



# Counterparts to Fermi-LAT sources from the ATPMN 5 and 8GHz catalogue

David McConnell ATNF/CASS

# Counterparts to Fermi-LAT sources from the ATPMN 5 and 8GHz catalogue

A comparison of the Fermi Large Area Telescope gamma-ray catalogues 1FGL and 2FGL with the ATPMN radio catalogue.

Collaborators: Elaine Sadler, Tara Murphy, Ron Ekers

**ATPMN: accurate positions and flux densities at 5 and 8 GHz for 8385 sources from the PMN survey**

MNRAS 422, 1527–1545 (2012)

# The ATPMN catalogue

- Selected 8385 sources :
  - $S_{4.8} > 70\text{mJy}$  in  $-73^\circ < \delta < -38.5^\circ$
  - $S_{4.8} > 50\text{ mJy}$  in  $-87^\circ < \delta < -73^\circ$
  - $|b| > 2^\circ$
- Observations made in 5 sessions Nov 1992 to Mar 1994
- 6km arrays
- 128 MHz bandwidth at 4.8 GHz and 8.64 GHz, with full polarization
- 30 second observations at HA  $-4^h$ ,  $0^h$ ,  $+4^h$  on each source
- Typical image *rms* of 2 mJy



# The ATPMN catalogue

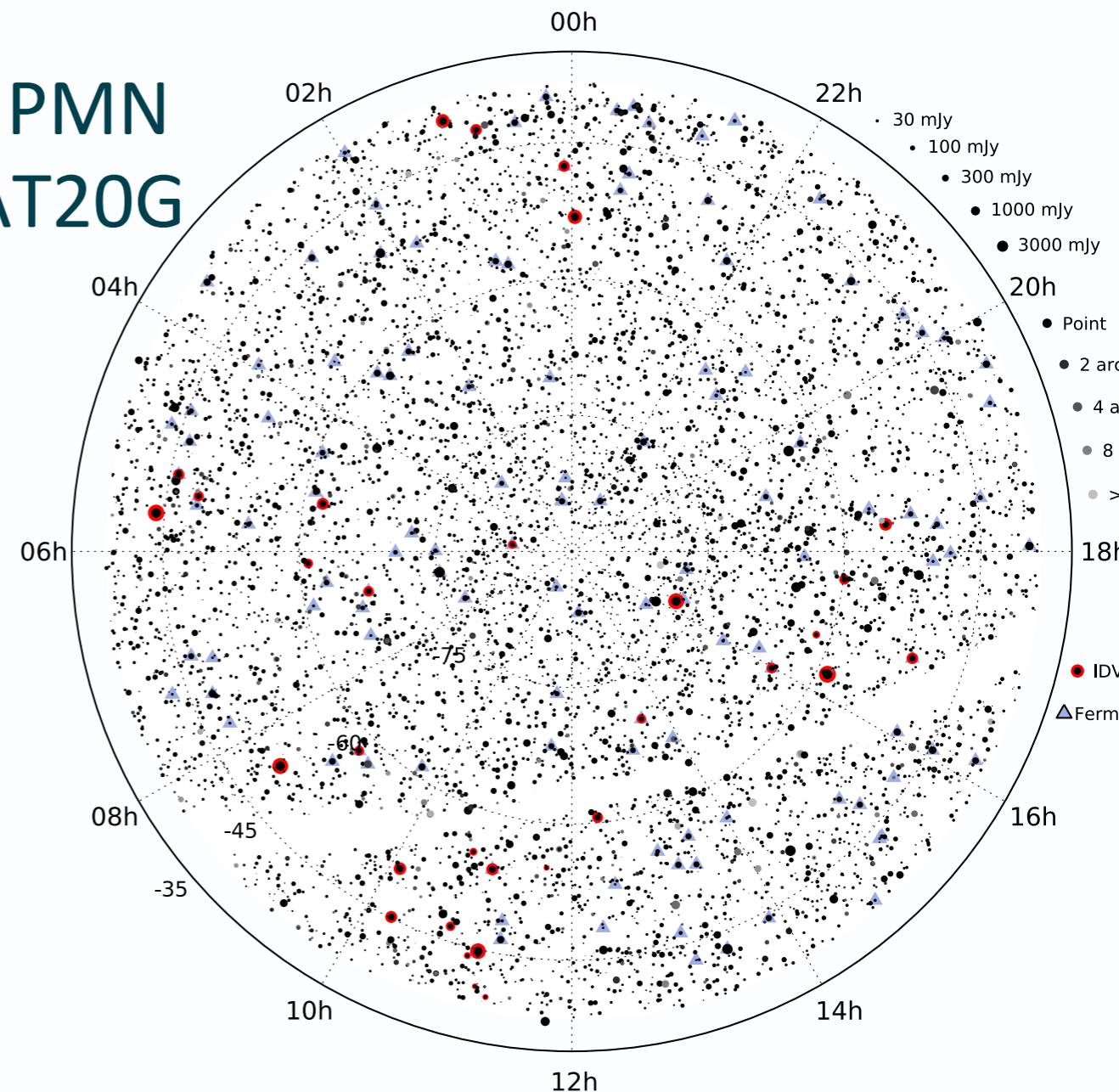
Three 45-s scans over 8 hours

100-fold resolution increase over PMN  
10-fold resolution increase over AT20G  
**1.5" × 2.5" (4.8GHz), 0.8" × 1.4" (8.6GHz)**

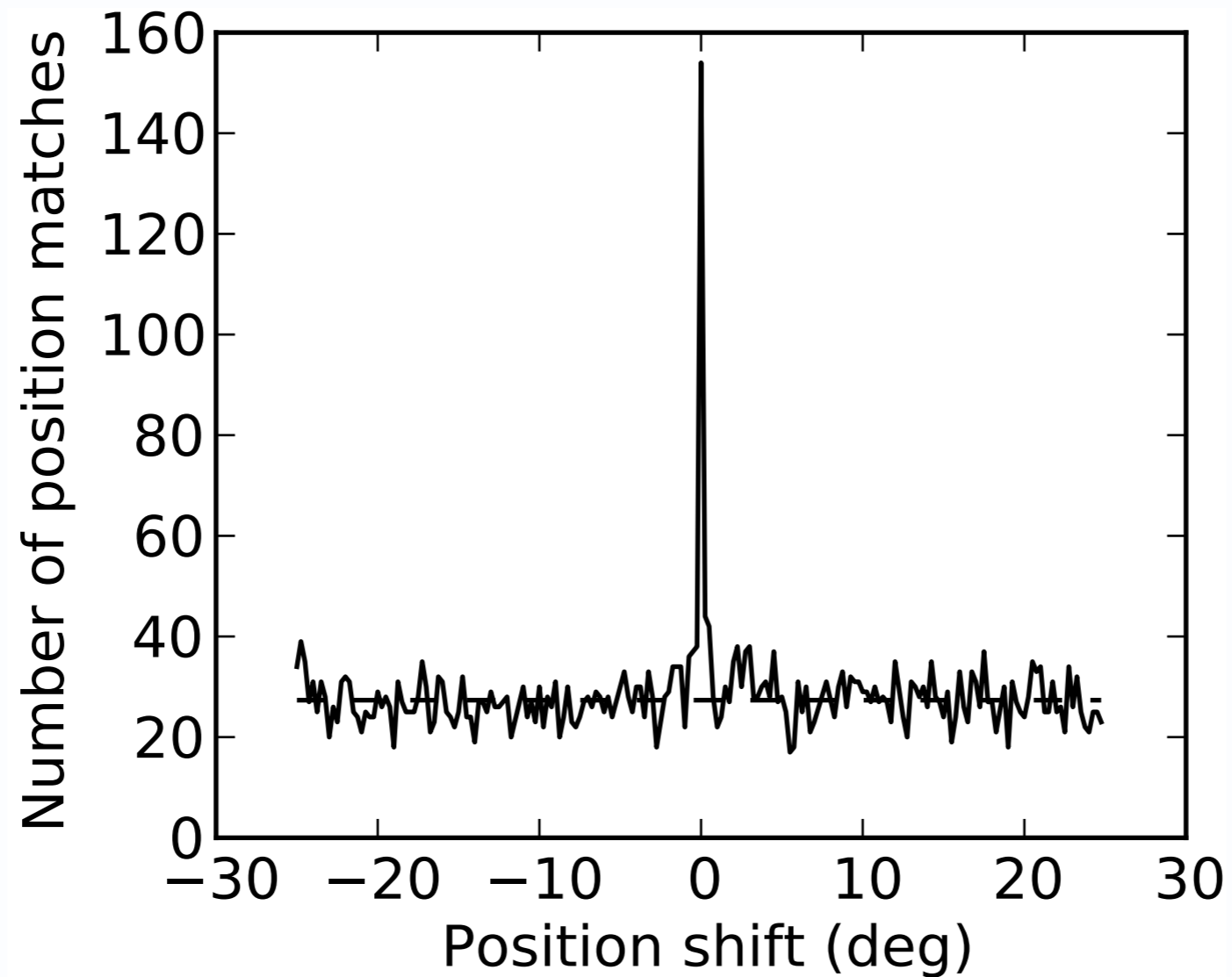
Flux-density at 4.8, 8.6 GHz  
**Estimates of spectral index**

