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Spectral properties of a sample of 20-GHz selected radio sources

Outline

- Description of KNoWS survey
- KNoWS follow-ups
- OCRA follow-ups
- KNoWS 20-GHz counts
- Color-color plots
- Comparison with other samples
- Conclusion and future work

KNoWS

K-band Northern Wide Survey:

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Group (INAF-IRA):
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Alessandra Zanichelli, Isabella Prandoni,
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Franco Mantovani, Marcella Massardi,
Rashmi Verma (Estrela PhD)

- INAF-IRA Medicina 32-m dish
- New 7-feed 18-26.5 GHz receiver (*SRT*)

Why *KNoWs*?

No wide-area surveys exist at these high frequencies for the northern hemisphere

Goal:
to survey the northern sky at 20 GHz
to detect sources **down to 50 mJy**

- **study of extragalactic compact sources as foregrounds for CMB observations**

- study of the astrophysical properties of extragalactic sources

Complementary to the **AT20G** survey (Murphy et al. 2010, Massardi et al. 2011) carried out in the southern sky with ATNF-ATCA

18-26.5 GHz 7-feed receiver

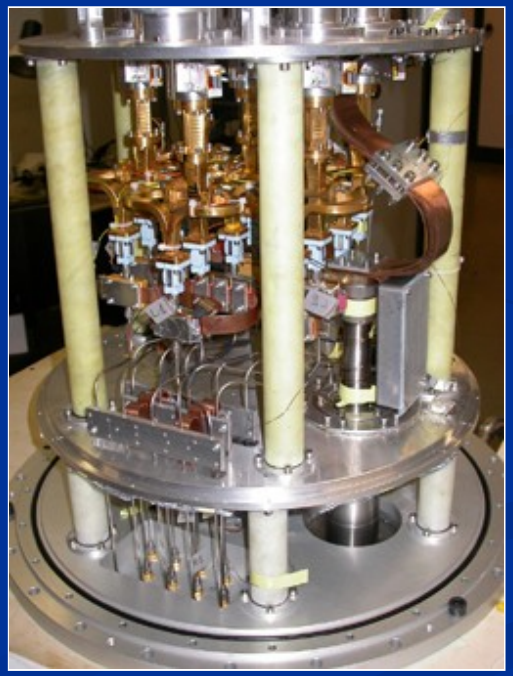
T_{sys} = 70 K (22 GHz, El=45°, $\tau\alpha\upsilon$= 0.1)

Gain = 0.11 K/Jy (22 GHz, El=45°)

HPBW = 92” (22 GHz)

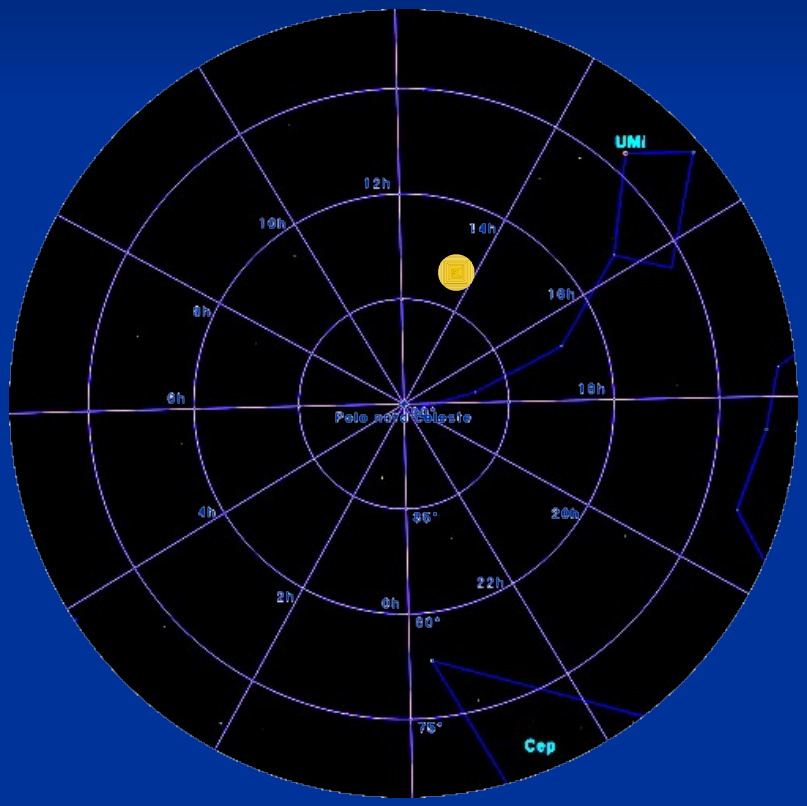
Sky distance between beam couples = 212”

14 output channels (7 LCP + 7 RCP) with 2 GHz-wide IF bands



KNoWS strategy: azimuth scans

Fast scans at constant elevation, moving back and forth within the desired azimuth range, exploiting the sky apparent rotation to map the wanted area.



