International Centre for Radio Astronomy Research

MWA GLEAM
Insights to extragalactic radio sources @ low frequencies

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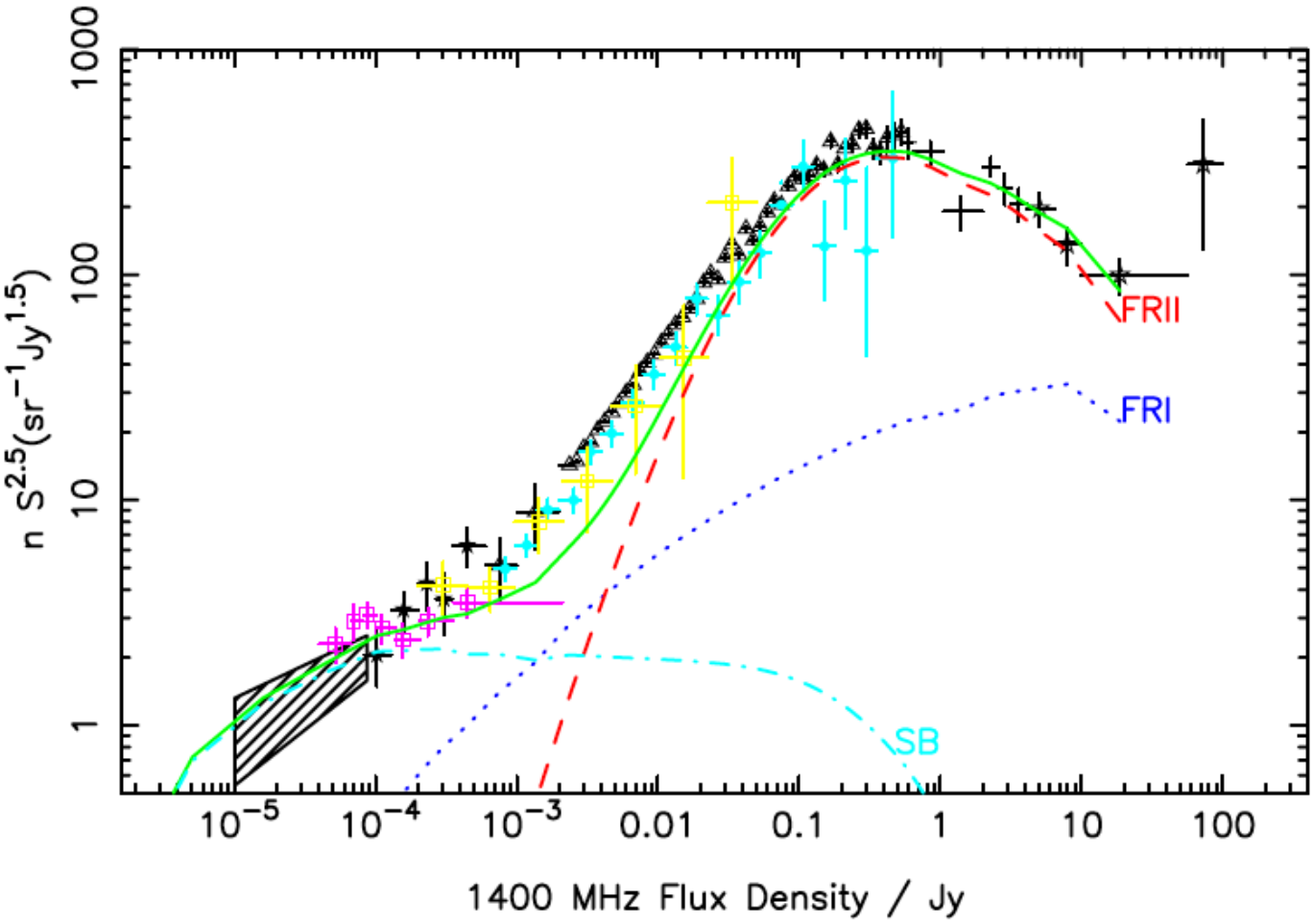
20 October 2015

