The Radio Fundamental Catalogue

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The first fundamental catalogue

Normal Star Catalogue (4 century BC?)

Accuracy: 0.02 rad.

State of the fundamental radio astrometry on 2015.08.01:

sources: 9510

percentile of accuracy:

20%	< 0.25	mas
50% (median)	< 0.62	mas
80%	< 2.0	mas
90%	< 4.0	mas
97%	< 12	mas

Flux density @ X-band: [0.003, 22] Jy, median: 120 mJy

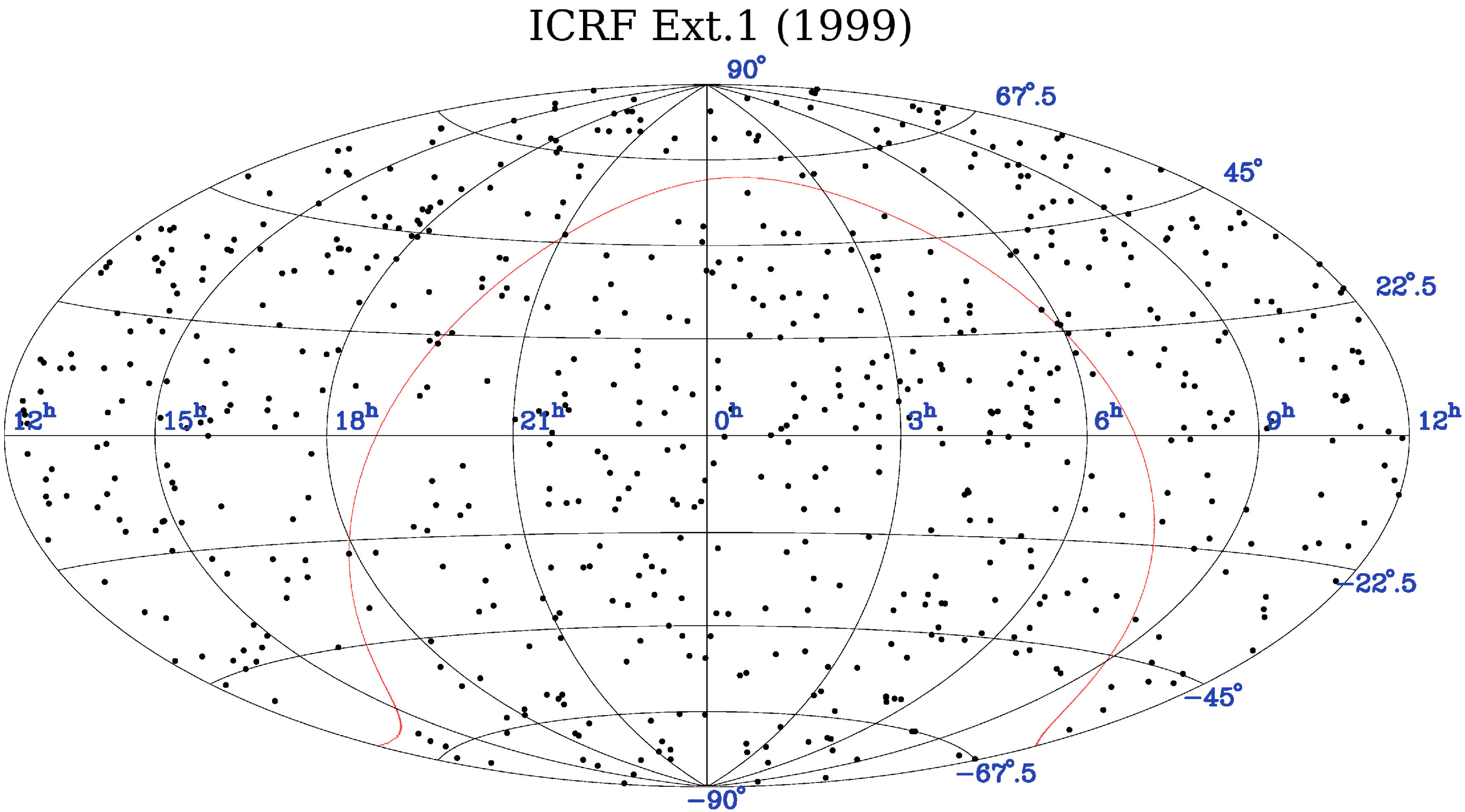
Observed band:

Dual-band:	51%
8 GHz	37%
5 GHz	9%
22 GHz	2%
2 GHz	1%

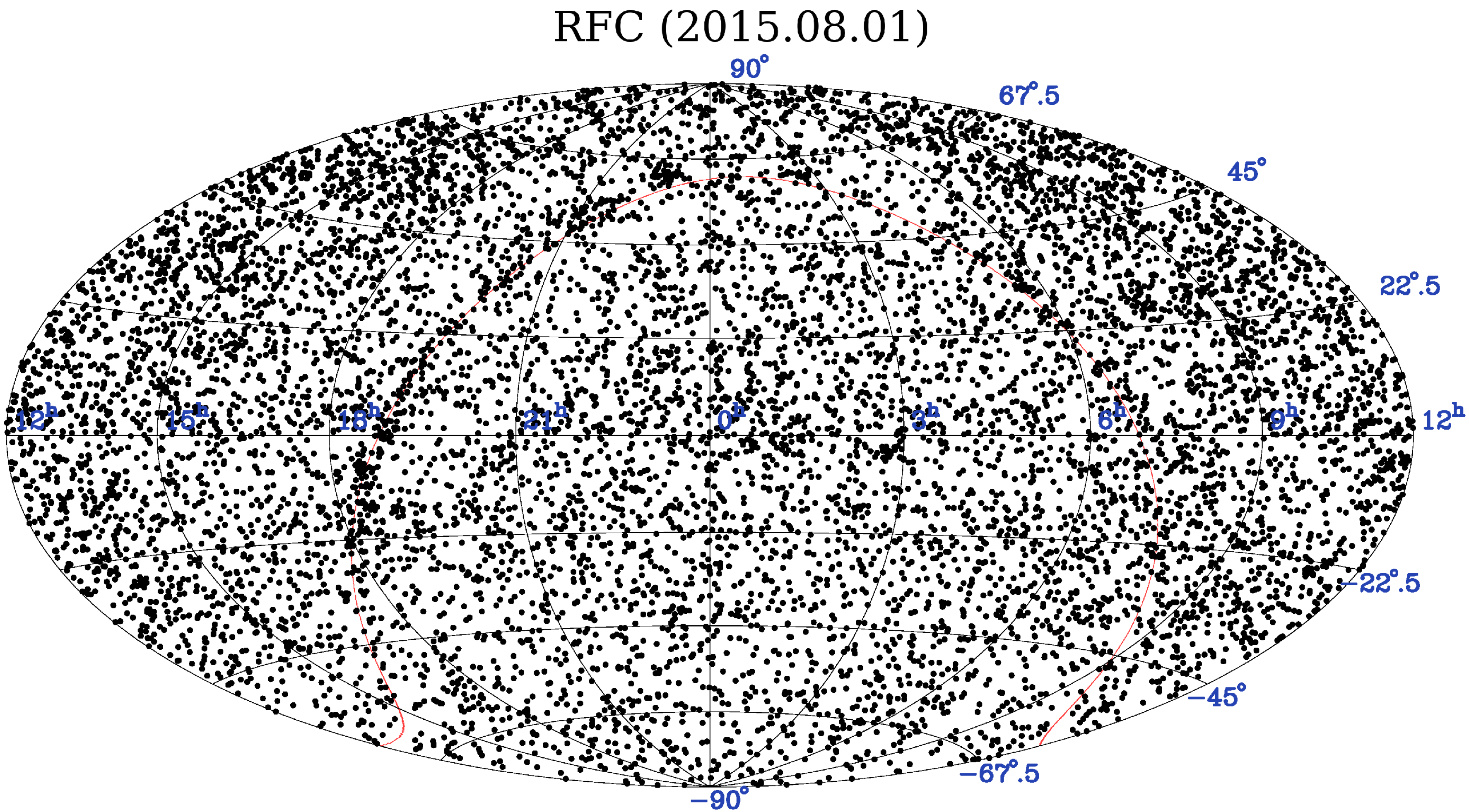
Number of observing sessions

1	55%
1–2	77%
1–5	90%
10+	8%
100+	3%

State-of-the-art at the XXth century: 666 objects