Pros

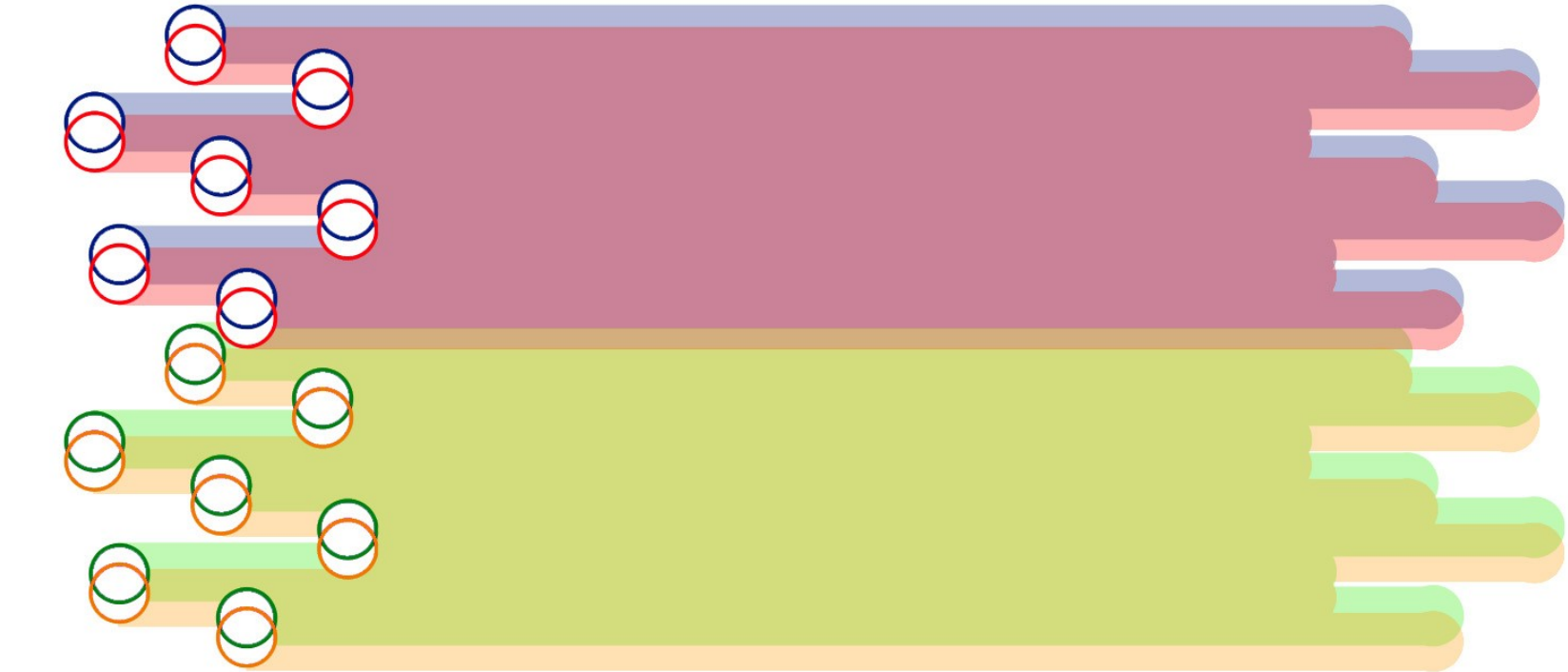
- All acquisition at same elevation, i.e. same airmass

Cons

- If there's RFI, it affects all scans
- Strictly LST-based strategy

Strategy by E.Carretti developed at Parkes (for S-PASS survey)

Zoom in



Sequence 1

Sequence 2 (+ 1 LST interleave)

Sequence 3 (+14 LST interleaves)

Sequence 4 (+15 LST interleaves)

Details: pilot survey setup

Azimuth range: 1° - 25° (Dec > 73.2°)
Fixed elevation: 44.52°
Scanning speed: 15 °/m (10.7 °/min on sky)
Sampling interval: 40 ms
Beamsize (FWHM): 108"
Samples/beam, single subscan: 4.2
Integration/beam, full map: 0.672 s

