Updates from SCORPIO:

studying resolved Galactic sources (part 2)

Adriano Ingallinera (INAF - Osservatorio Astrofisico di Catania)

G. Umana (PI), C. Trigilio, R. Norris, T. Franzen, P. Leto, C. Buemi, F. Schillirò, F. Bufano, S. Riggi, F. Cavallaro

... on the previous episode

SCORPIO is a pathfinder survey in the Galactic plane for EMU

Helping to address data reduction and analysis strategy on the Galactic plane for ASKAP

Full-Stokes map production with multiple instruments and configurations and relative issues

Extended sources automated extraction

SCORPIO: project overview

Survey design:

- covered area: $2^\circ \times 2^\circ$
- survey centre: $l = 343.5^\circ$, $b = 0.5^\circ$
- instruments: **ATCA** (then Parkes and ASKAP-beta)
- total integration time: $\sim$320 hours
- frequency range: 1.4 - 3.1 GHz
- sensitivity: from $\sim$30 to $\sim$100 μJy/beam
- resolution: $\sim 10''$

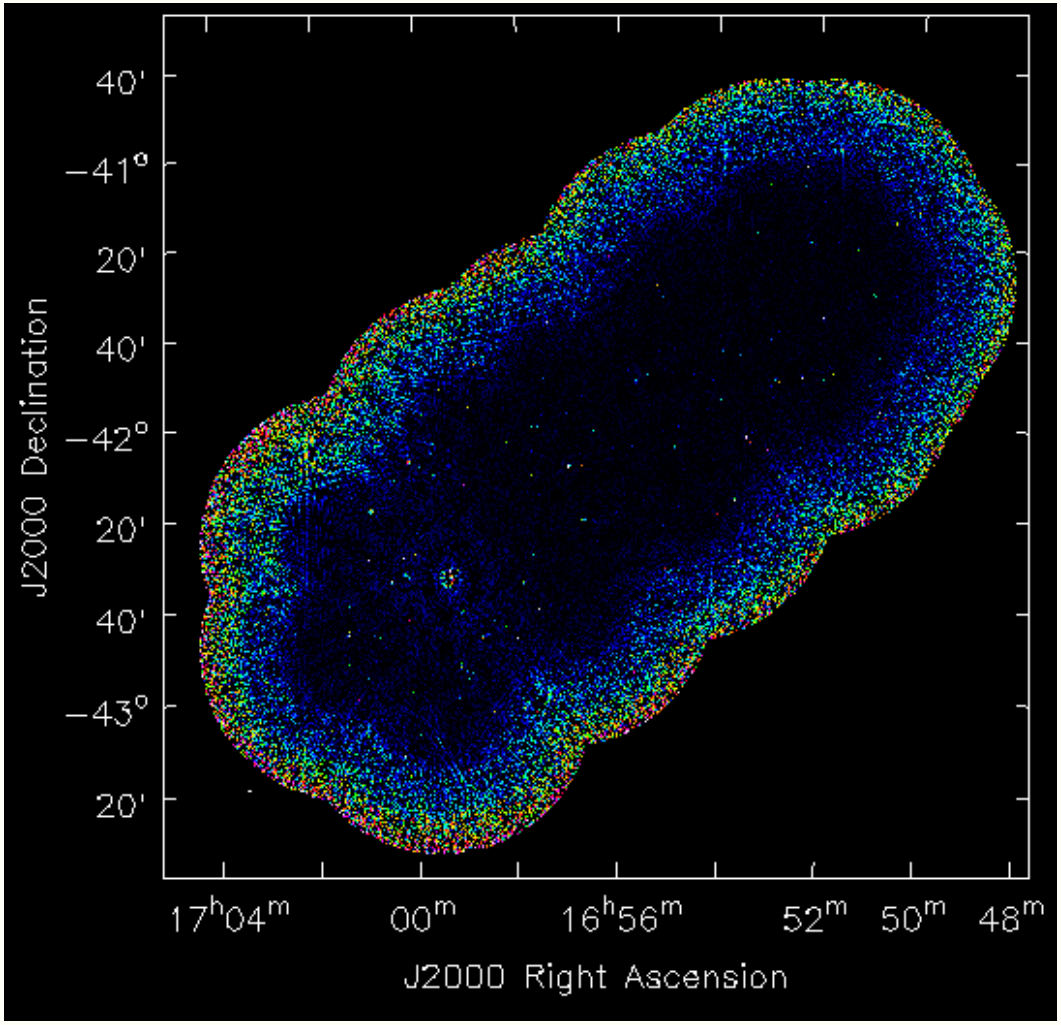
SCORPIO: project overview

First blind survey of the Galactic plane at this frequency with a planned sensitivity of 30 μJy/beam.

Scientific goals:

- unbiased search for radio stellar emission
- insights on the physics of particular classes of stellar systems
- search for coherent radio emission from stellar systems
- study the occurrence of different Galactic object
- provide us with a clear forecast on the potential of SKA and its precursors in the field of Galactic radio astronomy

The pilot map



Umana et al. 2015

Point source extraction and catalogue

Source extraction:

- extraction algorithm by Franzen et al. (2011)
- **614** point sources found

Catalogue name	Number of matches	Band/λ	Spurious per cent
NOMAD	320	NIR–Opt	NA
2MASS	301	NIR	NA
GLIMPSE	229	NIR–MIR	NA
WISE	116	NIR–MIR	NA
MSX6C	47	NIR–MIR	NA
AKARI	34	MIR	27
IRAS	117	MIR–FIR	40
Hi-Gal	148	FIR	35
ATLASGAL	14	mm	26
MGPS-2	43	cm	4
WBH2005	18	cm	1
RMS	6	cm	0

