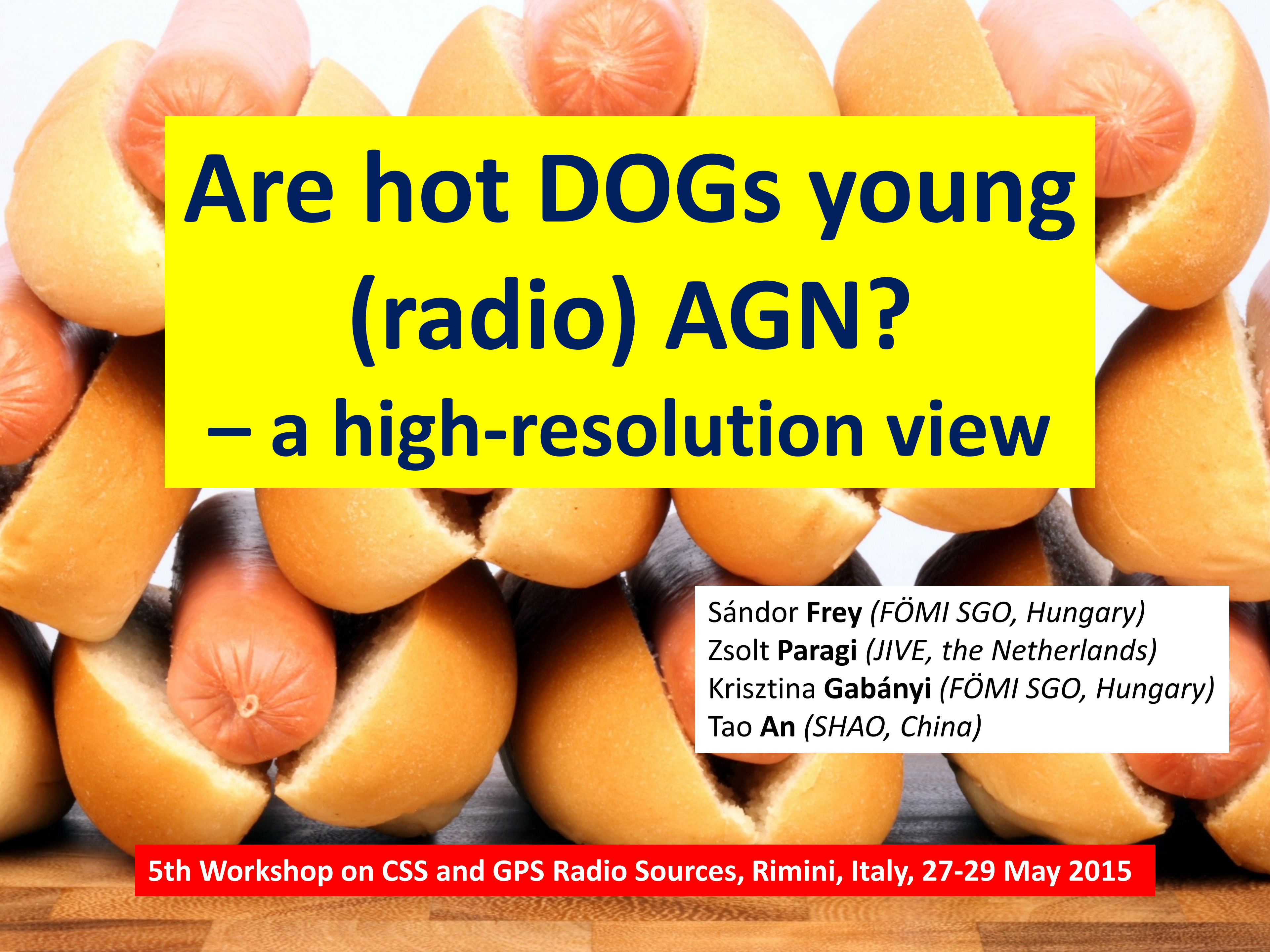

Are hot DOGs young (radio) AGN? – a high-resolution view

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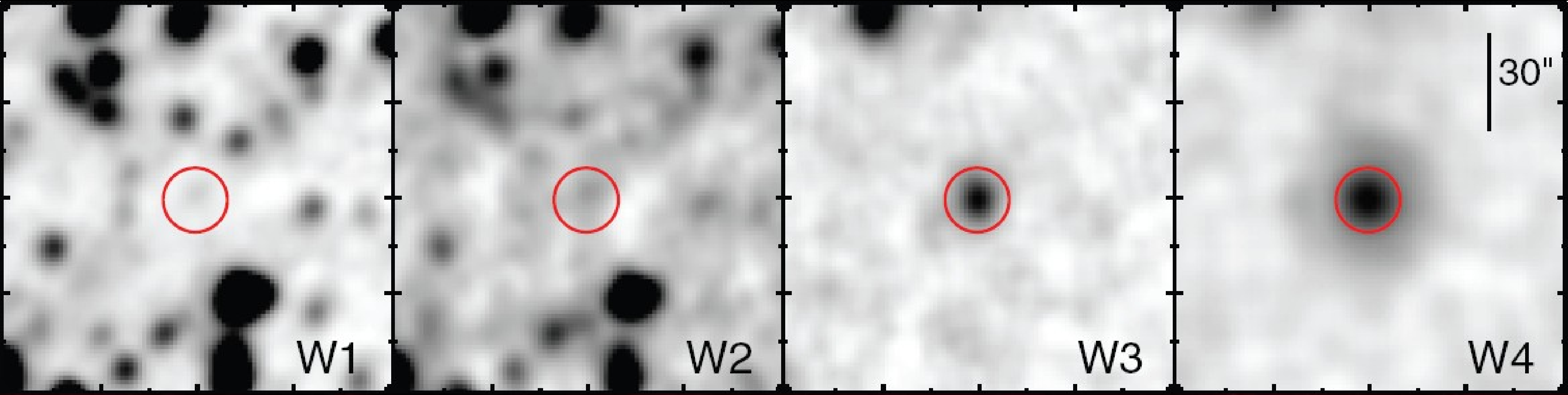
What are the hot DOGs?