Final average rms: ~20 mJy

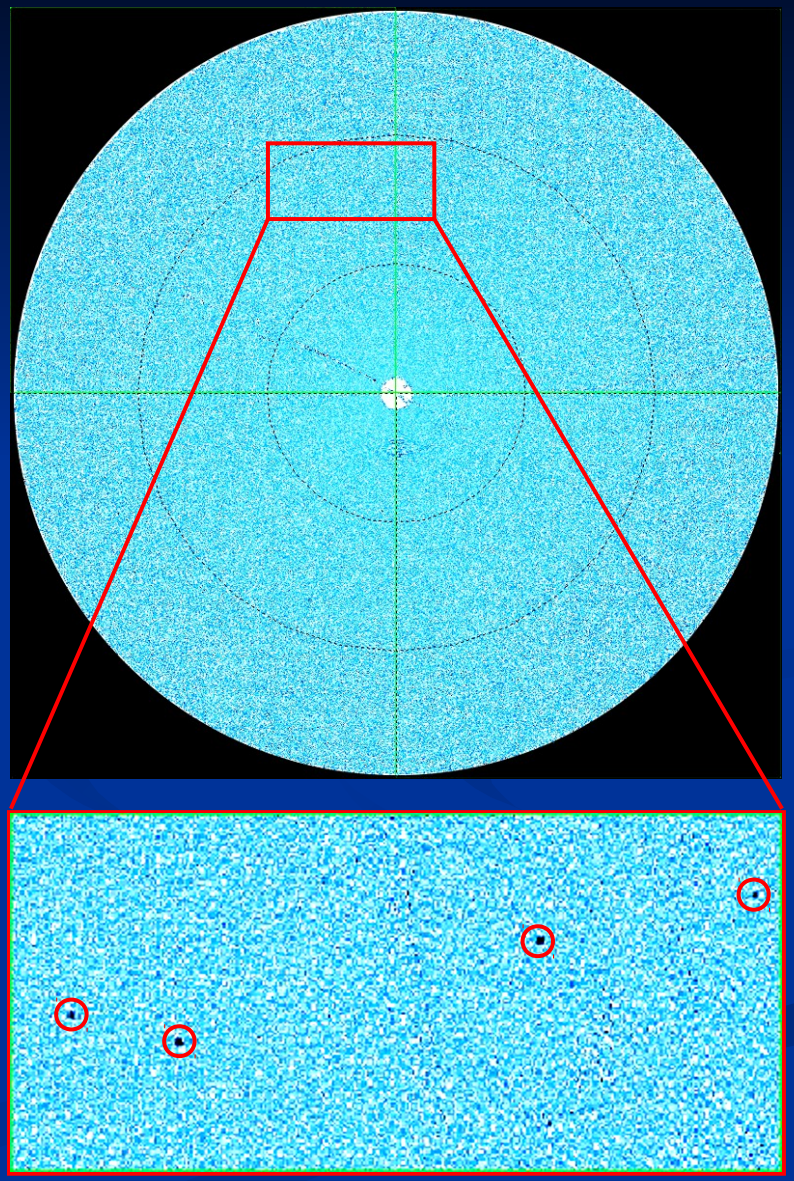
Status: pilot survey

Pilot survey for Dec > 73.2°
(~ 900 sq deg) was performed in total intensity in winter 2009-2010 (heavily affected by bad weather)

Map: all diffuse contributions are subtracted, looking for point-like sources.

Data reduction confirmed the expected system performances.

Use of different source extraction tools → identification of **~ 150 candidate sources down to 100 mJy**



