

4MOST and the new radio surveys

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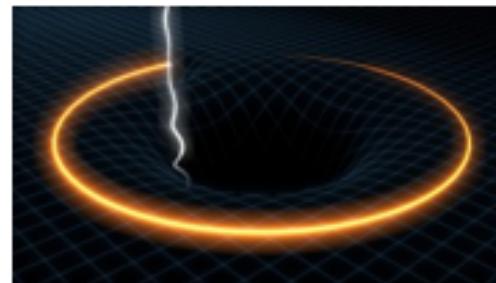
SKA Site Bid Announcement

On 25 May 2012 the Members of the SKA Organization announced that the SKA telescope would be split over Africa and Australia, with a major share of the telescope destined to be built in South Africa.

The Square Kilometre Array – The Science Questions



Investigating galaxy evolution,
cosmology and dark energy



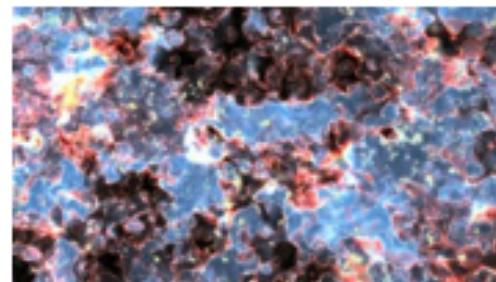
Strong-field tests of gravity using
pulsars and black holes



Investigating the origin and
evolution of cosmic magnetism



The cradle of life searching for life
and planets



Probing the dark ages - the first
black holes and stars

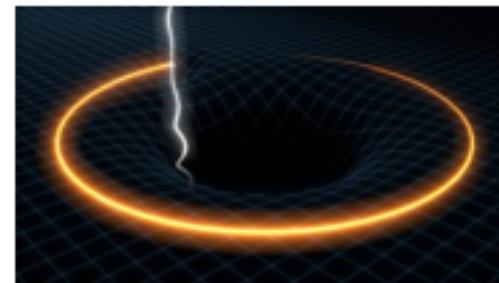


Flexible design will enable
exploration of the unknown

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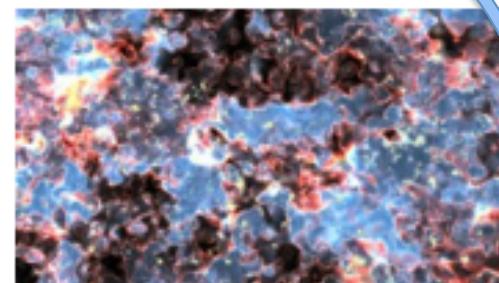
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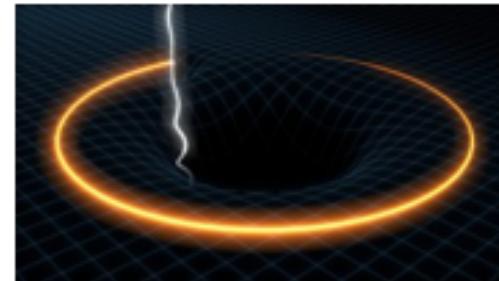


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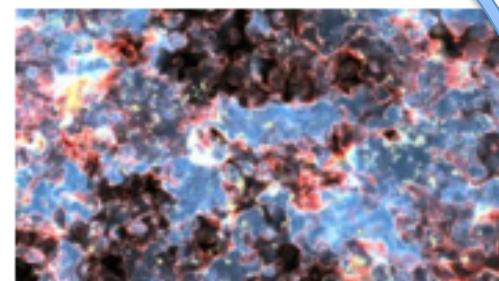
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The new radio surveys on the pathway to the SKA



High-frequency (0.8-10GHz)



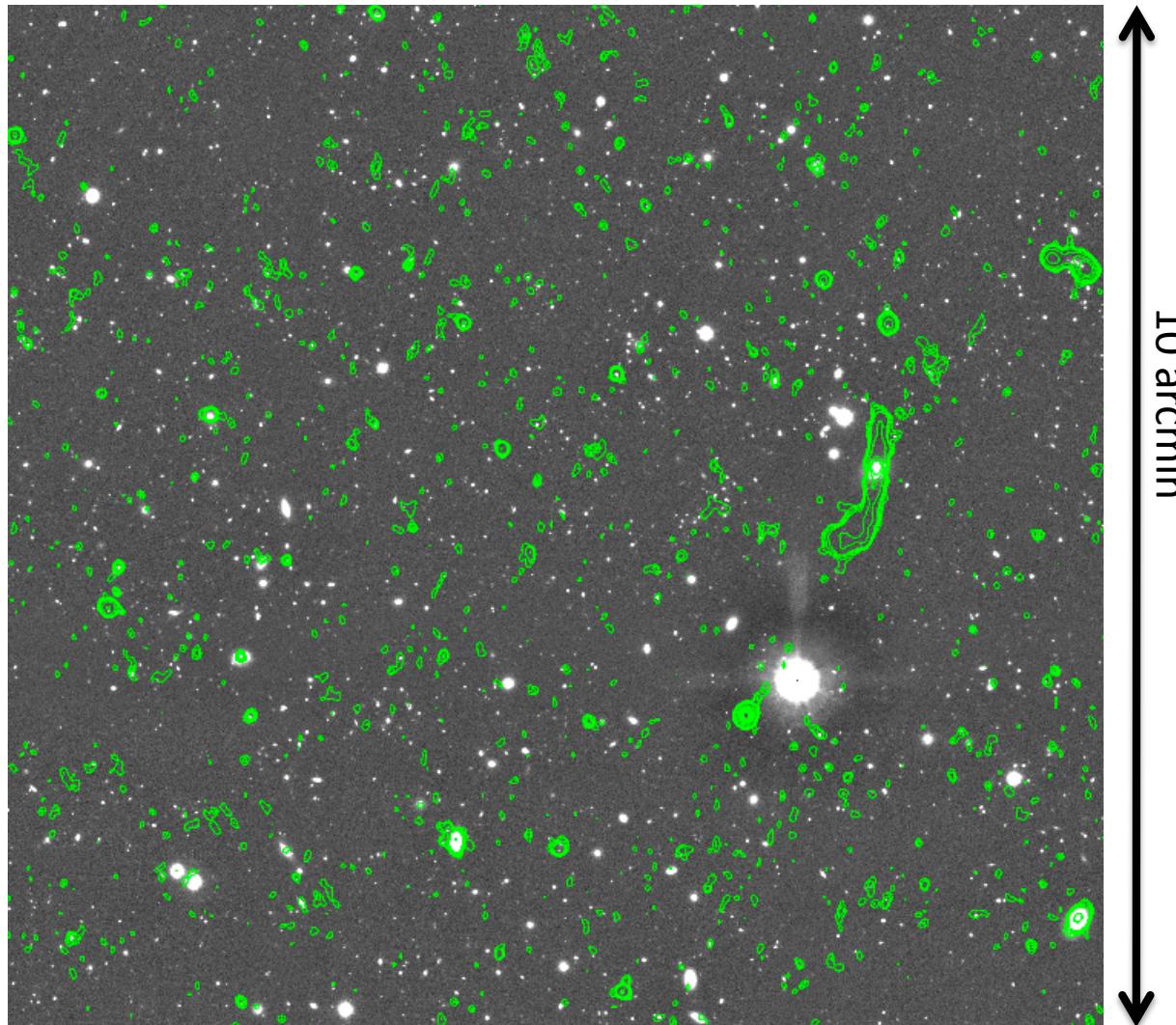
Low-frequency (50-400MHz)



Mid-frequency (400-1000MHz)