= **hot dust-obscured galaxies** (Wu+ 2012, ApJ 756, 96)

Identified with the *Wide-field Infrared Survey Explorer* (WISE) satellite as **W1W2-dropout objects**, i.e. prominent in the W3 (12 μm) and W4 (22 μm) bands, but very weak or undetected in the W1 (3.4 μm) and W2 (4.6 μm) bands

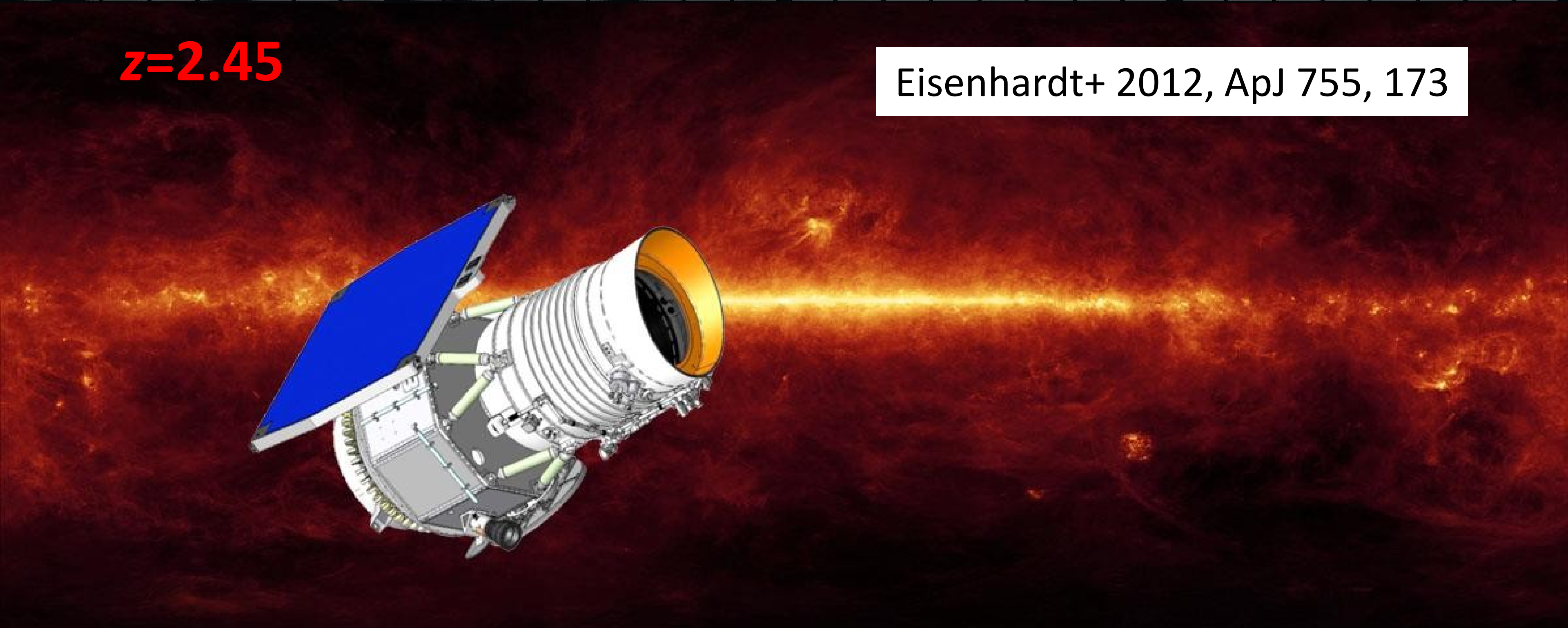
The all-sky population of these hyperluminous galaxies contains ~1000 sources