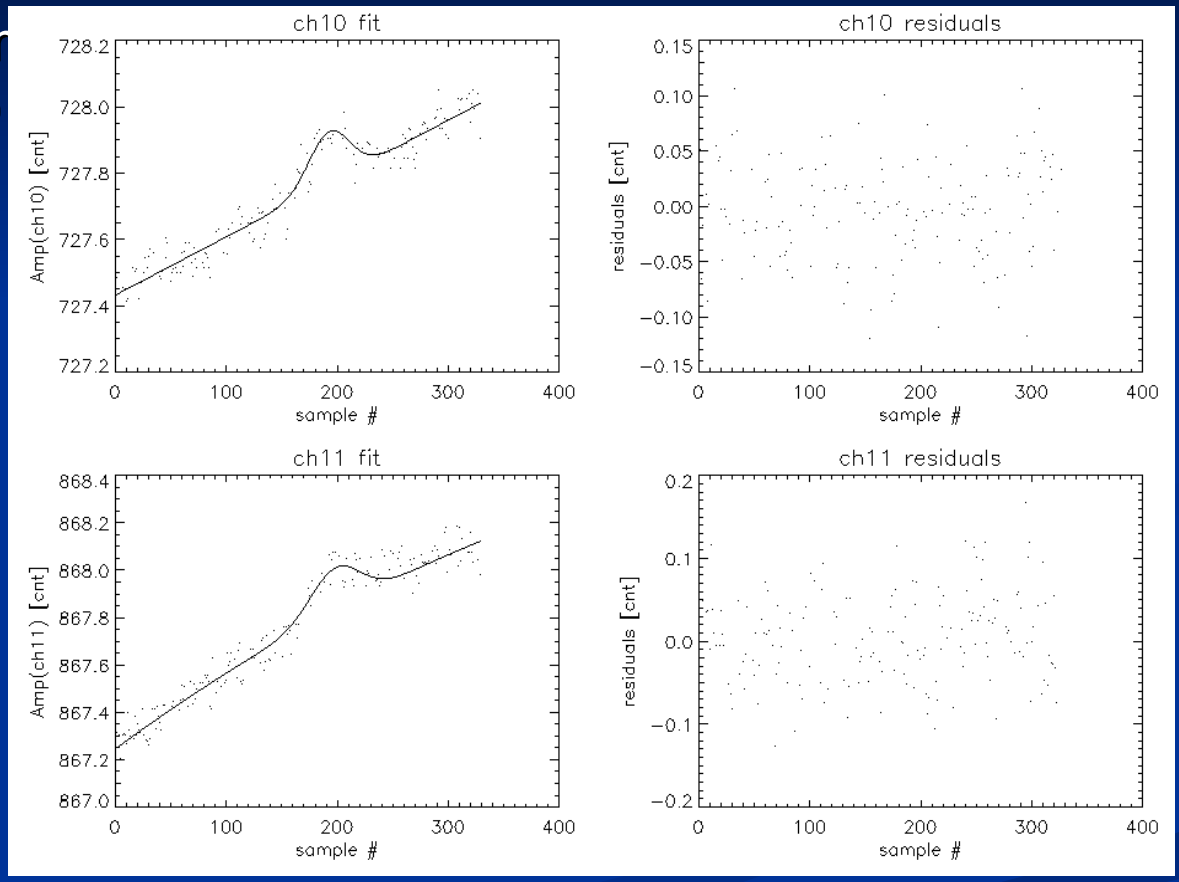
KnoWS follow-up

- Confirmation and multi-frequency continuum follow-up (5, 8.3, 20 GHz) of *151* pilot survey candidates, in April 2011

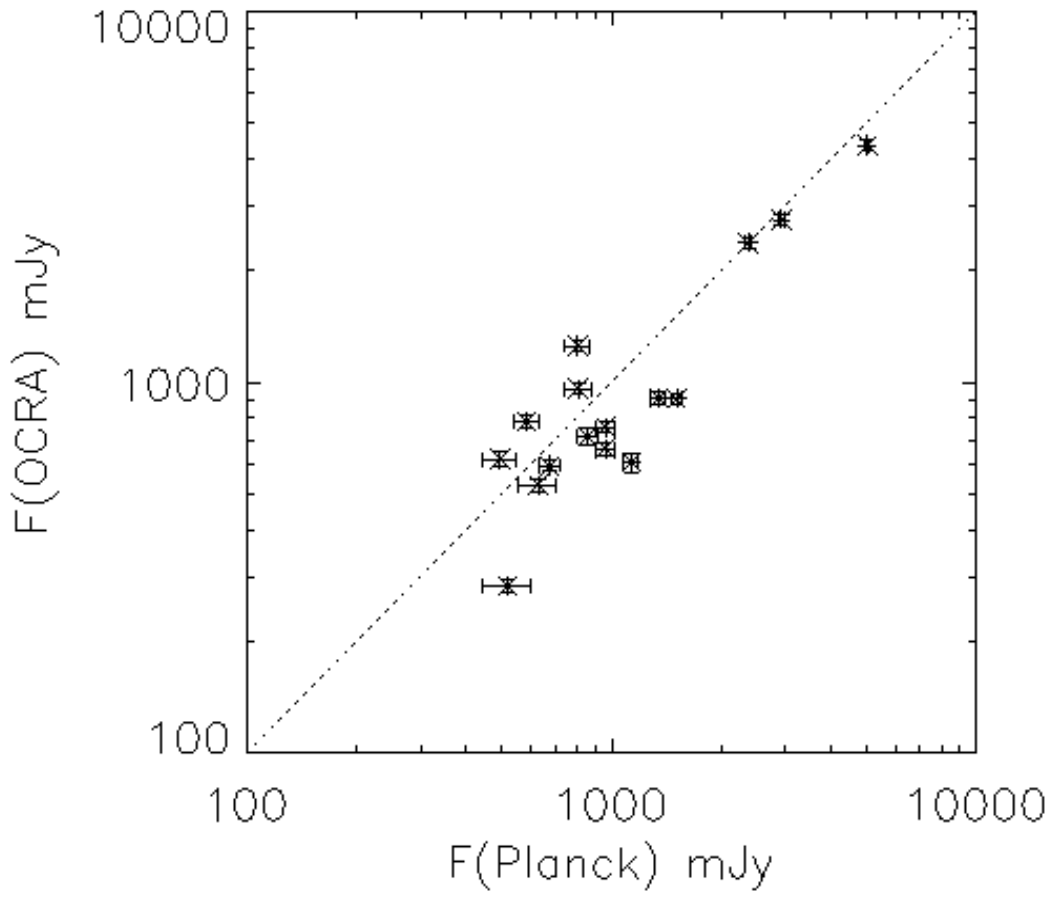
(+ 30 GHz OCRA observations for a sample of sources)

