

# 1.1\_DataFusion-Spitzer

January 18, 2018

## 1 xFLS master catalogue

### 1.1 Preparation of DataFusion-Spitzer data

The catalogue comes from dmu0\_DataFusion-Spitzer.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture magnitude.
- The total magnitude.

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

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

### 1.2 I - Column selection

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

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

### 1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

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

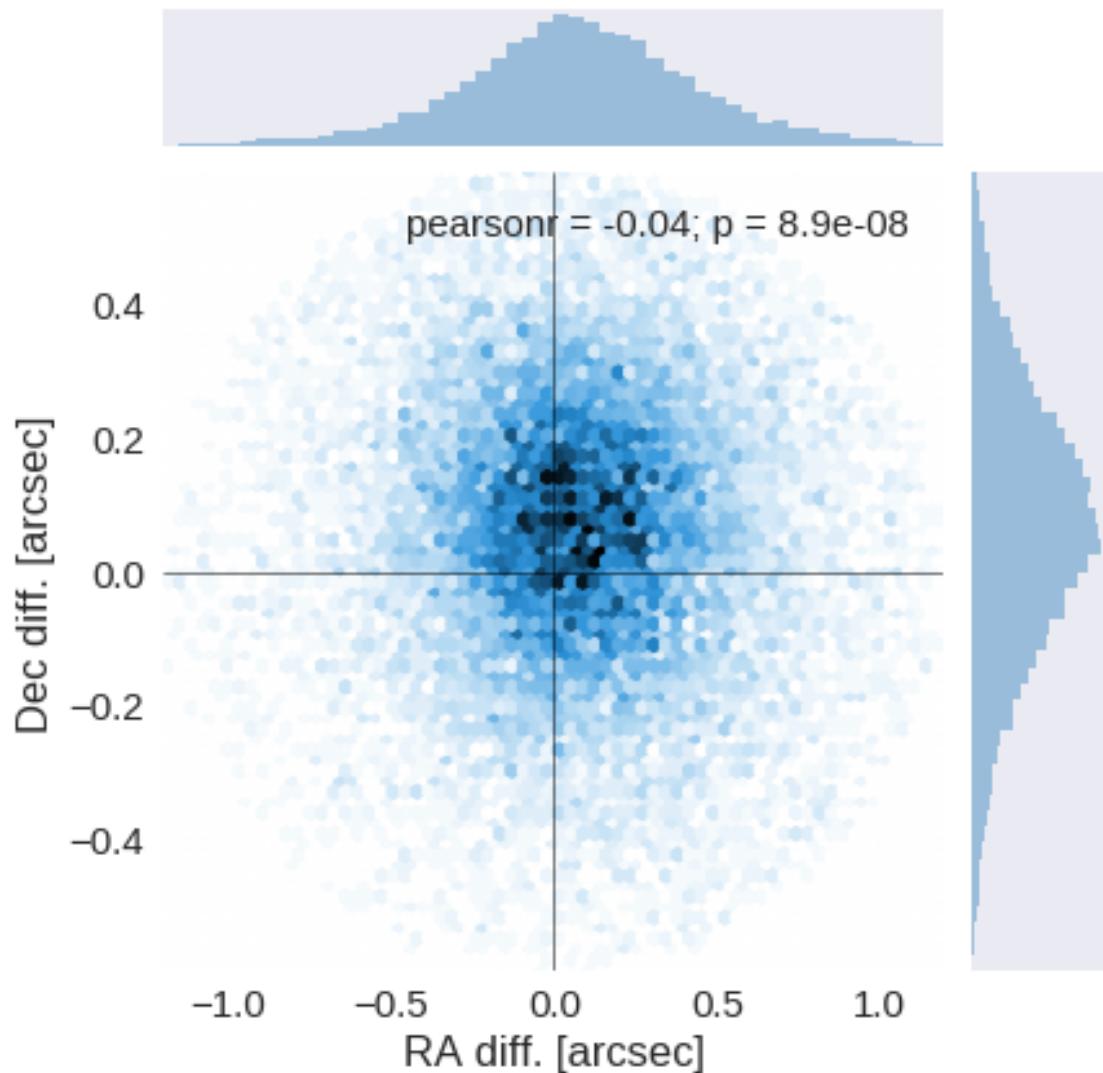
The initial catalogue had 228354 sources.

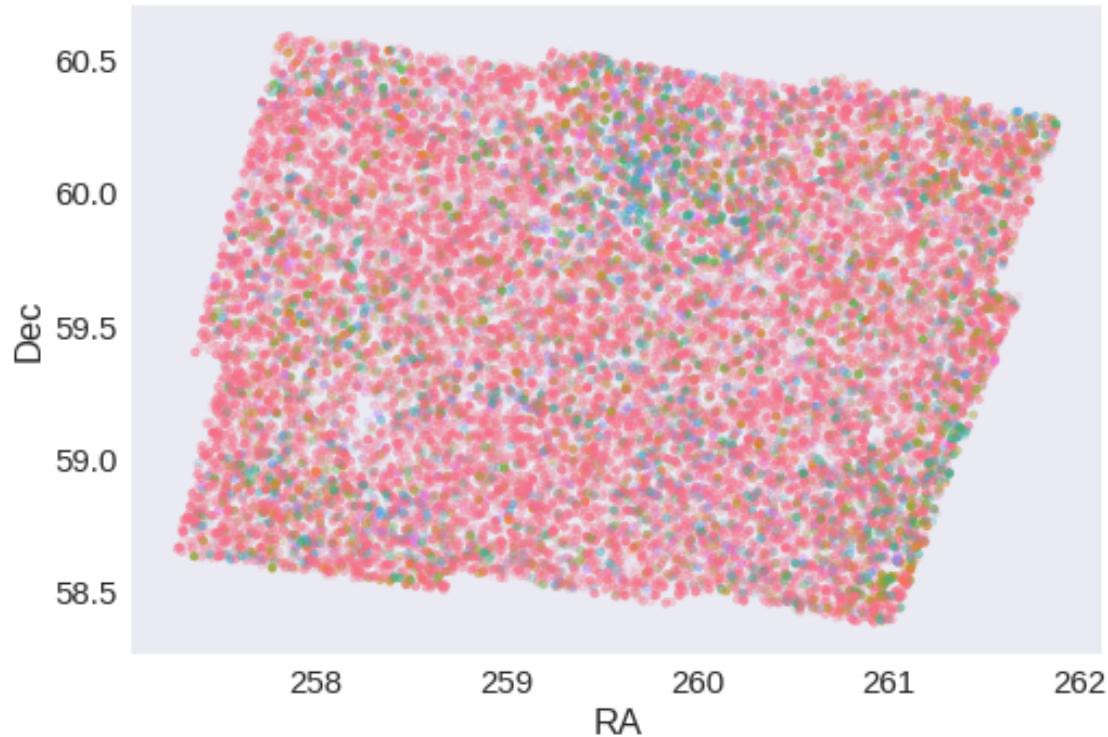
The cleaned catalogue has 228354 sources (0 removed).

The cleaned catalogue has 0 sources flagged as having been cleaned

## 1.4 III - Astrometry correction

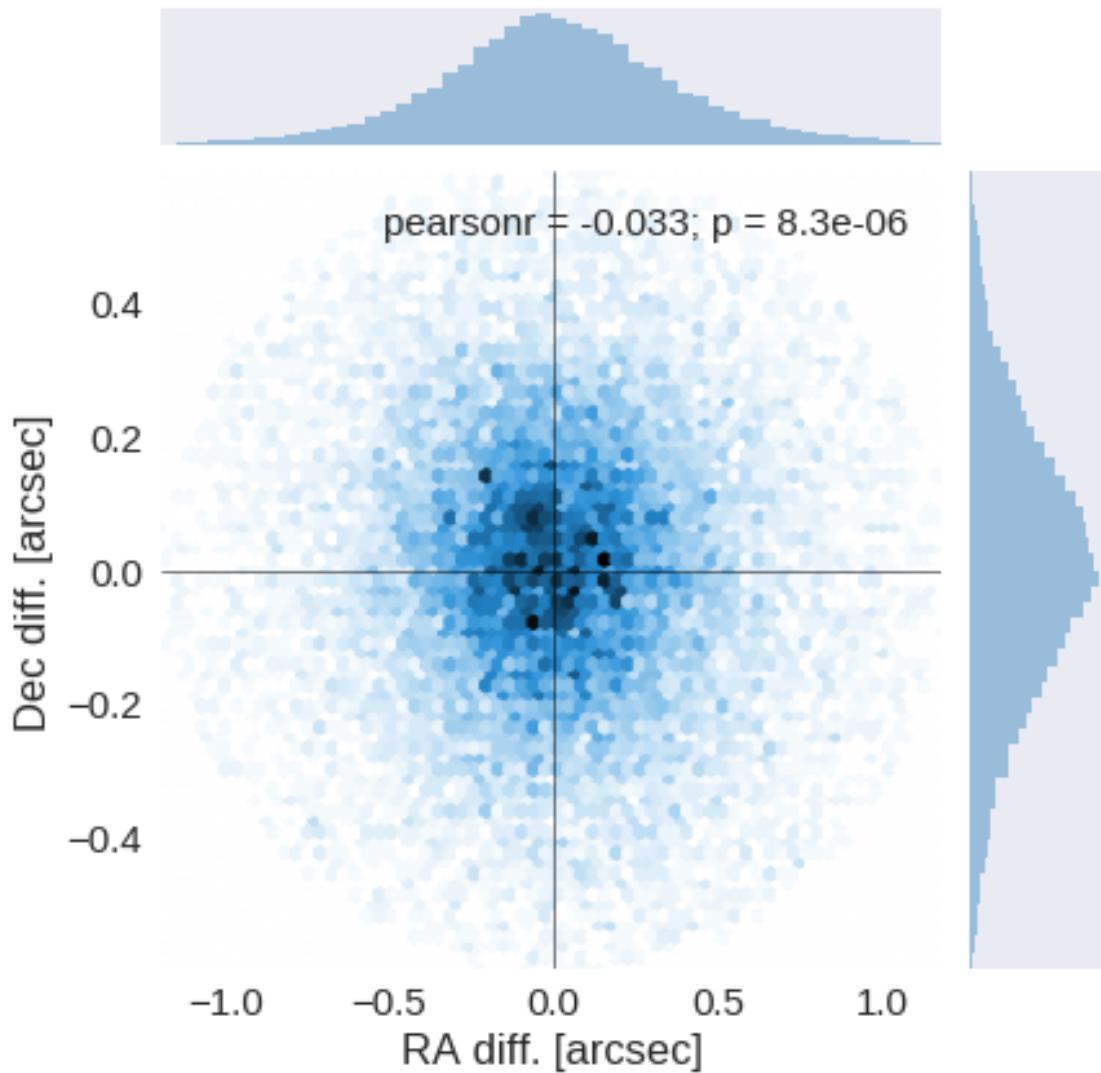
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

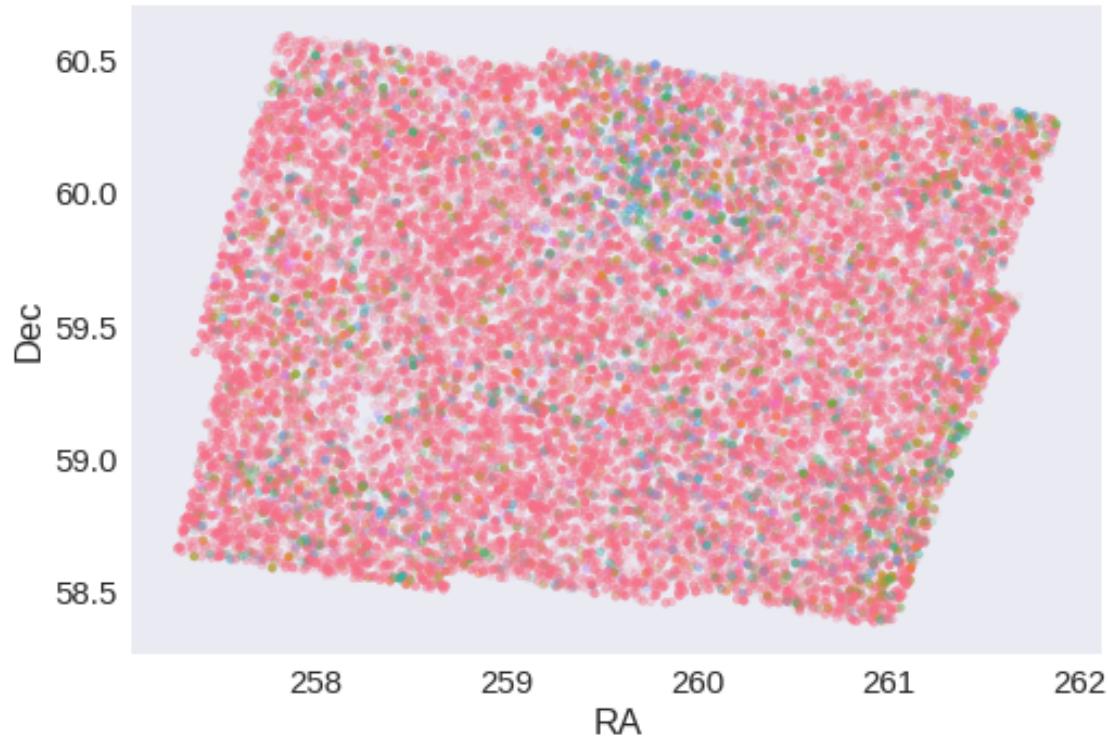




RA correction: -0.07282967051196465 arcsec

Dec correction: -0.06646679910460307 arcsec





## 1.5 IV - Flagging Gaia objects

21058 sources flagged.

## 2 V - Saving to disk

## 1.2 INT-WFC

January 18, 2018

### 1 xFLS master catalogue

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

Isaac Newton Telescope / Wide Field Camera (INT/WFC) catalogue: the catalogue comes from dmu0\_INTWFC.

In the catalogue, we keep:

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

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

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

#### 1.2 I - Column selection

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

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

#### 1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

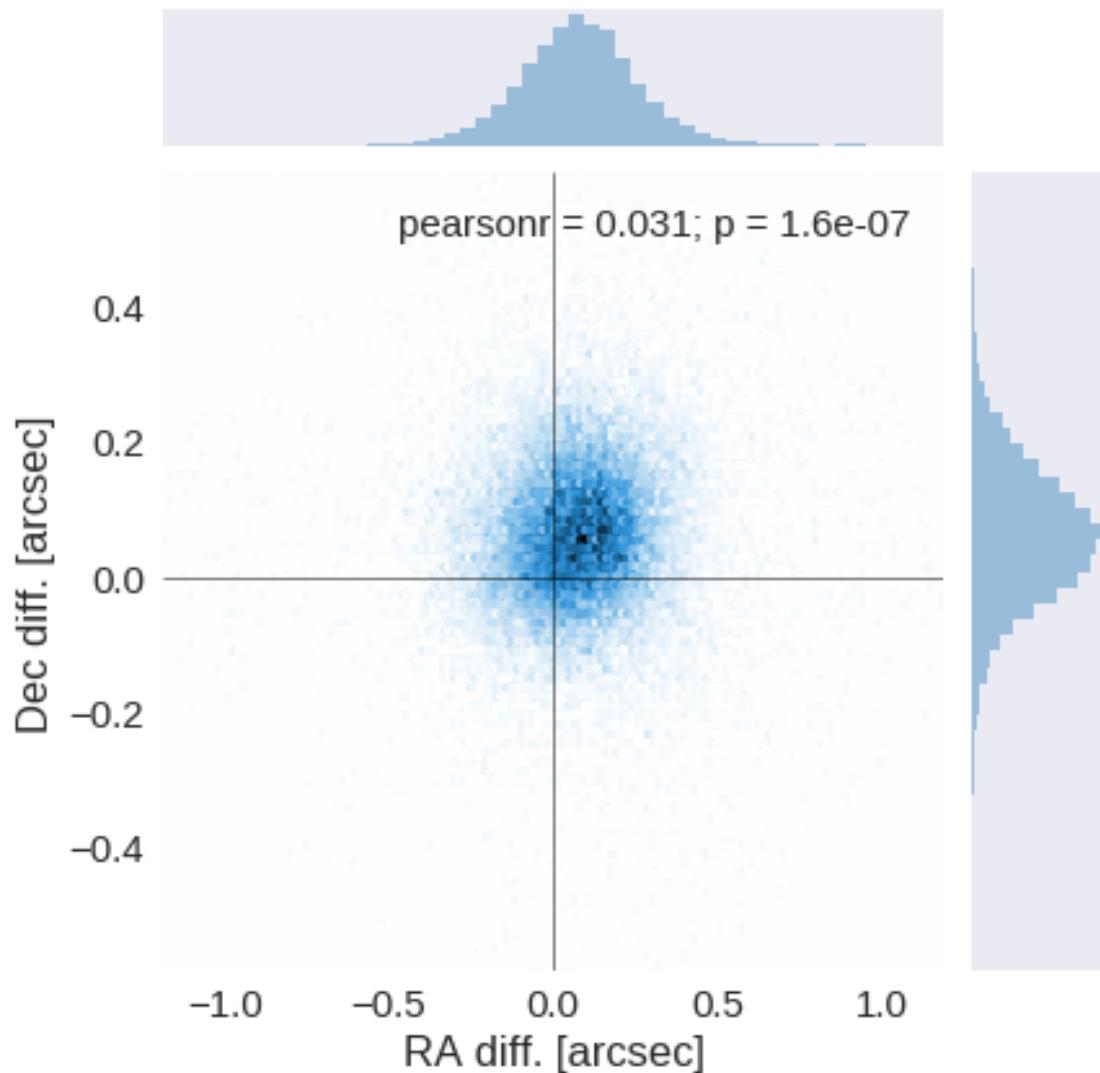
The initial catalogue had 490954 sources.

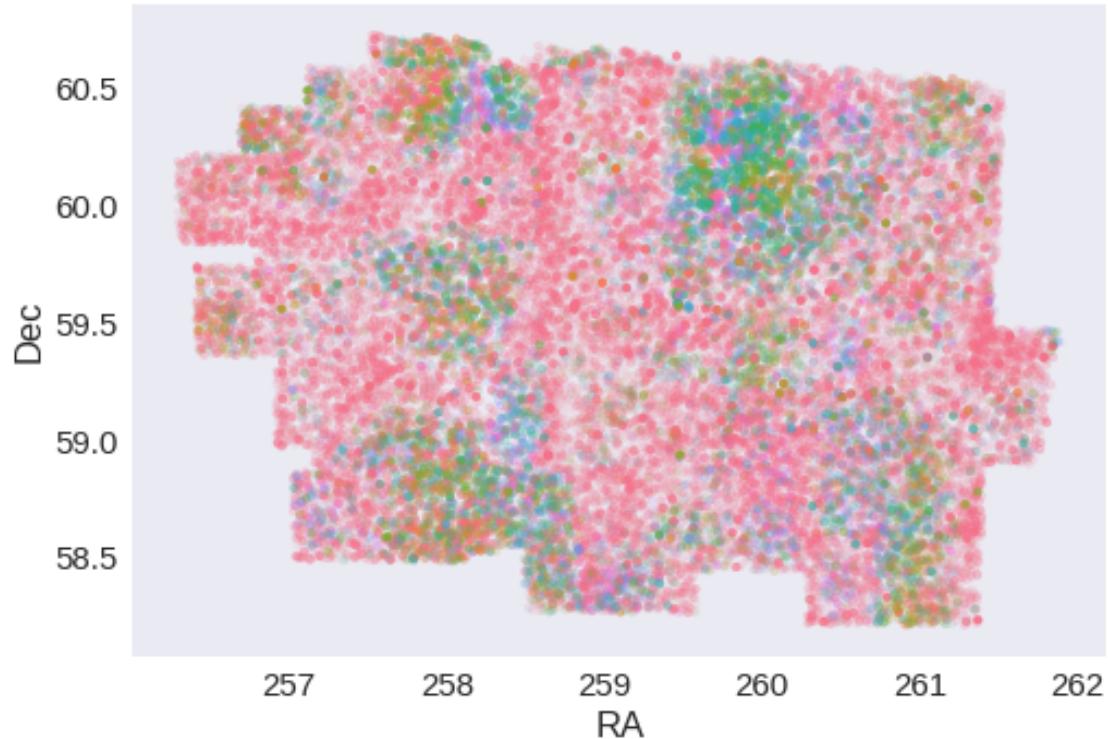
The cleaned catalogue has 490467 sources (487 removed).

The cleaned catalogue has 487 sources flagged as having been cleaned

## 1.4 III - Astrometry correction

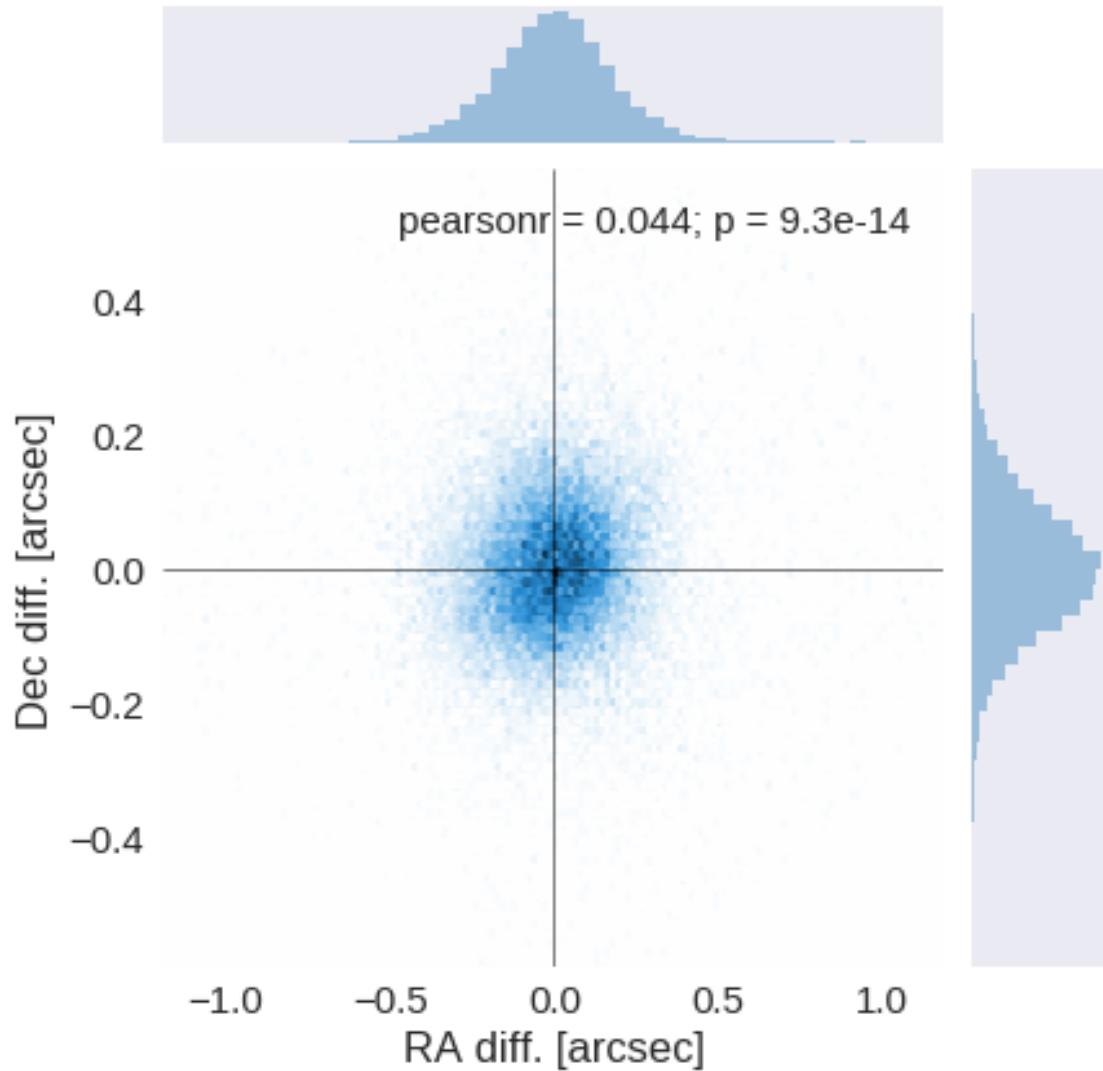
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

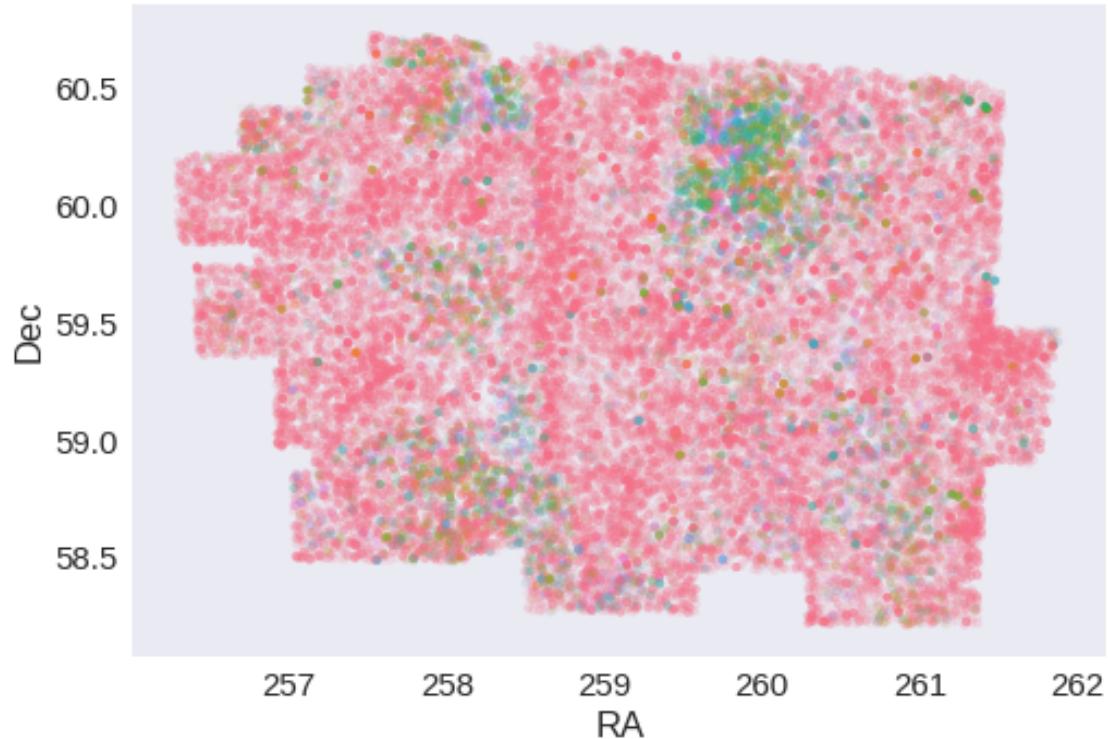




RA correction: -0.07881807600824686 arcsec

Dec correction: -0.05963852196089192 arcsec





## 1.5 IV - Flagging Gaia objects

31269 sources flagged.

## 2 V - Saving to disk

## 1.3\_KPNO-FLS

January 18, 2018

### 1 xFLS master catalogue

#### 1.1 Preparation of KPNO-FLS data

Isaac Newton Telescope / Wide Field Camera (INT/WFC) catalogue: the catalogue comes from dmu0\_KPNO-FLS.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture magnitude;
- The total magnitude.

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

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

#### 1.2 I - Column selection

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

#### 1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

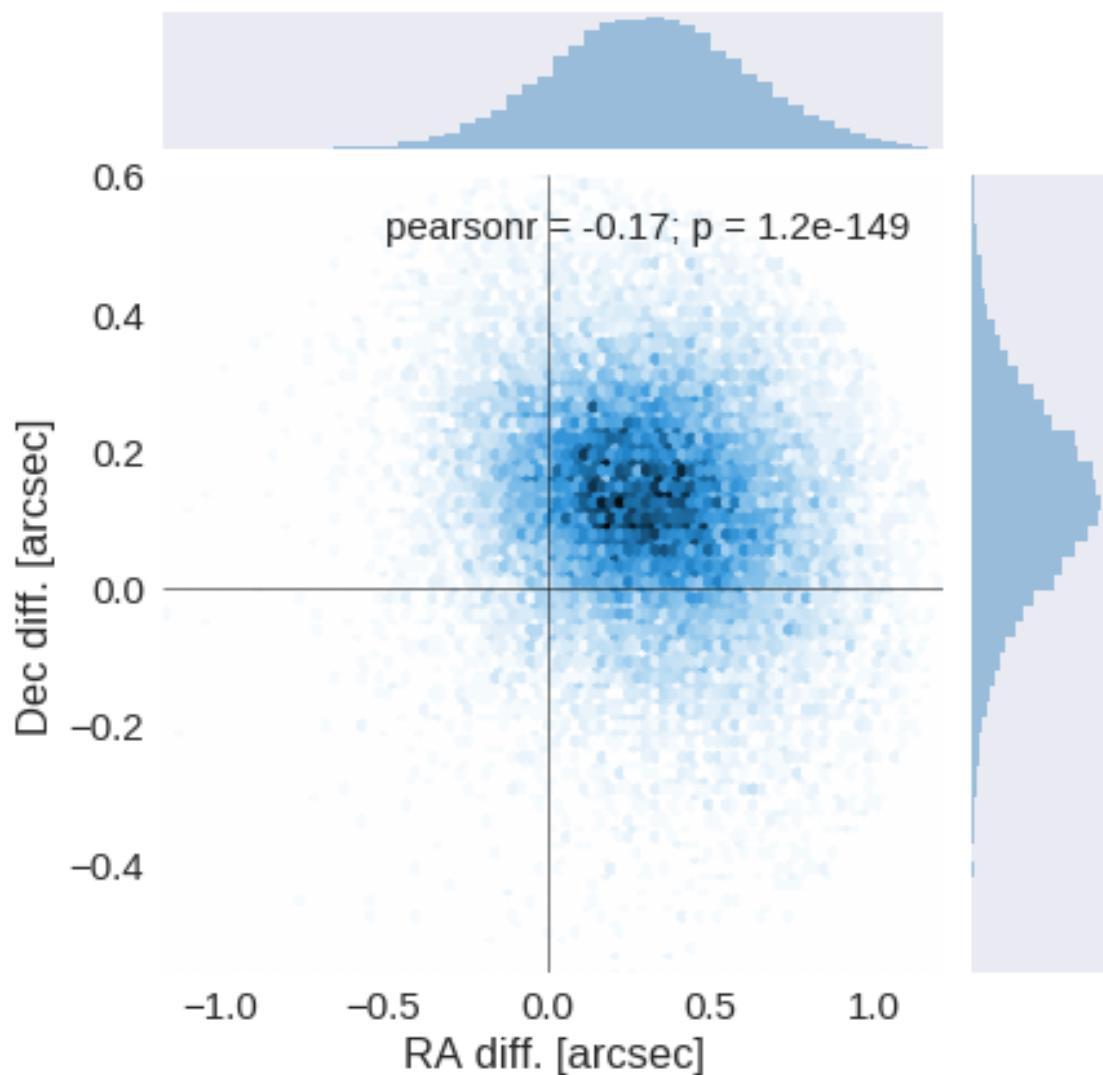
The initial catalogue had 722525 sources.