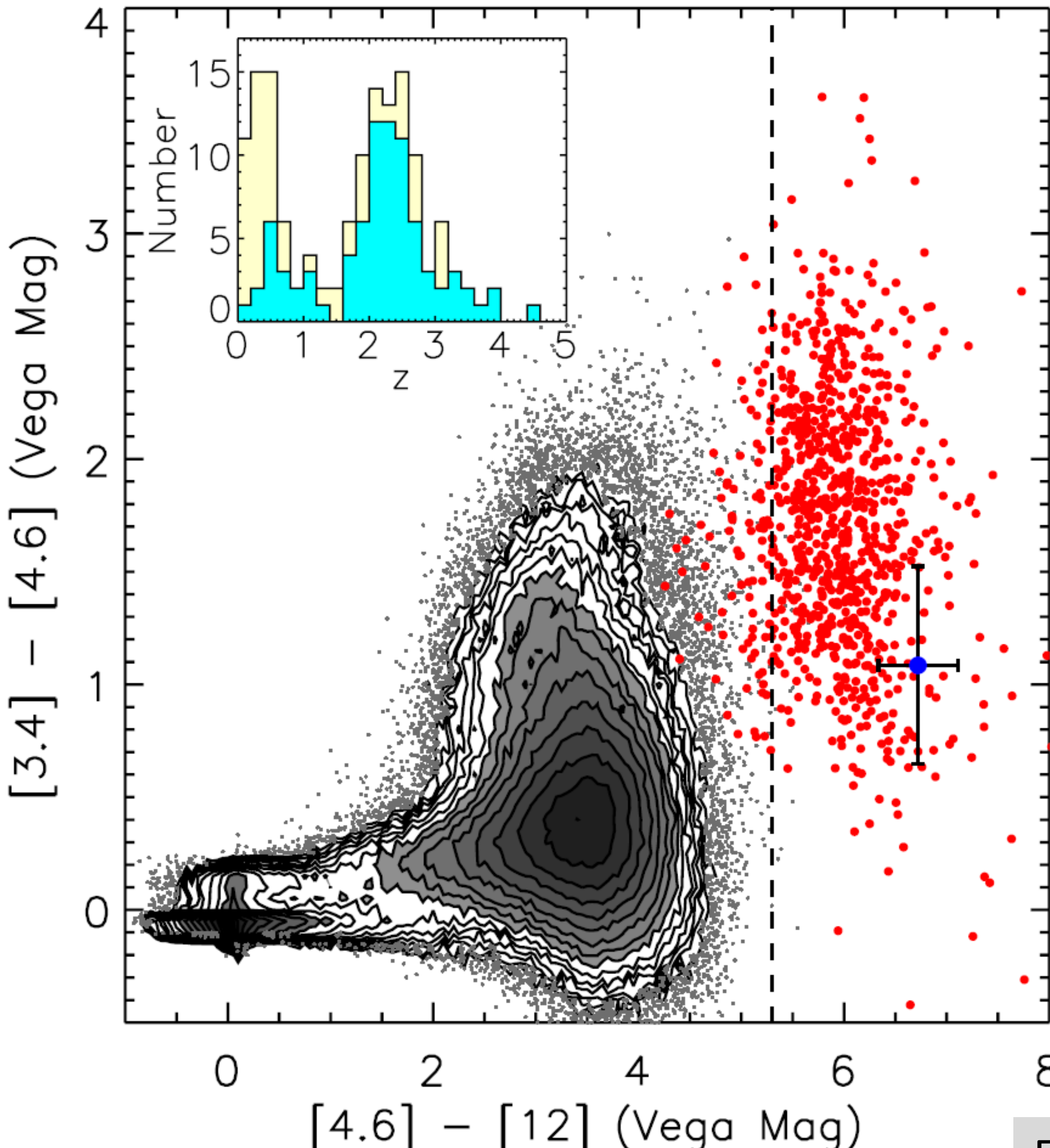
The prototype: W1814+3412



z=2.45

Eisenhardt+ 2012, ApJ 755, 173





Red dots: hot DOGs
(all sky)
colours also from
follow-up *Spitzer* data

The rest: a typical
WISE sample (*b*>80°)

inset: redshift
distribution

Eisenhardt+ 2012, ApJ 755, 173

Our current understanding of hot DOGs

Redshifts are typically high, with a distribution peaking between 2 and 3
→ at the peak of cosmic star formation and AGN activity

Many spectra show signs of **obscured AGN**

Luminosities (~10^{13}–10^{14} $L_{\odot}$) are comparable to the most luminous quasars

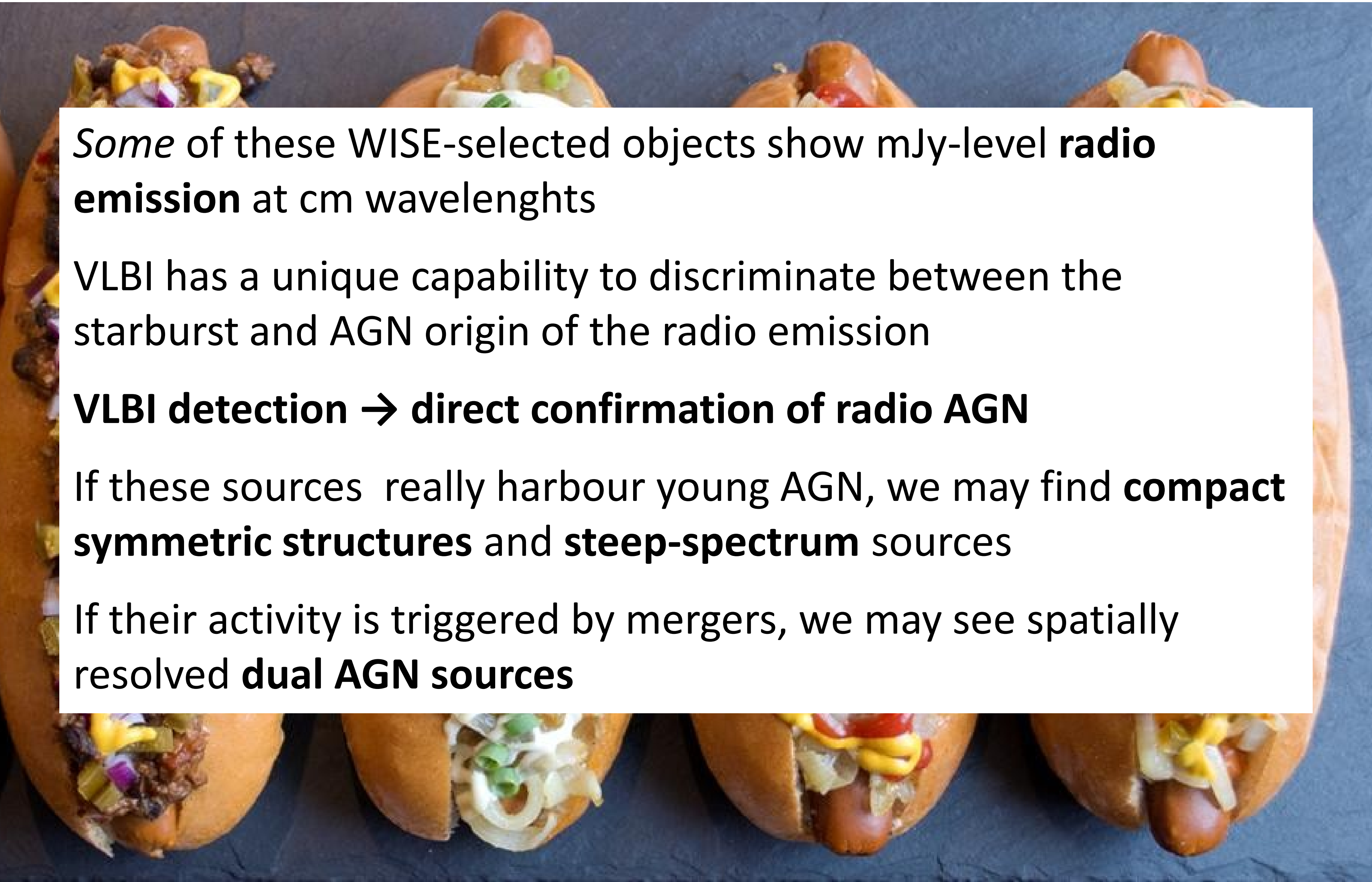
SEDs are different from other known populations, the high mid-IR/submm luminosity ratio indicates that the dominant emission comes from **hot dust** (60–120 K)