73 sources were confirmed

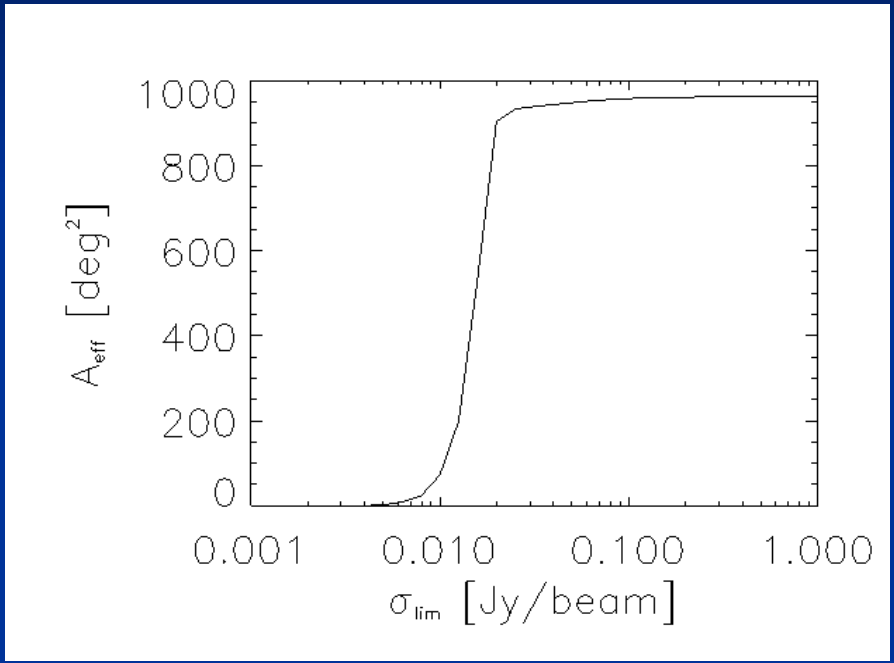
Righini et al., 2012.
(+Ricci et al., in prep.)