Umana et al. 2015

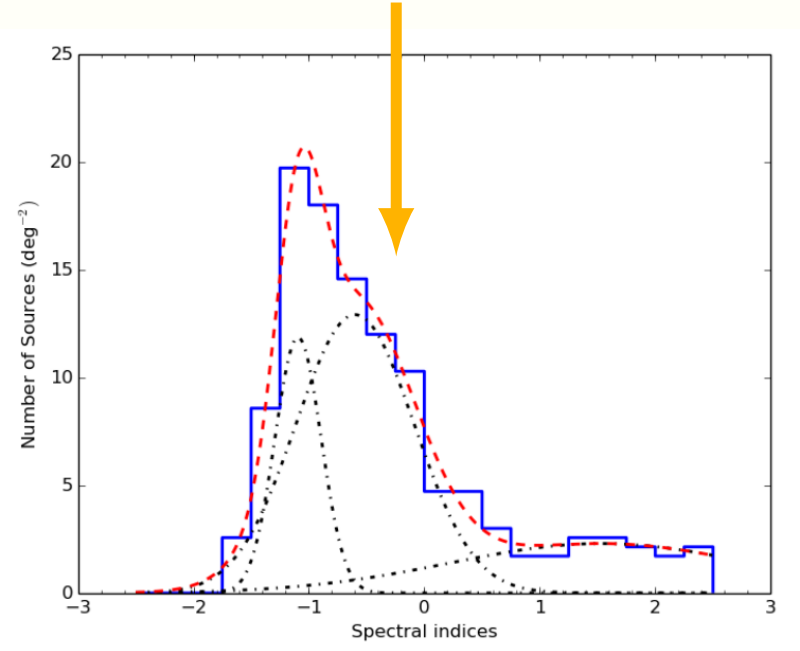
Cross-matches:

- cross-matching impossible with optical and NIR catalogues
- 3/4 of the point sources without a clear counterpart

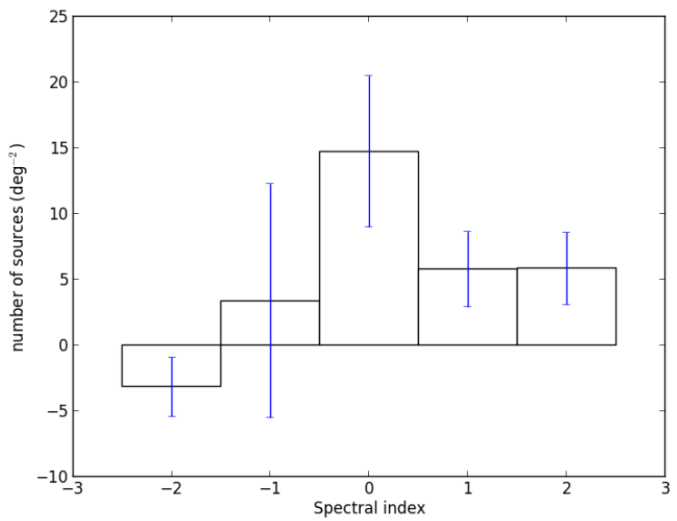
Point source characterization

Radio spectral index analysis to characterize the point source emission.

