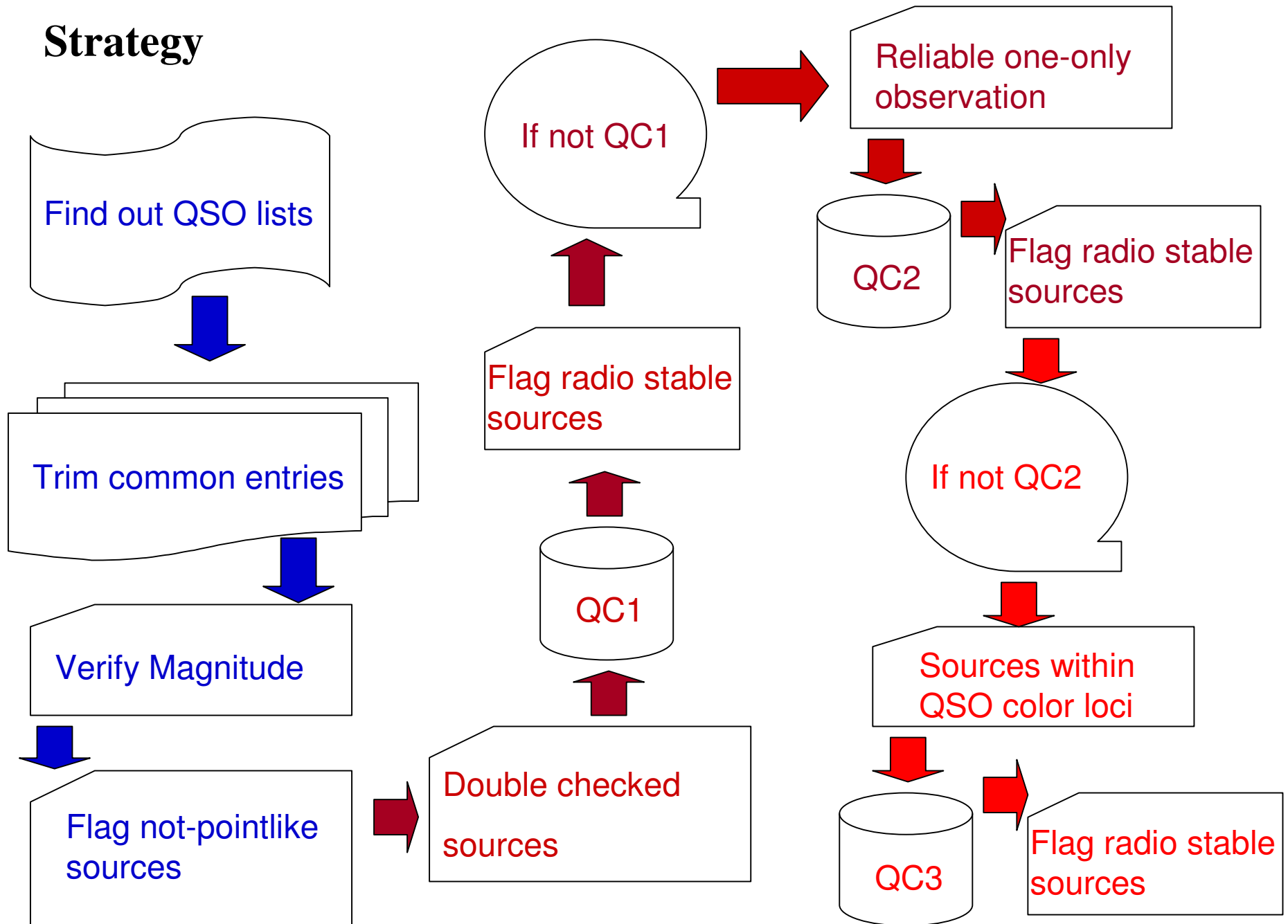


A GAIA Oriented Analysis of a Large Sample of Quasars

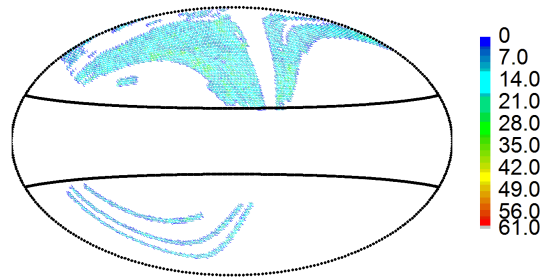
A.H. Andrei (*Observatório Nacional/MCT, associated researcher to Observatório do Valongo/UFRJ and SYRTE/Observatoire de Paris*), **M. Assafin** (*Observatório do Valongo/UFRJ*), **C. Barache** (*SYRTE/Observatoire de Paris*), **S. Bouquillon** (*SYRTE/Observatoire de Paris*), **G. Bourda** (*Observatoire de Bordeaux*), **J.I.B. Camargo** (*Observatório do Valongo/UFRJ*), **J.-F. Le Campion** (*Observatoire de Bordeaux*), **P. Charlot** (*Observatoire de Bordeaux*), **A.-M. Gontier** (*SYRTE/Observatoire de Paris*), **S. Lambert** (*SYRTE/Observatoire de Paris*), **J.J. Pereira Osório** (*Observatório Astronômico da Universidade do Porto*), **D.N. da Silva Neto** (*Observatório do Valongo/UFRJ*), **J. Souchay** (*SYRTE/Observatoire de Paris*), **R. Vieira Martins** (*Observatório Nacional/MCT*)

