0.17
- 1% percentile: -2.1061782836914062
- 99% percentile: 2.0453281402587957



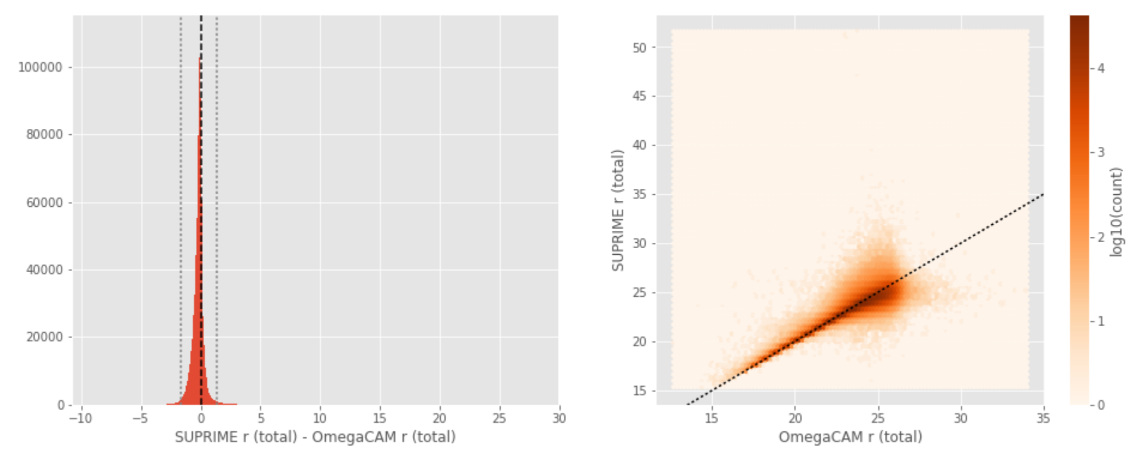
GPC1 r (total) - DECam r (total):
- Median: 0.22
- Median Absolute Deviation: 0.14
- 1% percentile: -1.417061996459961
- 99% percentile: 1.7604949951171998



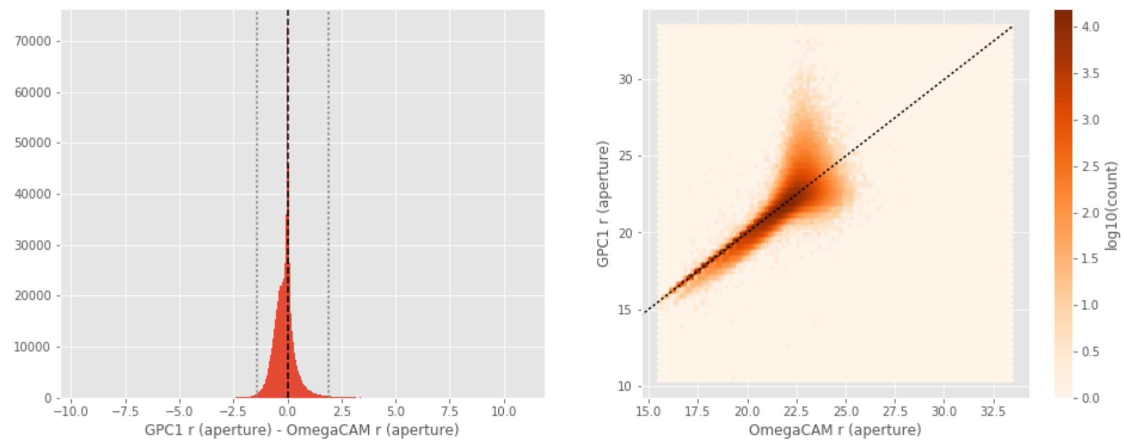
SUPRIME r (aperture) - OmegaCAM r (aperture):
- Median: -0.03
- Median Absolute Deviation: 0.11
- 1% percentile: -0.7935680770874024
- 99% percentile: 0.921067752838133



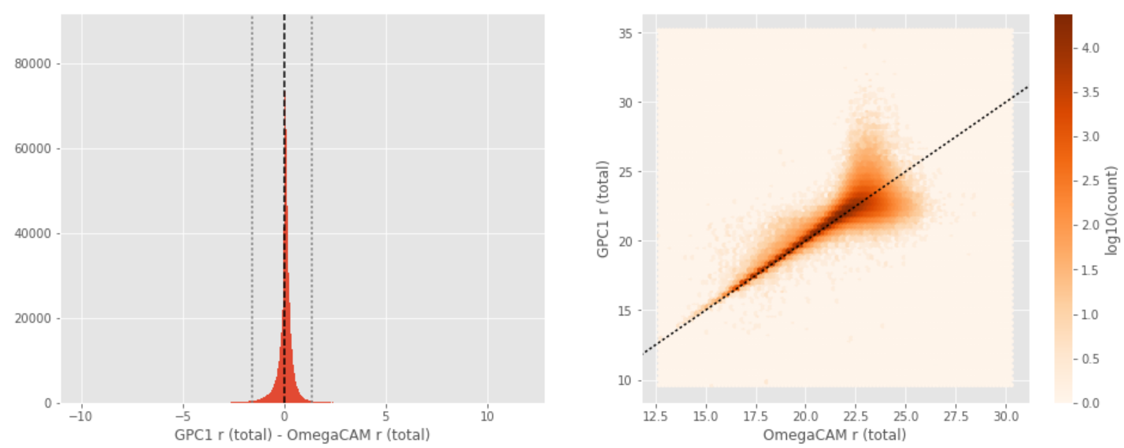
SUPRIME r (total) - OmegaCAM r (total):
- Median: -0.15
- Median Absolute Deviation: 0.20
- 1% percentile: -1.6458333587646483
- 99% percentile: 1.3592094230651939



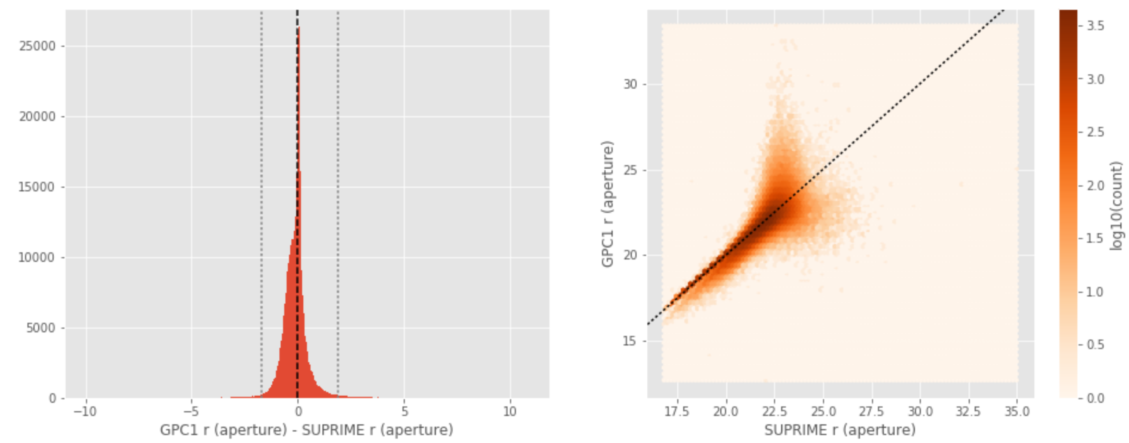
GPC1 r (aperture) - OmegaCAM r (aperture):
- Median: -0.07
- Median Absolute Deviation: 0.24
- 1% percentile: -1.3887310028076172
- 99% percentile: 1.8794038391113053



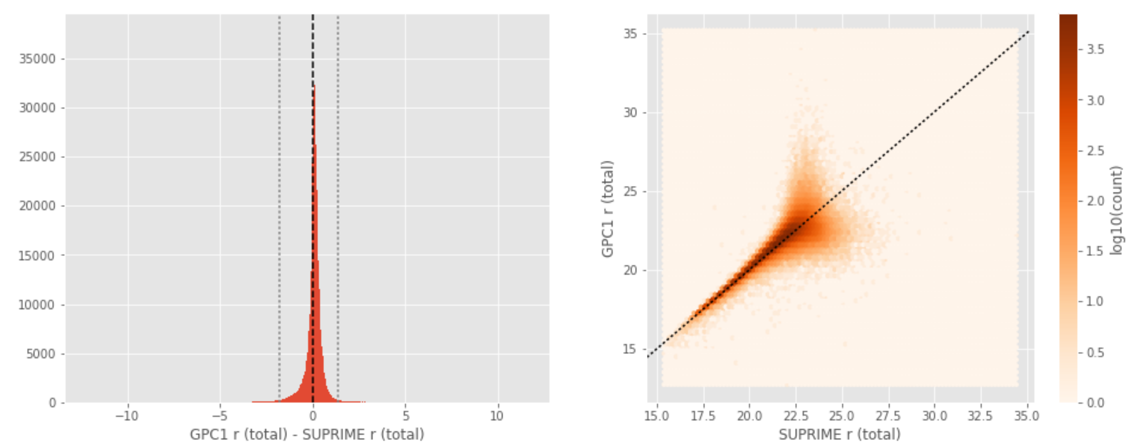
GPC1 r (total) - OmegaCAM r (total):
- Median: 0.07
- Median Absolute Deviation: 0.12
- 1% percentile: -1.5563980484008788
- 99% percentile: 1.3742783355712724



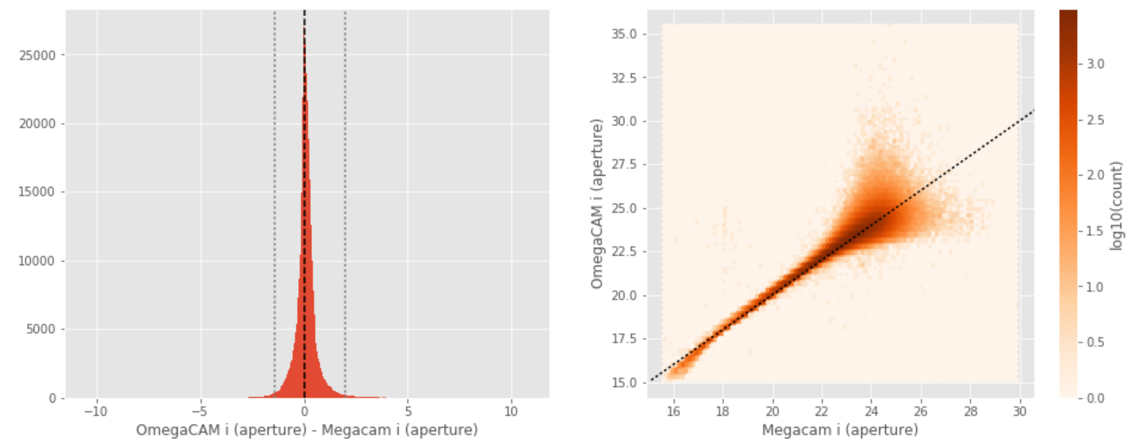
GPC1 r (aperture) - SUPRIME r (aperture):
- Median: -0.06
- Median Absolute Deviation: 0.25
- 1% percentile: -1.690224494934082
- 99% percentile: 1.9183167648315413



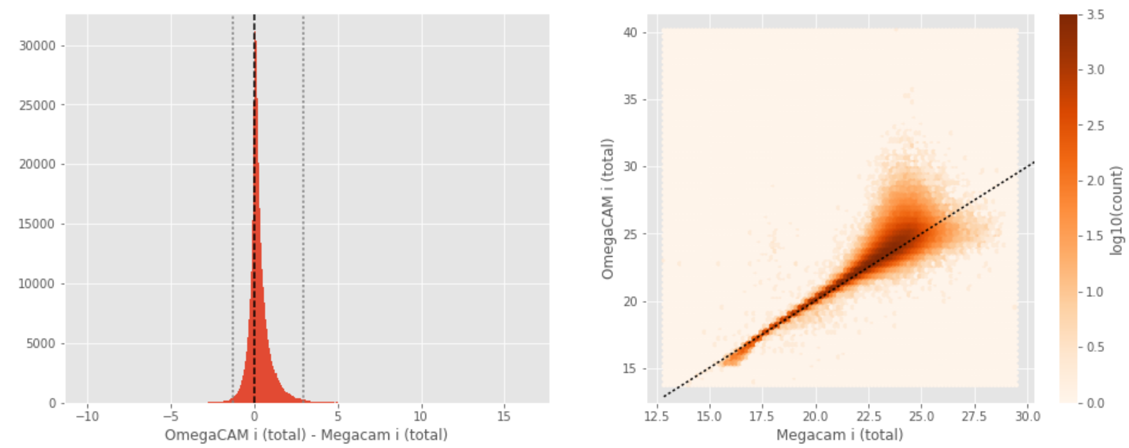
GPC1 r (total) - SUPRIME r (total):
- Median: 0.09
- Median Absolute Deviation: 0.15
- 1% percentile: -1.778599109649658
- 99% percentile: 1.3640725708007793



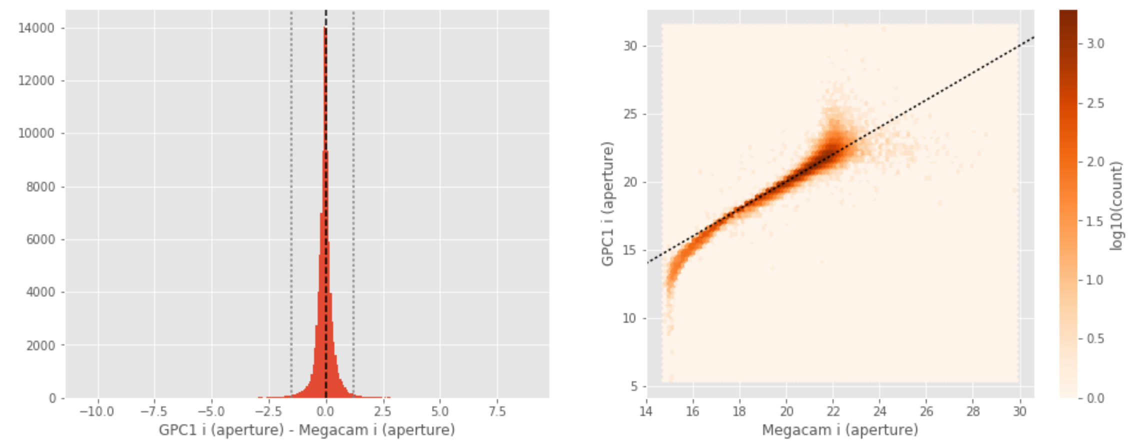
OmegaCAM i (aperture) - Megacam i (aperture):
- Median: 0.08
- Median Absolute Deviation: 0.19
- 1% percentile: -1.3832026290893555
- 99% percentile: 1.9946659278869625



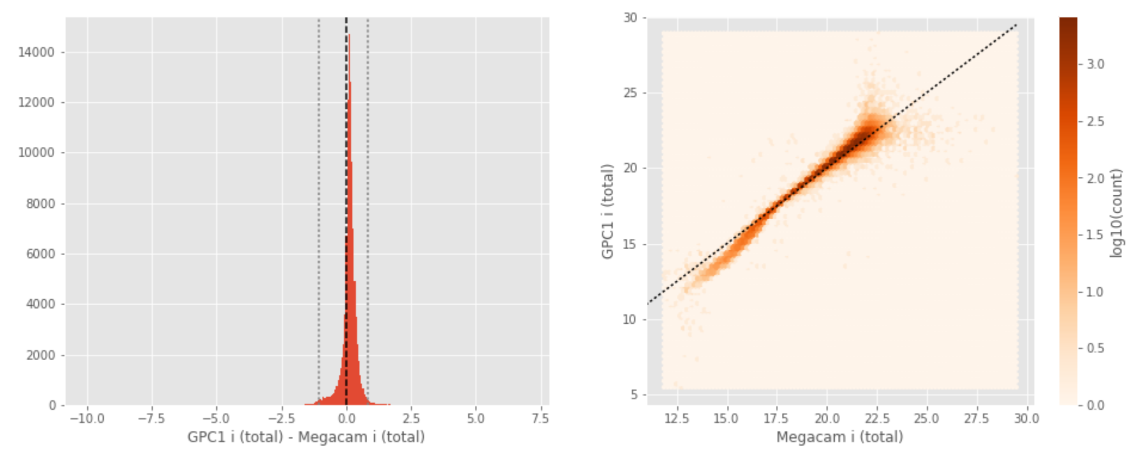
OmegaCAM i (total) - Megacam i (total):
- Median: 0.18
- Median Absolute Deviation: 0.25
- 1% percentile: -1.241908721923828
- 99% percentile: 2.9465506744384746



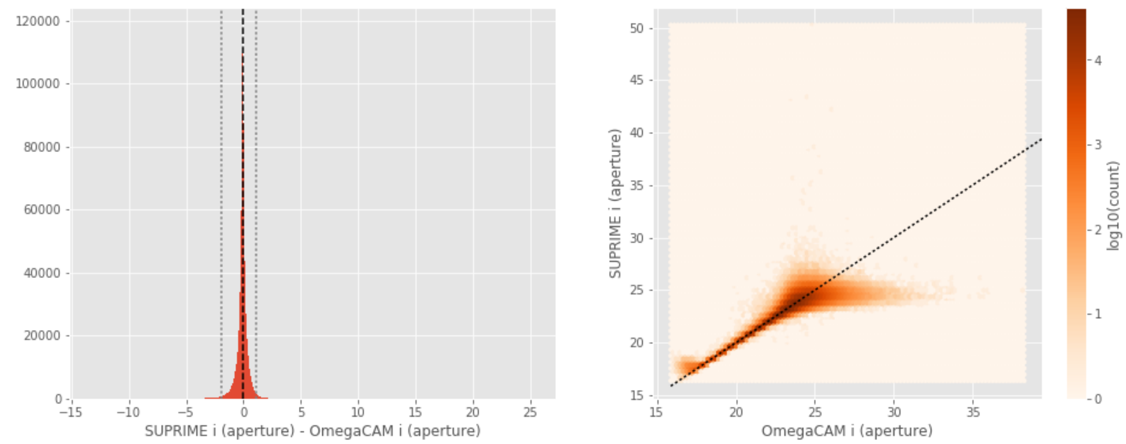
No sources have both Megacam i (aperture) and SUPRIME i (aperture) values.
No sources have both Megacam i (total) and SUPRIME i (total) values.
GPC1 i (aperture) - Megacam i (aperture):
- Median: -0.03
- Median Absolute Deviation: 0.15
- 1% percentile: -1.5005756759643554
- 99% percentile: 1.2333040618896551



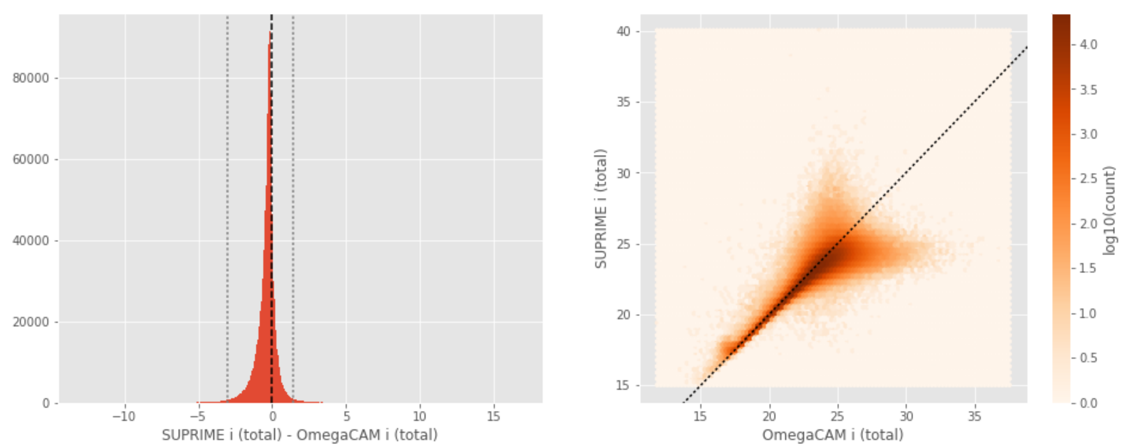
GPC1 i (total) - Megacam i (total):
- Median: 0.13
- Median Absolute Deviation: 0.11
- 1% percentile: -1.0404205799102784
- 99% percentile: 0.8547141075134261



