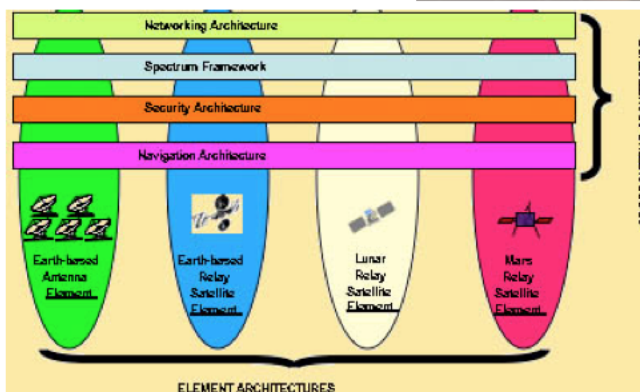
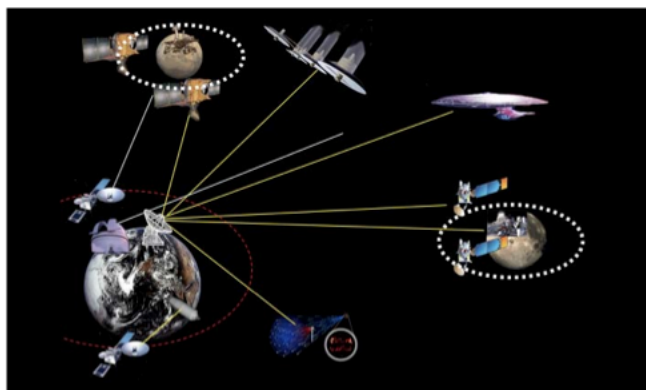
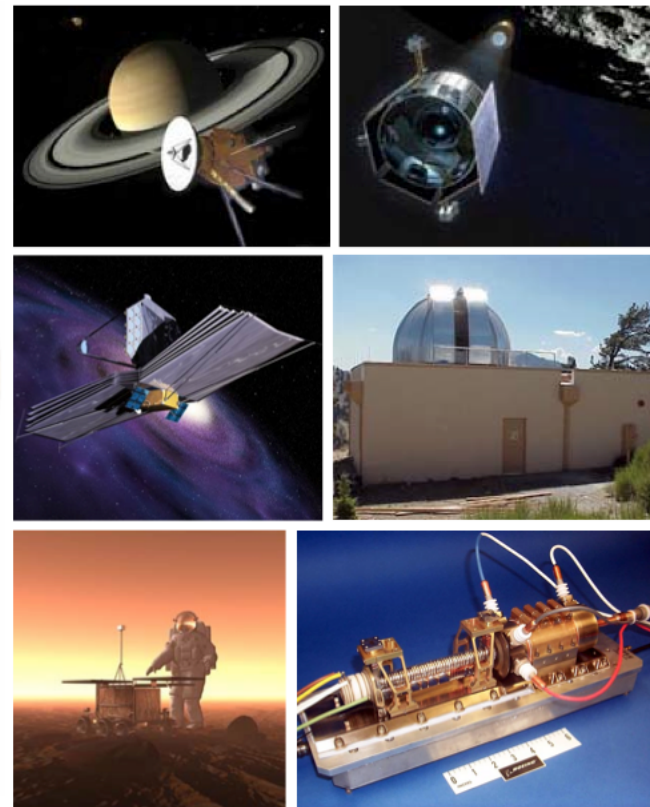