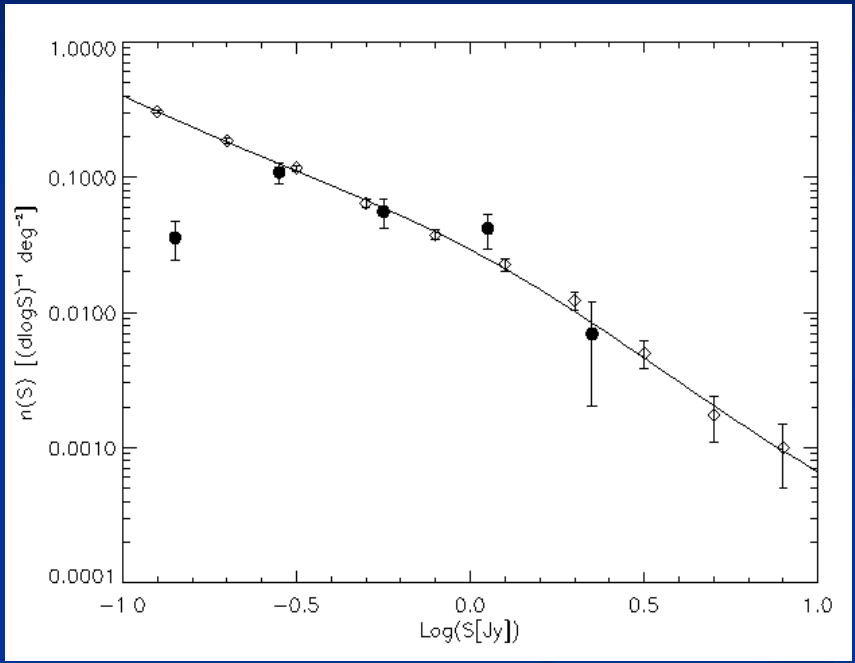


OCRA follow-up



KNoWS Source counts



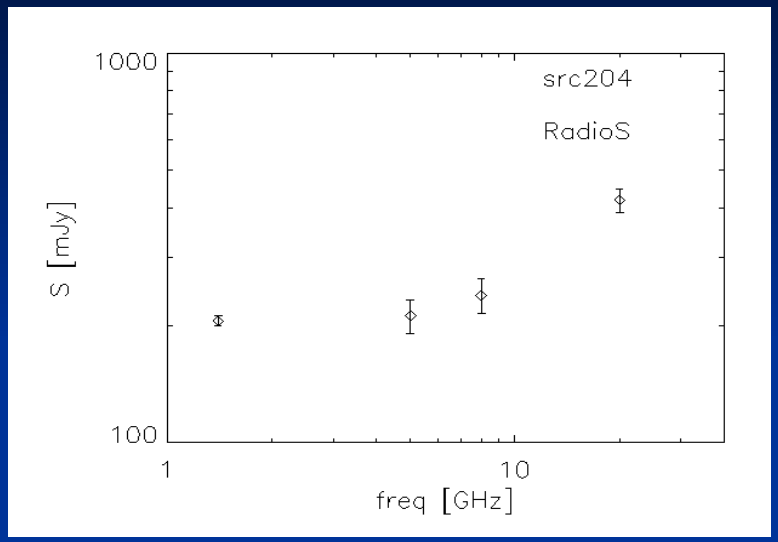


Effective Area as function of sensitivity

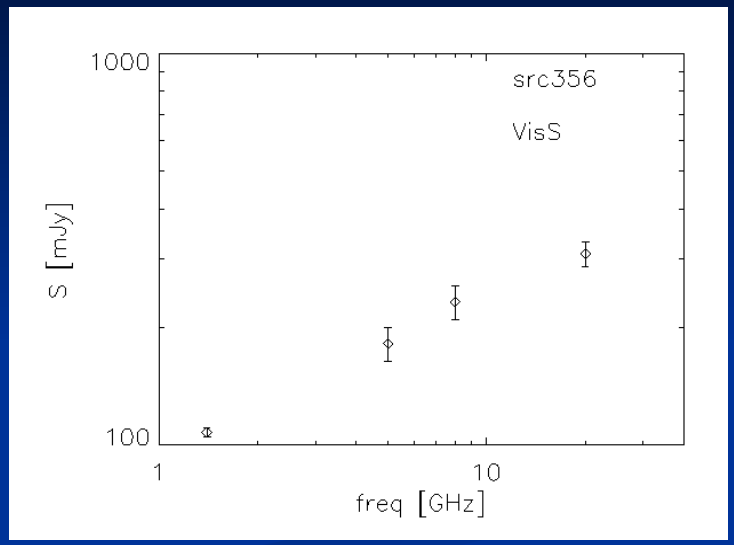
Filled circles: KnoWS
Diamonds: AT20G
Solid line: model de Zotti+ 05