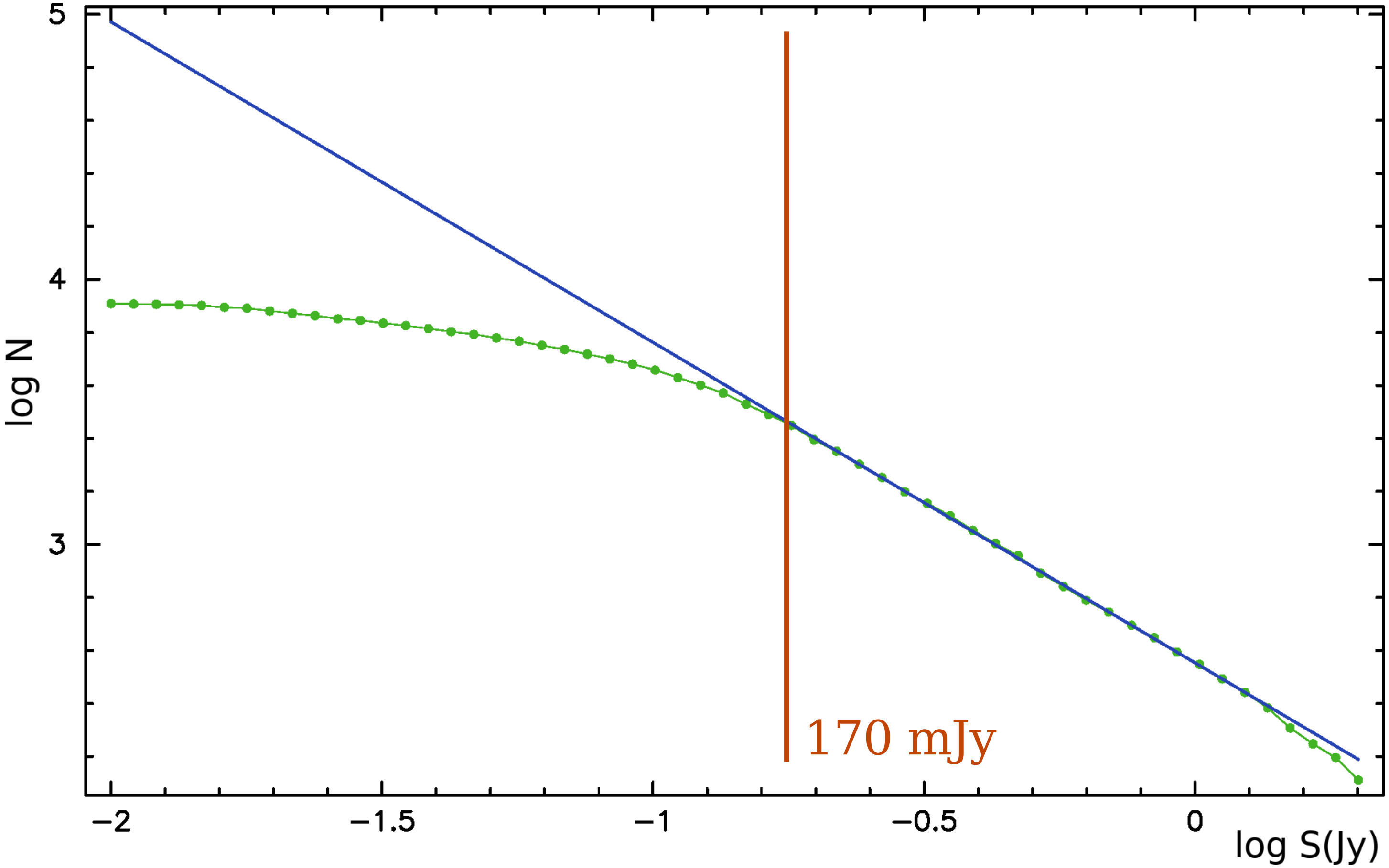


State-of-the-art at the XXIth century: 9510 objects



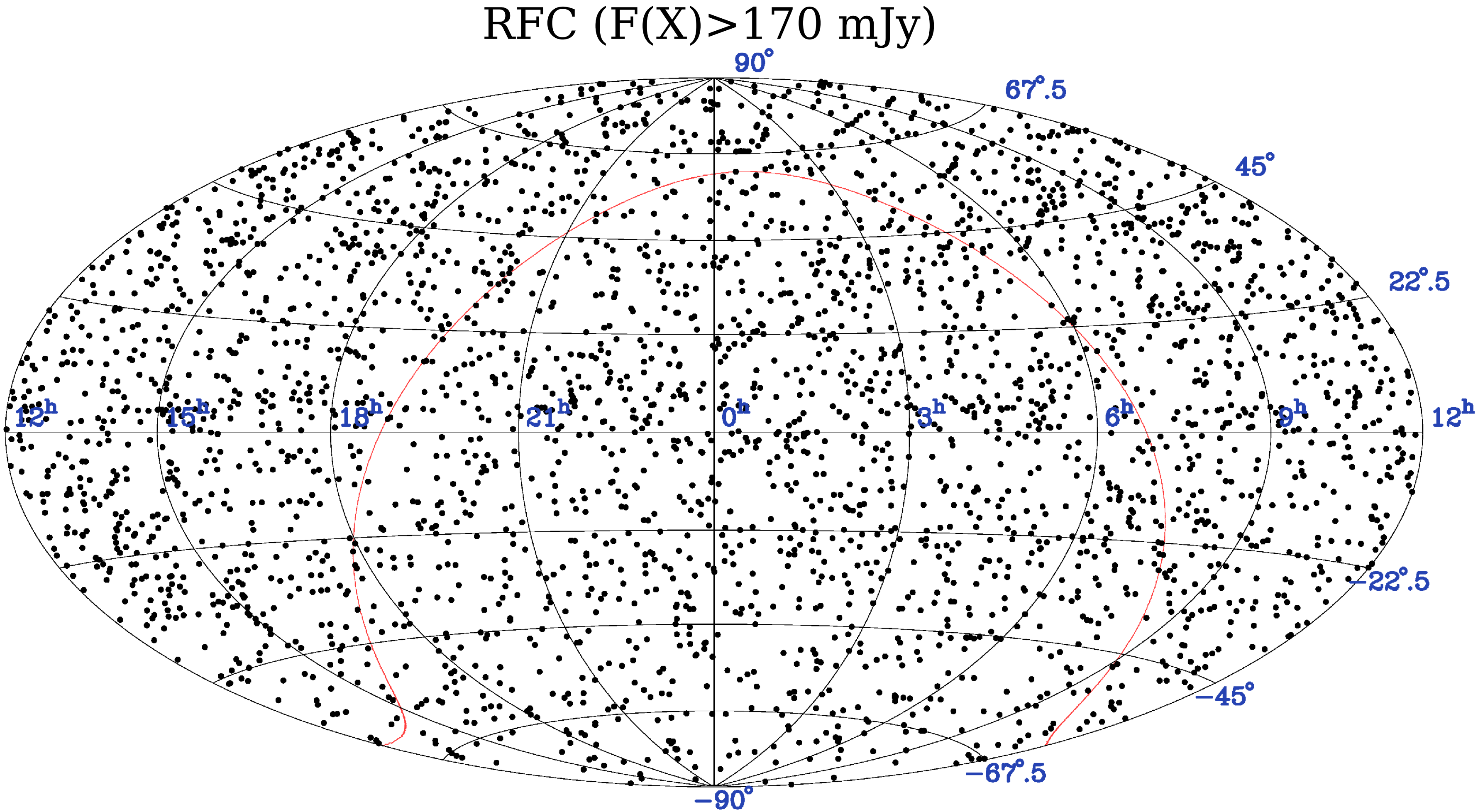
Completeness of RFC

$\log N$ versus $\log S$ diagram. $S_{\rm corr}$ @ 8 GHz at baselines 200–1000 km