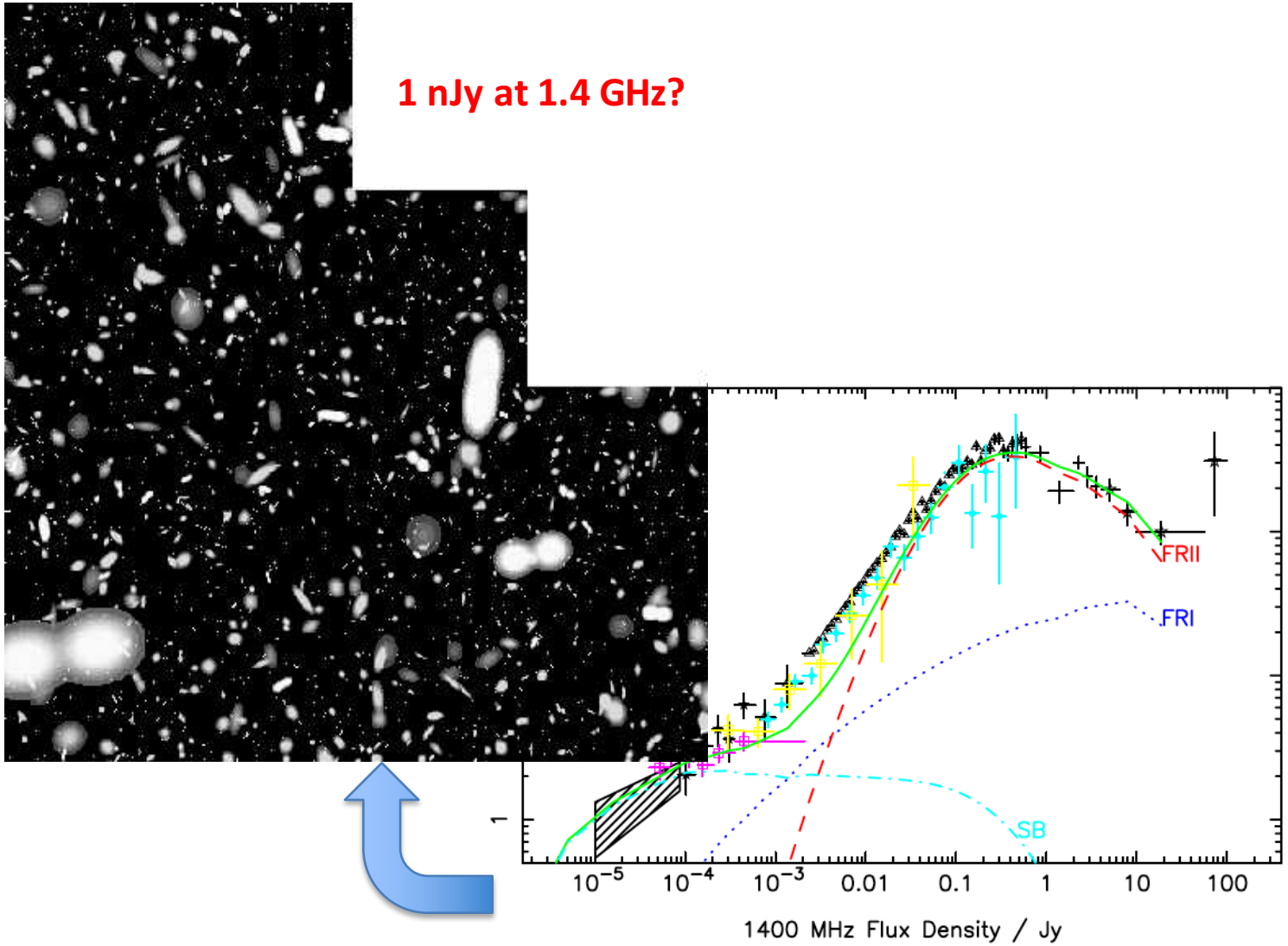
THE UNIVERSITY OF WESTERN AUSTRALIA

The extragalactic sky; defined > 1 GHz

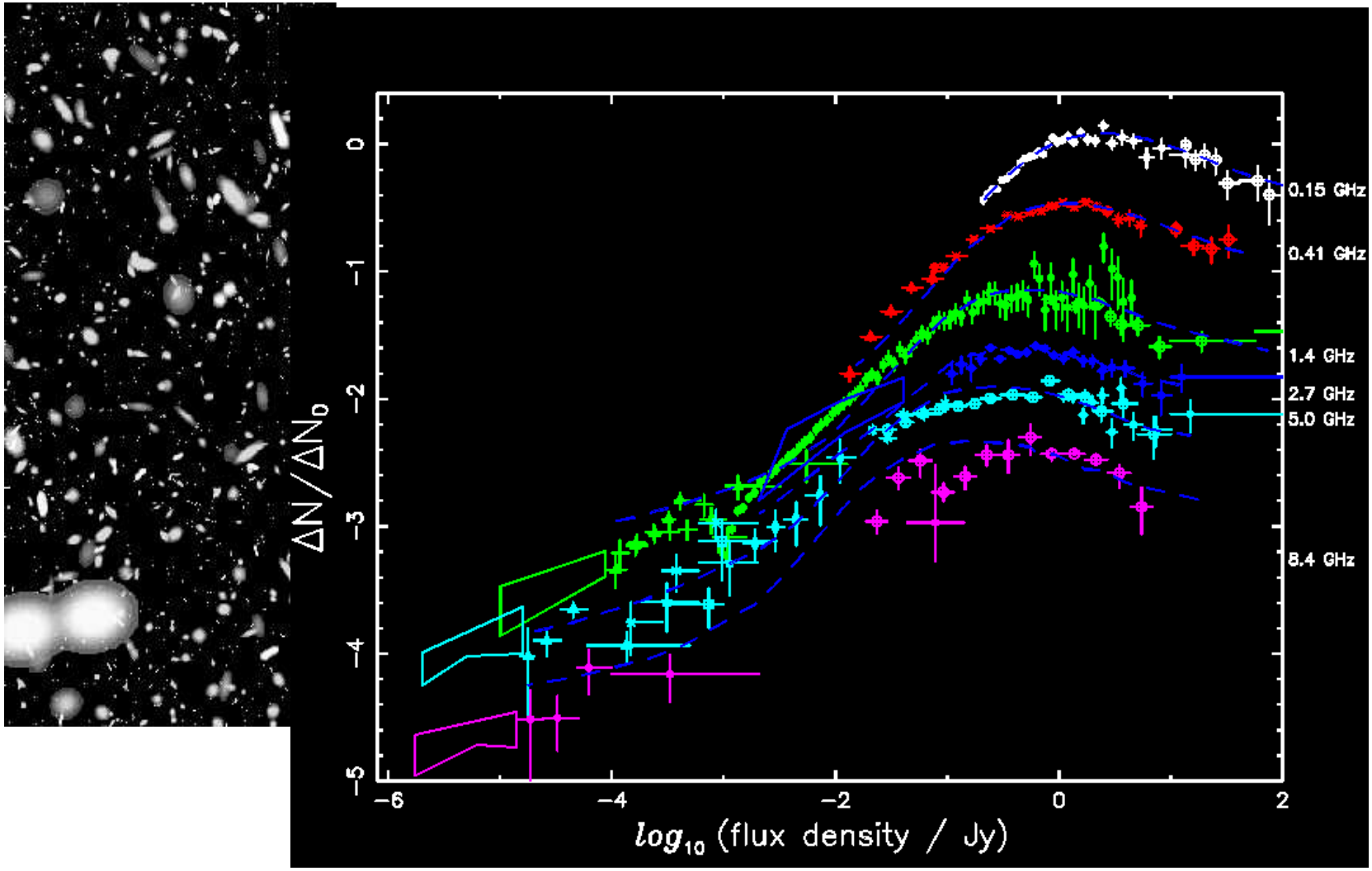


The extragalactic sky; defined > 1 GHz

1 nJy at 1.4 GHz?



The extragalactic sky; defined > 1 GHz



Compilation by Wall, 1994

The extragalactic low frequency sky

Current work involves significant extrapolation from higher ν

Samples at low frequencies are tiny

& are highly degenerate to model fits.

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Use (new) low-frequency samples (< few hundred MHz)
LOFAR (10-250 MHz) and MWA GLEAM (72 – 231 MHz)

Define populations, characteristics etc using WISE, SDSS, VLA, AT20G, GAMA, SKA precursors etc.

-> precision sky models for SKA-era of billion-galaxy surveys, Foreground extraction (EOR), AGN lifetime (fueling, feedback) etc.