Extreme and rare cases of luminous DOGs, representing a **short evolutionary phase in galaxy evolution** through mergers

Starburst – AGN transitions?

Wu+ 2012, ApJ 756, 96; Wu+ 2014, ApJ 793, 8

Hot DOGs as young radio AGN?



Some of these WISE-selected objects show mJy-level **radio emission** at cm wavelenghts

VLBI has a unique capability to discriminate between the starburst and AGN origin of the radio emission

VLBI detection → direct confirmation of radio AGN

If these sources really harbour young AGN, we may find **compact symmetric structures** and **steep-spectrum** sources

If their activity is triggered by mergers, we may see spatially resolved **dual AGN sources**

Test of the compact radio structures

Sensitive phase-referenced observations initiated with the *European VLBI Network* (EVN)

2014 Feb 21/22, total time 14 h

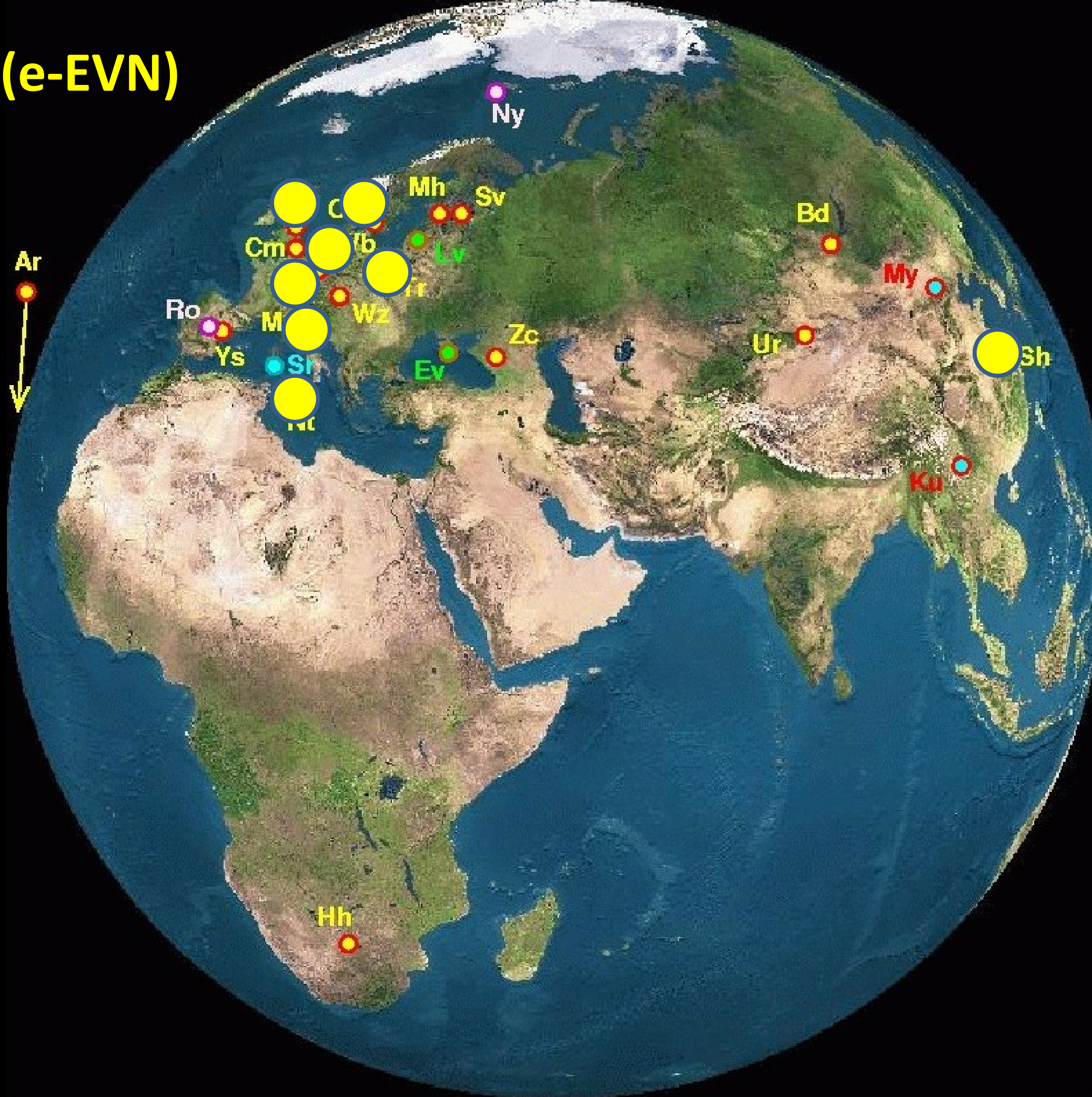
Observed in **e-VLBI mode**