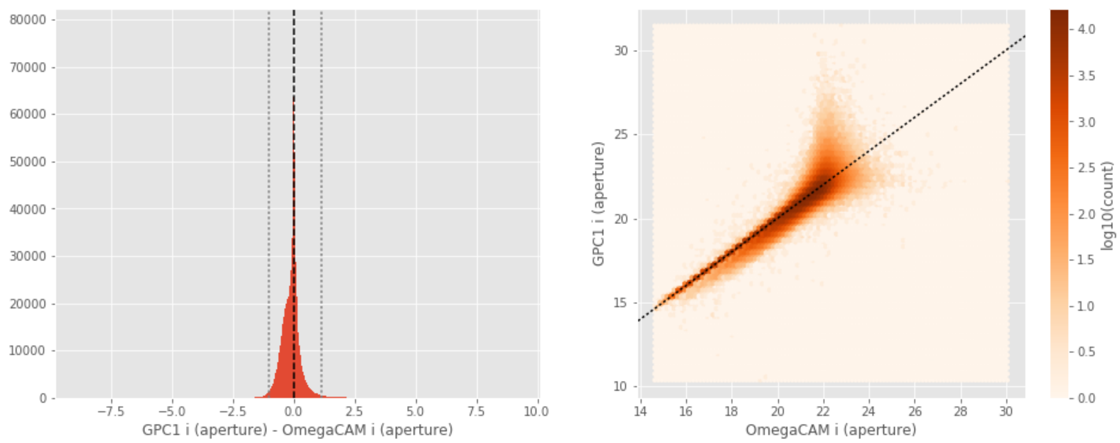
SUPRIME i (aperture) - OmegaCAM i (aperture):
- Median: -0.08
- Median Absolute Deviation: 0.16
- 1% percentile: -1.892069320678711
- 99% percentile: 1.1368710327148435



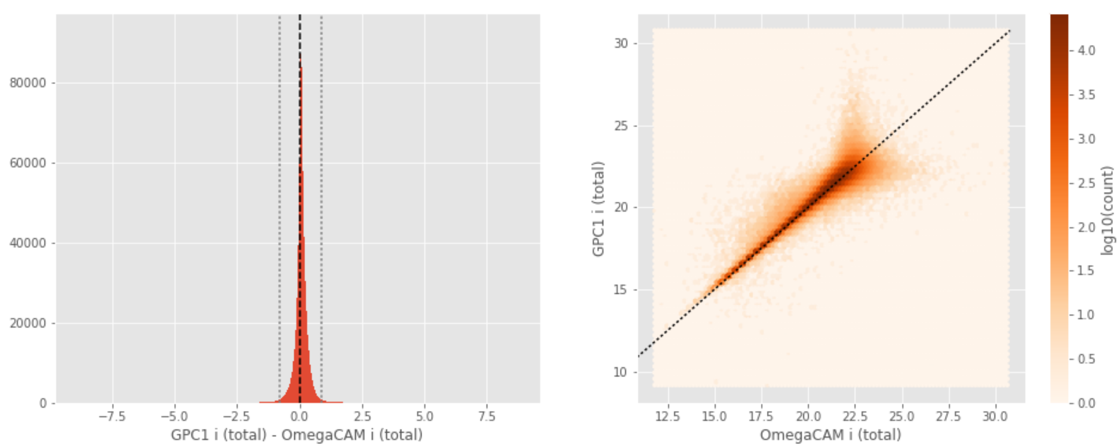
SUPRIME i (total) - OmegaCAM i (total):
- Median: -0.26
- Median Absolute Deviation: 0.26
- 1% percentile: -2.98850830078125
- 99% percentile: 1.467466888427733



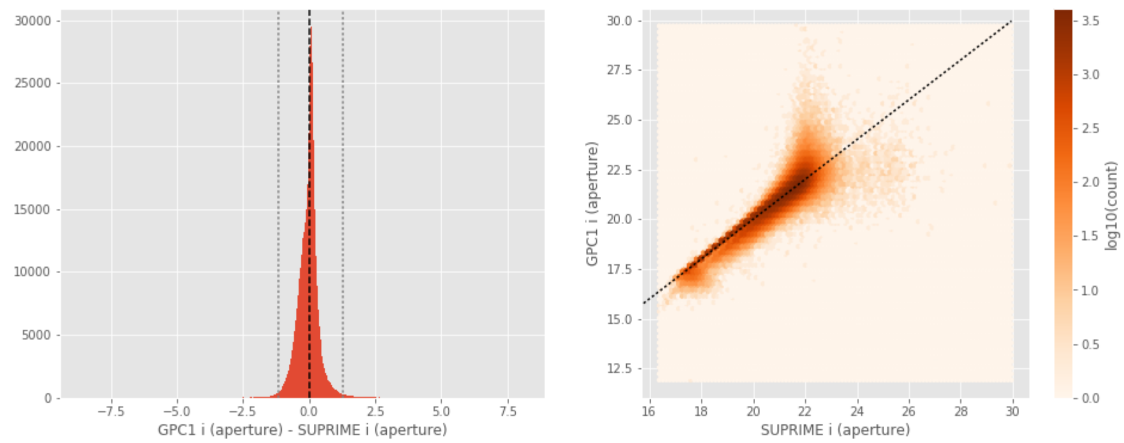
GPC1 i (aperture) - OmegaCAM i (aperture):
- Median: -0.04
- Median Absolute Deviation: 0.17
- 1% percentile: -1.012455883026123
- 99% percentile: 1.162801818847658



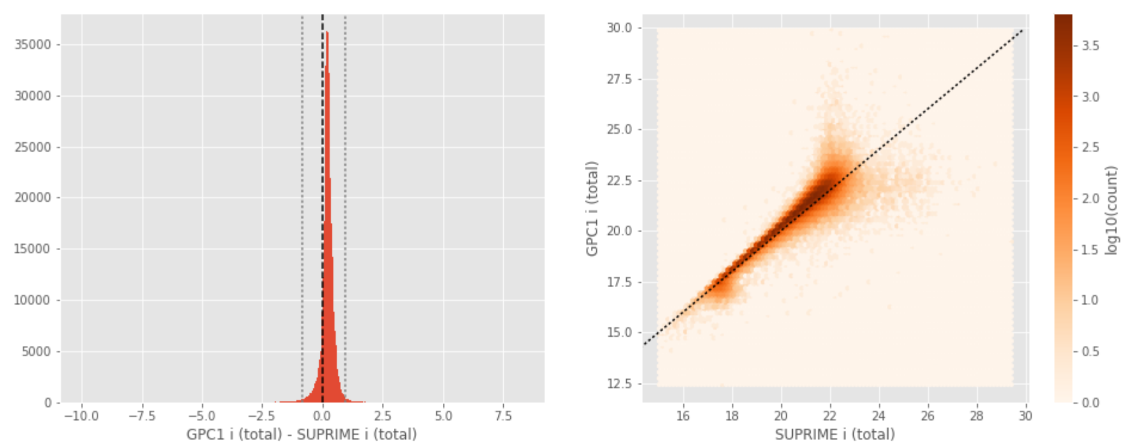
GPC1 i (total) - OmegaCAM i (total):
- Median: 0.07
- Median Absolute Deviation: 0.10
- 1% percentile: -0.8052410125732422
- 99% percentile: 0.8787147521972614



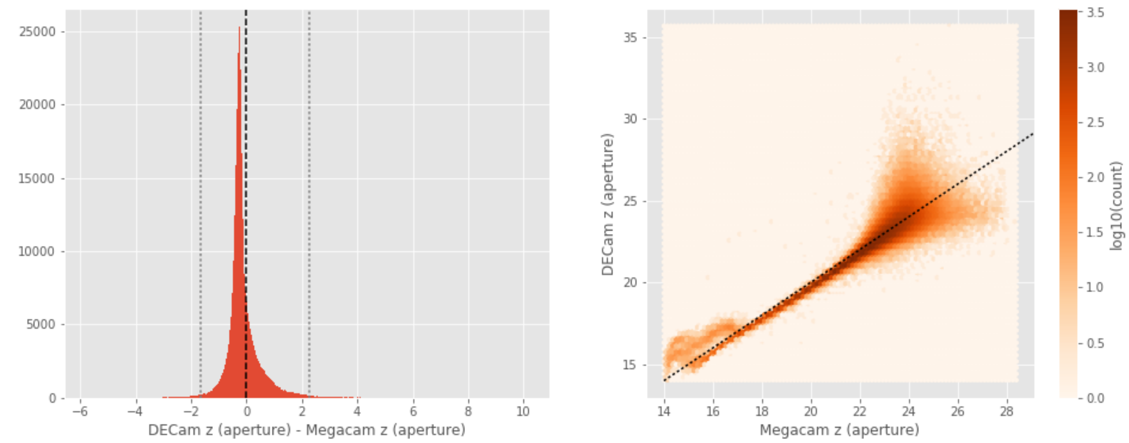
GPC1 i (aperture) - SUPRIME i (aperture):
- Median: 0.01
- Median Absolute Deviation: 0.20
- 1% percentile: -1.1477067947387696
- 99% percentile: 1.2791937446594244



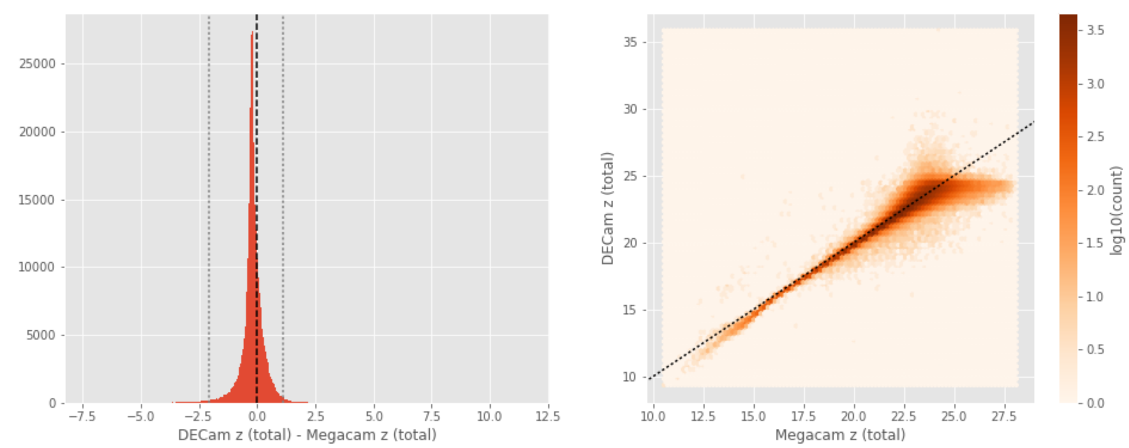
GPC1 i (total) - SUPRIME i (total):
- Median: 0.22
- Median Absolute Deviation: 0.11
- 1% percentile: -0.8407560348510743
- 99% percentile: 0.9342291259765623



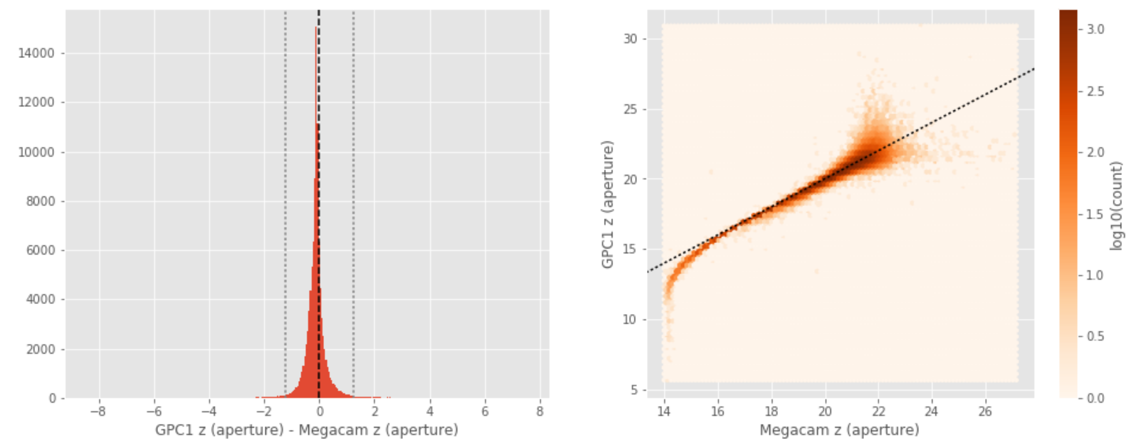
DECam z (aperture) - Megacam z (aperture):
- Median: -0.25
- Median Absolute Deviation: 0.19
- 1% percentile: -1.6546760368347166
- 99% percentile: 2.257709140777583



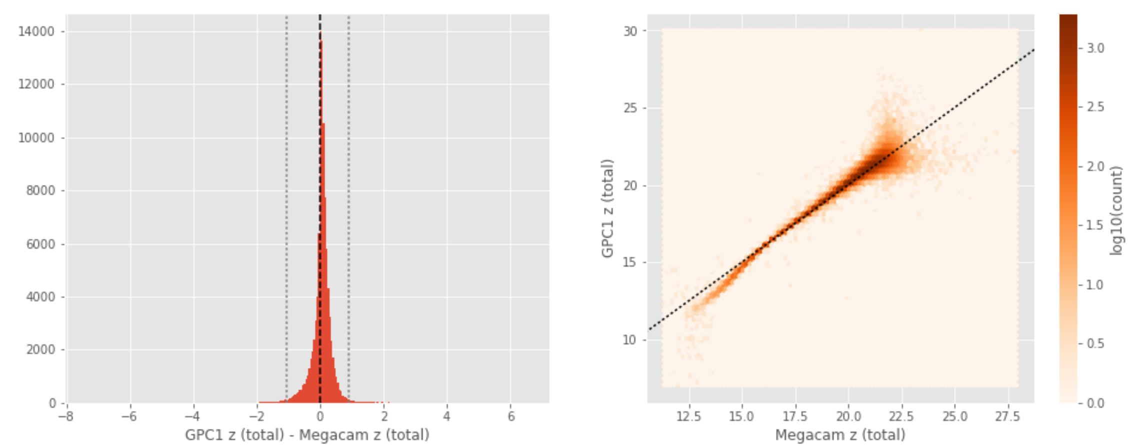
DECam z (total) - Megacam z (total):
- Median: -0.19
- Median Absolute Deviation: 0.18
- 1% percentile: -2.0613699340820313
- 99% percentile: 1.1164606857299815



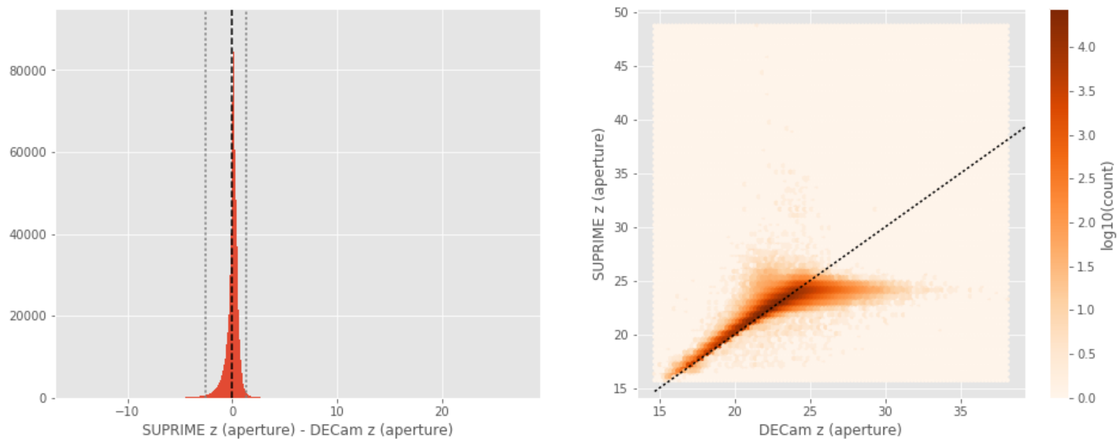
No sources have both Megacam z (aperture) and SUPRIME z (aperture) values.
No sources have both Megacam z (total) and SUPRIME z (total) values.
GPC1 z (aperture) - Megacam z (aperture):
- Median: -0.11
- Median Absolute Deviation: 0.13
- 1% percentile: -1.2350538158416748
- 99% percentile: 1.2366098022460934



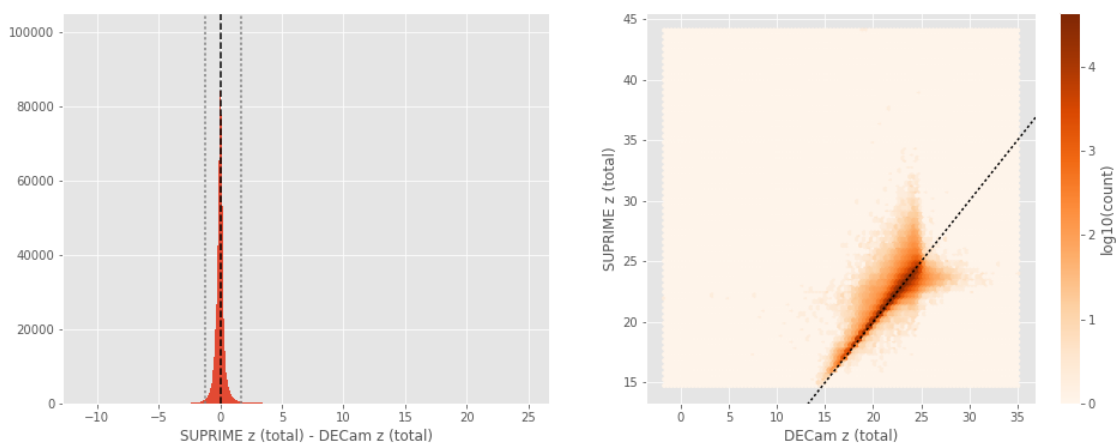
GPC1 z (total) - Megacam z (total):
- Median: 0.06
- Median Absolute Deviation: 0.11
- 1% percentile: -1.062198543548584
- 99% percentile: 0.8984934425354041



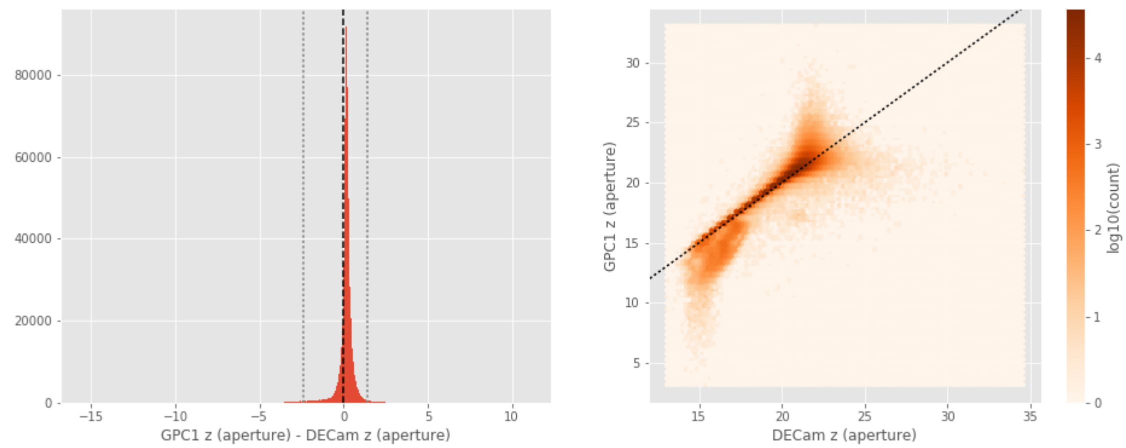
SUPRIME z (aperture) - DECam z (aperture):
- Median: 0.10
- Median Absolute Deviation: 0.24
- 1% percentile: -2.5782276916503903
- 99% percentile: 1.3022348785400366