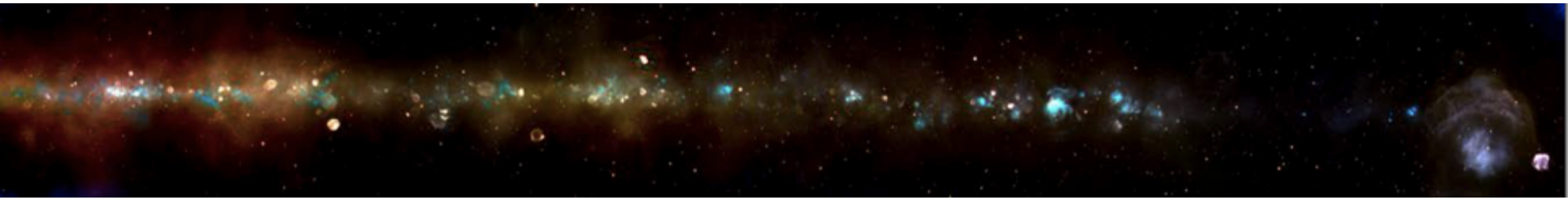
MWA GLEAM survey

MWA – observe all southern sky < +30 deg dec; 72 -231 MHz

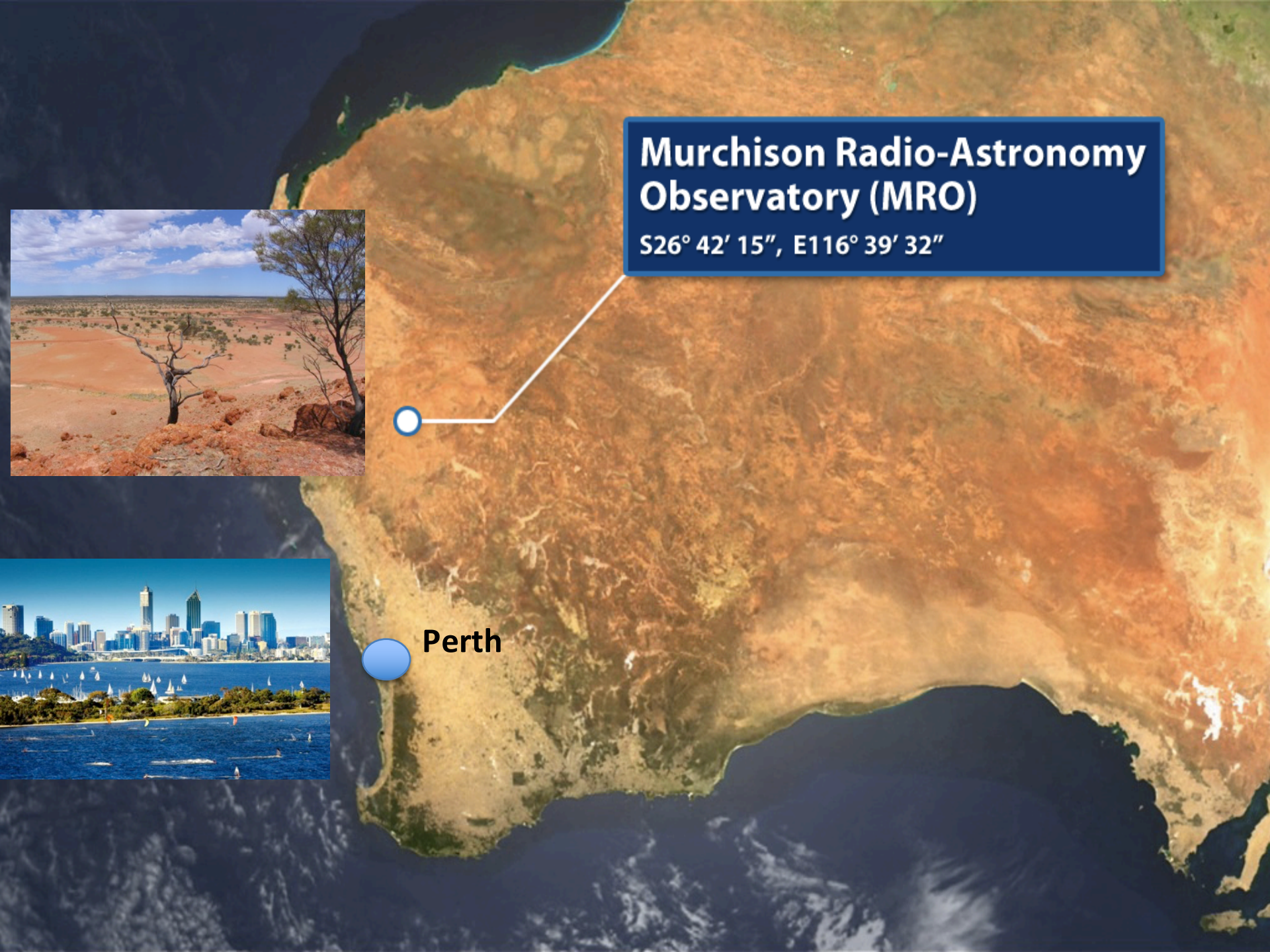
MWACS survey (Hurley-Walker et al) PASA 2014
GLEAM survey paper (Wayth et al) PASA 2015

1st year GLEAM extragal catalogue: release early 2016
~300,000 sources to ~8 mJy rms
5 x 30 MHz bands 'wide'
20 x 8 MHz bands 'narrow'
(Hurley-Walker et al, in prep)

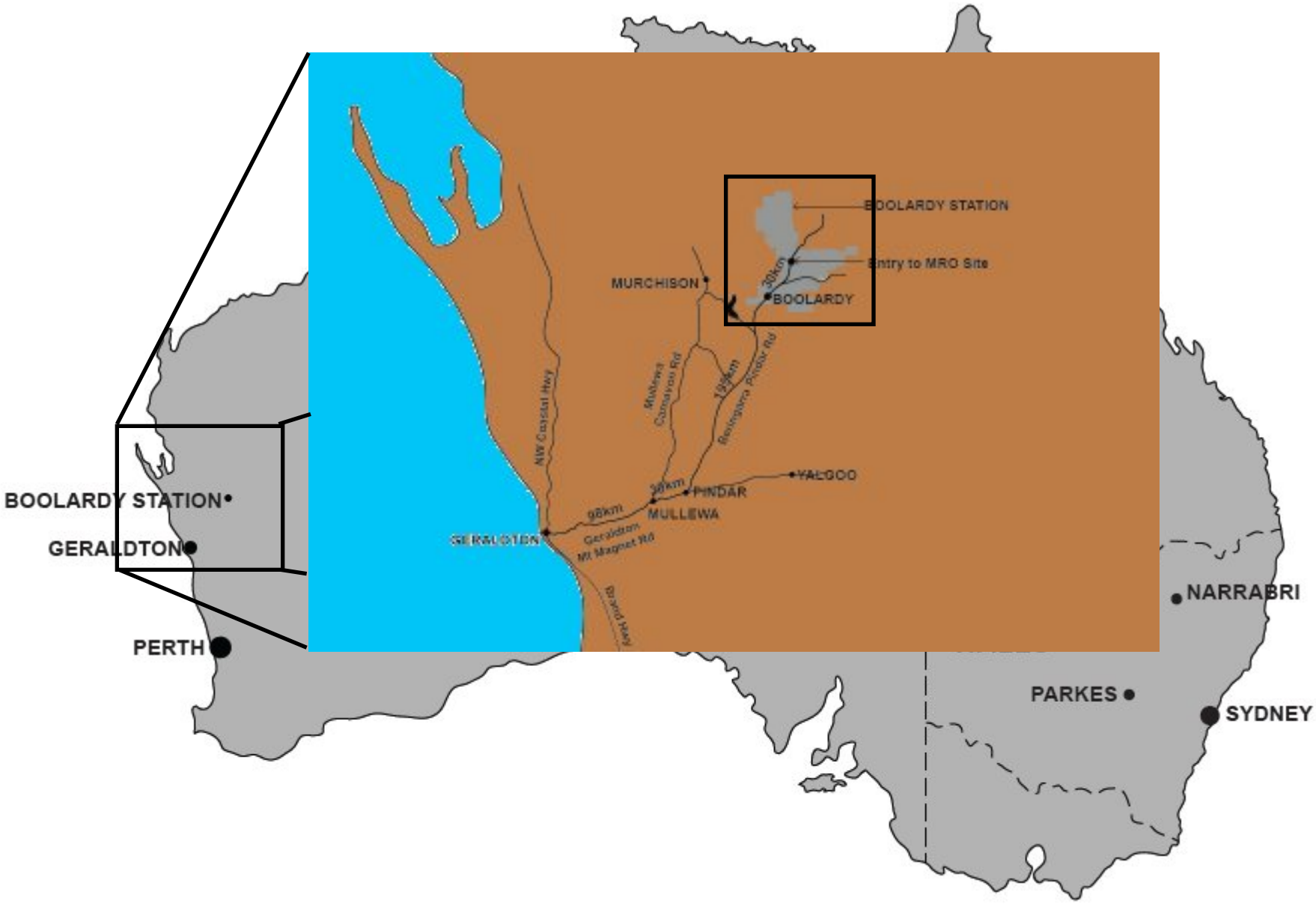
+ 2nd year observations complete: reaching confusion limit ~100 MHz