SPECTRAL INDEX DISTRIBUTION



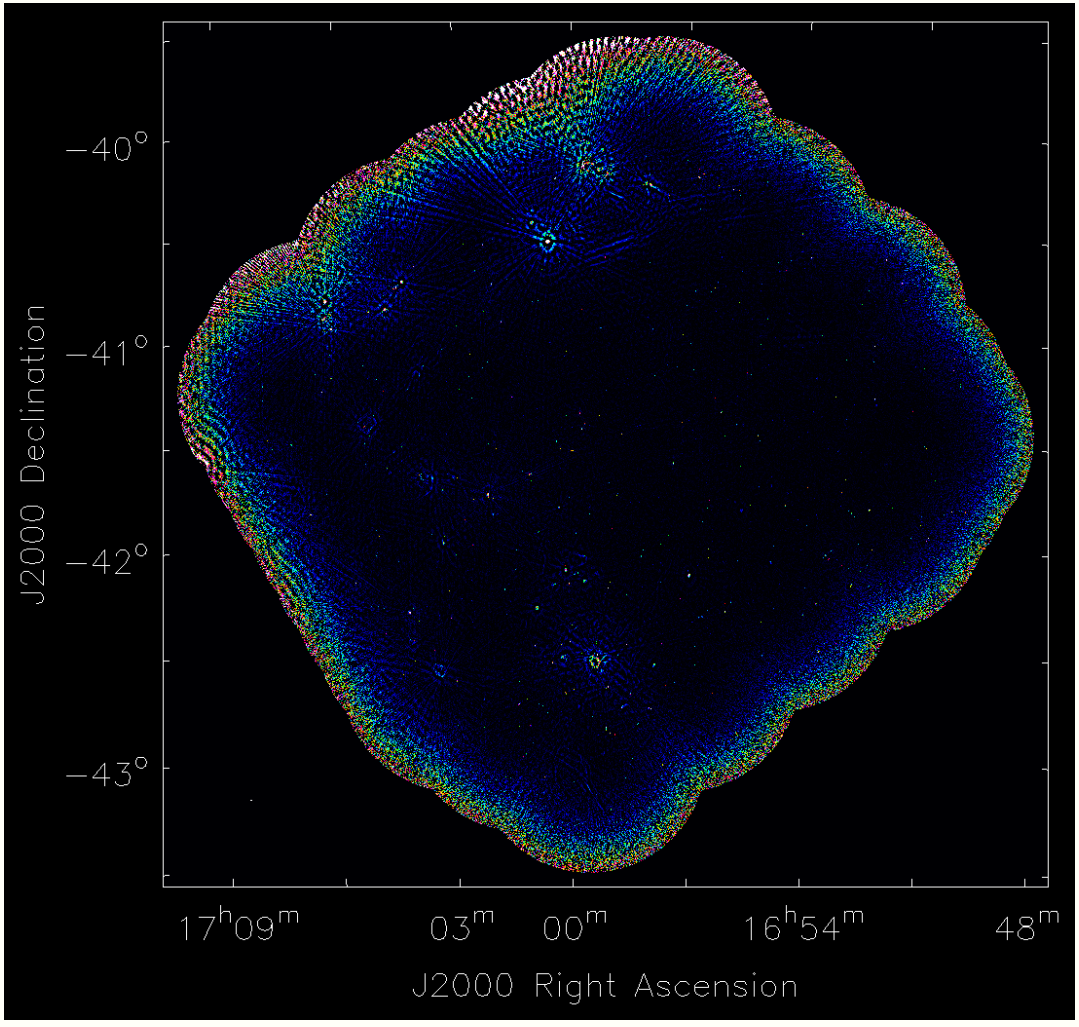
Cavallaro et al. submitted



Comparison with ATLAS:

- no difference for $\alpha \ll 0$
- source excess for $\alpha \gtrsim 0$

The whole field map



Complete catalogue of point sources

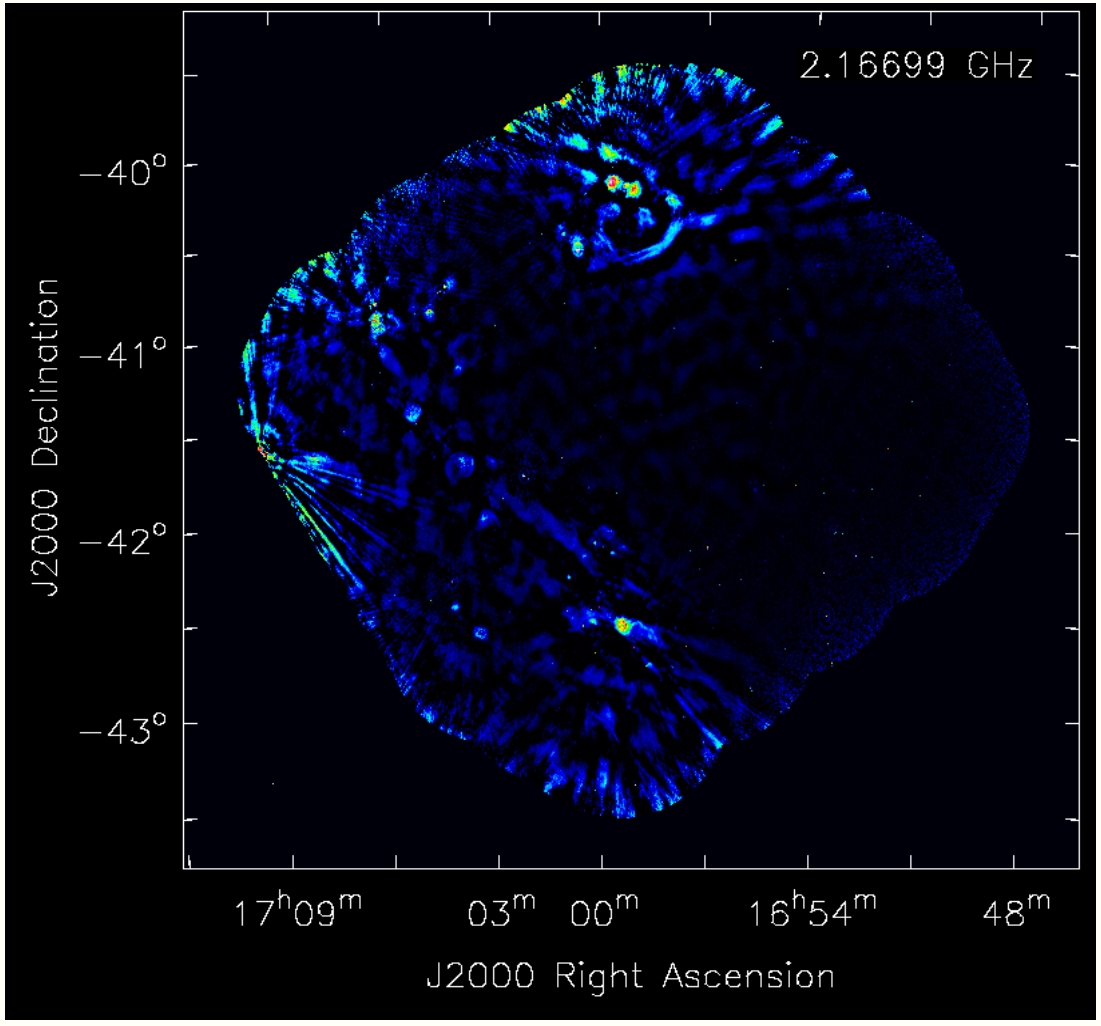
More than 2000 point sources are detected in the whole field.