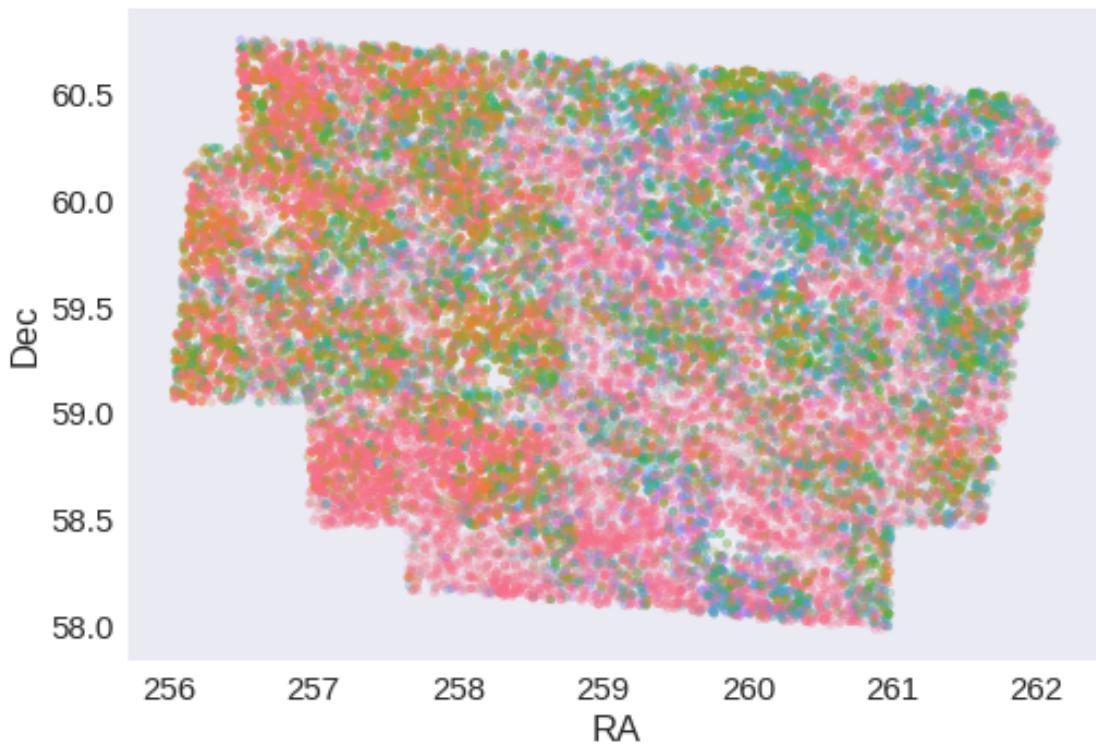
The cleaned catalogue has 670833 sources (51692 removed).

The cleaned catalogue has 50497 sources flagged as having been cleaned

#### 1.4 III - Astrometry correction

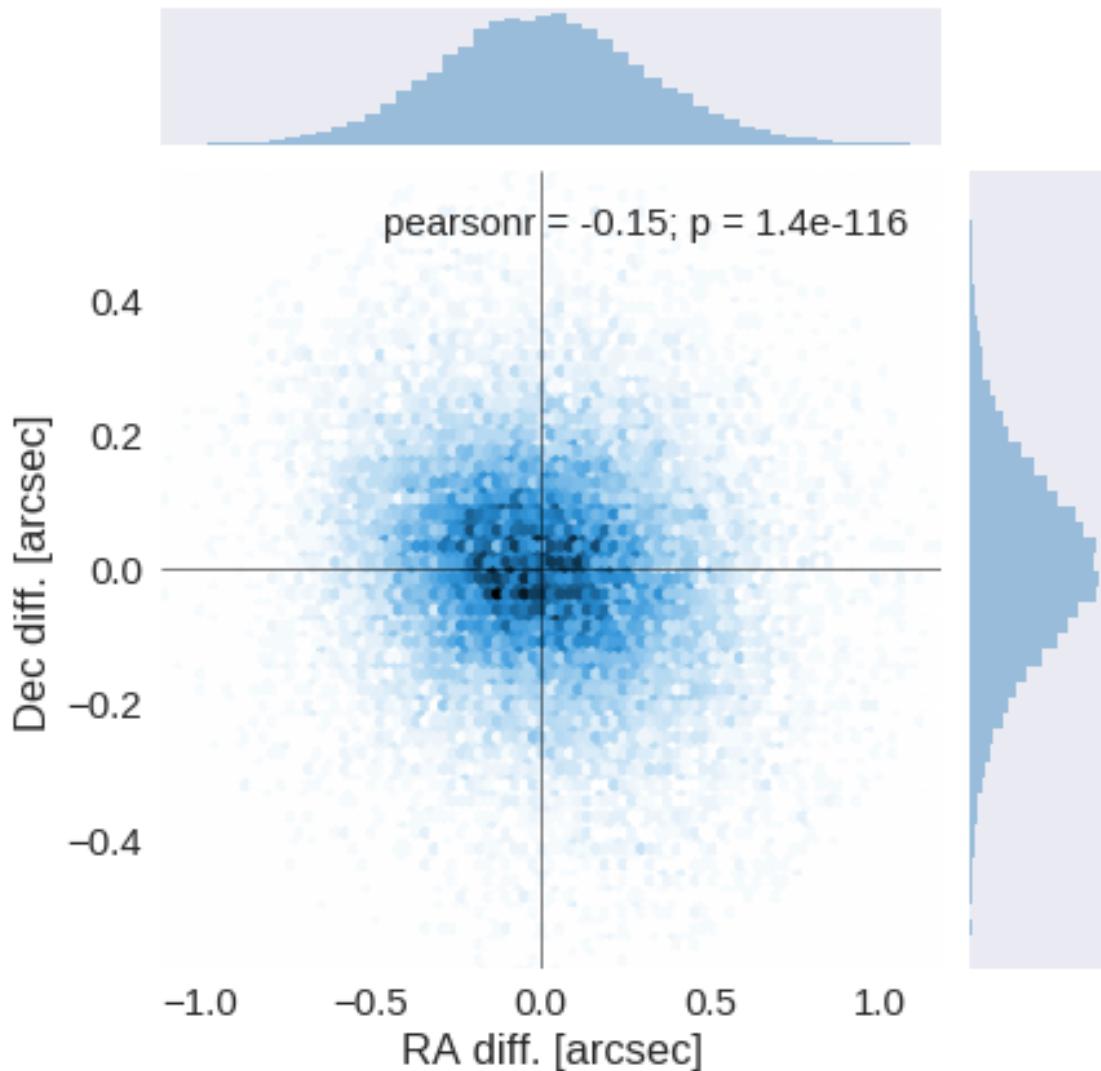
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

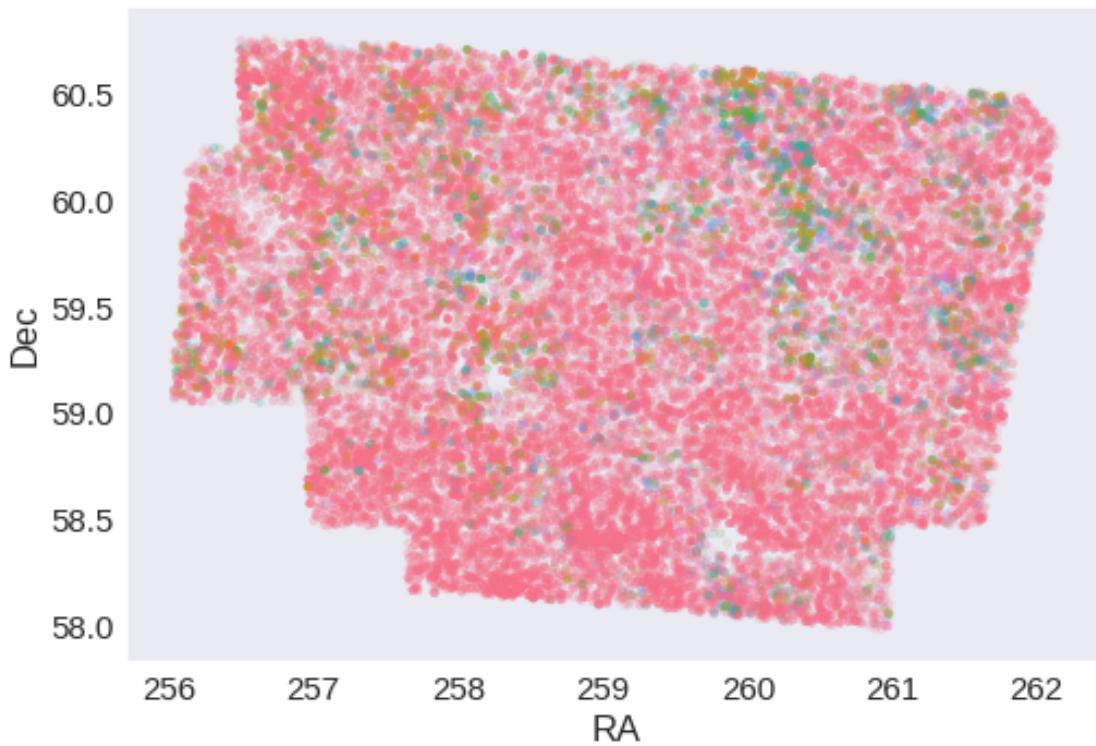




RA correction: -0.3095527144182597 arcsec

Dec correction: -0.12726026545522018 arcsec





### 1.5 IV - Flagging Gaia objects

24932 sources flagged.

## 2 V - Saving to disk

## 1.4\_PanSTARRS-3SS

January 18, 2018

### 1 xFLS master catalogue

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

This catalogue comes from dm0\_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 were done between 2010 and 2015 ([ref](#)).

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

**TODO:** Check for stellarity.

This notebook was run with herschelhelp\_internal version:  
255270d (Fri Nov 24 10:35:51 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)
```

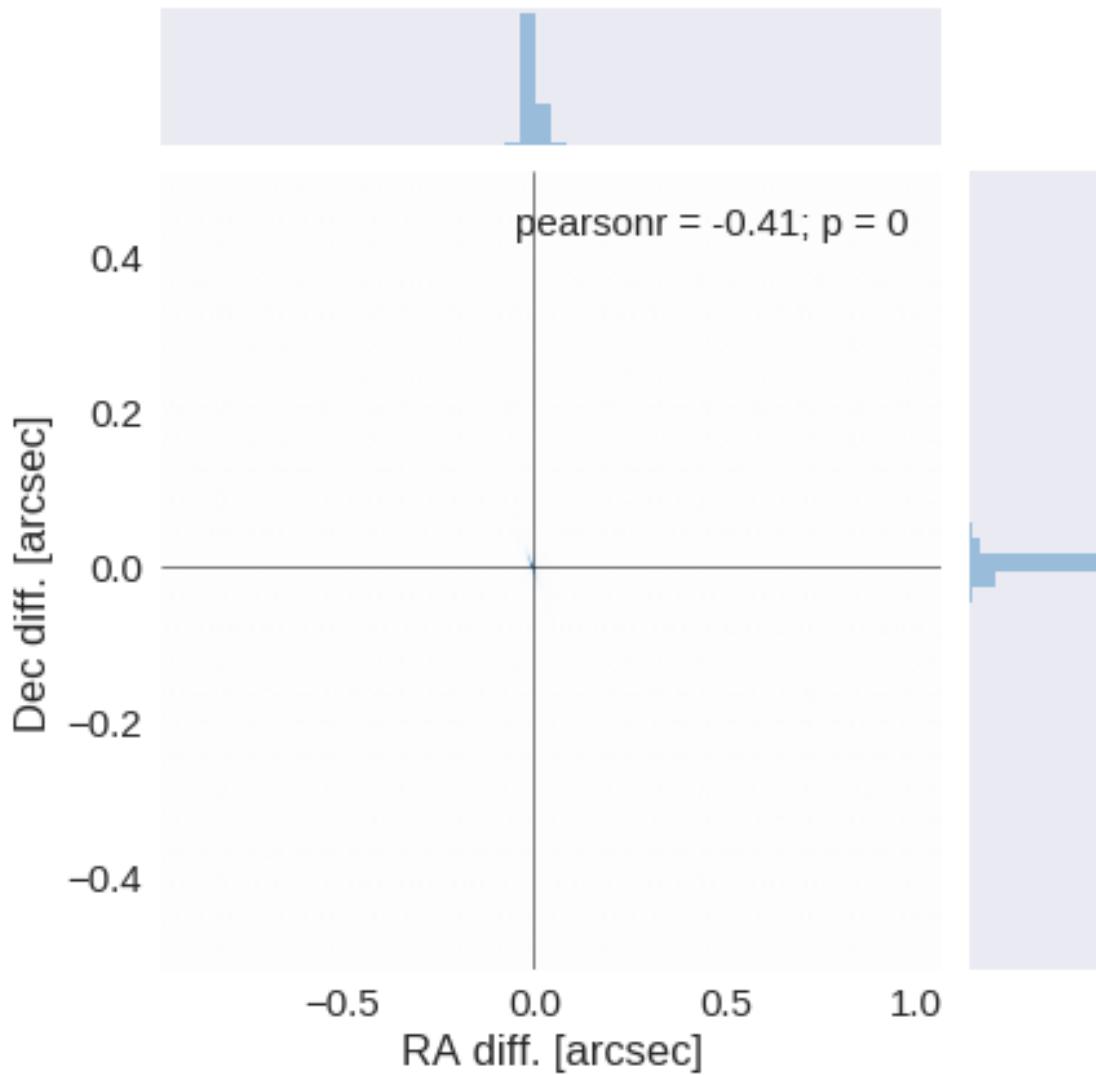
The initial catalogue had 168951 sources.

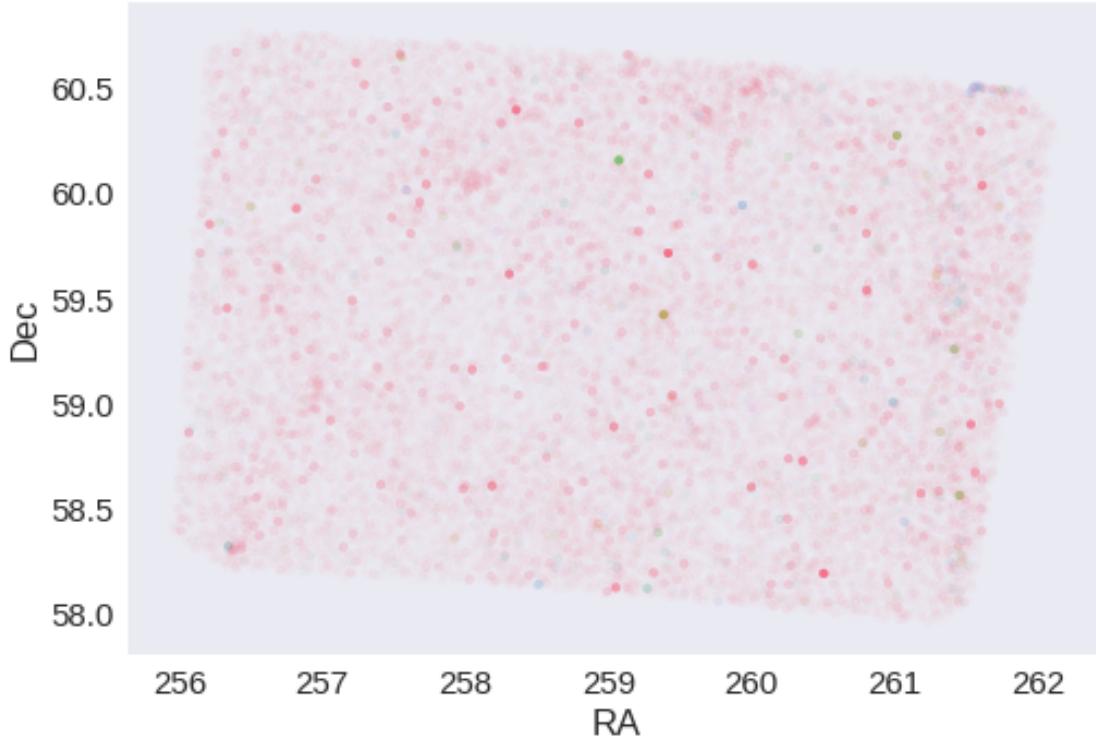
The cleaned catalogue has 168911 sources (40 removed).

The cleaned catalogue has 40 sources flagged as having been cleaned

## 1.4 III - Astrometry correction

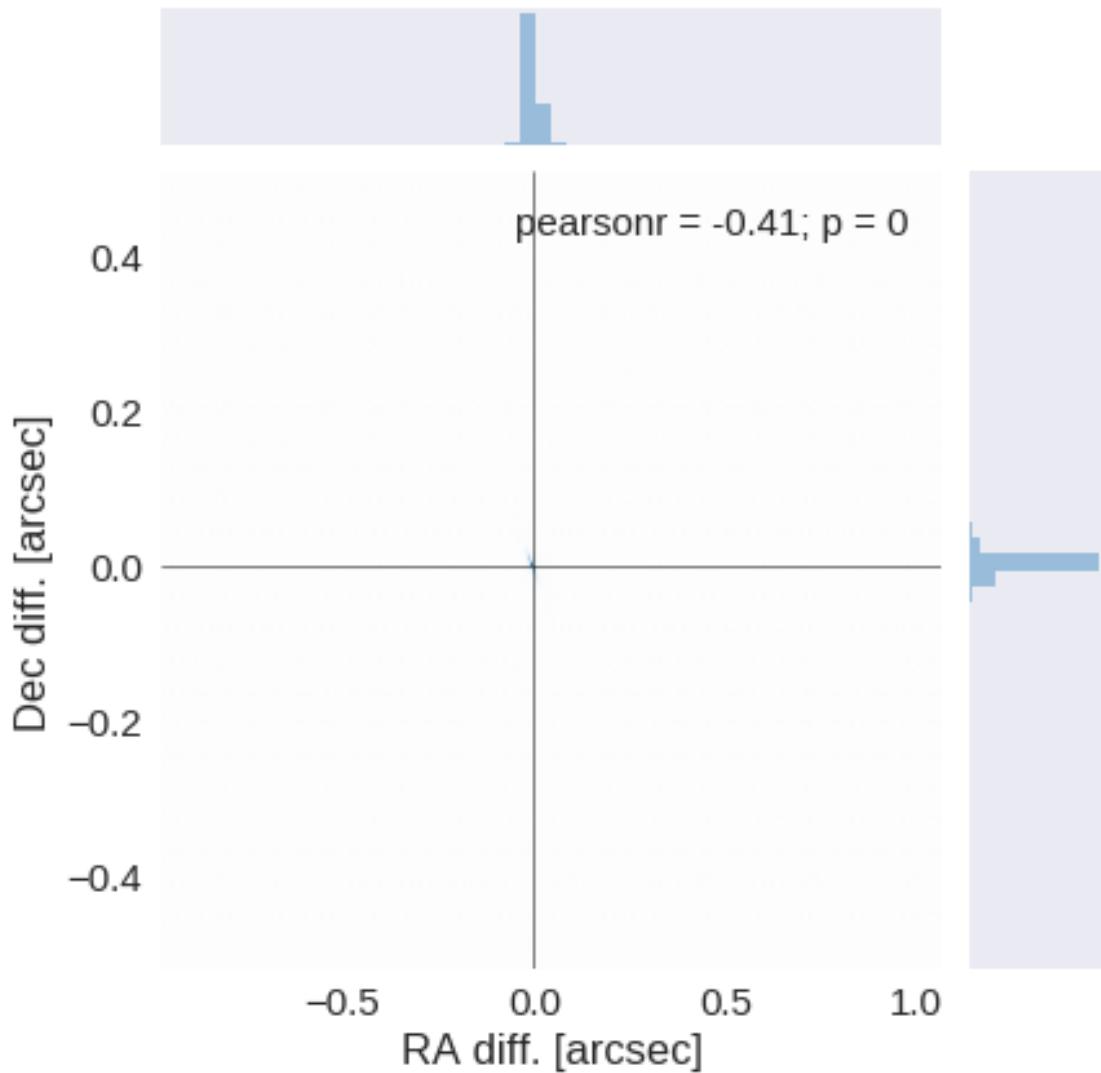
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

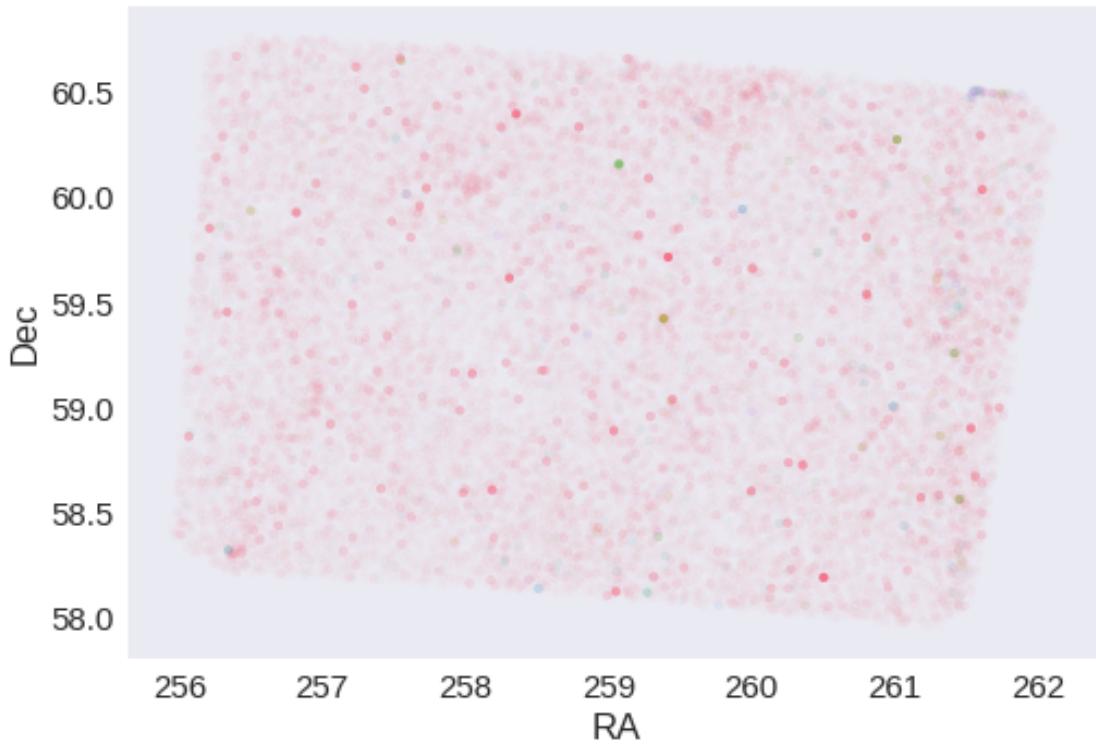




RA correction: 0.00047764447117515374 arcsec

Dec correction: -0.001210390917094628 arcsec





### 1.5 IV - Flagging Gaia objects

39668 sources flagged.

## 2 V - Saving to disk

# 1.5\_LegacySurvey

January 18, 2018

## 1 xFLS master catalogue

### 1.1 Preparation of Legacy Survey data

The catalogue comes from `dmu0_LegacySurvey`.

In the catalogue, we keep:

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

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

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

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

### 1.2 I - Aperture correction

To compute aperture correction we need to determine two parameters: 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:

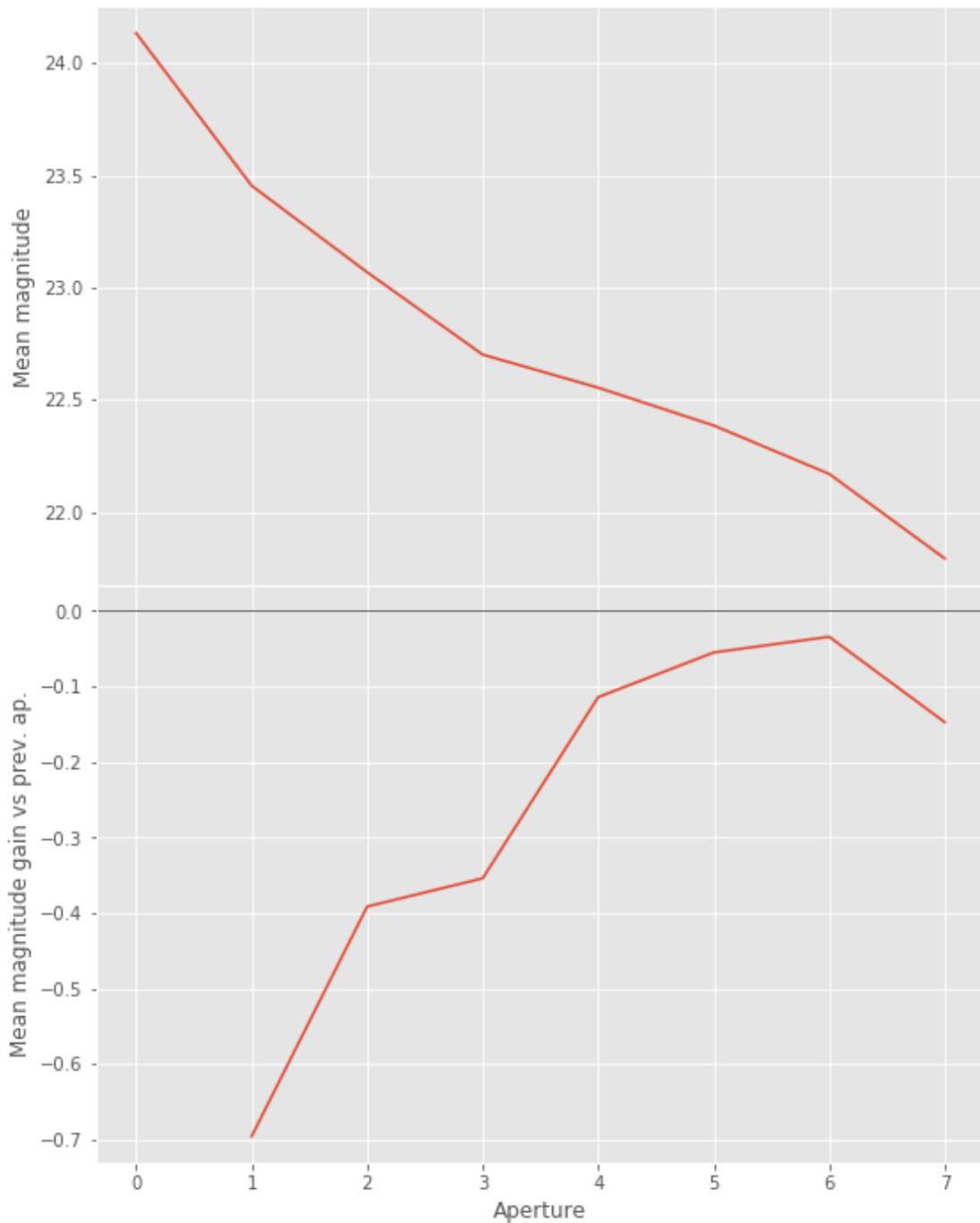
- The evolution of the magnitudes of the objects by plotting on the same plot aperture number vs the mean magnitude.
- The mean gain (loss when negative) of magnitude is each aperture compared to the previous (except for the first of course).

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

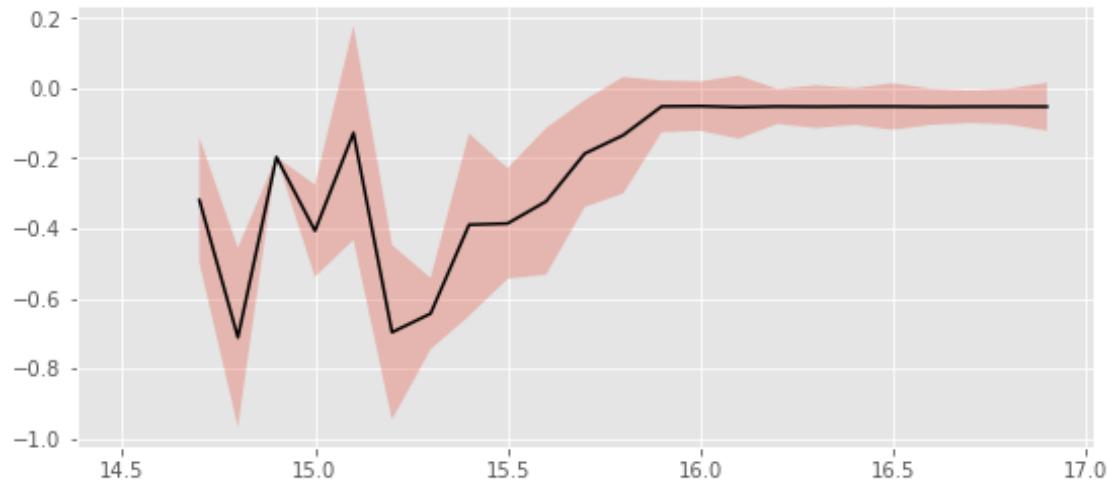
**Magnitude range:** To know what limits in aperture to use when doing the aperture correction, we plot for each magnitude bin the correction that is computed and its RMS. We should then use the wide limits (to use more stars) where the correction is stable and with few dispersion.

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value encountered in log10
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: divide by zero encountered in log10
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:80: RuntimeWarning: invalid value encountered in log
  errors = 2.5 / np.log(10) * errors_on_fluxes / fluxes
```

### 1.2.1 I.a - g band



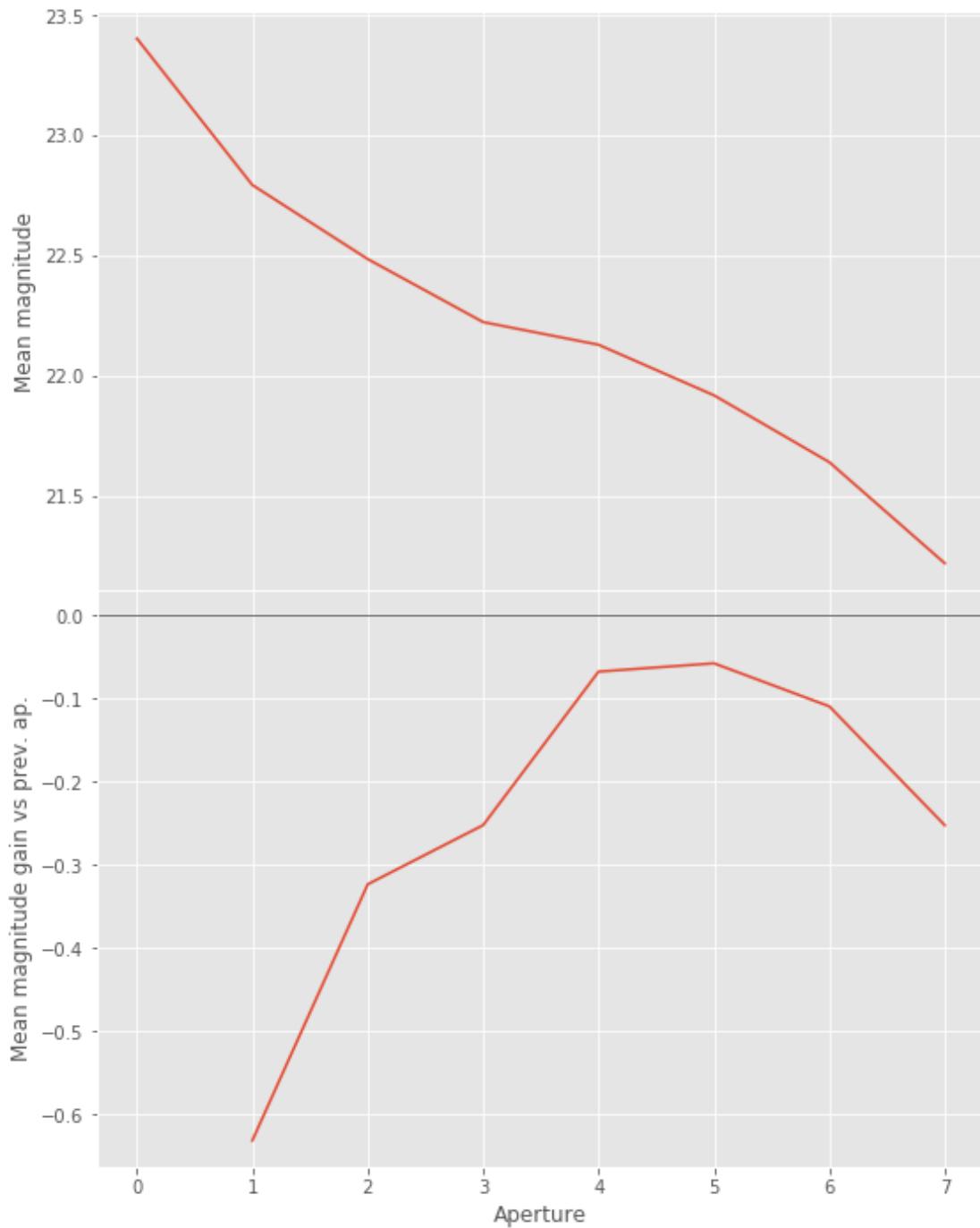
We will use aperture 5 as target.