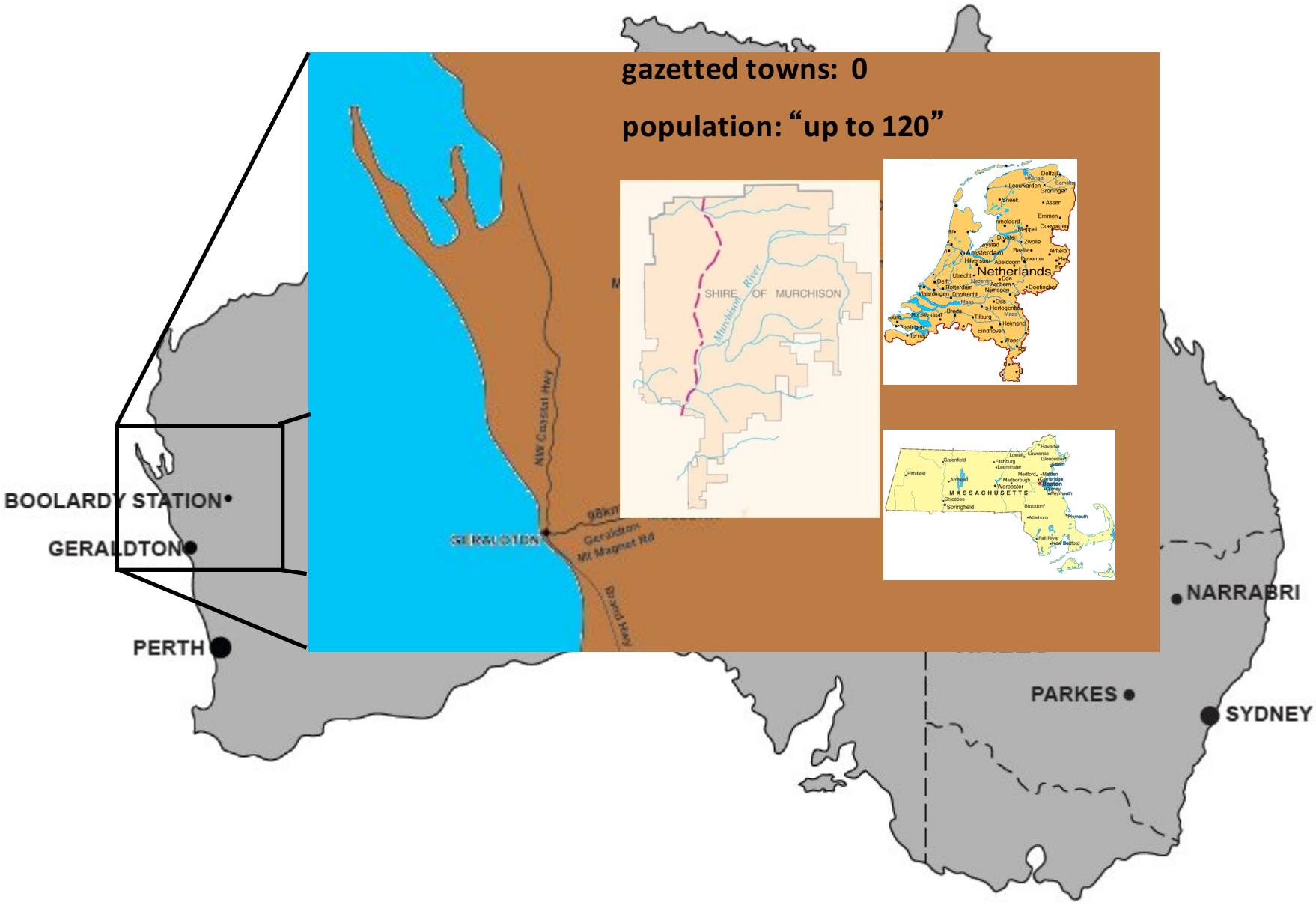
False colour image MWA Gleam: Hurley-Walker et al


Murchison Radio-Astronomy Observatory (MRO)
S26° 42′ 15″, E116° 39′ 32″
Perth

MRO: Australia's SKA site



MRO: Australia's SKA site



Murchison Widefield Array (MWA)

- World's first operational SKA precursor (August 2013)
- Managed & operated by Curtin University
- 128 tiles (collecting area ~2750 m^2 at 150 MHz) – each of 16 dipoles
- Frequency range 72 MHz - 300 MHz (30 MHz BW)
- Maximum baseline 3 km
- MWA System description

  Tingay et al. PASA, 2013

MWA
MURCHISON
WIDEFIELD
ARRAY

Curtin University

MWA – Murchison Widefield Array

MWA International Collaboration -2015

Aus, NZ, India, USA

Raman Research Institute
Bangalore

UNIVERSITY
OF TASMANIA

THE UNIVERSITY OF WESTERN AUSTRALIA

MWA Science (since mid 2013)

1 Statistical detection of EOR global signature (~120 – 180 MHz)

2 Galactic & Extragalactic Survey science
72 – 231 MHz all-sky survey (continuous frequency coverage)
Talk by Tom Franzen

3 Time domain astronomy: Transients, FRBs, Pulsars, ESPs & more
Talk by J-P Macquart

4 Solar science & space weather (including ionosphere)
Poster by John Morgan

39 refereed journal papers (published or accepted)

MWA data released: mwatelescope.org/astronomers/public-data-release

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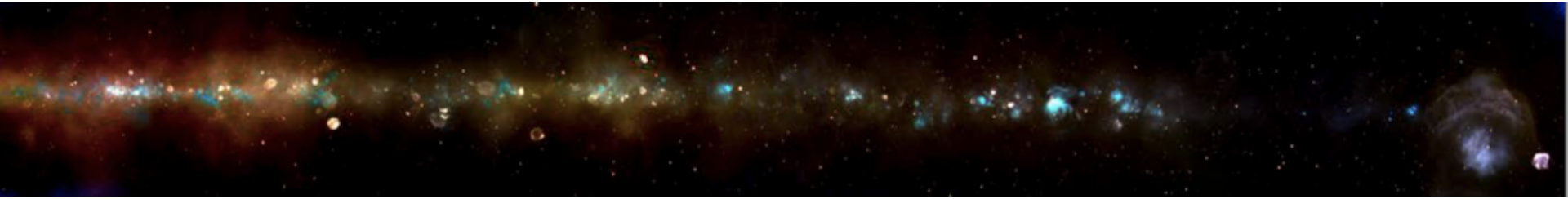

False colour image MWA Gleam: Hurley-Walker et al

The TEAM

Martin Bell (CSIRO)
Joe Callingham (U Syd)
K S Dwarakanath (RRI)
Bi-Qing For (ICRAR-UWA)
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Natasha Hurley-Walker (ICRAR-Curtin)
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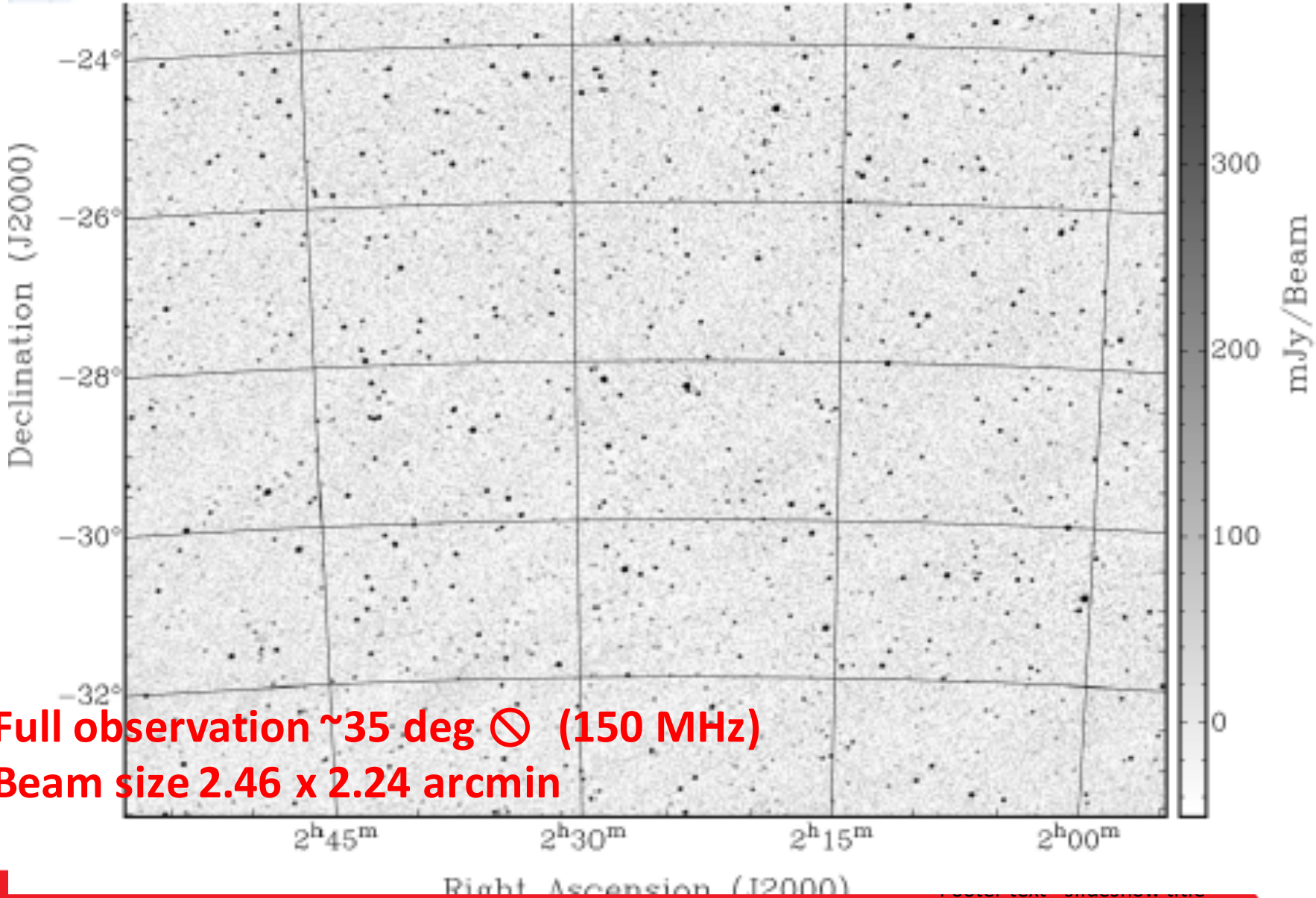
Anna Kapinska (ICRAR-UWA)