Past and Planned Radio Surveys A Census

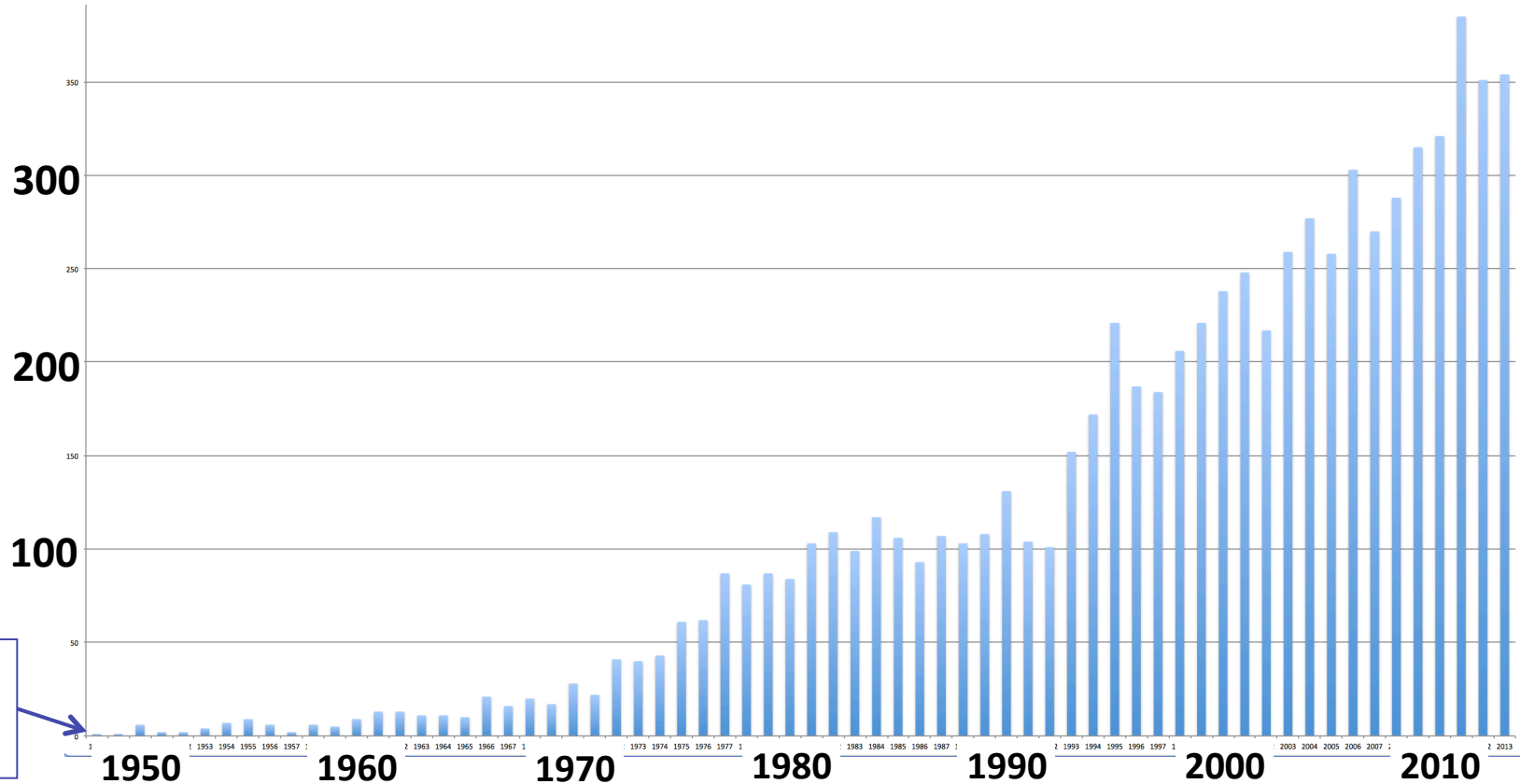
Joseph Lazio
Interplanetary Network Directorate
Jet Propulsion Laboratory, California Institute of
Technology





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California Institute of Technology