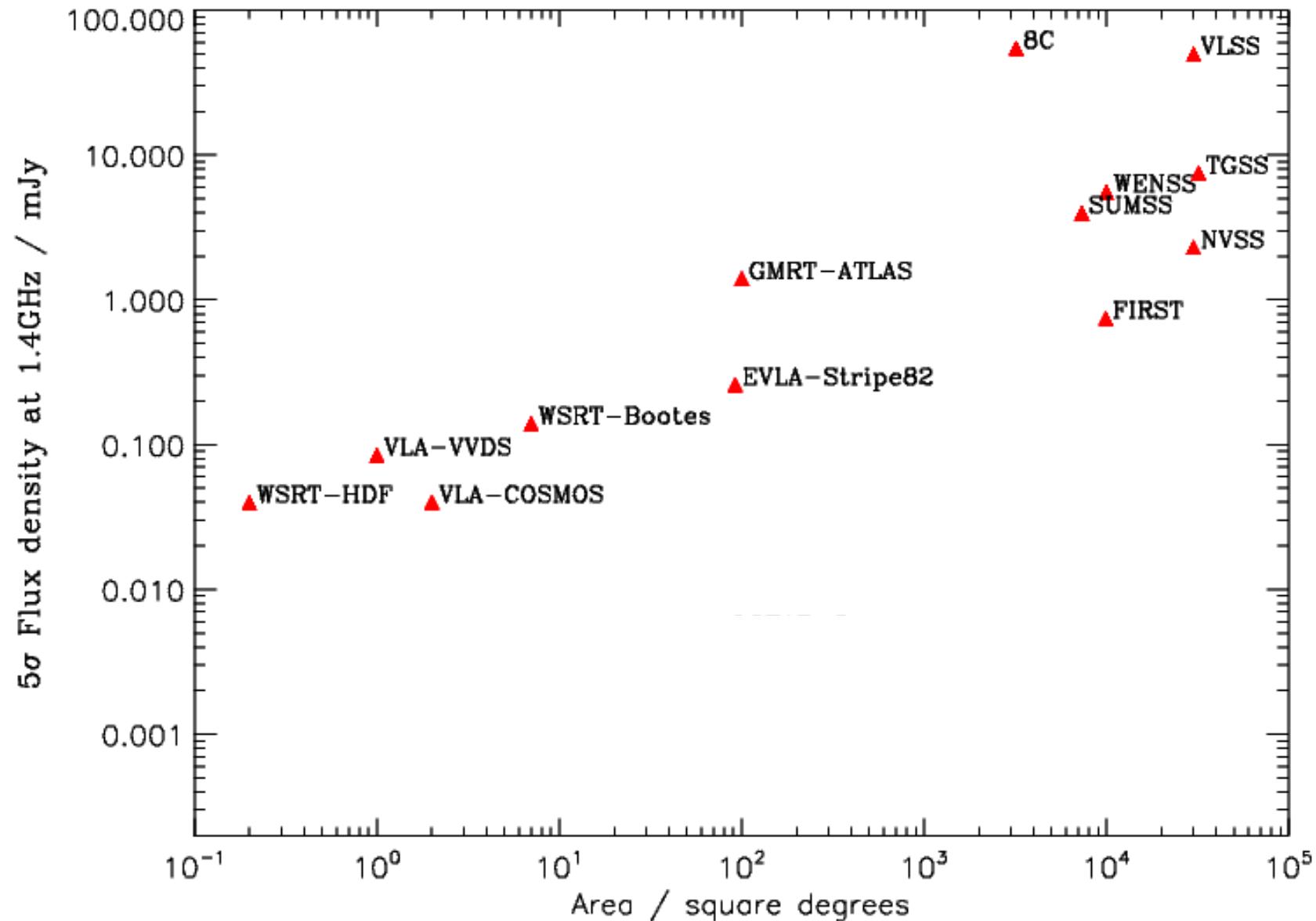
The Square Kilometre Array – The Science