Emil Lenc (U Syd)
Ben McKinley (U Melbourne)
John Morgan (ICRAR-Curtin)
Andre Offringa (ANU/ASTRON)
Pietro Procopio (U Melbourne)
Randall Wayth (ICRAR-Curtin)
Chen Wu (ICRAR-UWA)
Cathie Zheng (VUW)

+ large number of MWA collaboration members using GLEAM for galactic & Extragalactic research

GLEAM zoomed snapshot (2 min)



Full observation ~35 deg ⊘ (150 MHz)

Beam size 2.46 x 2.24 arcmin

The extragalactic low frequency sky

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Samples at low frequencies are tiny

& are highly degenerate to model fits.

***Small* is the word at low frequency – small area &/or small #s….**

3CRR – 173 sources, S_{178} MHz > 10.9 Jy – 100% complete

7CI – 37 sources, S_{151} MHz > 0.51 Jy – 90% complete

7CII – 54 sources, S_{151} MHz > 0.48 Jy – 90% complete

7CIII - 37 sources, S_{151} MHz > 0.5 Jy – 95% complete

TOOTS-00 – 47 sources, S_{178} MHz > 0.1 Jy – ~80% complete

3CRR – Laing, Riley & Longair, MRAS, 1983

7C & TOOTS compilations collated & updated by L M Ker

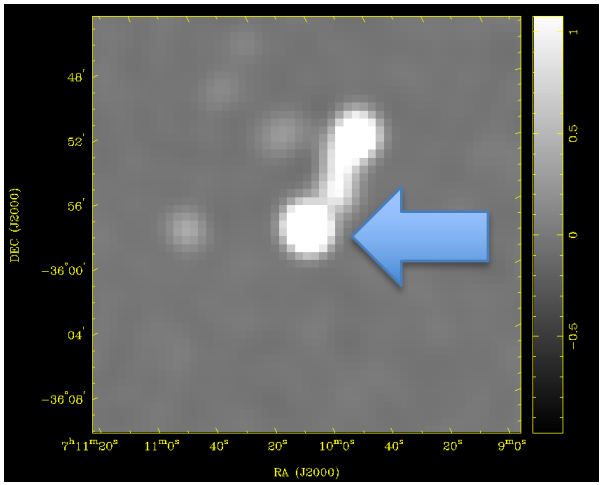
(PhD thesis; Edinburgh 2013)

Low-resolution extragalactic science

MWA (GLEAM) science Workshop (Oct 2014)

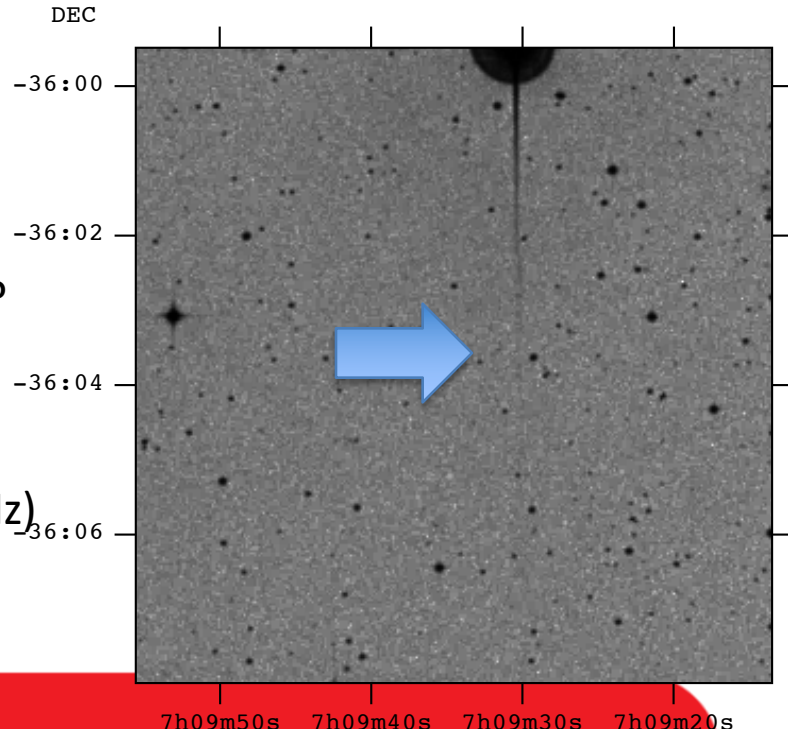
Working with MWA resolution

- Cross waveband id's (radio, optical…)
  Resolution (blending of sources; complex sources)
- Multitude of radio & other data:
  source density ~8 sources per sq deg at 200 MHz (S > 80mJy)
- Reliability and confidence limits
- Noise: sidelobes, confusion



Host galaxy?

MWA J0709-3603
S = 7.64 Jy (150 MHz)



GLEAM Bright Source sample

"GLEAM 4 Jy sample"