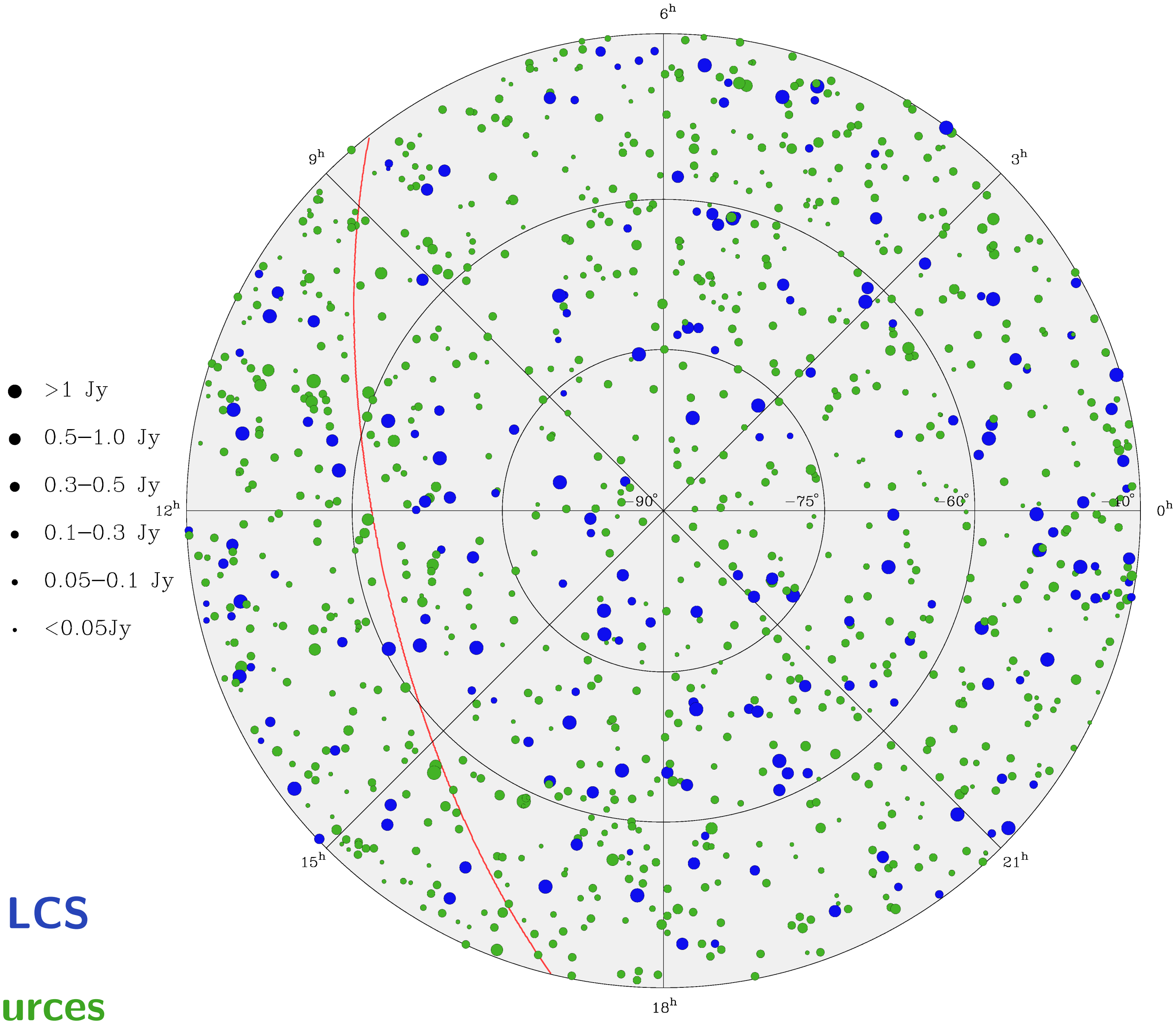


170 mJy	97%
100 mJy	80%
50 mJy	45%
10 mJy	10%

Source sky distribution (complete subsample of 3000 objects)



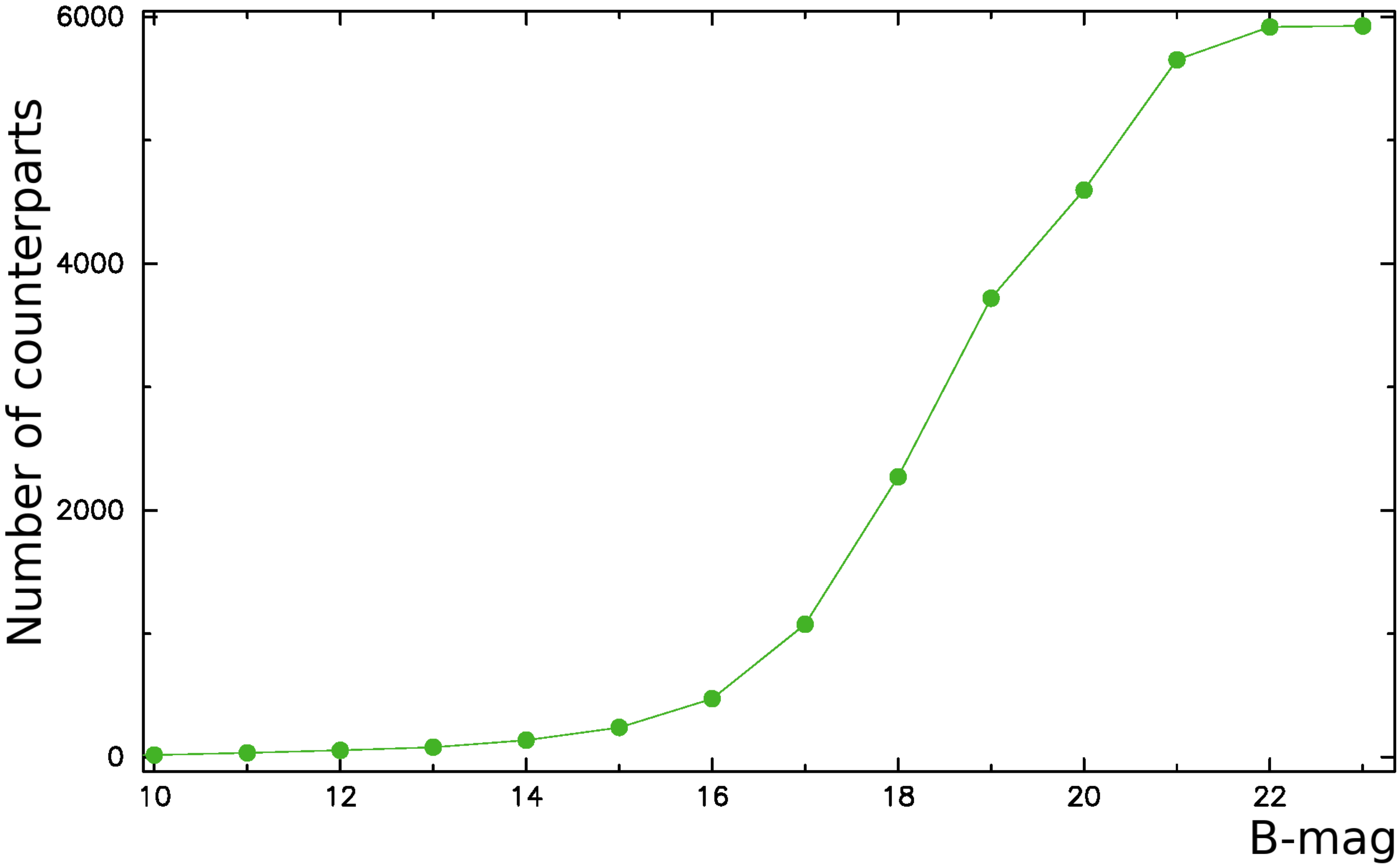
Source distribution at the southern hemisphere