Characterization:

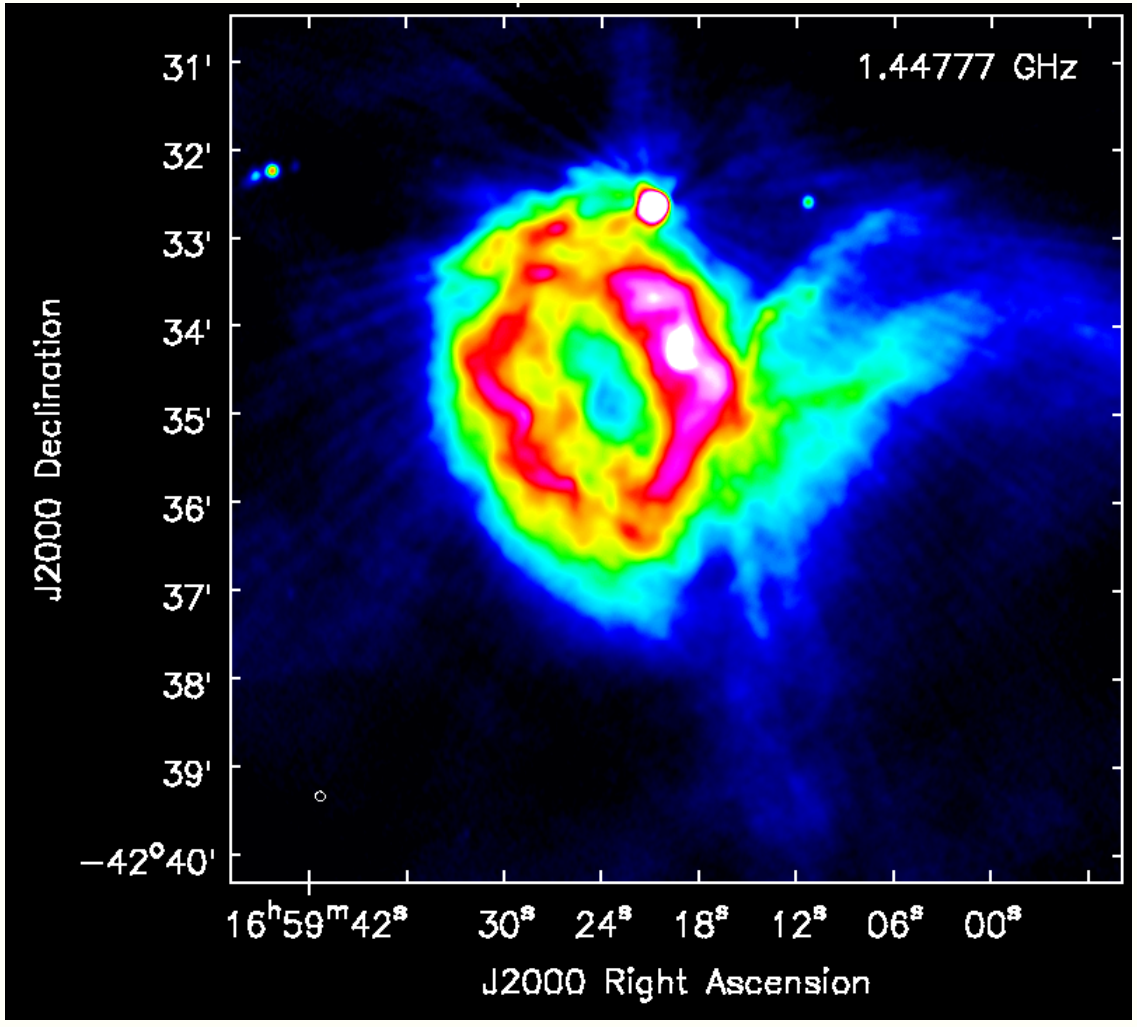
- $\sim$40 stars
- 6 pulsars
- $\sim$30 ultra- and hyper-compact H II regions
- $>$ 1200 extragalactic sources
- $\sim$700 sources without a clear identification

The complete catalogue will be released soon (Trigilio et al. *in prep.*).