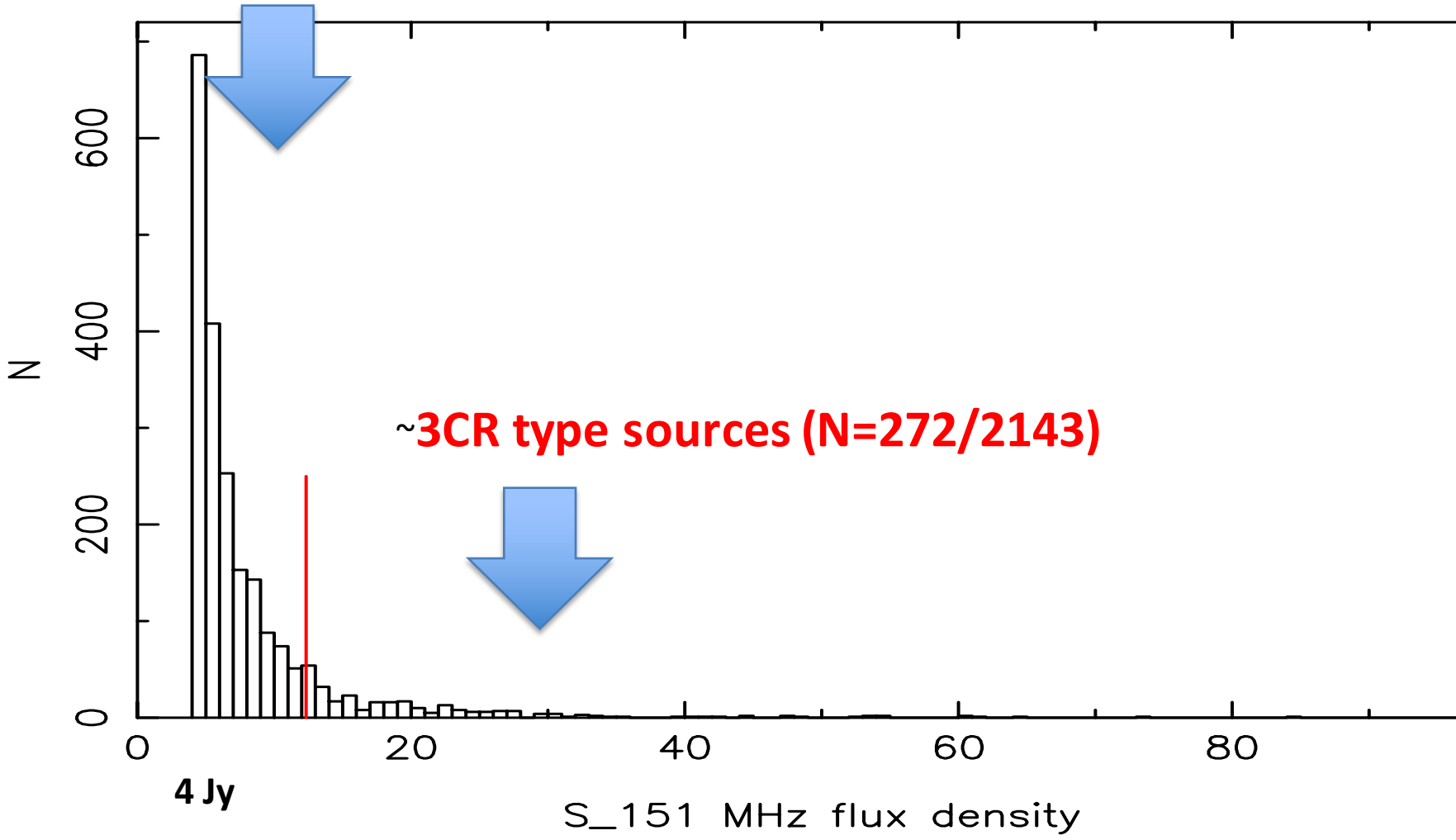
- **A fundamental southern sky sample of bright radio sources akin to 3CR**
- **About 10* larger: 2143 sources vs 173 in 3CR**
- **Direct insight to source populations & their evolution (space density) + GLEAM SEDs 72-231 MHz**

Sources catalogued @ 151 MHz (147-155 MHz narrow band image)
RA 0 - 24 hr, Dec +20, -72 deg; |b| > 10 deg (4.9 sr)

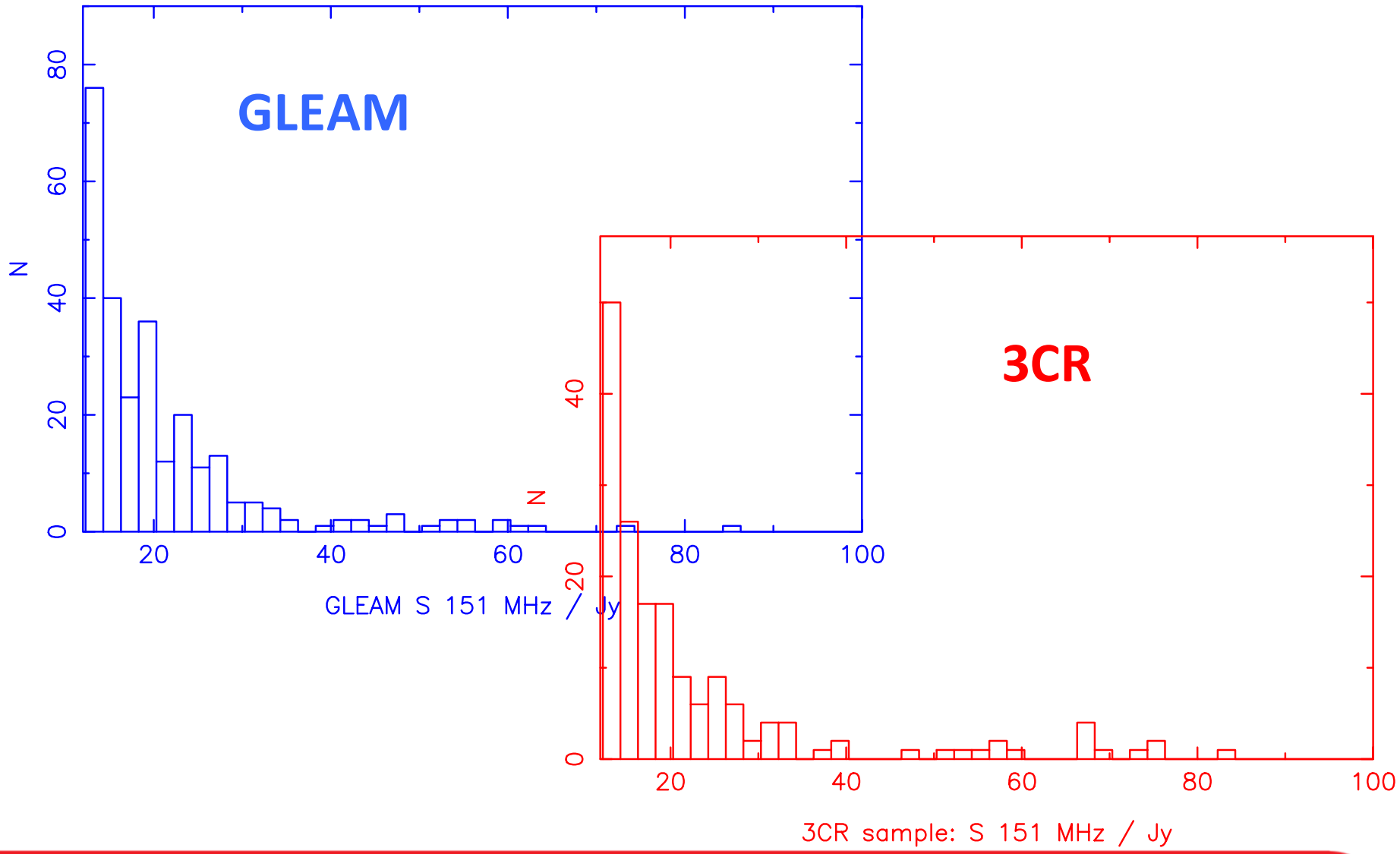
=> remove (a few) galactic source contaminants;
=> excludes a few class A sources excised in GLEAM imaging;
=> check for any diffuse extragalactic sources (later).