Before LCS

LCS sources

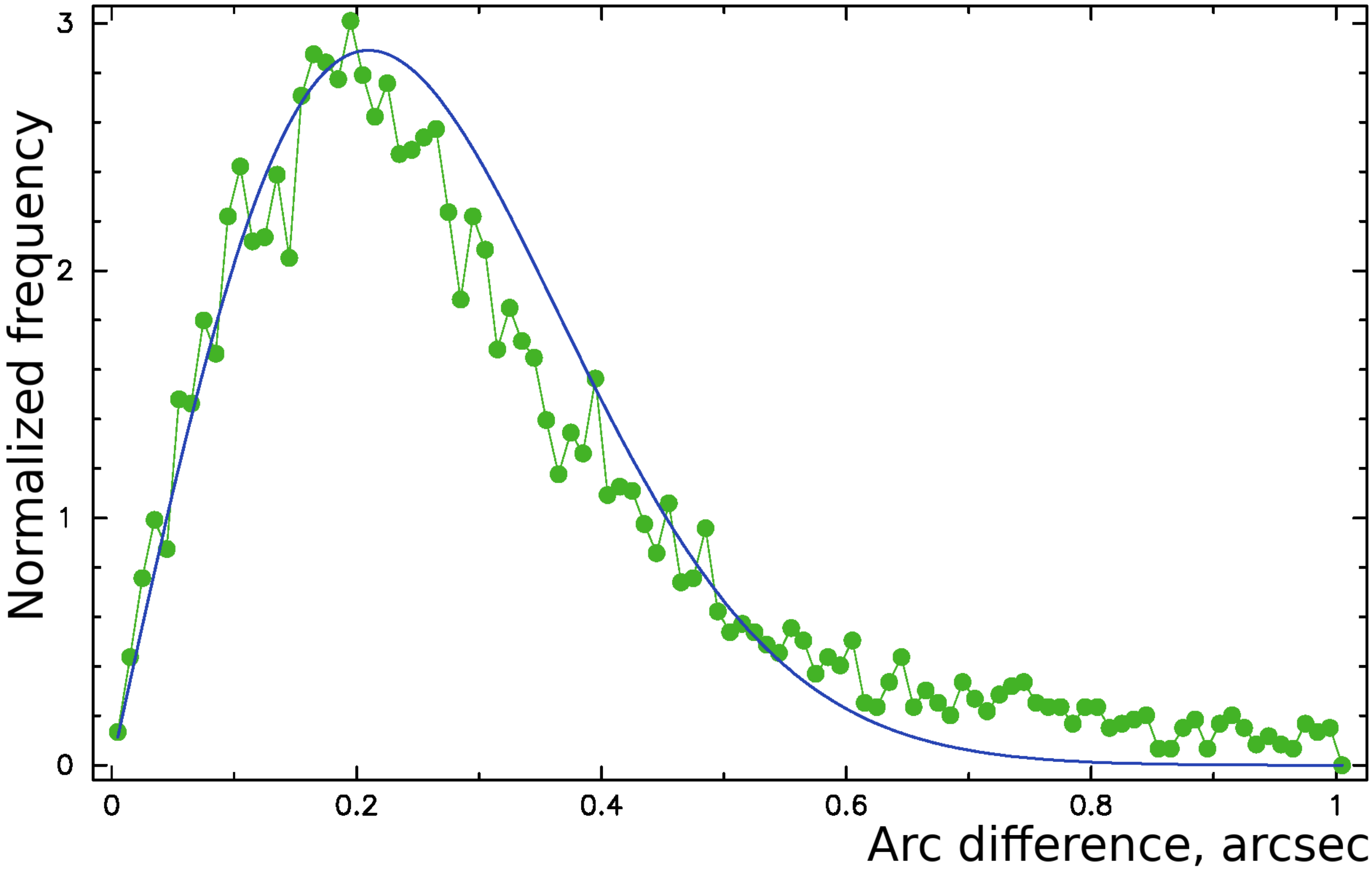
Comparison with NOMAD catalogue



In total, there are 5951 matches (62%)

There are 2271 optical counterparts brighter B 18^m.
There are 4596 optical counterparts brighter B 20^m.

Comparison with NOMAD catalogue

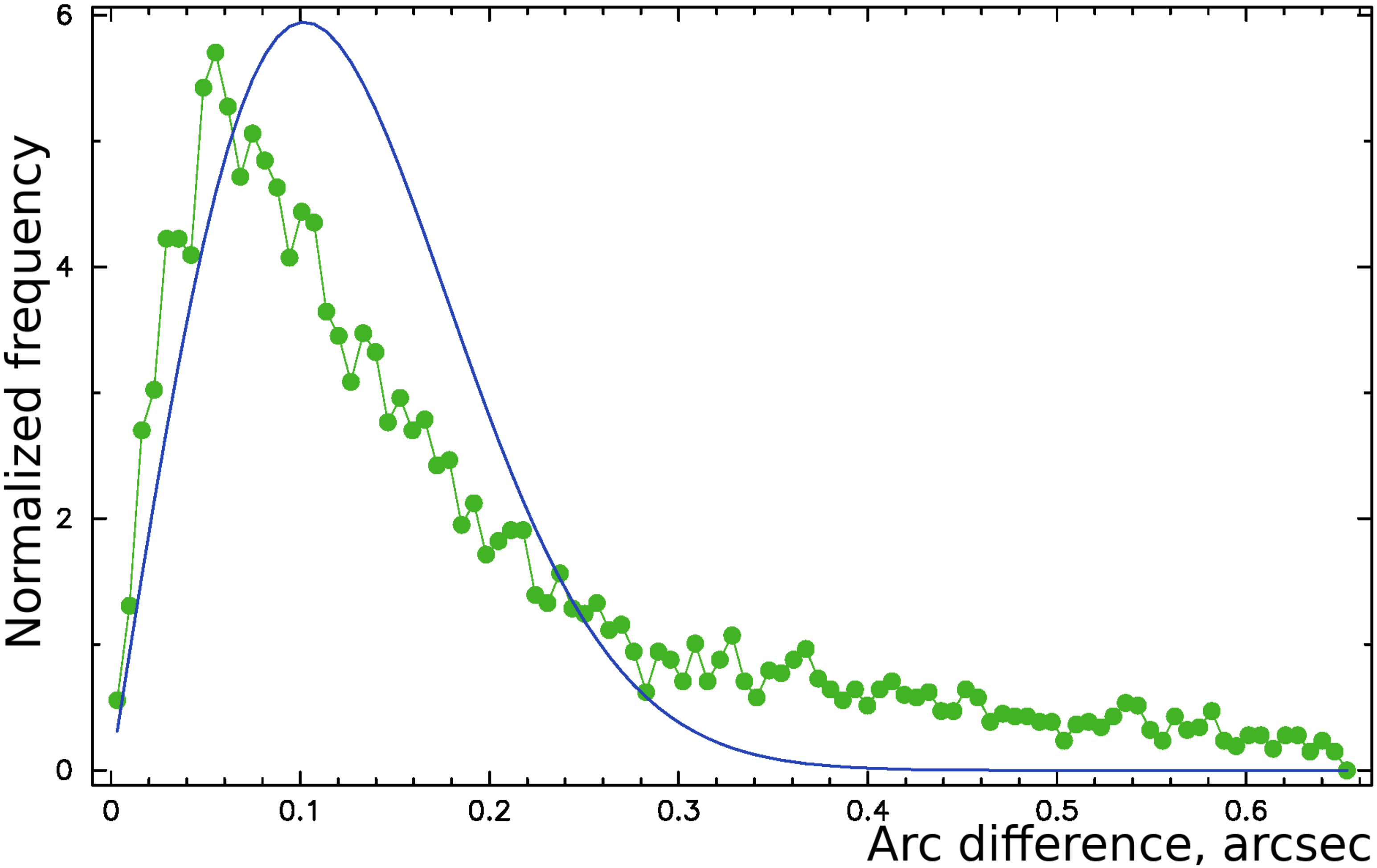


There are 5988 matches with NOMAD (62%).