Polarization

9040 catalogues sources

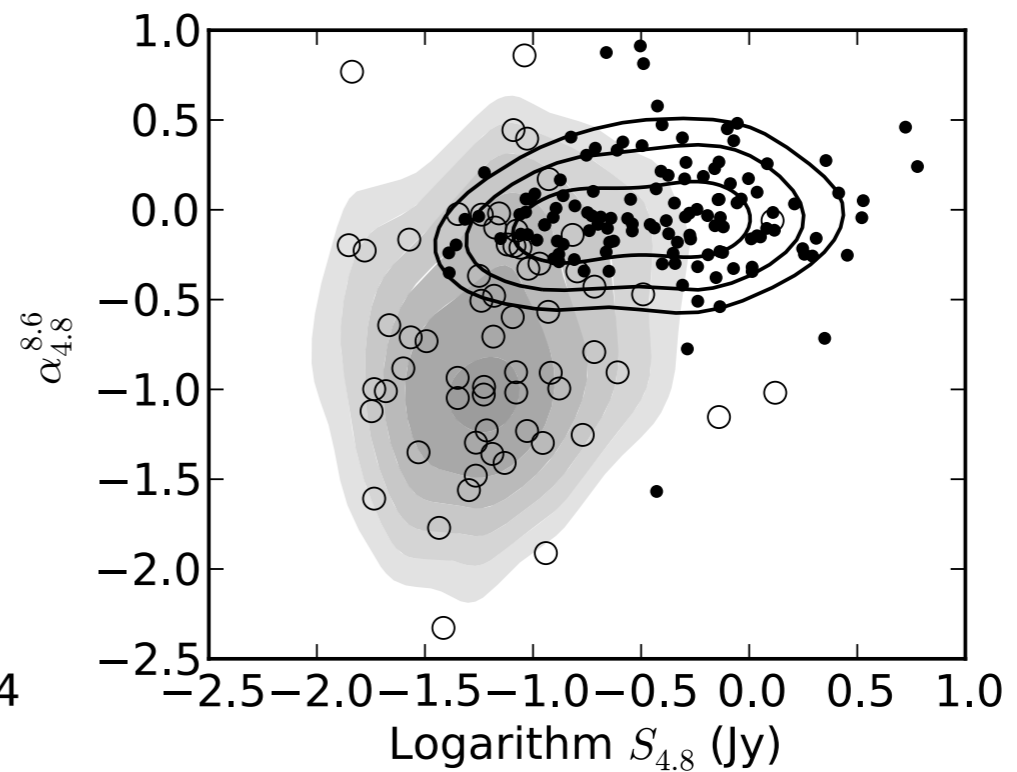
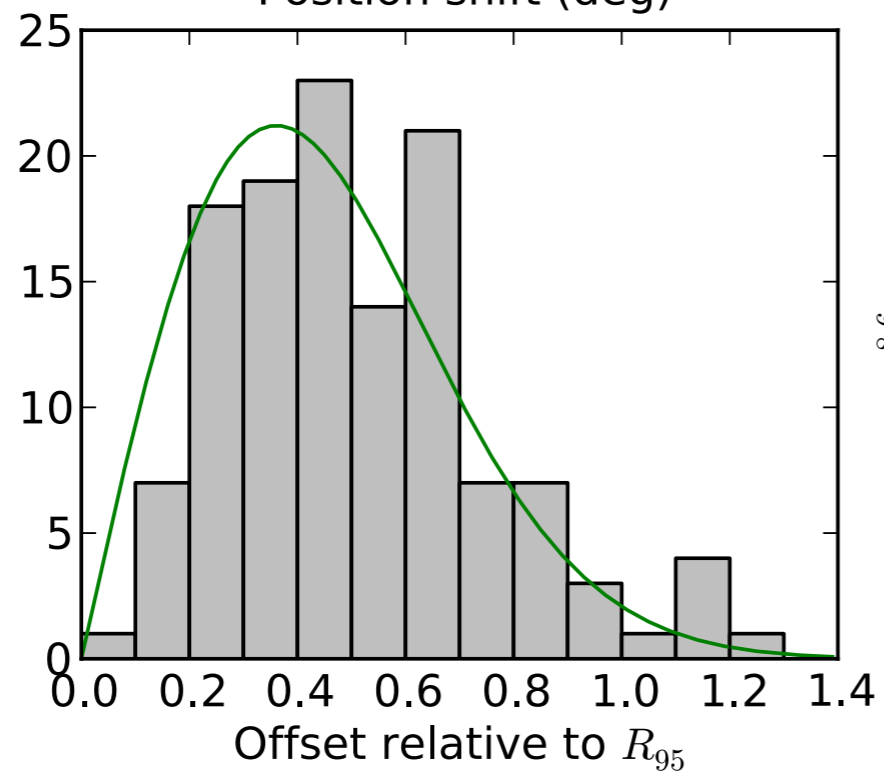
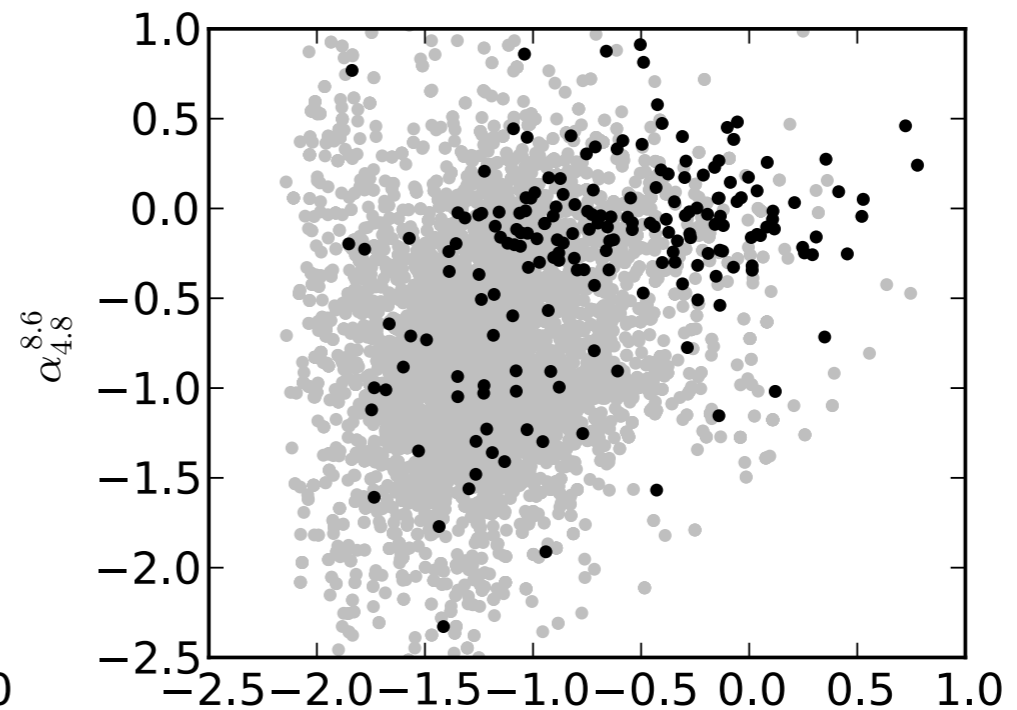
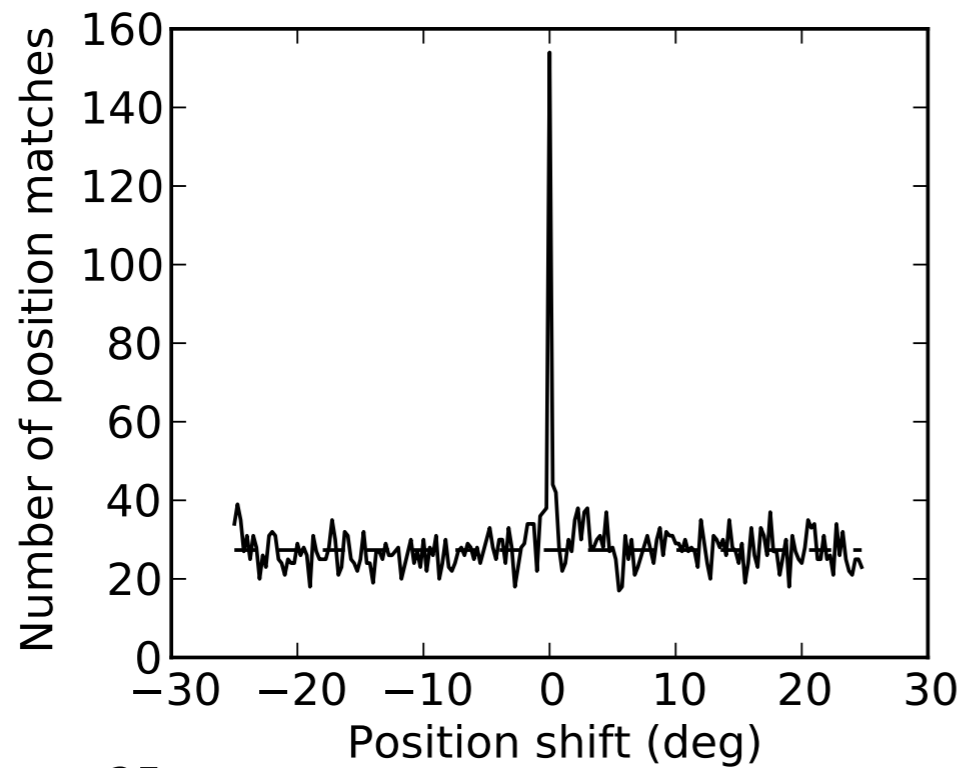