Examples of Radio spectra

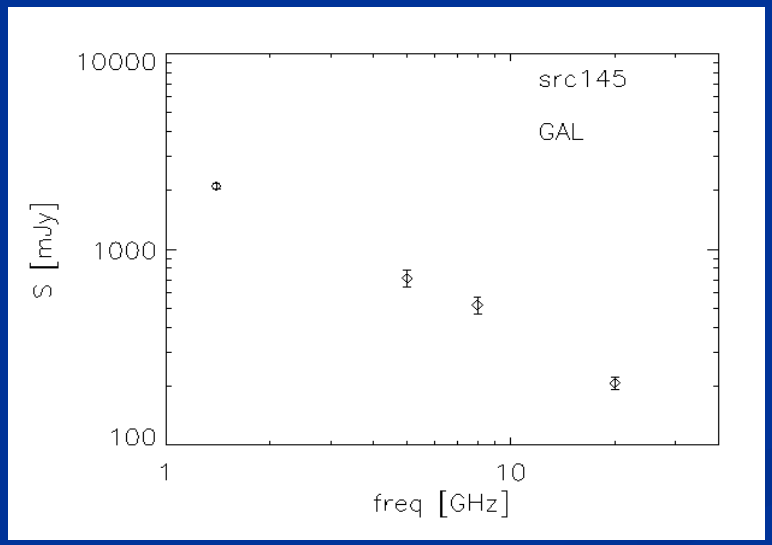
Upturn



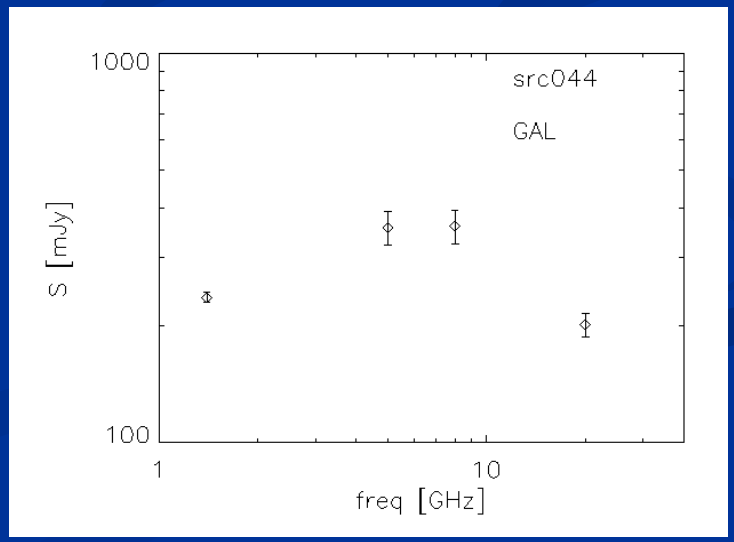
inverted



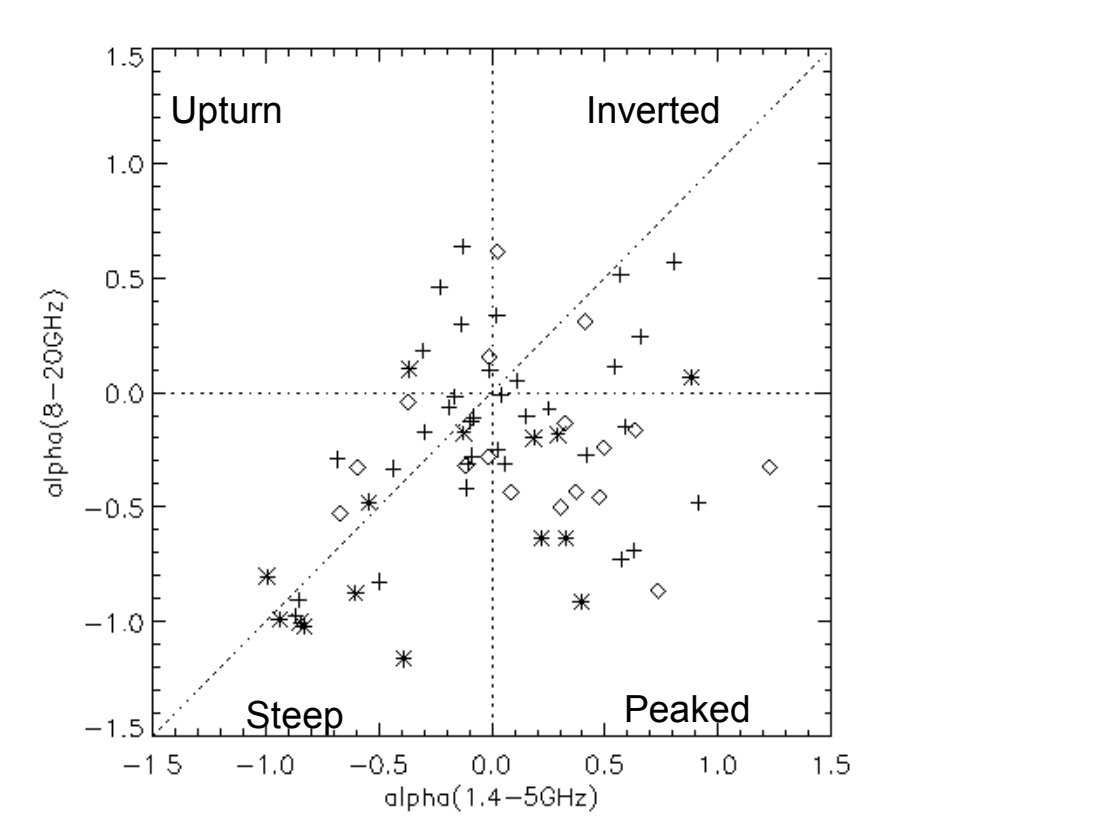
Steep



Peaked



KnoWS Radio Spectra: Colour-Colour Plots

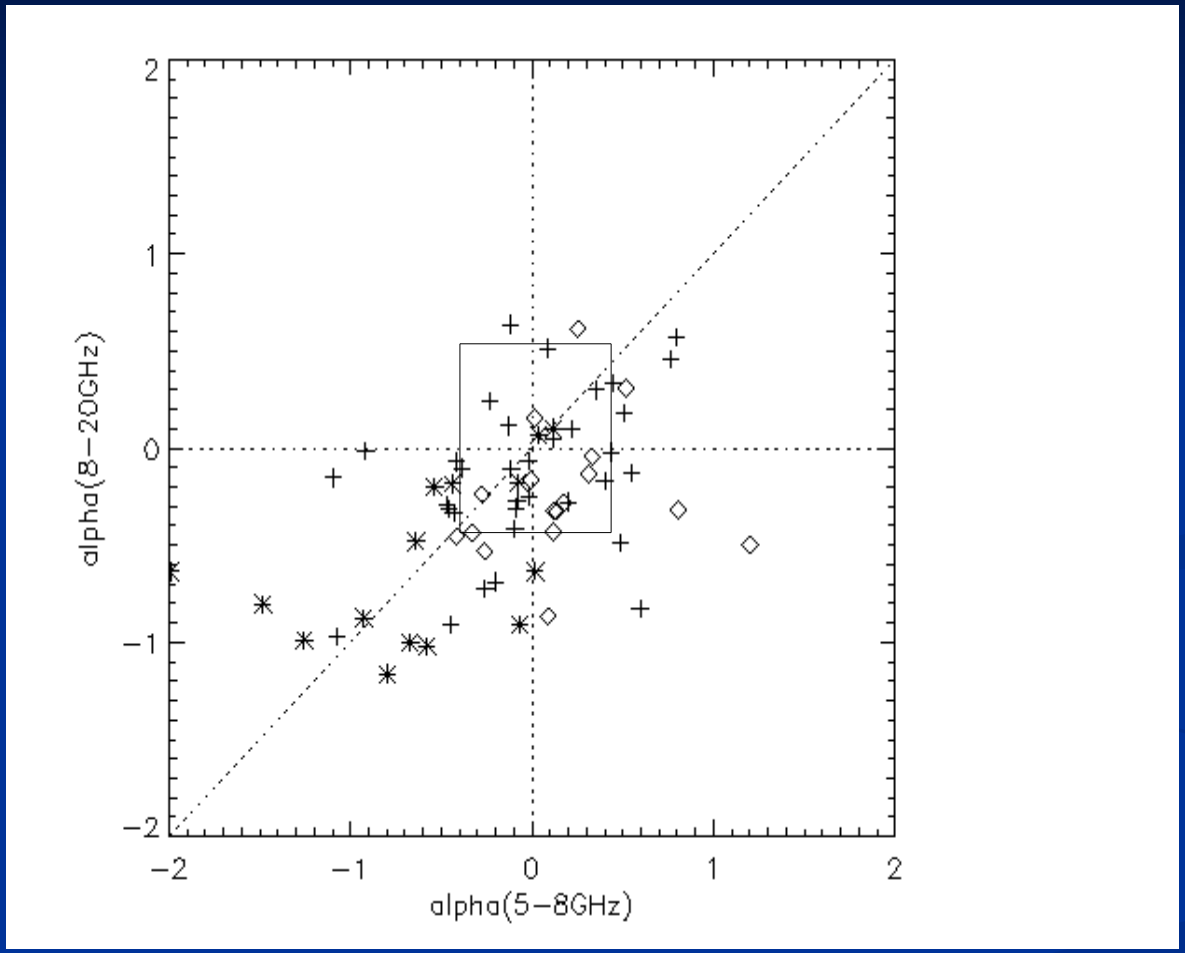


Median spectral index

- α(1.4-5) = 0.02
- α(8-20) = -0.07
- 66 objects

Crosses: QSOs (34)
Asterisks: Gals (15)
Diamonds: other ID's (17)

Colour-colour plots (II)



Median spectral index
- α(5-8)= -0.07
- α(8-20) = -0.25
- 66 objects

ATESP (Prandoni+10)
- 26 objects
- α(5-8) = -0.18±0.11
- α(8-20) = -0.79±0.16

AT20G FSR (Massardi+11)
- 3332 objects
- α(5-8) = -0.16
- α(8-20) = -0.25

Source populations: % Stats table (I)

Comparison with Prandoni et al. 2010

Type	ATESP	KNoWS α(5-8)	KNoWS α(1.4-5)
Upturn	9 ± 5	5 ± 3	11 ± 4
Inverted	13 ± 7	20 ± 5	14 ± 5
Steep	61 ± 14	52 ± 9	39 ± 8
Peaked	17 ± 8	24 ± 6	36 ± 7

Source Populations: % Stats Table (II)

Comparison with AT20G FSR (Massardi et al. 2011)

Type	KNoWS	FSR	FSR	FSR	FSR
	>100 mJy	<100 mJy	100-500 mJy	> 500 mJy	All survey
I	9	4.3	6.5	11.4	5.8
P	9	5.9	4.6	8.3	5.5
U	2	4.7	1.8	0.4	3.1