1-σ error **234 mas** (**210 mas**)

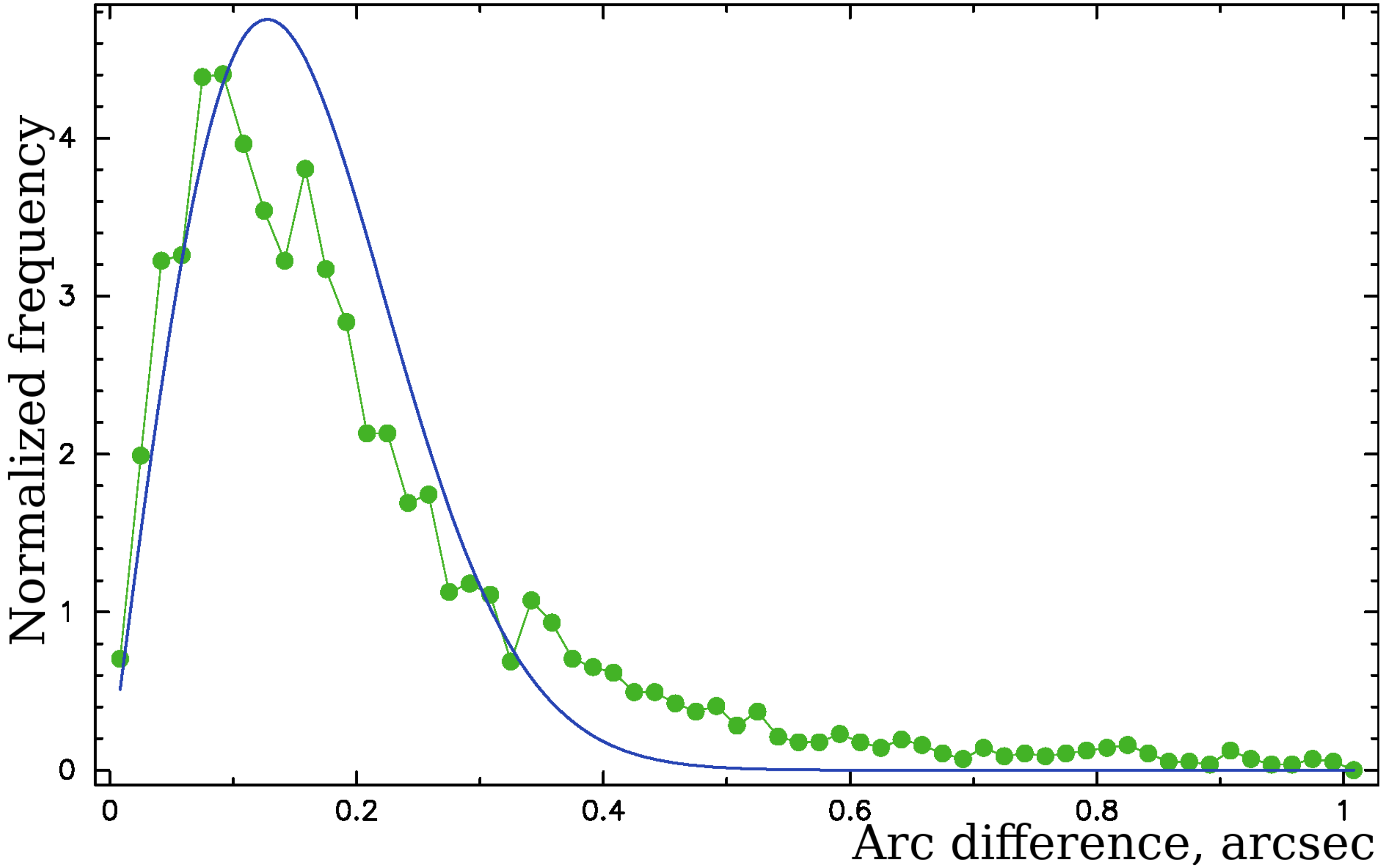
NOMAD errors are 380 times worse than errors of RFC.

Comparison with WISE catalogue



There are 7187 matches with WISE (76%). 1-σ error **138 mas** (**102 mas**)

Comparison with 2MASS (point source catalogue)



There are 3426 matches with 2MASS, point source catalogue (36%).

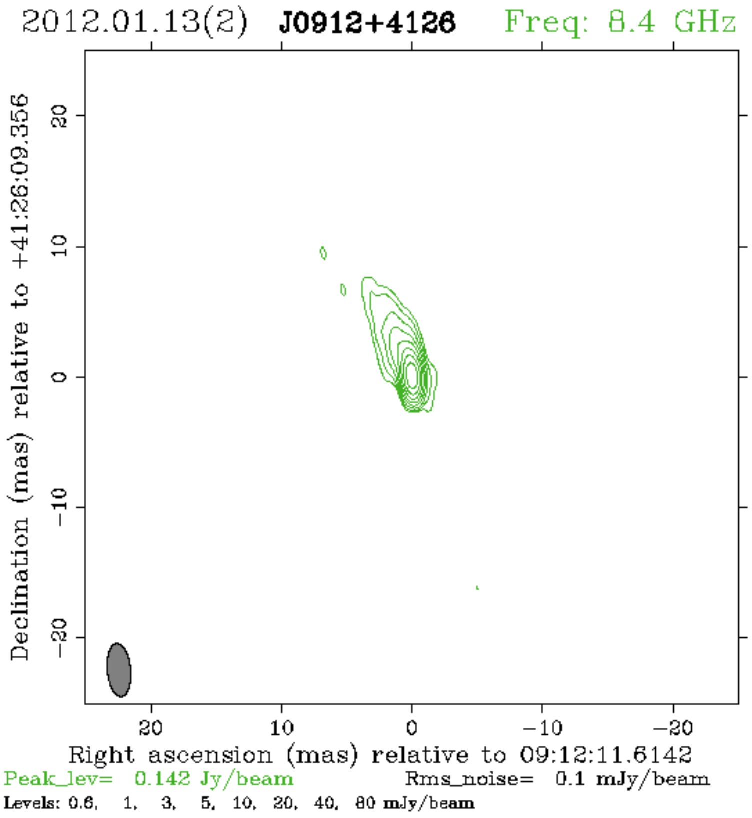
1-σ error **162 mas** (**127 mas**)