- **To consolidate the existing lists of QSOs (photometry, astrometry, redshift)**
- **To consolidate their astrometry (building a single reference frame)**
- **To build an initial QSO catalogue for GAIA (and for the tie to the ICRF)**

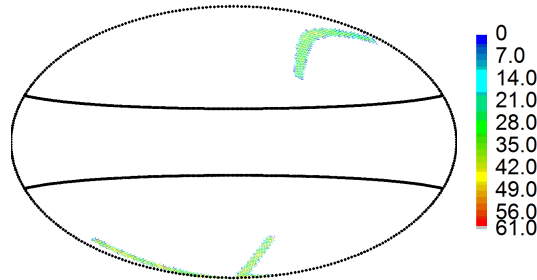
Strategy



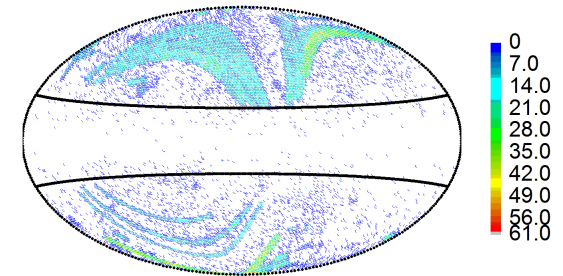
Sky Distribution – 1deg² cells count



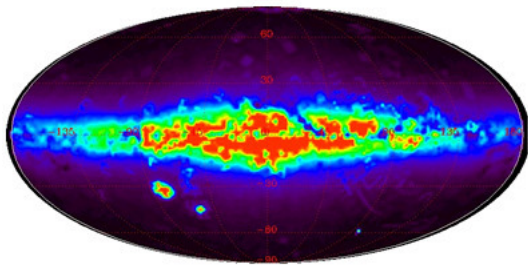
SDSS DR5
74,869 sources



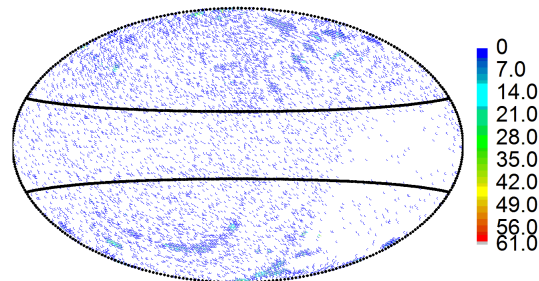
2dF – QSO
23,803 sources



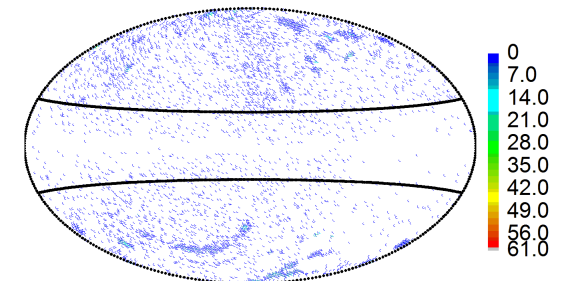
V&V
85,221 sources



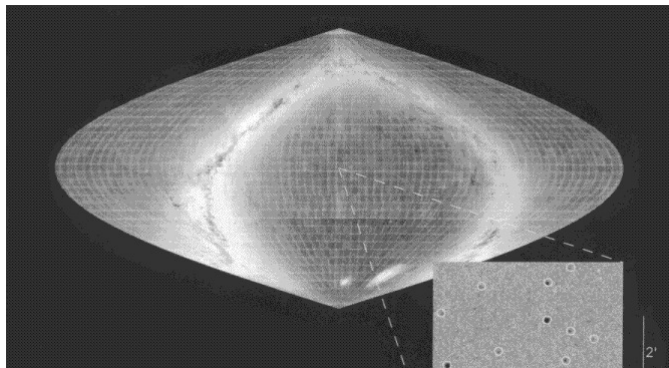
GSC2.3 and B1.0 - All sky to V=21



All Radio QSOs
11,781 sources



Radio QSOs found in
the GSC2.3 or B1.0
6,941 sources



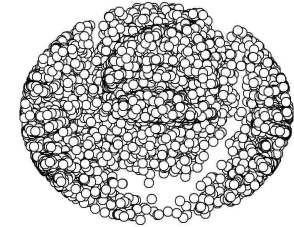
VLQAC – Very Large Quasar Astrometric Catalogue