S	26	40.1	28.5	11.8	32.6
F	54	45.0	58.6	68.1	53.0
# src	66	1544	1534	254	3332

F: $-0.5 < \alpha(5\text{-}8) < 0.5$ & $-0.5 < \alpha(8\text{-}20) < 0.5$
I: $\alpha(5\text{-}8) > 0$ & $\alpha(8\text{-}20) > 0$ – F
P: $\alpha(5\text{-}8) > 0$ & $\alpha(8\text{-}20) < 0$ – F
U: $\alpha(5\text{-}8) < 0$ & $\alpha(8\text{-}20) > 0$ – F
S: $\alpha(5\text{-}8) < 0$ & $\alpha(8\text{-}20) < 0$ – F

Conclusions and future work

- KnoWS pilot survey succesfully commissioned the K-band multi-feed receiver
- Sample of 66 radio sources down to 100 mJy extracted and analysed
  - source counts in agreement with previous measurements and model
  - follow-up flux density measurements used to compute spectral indices
  - spectral index analysis indicates that source populations are distributed as in AT20G full sample in the flux range 100-500 mJy

- Completion of KnoWS survey with K-band multi-feed at the Sardinian Radio Telescope (being commissioned right now)
- 20-GHz deep survey to study radio spectral properties of radio sources in the 1-mJy regime matching the work of Franzen et al. (10C) and Sadler et al. (southern Hemisphere)