Number of matches

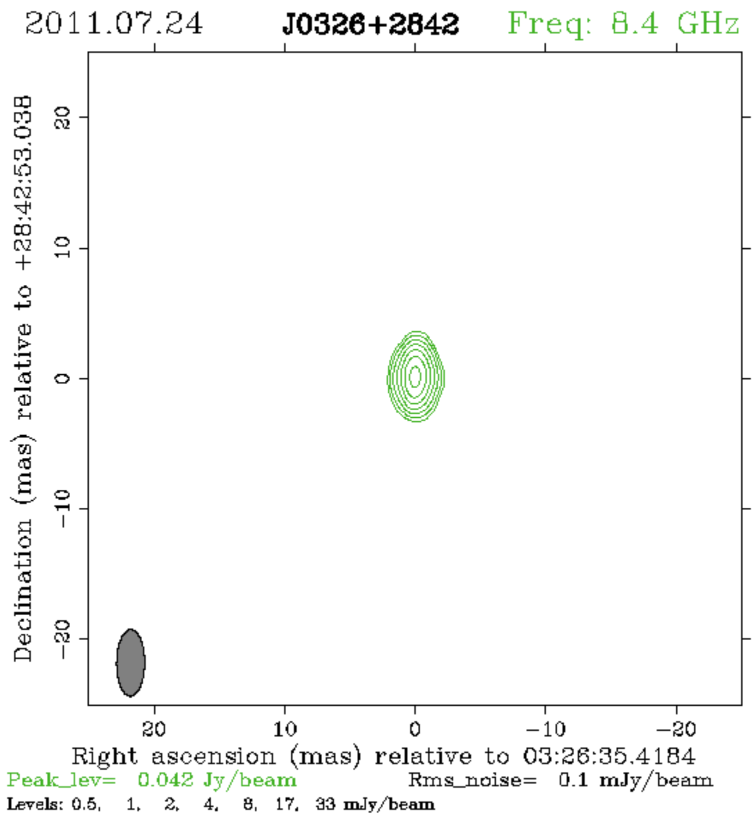
γ-ray	Fermi:	15%
X-ray	Chandra	3%
infra-red	WISE:	76%
infra-red	2MASS:	36% (point sources)
infra-red	2MASS:	11% (extended sources)
optic	NOMAD:	62%
optic	Gaia:	20–40% (expectation)
optic	PanStarrs:	93% (unconfirmed)

Observed objects

9498 Active galaxy nuclea



12 radio stars



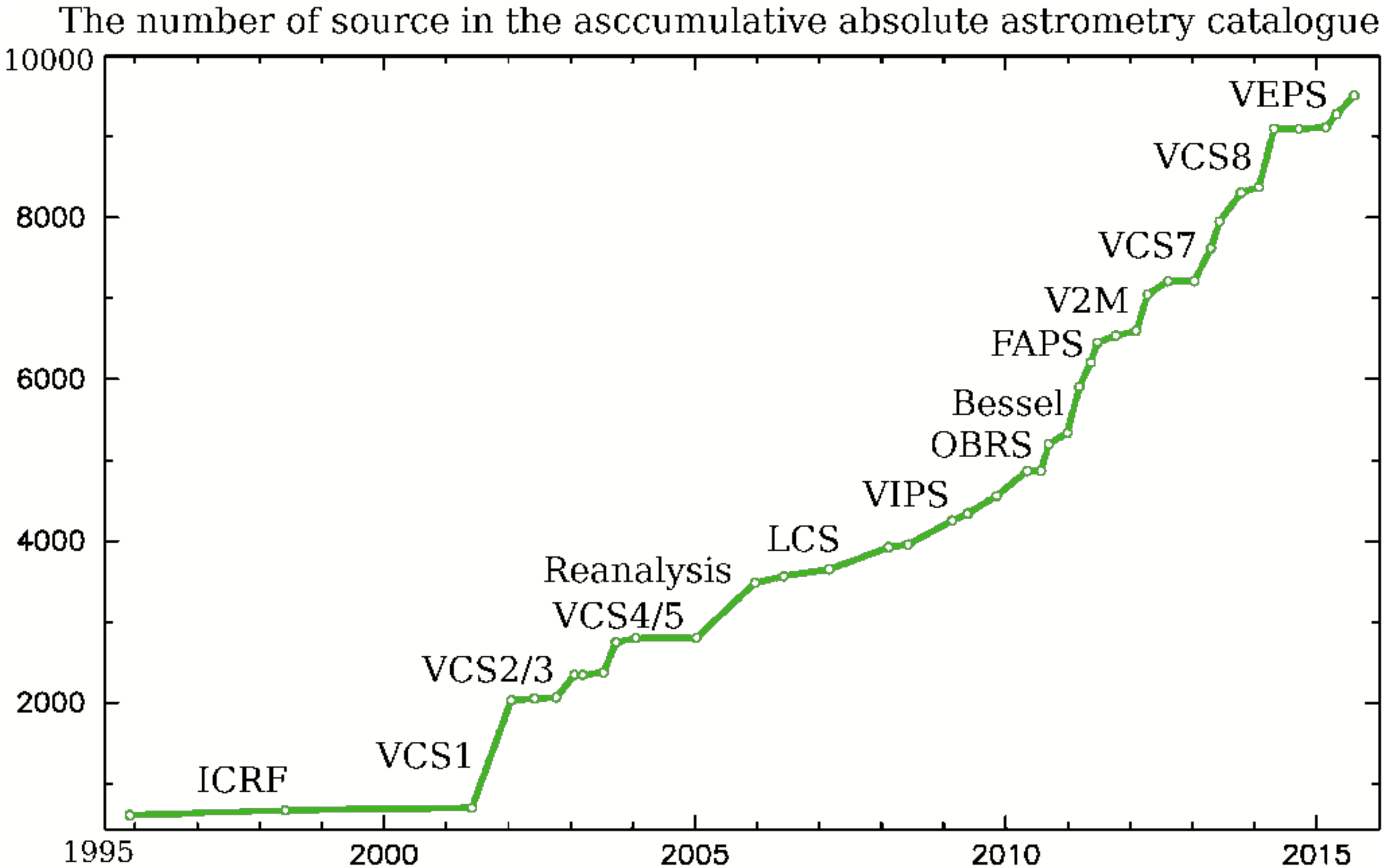
Error analysis

- Thermal noise
- Phase jitter. SNR limit: ~ 30–50.
- Troposphere. Typically: 0.1–0.2 mas.
- Ionosphere. Negligible for dual-band. 0.1–10 mas for single-band obs.
- Source structure. Typically, 0.1–0.2 mas.
- Core shift. Fundamental limit: 0.2 mas