Surveys of the Sky at Radio Wavelengths

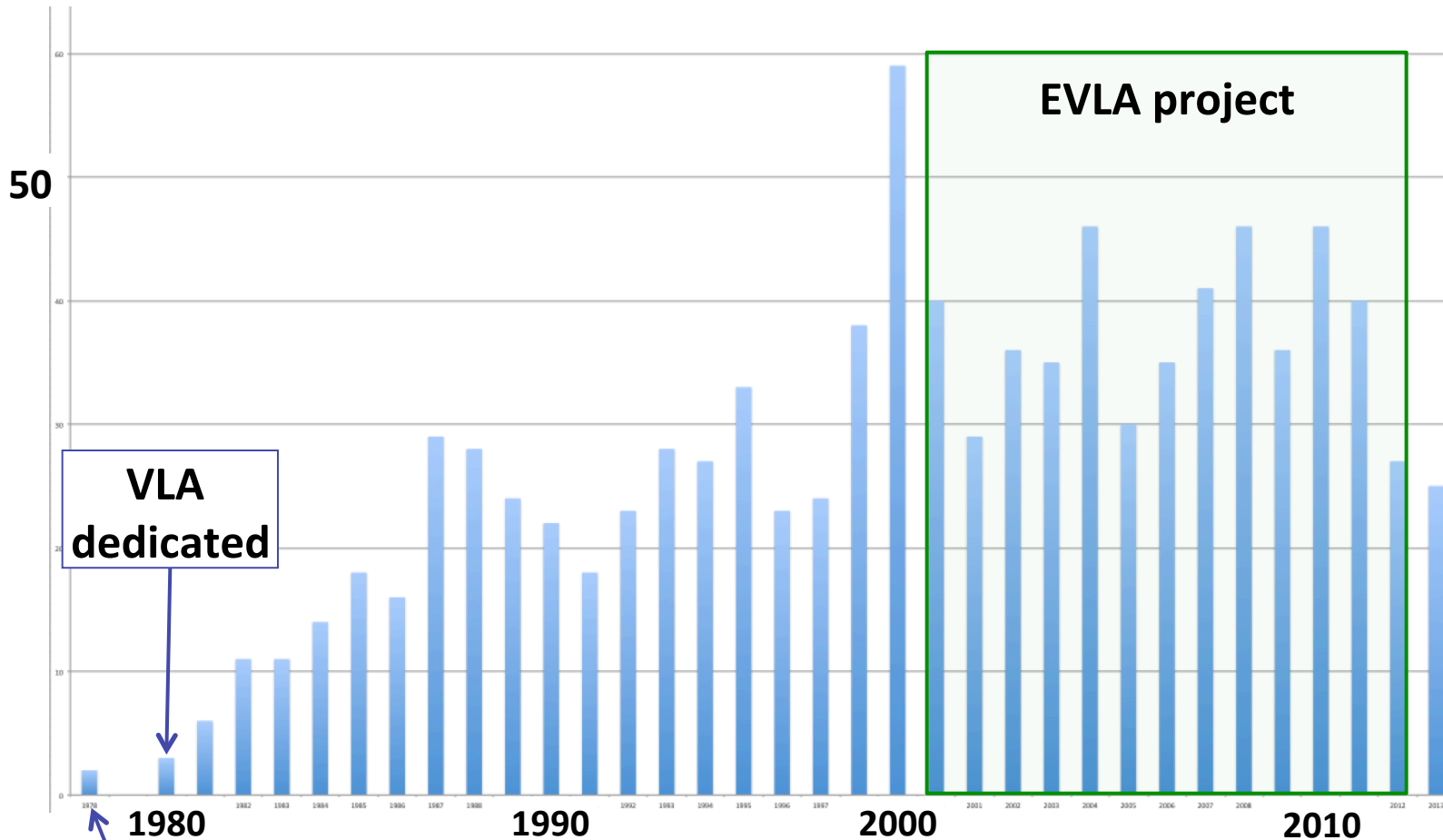


- ADS: 7548 refereed papers with “radio” and “survey” in abstract
- Surveys have been part of the field essentially since the radio window on the Universe was opened



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Surveys with the Very Large Array



Owen &
Gibson
(1978)

- ADS: 1224 surveys, or 18% of the total radio surveys
- Surveys started even before the VLA was dedicated