8 stations: Ef, Wb, Jb (Lovell), On, Mc, Nt, Tr, Sh

1.7 GHz frequency: higher chance of detection (presumably **steep-spectrum** sources)

Sources yet unexplored with VLBI → a pilot project, with **4 targets** only, at a single frequency

L-band (e-EVN)



The EVN sample

Source designation	Redshift	FIRST L-band peak brightness *(mJy/beam)*	L-band flux density *(mJy)*
W0757+5113	2.227	3.19	3.57
W1146+4129	1.772	4.39	4.39
W1603+2745	2.633	1.77	2.28
W1814+3412	2.452		~1.2

A subsample from 26 hot DOGs

Wu+ 2012, ApJ 756, 96

12 in the FIRST coverage, 3 with radio detection (>1 mJy)

+1 source (the "prototype") with EVLA flux density data

Eisenhardt+ 2012, ApJ 755, 173

Results

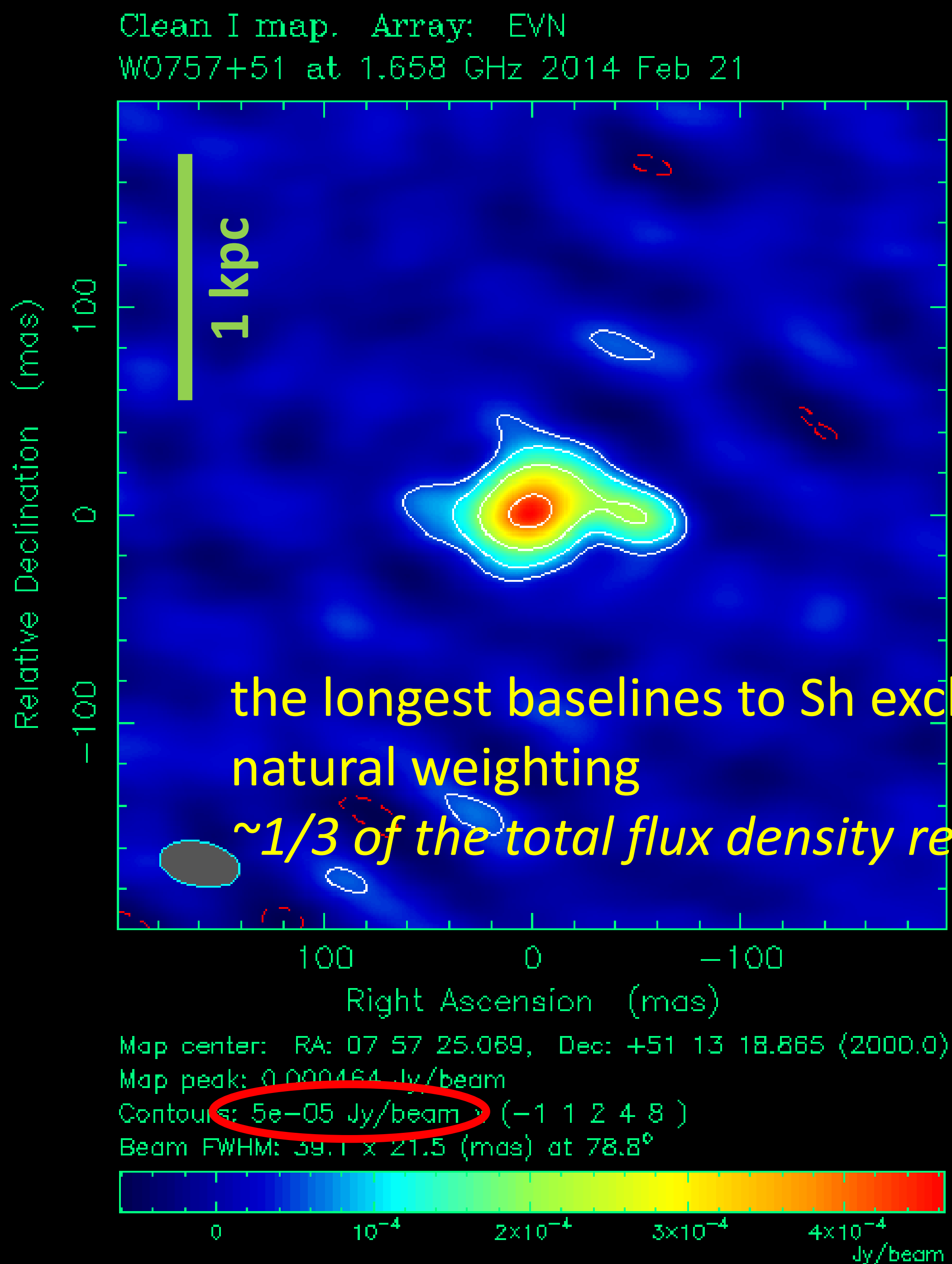
Radio observations are **free form dust obscuration**, so we can look directly into the galaxy cores

Four mJy-level targets, **four detections!** – albeit three (and especially two) of them are rather weak