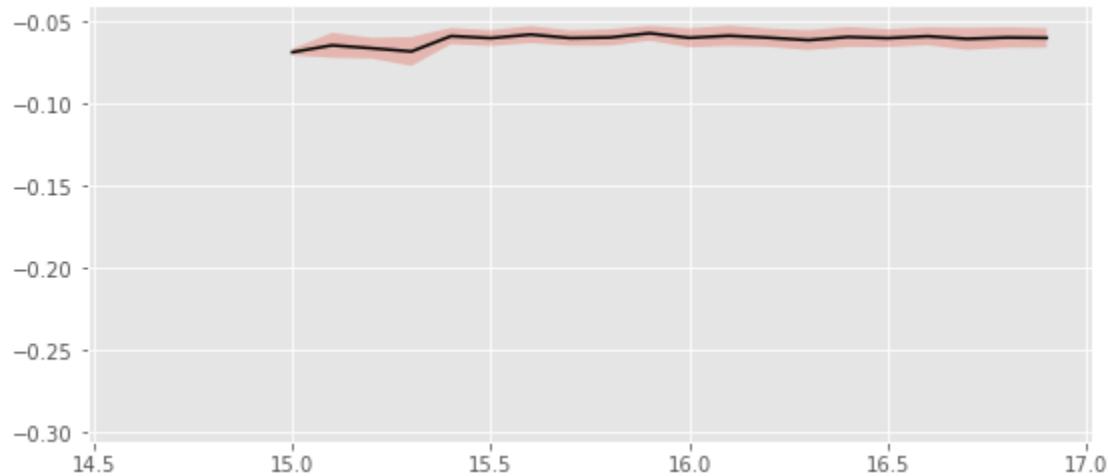
We will use magnitudes between 17.0 and 18.5

Aperture correction for g band:  
Correction: -0.052710849784986635  
Number of source used: 4025  
RMS: 0.055636831447624685

### 1.2.2 I.b - r band



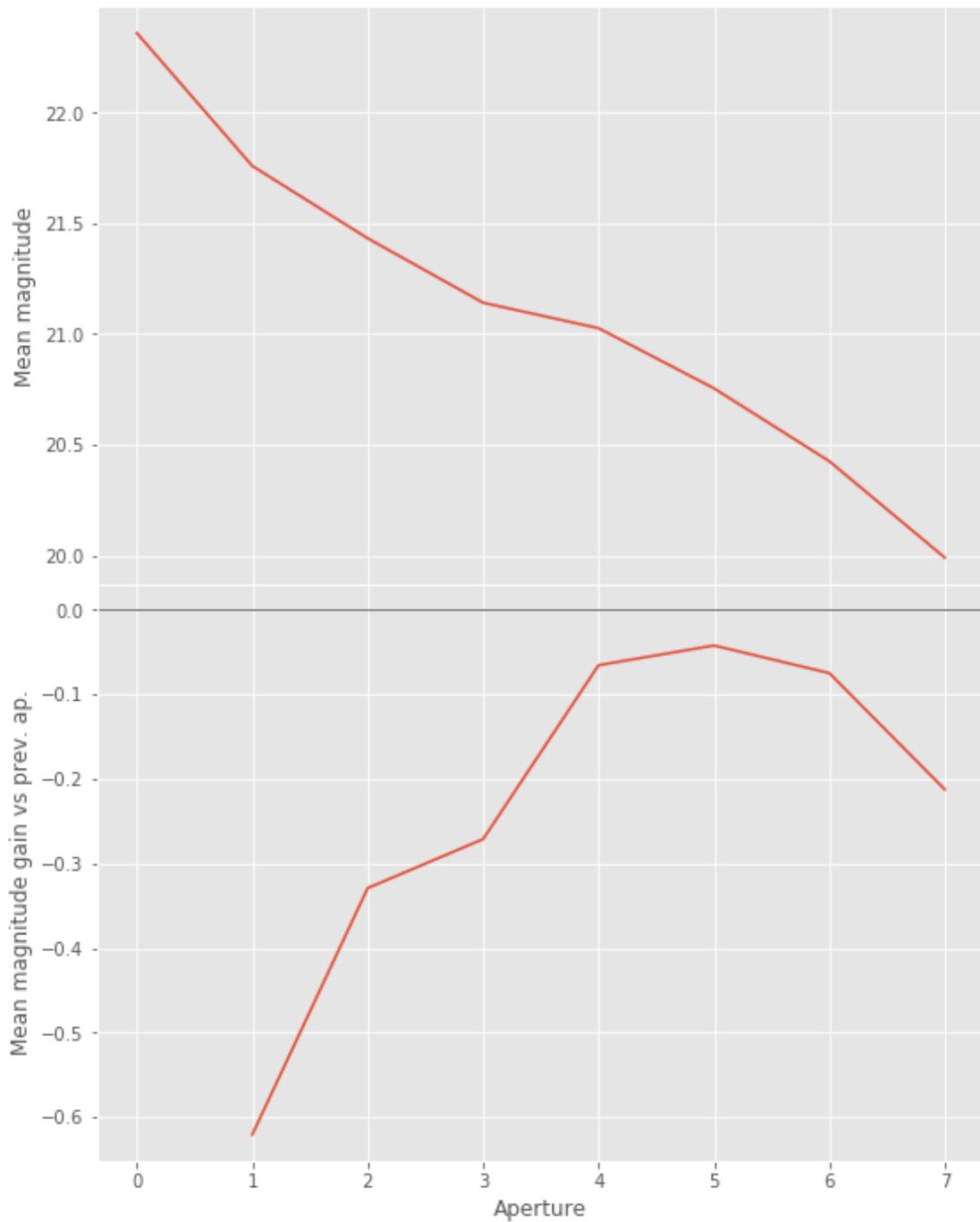
We will use aperture 5 as target.



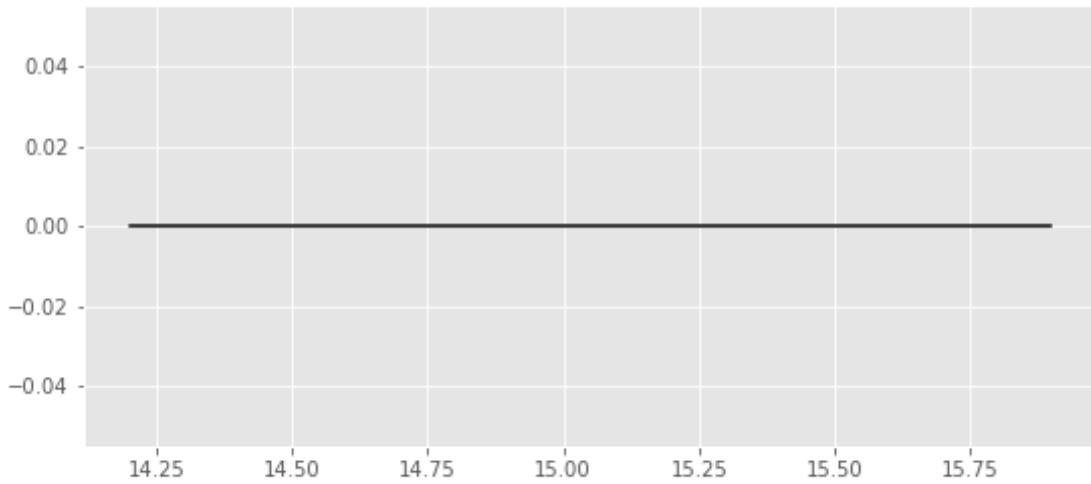
We use magnitudes between 17.0 and 18.5.

Aperture correction for r band:  
Correction: -0.05966928398234472  
Number of source used: 1570  
RMS: 0.007477466189163089

### 1.2.3 I.c - z band



We will use aperture 4 as target.



We use magnitudes between 16.0 and 17.5.

Aperture correction for z band:

Correction: -0.09809793899898978

Number of source used: 3027

RMS: 0.053383225487848615

### 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)
0	-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
	-1	Star	90.0	5.0	5.0	0.0
	0	Noise	5.0	5.0	90.0	0.0
	+1	Galaxy	5.0	90.0	5.0	0.0

### 1.4 II - Column selection

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

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value encountered in log10
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:80: RuntimeWarning: divide by zero encountered in log
  errors = 2.5 / np.log(10) * errors_on_fluxes / fluxes
```

Out[19]: <IPython.core.display.HTML object>

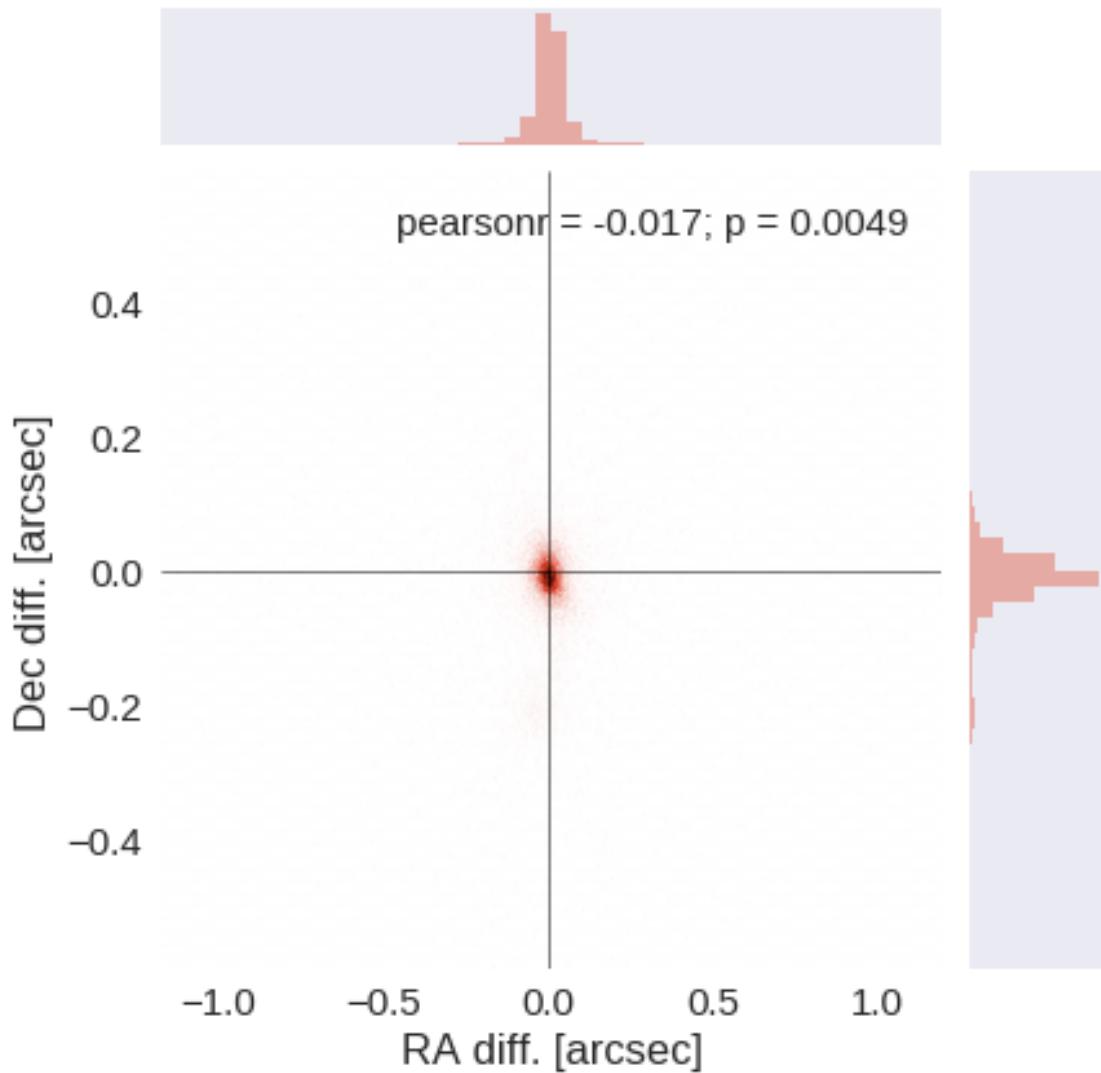
## 1.5 III - Removal of duplicated sources

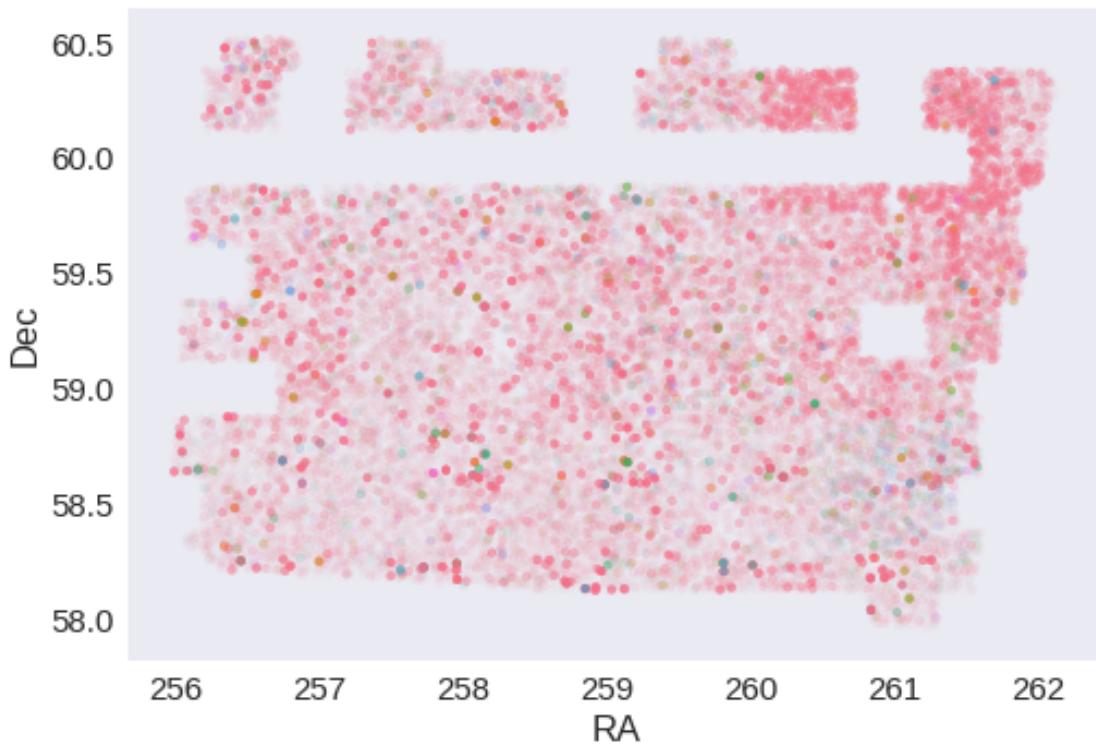
We remove duplicated objects from the input catalogues.