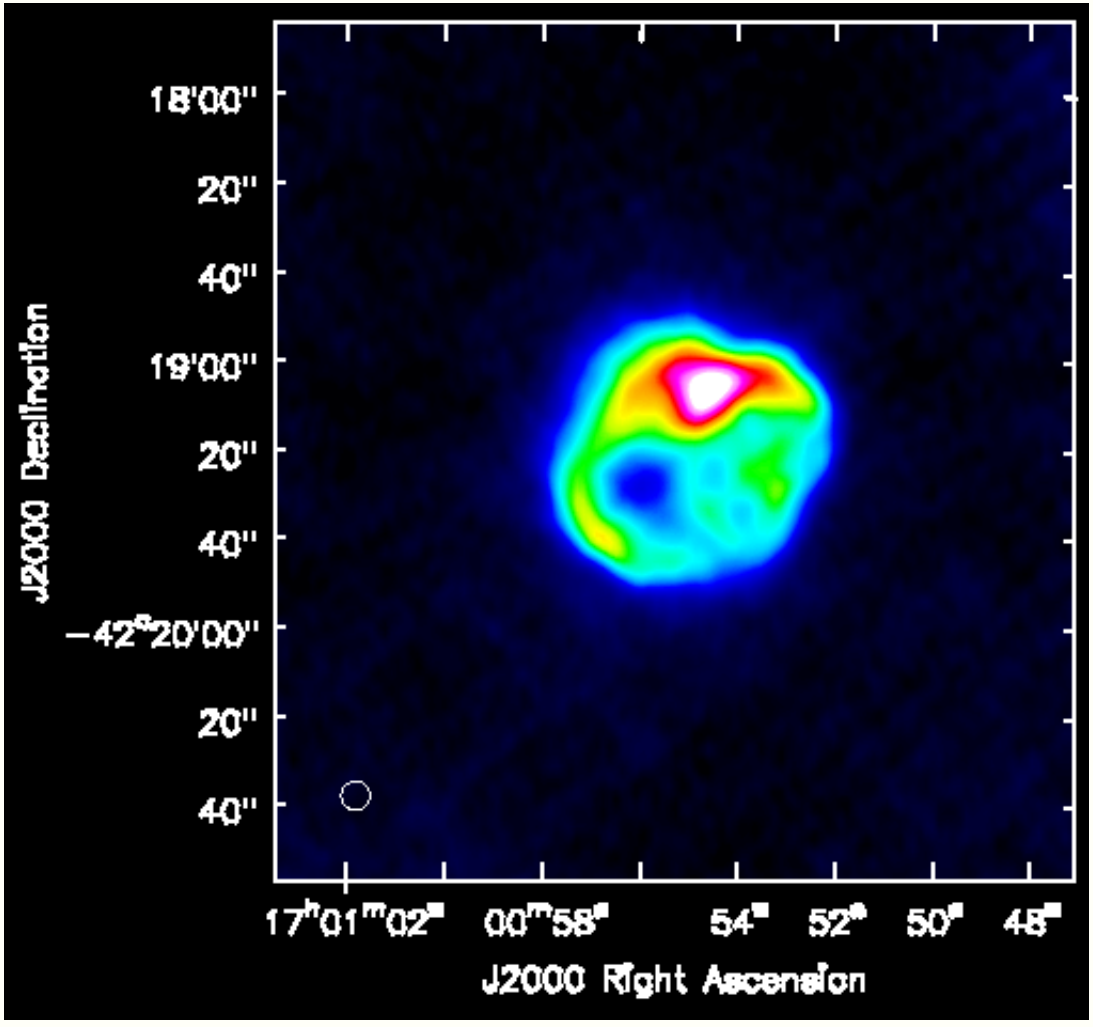
Extended + compact configurations



Extended source examples



Extended source examples



Extended sources: characterization

Characterization of extended sources by radio morphology and comparison with IR.

Characterization:

- $\sim$40 compact and classical H II regions
- 4 planetary nebulae
- 1 supernova remnant
- 2 supernova remnant candidates
- probably $>$ 30 sources without an identification

A discussion on extended sources will be submitted soon (Ingallinera et al. *in prep.*).

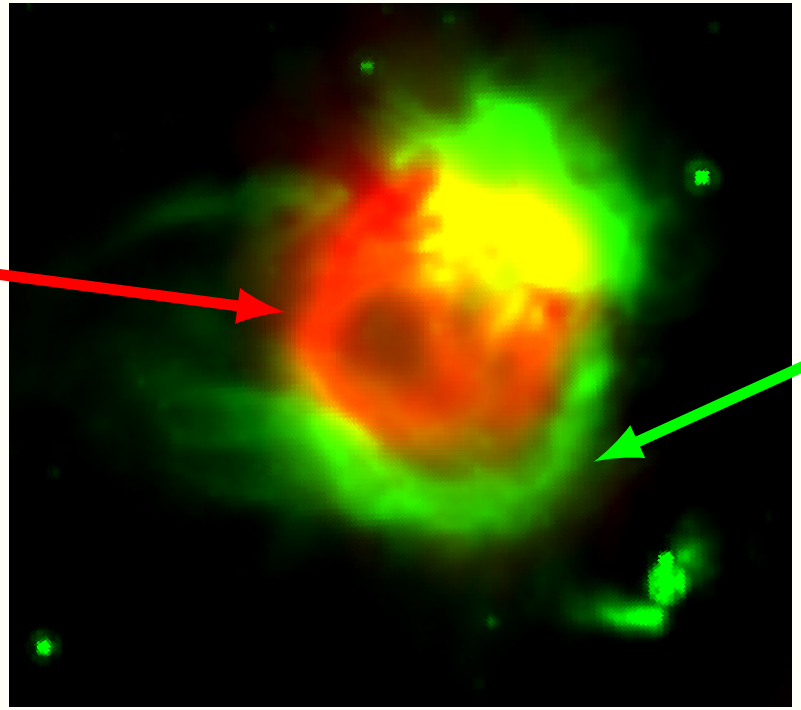
Extended sources: comparison with IR

Distinguish evolved stars from radio (Ingallinera et al. 2016)

- PNe: roundish or elliptical objects
- massive evolved stars: central star + nebula

And use IR to disclose H II regions:

RADIO:
ionized gas



IR (8 μm):
PAH emission

Extended sources: comparison with IR

Exploiting radio and IR morphology to automate source classification for large surveys by means of edge-sensitive algorithms (Ingallinera et al. *in prep.*).