Souchay et al., 2007

Catalog Name	ICRF	VLBA	VLA-	JVAS	DR5	2qZ	FIRST	VLA+	H&B	2Mass	GSC23	B1.0
ICRF-Ext2	717	643	582	377	72	6	27	0	232	333	500	480
VLBA		3358	1598	1577	288	33	71	1	375	911	2034	1964
VLA-0.15			1702	1272	203	10	52	0	308	576	1133	1090
JVAS				2119	253	6	53	0	238	547	1306	1267
SDSS DR5					74885	2053	553	5	1316	11736	69705	62764
2qZ						22974	0	0	479	619	19508	17277
FIRST							972	2	141	528	874	798
VLA+0.15								157	11	18	32	36
Hew & Burb									7259	904	2225	2087
2Mass										13499	13086	12601
GSC2.3											90550	77722
B1.0												81233

Another 8707 quasars with different degrees of certainty on the redshifts and spectra are spread over 1000 small catalogues. But a **half of those in the 16 larger catalogues.**

Photometry



- Number of QSOs found: 98,920 (74% of the candidates)

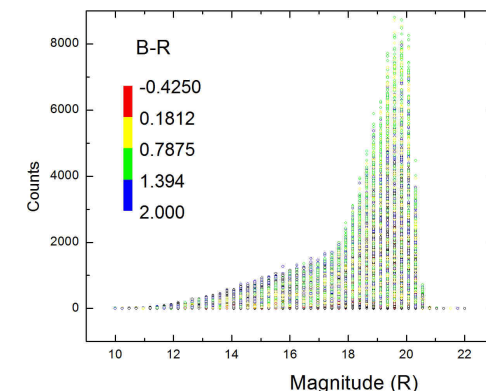
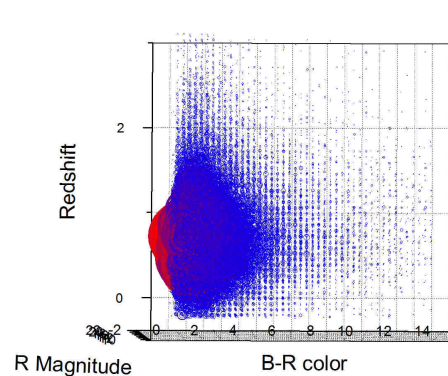
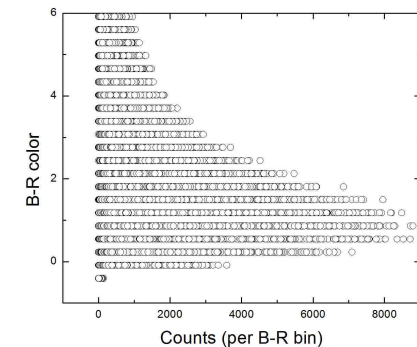
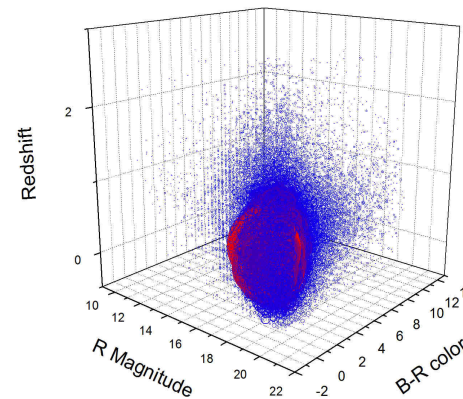
- Are they real ? A fake sample was generated by shifting the GSC23 QSOs sample positions by 5 arcmin on right ascension and on declination. The shift is sufficiently small to keep the fake sources in the same neighborhood as the corresponding true ones. A 2 arcsec search now results in only 0.1% matches.

- Classification: 94,920 QSOs amidst 58,304,812 stars!