# Correspondence with the 2FGL



	In ATPMN sky	Near radio source	Coincidence	Likely associations
1FGL	214	107	27±4	80±4
2FGL	330	154	28±4	127±4

# Finding the radio counterparts



# Information on each source

## ATCA

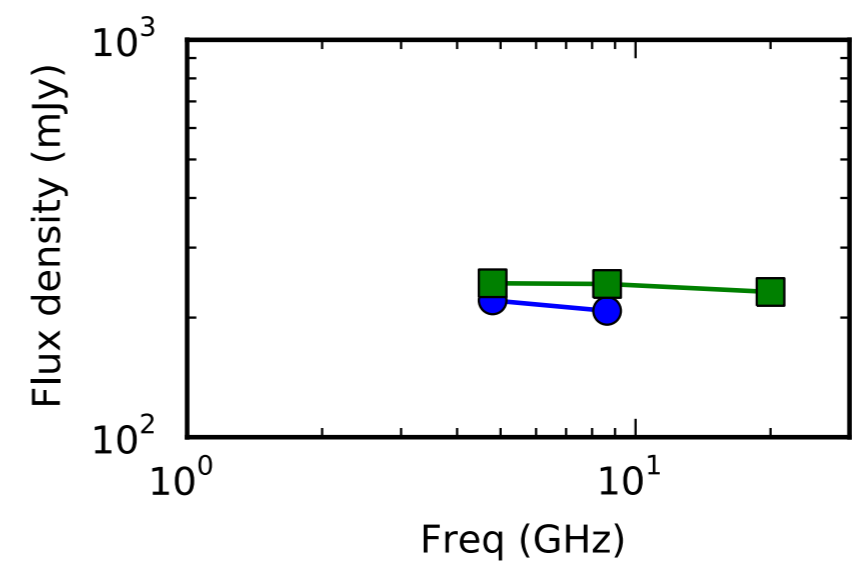
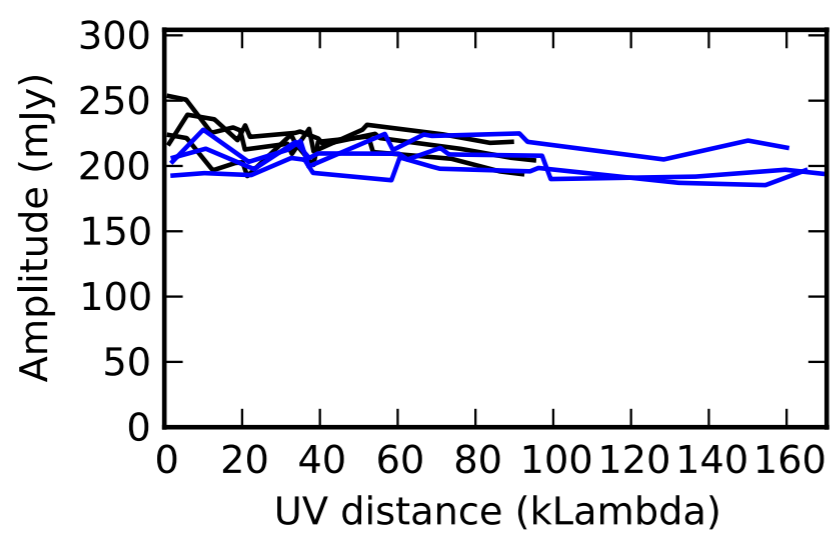
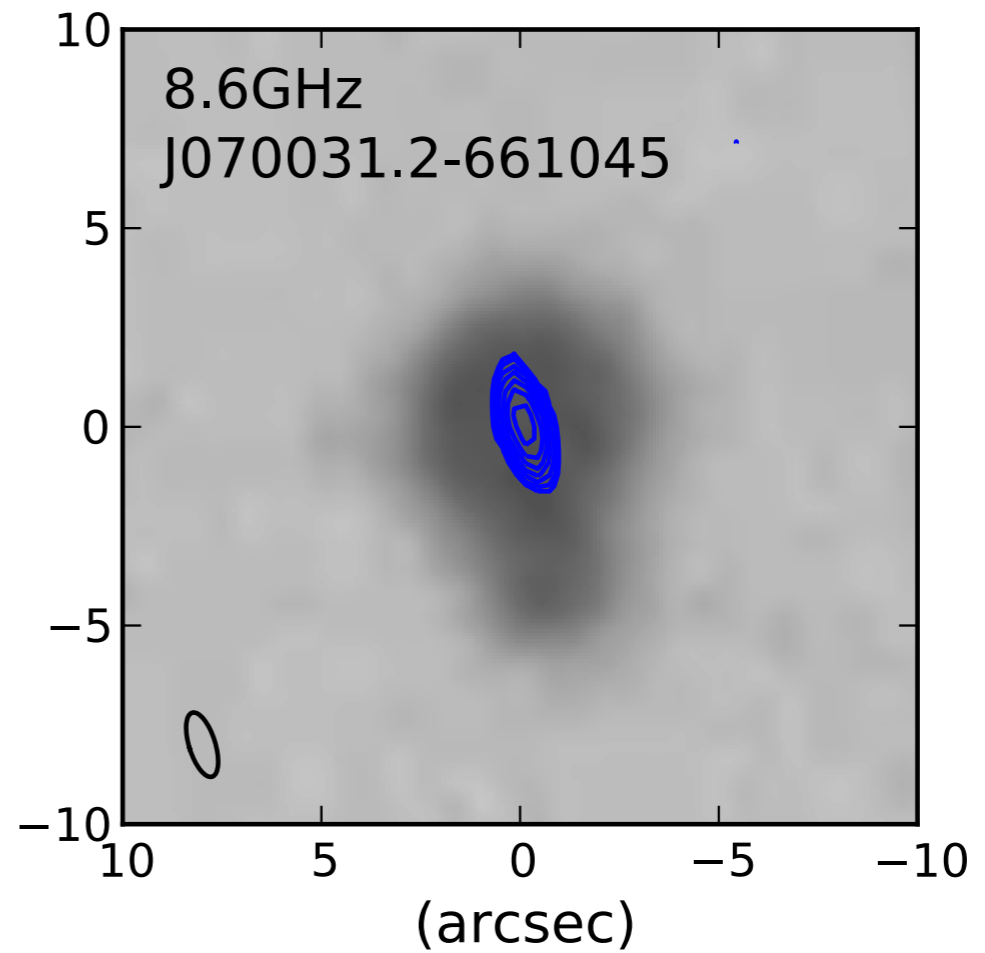
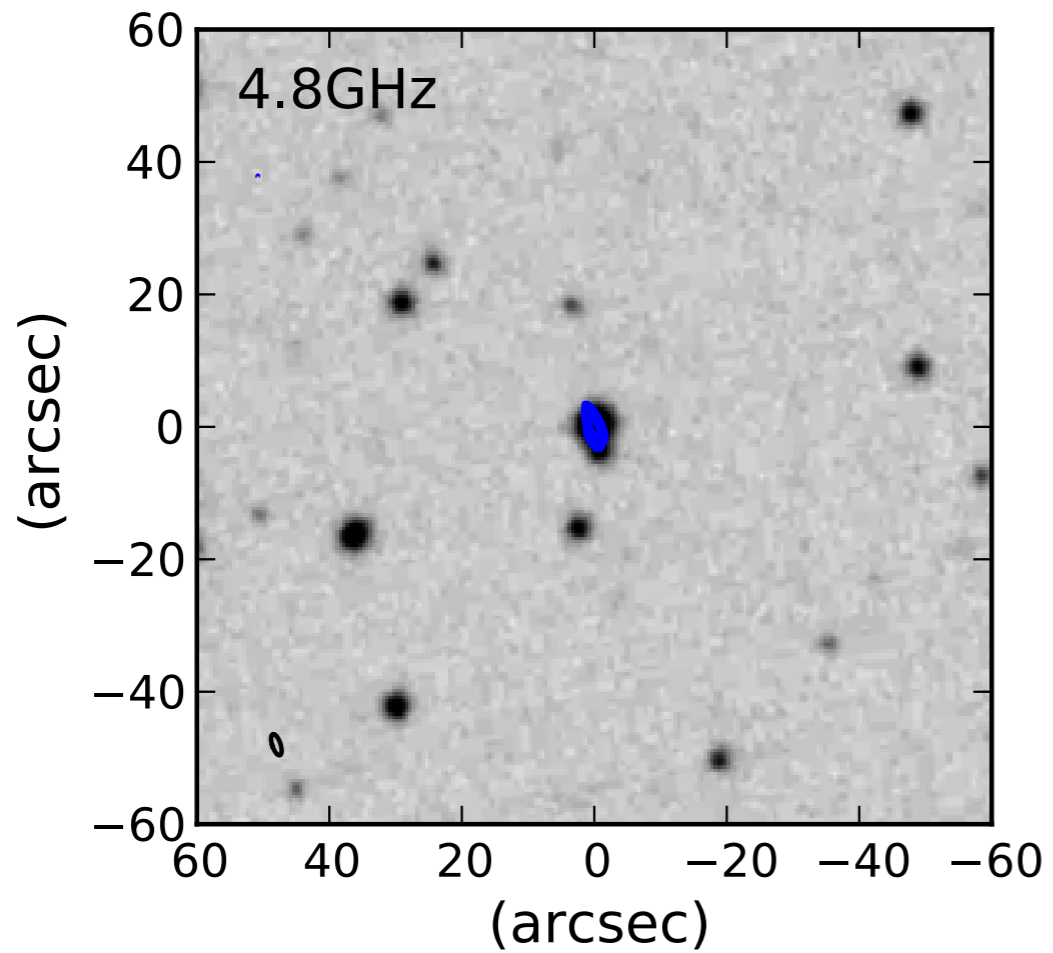
- Flux-density at 4.8,8.6 GHz : Spectral index
- Position and structural information, resolution  $\sim 1$  arcsec
- Polarization state

## AT20G

- Flux-density at 4.8,8.6 and 20 GHz and different epoch

## Optical identification (UK Schmidt survey)

- 112 of 126 2FGL associations have optical identification within  $3''$
- B, R and I magnitudes