```
The initial catalogue had 183157 sources.
The cleaned catalogue has 179896 sources (3261 removed).
The cleaned catalogue has 3214 sources flagged as having been cleaned
```

## 1.6 III - Astrometry correction

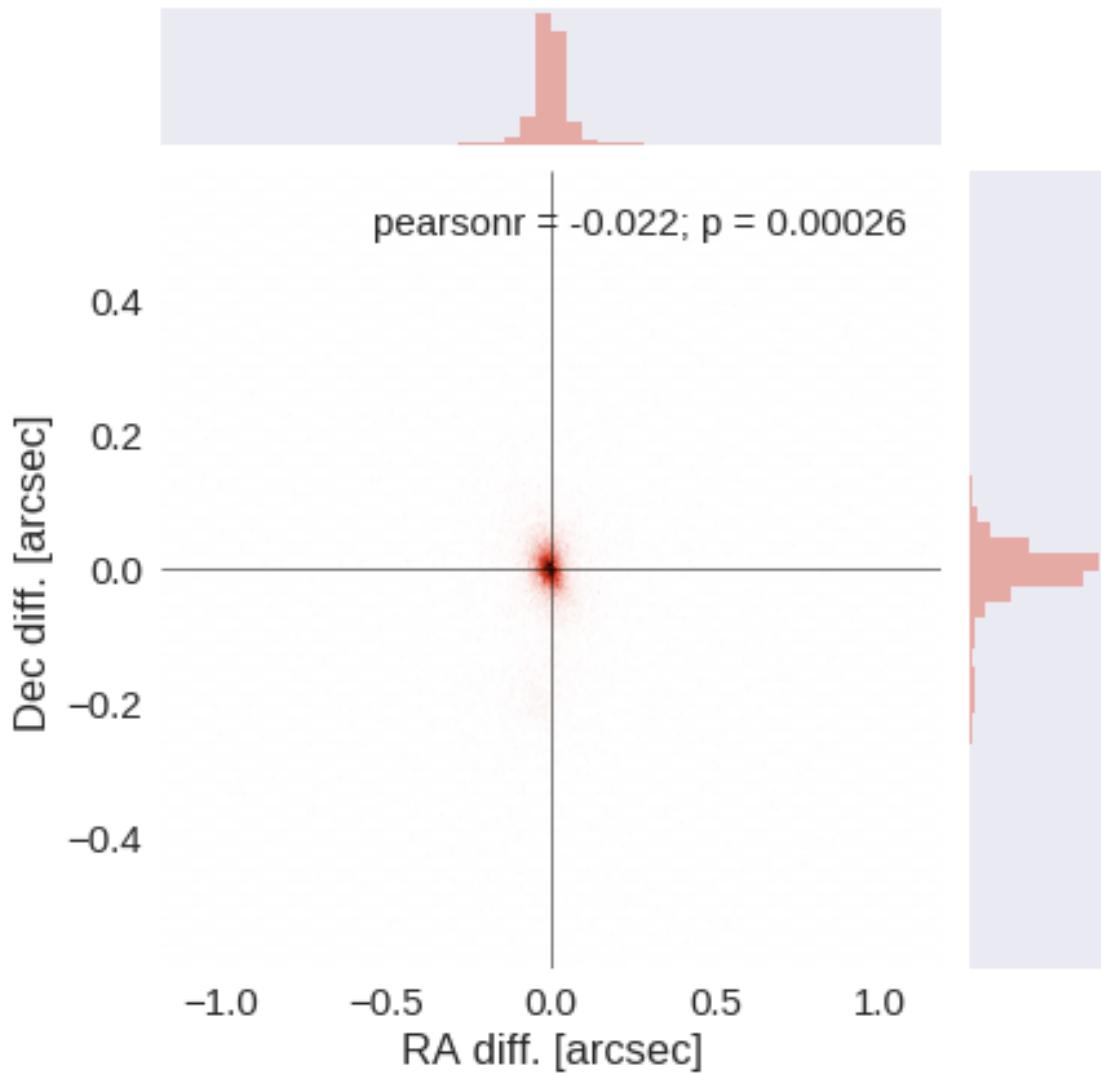
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

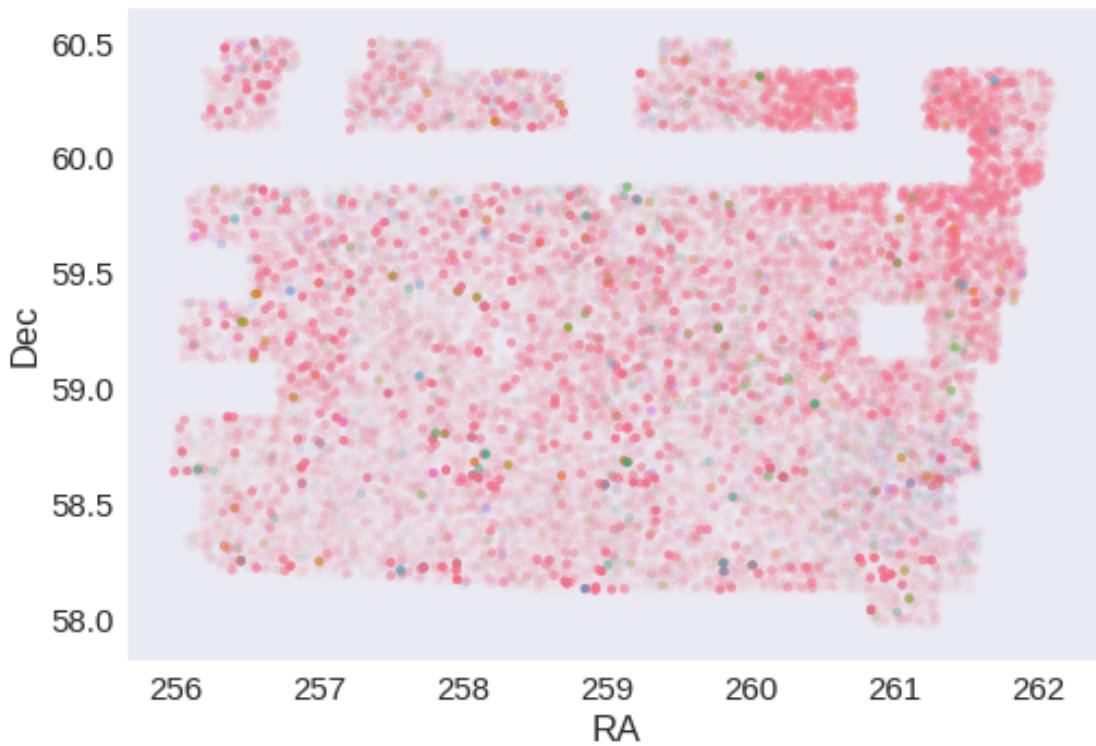




RA correction: -0.00725189001968829 arcsec

Dec correction: 0.0062373993586106735 arcsec





### 1.7 IV - Flagging Gaia objects

29450 sources flagged.

## 2 V - Saving to disk

# 1.6\_UHS

January 18, 2018

## 1 xFLS master catalogue

### 1.1 Preparation of UKIRT Hemisphere Survey (UHS) data

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

In the catalogue, we keep:

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

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

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

### 1.2 I - Column selection

0.925175419285

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

Out[7]: <IPython.core.display.HTML object>

### 1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

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

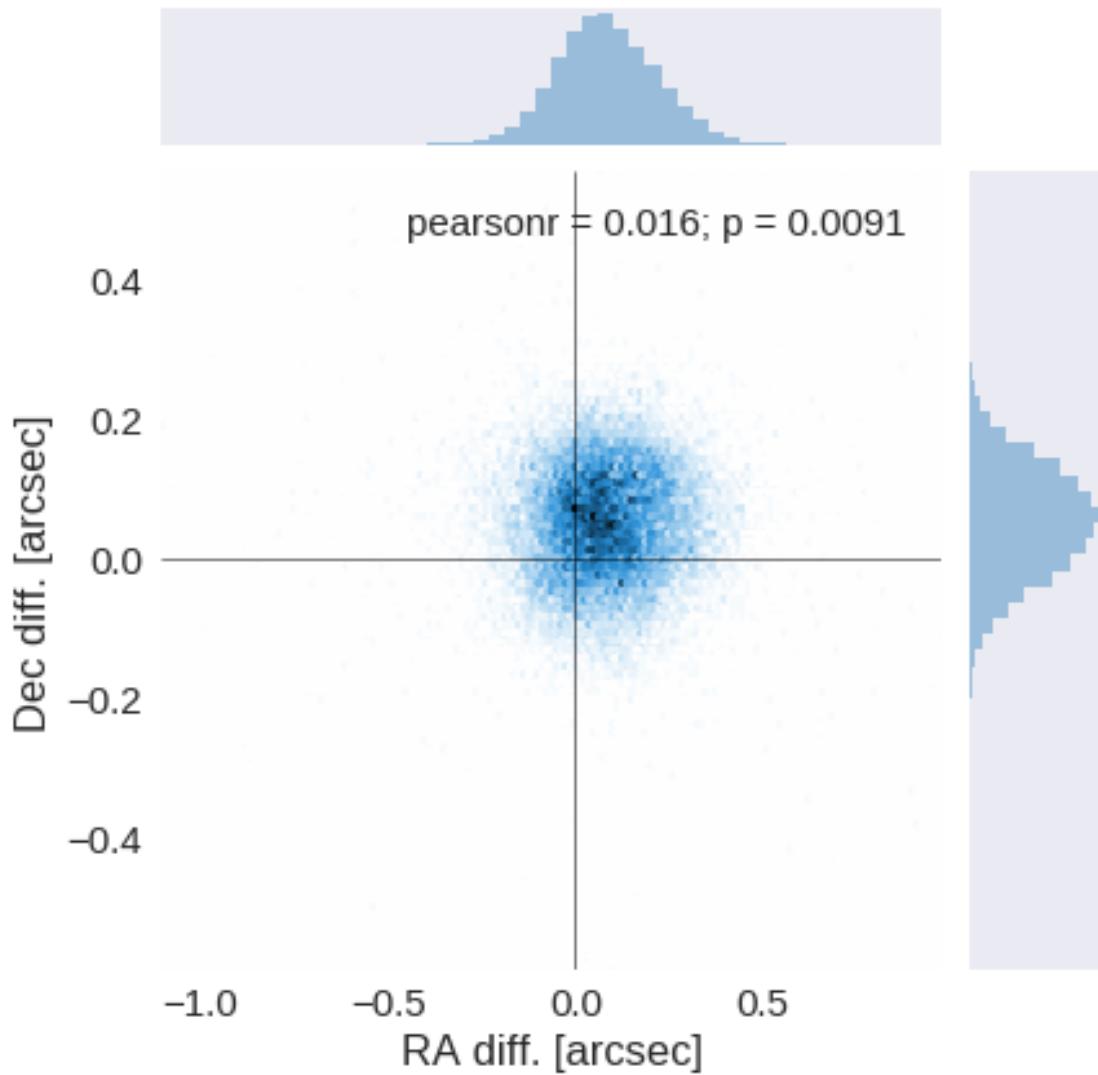
The initial catalogue had 87317 sources.

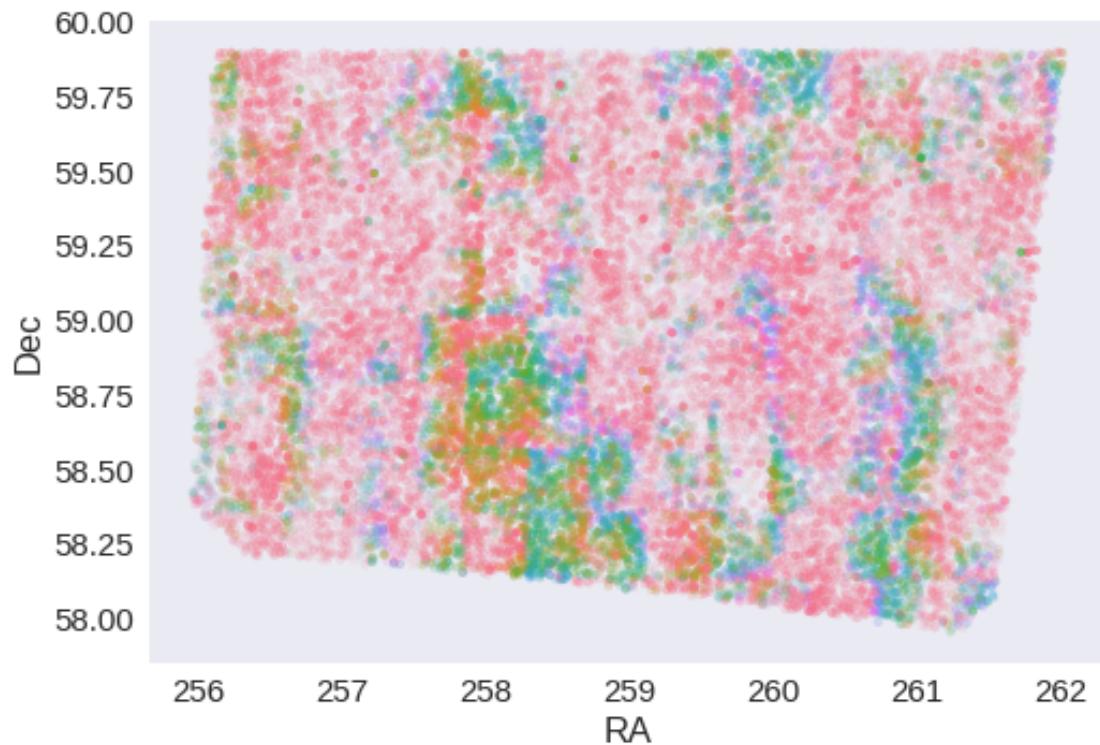
The cleaned catalogue has 81760 sources (5557 removed).

The cleaned catalogue has 5356 sources flagged as having been cleaned

## 1.4 III - Astrometry correction

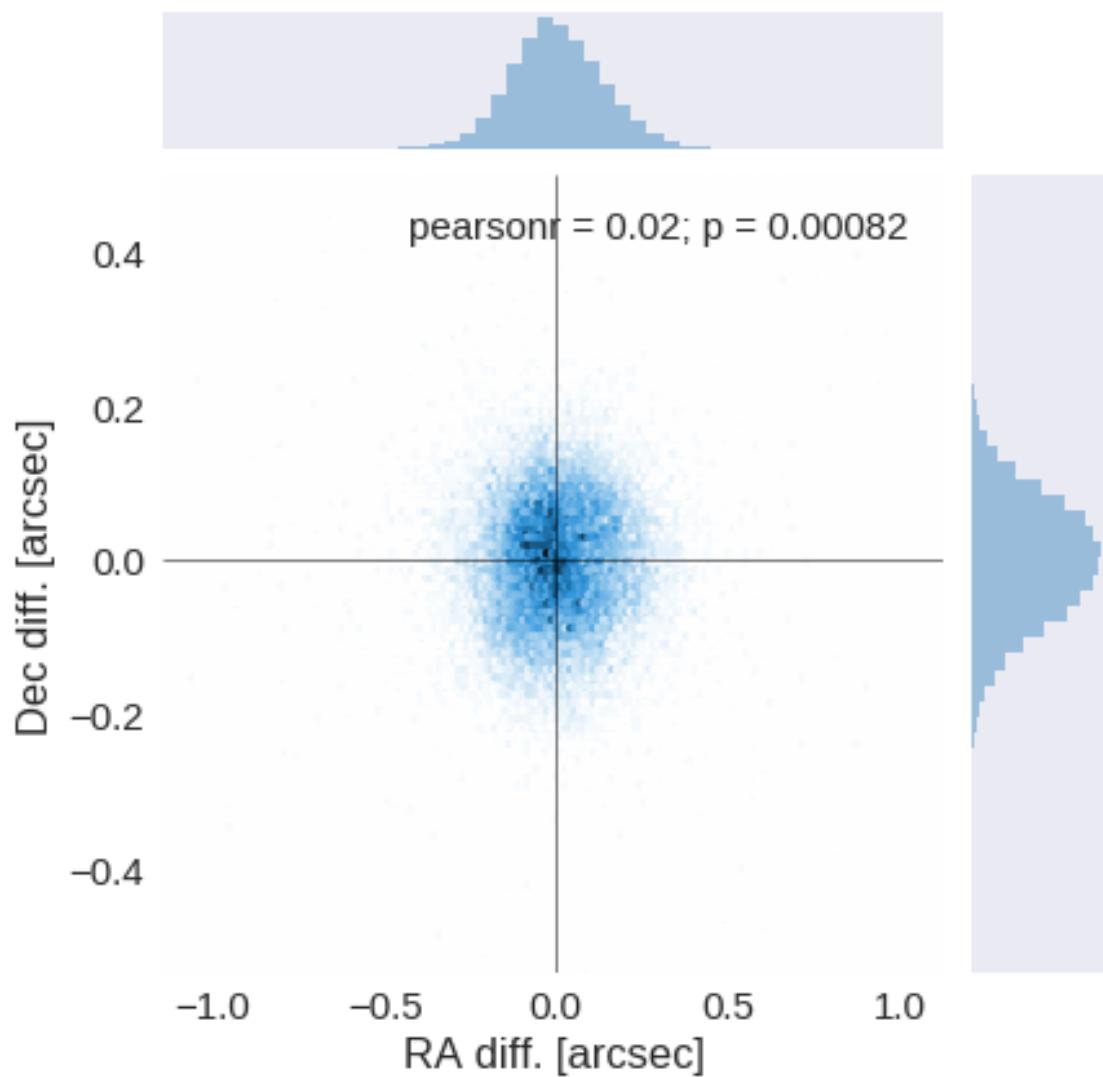
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

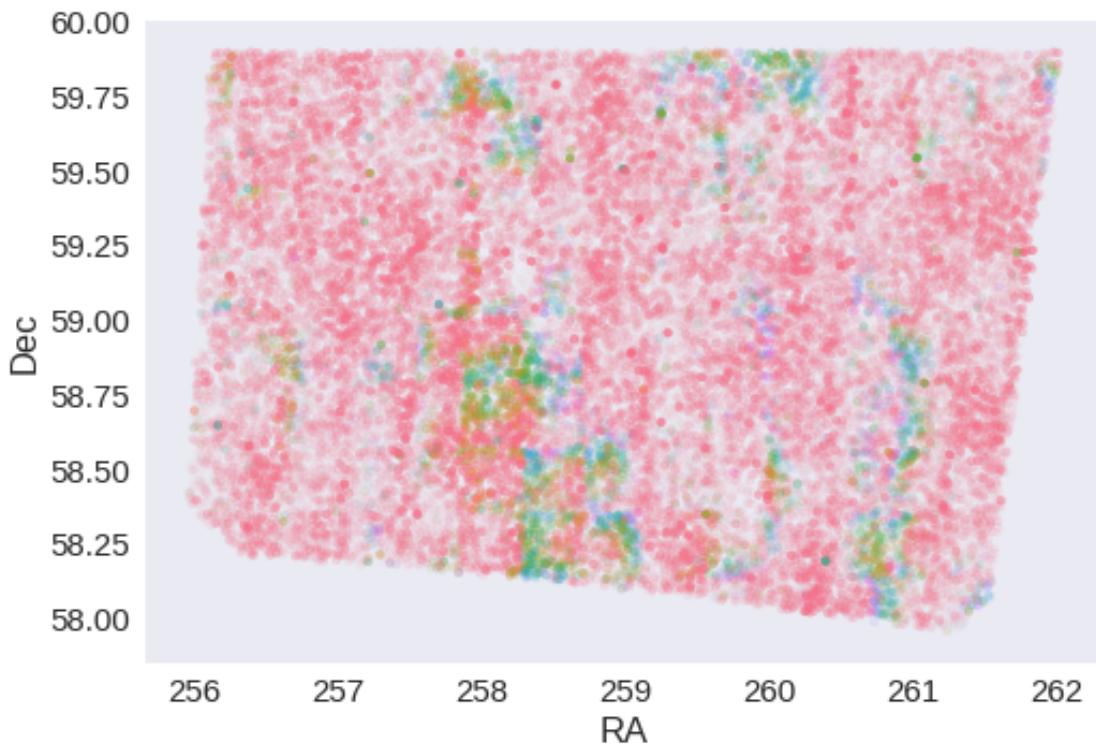




RA correction: -0.07672536188465529 arcsec

Dec correction: -0.0534351193692828 arcsec





## 1.5 IV - Flagging Gaia objects

28022 sources flagged.

## 2 V - Saving to disk

# 2\_Merging

January 18, 2018

## 1 xFLS master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP master catalogue on xFLS.

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

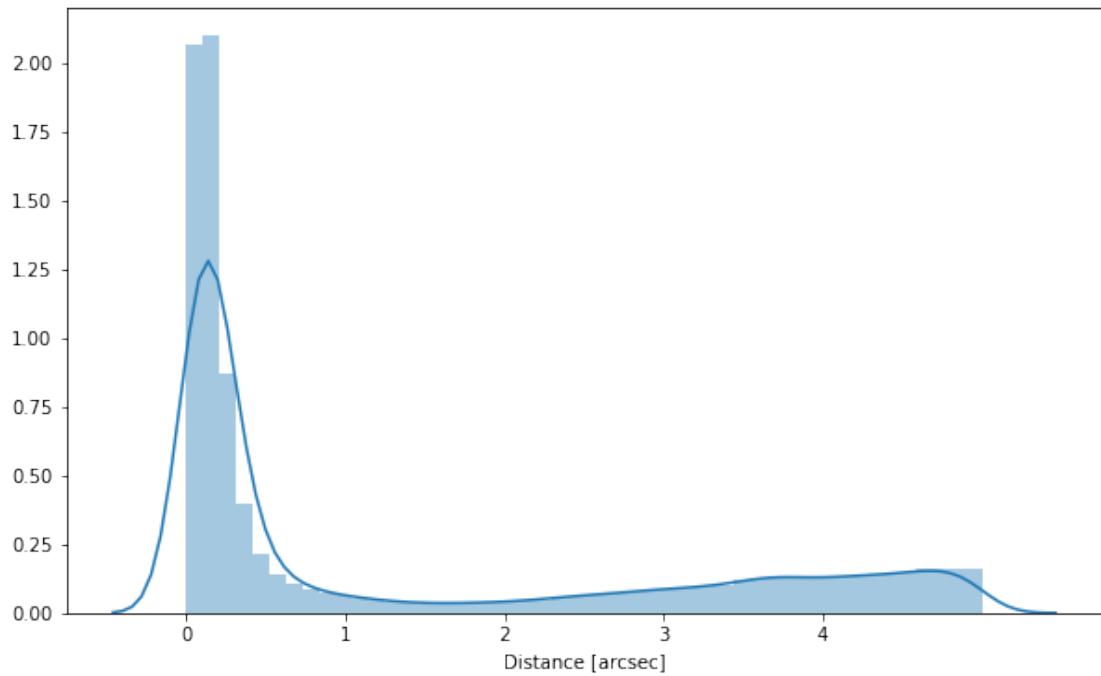
### 1.1 I - Reading the prepared pristine catalogues

### 1.2 II - Merging tables

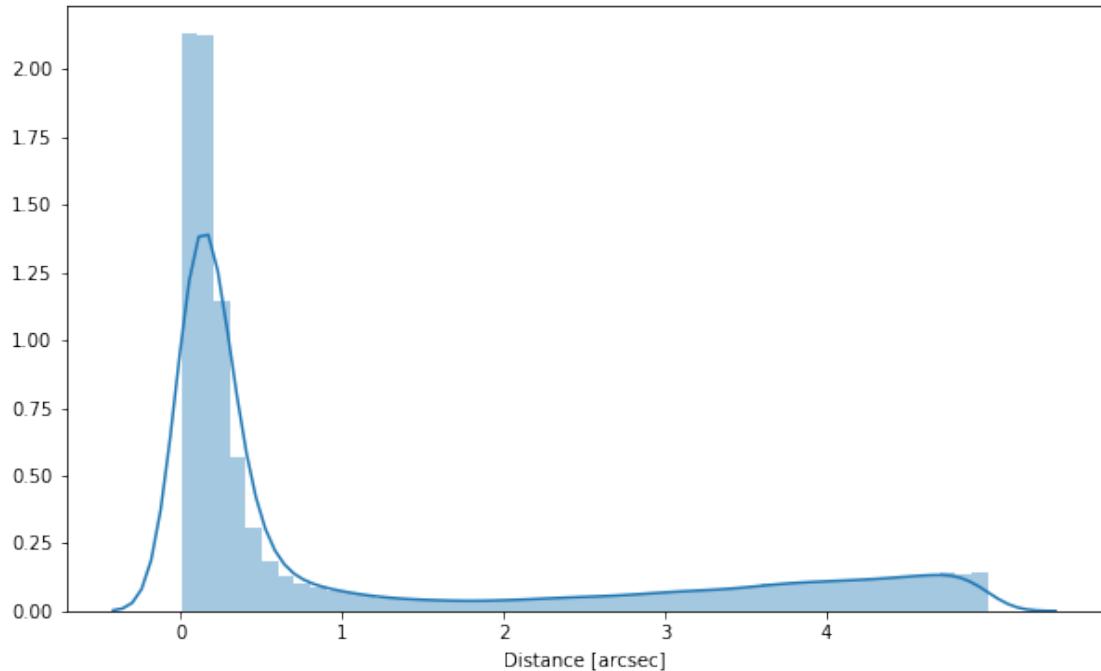
At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

### 1.2.1 WFC

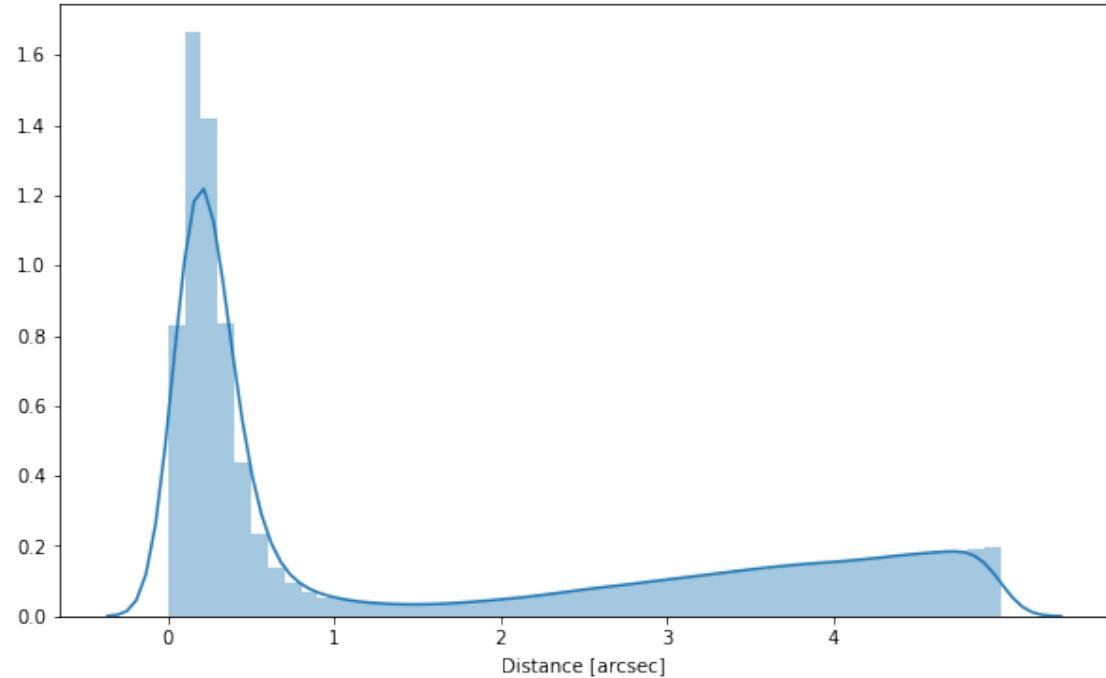
### 1.2.2 Add PanSTARRS



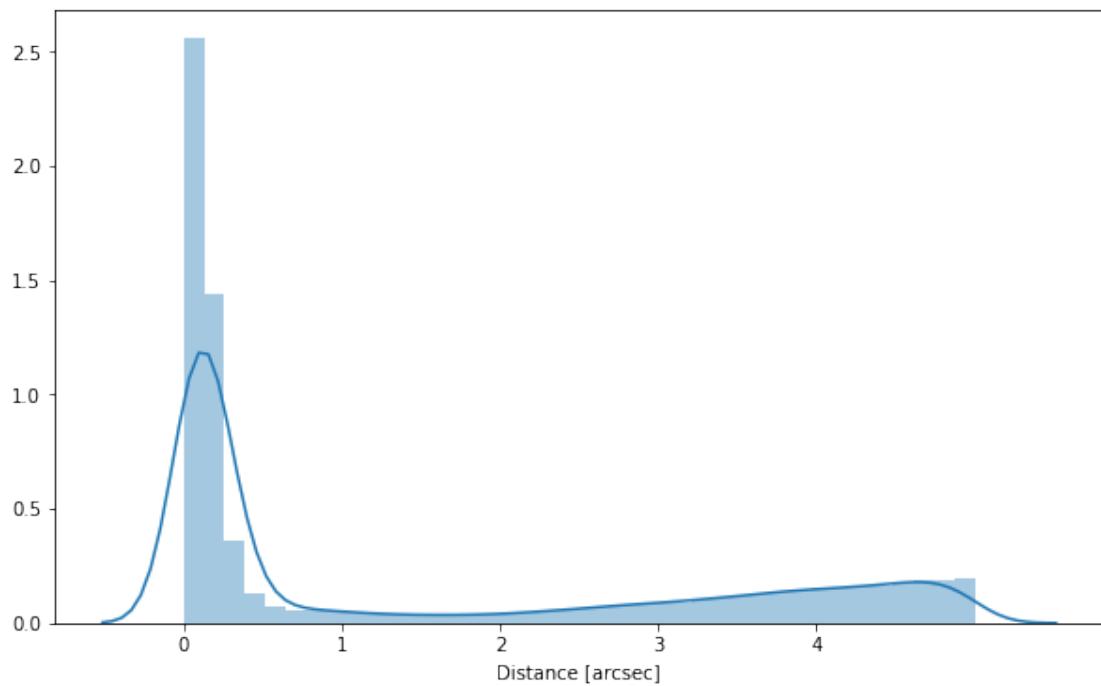
### 1.2.3 Add Legacy Survey



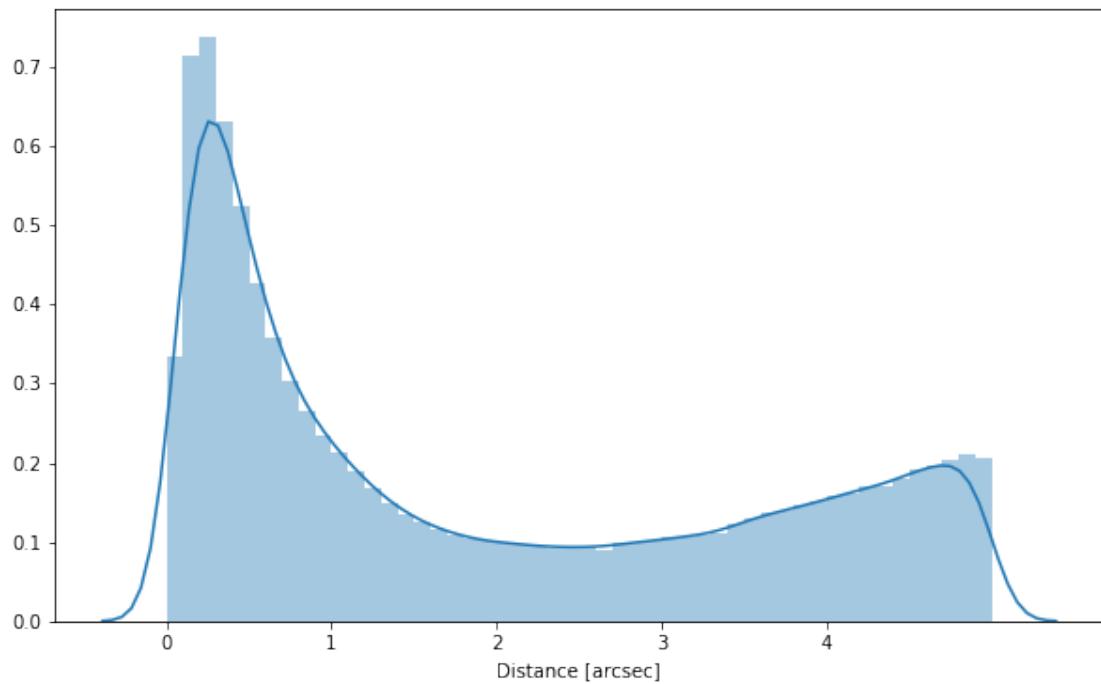
#### 1.2.4 Add KPNO



### 1.2.5 Add UHS



### 1.2.6 Add Spitzer



### 1.2.7 Cleaning

When we merge the catalogues, astropy masks the non-existent values (e.g. when a row comes only from a catalogue and has no counterparts in the other, the columns from the latest are masked for that row). We indicate to use NaN for masked values for floats columns, False for flag columns and -1 for ID columns.

Out[17] : <IPython.core.display.HTML object>

## 1.3 III - Merging flags and stellarity

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

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

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

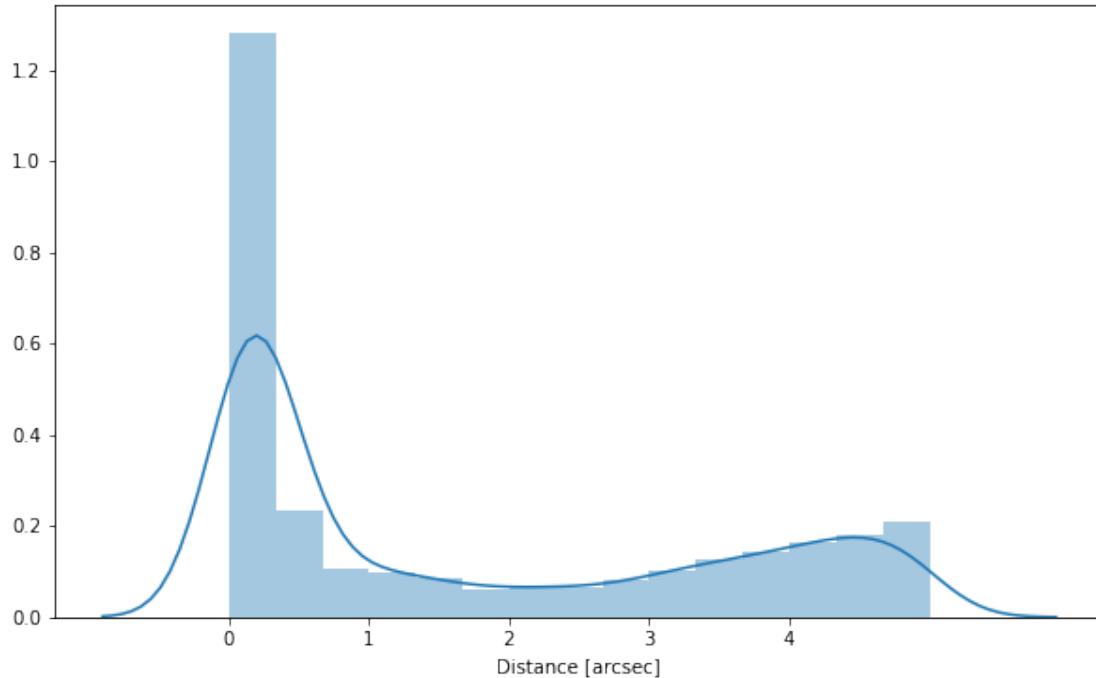
wfc\_stellarity, legacy\_stellarity, kpno\_stellarity, uhs\_stellarity, spitzer\_stellarity

## 1.4 IV - Adding E(B-V) column

## 1.5 V - Adding HELP unique identifiers and field columns

OK!

## 1.6 VI - Cross-matching with spec-z catalogue



## 1.7 VII - Choosing between multiple values for the same filter

No overlapping filters on xFLS.

## 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 but not in mid-infrared would have this flag at  $1 + 2 = 3$ .

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

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

## 1.9 VIII.b Wavelength domain detection

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

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

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

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

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

## 1.10 IX - Cross-identification table

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

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

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

```
['wfc_id', 'ps1_id', 'legacy_id', 'kpno_intid', 'uhs_id', 'spitzer_intid', 'help_id', 'specz_id'
```

## 1.11 X - Adding HEALPix index

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

## 1.12 XI - Saving the catalogue

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

# 3\_Checks\_and\_diagnostics

January 18, 2018

## 1 xFLS master catalogue

### 1.1 Checks and diagnostics

These revealed a number of issues to be corrected. There was a unit issue with the BASS Legacy Survey magnitudes and fluxes which needs to be corrected across all the fields. The UHS magnitudes are Vega and needed to be corrected.

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

Diagnostics done using: master\_catalogue\_xfls\_20171201.fits

### 1.2 0 - Quick checks

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

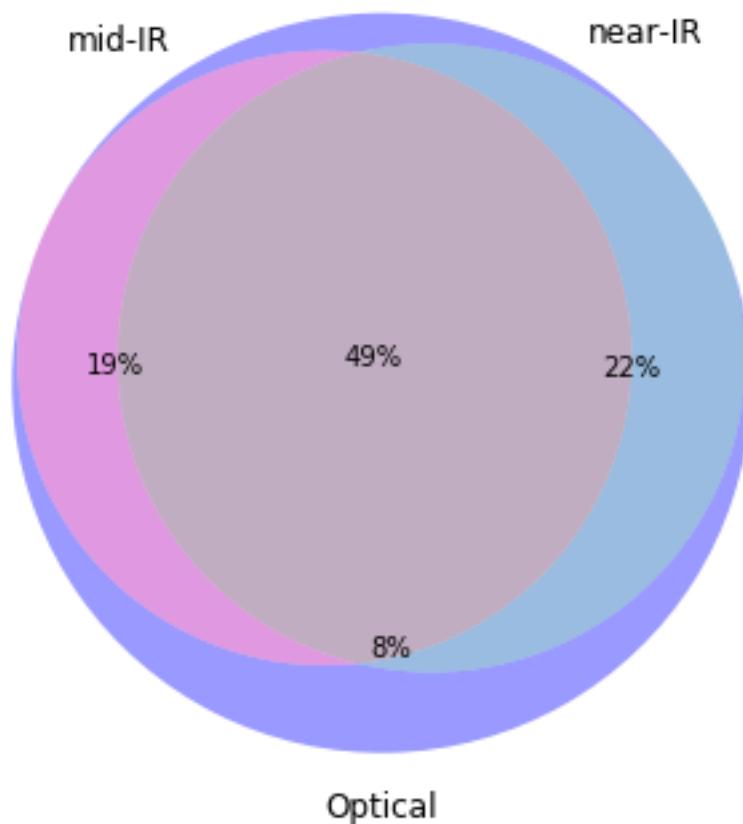
Table shows only problematic columns.

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

### 1.3 I - Summary of wavelength domains

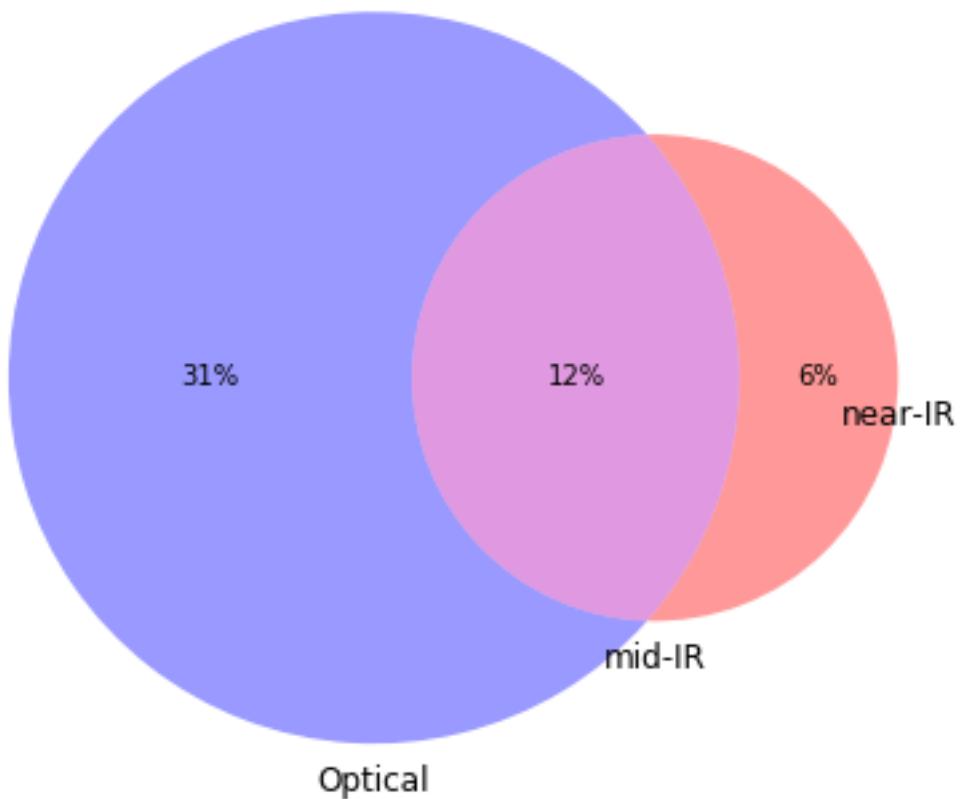
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/matplotlib_venn/_venn3.py:  
    warnings.warn("Bad circle positioning")
```

## Wavelength domain observations



```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/matplotlib_venn/_venn3.py:  
    warnings.warn("Circle B has zero area")
```

Detection of the 494,006 sources detected  
in any wavelength domains (among 977,148 sources)