McAlpine, Smith, MJJ, Bonfield & Fleuren 2012

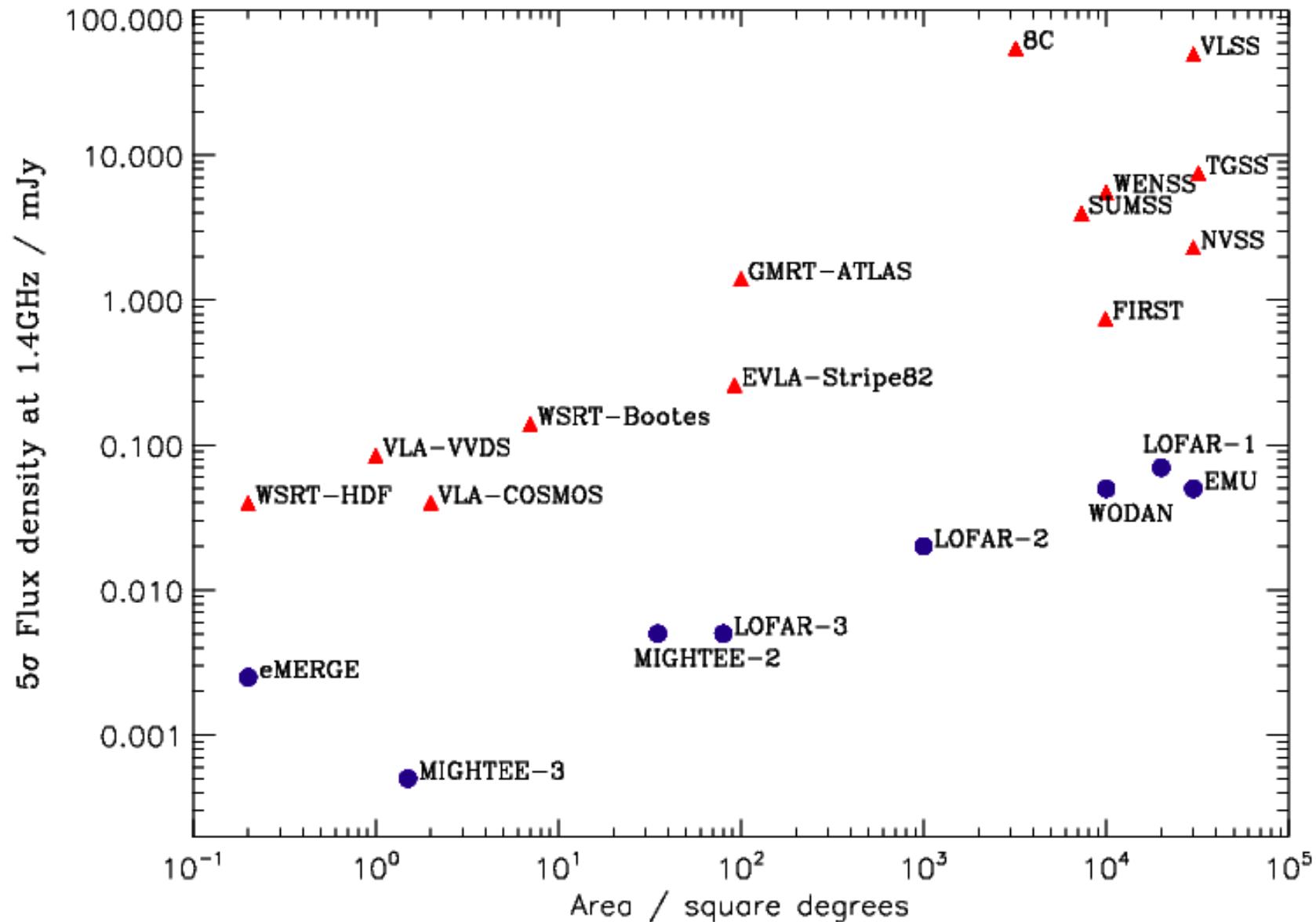


Traditional realms of radio astronomy at $z>0.1$

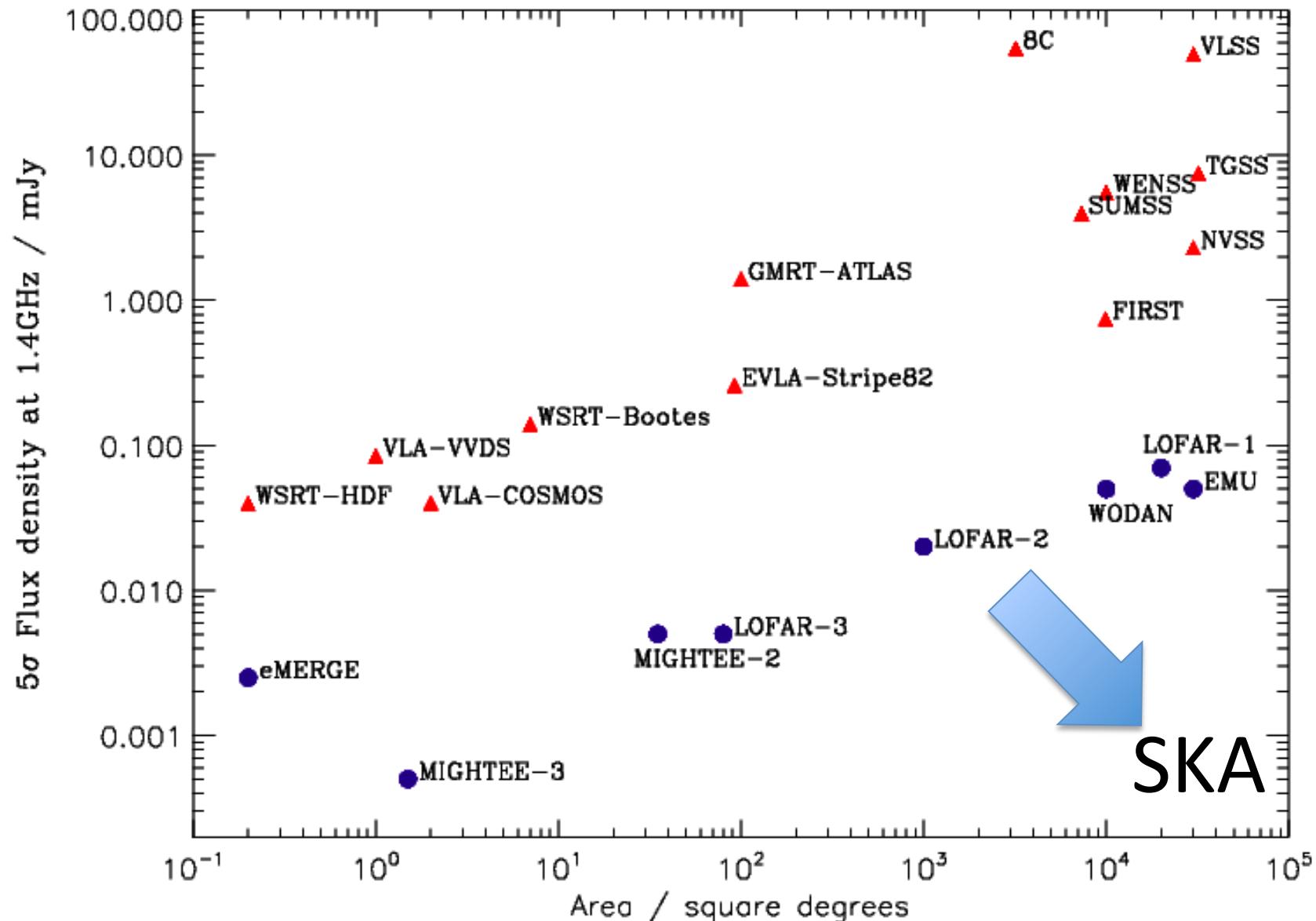
The new radio continuum surveys



The new radio continuum surveys



The new radio continuum surveys



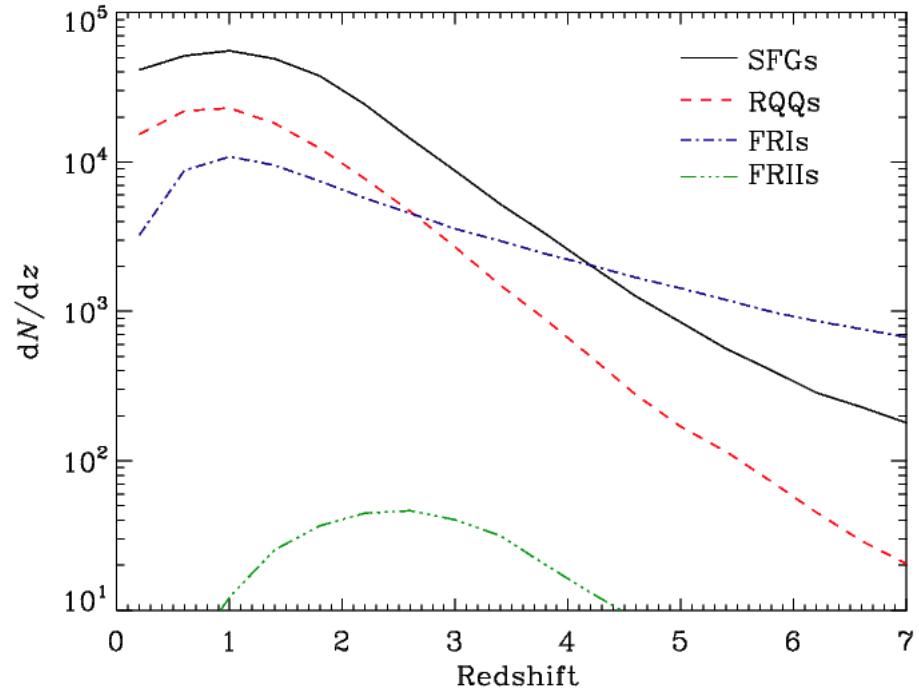
The SKA Precursor/Pathfinder Telescopes