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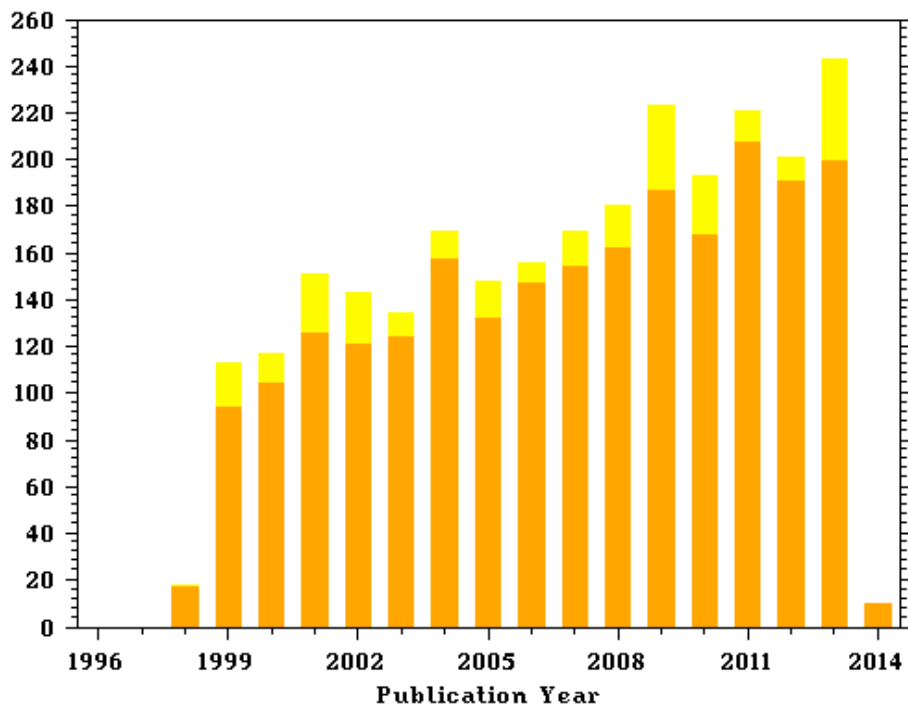
Surveys of the Sky at Radio Wavelengths



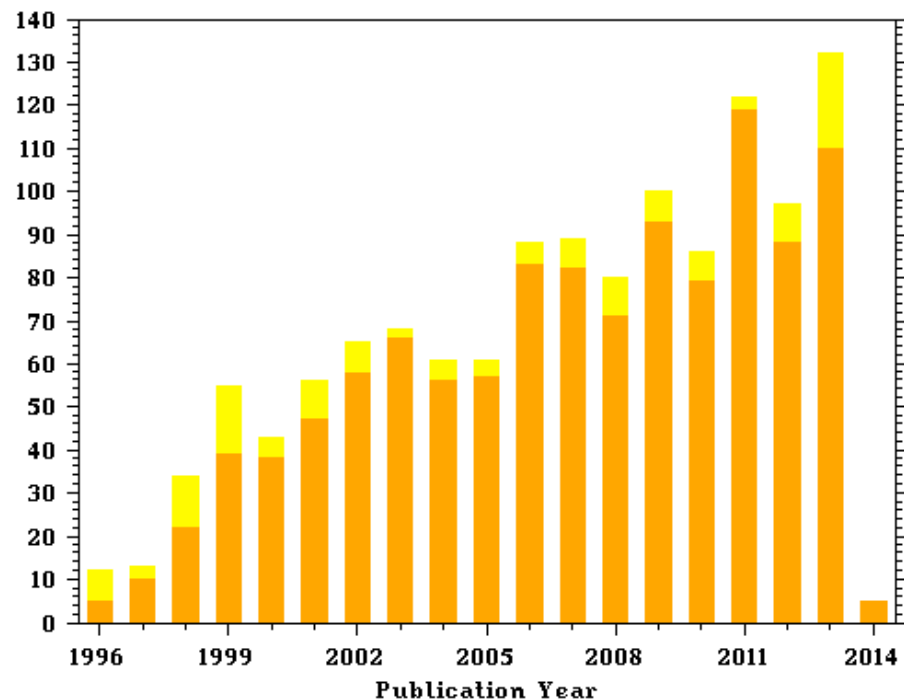
NVSS: 2580+ citations

FIRST: 1260+ citations

Citations/Publication Year for 1998AJ....115.1693C



Citations/Publication Year for 1995ApJ...450..559B



Survey relevance can be decade or longer



Survey Approaches



Science-driven

Find all objects with certain characteristics or obtain sufficient number of objects to constrain a quantity or process