VLBI detection at these redshifts implies powers and brightness temperatures explained only by **AGN origin** of the radio emission

The sources are all **resolved** on ~10–30 mas angular scales

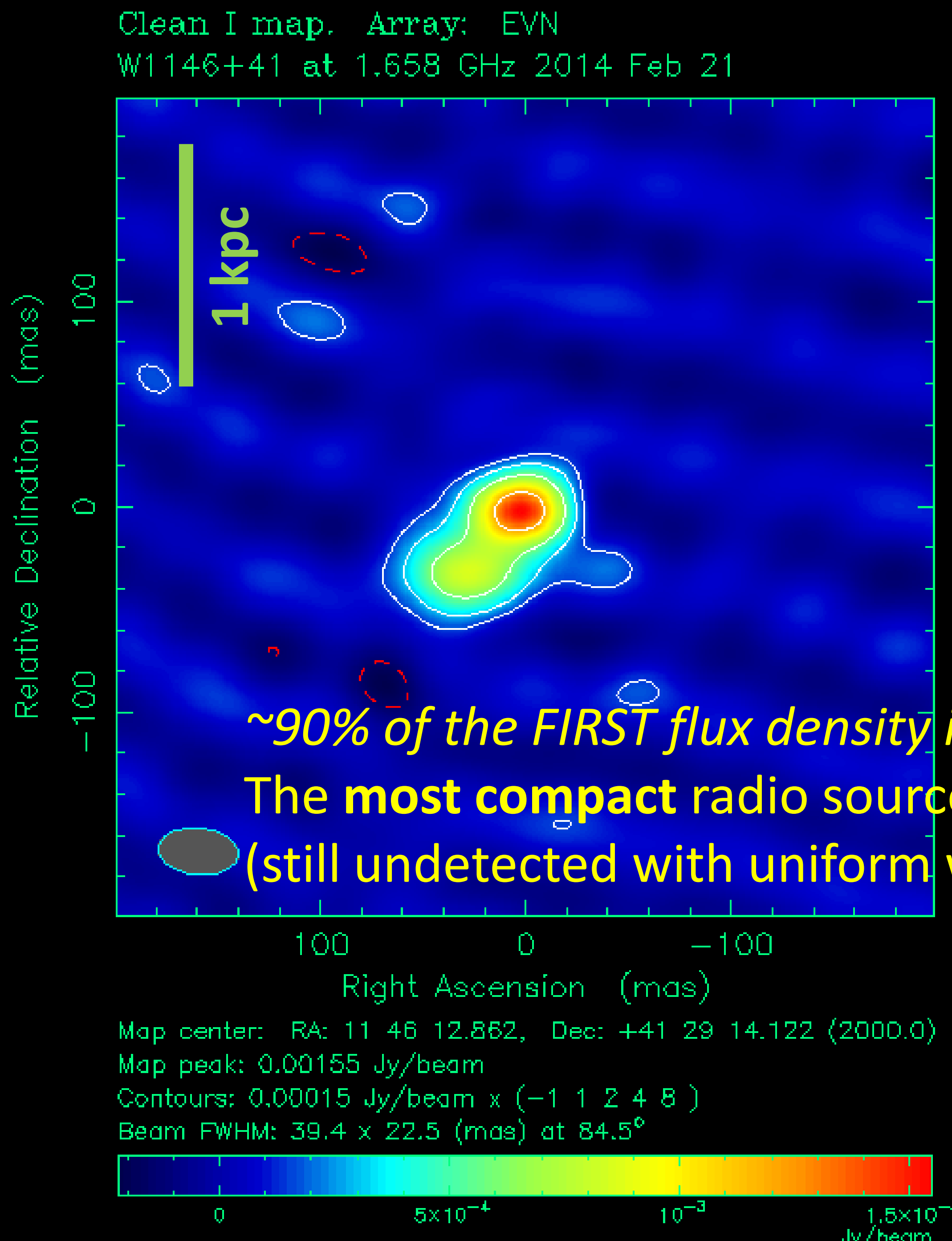
VLBI phase-referencing provides **the most accurate positional information** available for these sources