GLEAM bright source sample

Fainter RGs, lower Power &/or higher z



GLEAM bright source sample



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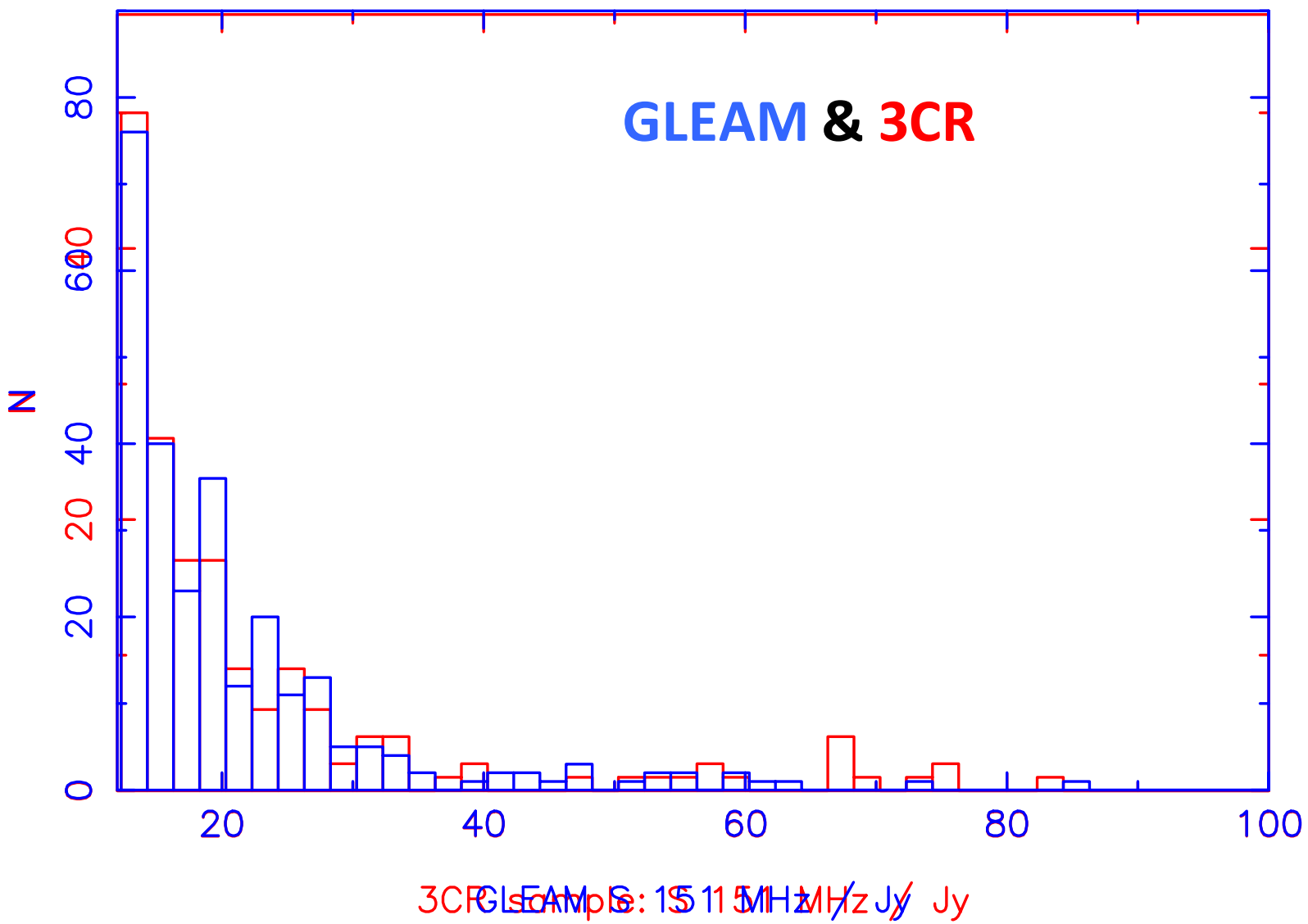
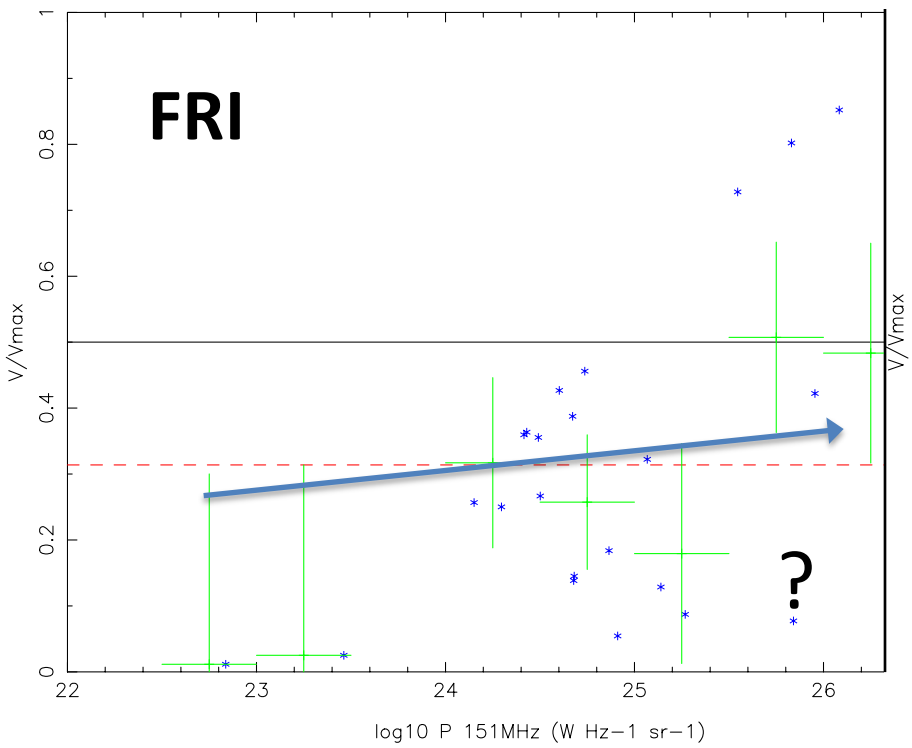
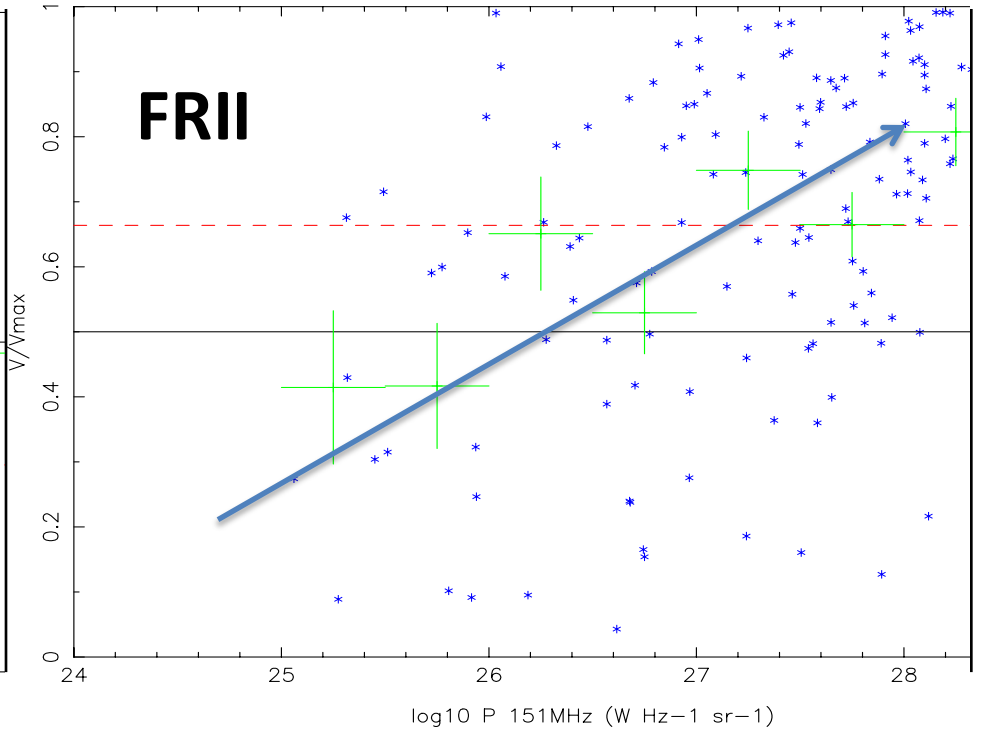