LOFAR will be the fastest survey telescope in the world. Multi-tiered survey

APERTIF + ASKAP to provide all sky “shallow”surveys

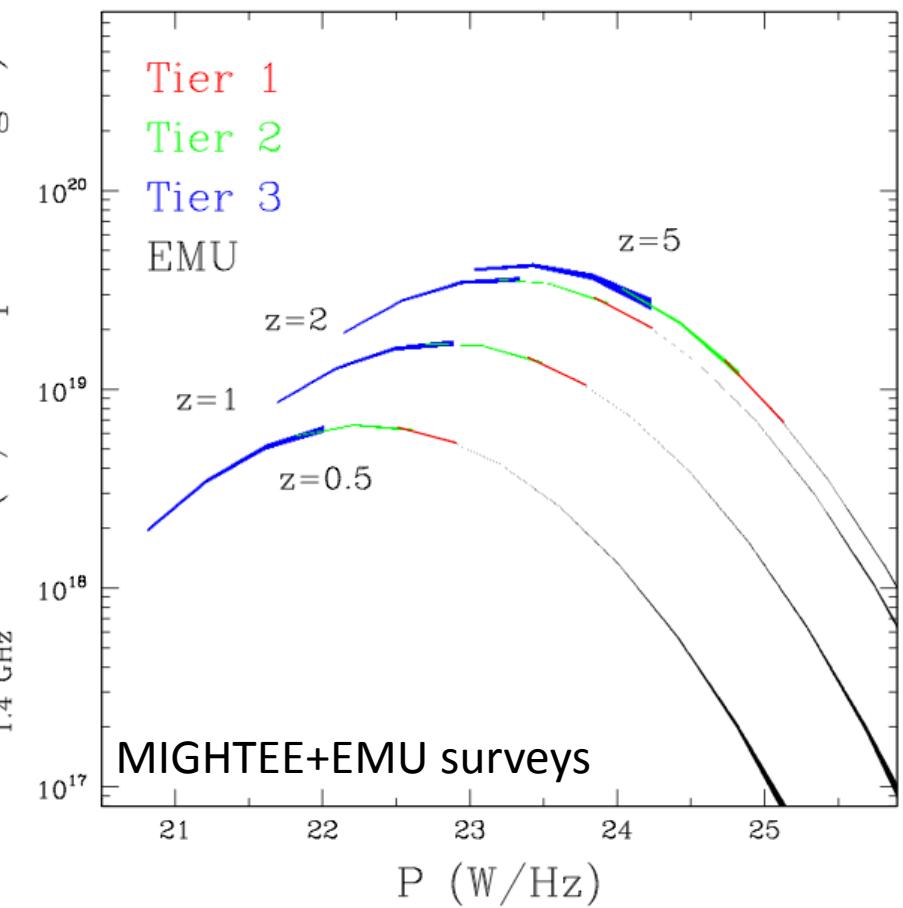
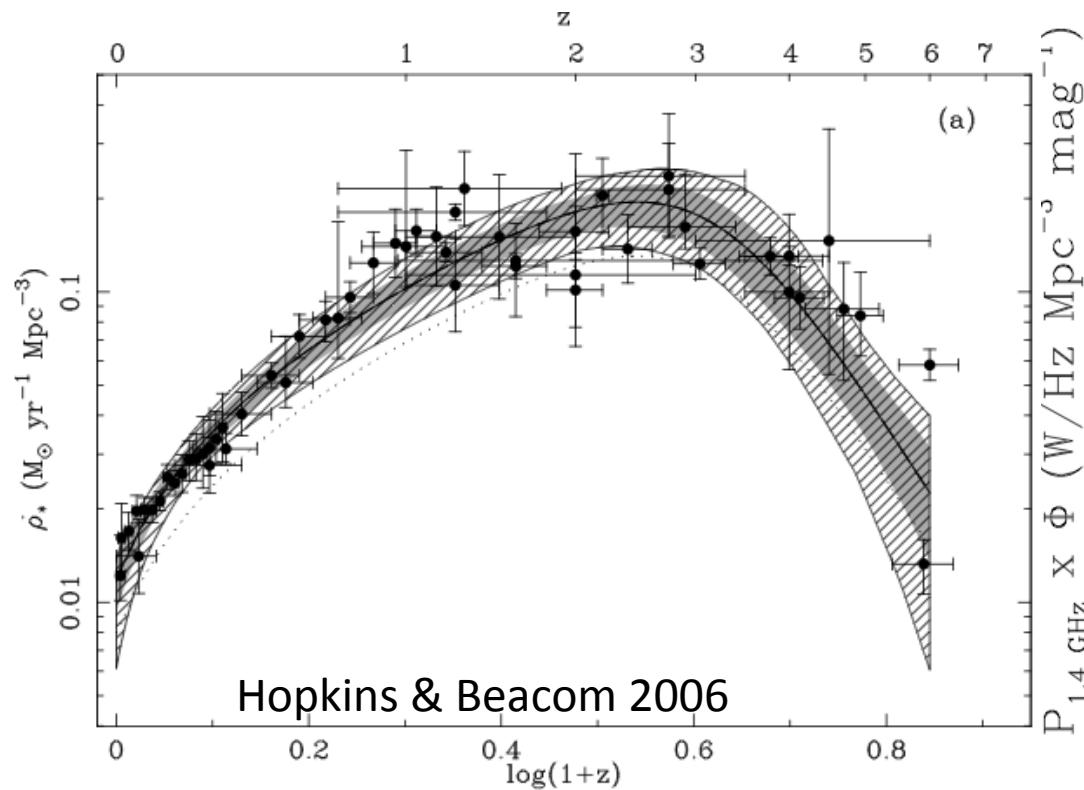
MeerKAT will provide very deep observations over 50-1000 sq.deg



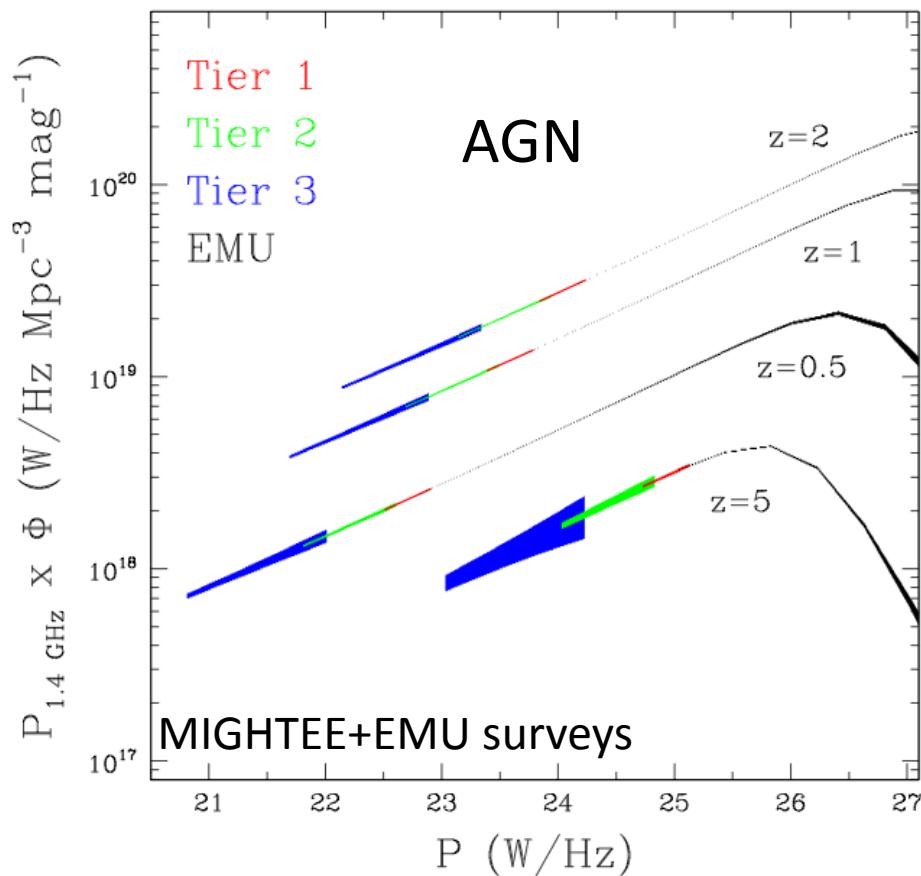
The dominance of star-forming galaxies in the new radio continuum surveys.