the longest baselines to Sh excluded

natural weighting

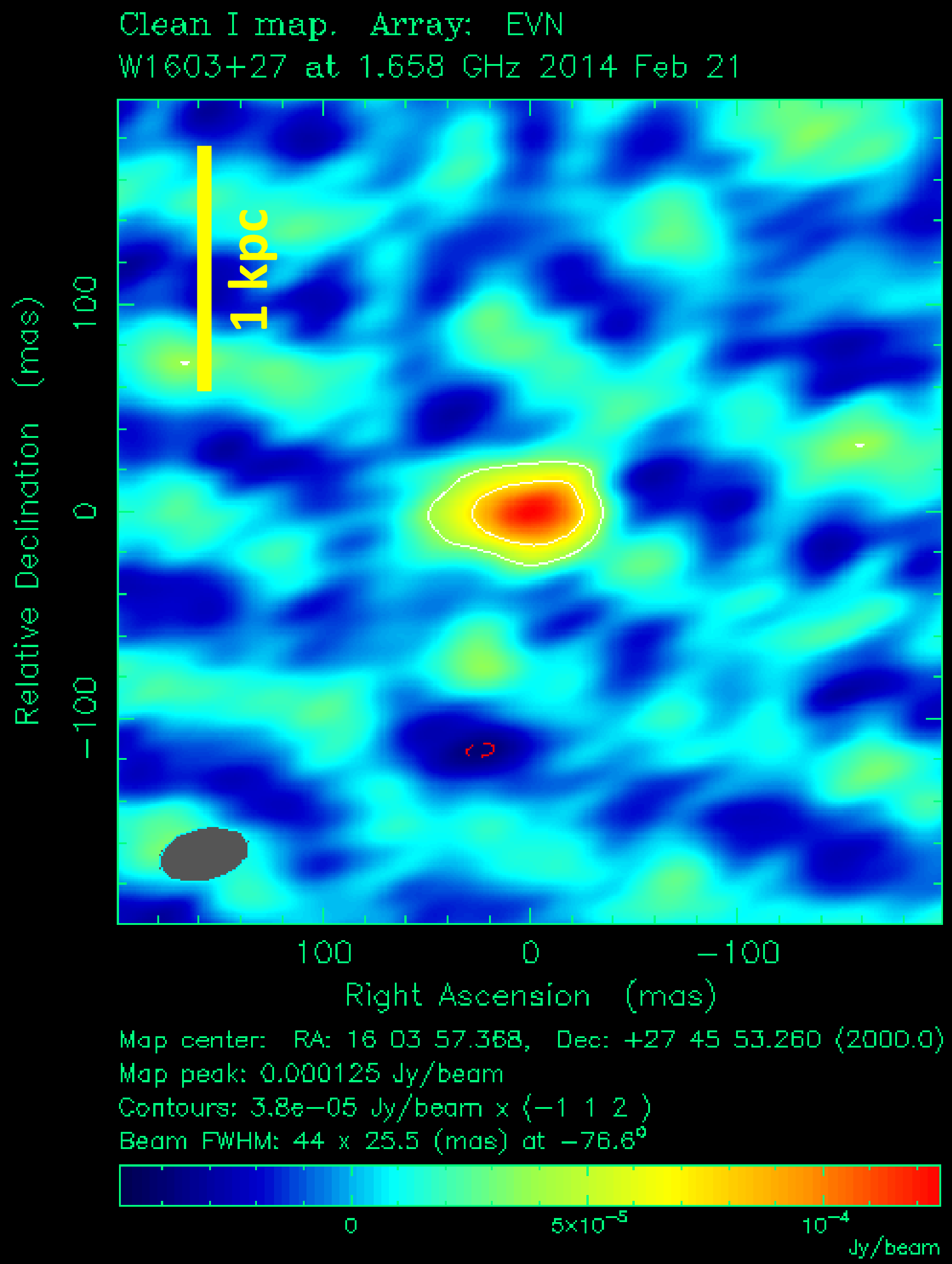
~1/3 of the total flux density recovered



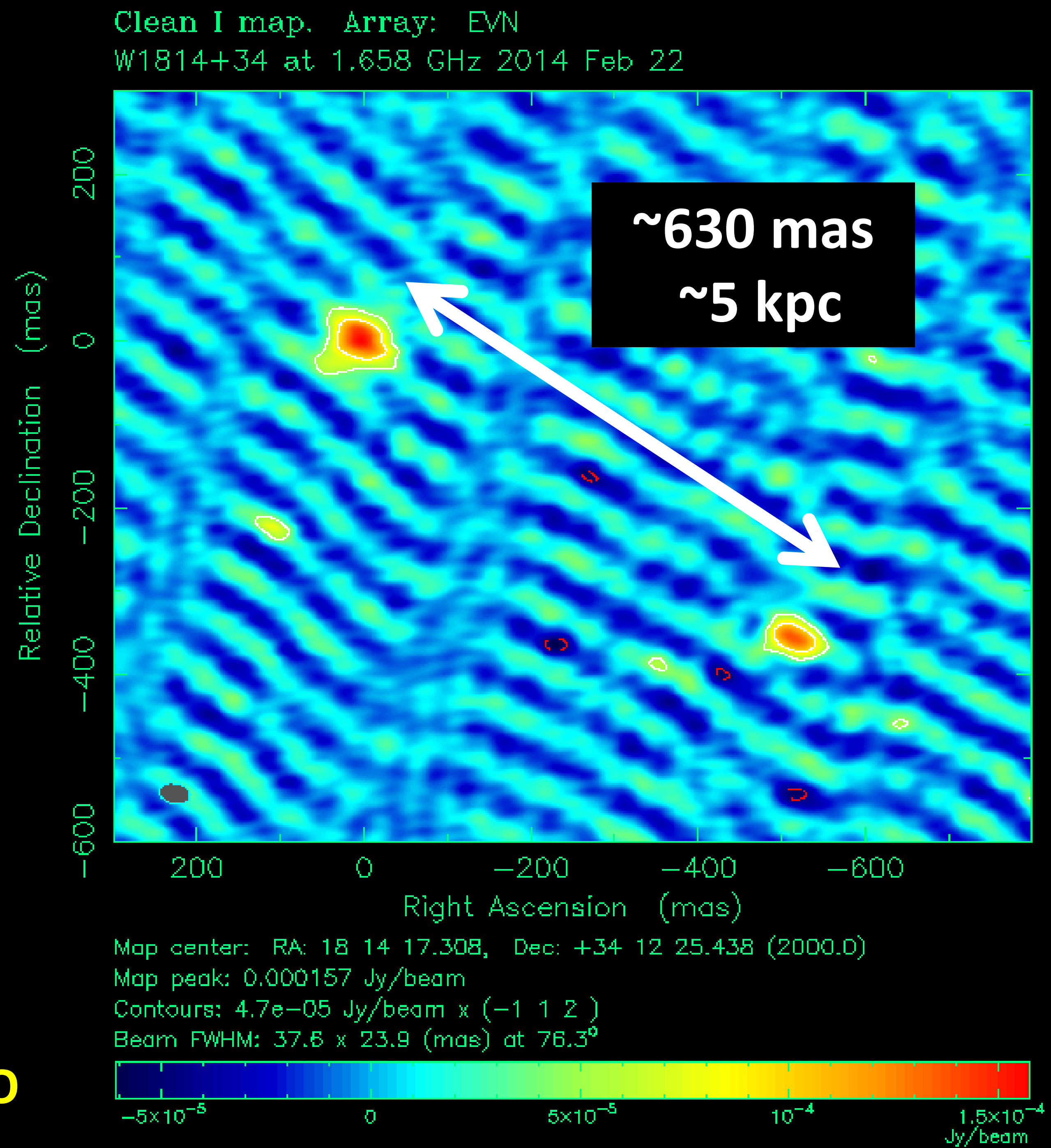
~90% of the FIRST flux density is recovered