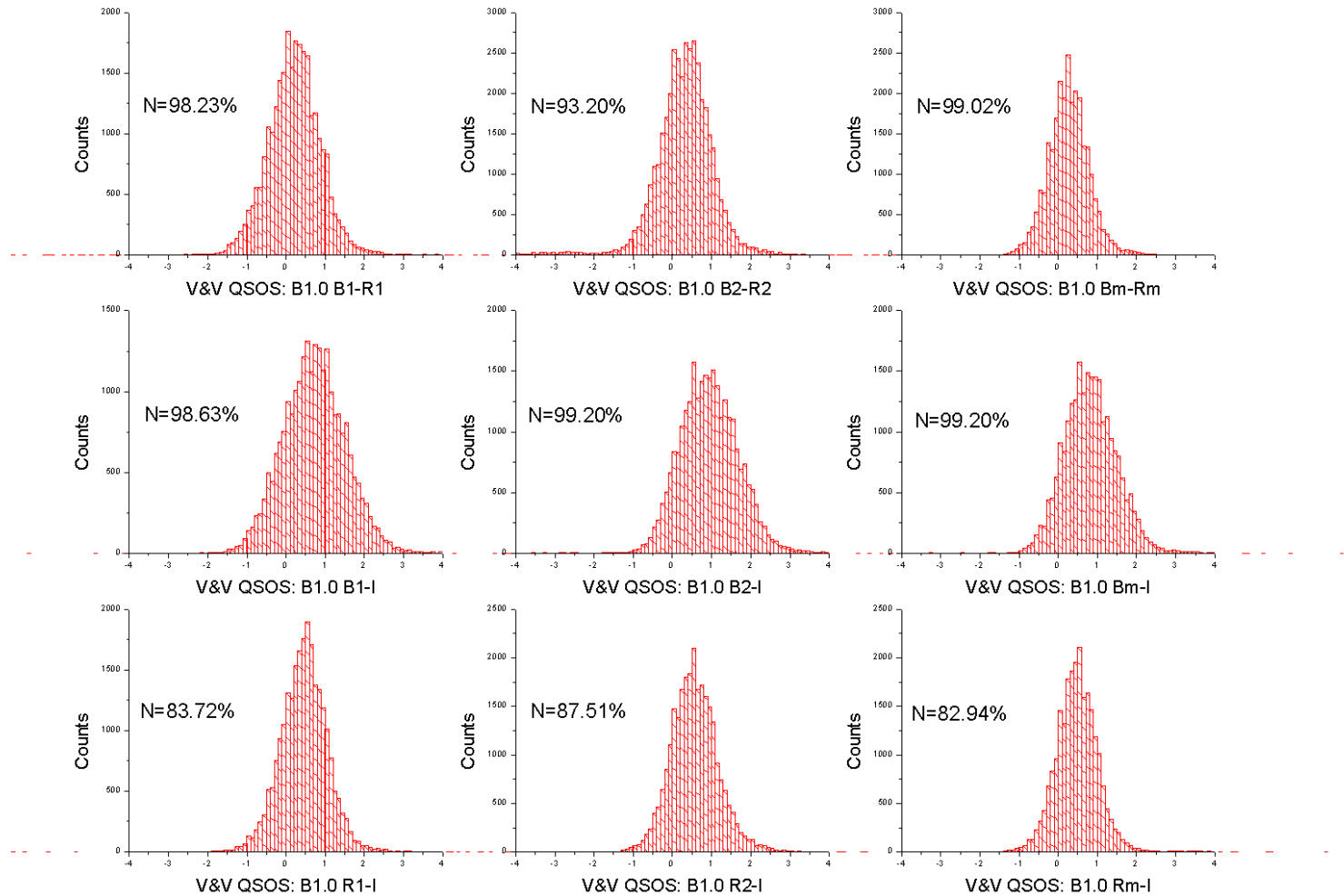
- Scheme: nearest space algorithm

- Results: Best outputs using B-R and B-I colors, Magnitude > 17th R, $\mu < 5 \text{ mas/y}$, μ significance < 1

- 1 known QSO out of 10 candidates



- The distributions approach well to Gaussians, then they can be used to define the QSOs locus (based on B1.0 colors only).



Morphology

* One might expect a fair amount of resolved host galaxies around the GAIA extragalactic reference frame QSOs (because the host galaxies do are large and bright enough; because of contamination by alien AGNs; and because the QSOs will be nearby ones). Not to mentions AGNs themselves

* The *GSC23* classification scheme gives out 31 parameters of classification: adjusting of image and centroid, errors, co-variances, and 16 levels of intensity (from which 15 step-intervals can be worked out).

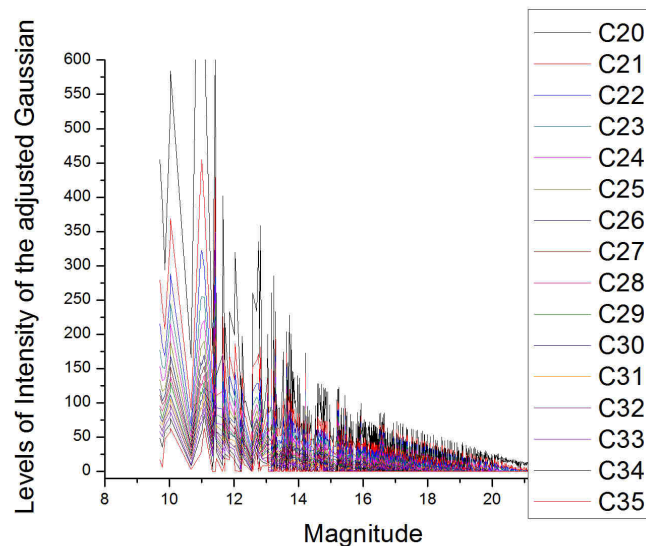
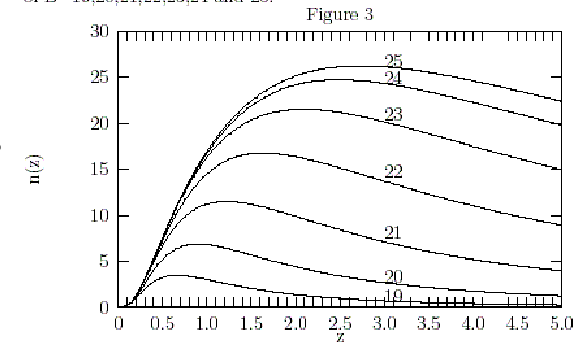


Fig. 3.— Number of quasars per square degree as a function of redshift for m of $B=19,20,21,22,23,24$ and 25 .