Wilman & MJJ et al. 2010

The new radio continuum surveys & the evolution of activity

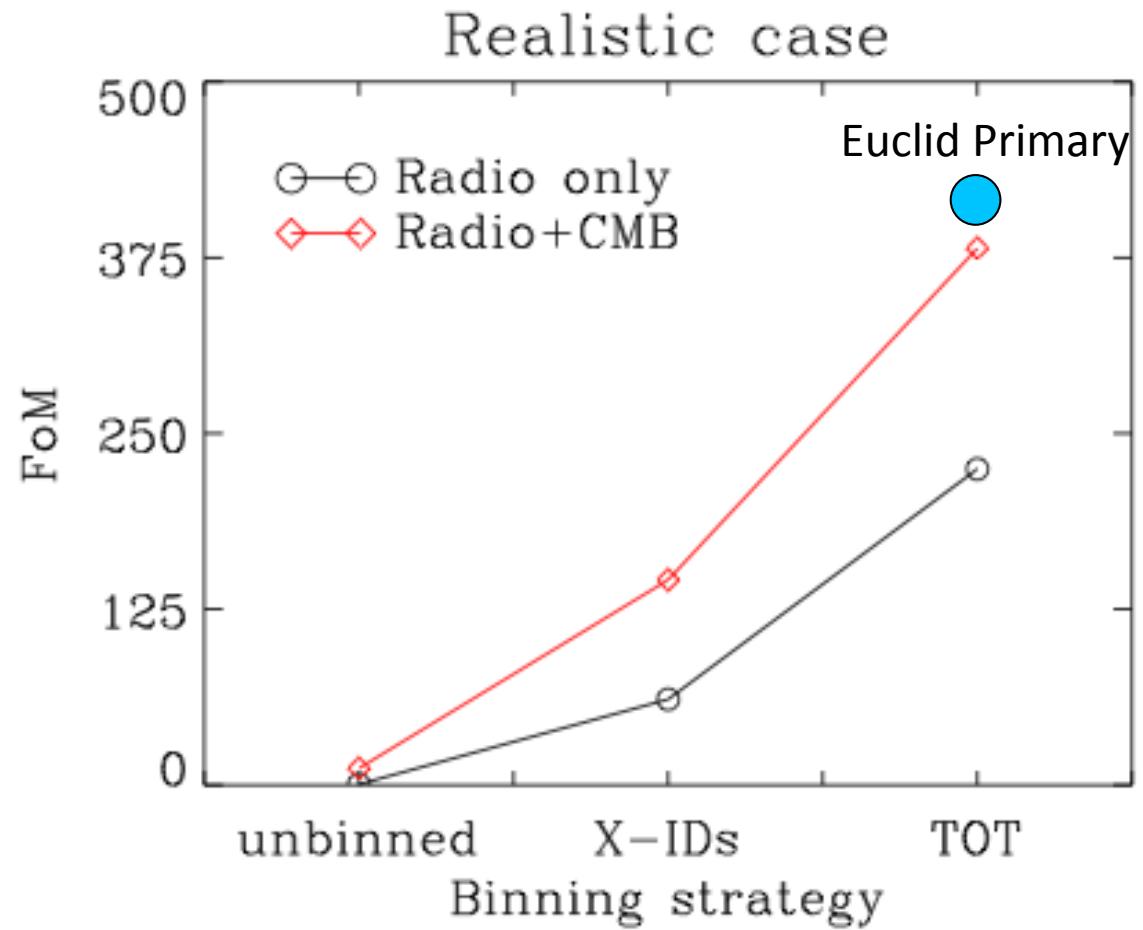
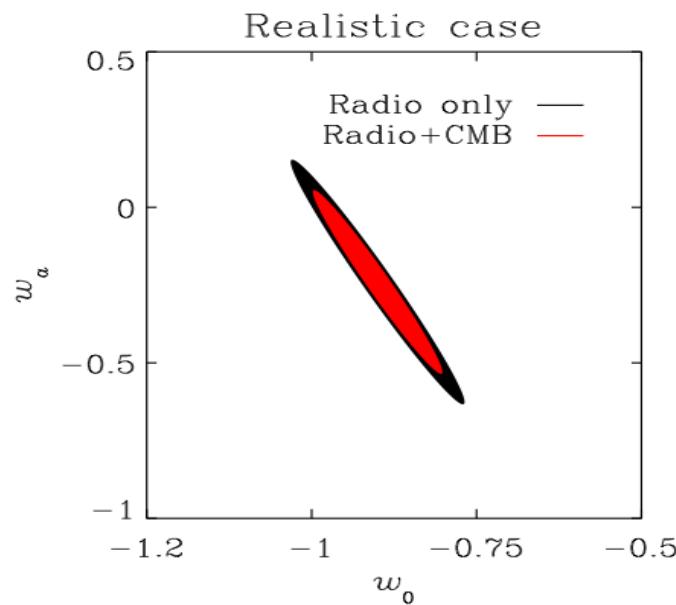
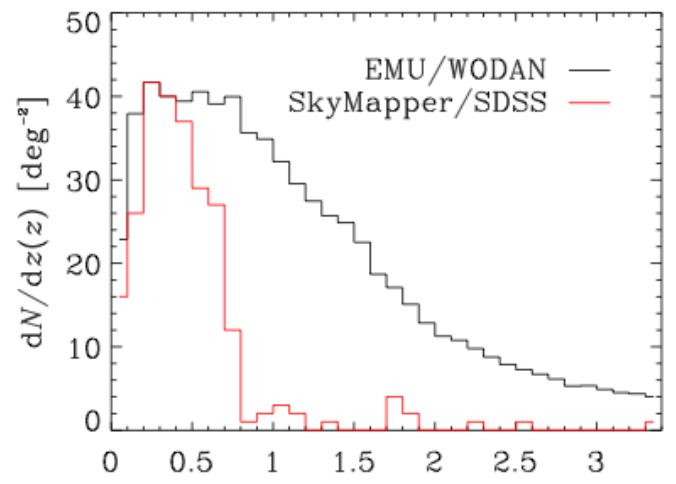


The new radio continuum surveys & the evolution of activity



- Role of spectroscopy would be to determine the presence of AGN activity via emission line diagnostics
- Don't need anywhere near 10,000 sq.deg though?
- Really the realm of deeper narrower surveys. Need ~30-50sq.deg to fully sample radio populations
- Limitation is radio data and not optical/nearIR depth.