Bottom line:

1. Fundamental limit of accuracy is ~ 1 nrad (0.2mas)
2. 20% sources reached that limit.

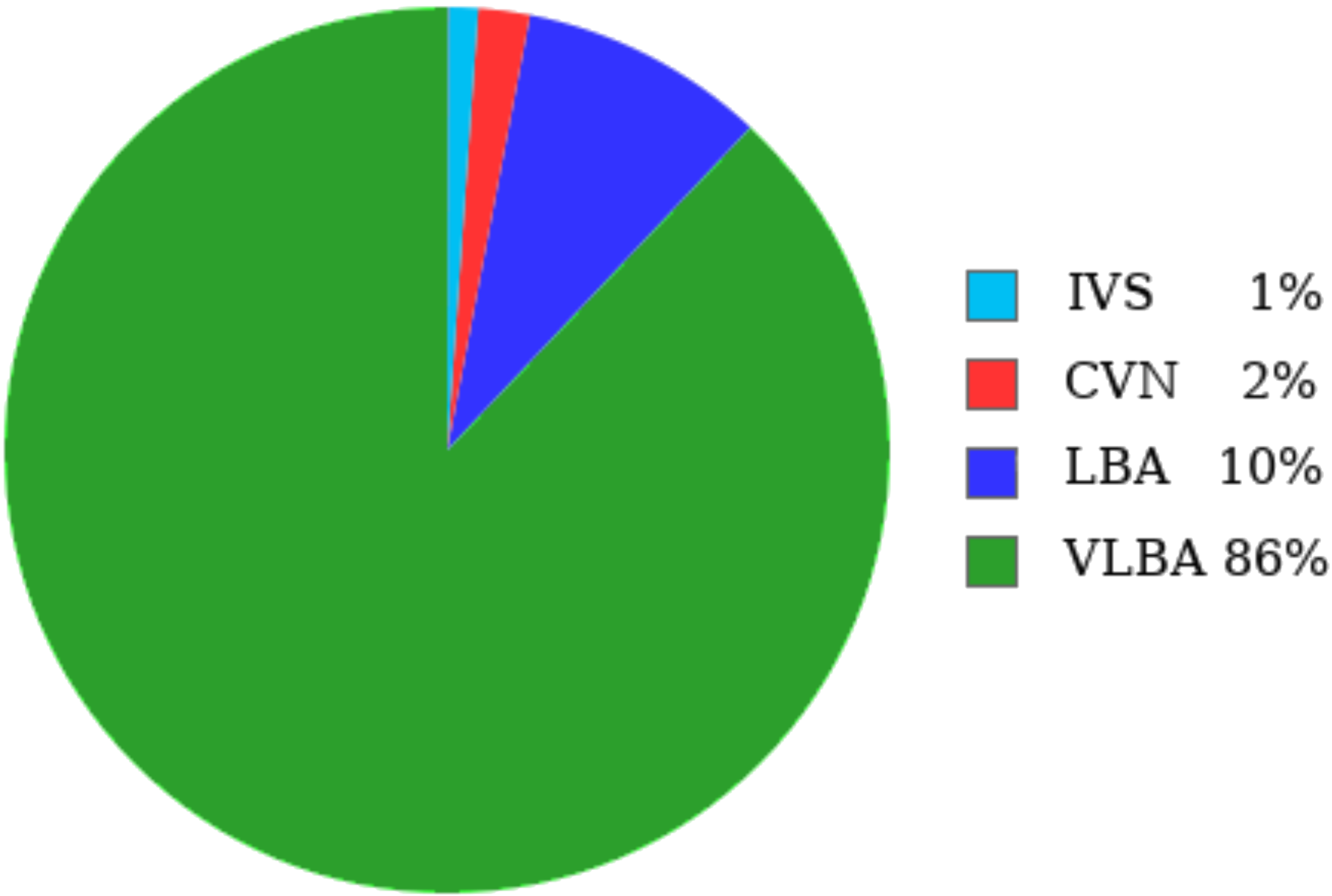
Observing campaigns



438 dedicated observing campaigns. Approximately 1 year on-source time.

30 Tb visibility data.

Participating VLBI networks



Processing pipeline

- Automatic scheduling triggered by the array operator
- Correlation
- Coarse fringe fitting
- Bandpass calibration
- 1st fine fringe fitting
- Interactive analysis
- 2nd fine fringe fitting
- Interactive analysis
- re-fringing with a narrow window
- Final interactive analysis
- Imaging
- Coarse global solution
- Reweighting
- Final global solution

The RFC is updated on a quarterly basis.

Future work

- Further densification: VCS9 campaign: 5000 new targets.
  Goal: one RFC source per PanSTARRS field.
  At the moment, there are 22% PanSTARRS fields without an RFC source.

  By 2015.09.19, 130 new sources were added.

- VCS-R: Improvement of positions of 500–800 sources.

- VEPS: Ecliptic plane survey. Goal: reaching completeness at 50 mJy and position accuracy 1.5 nrad within $|\beta| < 7.5^\circ$.

- R&D: Breaking 1 nrad limit. Goal: improvement of accuracy down to 0.05 mas level for 20–100 sources.

Conclusions

- The radio fundamental catalogue has $\sim$10,000 sources.
- Based on <u>all</u> suitable public available VLBI observations.
- Median position accuracy: 0.62 mas.
- Images are available for 76% sources.
- Complete at 170 mJy level at X-band.
- Updated on a quarterly basis.

http://astrogeo.org/rfc