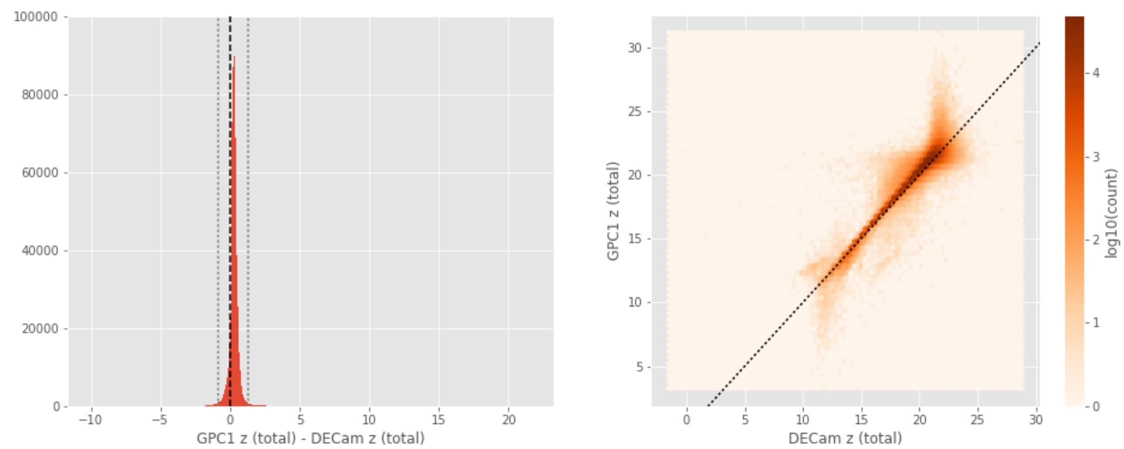
SUPRIME z (total) - DECam z (total):
- Median: 0.00
- Median Absolute Deviation: 0.16
- 1% percentile: -1.262060317993164
- 99% percentile: 1.7105876922607433



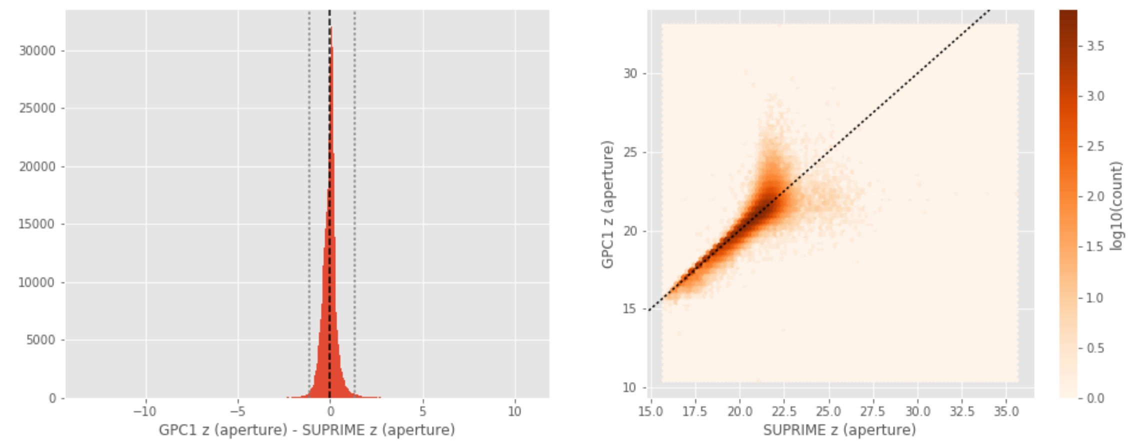
GPC1 z (aperture) - DECam z (aperture):
- Median: 0.17
- Median Absolute Deviation: 0.12
- 1% percentile: -2.4121409606933595
- 99% percentile: 1.3761706542968781



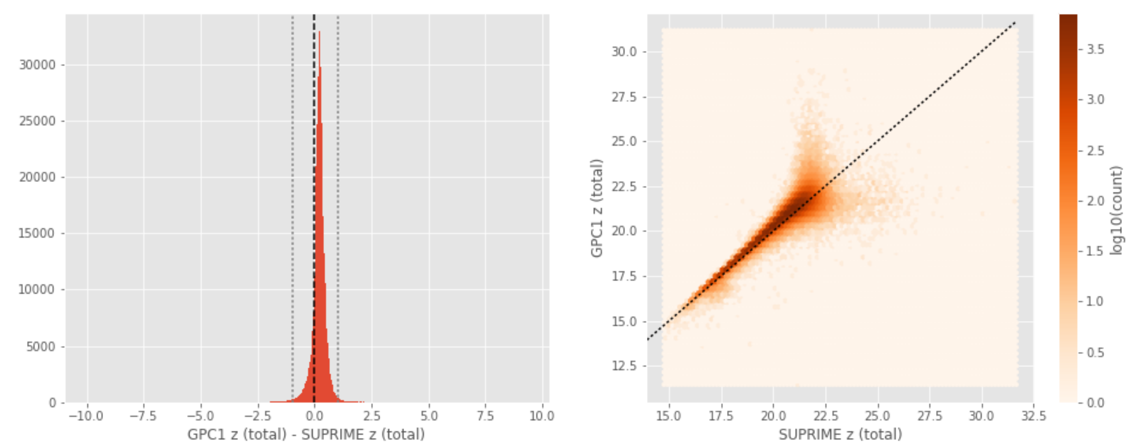
GPC1 z (total) - DECam z (total):
- Median: 0.28
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8339986610412597
- 99% percentile: 1.336584320068357



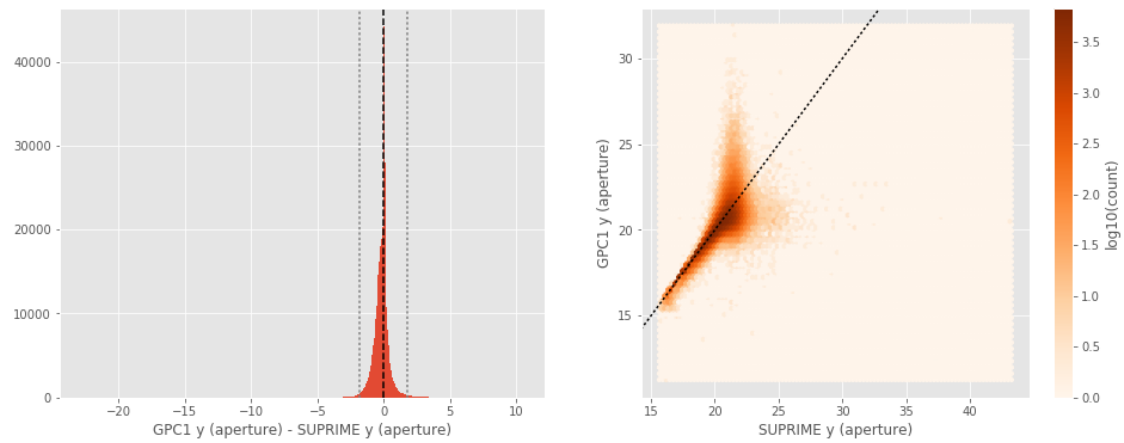
GPC1 z (aperture) - SUPRIME z (aperture):
- Median: 0.01
- Median Absolute Deviation: 0.19
- 1% percentile: -1.1201167297363281
- 99% percentile: 1.3065491867065397



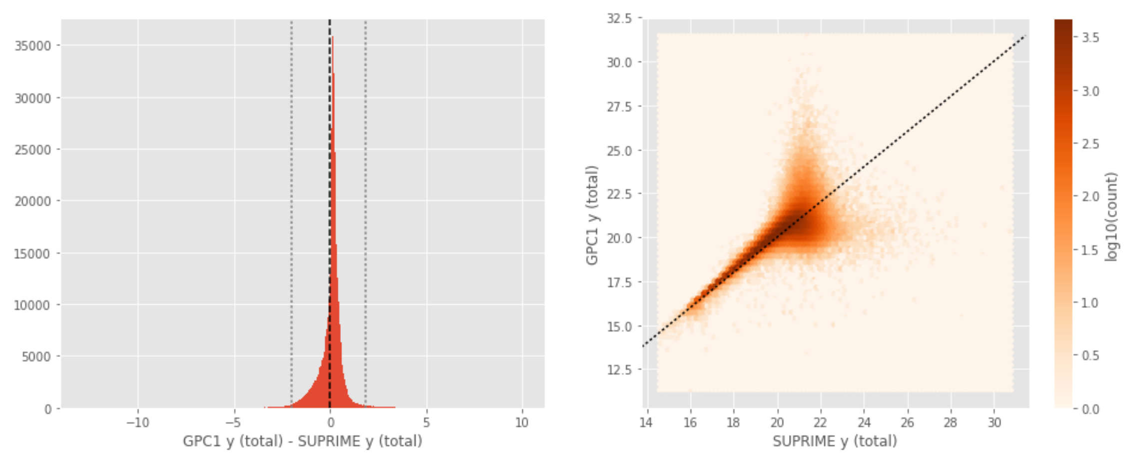
GPC1 z (total) - SUPRIME z (total):
- Median: 0.22
- Median Absolute Deviation: 0.13
- 1% percentile: -0.9406272888183593
- 99% percentile: 1.0296527099609385



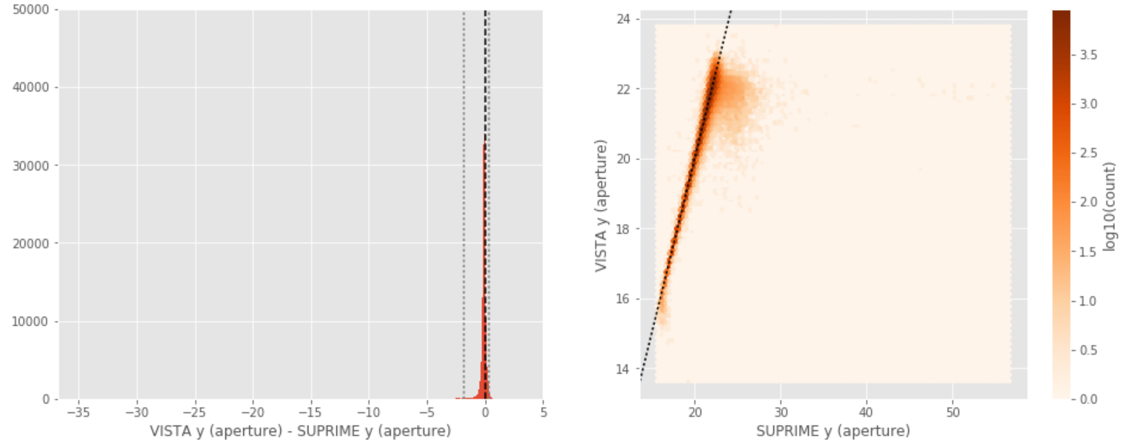
GPC1 y (aperture) - SUPRIME y (aperture):
- Median: -0.09
- Median Absolute Deviation: 0.24
- 1% percentile: -1.8509708976745607
- 99% percentile: 1.8031742477416985



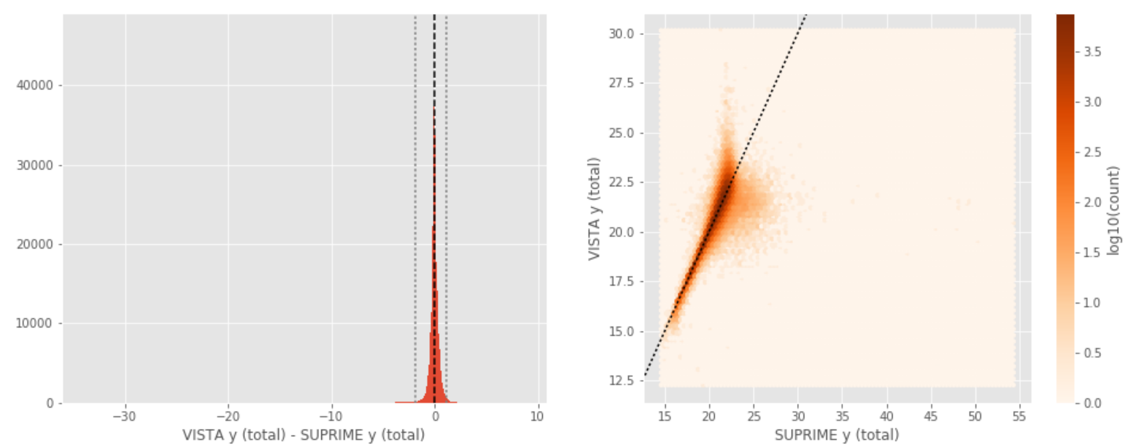
GPC1 y (total) - SUPRIME y (total):
- Median: 0.15
- Median Absolute Deviation: 0.20
- 1% percentile: -2.012035598754883
- 99% percentile: 1.876803054809569



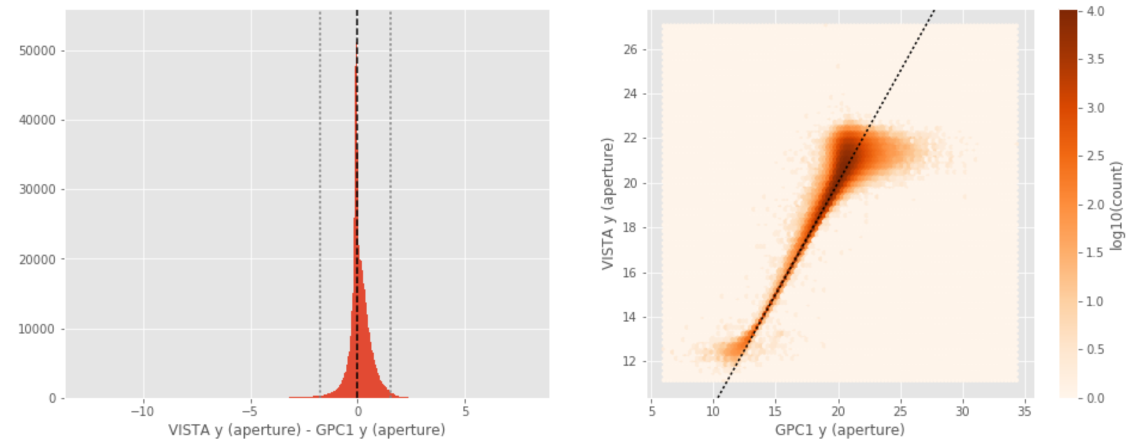
VISTA y (aperture) - SUPRIME y (aperture):
- Median: -0.07
- Median Absolute Deviation: 0.07
- 1% percentile: -1.813660430908203
- 99% percentile: 0.35906028747558416



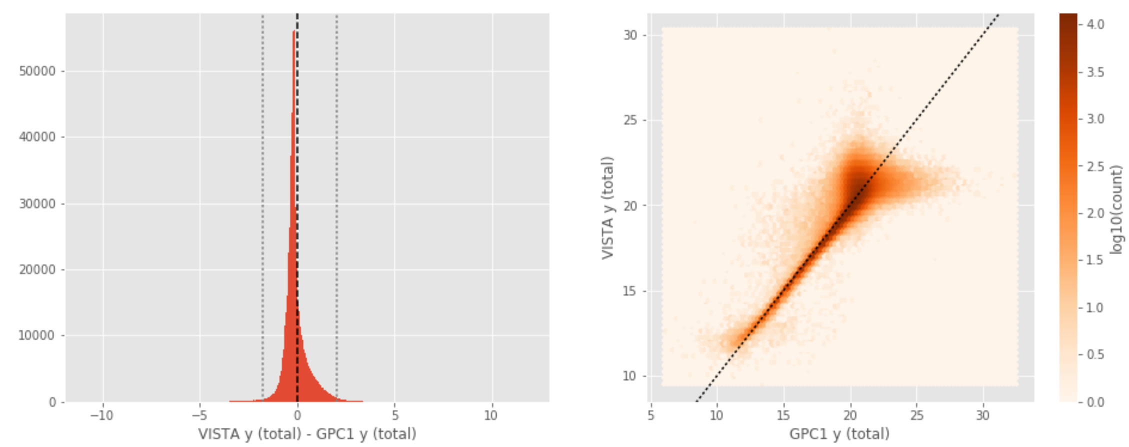
VISTA y (total) - SUPRIME y (total):
- Median: -0.02
- Median Absolute Deviation: 0.17
- 1% percentile: -1.8913174438476563
- 99% percentile: 1.1965563964843762



VISTA y (aperture) - GPC1 y (aperture):
- Median: 0.00
- Median Absolute Deviation: 0.22
- 1% percentile: -1.7562258529663086
- 99% percentile: 1.5490060424804661




```
VISTA y (total) - GPC1 y (total):
- Median: -0.17
- Median Absolute Deviation: 0.21
- 1% percentile: -1.7571101379394531
- 99% percentile: 2.053238945007324
```



1.5 III - Comparing magnitudes to reference bands

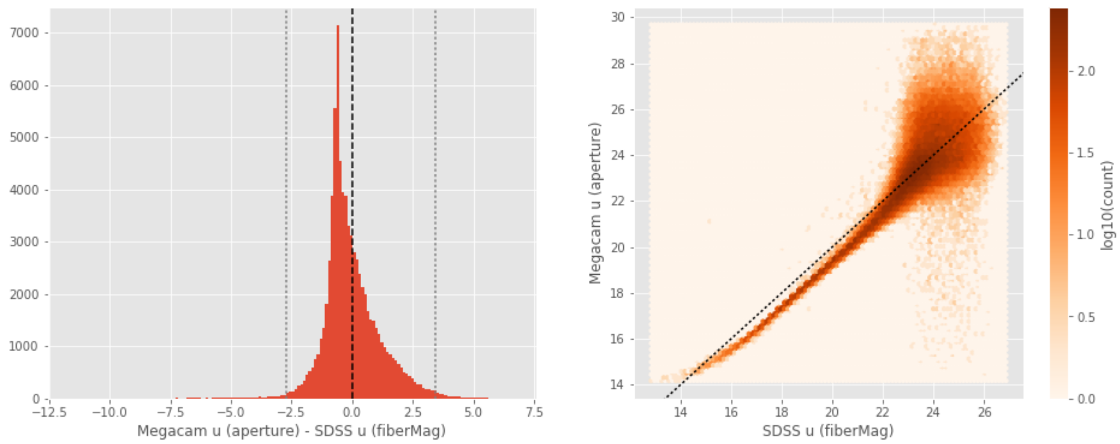
Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

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

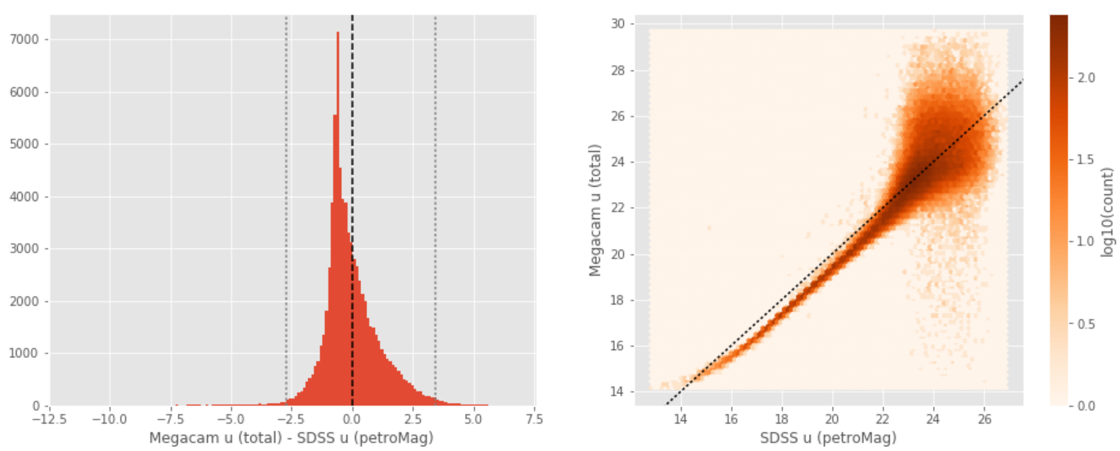
The catalogue is cross-matched to SDSS-DR13 withing 0.2 arcsecond.