The **most compact** radio source in the sample

(still undetected with uniform weighting)

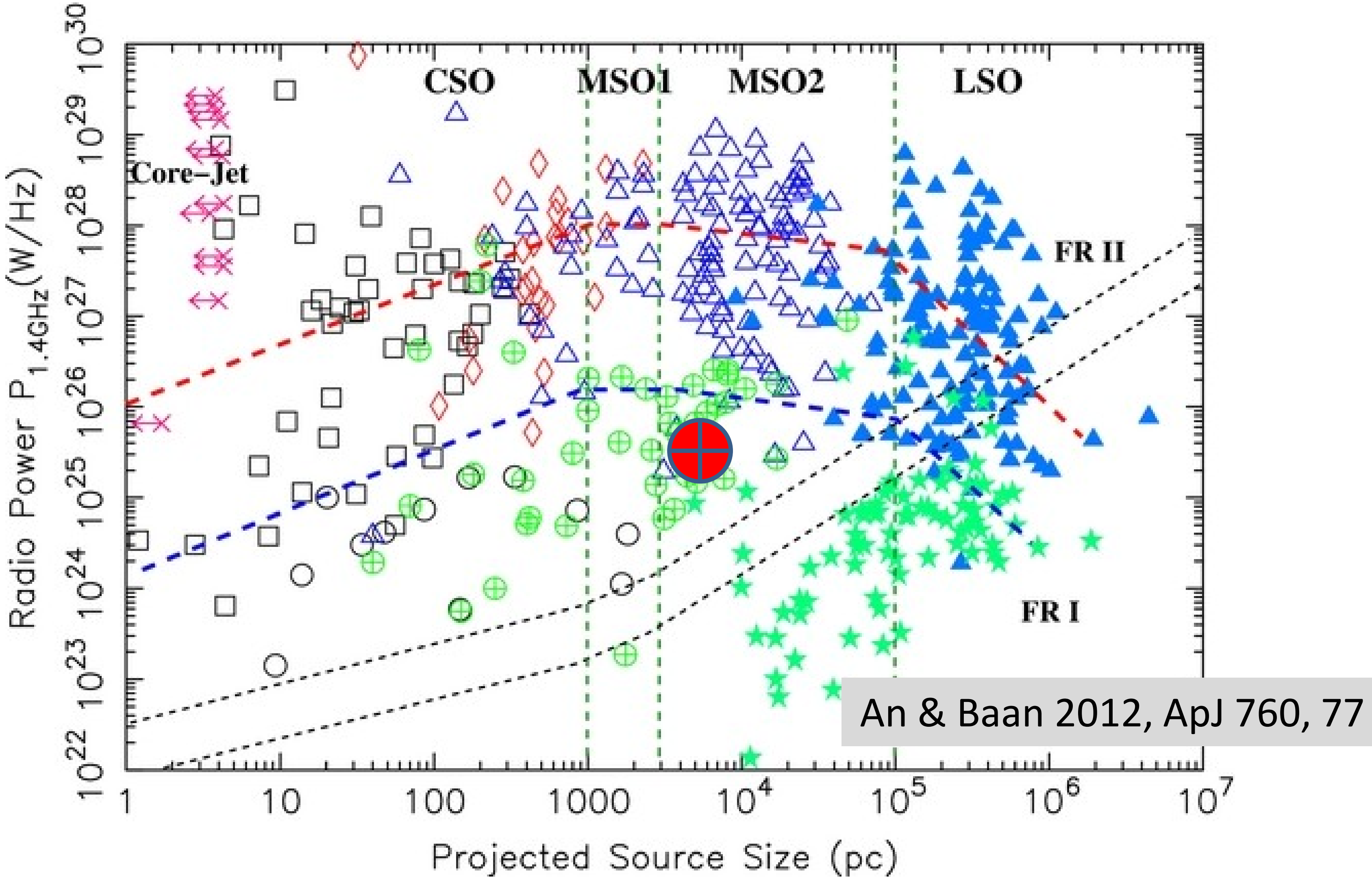


~10% of FIRST flux density



~80% of the total flux density
in two distinct, resolved components

looks like an MSO



W1814+3412 fits well to the **power vs. separation plot** for low-power CSS sources in the evolutionary scheme of young AGN

Summary & outlook

❖ A small mJy-level radio subsample, **four hot DOGs** were observed with the EVN at L band; all four were **detected**

❖ All of them are **resolved**, with various fractions (~10% to 90%) of the total flux density found in the VLBI components

❖ The radio emission is related to AGN activity, with contributions from **more extended** "lobe" structures or **startburst**-related activity

❖ W1814+3412, the prototype hot DOG has a **symmetric double structure** with ~5 kpc projected separation, most likely an MSO

Directions for the future:

❖ Interpreting the results in the context of growing **multi-band data**

❖ Targeting a **larger sample** of hot DOGs with known radio emission

❖ Obtaining **spectral information** at 5 GHz (where feasible)