RG Population evolution 3CR sample

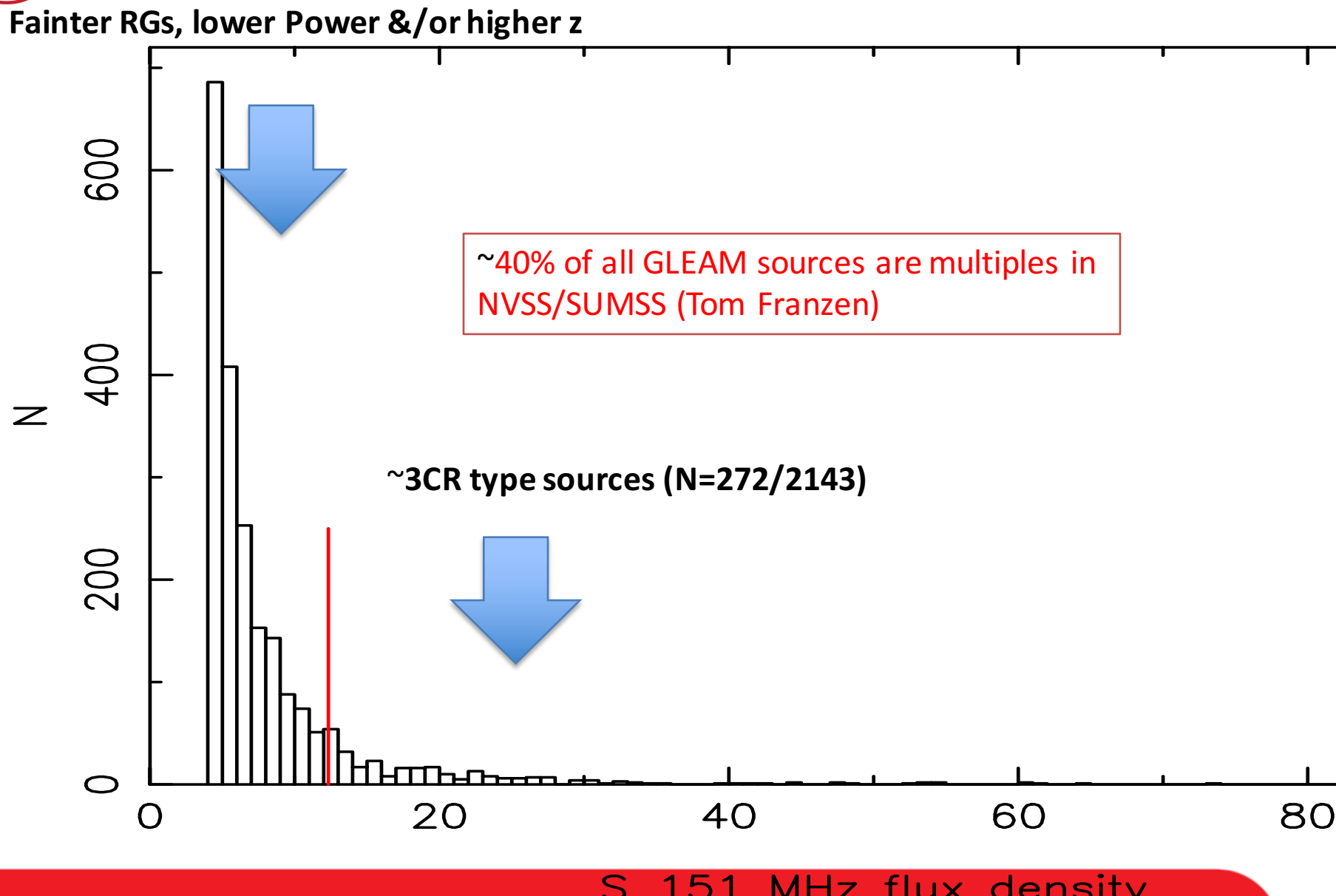
V/Vmax (3C Qs: Longair & Scheuer, 1970)



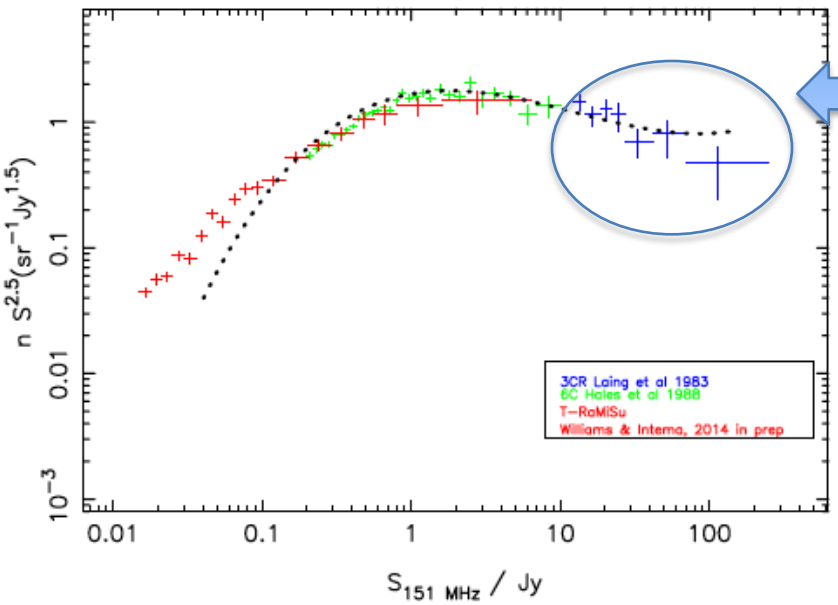


Is this real, or biased by the small luminosity range

GLEAM bright source sample



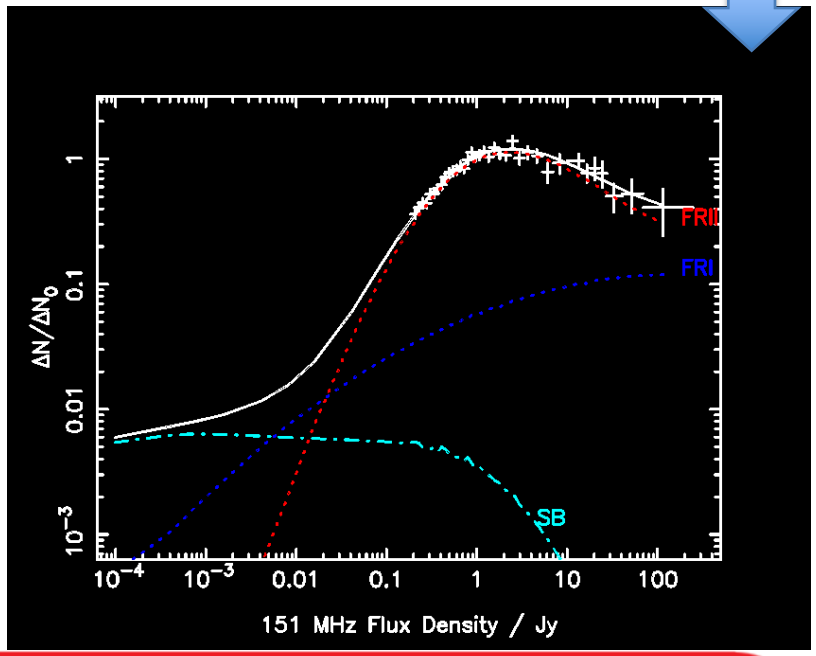
3CR inference & source count mis-fits



Blue: 3CRR – defines small part of RLF across large (P, z) range

GLEAM 4 Jy – much wider (P,z)

'fit' can be constrained by deep counts but liable to massive extrapolation… !



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