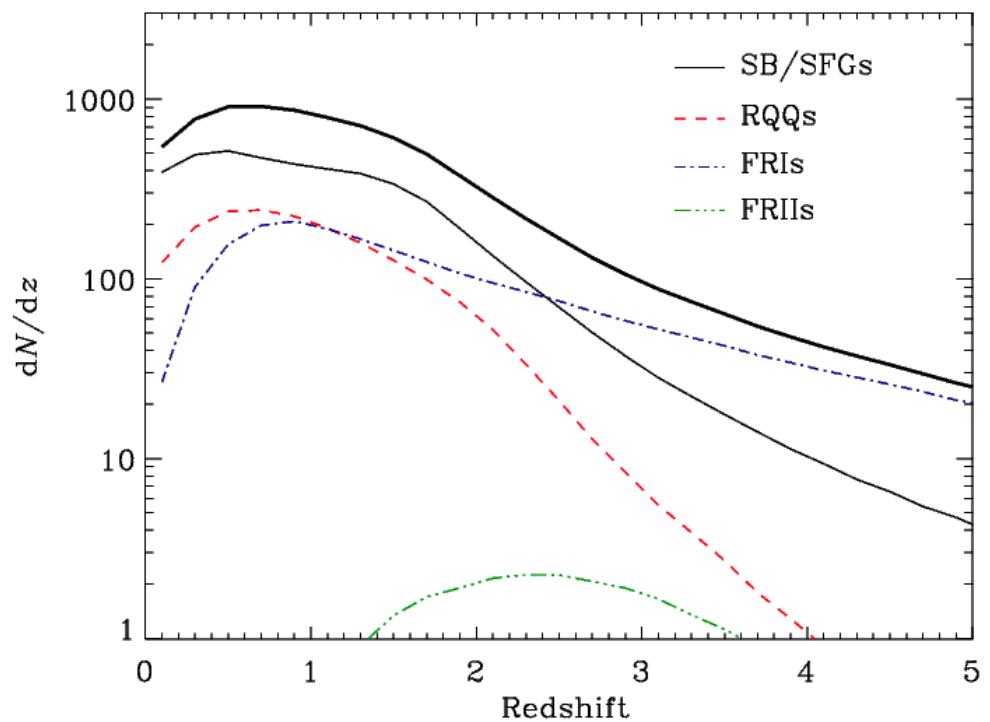
The link to cosmology



Camera, Santos, Bacon, MJJ et al. 2012

The link to cosmology

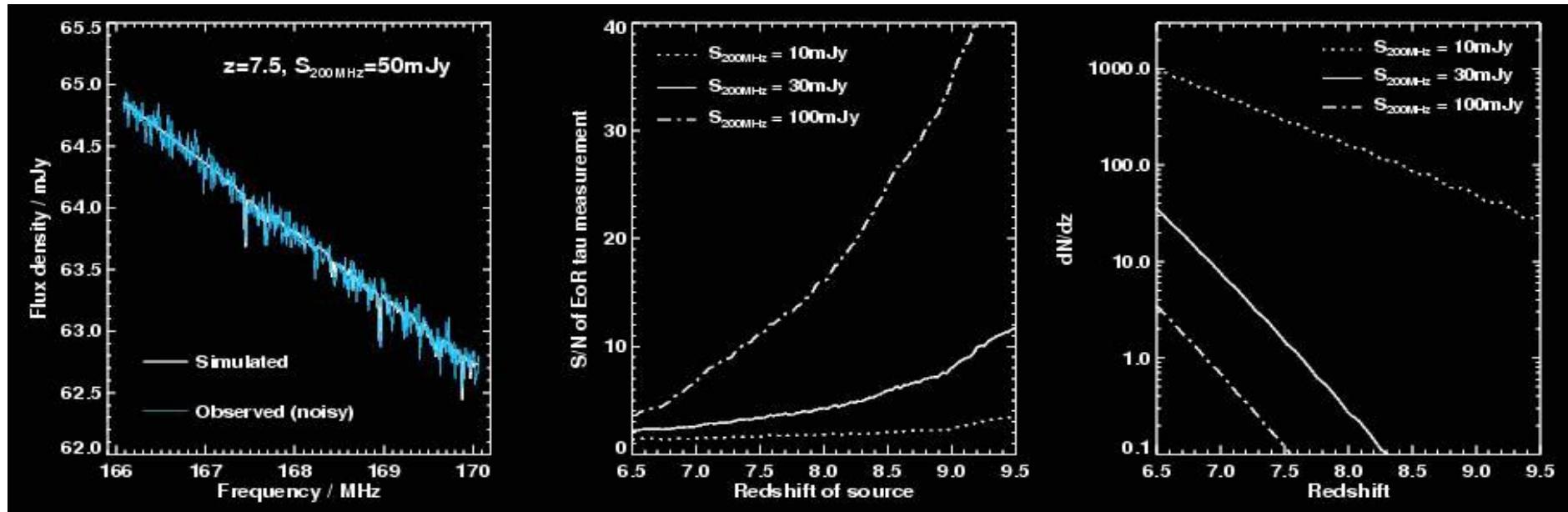
- Key fact about radio sources is that most (60-80%) have emission lines.
- This provides a very efficient way of selecting emission line objects at high-z for 4MOST.
- 4MOST can detect [OII] to $z \sim 1.4$ (900nm limit) or $z \sim 1.8$ (1050nm limit).
- Source density of EMU at 5sigma is ~ 2000 sources per sq.deg
- This gives a spectroscopic redshift source density of ~ 1400 per sq.deg.
- 550 at $0.8 < z < 1.4$
- 800 at $0.8 < z < 1.8$



Very similar strategy to Wigglez but extends redshift range and efficiency

4MOST in to the Epoch of Reionization?

- Using powerful radio sources within the EoR, the properties of the EoR can be studied in absorption, via the 21 cm forest.
- High flux limit (5mJy @1.4GHz), gives \sim 24 sources per sq.deg.
- Obtain spectra for all of these and expect 1 $z > 6$ powerful radio source per \sim 1000sq.deg for EoR absorption



4MOST and future HI surveys

Obreschkow et al. 2009



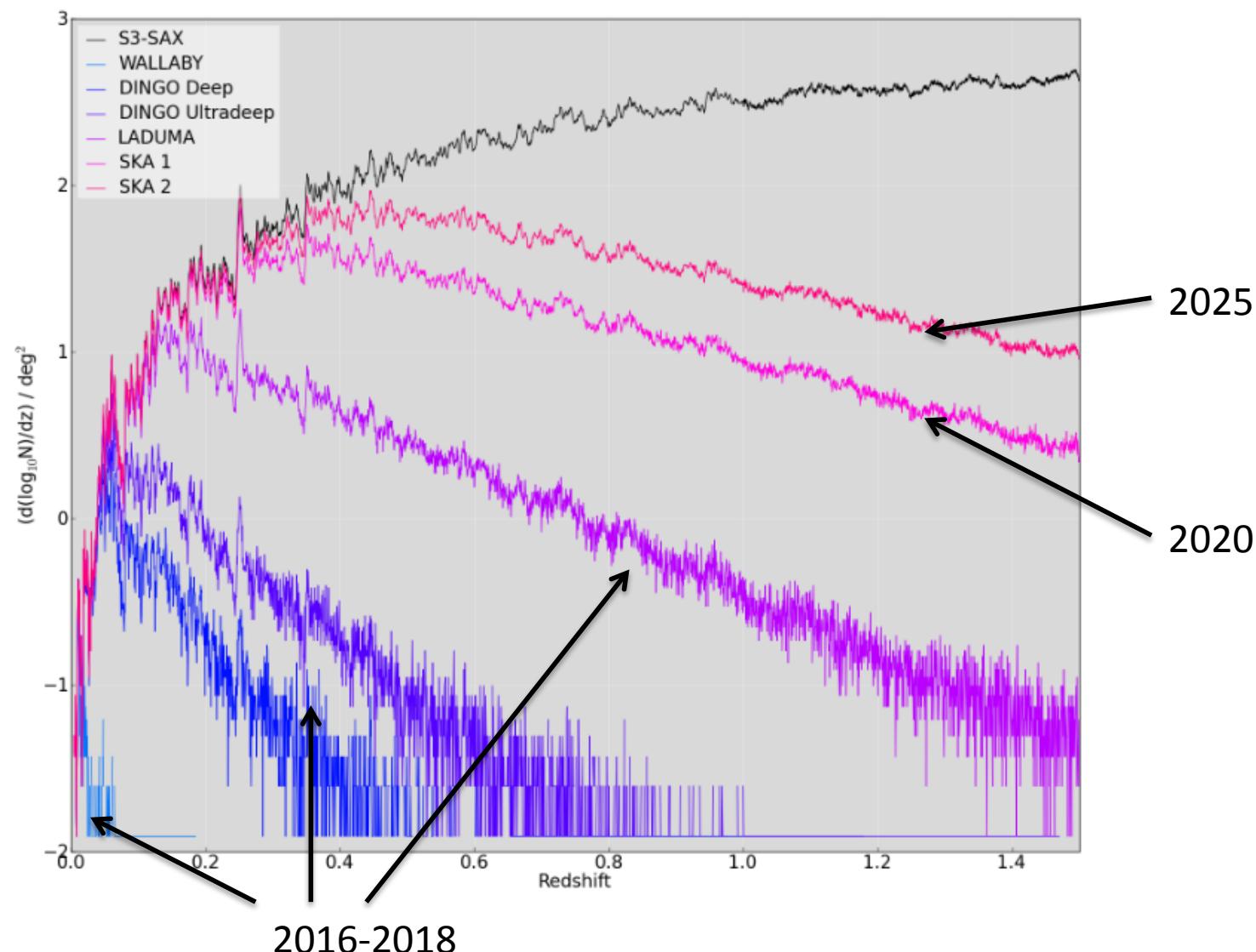
In the future HI will be detected to $z>1$.

In the age of SKA Phase 1 (2020) we will be in a position to make a HI cube over 1000s of sq.degrees to $z\sim 1$

So where does 4MOST help?