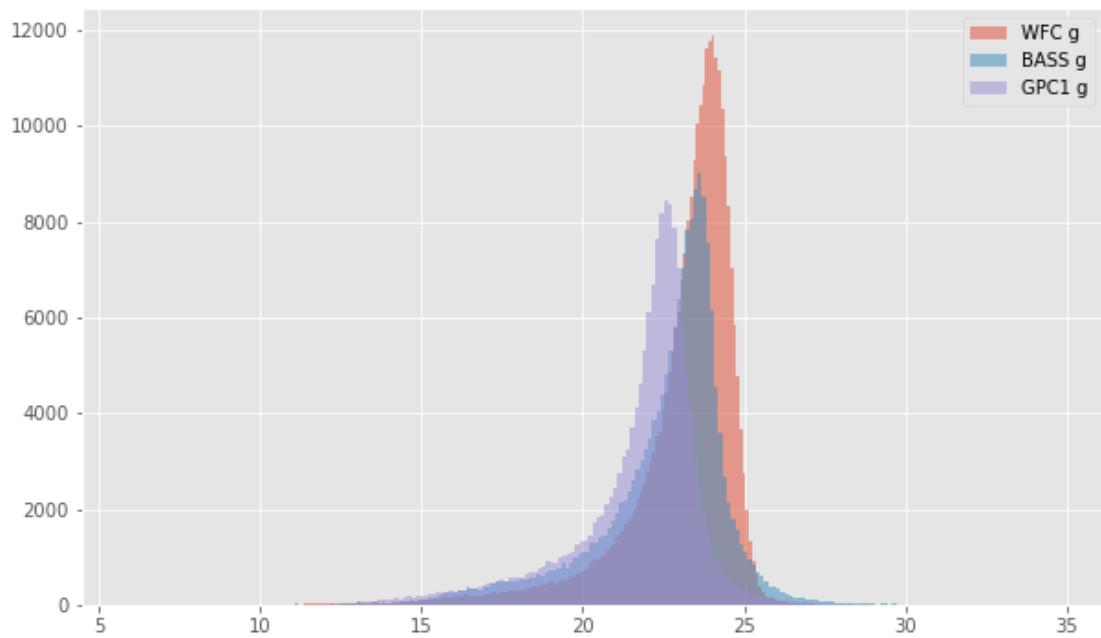
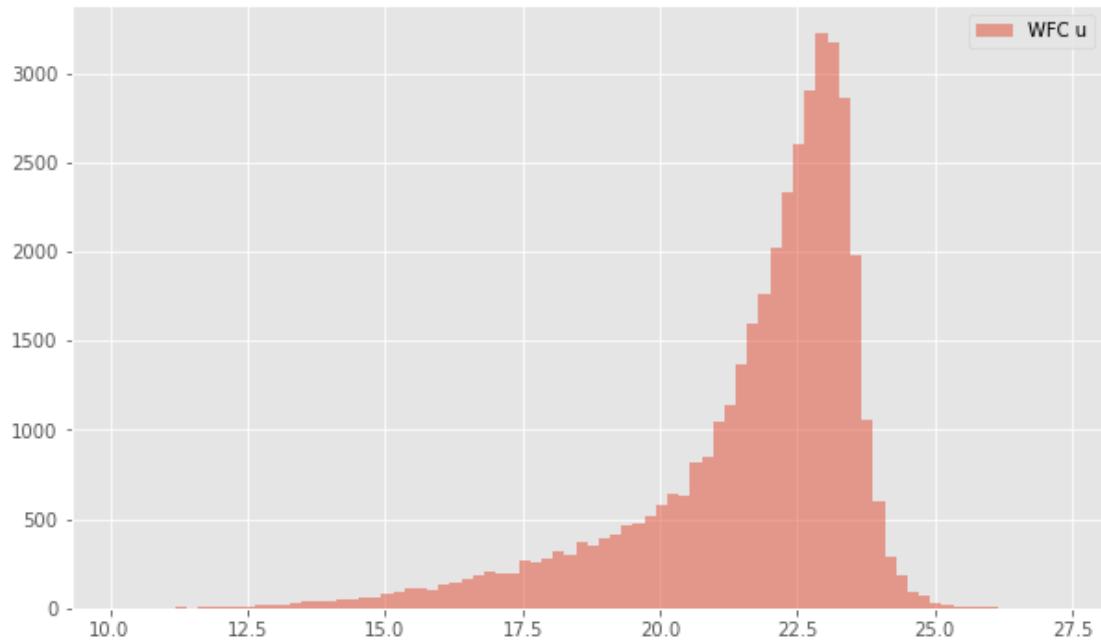


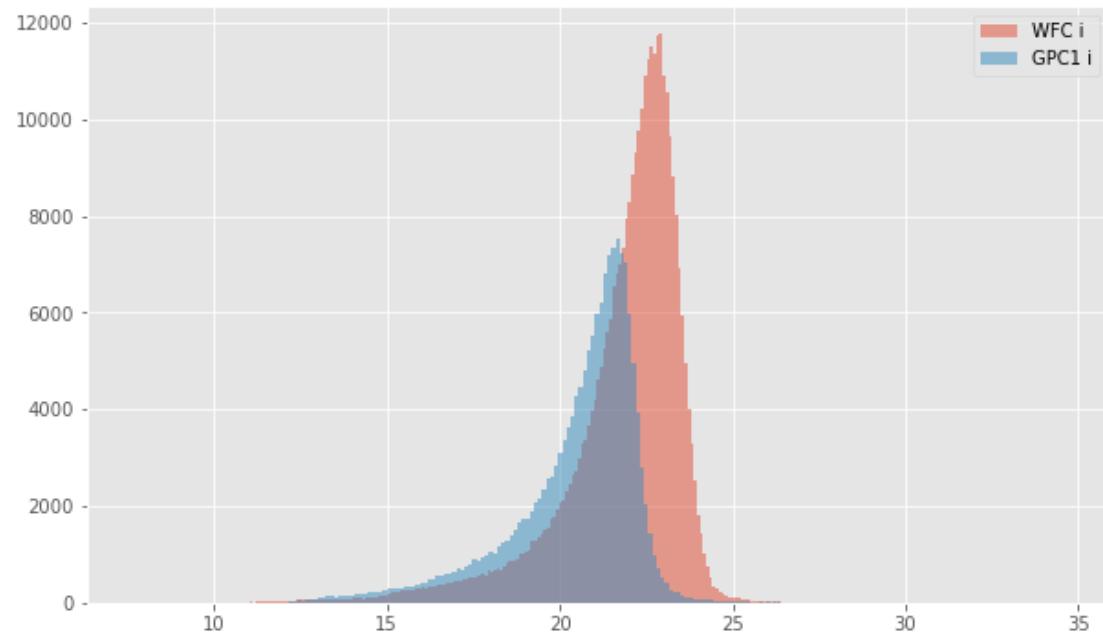
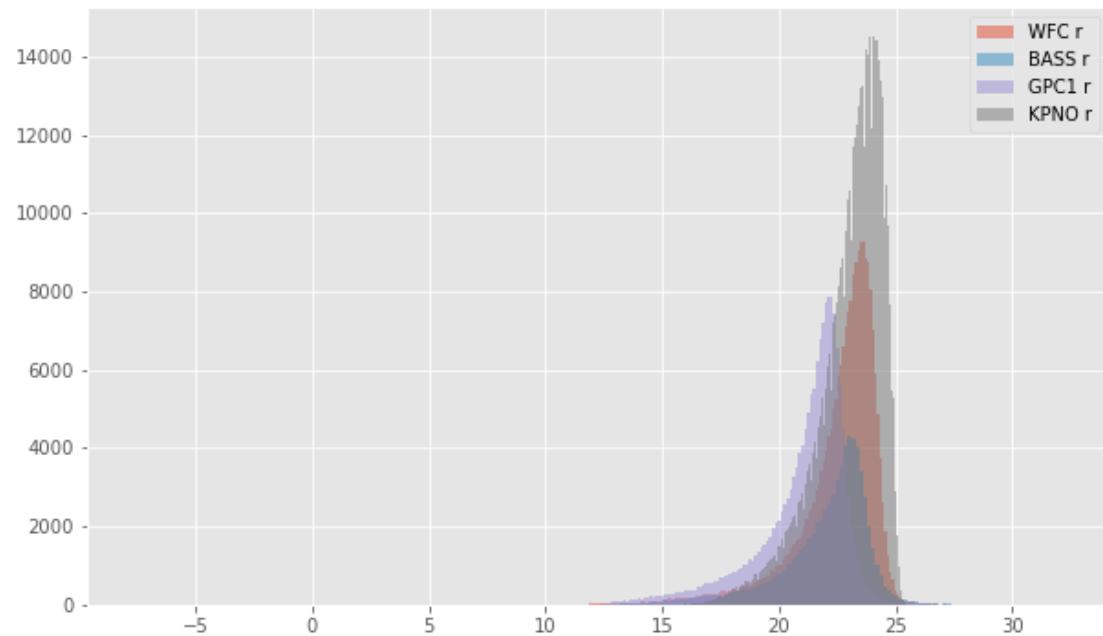
## 1.4 II - Comparing magnitudes in similar filters

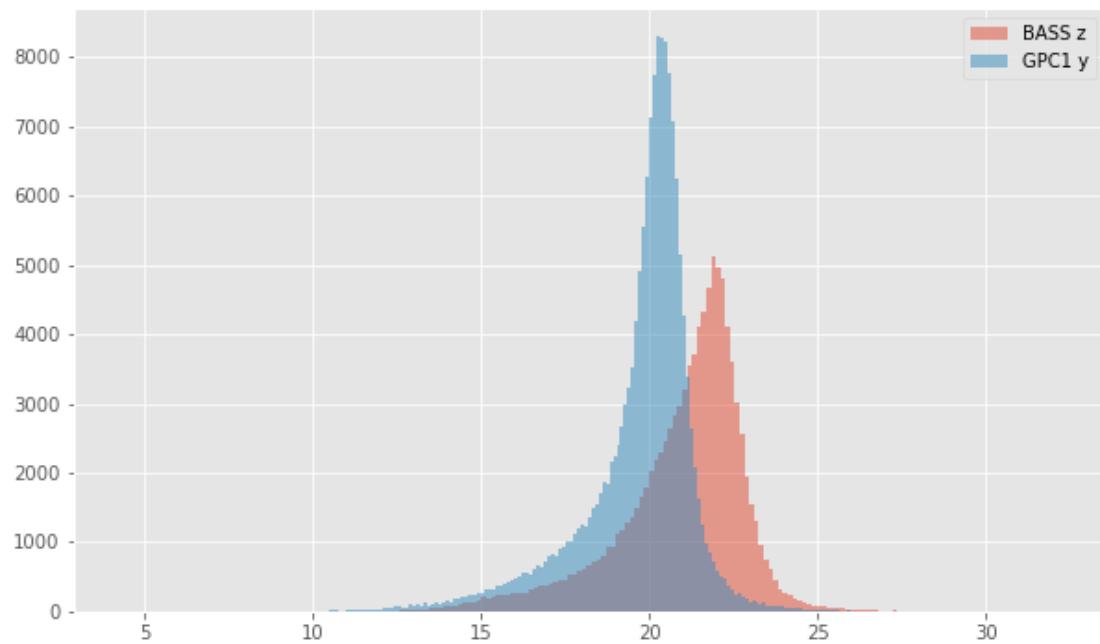
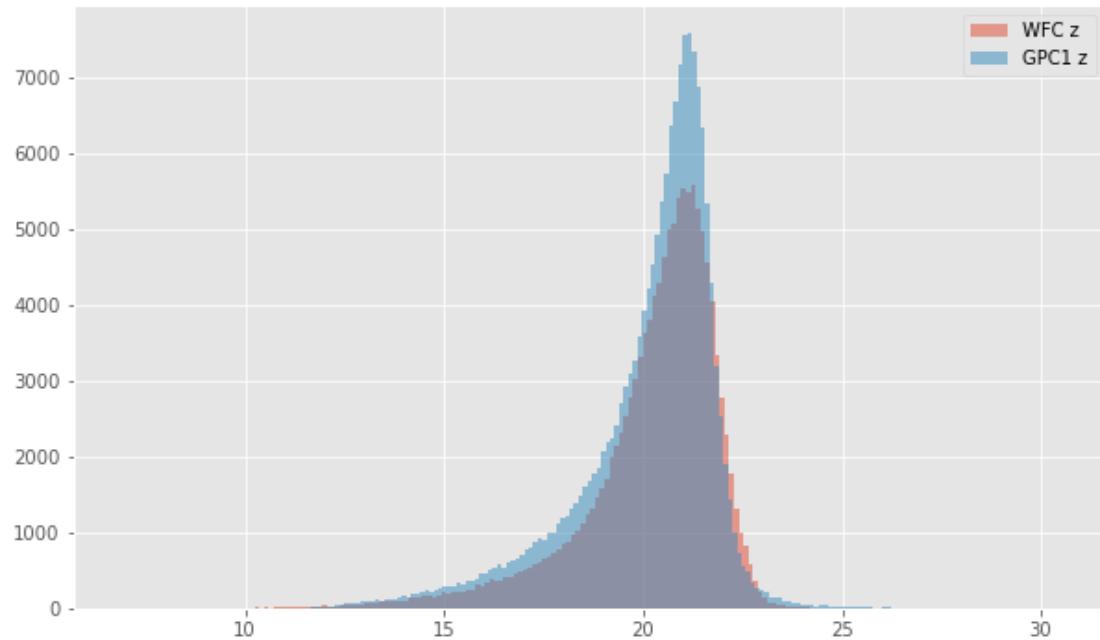
The master list is composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

### 1.4.1 II.a - Comparing depths

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



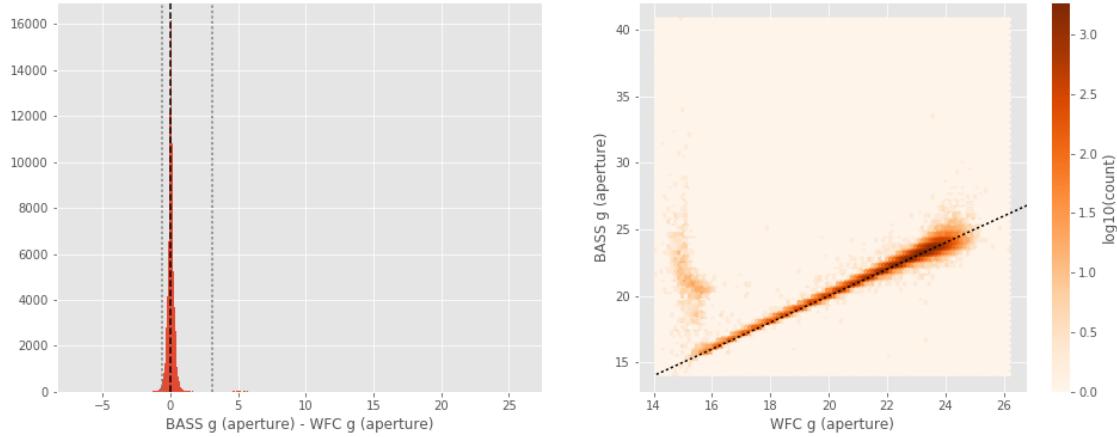




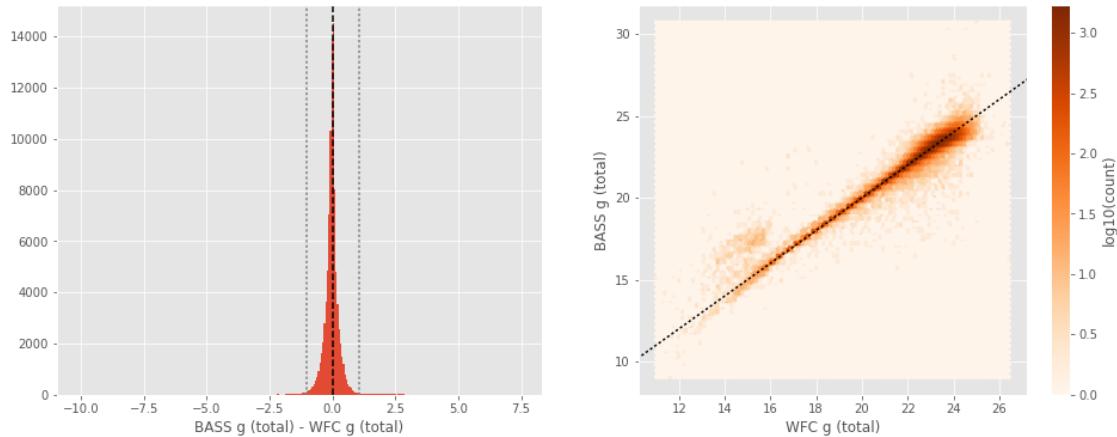
#### 1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

BASS g (aperture) - WFC g (aperture):  
 - Median: 0.05  
 - Median Absolute Deviation: 0.13  
 - 1% percentile: -0.6256225967407226  
 - 99% percentile: 3.0758930015563952

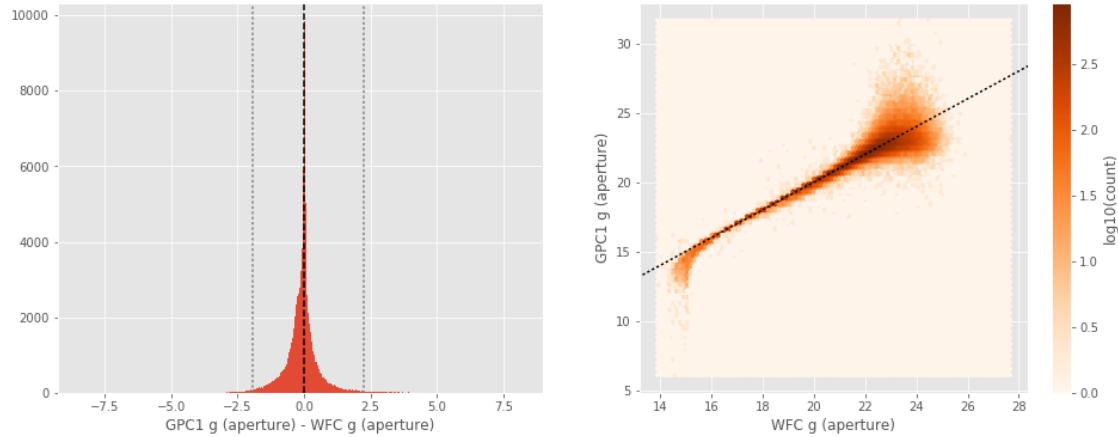


BASS g (total) - WFC g (total):  
 - Median: -0.02  
 - Median Absolute Deviation: 0.12  
 - 1% percentile: -1.0549715042114258  
 - 99% percentile: 1.0528565597534065



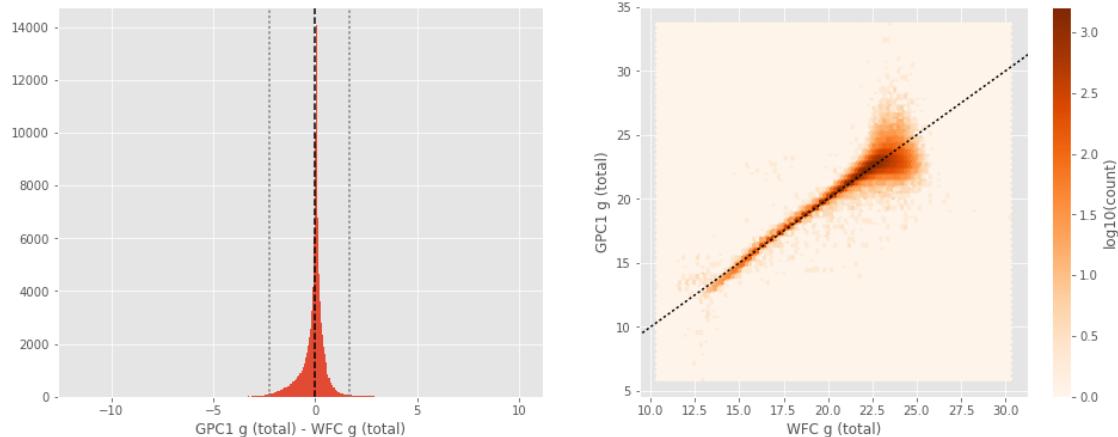
GPC1 g (aperture) - WFC g (aperture):  
 - Median: -0.03

- Median Absolute Deviation: 0.22
- 1% percentile: -1.936893730163574
- 99% percentile: 2.239777622222912



#### GPC1 g (total) - WFC g (total):

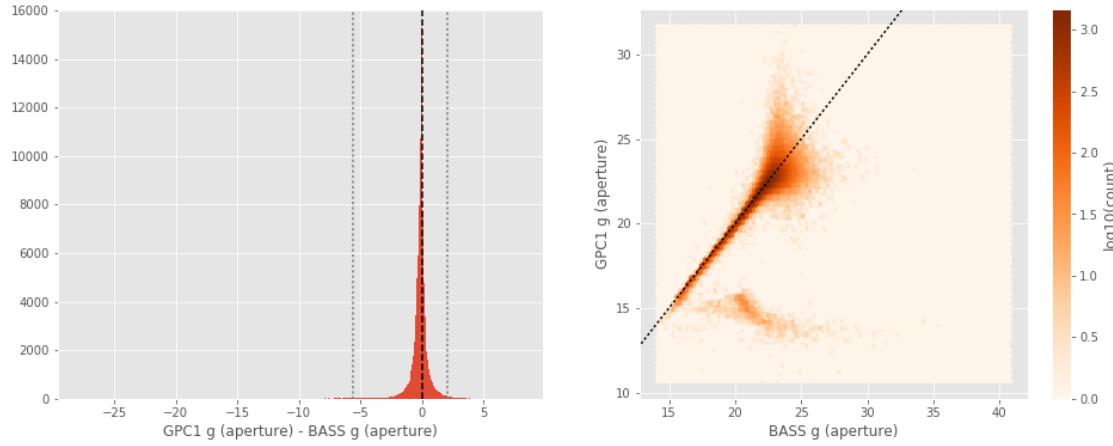
- Median: 0.03
- Median Absolute Deviation: 0.19
- 1% percentile: -2.26982141494751
- 99% percentile: 1.678289241790777



#### GPC1 g (aperture) - BASS g (aperture):

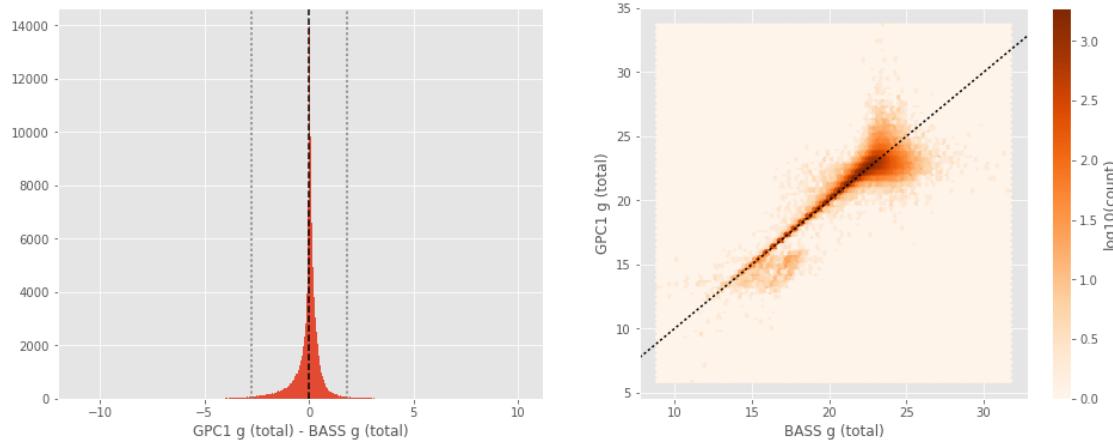
- Median: -0.11
- Median Absolute Deviation: 0.22
- 1% percentile: -5.588285446166992

- 99% percentile: 2.078149032592774



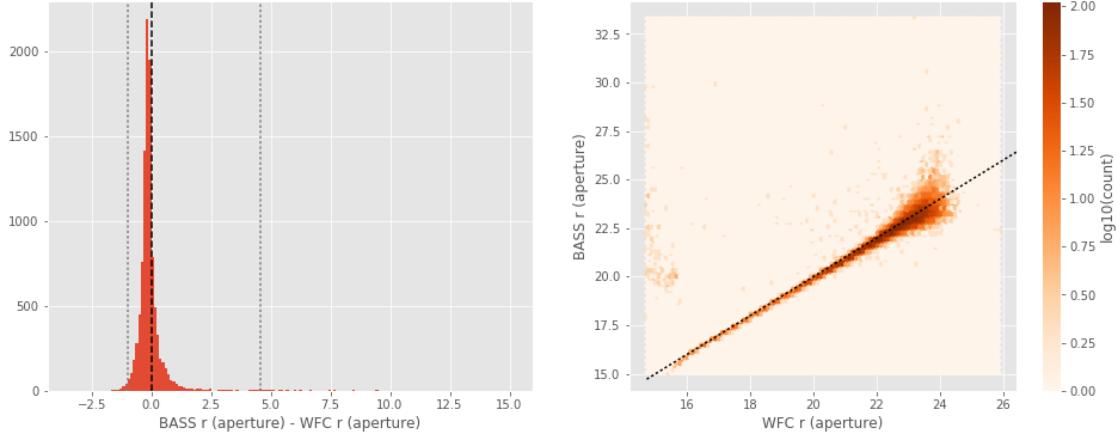
GPC1 g (total) - BASS g (total):

- Median: 0.03  
- Median Absolute Deviation: 0.18  
- 1% percentile: -2.754972381591797  
- 99% percentile: 1.8167191314697235



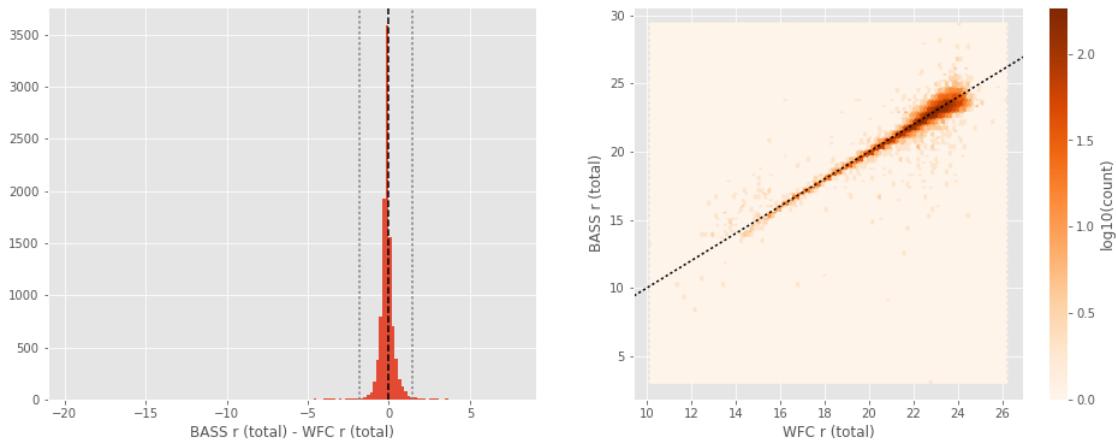
BASS r (aperture) - WFC r (aperture):

- Median: -0.13  
- Median Absolute Deviation: 0.15  
- 1% percentile: -1.005444869995117  
- 99% percentile: 4.584682769775396



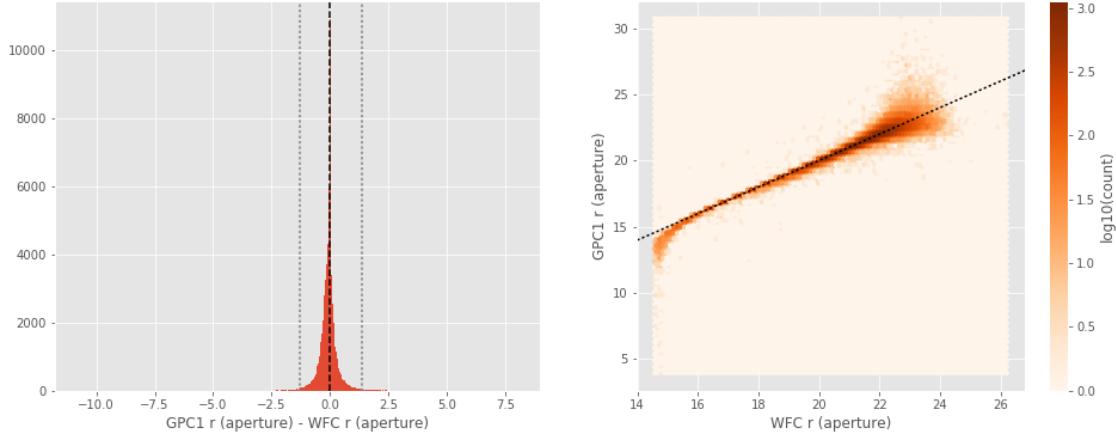
BASS r (total) - WFC r (total):

- Median: -0.13
- Median Absolute Deviation: 0.16
- 1% percentile: -1.8431853485107421
- 99% percentile: 1.4611610031127977



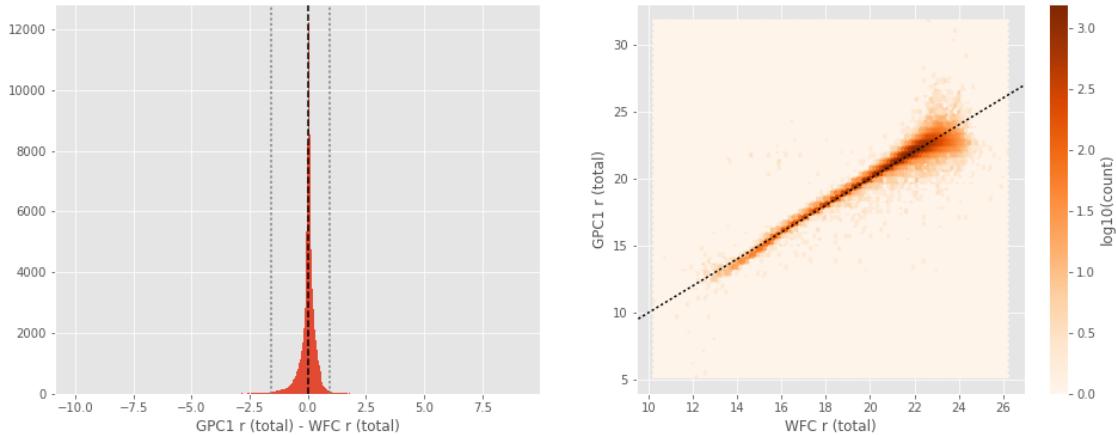
GPC1 r (aperture) - WFC r (aperture):

- Median: -0.03
- Median Absolute Deviation: 0.14
- 1% percentile: -1.2797001647949218
- 99% percentile: 1.3428354644775493



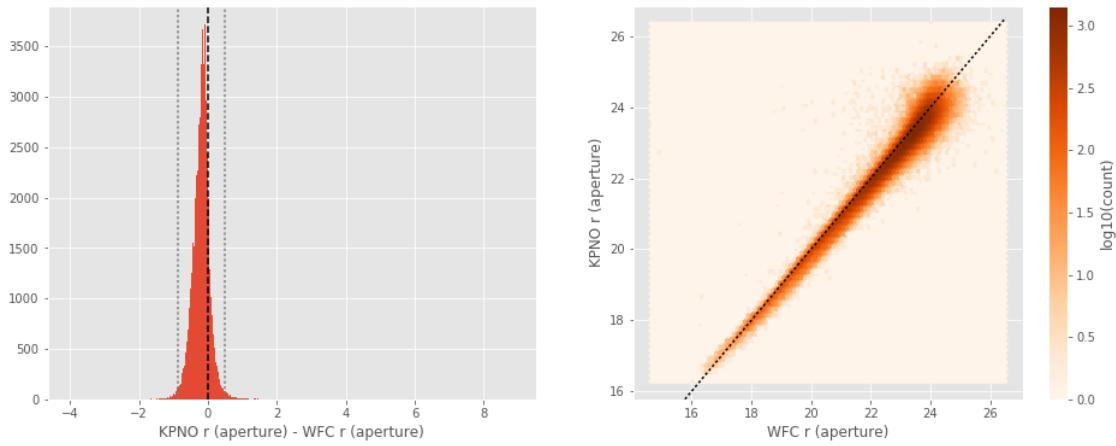
GPC1 r (total) - WFC r (total):