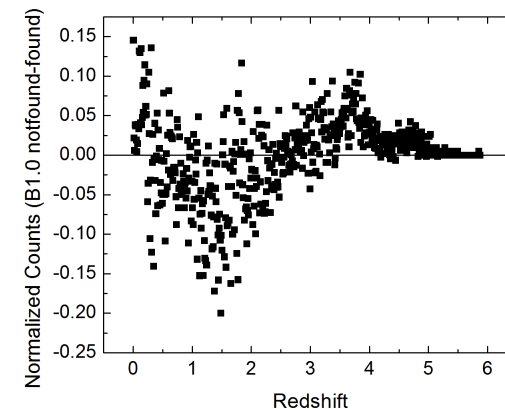
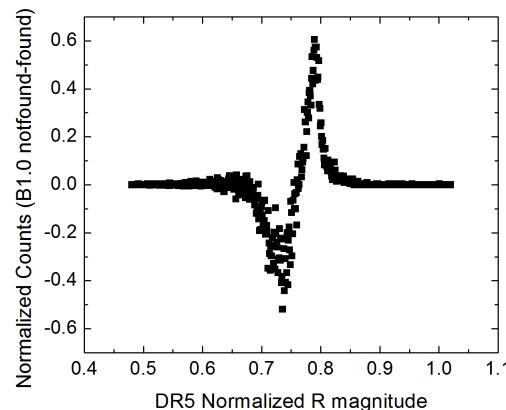


• A decision tree algorithm was developed. Still sensitive to magnitude (maybe) - bright sample is on its way to trial.

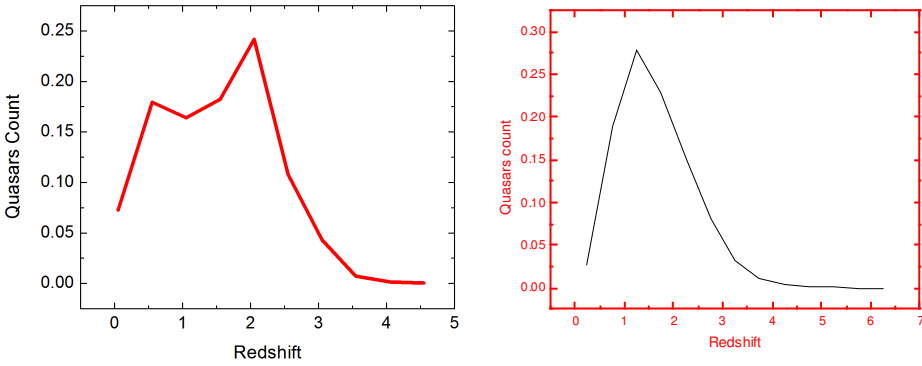
• But: at least one previously unknown QSO host galaxy was detected and traced back on the source image.

Magnitude - Redshift Distribution

- Though in the latest V&V 12th edition 75% of the sources come from the SDSS DR4 and from the 2dF/2qz, still it is a very sky concentrated sample. **The all sky distribution of V&V comes from the small basis catalogues.** Taking only basis catalogues with less than 100 sources, they are 1044 catalogues and amount to 10% of the total V&V sources (e.g, there are 399 basis catalogues containing 1 source, and 153 containing two sources).
- Taking V&V only, there are 7,901 sources referenced more than once. Notice than only the QSOs table was recollected from V&V.
- **28.53% of the SDSS DR5 quasars are missing from the USNO B1.0 catalogue (that is 21,357 sources). This indicates a magnitude threshold that is likewise GAIA's.** And the distribution of the missing sources deserves a better understanding.

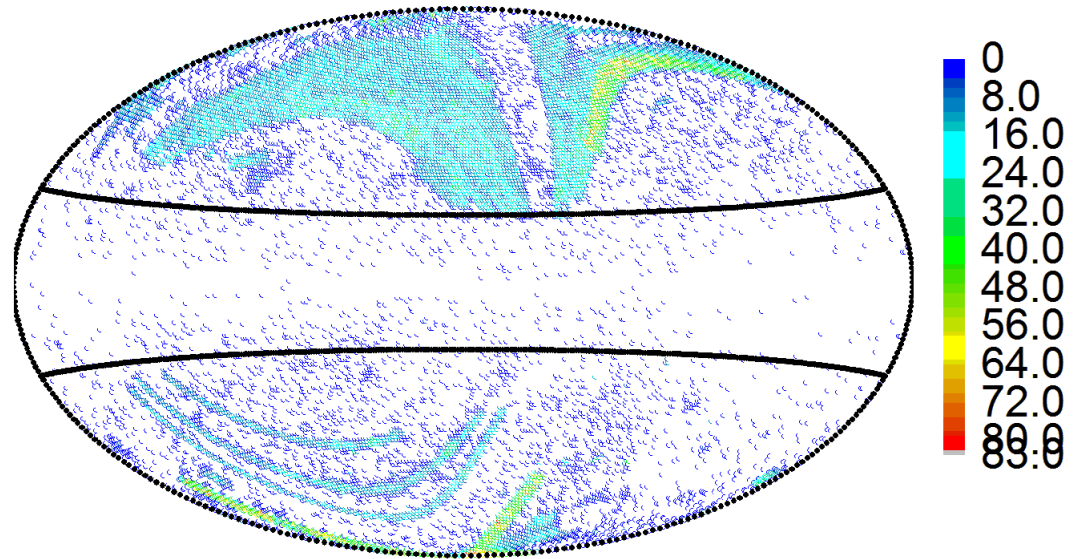
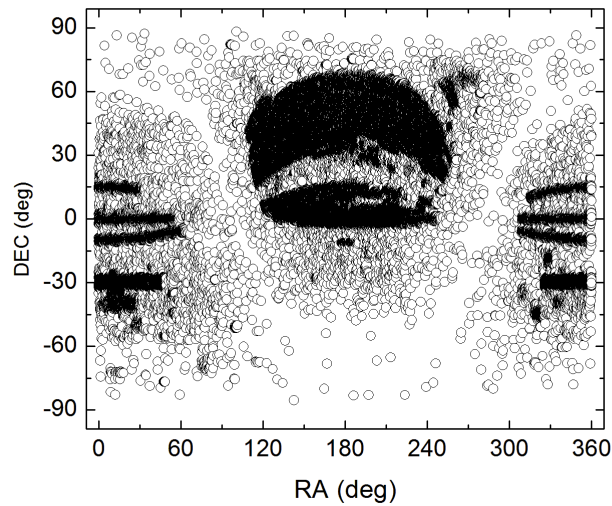