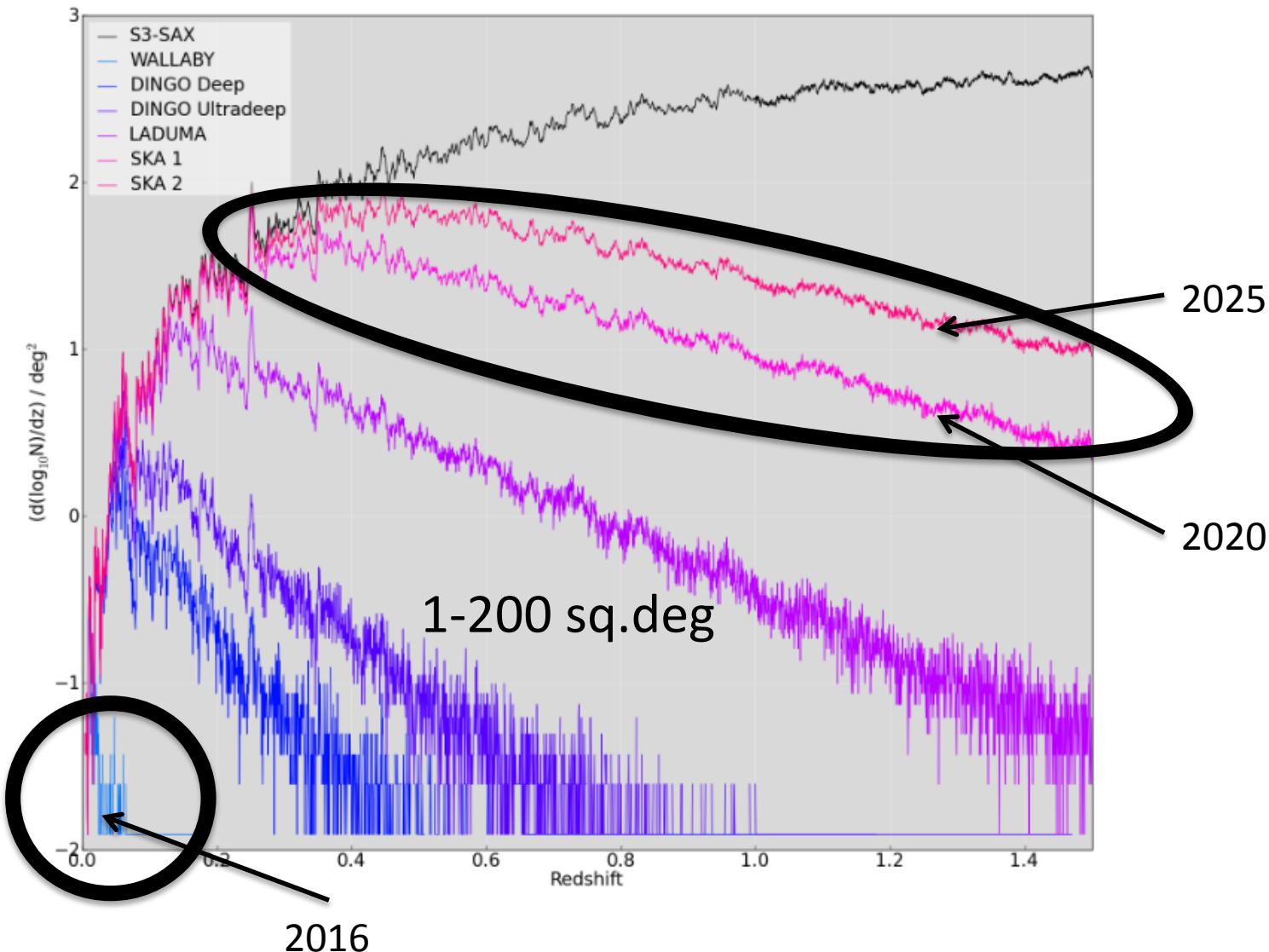
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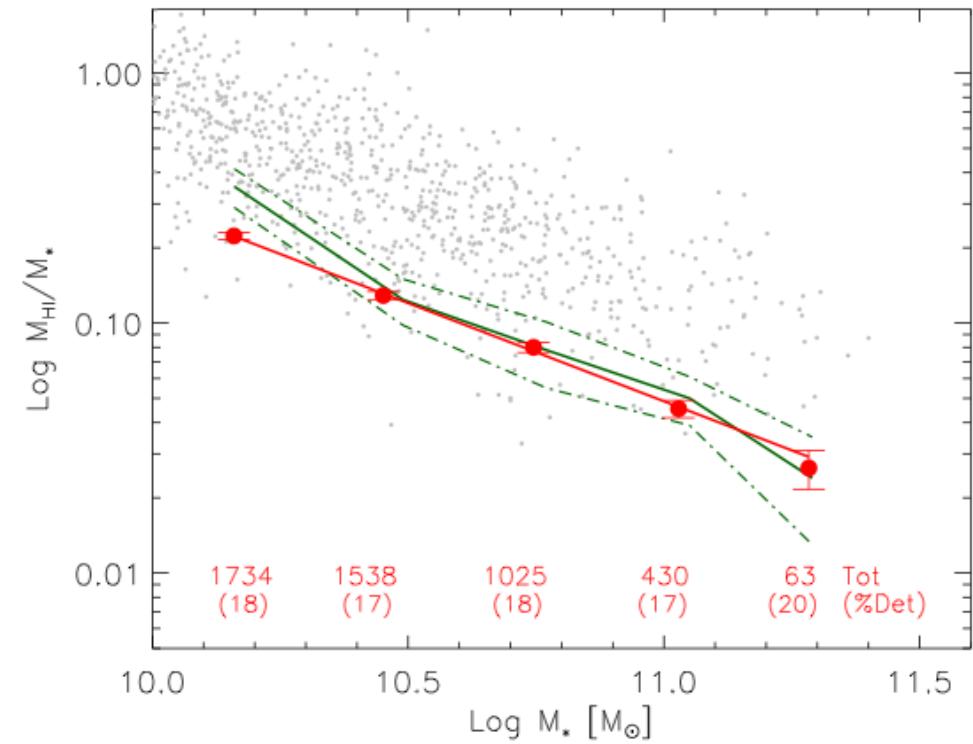
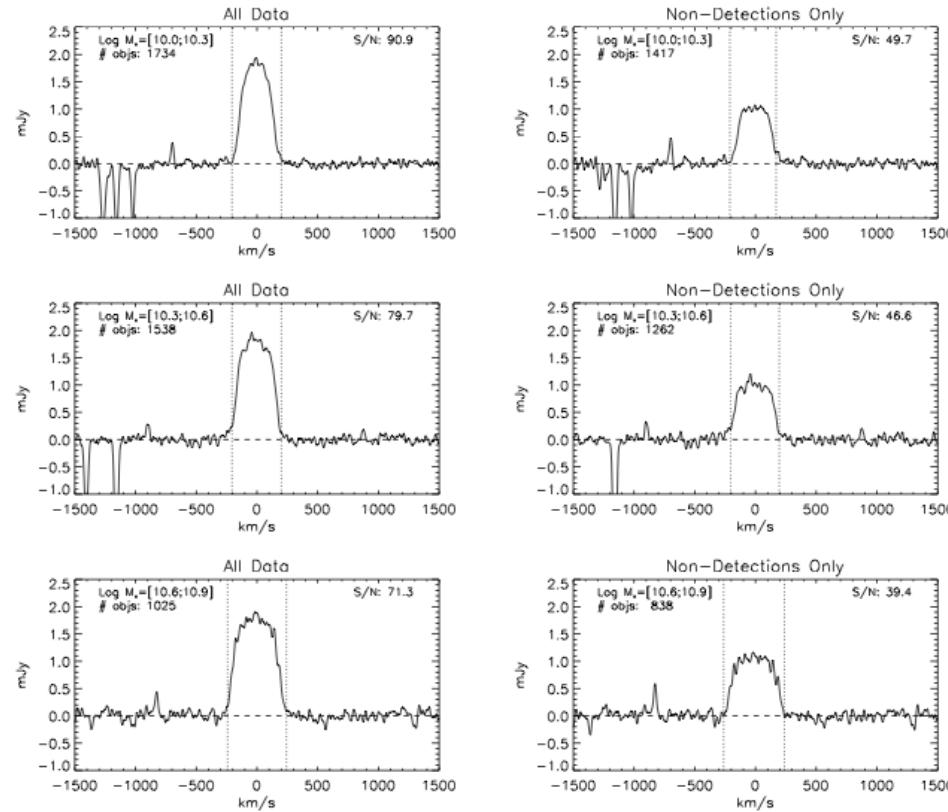


4MOST and future HI surveys

Obreschkow et al. 2009



4MOST and future HI surveys



Fabello et al. 2011, 2012 (see also Verheijen et al. 2007)