- Median: 0.05
- Median Absolute Deviation: 0.12
- 1% percentile: -1.5688879203796386
- 99% percentile: 0.9246087837219206



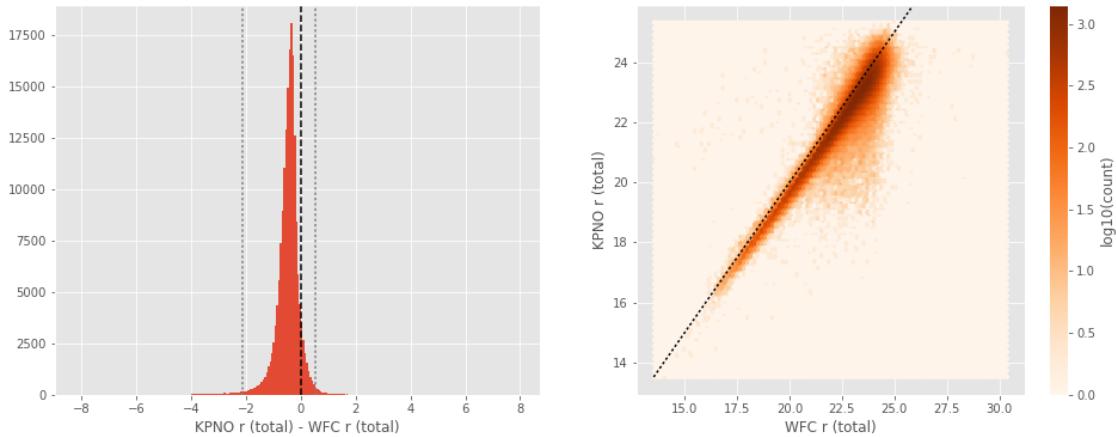
KPNO r (aperture) - WFC r (aperture):

- Median: -0.17
- Median Absolute Deviation: 0.14
- 1% percentile: -0.8770008087158203
- 99% percentile: 0.5059786605835066



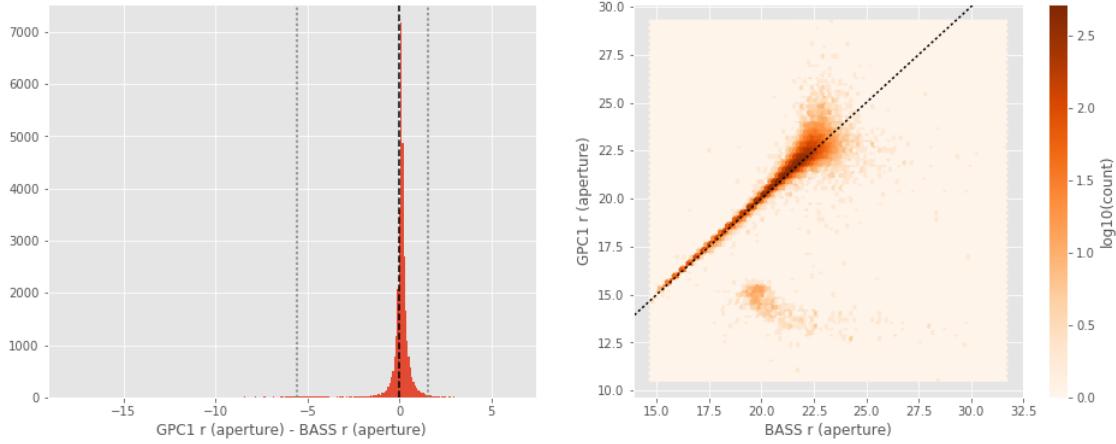
KPNO r (total) - WFC r (total):

- Median: -0.41
- Median Absolute Deviation: 0.19
- 1% percentile: -2.126770496368408
- 99% percentile: 0.5179996490478516



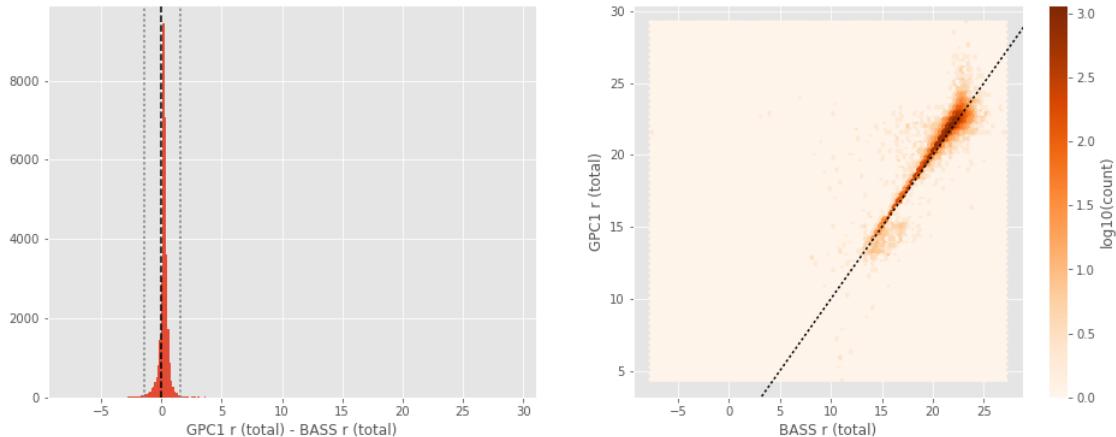
GPC1 r (aperture) - BASS r (aperture):

- Median: 0.10
- Median Absolute Deviation: 0.13
- 1% percentile: -5.567615804672242
- 99% percentile: 1.5617235946655268



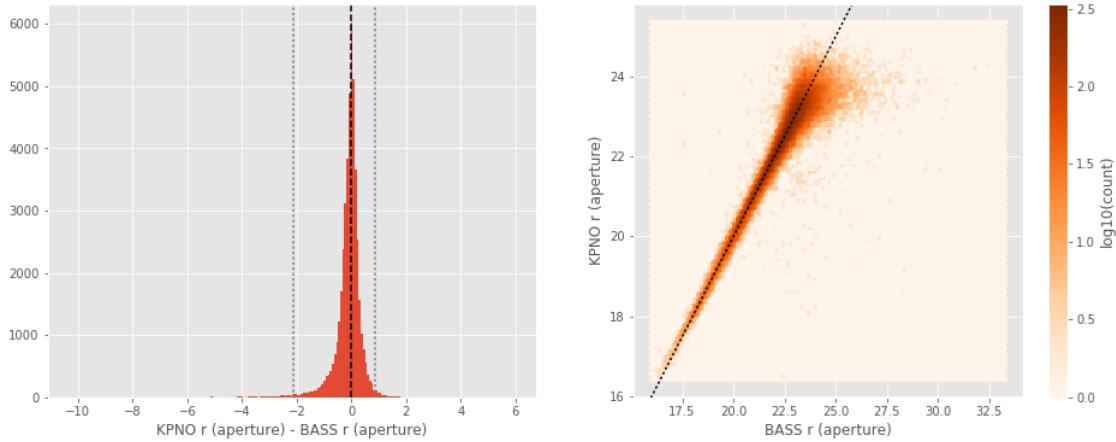
GPC1 r (total) - BASS r (total):

- Median: 0.21
- Median Absolute Deviation: 0.13
- 1% percentile: -1.4610954570770263
- 99% percentile: 1.5784747123718255



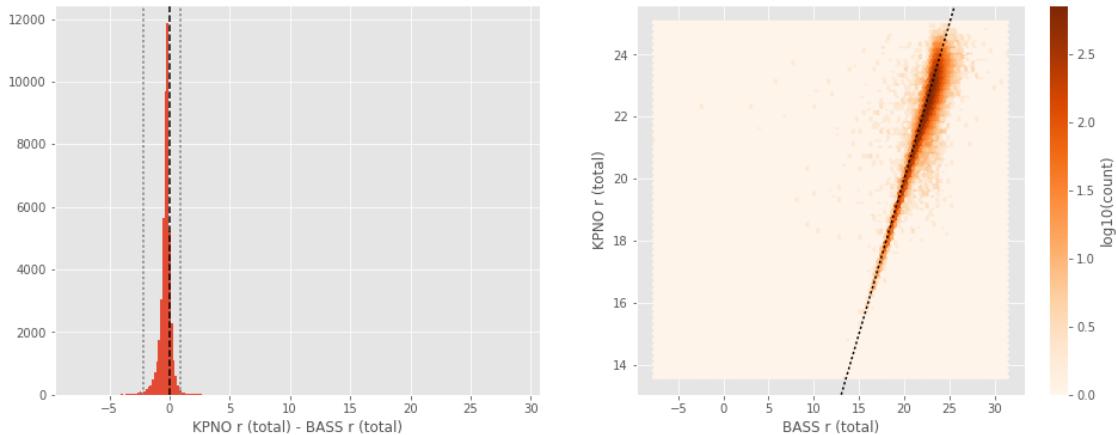
KPNO r (aperture) - BASS r (aperture):

- Median: -0.04
- Median Absolute Deviation: 0.18
- 1% percentile: -2.1393571090698242
- 99% percentile: 0.8618970489501949



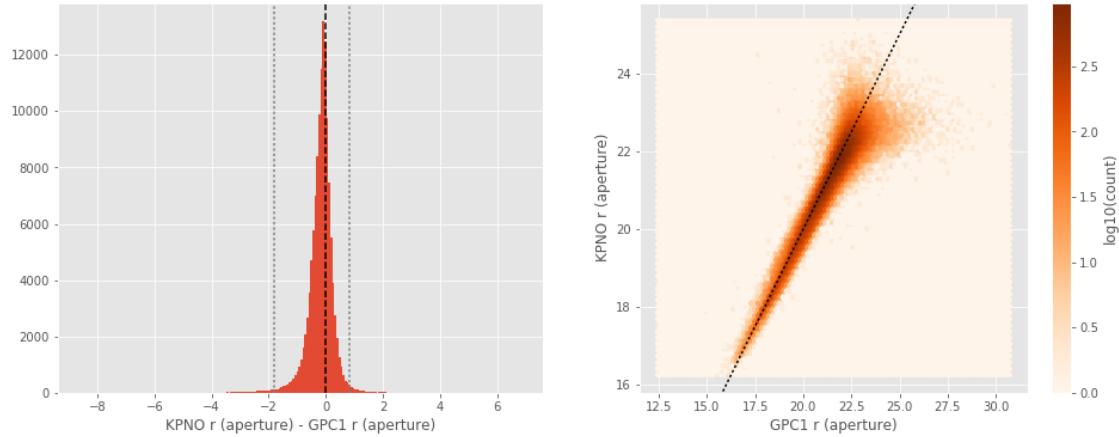
KPNO r (total) - BASS r (total):

- Median: -0.27
- Median Absolute Deviation: 0.19
- 1% percentile: -2.146008892059326
- 99% percentile: 0.9464354515075717



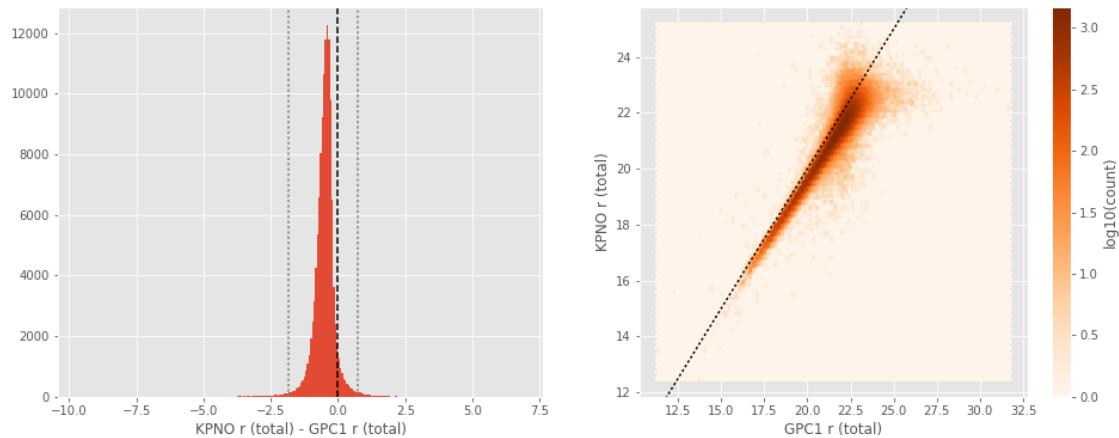
KPNO r (aperture) - GPC1 r (aperture):

- Median: -0.12
- Median Absolute Deviation: 0.20
- 1% percentile: -1.8193340682983399
- 99% percentile: 0.821635704040526



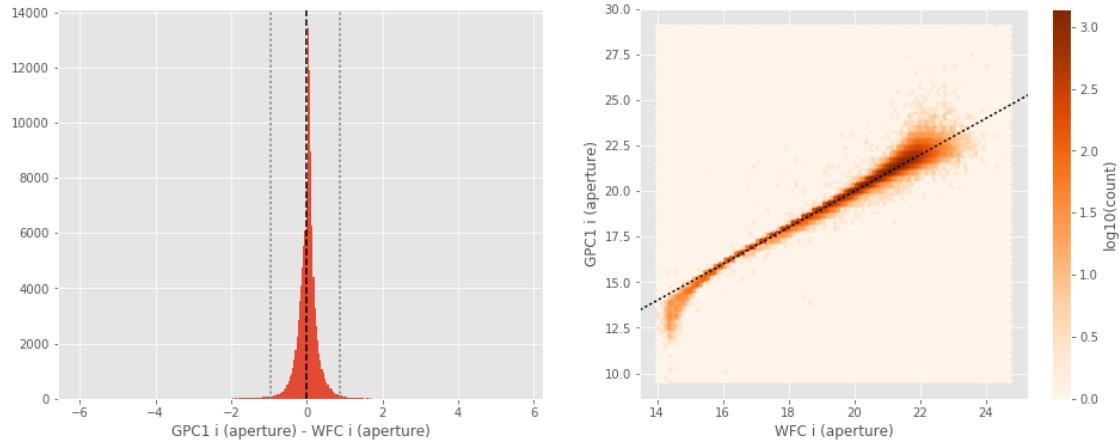
KPNO r (total) - GPC1 r (total):

- Median: -0.47
- Median Absolute Deviation: 0.18
- 1% percentile: -1.8546954727172853
- 99% percentile: 0.7358176422119134



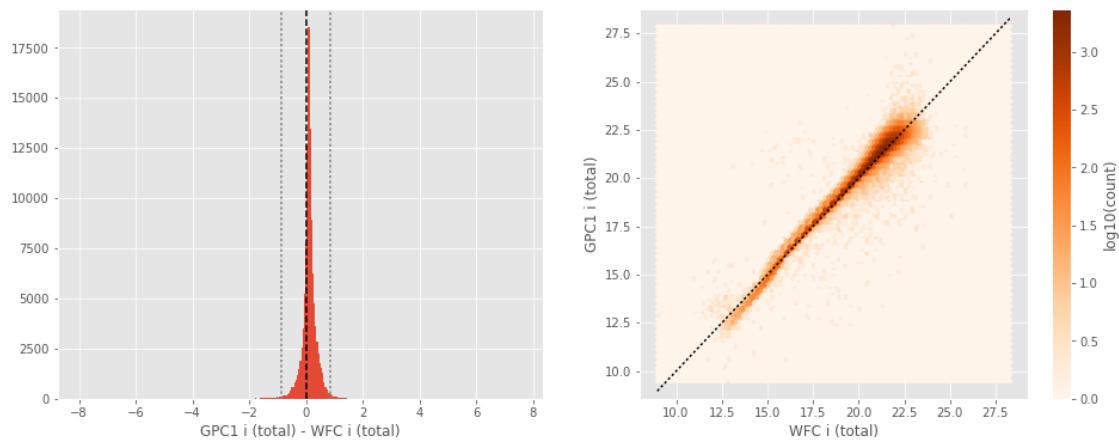
GPC1 i (aperture) - WFC i (aperture):

- Median: 0.04
- Median Absolute Deviation: 0.11
- 1% percentile: -0.952352294921875
- 99% percentile: 0.8918610382079997



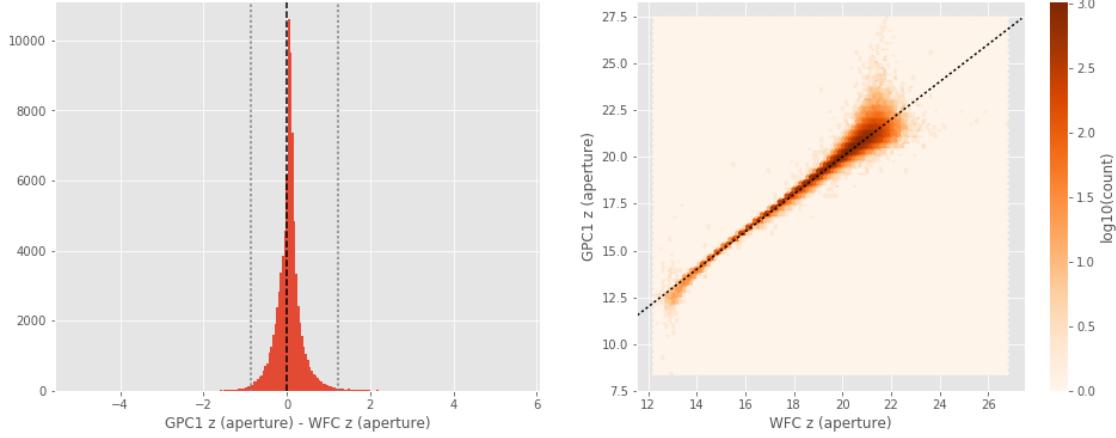
GPC1 i (total) - WFC i (total):

- Median: 0.11
- Median Absolute Deviation: 0.10
- 1% percentile: -0.8853607177734375
- 99% percentile: 0.8438045501708963



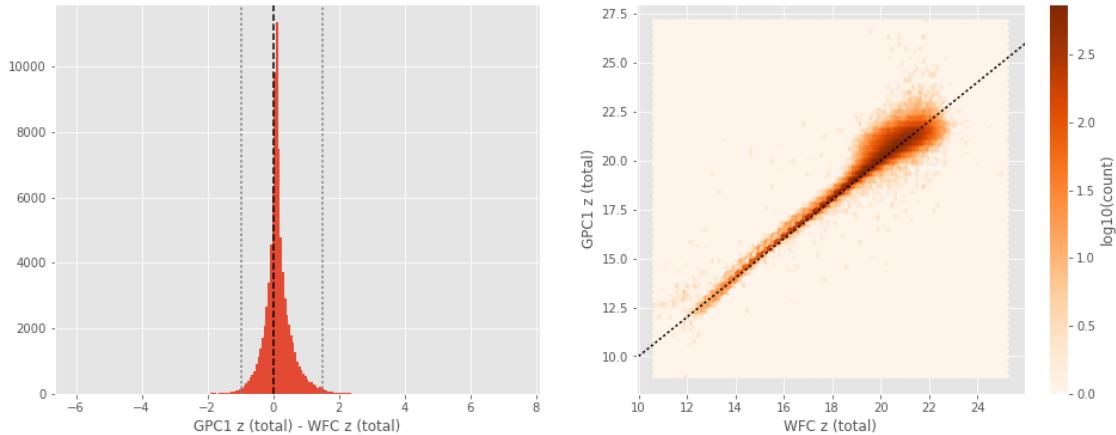
GPC1 z (aperture) - WFC z (aperture):

- Median: 0.06
- Median Absolute Deviation: 0.13
- 1% percentile: -0.8765241622924804
- 99% percentile: 1.23230981826782



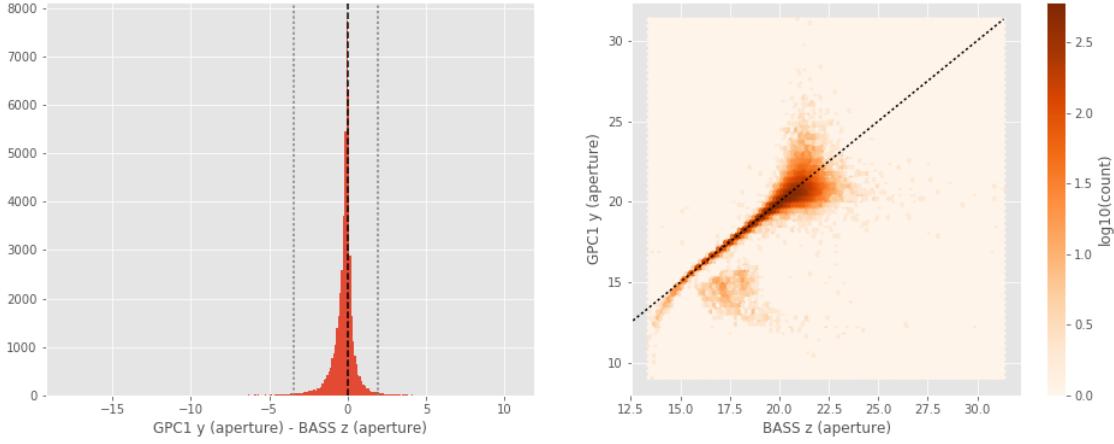
GPC1 z (total) - WFC z (total):

- Median: 0.10
- Median Absolute Deviation: 0.17
- 1% percentile: -0.9696512603759765
- 99% percentile: 1.490121402740476



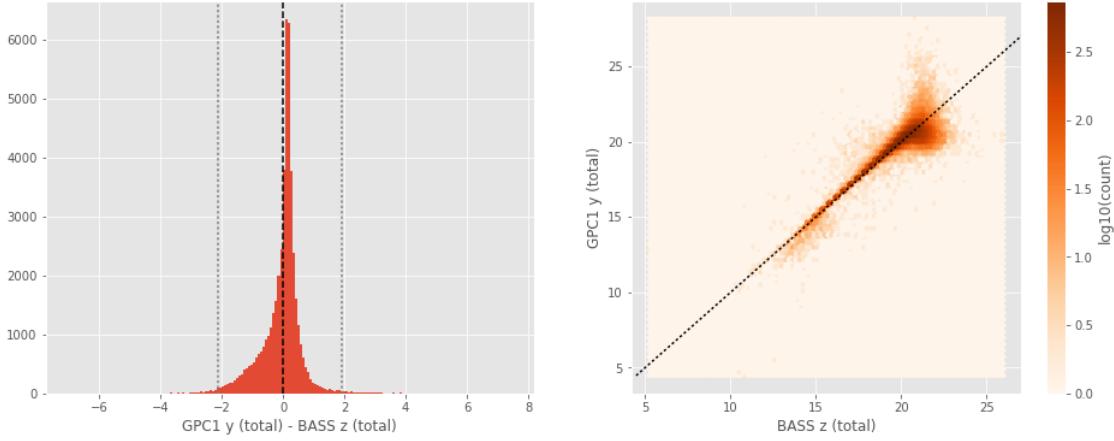
GPC1 y (aperture) - BASS z (aperture):

- Median: -0.10
- Median Absolute Deviation: 0.22
- 1% percentile: -3.4303236579895016
- 99% percentile: 1.9012526702880828



GPC1 y (total) - BASS z (total):

- Median: 0.08
- Median Absolute Deviation: 0.22
- 1% percentile: -2.127430629730225
- 99% percentile: 1.8989069938659666



## 1.5 III - Comparing magnitudes to reference bands

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

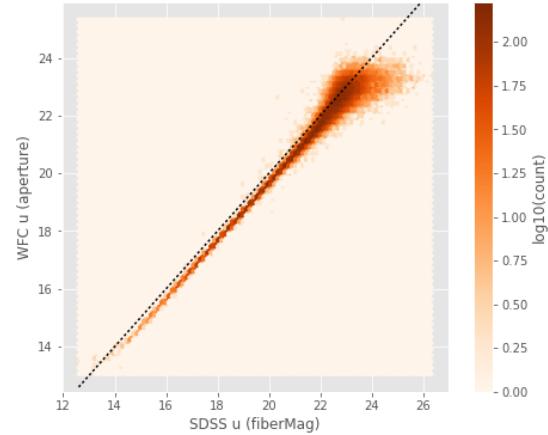
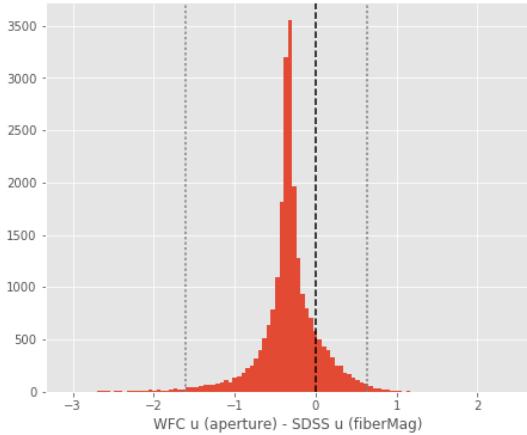
### 1.5.1 III.a - Comparing u, g, r, i, and z bands to SDSS

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

We compare the u, g, r, i, and z magnitudes to those from SDSS using `fiberMag` for the aperture magnitude and `petroMag` for the total magnitude.

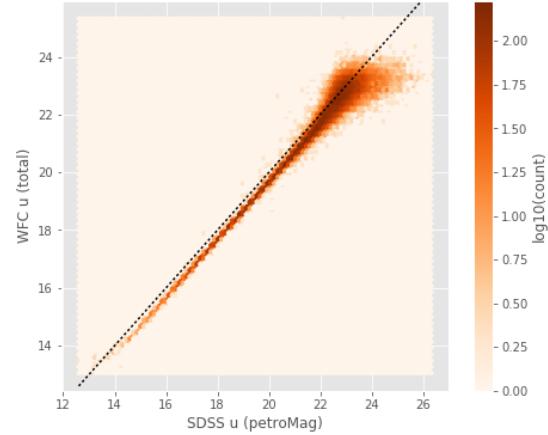
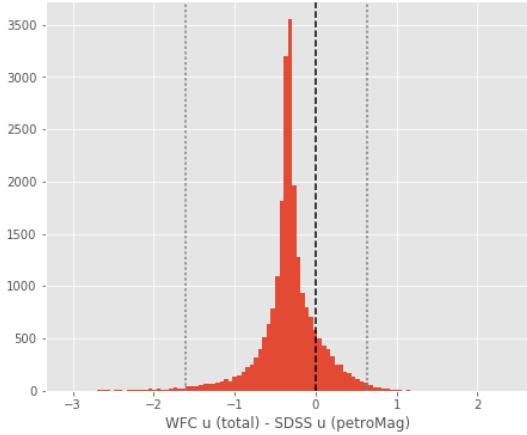
WFC u (aperture) - SDSS u (fiberMag):

- Median: -0.33
- Median Absolute Deviation: 0.13
- 1% percentile: -1.6017975616455078
- 99% percentile: 0.6325454711914066



WFC u (total) - SDSS u (petroMag):

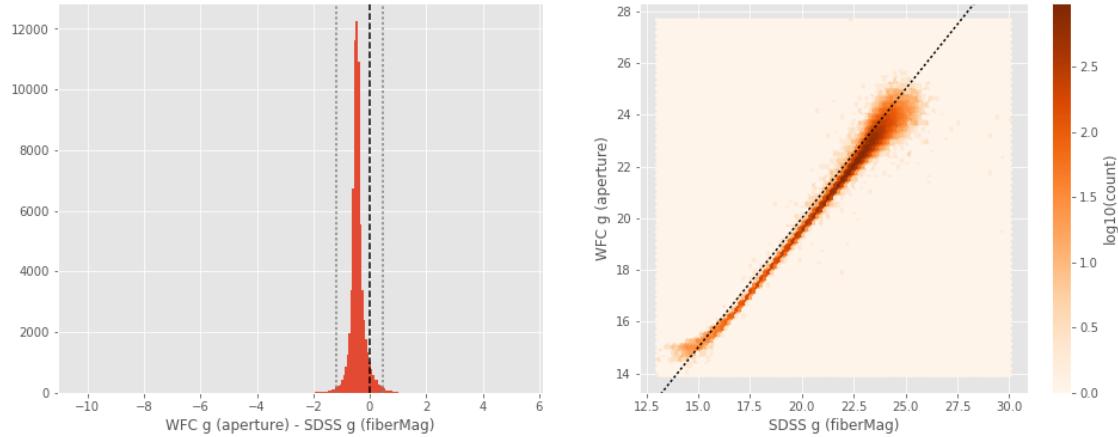
- Median: -0.33
- Median Absolute Deviation: 0.13
- 1% percentile: -1.6017975616455078
- 99% percentile: 0.6325454711914066



WFC g (aperture) - SDSS g (fiberMag):

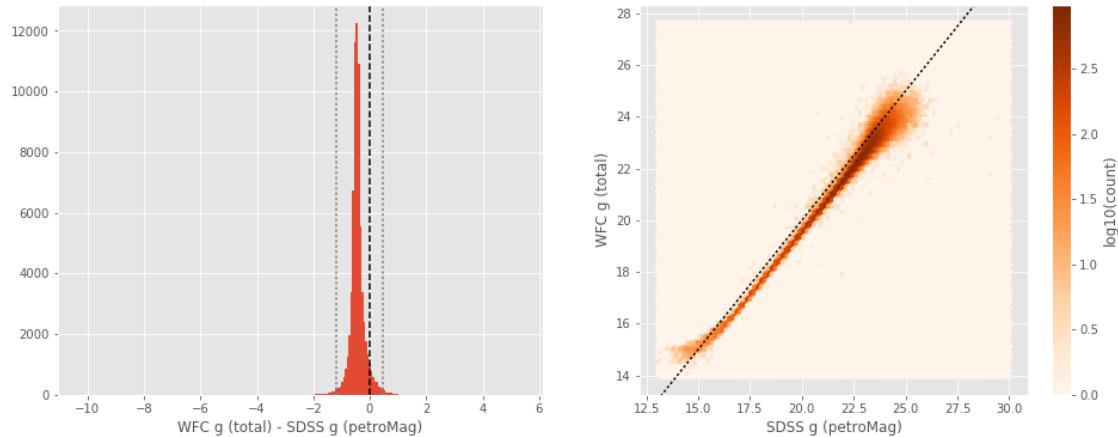
- Median: -0.45

- Median Absolute Deviation: 0.10
- 1% percentile: -1.1772414016723634
- 99% percentile: 0.4478158187866218