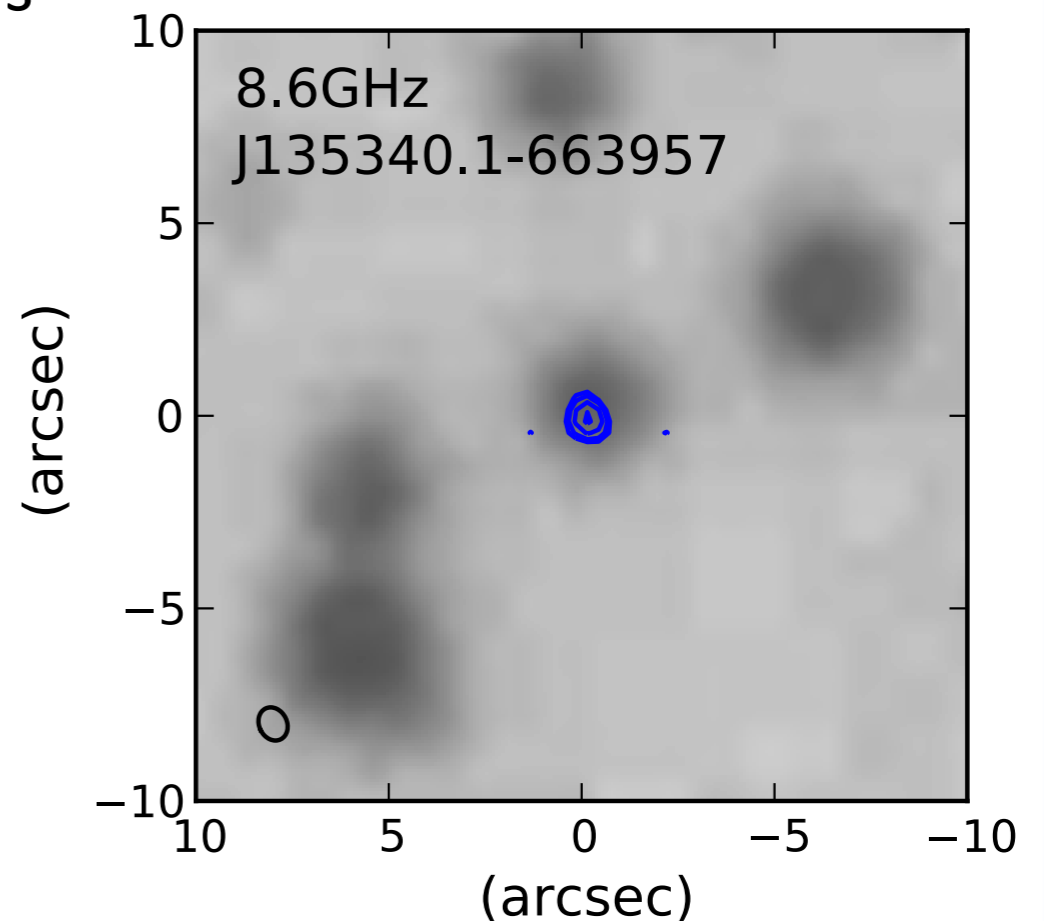
# 2FGL associations

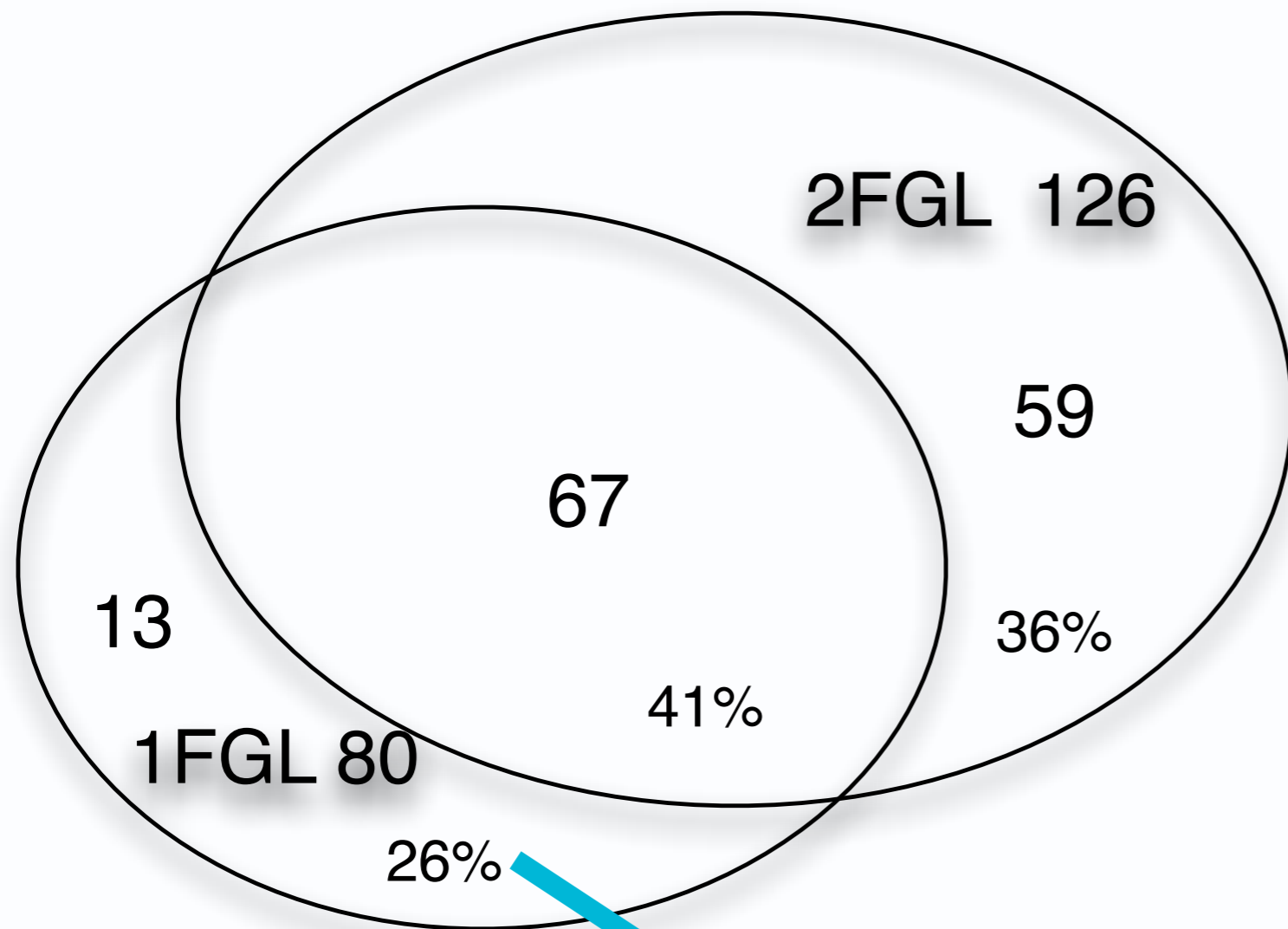
61% of sources in the 2FGL have been associated with a least one non-GeV  $\gamma$ -ray counterpart (Abdo + 2012)

- Including 125 of our 126 radio associations

## New association:

- 2FGLJ1353.5-6640 with ATPMNJ135340.1-663957
- also known as VASCJ1353-66, studied by Tsarevsky +(2005), searching for active stars in the Galaxy
- their candidates had hard X-ray and radio emission
- They concluded it to be a BL Lac-type object.