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.

```
Megacam u (aperture) - SDSS u (fiberMag):
- Median: -0.28
- Median Absolute Deviation: 0.54
- 1% percentile: -2.7285282135009767
- 99% percentile: 3.4120958328247073
```

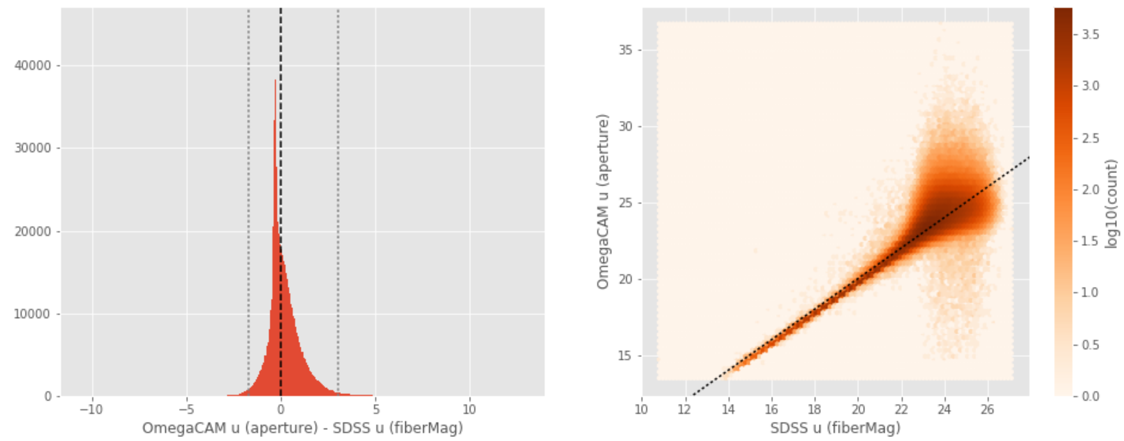



```
Megacam u (total) - SDSS u (petroMag):
- Median: -0.28
- Median Absolute Deviation: 0.54
- 1% percentile: -2.7285282135009767
- 99% percentile: 3.4120958328247073
```



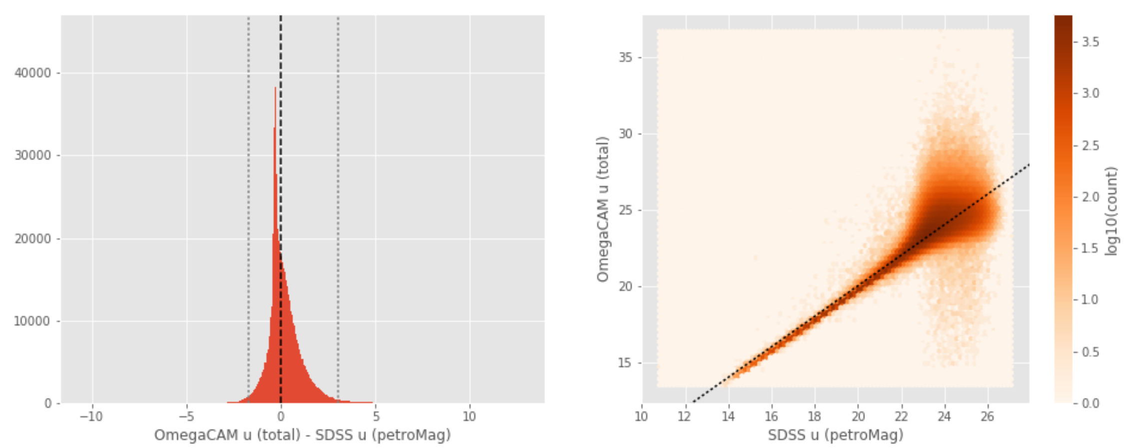

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:8: R
```

```
OmegaCAM u (aperture) - SDSS u (fiberMag):
- Median: 0.01
- Median Absolute Deviation: 0.40
- 1% percentile: -1.7317141723632812
- 99% percentile: 3.059096755981448
```

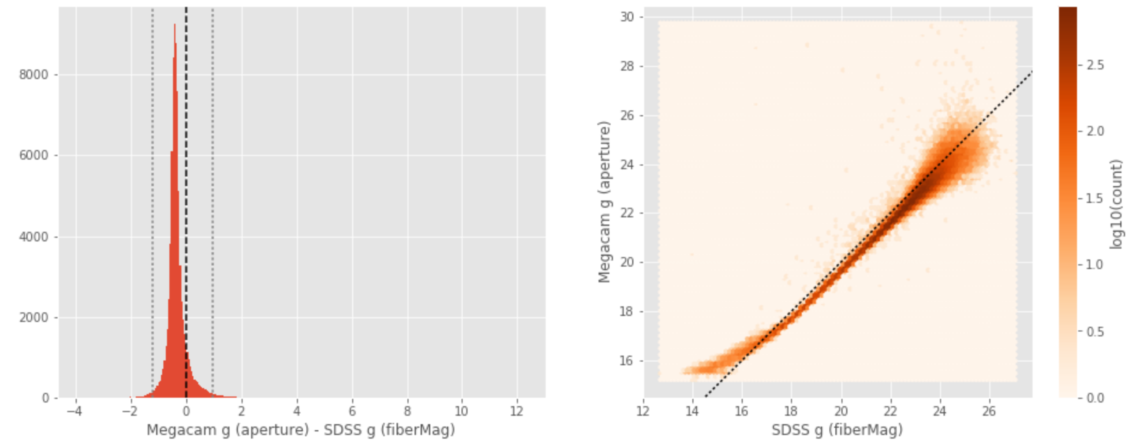



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:17:
```

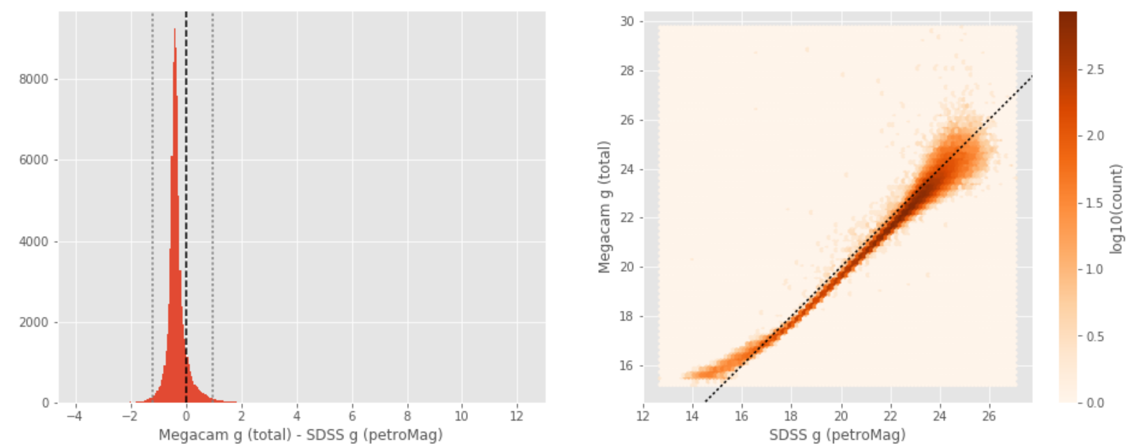
```
OmegaCAM u (total) - SDSS u (petroMag):
- Median: 0.01
- Median Absolute Deviation: 0.40
- 1% percentile: -1.7317141723632812
- 99% percentile: 3.059096755981448
```



```
Megacam g (aperture) - SDSS g (fiberMag):
- Median: -0.37
- Median Absolute Deviation: 0.12
- 1% percentile: -1.1864328956604004
- 99% percentile: 0.9577699279785143
```

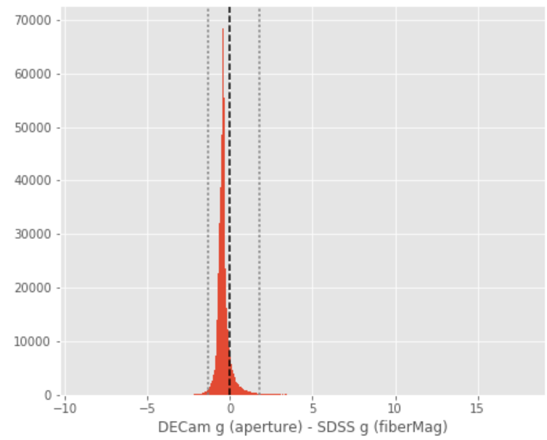


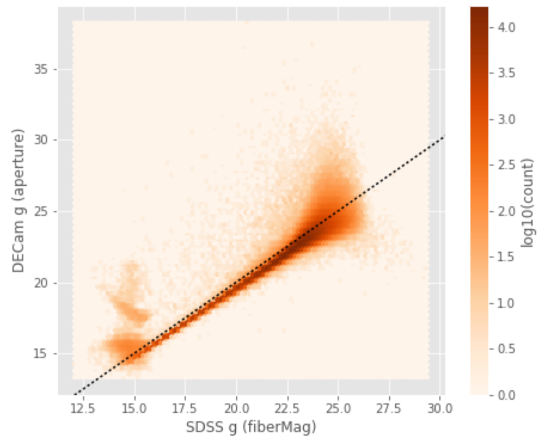

```
Megacam g (total) - SDSS g (petroMag):
- Median: -0.37
- Median Absolute Deviation: 0.12
- 1% percentile: -1.1864328956604004
- 99% percentile: 0.9577699279785143
```



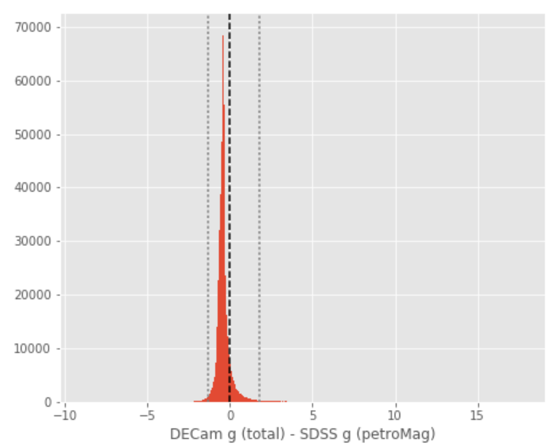

```
DECam g (aperture) - SDSS g (fiberMag):
- Median: -0.44
```

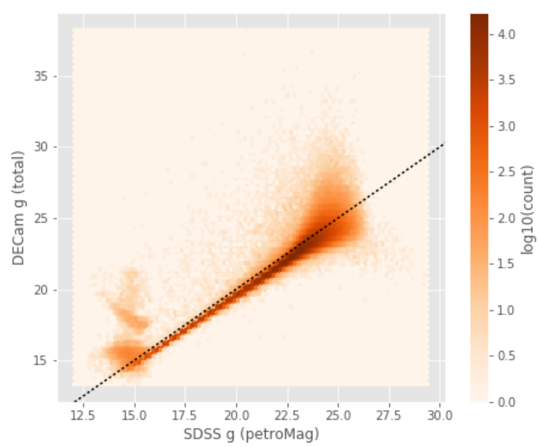
- Median Absolute Deviation: 0.14
- 1% percentile: -1.3305944061279296
- 99% percentile: 1.7608382606506396





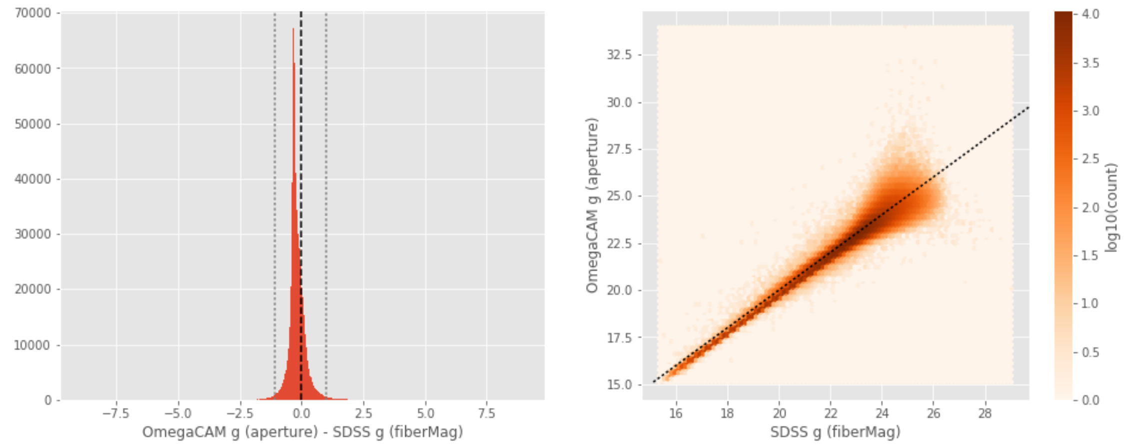
DECam g (total) - SDSS g (petroMag):
- Median: -0.44
- Median Absolute Deviation: 0.14
- 1% percentile: -1.3305944061279296
- 99% percentile: 1.7608382606506396



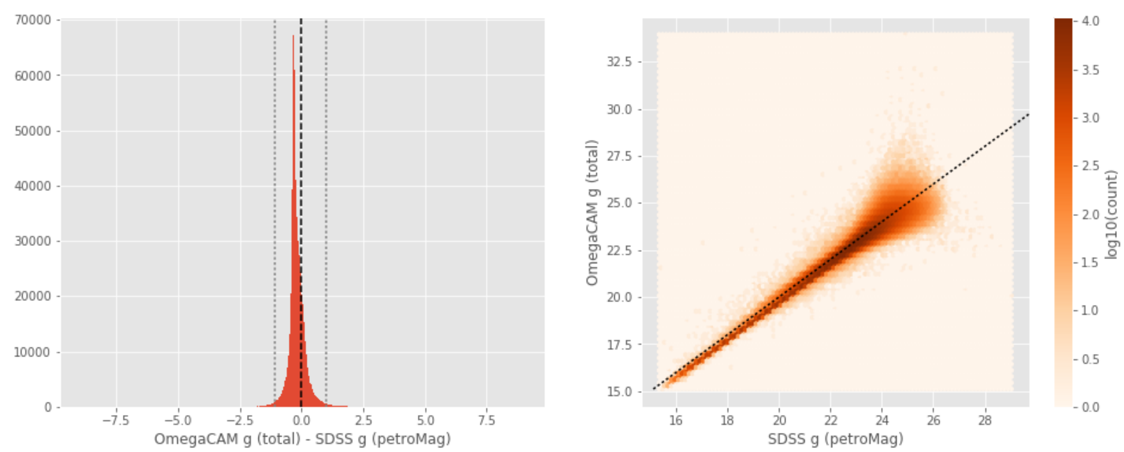


OmegaCAM g (aperture) - SDSS g (fiberMag):
- Median: -0.23
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0690904235839844

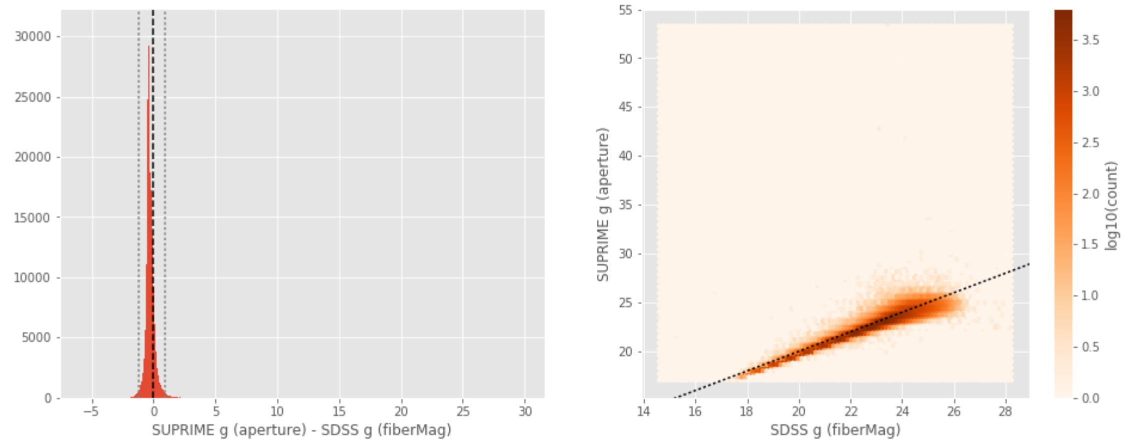
- 99% percentile: 0.9832198333740232



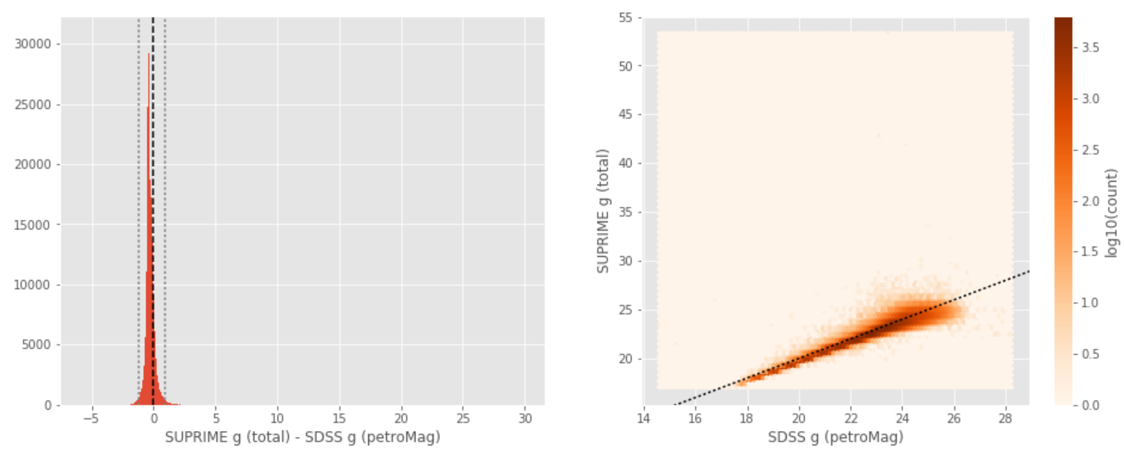
OmegaCAM g (total) - SDSS g (petroMag):
- Median: -0.23
- Median Absolute Deviation: 0.14
- 1% percentile: -1.0690904235839844
- 99% percentile: 0.9832198333740232



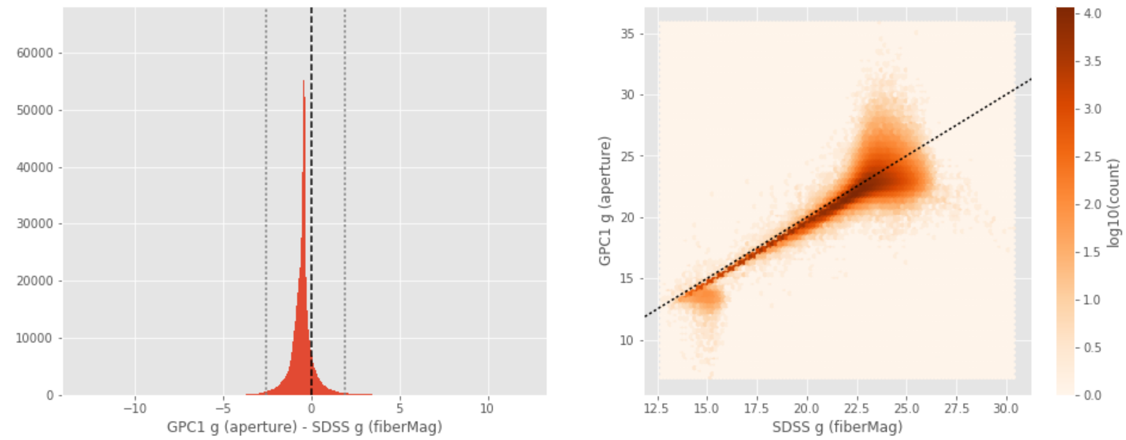
SUPRIME g (aperture) - SDSS g (fiberMag):
- Median: -0.33
- Median Absolute Deviation: 0.16
- 1% percentile: -1.1825745010375976
- 99% percentile: 0.950304050445561