Radio flux - Redshift Distribution

- From the radio lists, only the QSOs were recollected. No care was taken to the astrometric accuracy – for the present aim the correct match suffices.
 - There are 8,248 sources from the radio-loud QSOs group for which there is a determination of radio redshift. Notice however that the radio QSOs redshift profile differs from the V&V sources redshift profile.
- 
- The figure consists of two side-by-side line plots. Both plots have 'Quasars Count' on the y-axis and 'Redshift' on the x-axis. The left plot, representing radio QSOs, has a y-axis ranging from 0.00 to 0.25 and an x-axis from 0 to 5. The curve starts at approximately 0.08 at redshift 0, rises to a local peak of 0.18 at redshift 0.8, dips slightly to 0.16 at redshift 1.2, then rises to a global peak of 0.24 at redshift 2.0, before declining to near zero by redshift 4.0. The right plot, representing V&V sources, has a y-axis ranging from 0.00 to 0.30 and an x-axis from 0 to 7. The curve starts at approximately 0.03 at redshift 0.5, rises sharply to a peak of 0.28 at redshift 1.5, and then declines steadily to near zero by redshift 4.0.
- There is a magnitude determination for 8,369 radio QSOs. Of these, 1,096 are above mag 20. In order to verify the reliability of such magnitude determinations, and to verify which ones would be accessible by GAIA the radio QSOs were searched in the B1.0. **Using a box match of 0.6arcsec (three times the B1.0 nominal accuracy), only 21.74% are found (2,562 sources).**
 - **The same search made for the ICR sources, also finds a limited sample of 56.93% (409 sources).**

The Consolidated Sample

- The consolidated sample contains 114,097 candidates QSOs. There is at least one redshift determination for 98.75%, and at least one magnitude determination for 99.20%.