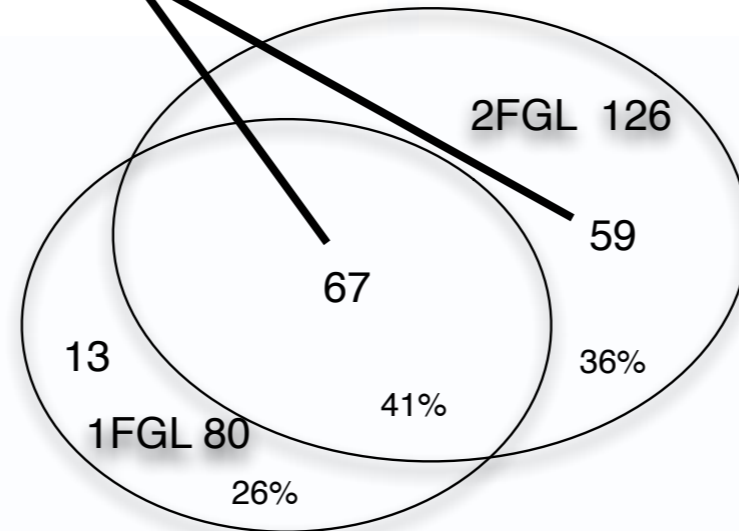
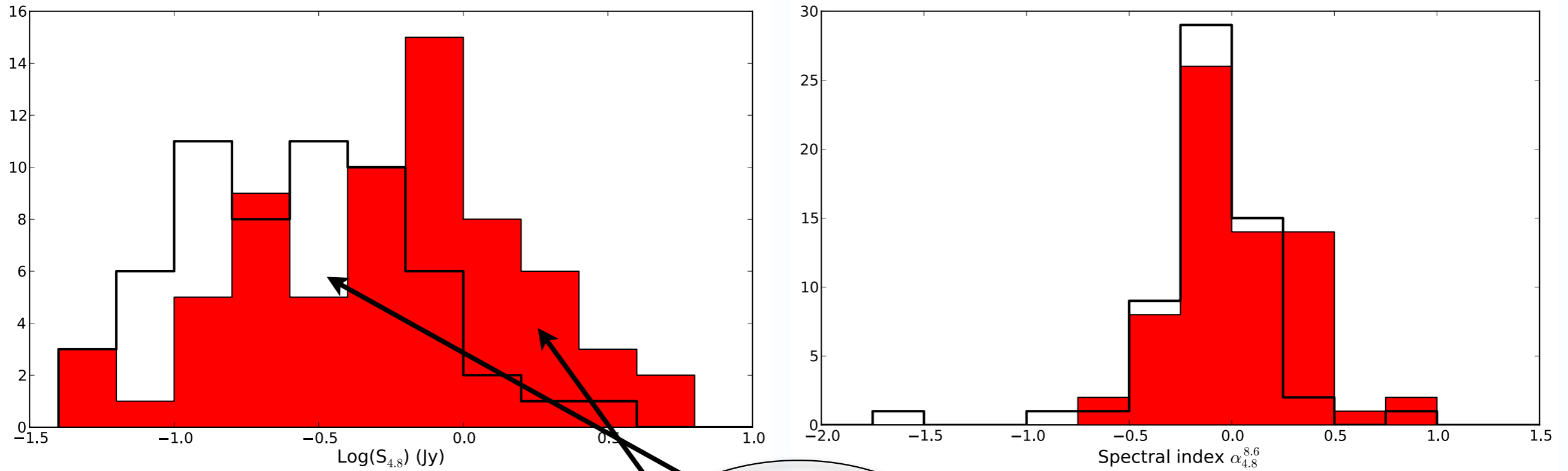




FGL sources with  
ATPMN  
associations

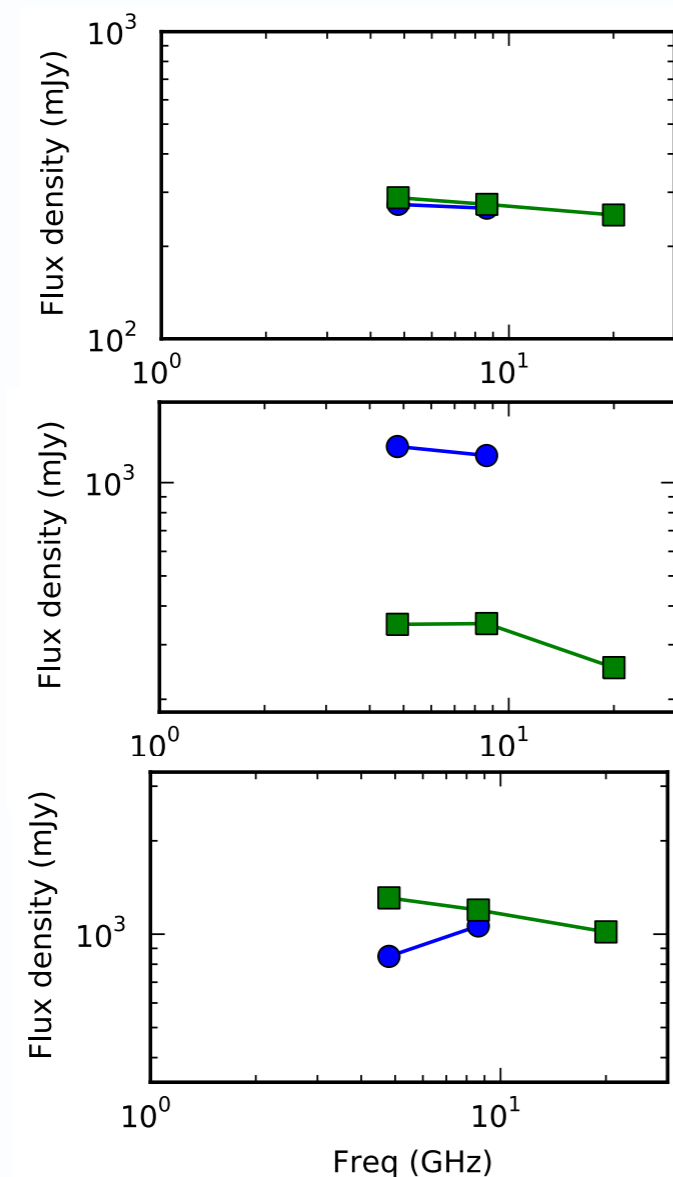
1FGL sources not in 2FGL  
have low significance  
(mean = 8.9)