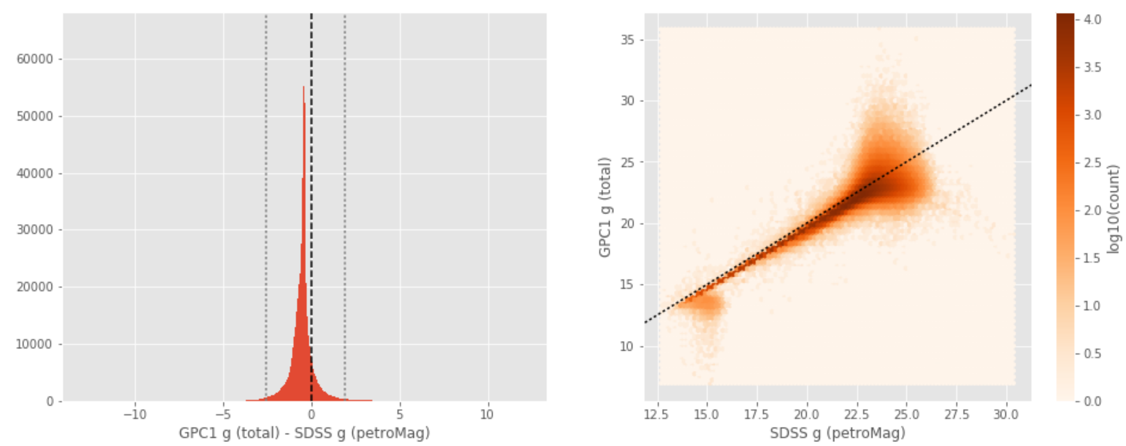
SUPRIME g (total) - SDSS g (petroMag):
- Median: -0.33
- Median Absolute Deviation: 0.16
- 1% percentile: -1.1825745010375976
- 99% percentile: 0.950304050445561



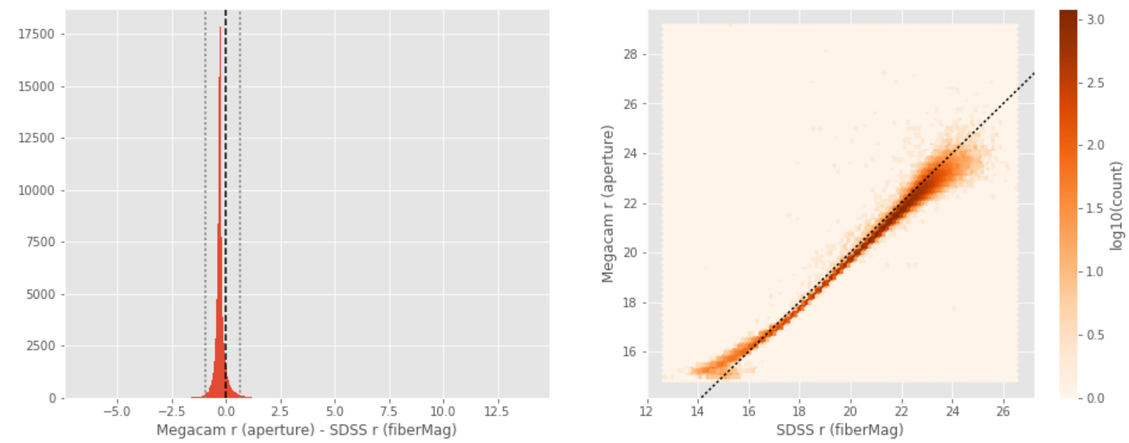
GPC1 g (aperture) - SDSS g (fiberMag):
- Median: -0.47
- Median Absolute Deviation: 0.23
- 1% percentile: -2.591961669921875
- 99% percentile: 1.9132631301879761



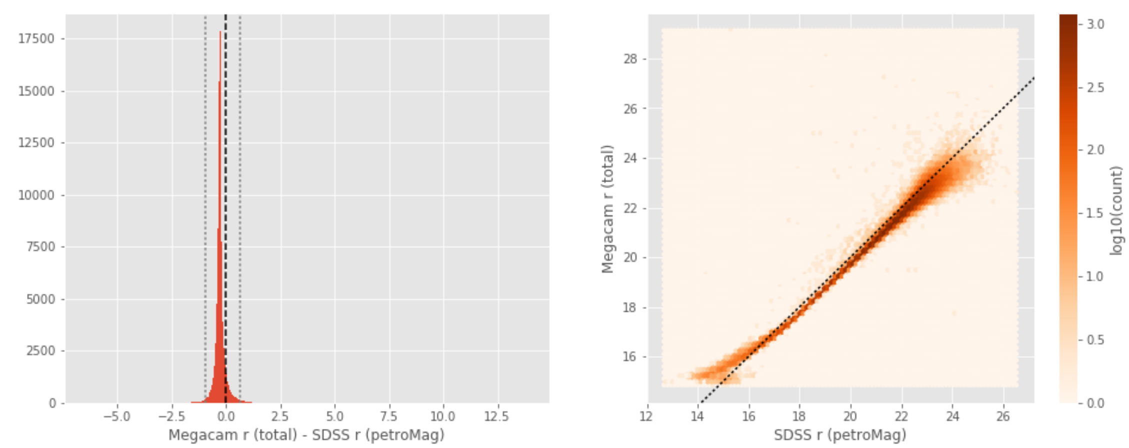
GPC1 g (total) - SDSS g (petroMag):
- Median: -0.47
- Median Absolute Deviation: 0.23
- 1% percentile: -2.591961669921875
- 99% percentile: 1.9132631301879761



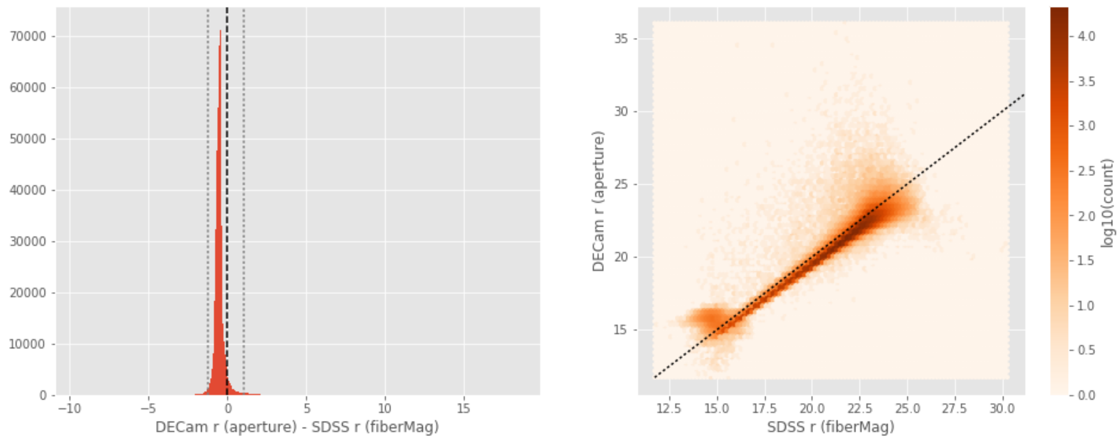
Megacam r (aperture) - SDSS r (fiberMag):
- Median: -0.29
- Median Absolute Deviation: 0.07
- 1% percentile: -0.9603889465332031
- 99% percentile: 0.674439620971681



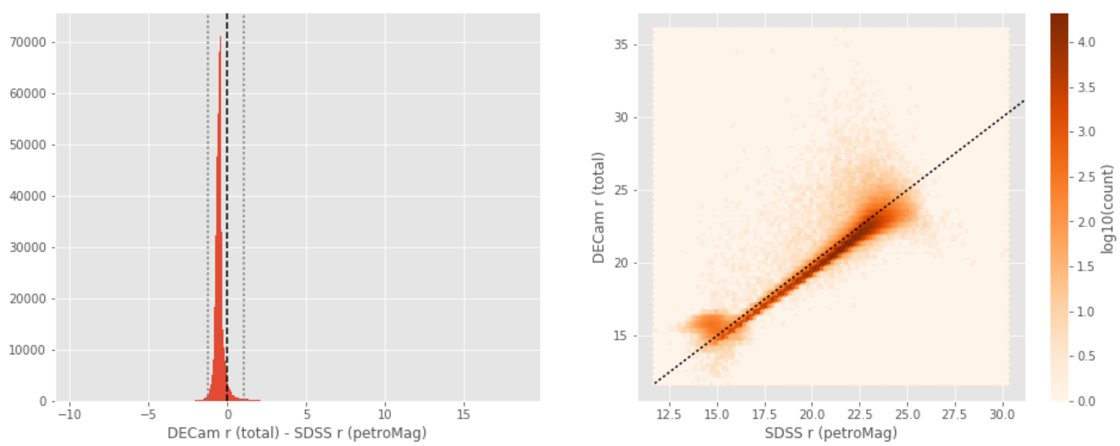
Megacam r (total) - SDSS r (petroMag):
- Median: -0.29
- Median Absolute Deviation: 0.07
- 1% percentile: -0.9603889465332031
- 99% percentile: 0.674439620971681



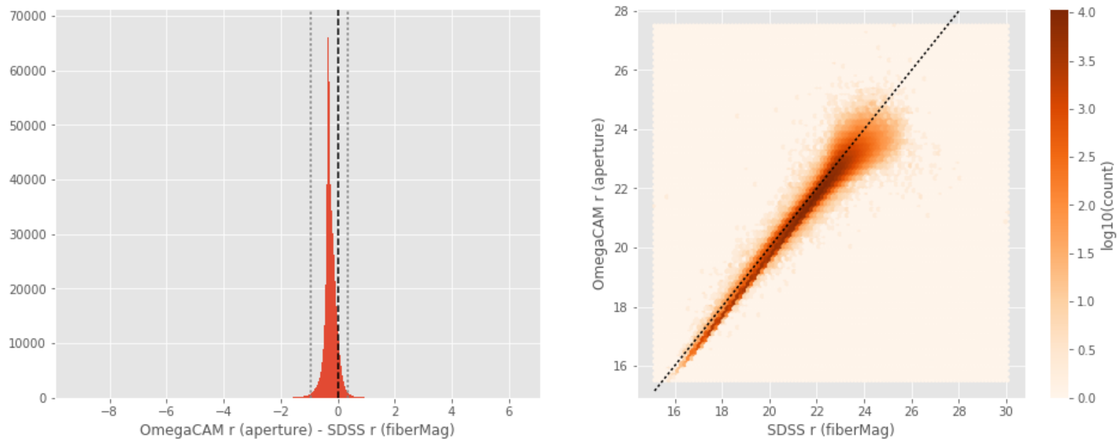
DECam r (aperture) - SDSS r (fiberMag):
- Median: -0.51
- Median Absolute Deviation: 0.12
- 1% percentile: -1.2388230133056641
- 99% percentile: 1.0683128929138186



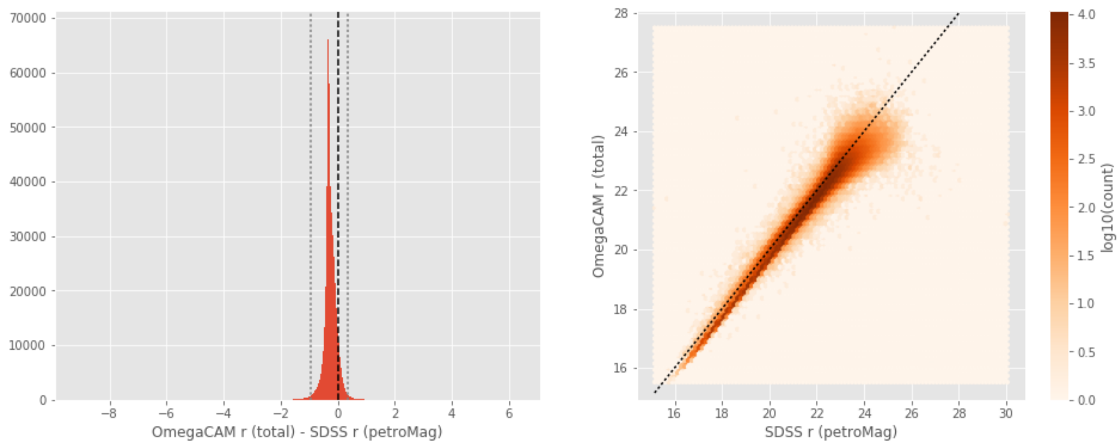
DECam r (total) - SDSS r (petroMag):
- Median: -0.51
- Median Absolute Deviation: 0.12
- 1% percentile: -1.2388230133056641
- 99% percentile: 1.0683128929138186



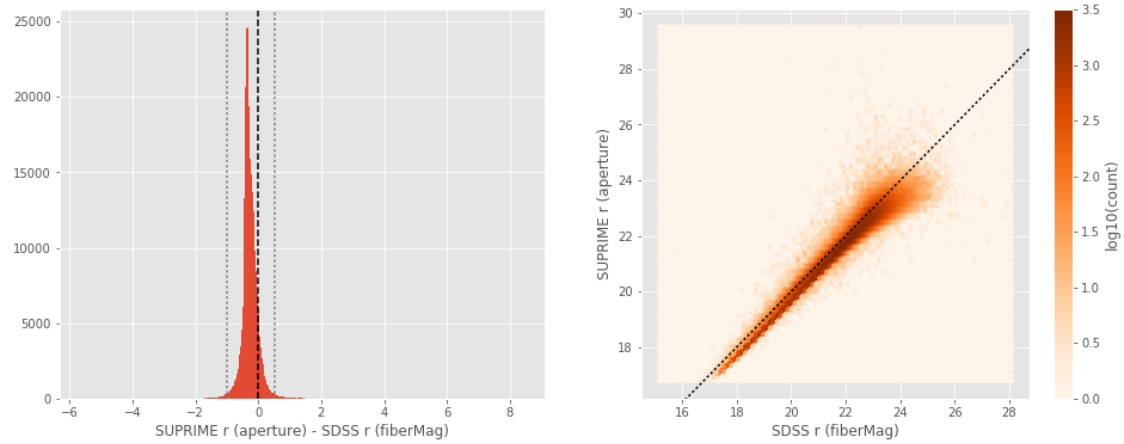
OmegaCAM r (aperture) - SDSS r (fiberMag):
- Median: -0.28
- Median Absolute Deviation: 0.10
- 1% percentile: -0.9489635467529297
- 99% percentile: 0.35431701660156234



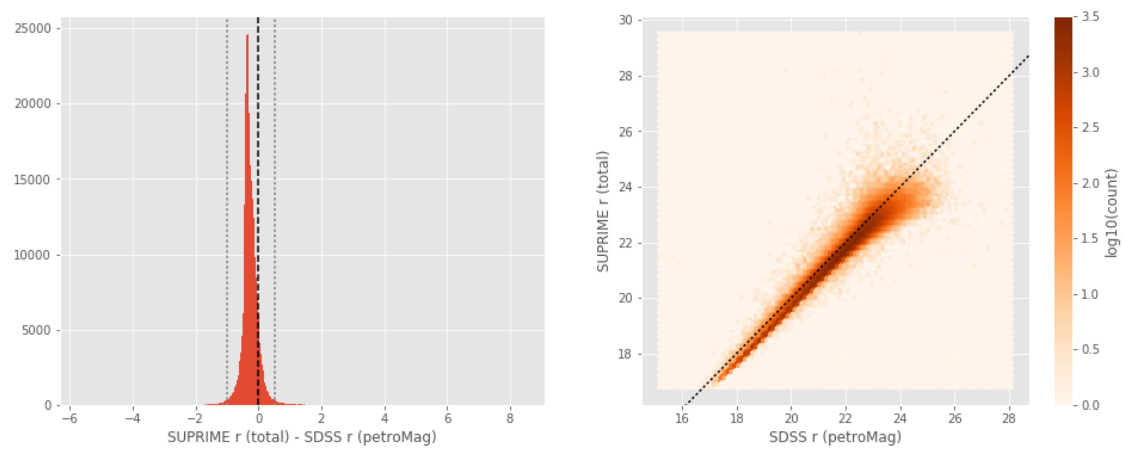
OmegaCAM r (total) - SDSS r (petroMag):
- Median: -0.28
- Median Absolute Deviation: 0.10
- 1% percentile: -0.9489635467529297
- 99% percentile: 0.35431701660156234



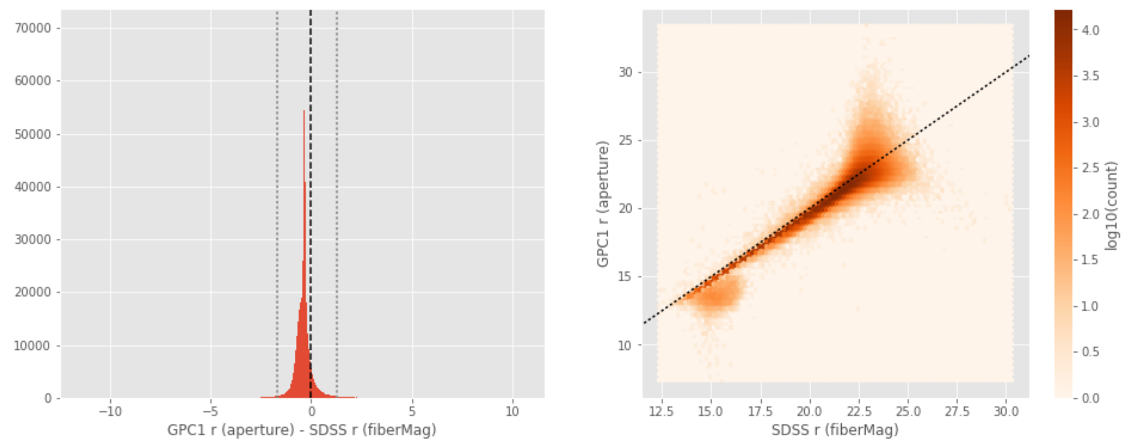
SUPRIME r (aperture) - SDSS r (fiberMag):
- Median: -0.29
- Median Absolute Deviation: 0.11
- 1% percentile: -0.9803993225097656
- 99% percentile: 0.5410190582275383



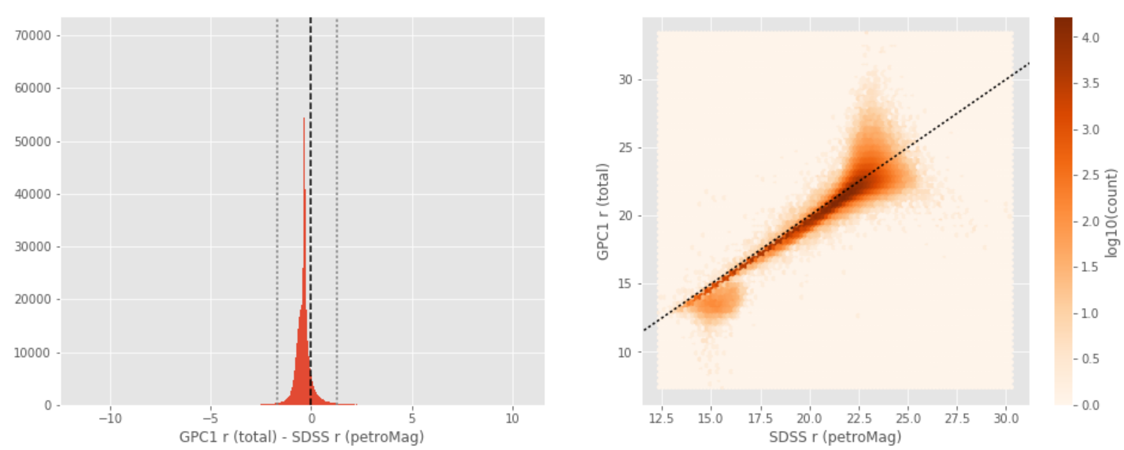
SUPRIME r (total) - SDSS r (petroMag):
- Median: -0.29
- Median Absolute Deviation: 0.11
- 1% percentile: -0.9803993225097656
- 99% percentile: 0.5410190582275383