WFC g (total) - SDSS g (petroMag) :

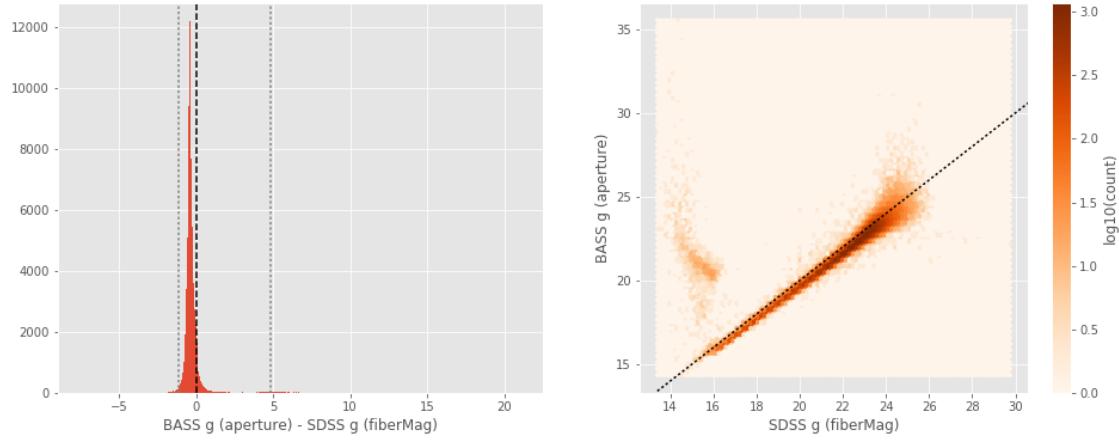
- Median: -0.45
- Median Absolute Deviation: 0.10
- 1% percentile: -1.1772414016723634
- 99% percentile: 0.4478158187866218



BASS g (aperture) - SDSS g (fiberMag) :

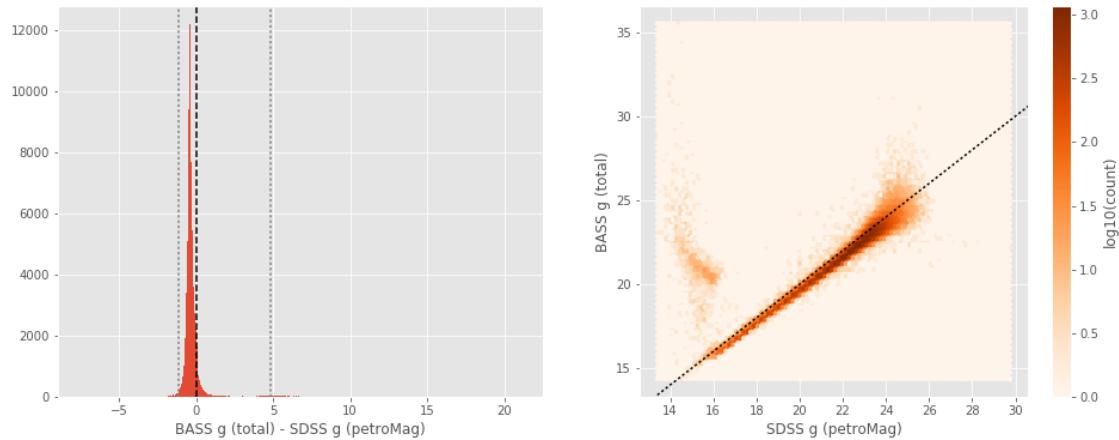
- Median: -0.38
- Median Absolute Deviation: 0.14
- 1% percentile: -1.101987075805664

- 99% percentile: 4.830027141571065



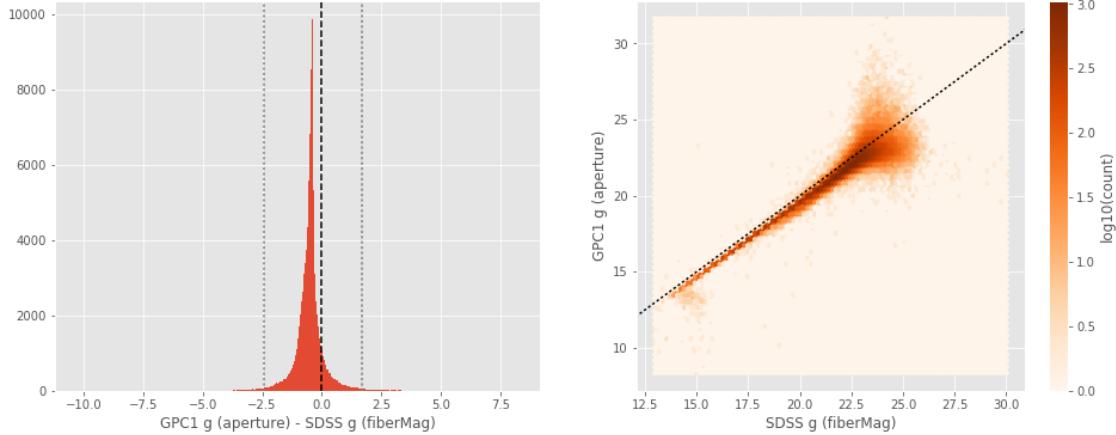
BASS g (total) - SDSS g (petroMag):

- Median: -0.38
- Median Absolute Deviation: 0.14
- 1% percentile: -1.101987075805664
- 99% percentile: 4.830027141571065



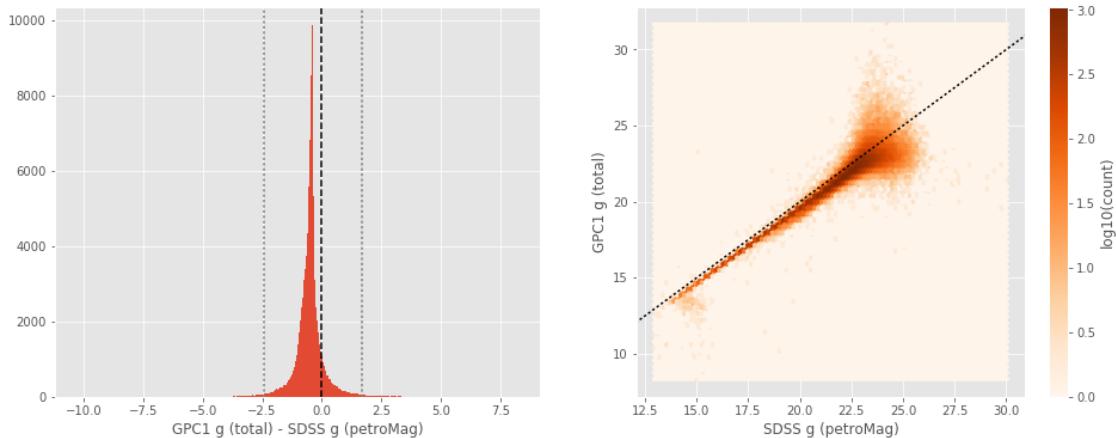
GPC1 g (aperture) - SDSS g (fiberMag):

- Median: -0.47
- Median Absolute Deviation: 0.20
- 1% percentile: -2.4040427207946777
- 99% percentile: 1.6819067001342773



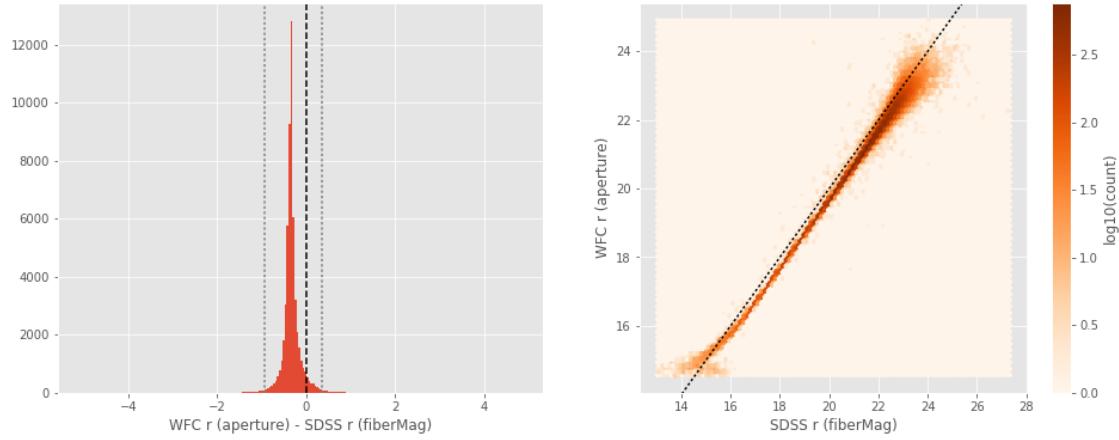
GPC1 g (total) - SDSS g (petroMag):

- Median: -0.47
- Median Absolute Deviation: 0.20
- 1% percentile: -2.4040427207946777
- 99% percentile: 1.6819067001342773



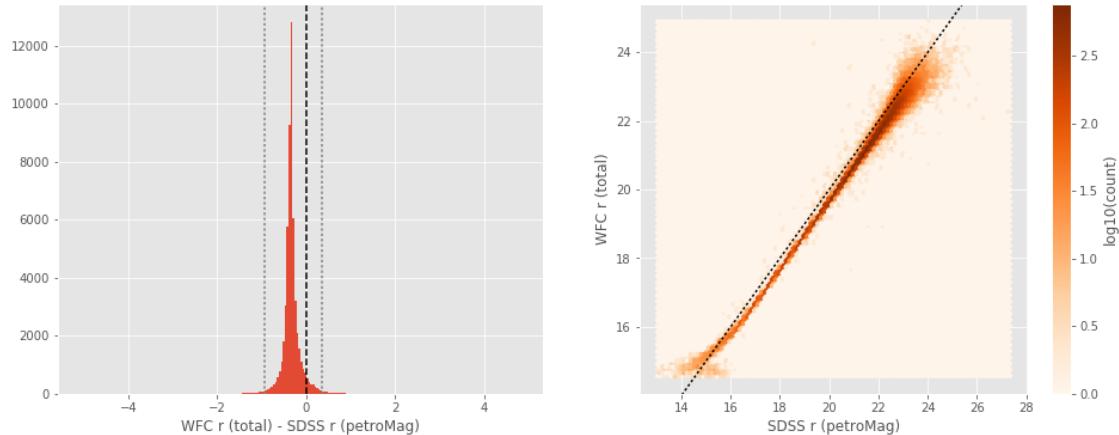
WFC r (aperture) - SDSS r (fiberMag):

- Median: -0.34
- Median Absolute Deviation: 0.06
- 1% percentile: -0.9351469993591308
- 99% percentile: 0.3601674079895015



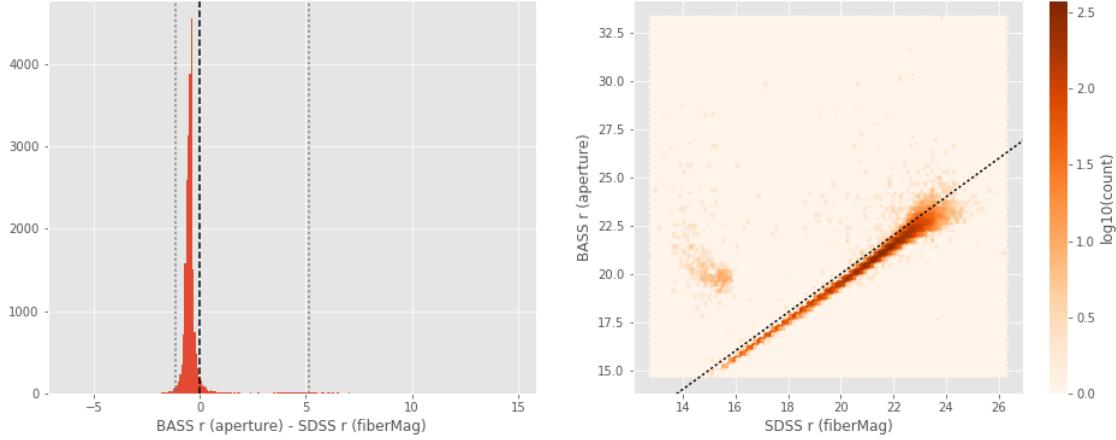
WFC r (total) - SDSS r (petroMag) :

- Median: -0.34
- Median Absolute Deviation: 0.06
- 1% percentile: -0.9351469993591308
- 99% percentile: 0.3601674079895015



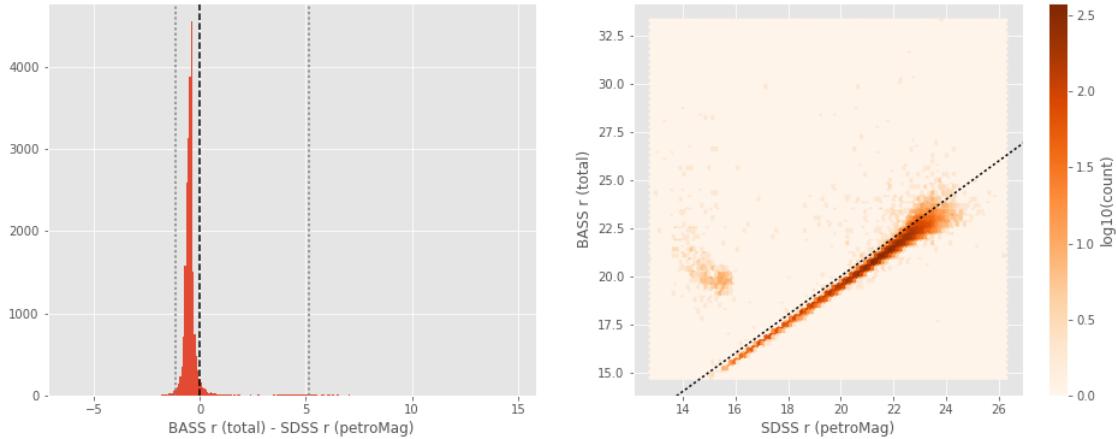
BASS r (aperture) - SDSS r (fiberMag) :

- Median: -0.46
- Median Absolute Deviation: 0.11
- 1% percentile: -1.1453510665893556
- 99% percentile: 5.127978057861326



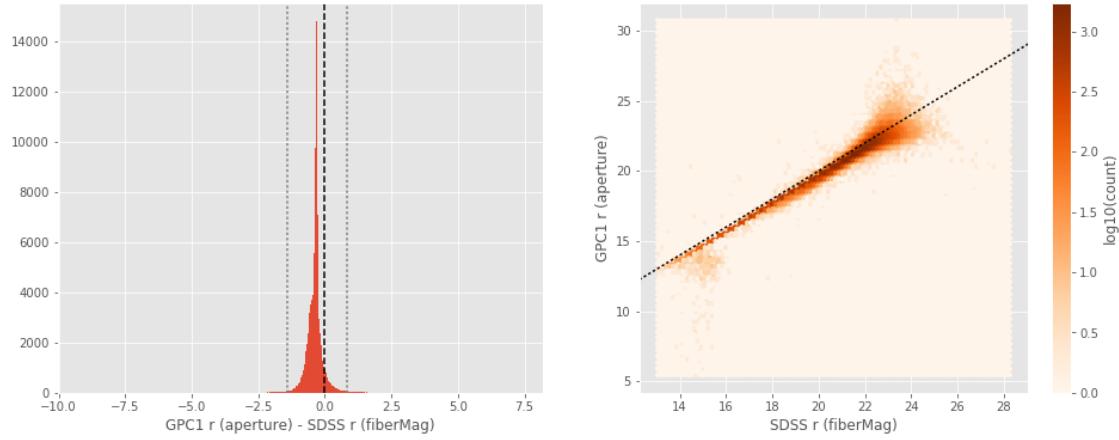
BASS r (total) - SDSS r (petroMag):

- Median: -0.46
- Median Absolute Deviation: 0.11
- 1% percentile: -1.1453510665893556
- 99% percentile: 5.127978057861326



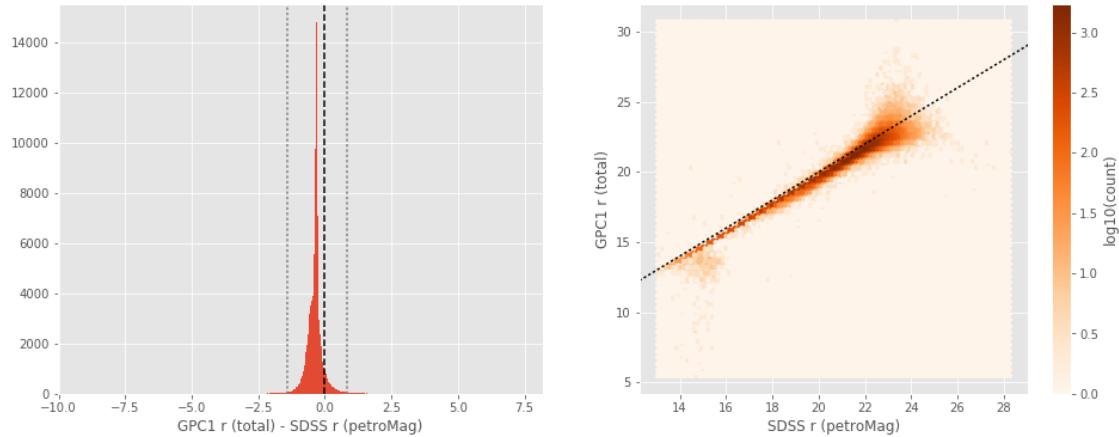
GPC1 r (aperture) - SDSS r (fiberMag):

- Median: -0.34
- Median Absolute Deviation: 0.12
- 1% percentile: -1.4154183197021484
- 99% percentile: 0.8237089157104492



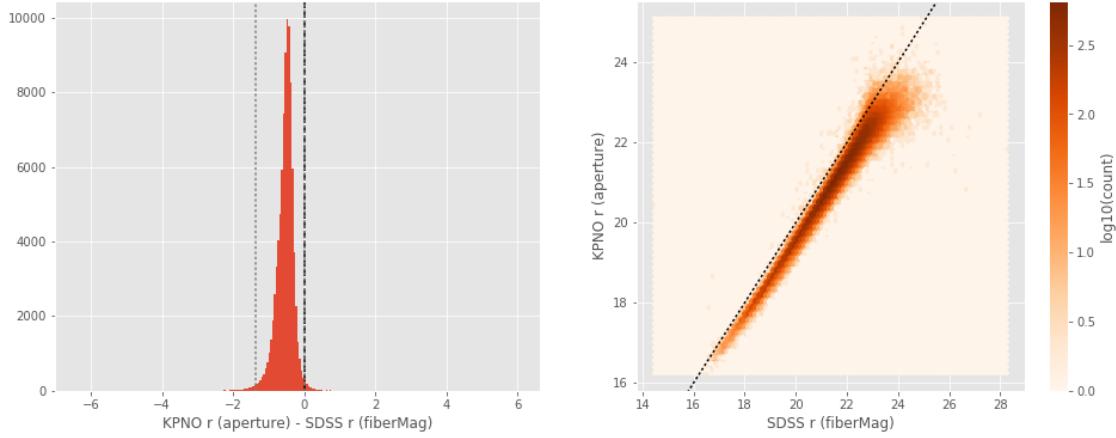
GPC1 r (total) - SDSS r (petroMag):

- Median: -0.34
- Median Absolute Deviation: 0.12
- 1% percentile: -1.4154183197021484
- 99% percentile: 0.8237089157104492



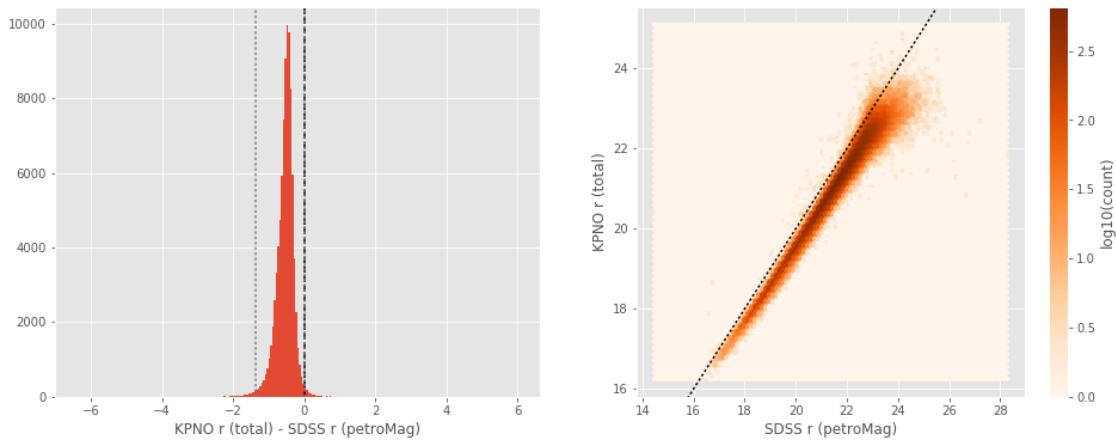
KPNO r (aperture) - SDSS r (fiberMag):

- Median: -0.50
- Median Absolute Deviation: 0.13
- 1% percentile: -1.3614568710327148
- 99% percentile: 0.02729091644287046



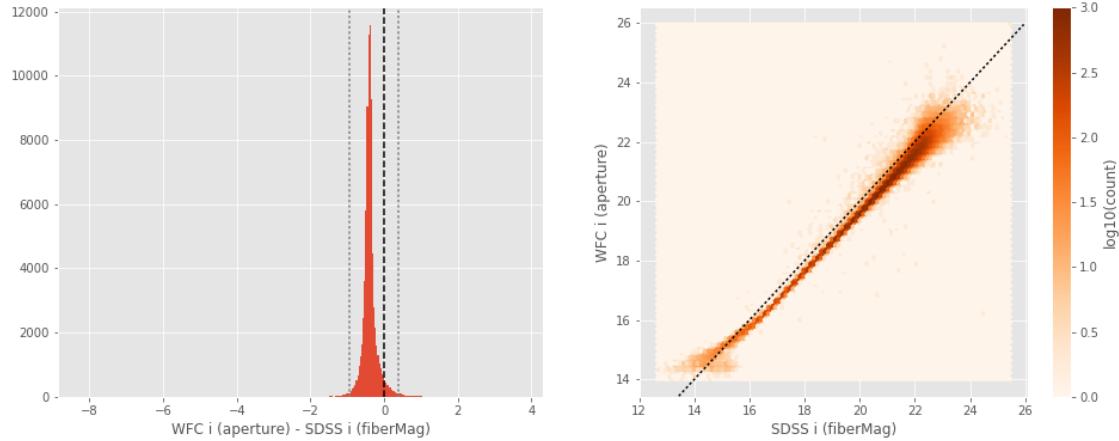
KPNO r (total) - SDSS r (petroMag):

- Median: -0.50
- Median Absolute Deviation: 0.13
- 1% percentile: -1.3614568710327148
- 99% percentile: 0.02729091644287046



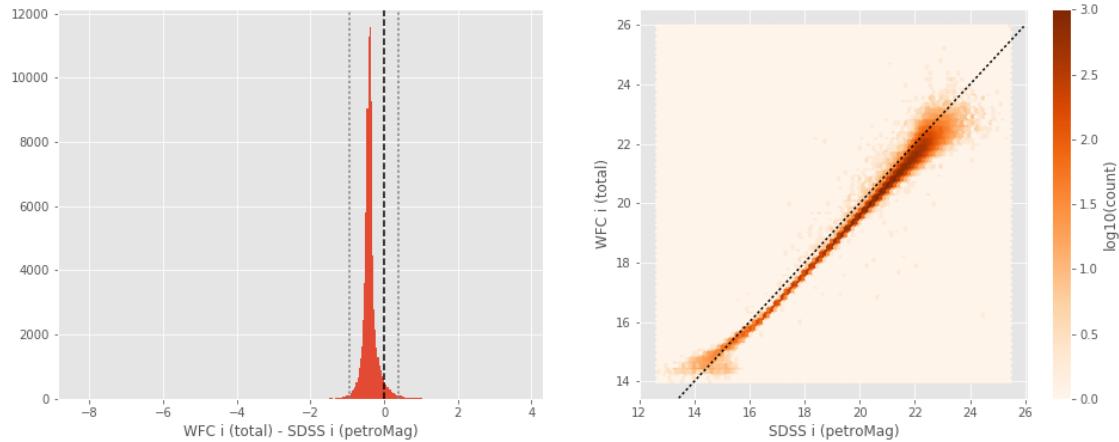
WFC i (aperture) - SDSS i (fiberMag):

- Median: -0.40
- Median Absolute Deviation: 0.07
- 1% percentile: -0.9382619476318359
- 99% percentile: 0.3755919170379611



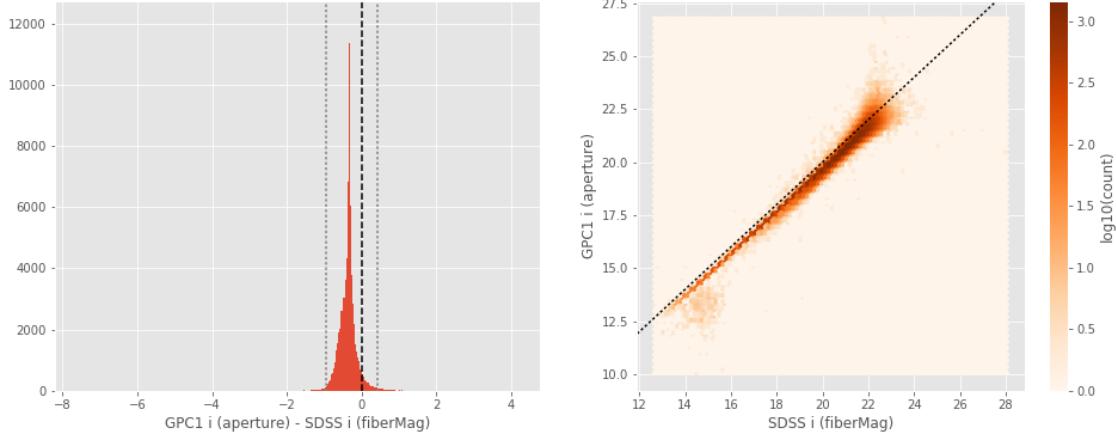
WFC i (total) - SDSS i (petroMag) :

- Median: -0.40
- Median Absolute Deviation: 0.07
- 1% percentile: -0.9382619476318359
- 99% percentile: 0.3755919170379611



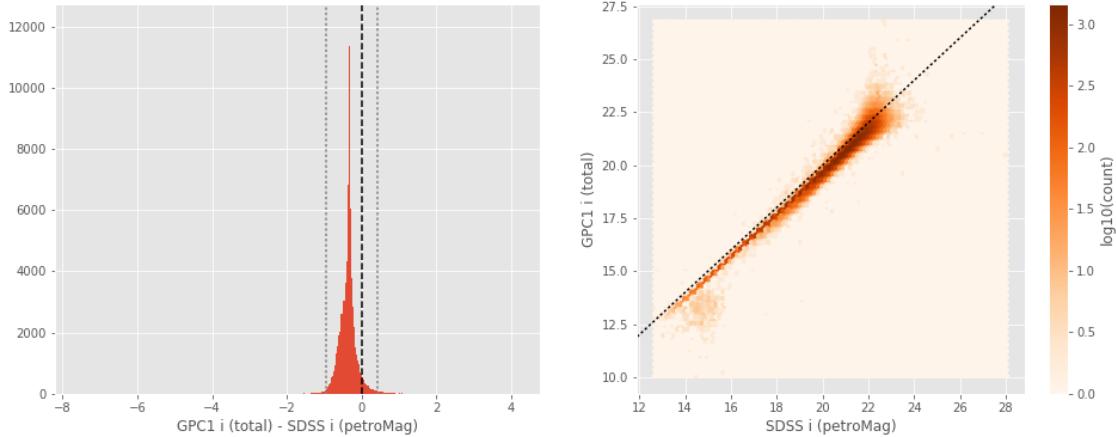
GPC1 i (aperture) - SDSS i (fiberMag) :

- Median: -0.34
- Median Absolute Deviation: 0.09
- 1% percentile: -0.9665631103515625
- 99% percentile: 0.4199513244628907



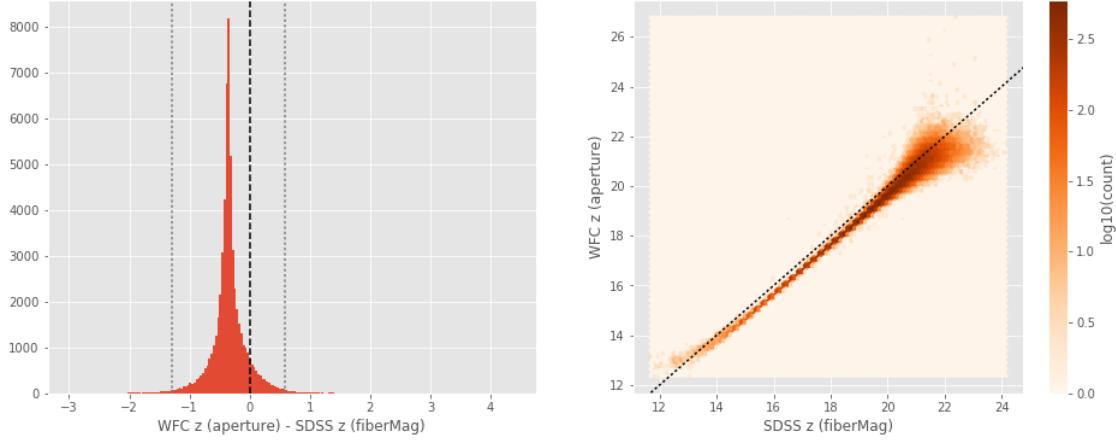
GPC1 i (total) - SDSS i (petroMag):

- Median: -0.34
- Median Absolute Deviation: 0.09
- 1% percentile: -0.9665631103515625
- 99% percentile: 0.4199513244628907