# Radio counterparts to 2FGL sources not in 1FGL have lower flux density:



# Long-term radio variability

10 - 14 years between ATPMN and AT20G observations



J015751.1-461423

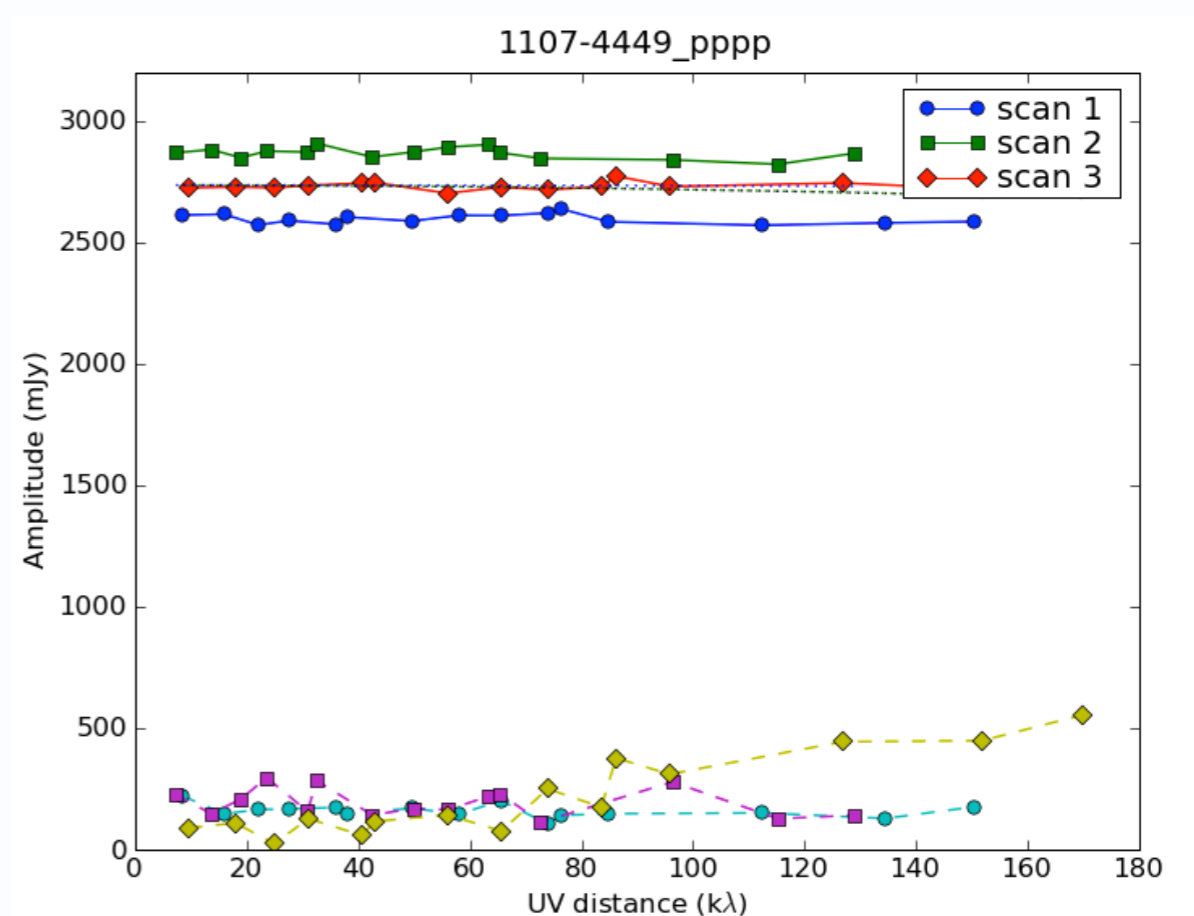
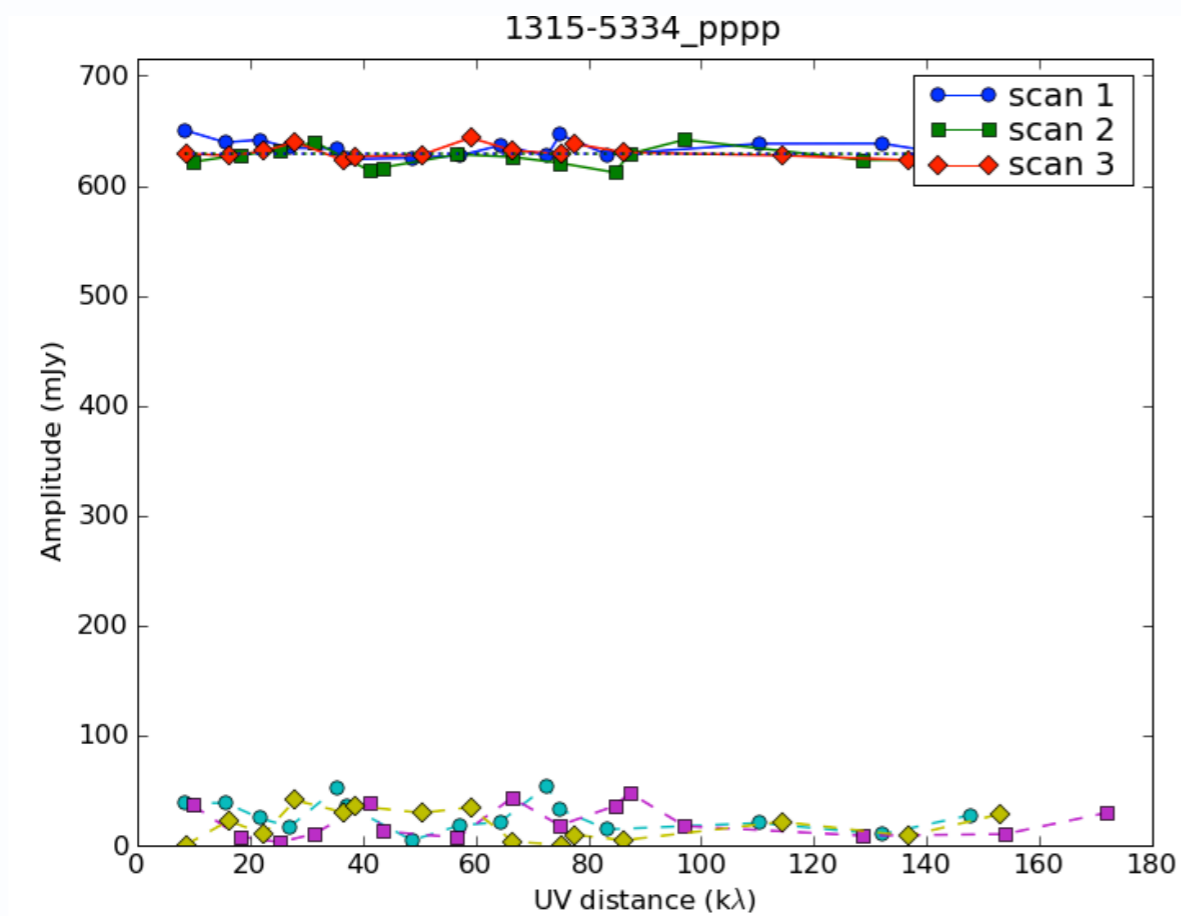
J072626.2-472853

J030956.0-605839

85% have significant variation

# Short-term radio variability

4 - 8 hours between ATPMN scans



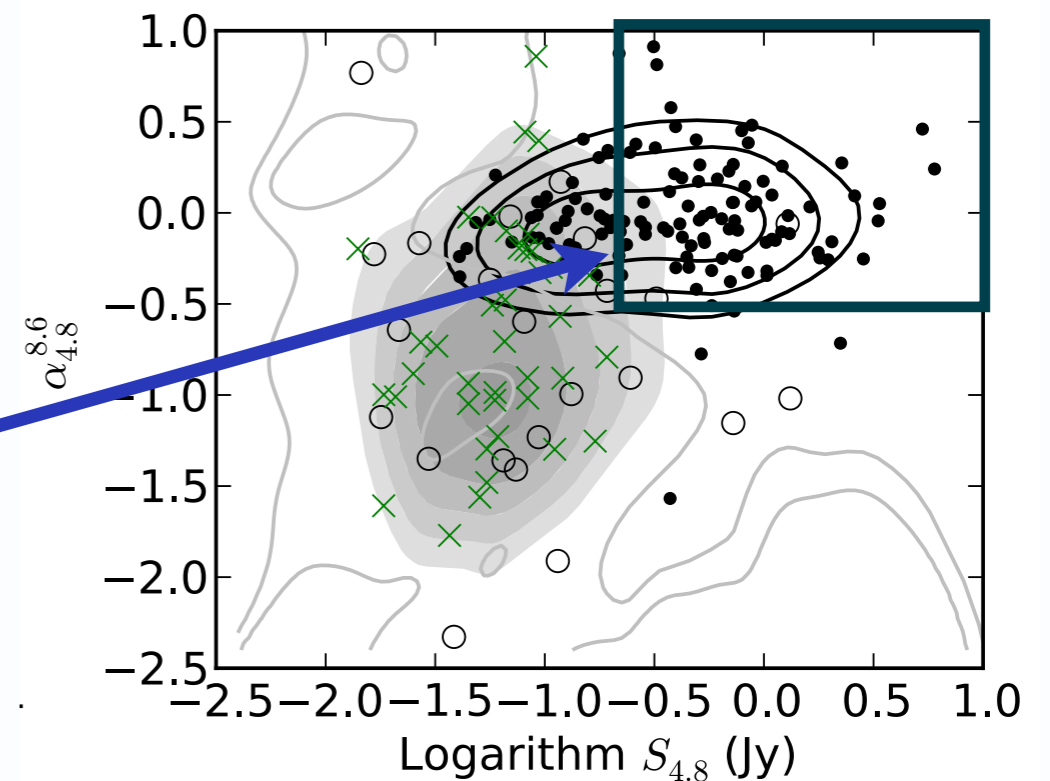


# Intra-day variability

The Interstellar scintillation explanation for hourly flux-density demands source sizes of 10s of  $\mu$  arcseconds (eg. Koay + 2011)