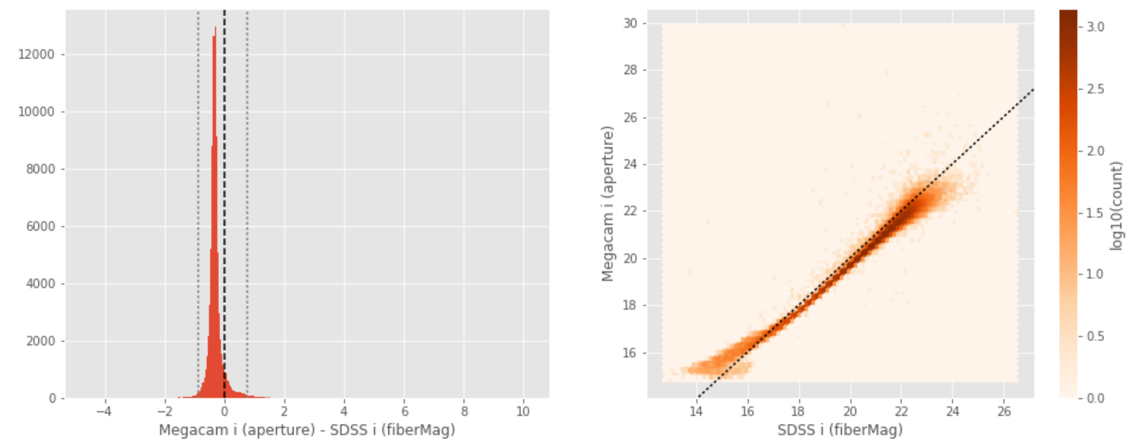
GPC1 r (aperture) - SDSS r (fiberMag):
- Median: -0.36
- Median Absolute Deviation: 0.15
- 1% percentile: -1.6626043891906739
- 99% percentile: 1.3034084701538093



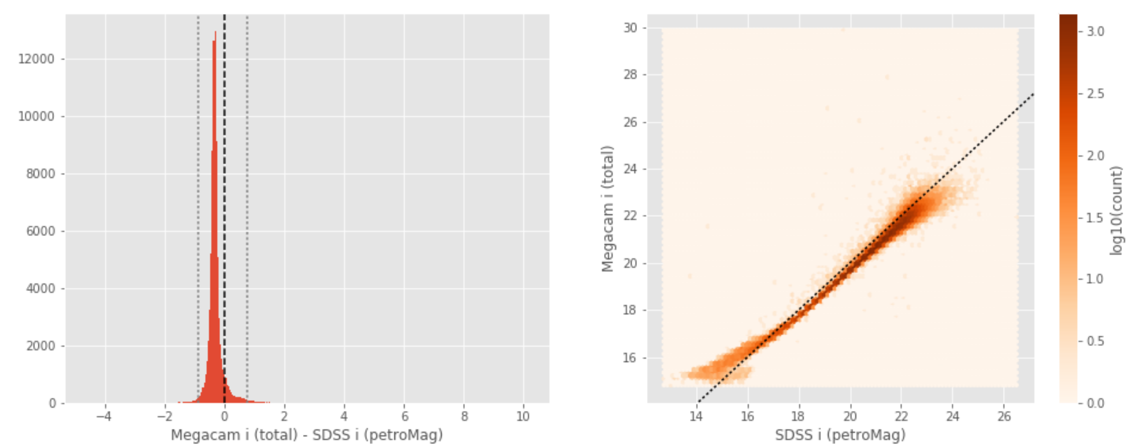
GPC1 r (total) - SDSS r (petroMag):
- Median: -0.36
- Median Absolute Deviation: 0.15
- 1% percentile: -1.6626043891906739
- 99% percentile: 1.3034084701538093



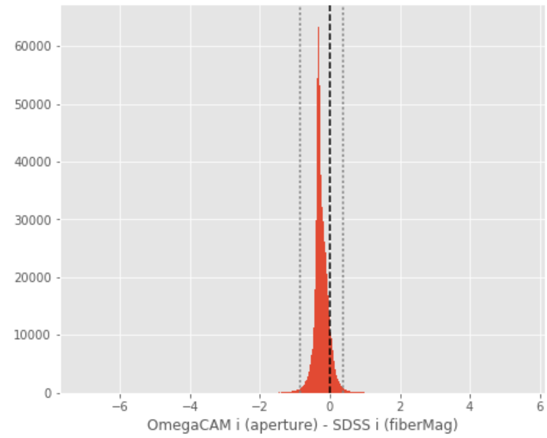
Megacam i (aperture) - SDSS i (fiberMag):
- Median: -0.33
- Median Absolute Deviation: 0.08
- 1% percentile: -0.8616498947143555
- 99% percentile: 0.7761422729492189

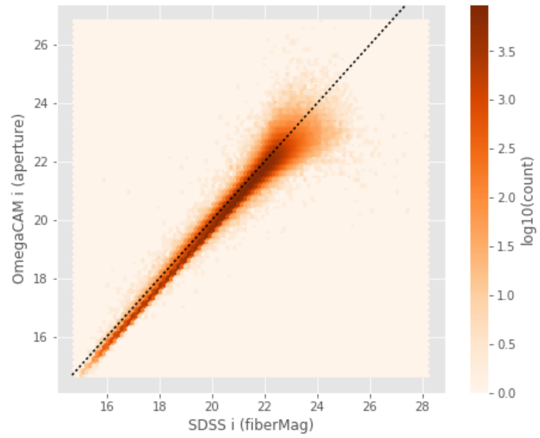


Megacam i (total) - SDSS i (petroMag):
- Median: -0.33
- Median Absolute Deviation: 0.08
- 1% percentile: -0.8616498947143555
- 99% percentile: 0.7761422729492189

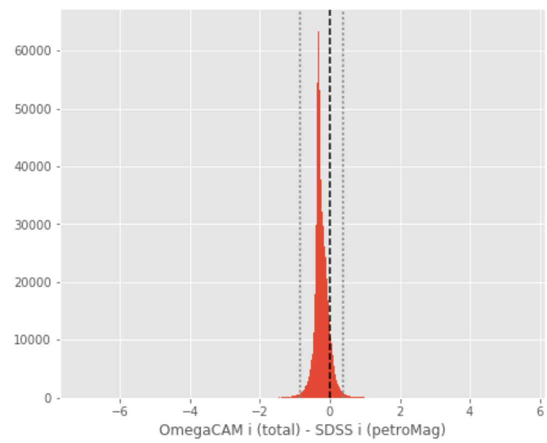


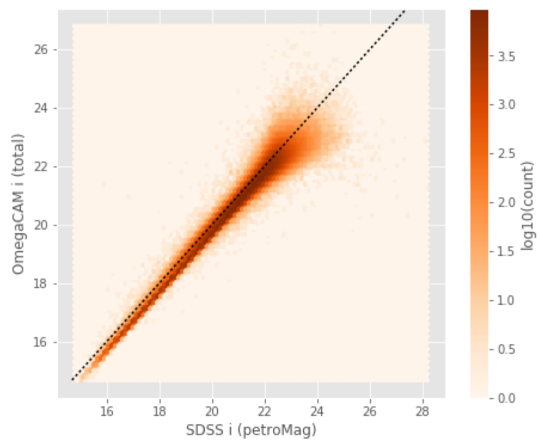
OmegaCAM i (aperture) - SDSS i (fiberMag):
- Median: -0.28
- Median Absolute Deviation: 0.10
- 1% percentile: -0.8460406303405762
- 99% percentile: 0.3708189964294435



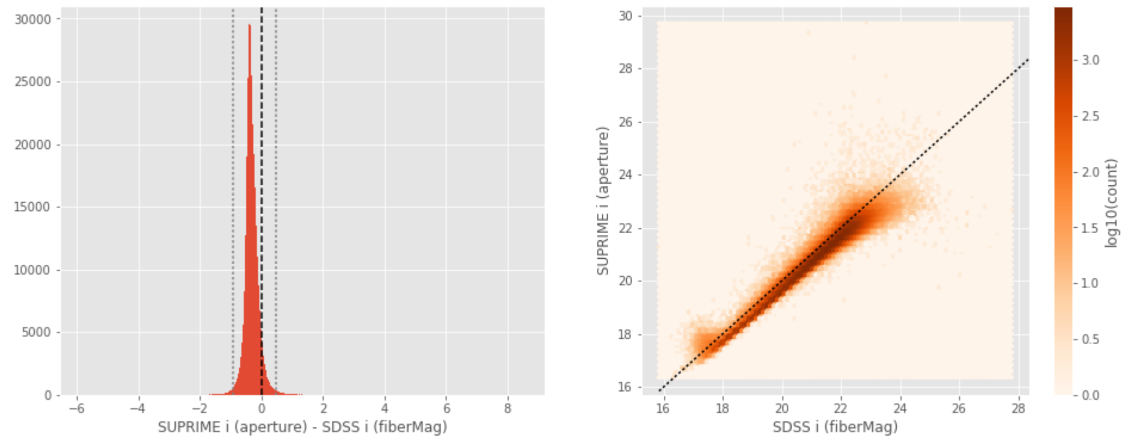


OmegaCAM i (total) - SDSS i (petroMag):
- Median: -0.28
- Median Absolute Deviation: 0.10
- 1% percentile: -0.8460406303405762
- 99% percentile: 0.3708189964294435

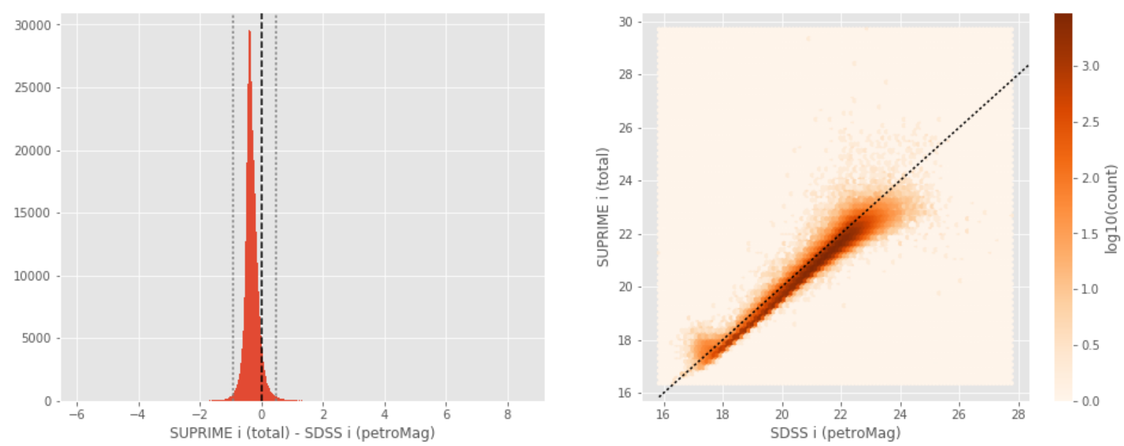




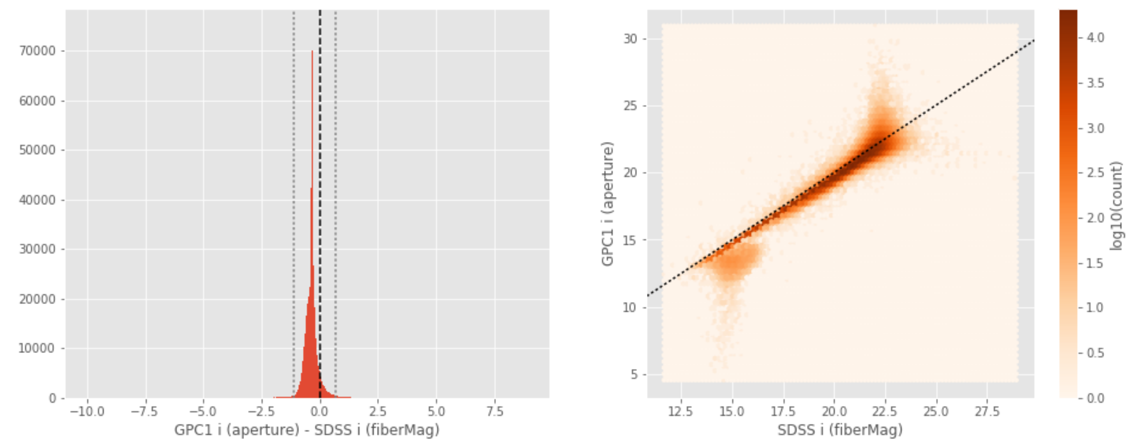
SUPRIME i (aperture) - SDSS i (fiberMag):
- Median: -0.33
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9216636276245117
- 99% percentile: 0.47454387664794895



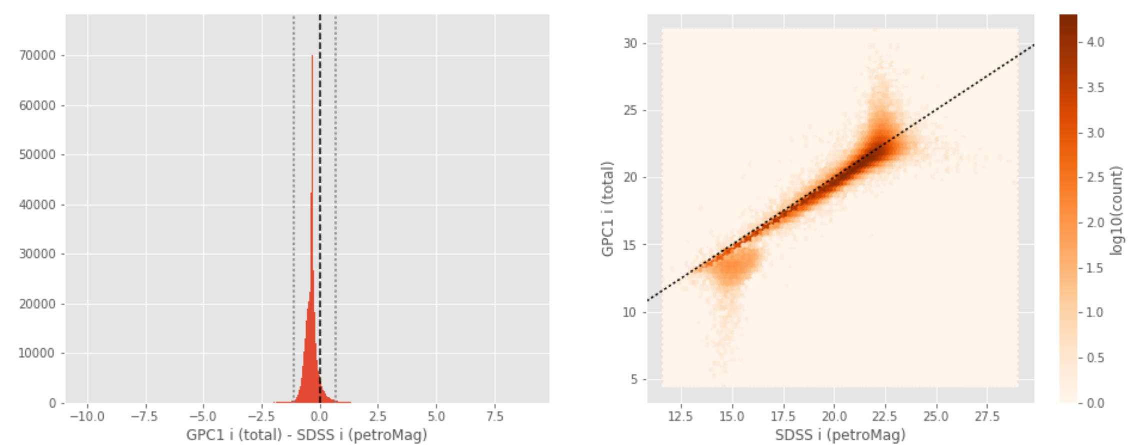
SUPRIME i (total) - SDSS i (petroMag):
- Median: -0.33
- Median Absolute Deviation: 0.12
- 1% percentile: -0.9216636276245117
- 99% percentile: 0.47454387664794895



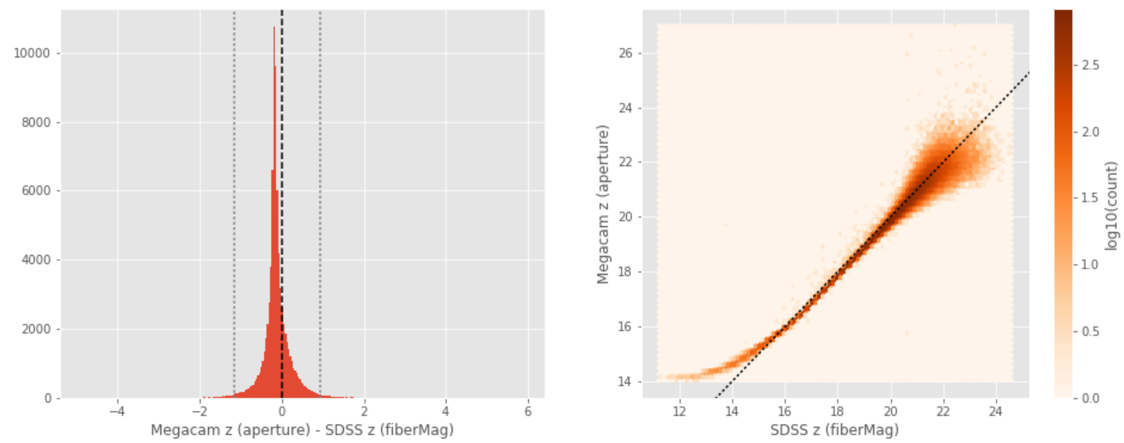
GPC1 i (aperture) - SDSS i (fiberMag):
- Median: -0.34
- Median Absolute Deviation: 0.11
- 1% percentile: -1.1247878074645994
- 99% percentile: 0.6950868606567342



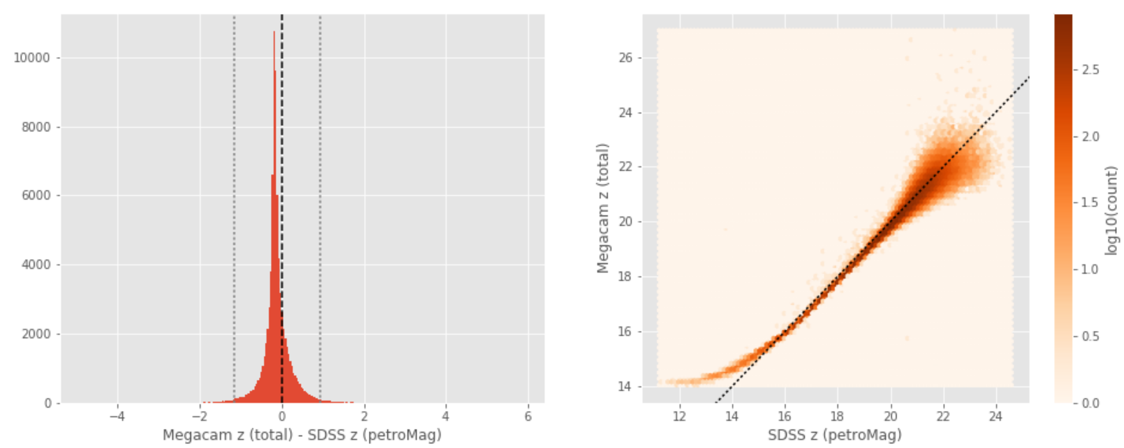
GPC1 i (total) - SDSS i (petroMag):
- Median: -0.34
- Median Absolute Deviation: 0.11
- 1% percentile: -1.1247878074645994
- 99% percentile: 0.6950868606567342



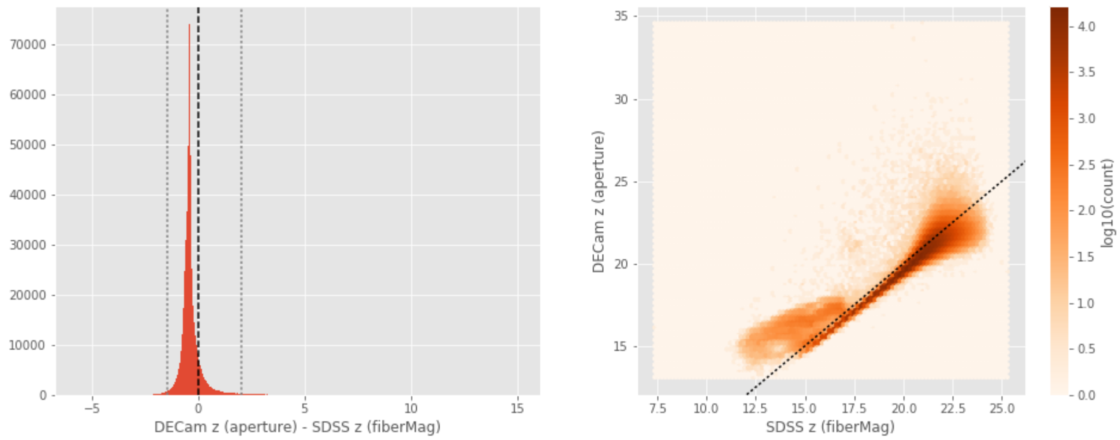
Megacam z (aperture) - SDSS z (fiberMag):
- Median: -0.16
- Median Absolute Deviation: 0.11
- 1% percentile: -1.1580963134765625
- 99% percentile: 0.9310274124145501