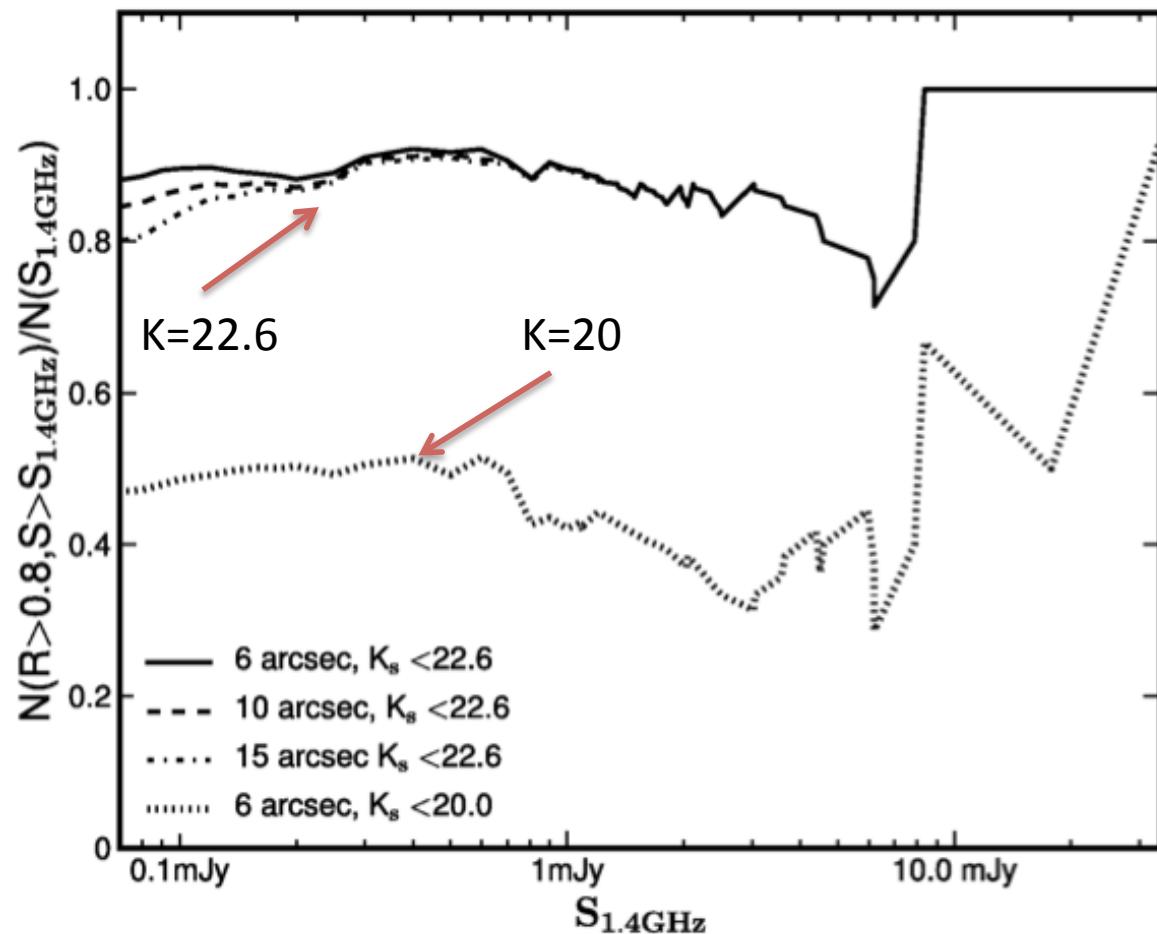
4MOST and future HI surveys

- Real synergy will come with cross-correlations
- BAO and RSDs traced by 4MOST & SKA
- But both will trace the underlying density field with different galaxies
- Independent tracers give more constraining power on cosmological models
- Intensity mapping can push this up to the Epoch of Reionization!

Summary

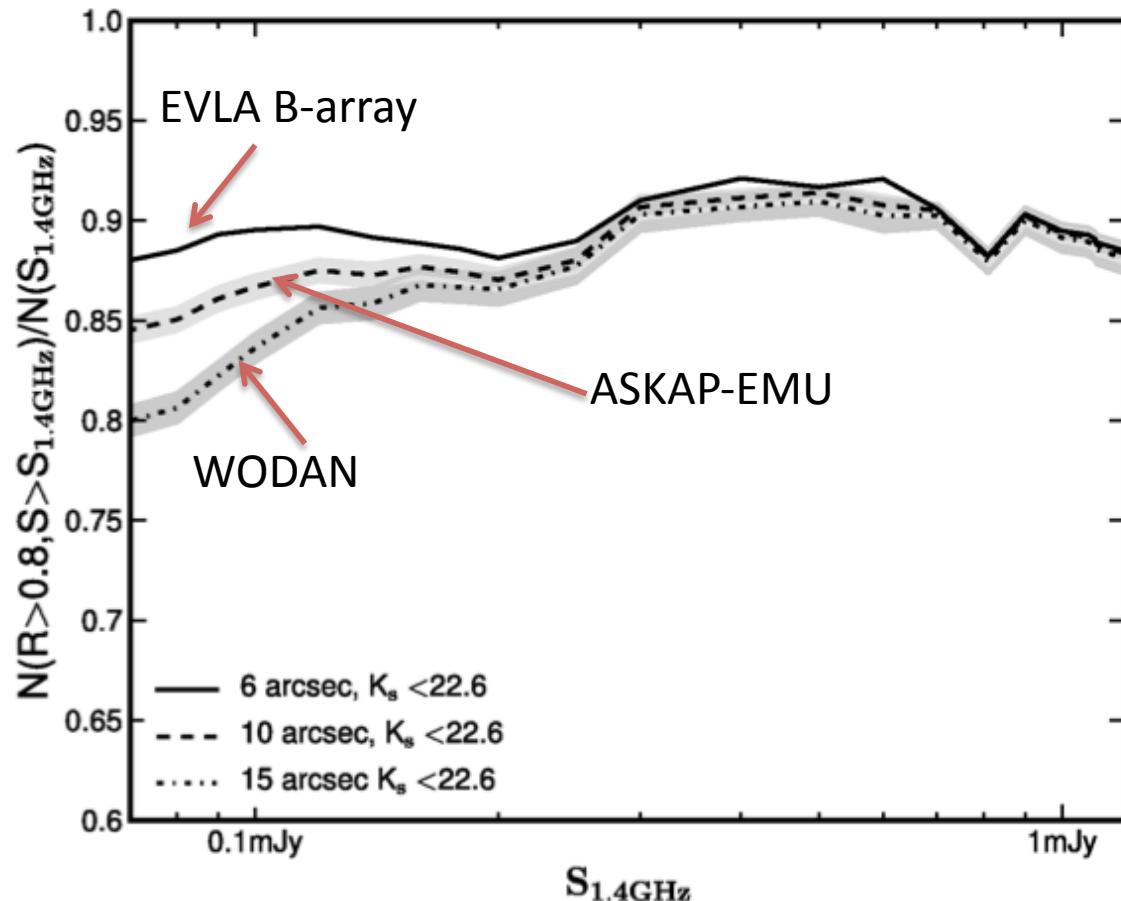
- Real synergies between 4MOST and radio continuum surveys
 - ✓ Emission line object selection enables highly efficient redshift survey
 - ✓ By-product could find $z > 6$ radio sources for EoR studies
 - ✓ Smaller deeper survey to address galaxy formation and evolution
 - ✓ High efficiency redshift survey could also be utilized for RSD over smaller area
- Real synergies between 4MOST and HI surveys
 - ✓ Stacking of HI on optical position requires accurate z 's. Can trace the depletion of HI in galaxies as function of type and cosmic time
 - ✓ Cross-correlations will be powerful tool for cosmology
- Other science includes the evolution of magnetic fields which would benefit from accurate redshifts and velocity dispersion of foreground galaxies and clusters which cause Faraday rotation

The likelihood ratio on the new radio surveys



Depth of optical/nearIR data
also crucial for radio source
identification

The likelihood ratio on the new radio surveys



- Resolution does matter in continuum radio surveys for cross-matching
- 85% of radio sources accurate to 1arcsec (enough for fibre positioning)