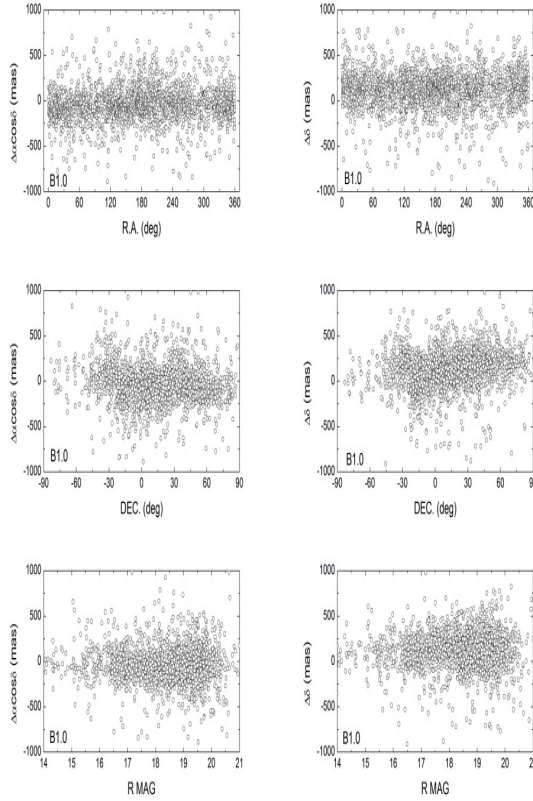


Input Optical Catalogues Astrometry

USNO B1.0

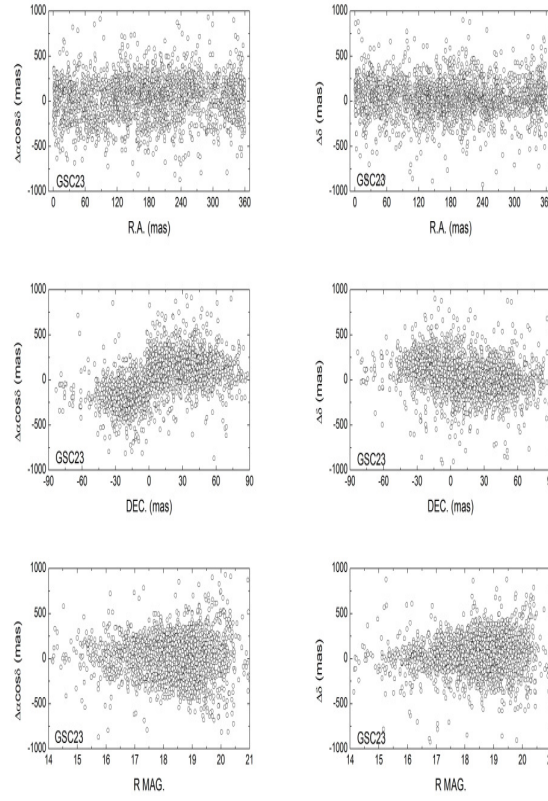
GSC 2.3

SDSS DR5



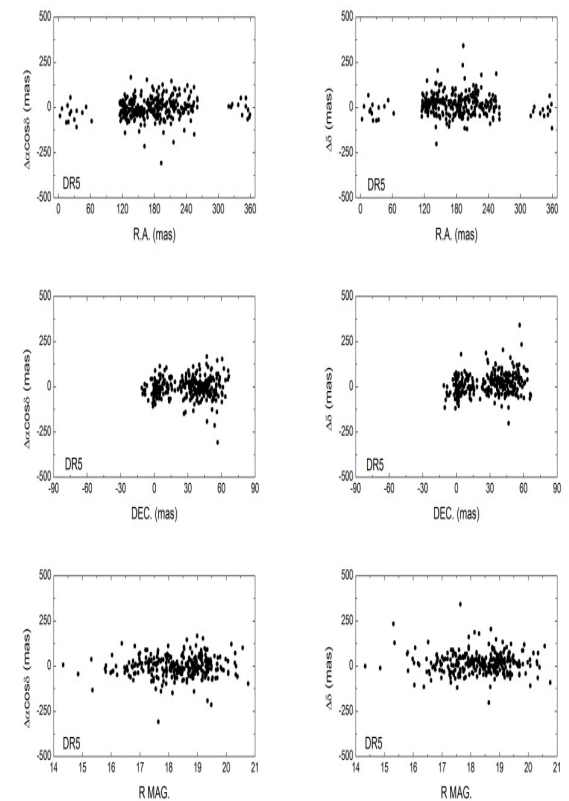
$$\langle \Delta \alpha \cos \delta \rangle = -37.1 \pm 4.7$$

$$\langle \Delta \delta \rangle = +120.5 \pm 4.9$$



$$\langle \Delta \alpha \cos \delta \rangle = +28.3 \pm 5.5$$

$$\langle \Delta \delta \rangle = +38.5 \pm 4.8$$

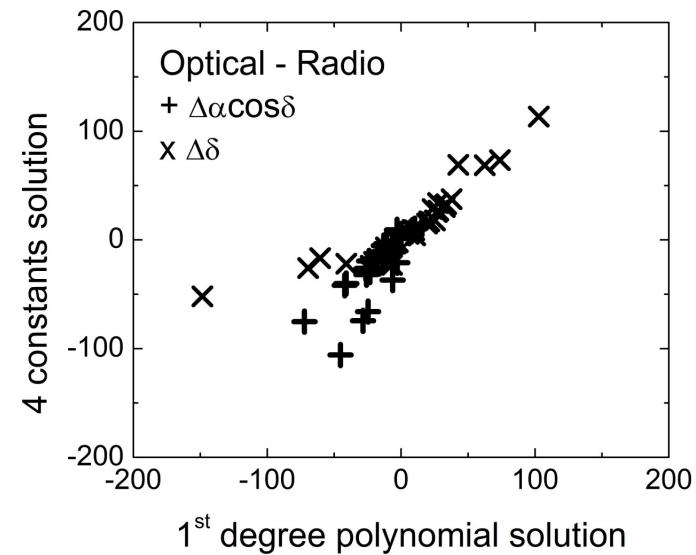
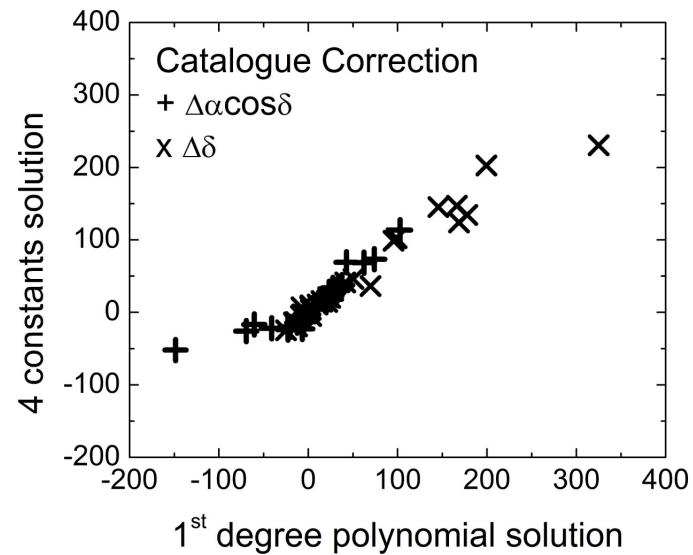