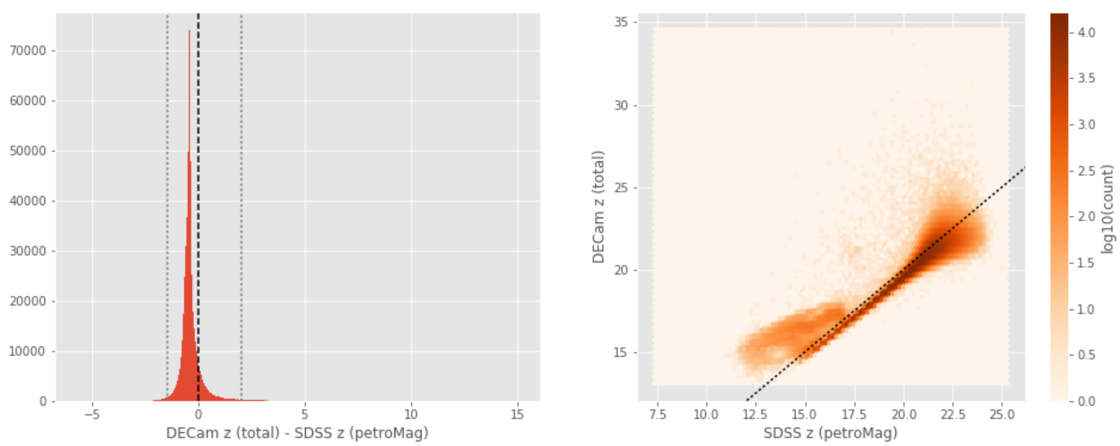
Megacam z (total) - SDSS z (petroMag):
- Median: -0.16
- Median Absolute Deviation: 0.11
- 1% percentile: -1.1580963134765625
- 99% percentile: 0.9310274124145501



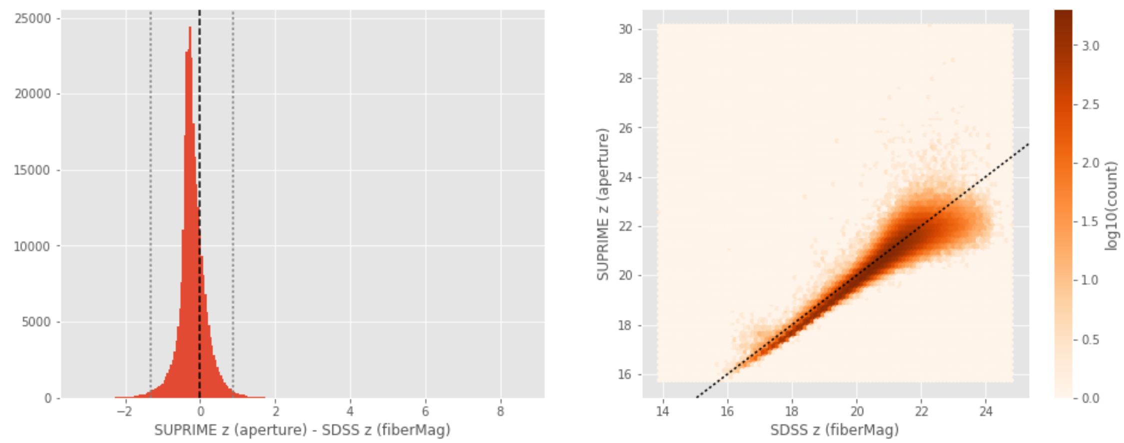
DECam z (aperture) - SDSS z (fiberMag):
- Median: -0.42
- Median Absolute Deviation: 0.15
- 1% percentile: -1.4285478210449218
- 99% percentile: 2.0198745727539062



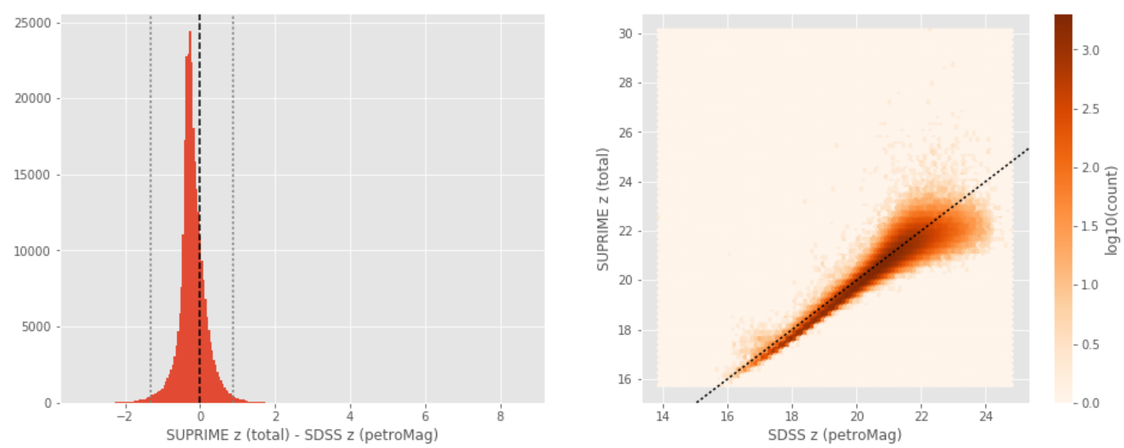
DECam z (total) - SDSS z (petroMag):
- Median: -0.42
- Median Absolute Deviation: 0.15
- 1% percentile: -1.4285478210449218
- 99% percentile: 2.0198745727539062



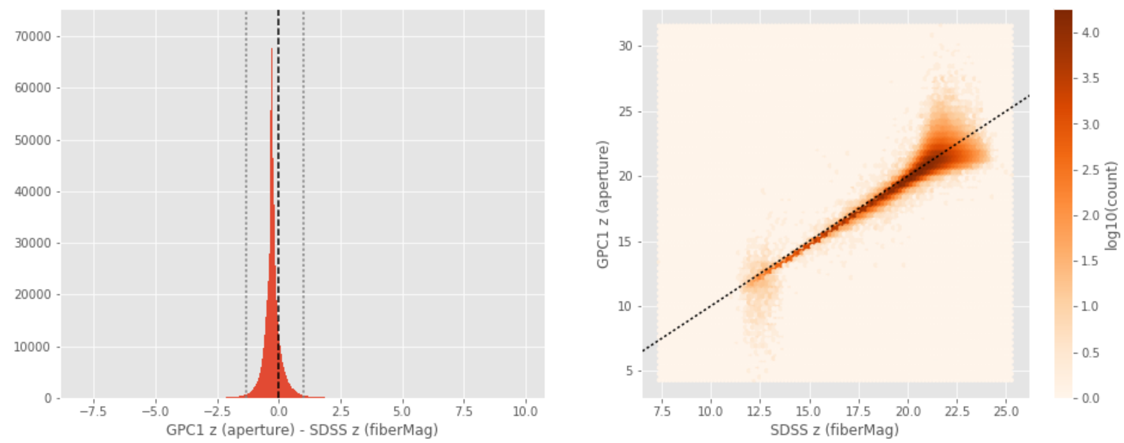
SUPRIME z (aperture) - SDSS z (fiberMag):
- Median: -0.24
- Median Absolute Deviation: 0.17
- 1% percentile: -1.324062385559082
- 99% percentile: 0.8835193634033214



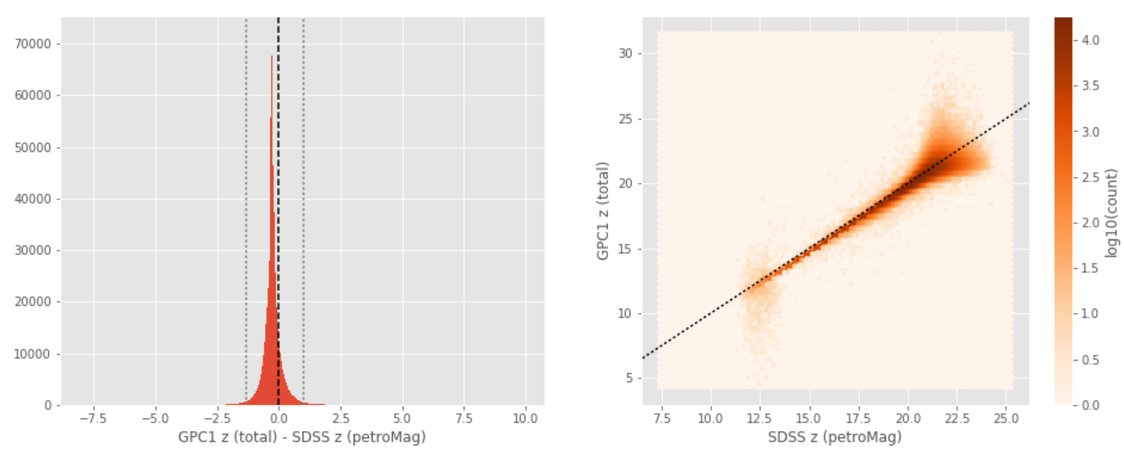
SUPRIME z (total) - SDSS z (petroMag):
- Median: -0.24
- Median Absolute Deviation: 0.17
- 1% percentile: -1.324062385559082
- 99% percentile: 0.8835193634033214



GPC1 z (aperture) - SDSS z (fiberMag):
- Median: -0.28
- Median Absolute Deviation: 0.13
- 1% percentile: -1.3353350448608399
- 99% percentile: 1.0197834777832036




```
GPC1 z (total) - SDSS z (petroMag):
- Median: -0.28
- Median Absolute Deviation: 0.13
- 1% percentile: -1.3353350448608399
- 99% percentile: 1.0197834777832036
```



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.

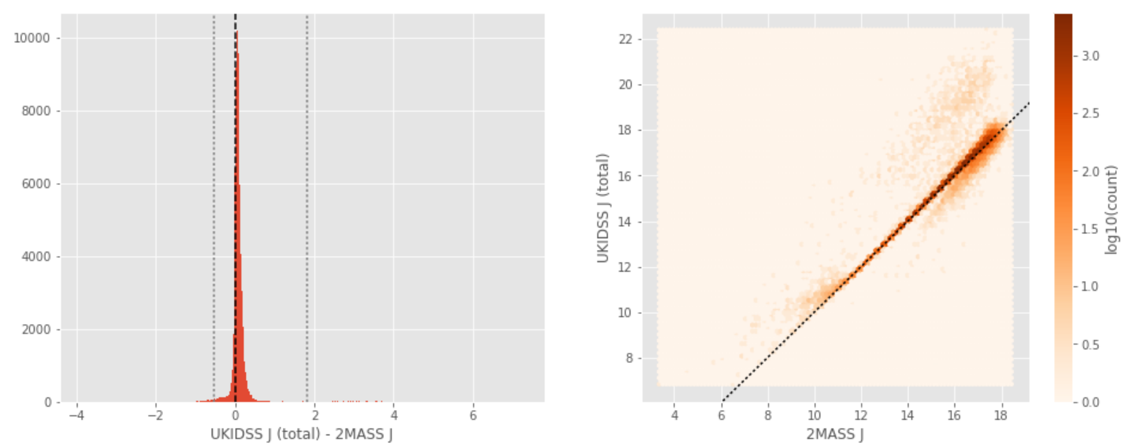
The 2MASS magnitudes are "*Vega-like*" and we have to convert them to AB magnitudes using the zero points provided on this page:

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

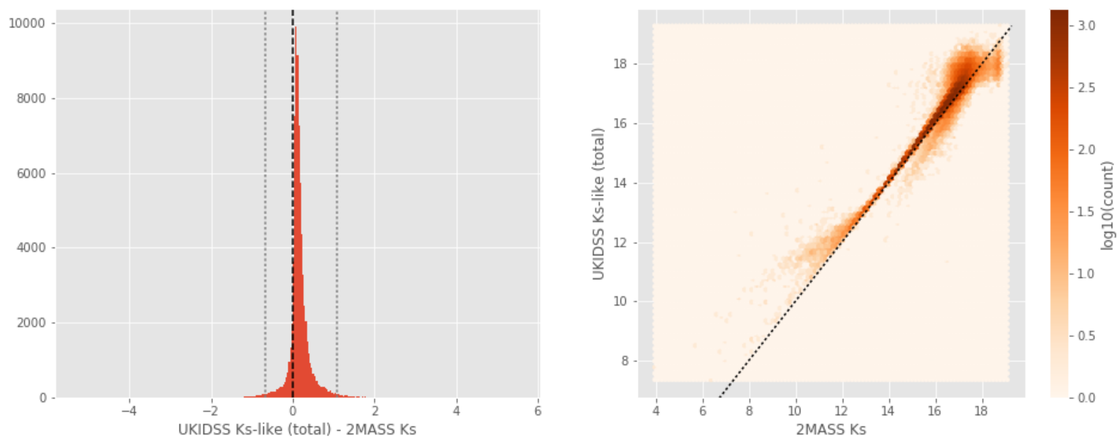
In addition, UKIDSS uses a K band whereas 2MASS uses a Ks (“short”) band, this page give a correction to convert the K band in a Ks band with the formula:

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

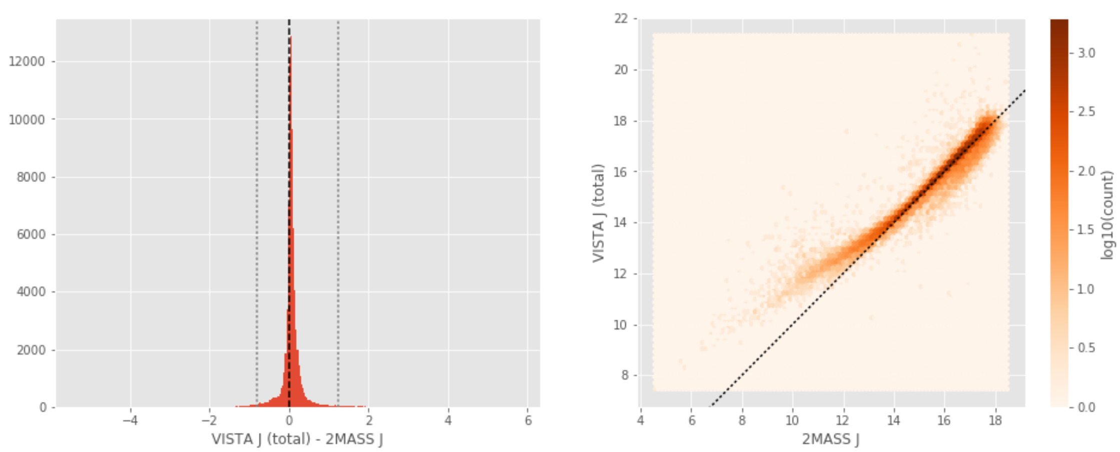
```
UKIDSS J (total) - 2MASS J:
- Median: 0.07
- Median Absolute Deviation: 0.05
- 1% percentile: -0.5310884551908337
- 99% percentile: 1.8137966424654275
```



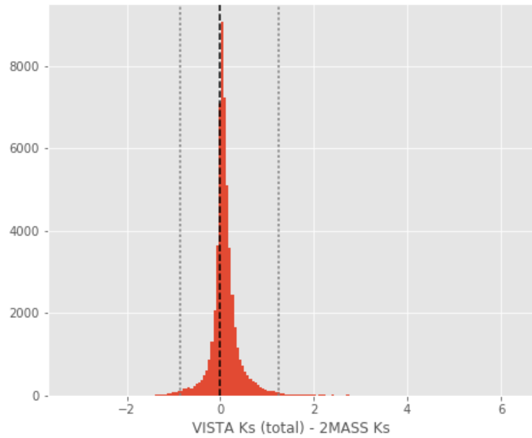

```
UKIDSS Ks-like (total) - 2MASS Ks:
- Median: 0.13
- Median Absolute Deviation: 0.08
- 1% percentile: -0.6729051793535736
- 99% percentile: 1.0822056199017966
```

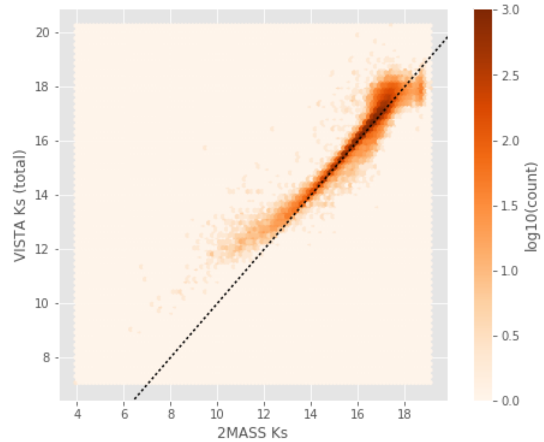


VISTA J (total) - 2MASS J:
- Median: 0.05
- Median Absolute Deviation: 0.06
- 1% percentile: -0.7988895172025503
- 99% percentile: 1.2357134048555731



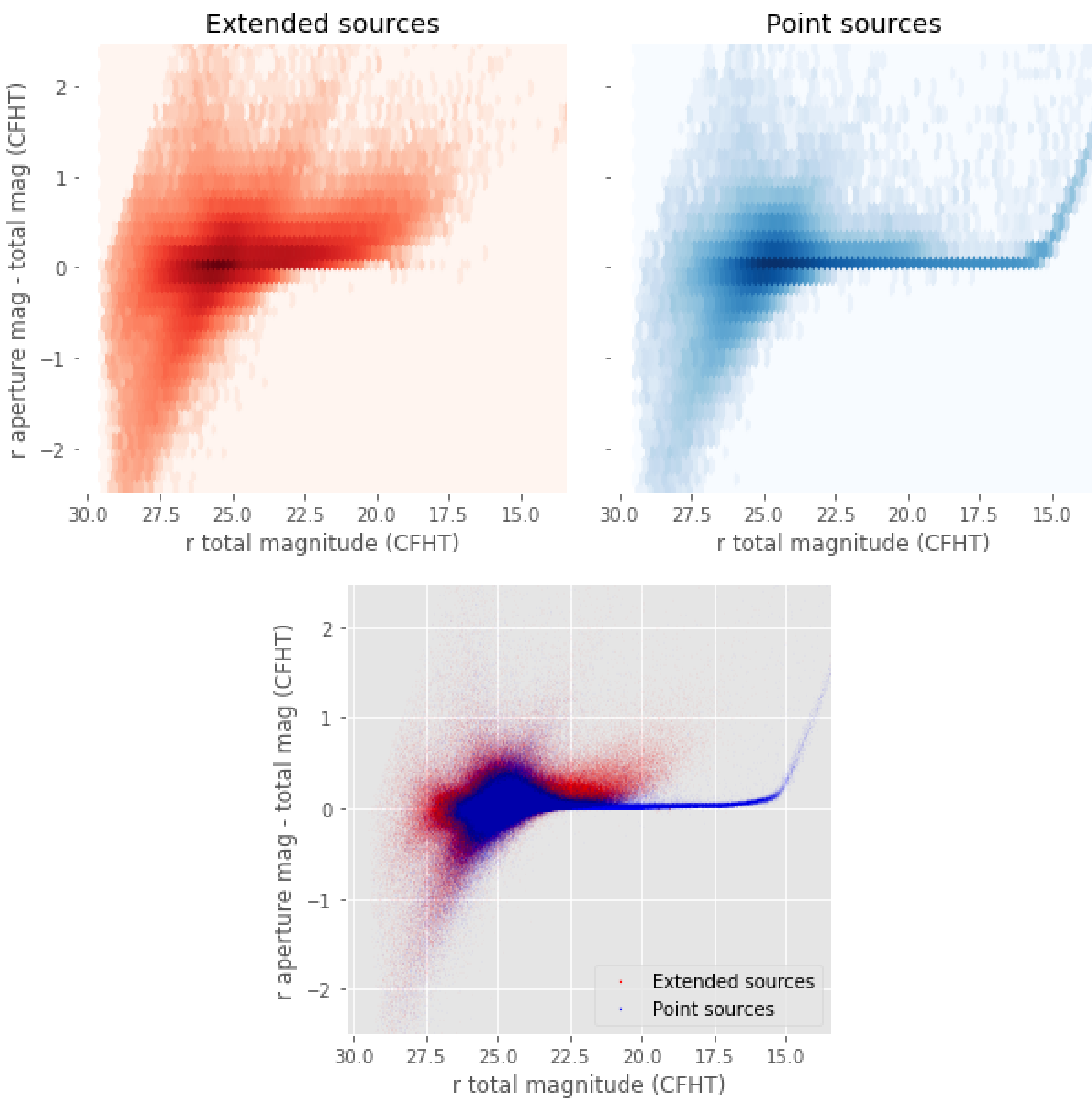
VISTA Ks (total) - 2MASS Ks:
- Median: 0.06
- Median Absolute Deviation: 0.10
- 1% percentile: -0.8557598713397279
- 99% percentile: 1.2350527665473388