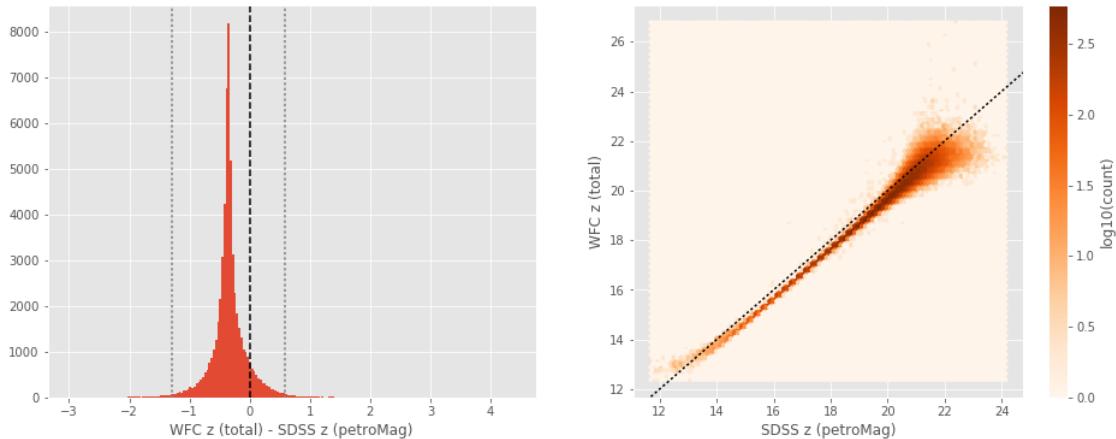
WFC z (aperture) - SDSS z (fiberMag):

- Median: -0.35
- Median Absolute Deviation: 0.10
- 1% percentile: -1.2951622009277344
- 99% percentile: 0.58636474609375



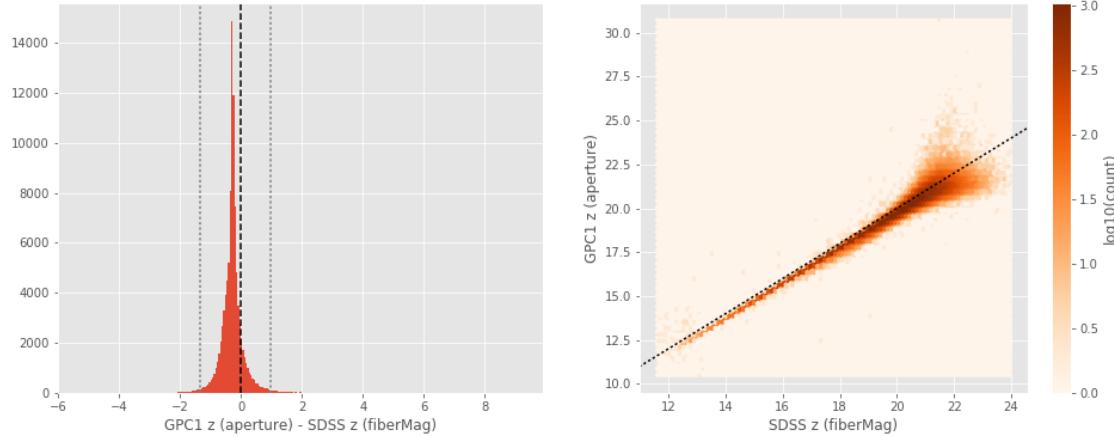
WFC z (total) - SDSS z (petroMag) :

- Median: -0.35
- Median Absolute Deviation: 0.10
- 1% percentile: -1.2951622009277344
- 99% percentile: 0.58636474609375



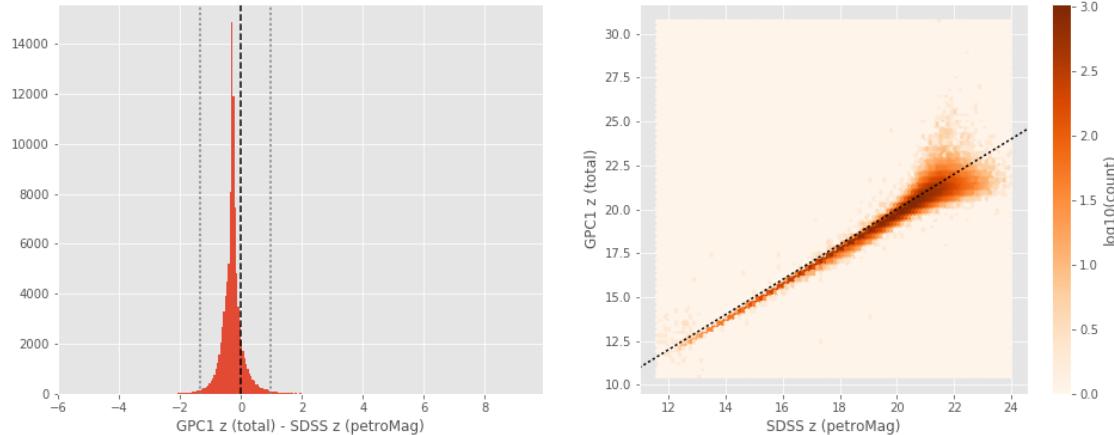
GPC1 z (aperture) - SDSS z (fiberMag) :

- Median: -0.29
- Median Absolute Deviation: 0.13
- 1% percentile: -1.3401688385009765
- 99% percentile: 0.9634982299804702



GPC1 z (total) - SDSS z (petroMag):

- Median: -0.29
- Median Absolute Deviation: 0.13
- 1% percentile: -1.3401688385009765
- 99% percentile: 0.9634982299804702



### 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](#):

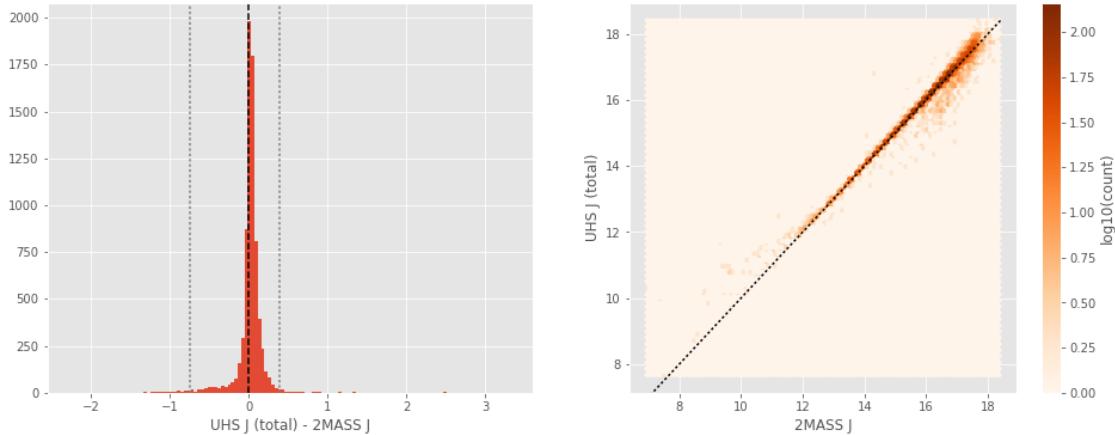
Band	F - 0 mag (Jy)
J	1594
H	1024
Ks	666.7

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:

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

UHS J (total) - 2MASS J:

- Median: 0.03
- Median Absolute Deviation: 0.04
- 1% percentile: -0.7433211570646104
- 99% percentile: 0.3831149141023818



The graph above originally revealed that UHS needed conversion to AB.

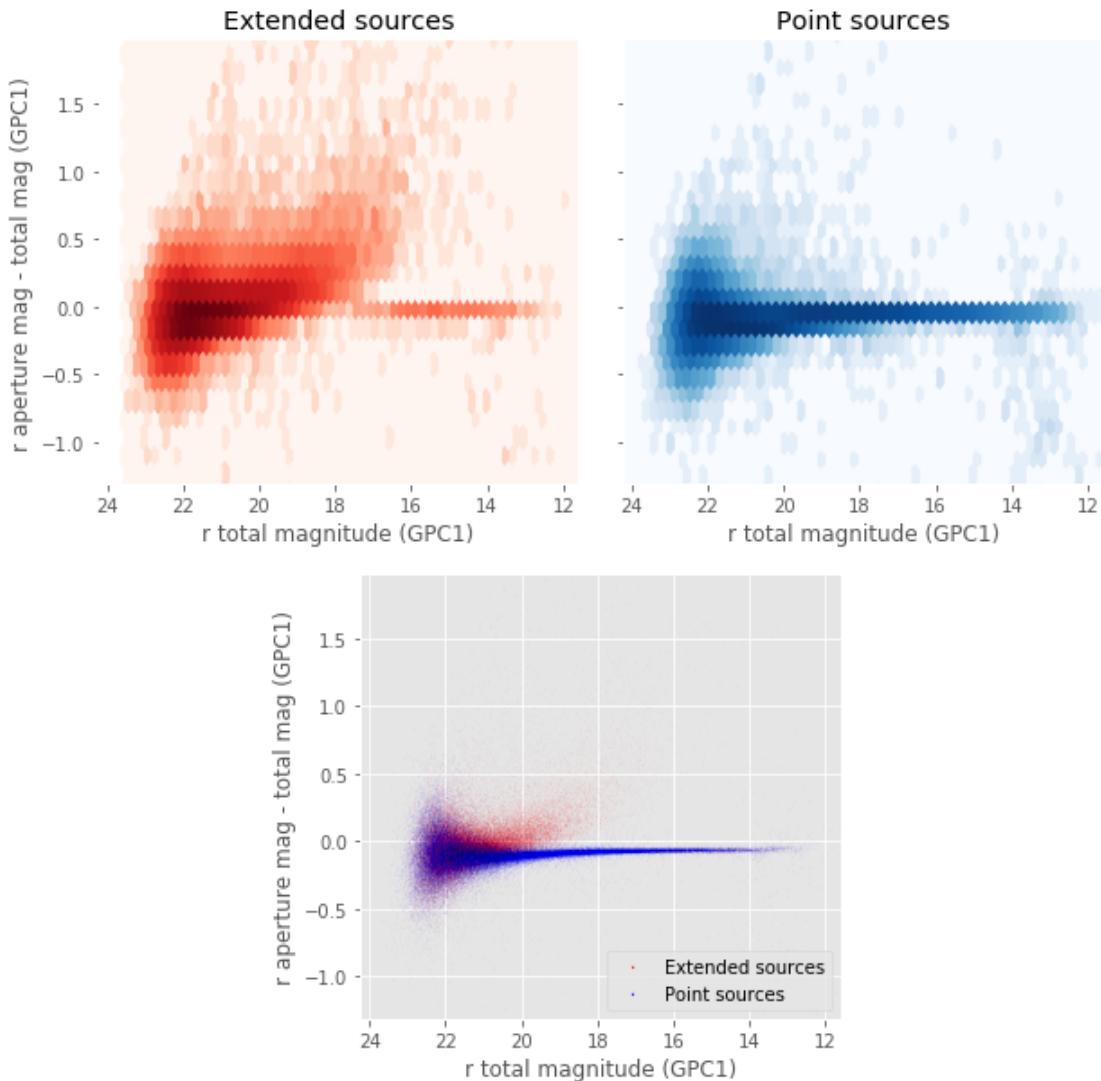
## 1.6 Keeping only sources with good signal to noise ratio

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

*To make it easier, we are setting to NaN in the catalogue the magnitudes associated with an error above 0.3 so we can't use these magnitudes after the next cell.*

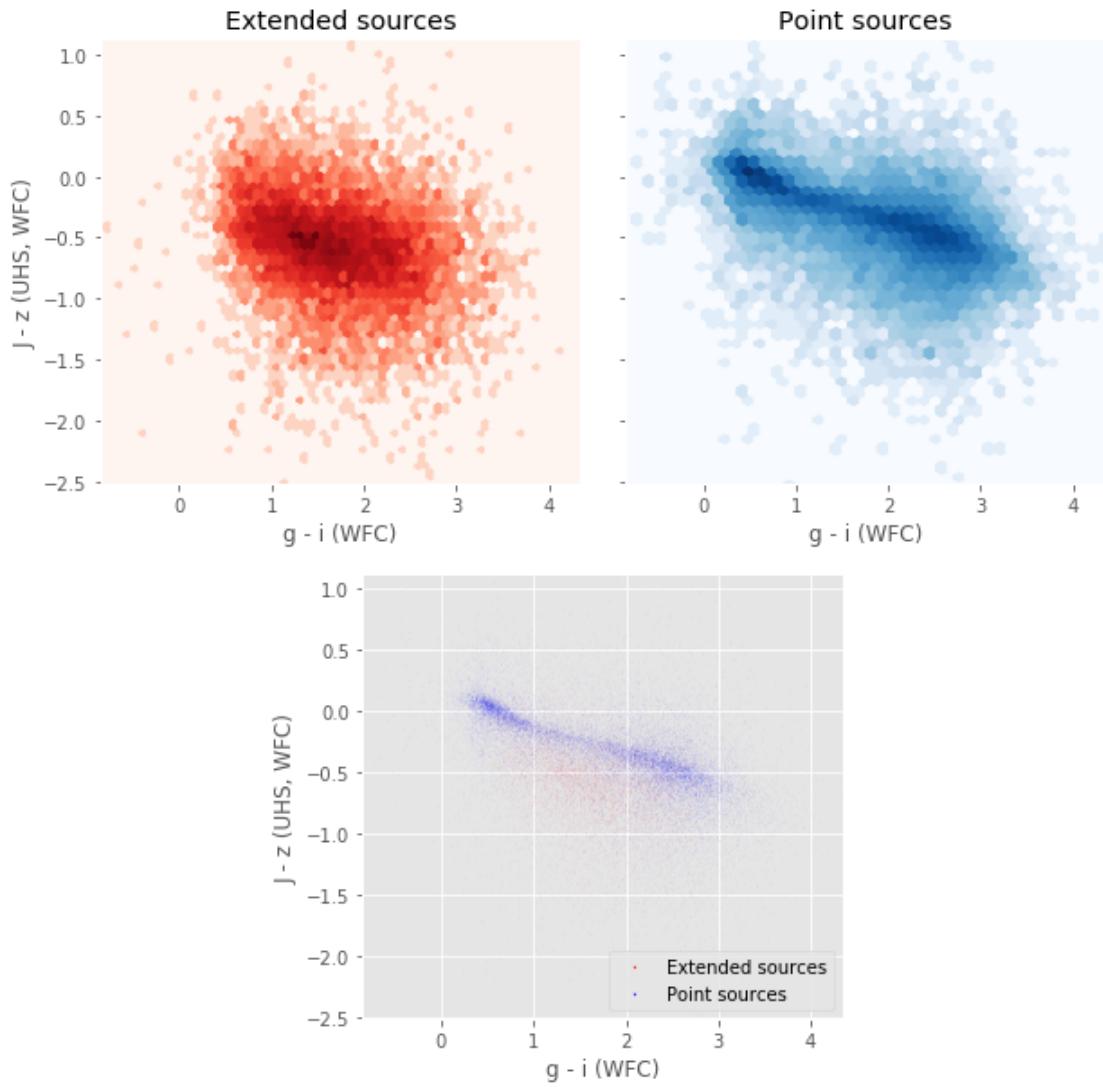
## 1.7 IV - Comparing aperture magnitudes to total ones.

Number of source used: 131785 / 977148 (13.49%)

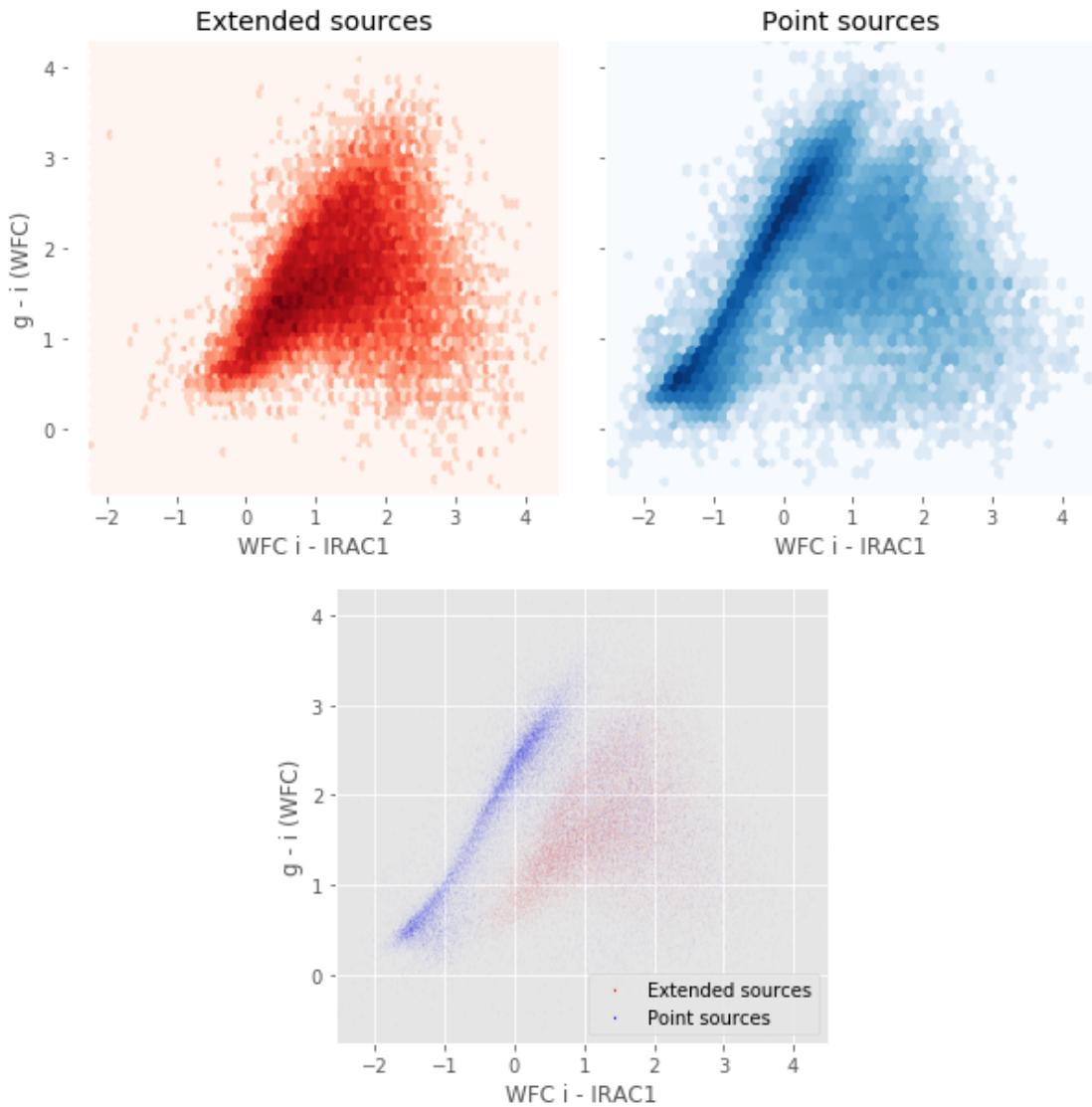


## 1.8 V - Color-color and magnitude-color plots

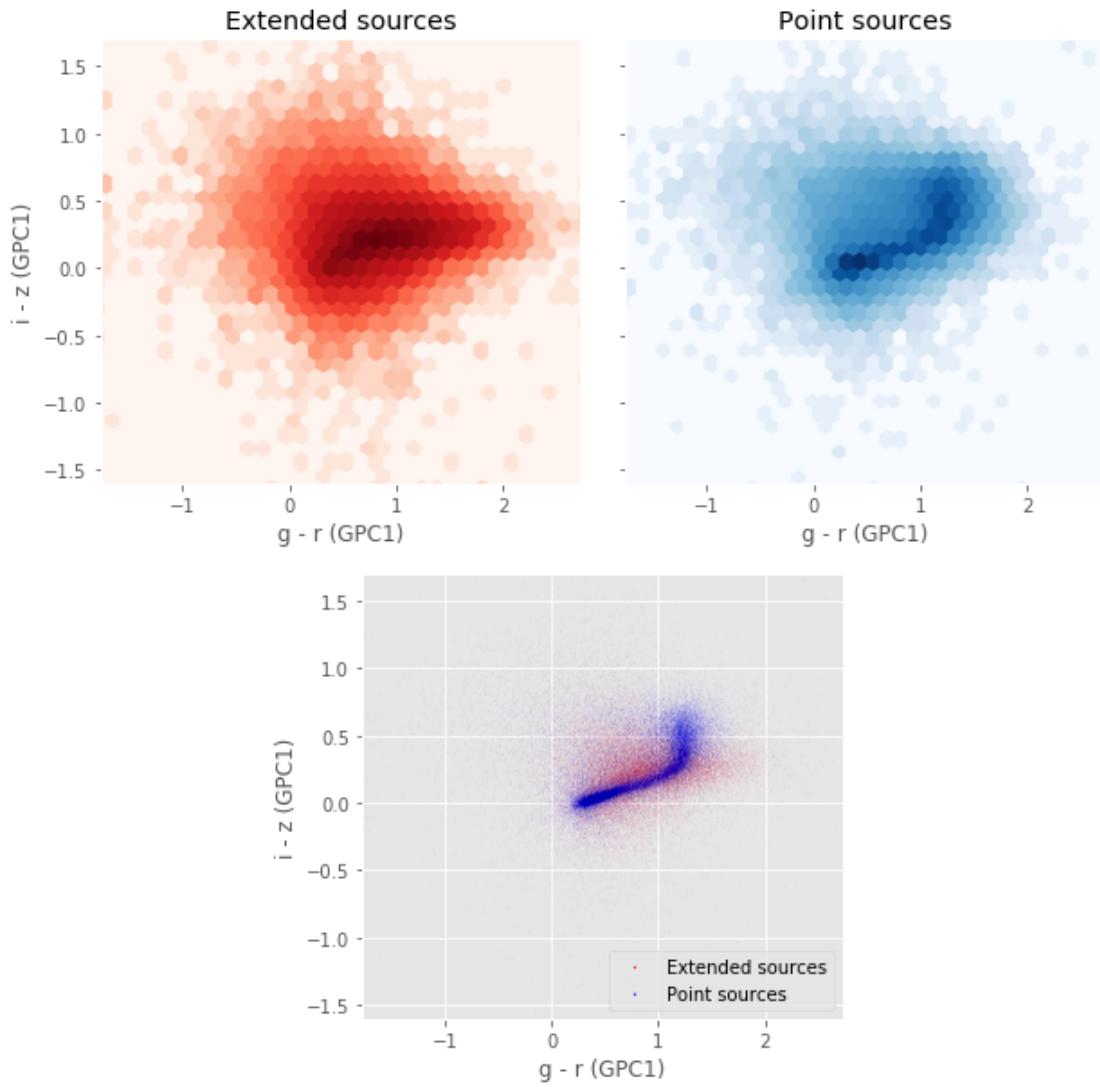
Number of source used: 31244 / 977148 (3.20%)



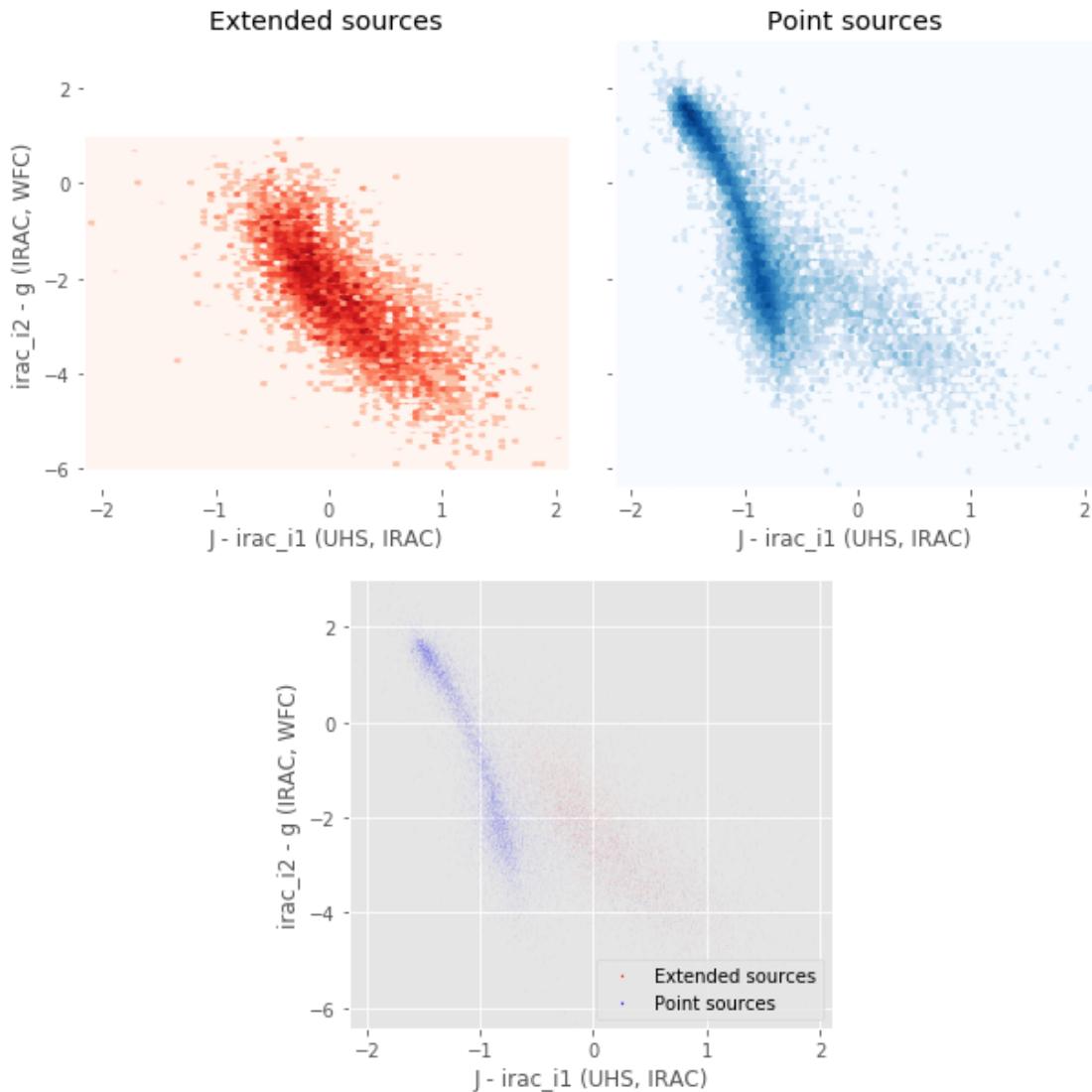
Number of source used: 48841 / 977148 (5.00%)



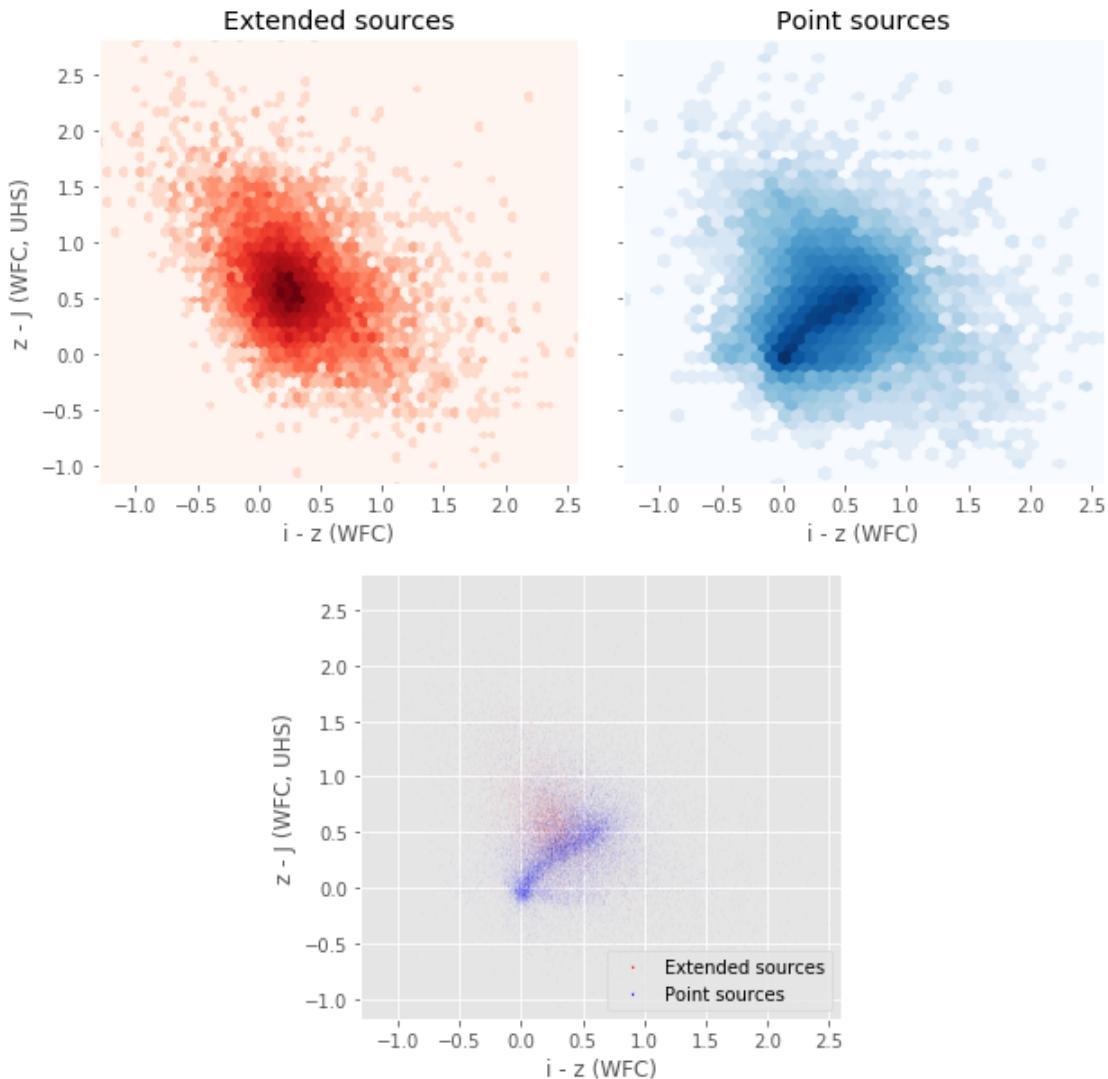
Number of source used: 93631 / 977148 (9.58%)



Number of source used: 17883 / 977148 (1.83%)



Number of source used: 33231 / 977148 (3.40%)



Number of source used: 6493 / 977148 (0.66%)