- “determine the radio luminosity function of a class of sources to a limiting power”
- “constrain cosmological parameters via weak lensing distortions of background sources”
- “survey a sufficient area to a sufficient depth to detect the emission from a required number of objects at redshift z ”
- “find 95% of the radio pulsars in the Milky Way Galaxy beamed toward the Earth”

Capability-driven

Exploit new telescope/
instrument

- Frequency / wavelength / energy
- Polarization
- Sensitivity
- Solid angle
 - Angular Resolution
 - Field of View
- Time



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Science-Driven Surveys



Extragalactic Astronomy

- Tends to favor $\sim 100 \text{ deg}^2$ survey area
- No requirement for high angular resolution
 - Avoid resolving out galaxies
 - Few arcseconds adequate

Cosmology

- Appears to be the primary (sole?) driver for all-hemisphere surveys
- Cosmic magnification and/or weak lensing survey in the radio could be quite powerful
 - PSF much better known/controlled, far fewer systematics
 - Requires relatively high angular resolution (sub-arcsecond)

+ Milky Way Galaxy/Local Group?



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Radio Wavelength Surveys



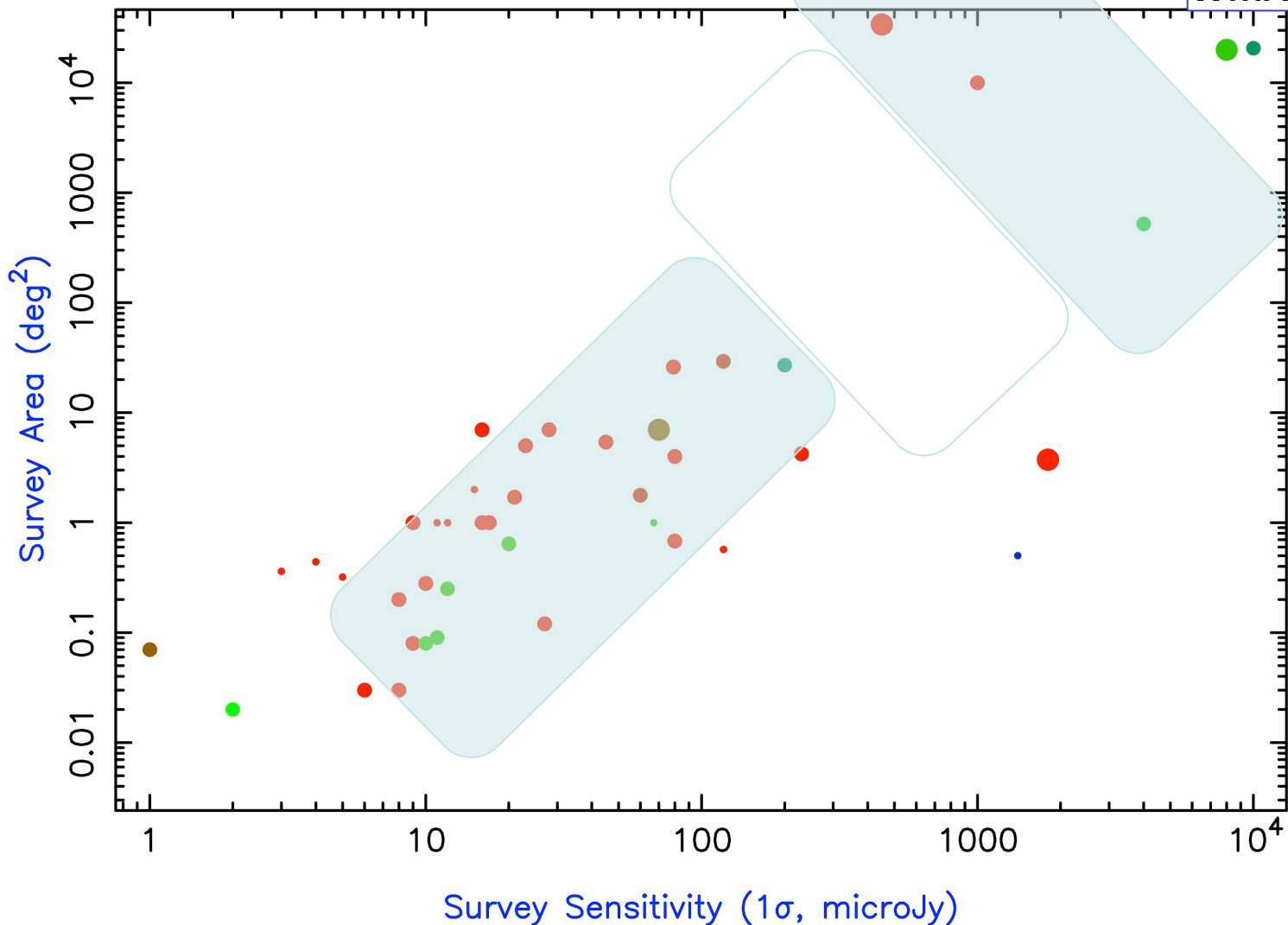
WMAP

Symbol size =
angular
resolution

- $< 3''$
- $3'' - 30''$
- $> 30''$

Color scale =
frequency

- 1 GHz
- 8 GHz
- 50 GHz



Almost certainly incomplete census!

Norris et al.



Notable Planned Surveys



- **Evolutionary Map of the Universe (EMU)**

- ASKAP (Australia)
- 1.4 GHz
- 10" resolution
- 10 $\mu\text{Jy}/\text{beam}$
- $\delta < +30^\circ$

- **MeerKAT International Giga-Hertz Tiered Extragalactic Exploration (MIGHTEE) Survey**

- MeerKAT (South Africa)
- 1.4 GHz
- 8.5" resolution
- 1000 deg^2
- 5 $\mu\text{Jy}/\text{beam}$

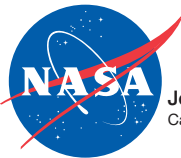
- **Westerbork Observations of the Deep APERTIF Northern-Sky (WODON)**

- WSRT/APERTIF (The Netherlands)
- 1.4 GHz
- 15" resolution
- 10 $\mu\text{Jy}/\text{beam}$
- $\delta > +30^\circ$

- **WALLABY: Widefield ASKAP L-Band Legacy All-Sky Blind Survey**

- ASKAP (Australia)
- 1.1–1.4 GHz
- 30" angular resolution
- 10 $\mu\text{Jy}/\text{beam}$
- 3.9 km/s velocity resolution

+ pulsar surveys, absorption line surveys, ...