$$\langle \Delta \alpha \cos \delta \rangle = -4.0 \pm 3.4$$

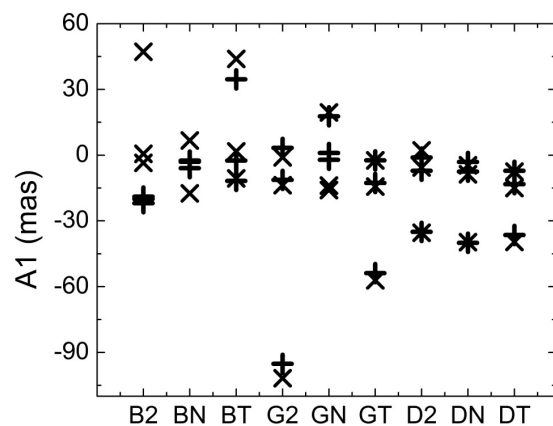
$$\langle \Delta \delta \rangle = +16.6 \pm 3.5$$

Local Astrometric Correction

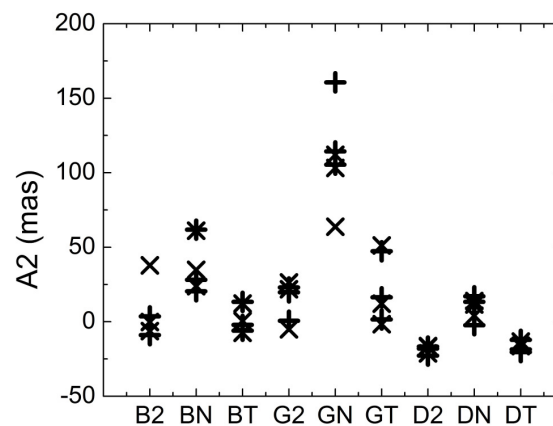
- 67"/mm plate scale, small regions, at least 6 reference stars
- 1st degree complete polynomial or 4 constants (low number of stars)
- Reduction by UCAC2 and 2Mass



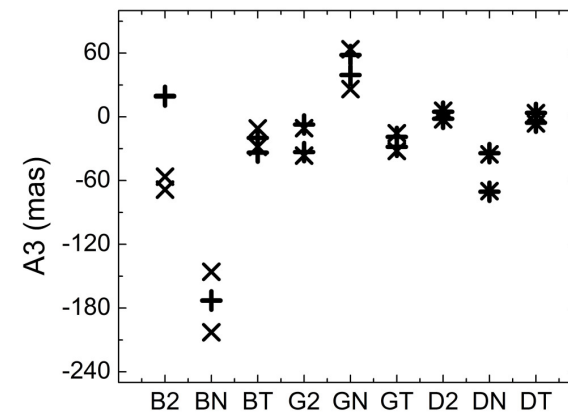
Rotation and Equatorial Bias to the ICRF



Local Astrometric Solution

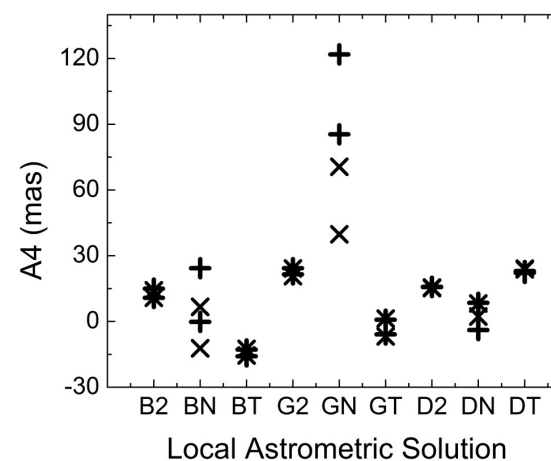


Local Astrometric Solution



Local Astrometric Solution

Solution	A1	A2	A3	A4
BU	-3±17	-9±18	-49±13	+15±15
BT	-2±12	-2±14	-33±11	-12±12
GU	-11±13	+19±14	-7±10	+21±12
GT	-12±10	+16±11	-18±9	+0±10
DU	-7±4	-18±4	+4±3	+15±3
DT	-13±5	-18±5	+3±4	+23±4



All values in mas

Spherical Harmonics

$$A_c = C_{c p n m l} \times H_p(R') \times \ln(\sin \delta) \times F_{m l}(\alpha)$$

- terms up to 30th order
- 2,760 terms significant to 3σ
- isolated terms are minority (mostly on δ)
- progressive solution from lower order terms
- now only 16 significant terms
- magnitude terms significant for the GSC2.3
- Higher order terms for DR5 (mostly relative to UCAC2)