1.6 IV - Comparing aperture magnitudes to total ones.

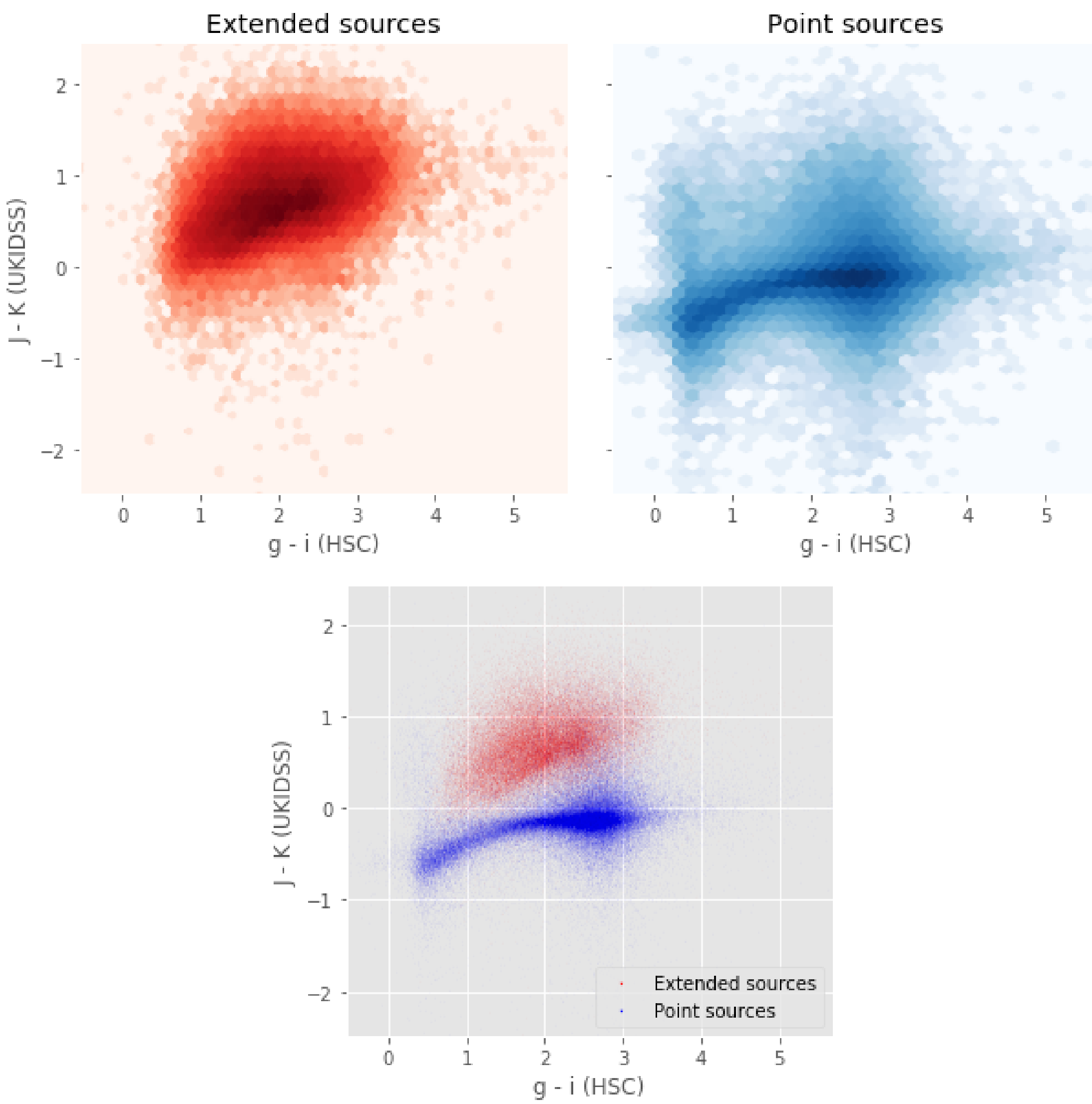
Number of source used: 982483 / 12937982 (7.59%)



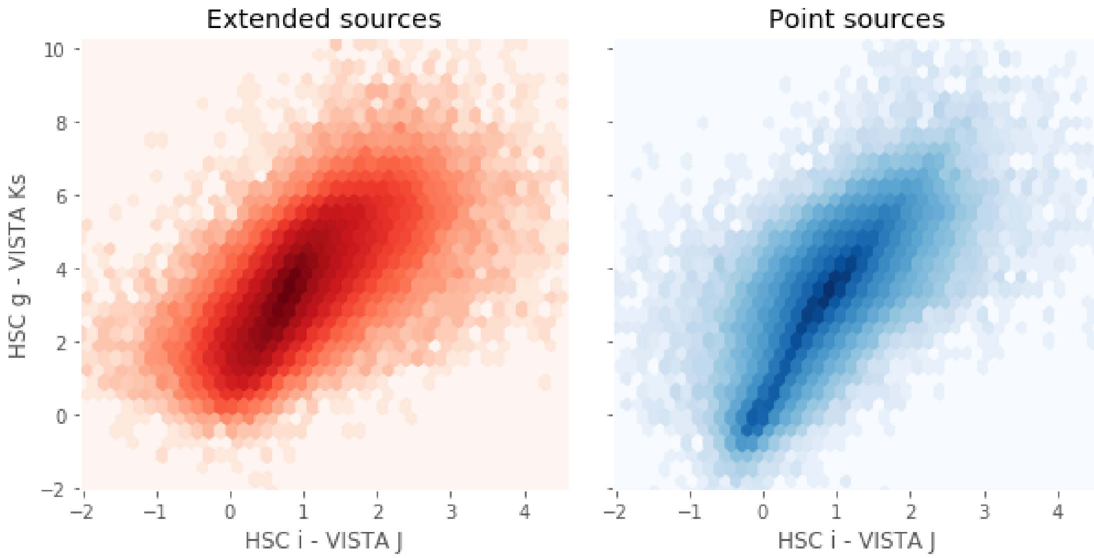
1.7 V - Color-color and magnitude-color plots

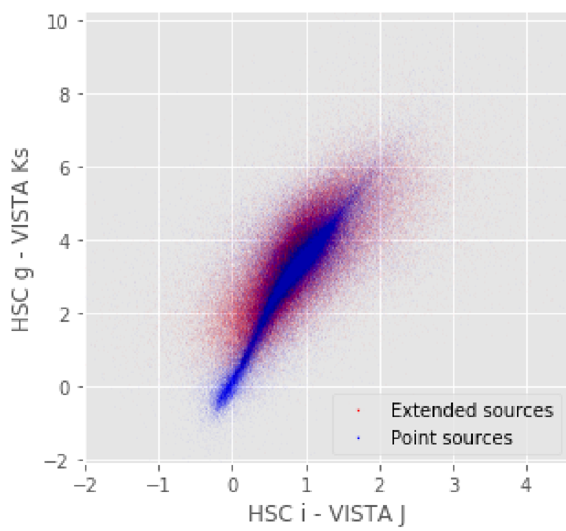
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/ipykernel/__main__.py:2: R
  from ipykernel import kernelapp as app
```

```
Number of source used: 166629 / 12937982 (1.29%)
```

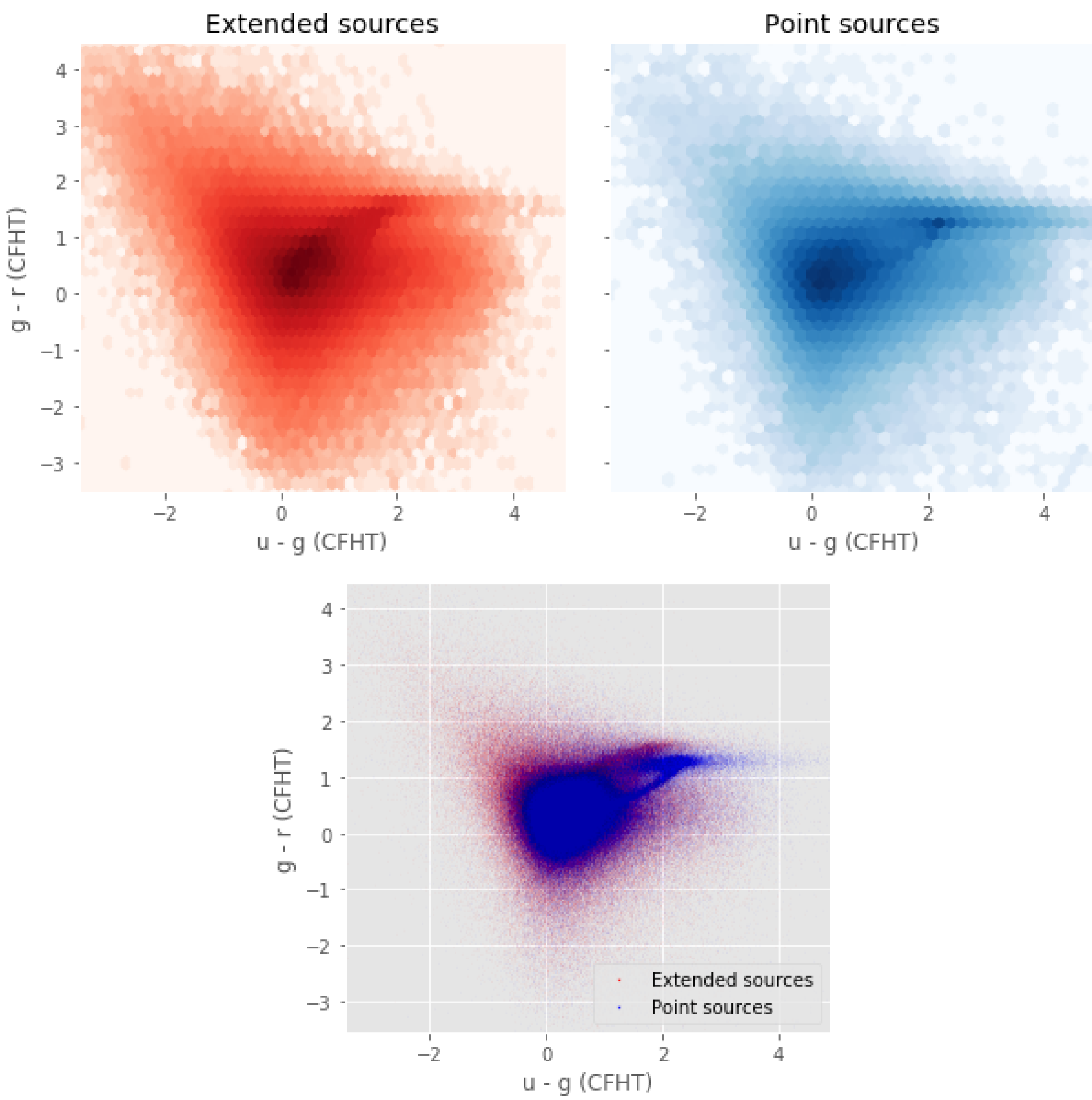


Number of source used: 290884 / 12937982 (2.25%)

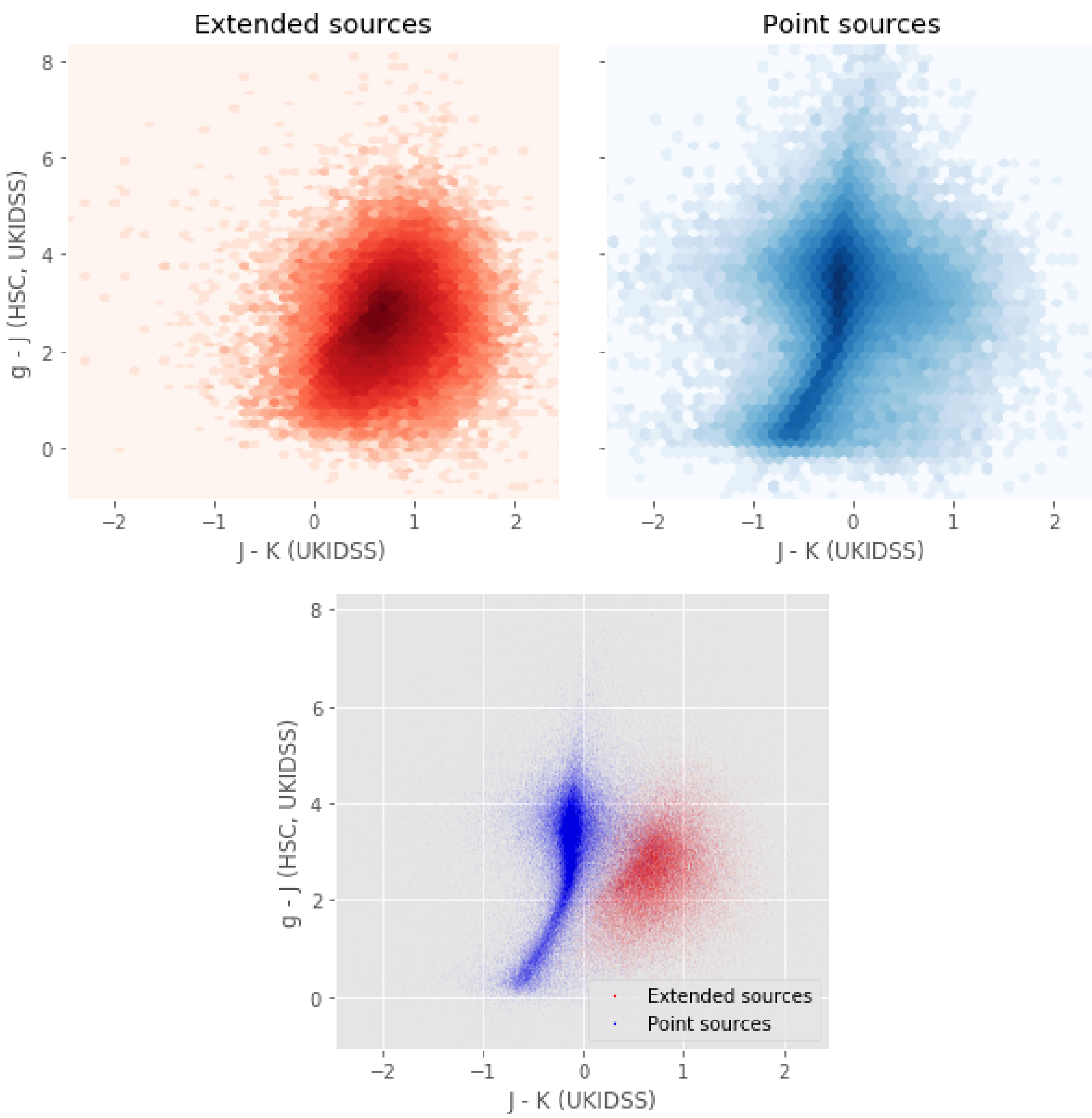





```
Number of source used: 856566 / 12937982 (6.62%)
```

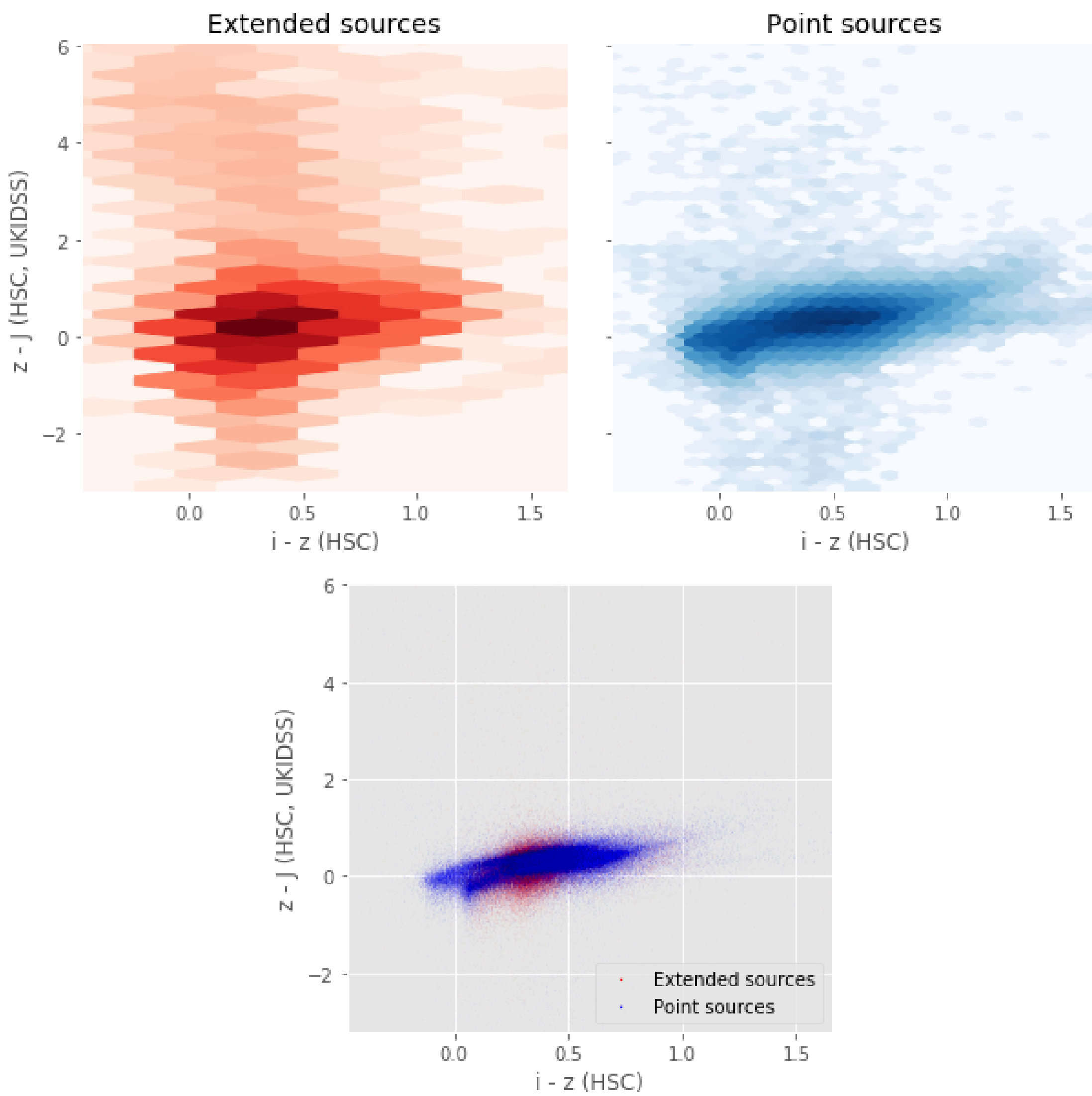


Number of source used: 166646 / 12937982 (1.29%)




```
/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: 196743 / 12937982 (1.52%)
```


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