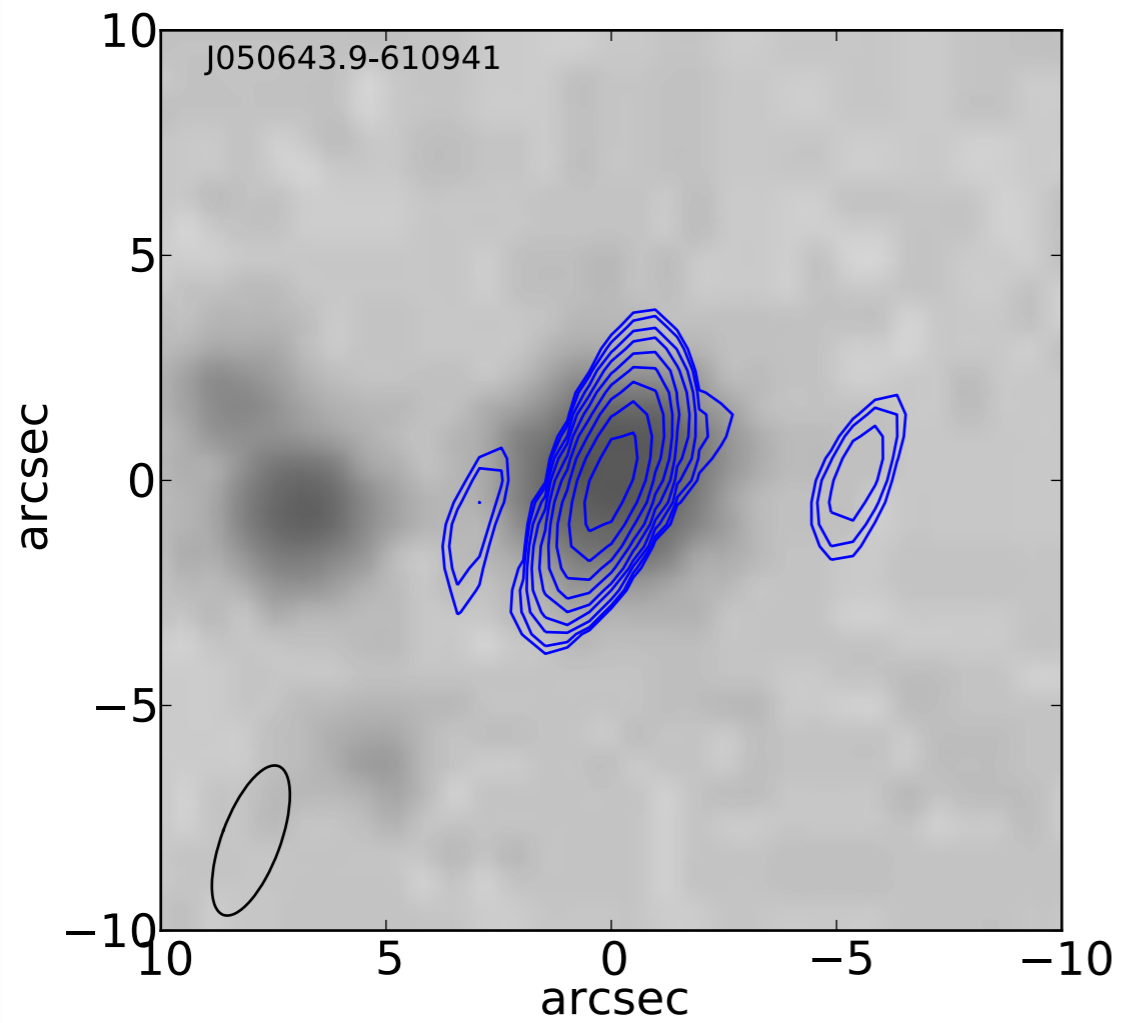
Of the 126 ATPMN sources associated here with 2FGL sources, about 30%, with variations up to 10% over 8 hours.

The incidence of IDV in ATPMN sources (418) in the boxed space ( $S_{4.8} > 200$  mJy, and  $\alpha > -0.5$ ) is similar to that of the 2FGL counterparts (84).

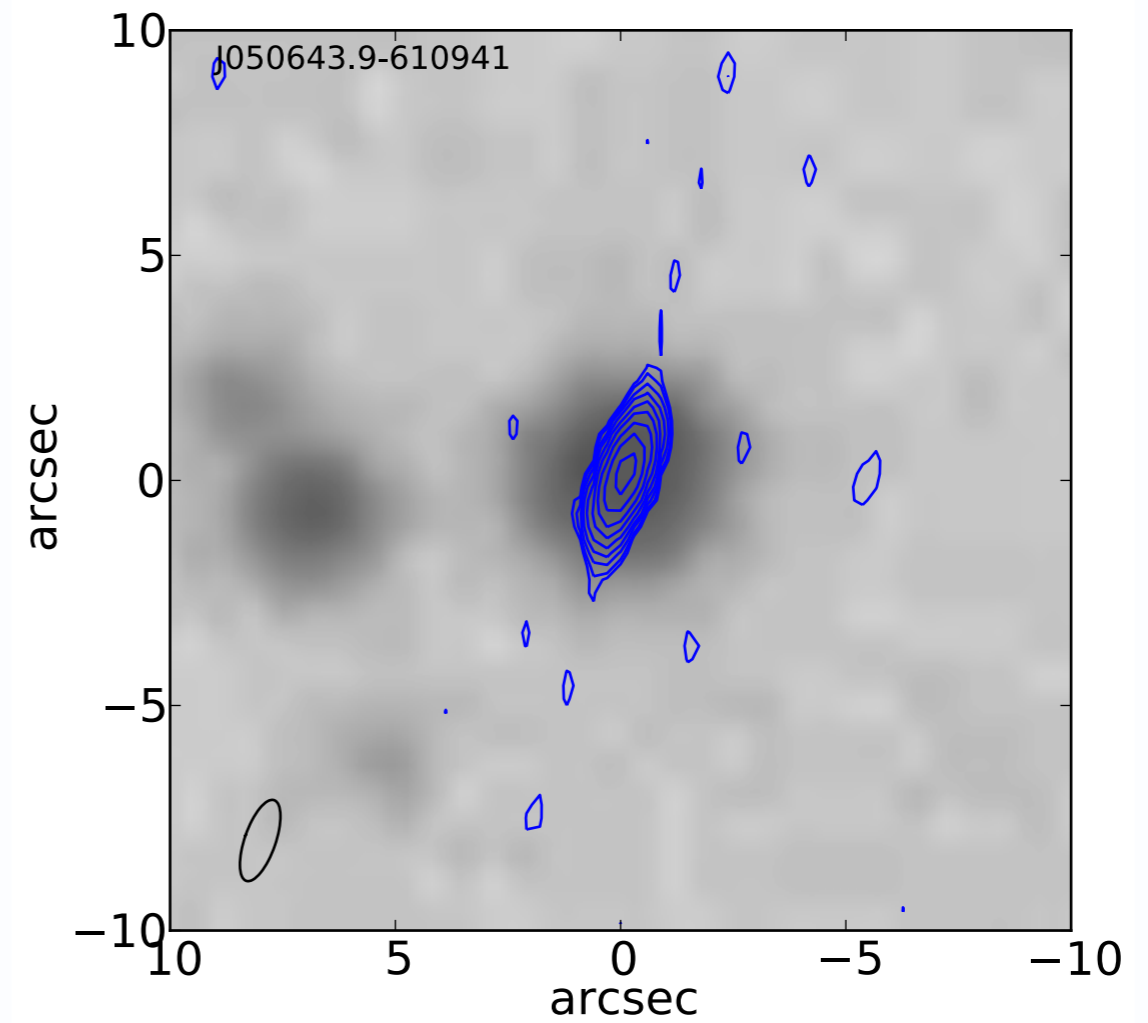


# Source structure

4.8GHz



8.6GHz



J050643.9-610941

# Summary

ATPMN gives new information on ~126 2FGL sources

- positions and structure with 1 arcsec resolution
- optical identification for most
- radio spectral index near 8GHz

Gamma-ray objects new to 2FGL have lower radio flux-density

Most show long-term radio variability

About 30% have intra-day variability

- These will be followed up with ATCA observations later this year.