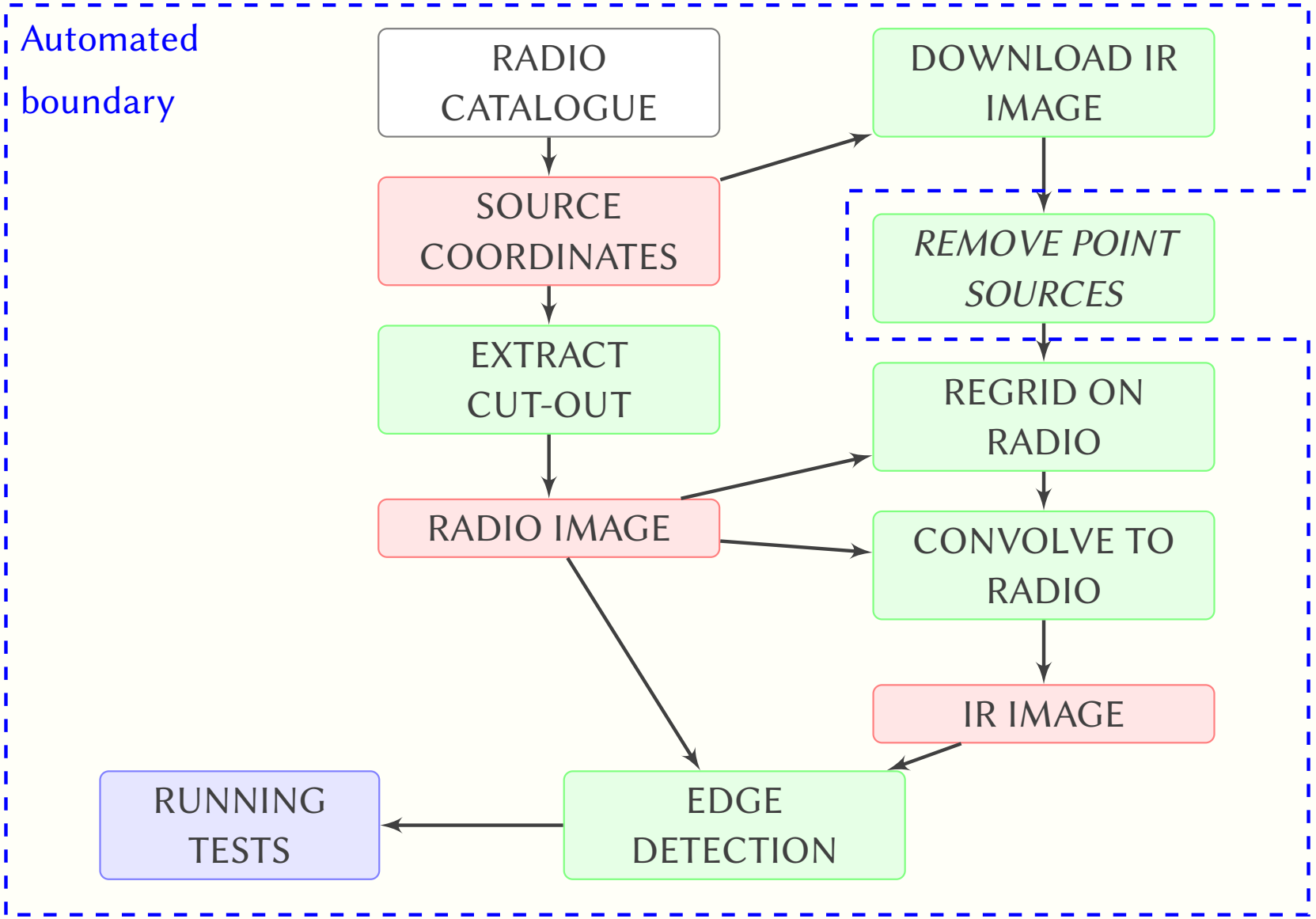
Testing procedures to:

- coincidence in the IR and radio emitting areas
- reciprocal configurations of IR and radio emission borders

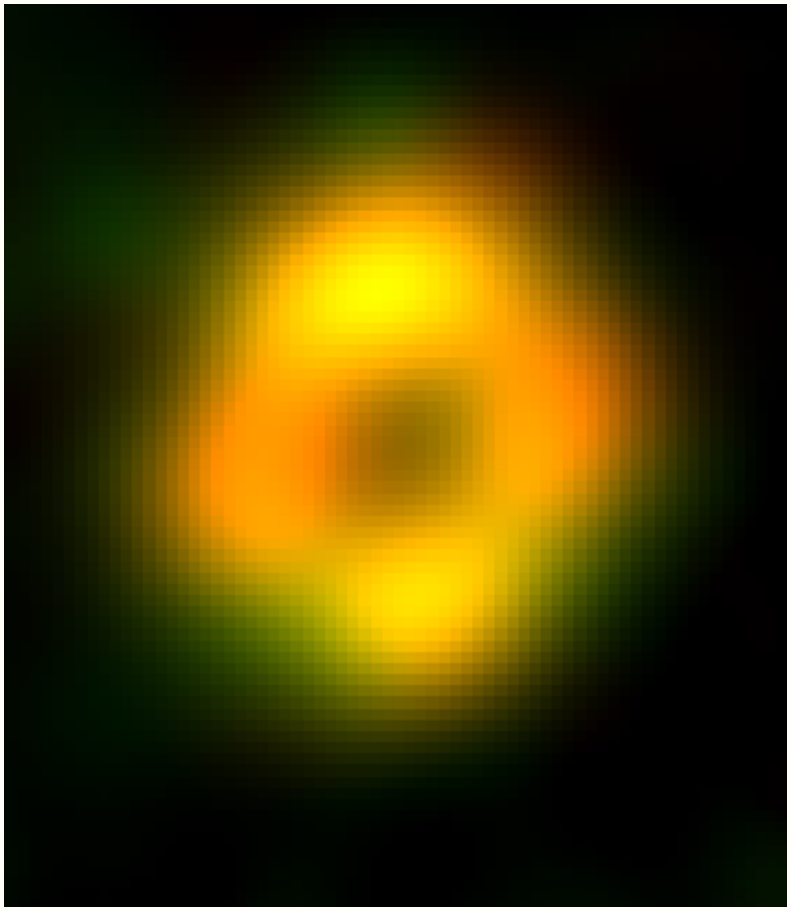
Main goal:

- recognize and distinguish **PNe** and **H II regions**

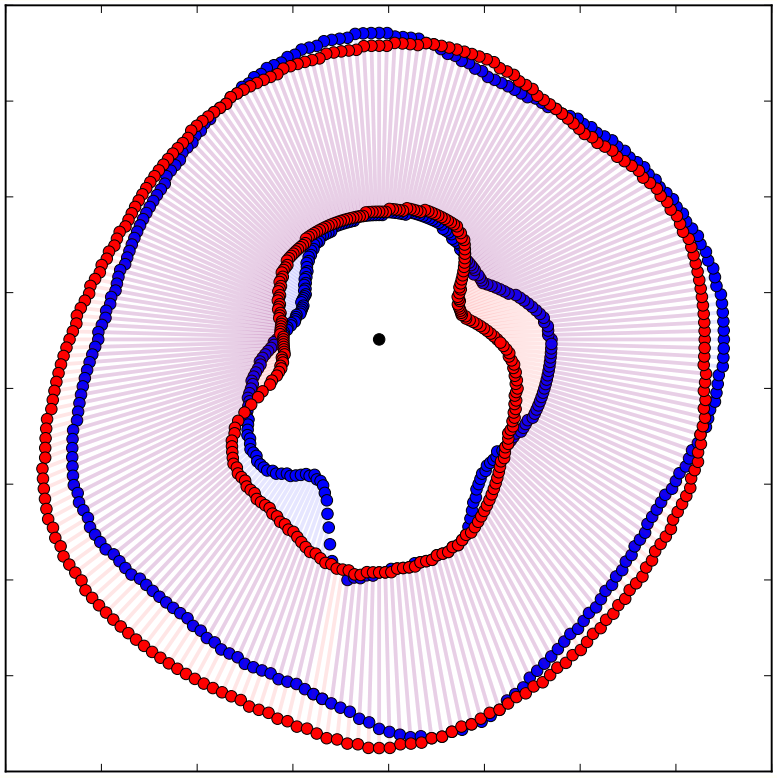
Extended sources: comparison with IR



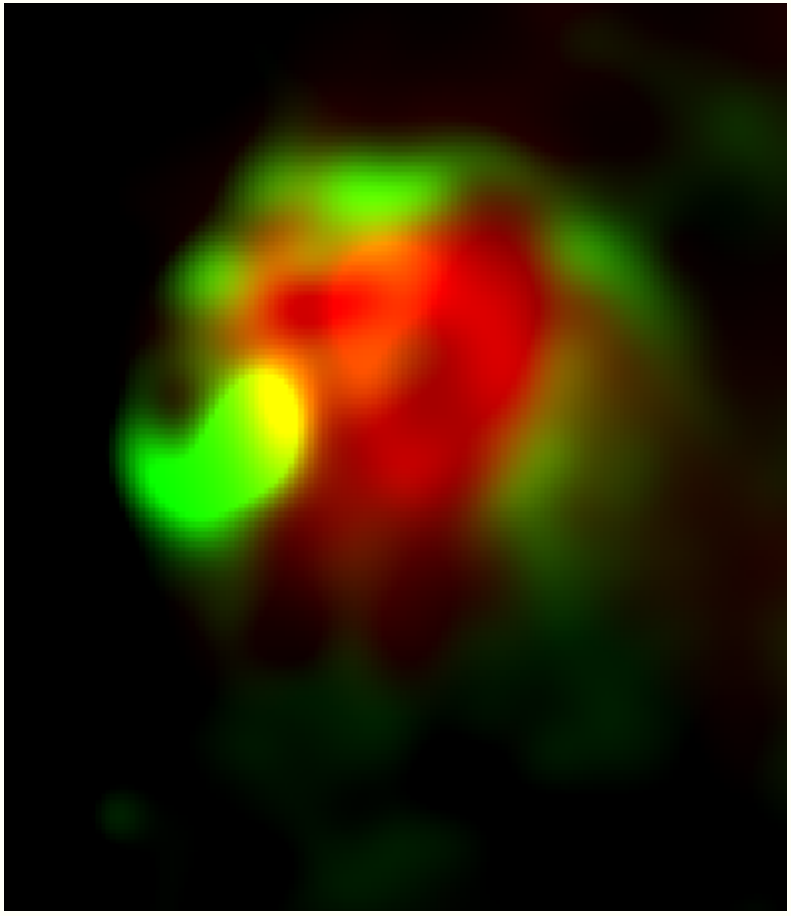
Extended sources: comparison with IR

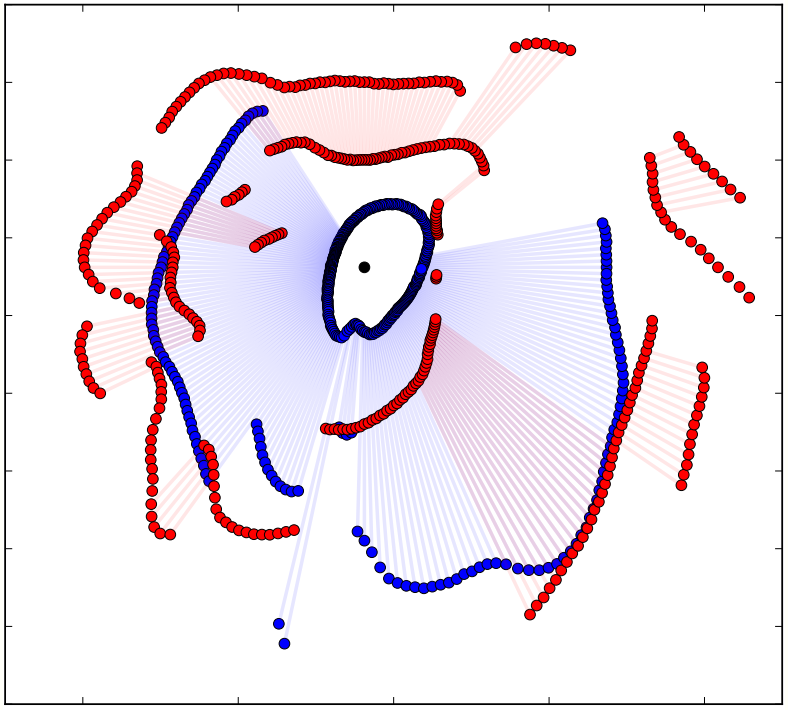


edges match: PN!

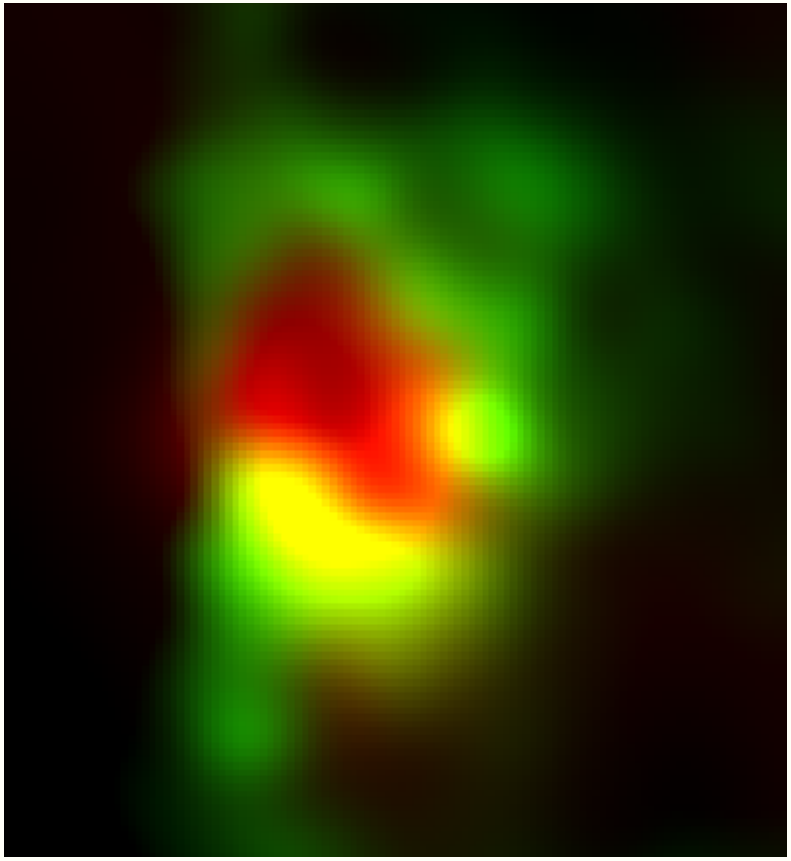


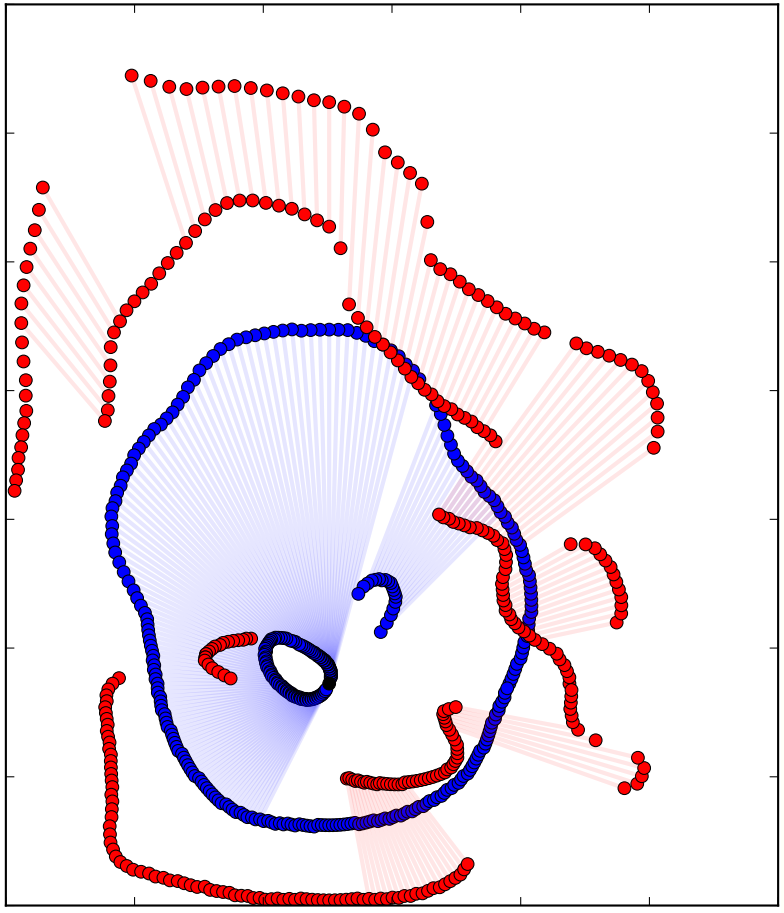
Extended sources: comparison with IR





Extended sources: comparison with IR





Conclusions

- SCORPIO is the first blind survey with this sensitivity in the Galactic plane at this frequency.
- Preliminary but interesting scientific results already produced.
- More than 2000 point sources: stars, HC/UC H II regions, pulsars, galaxies...
- More than 80 extended sources: H II regions, PNe, SNRs...
- Efforts for full and **automated** characterization.