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Radio Wavelength Surveys

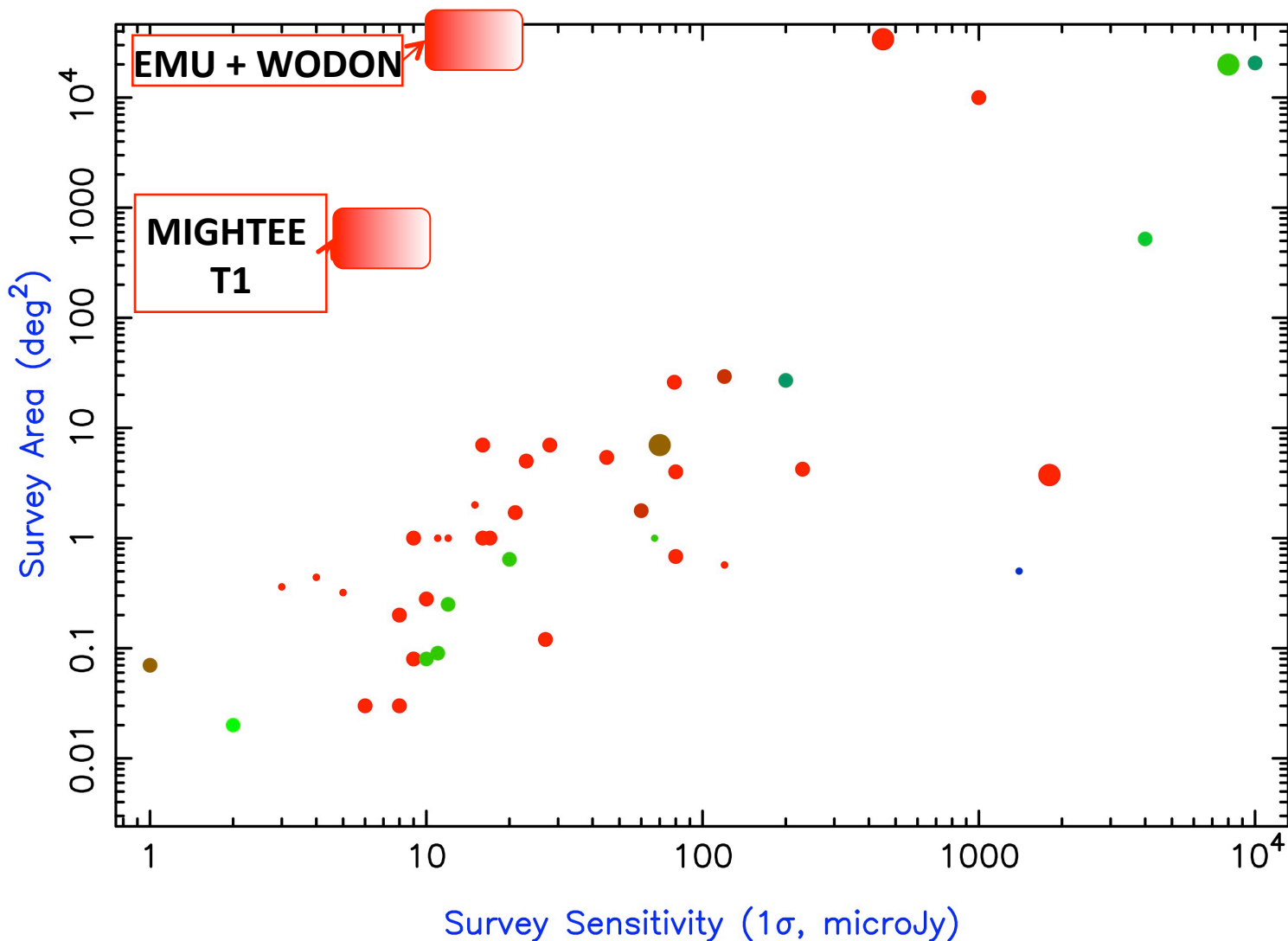


Symbol size =
angular
resolution

- $< 3''$
- $3'' - 30''$
- $> 30''$

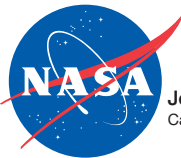
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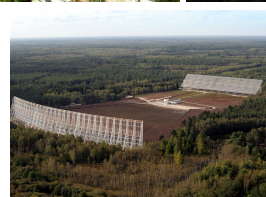
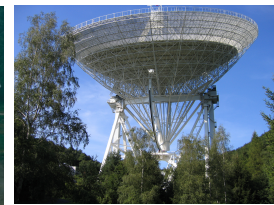
Radio Astronomy Landscape (c. 2015)



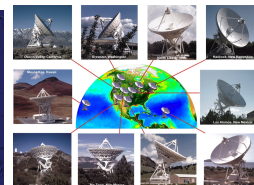
Meter and decameter
wavelength
interferometers



Decimeter and centimeter wavelength
single dishes



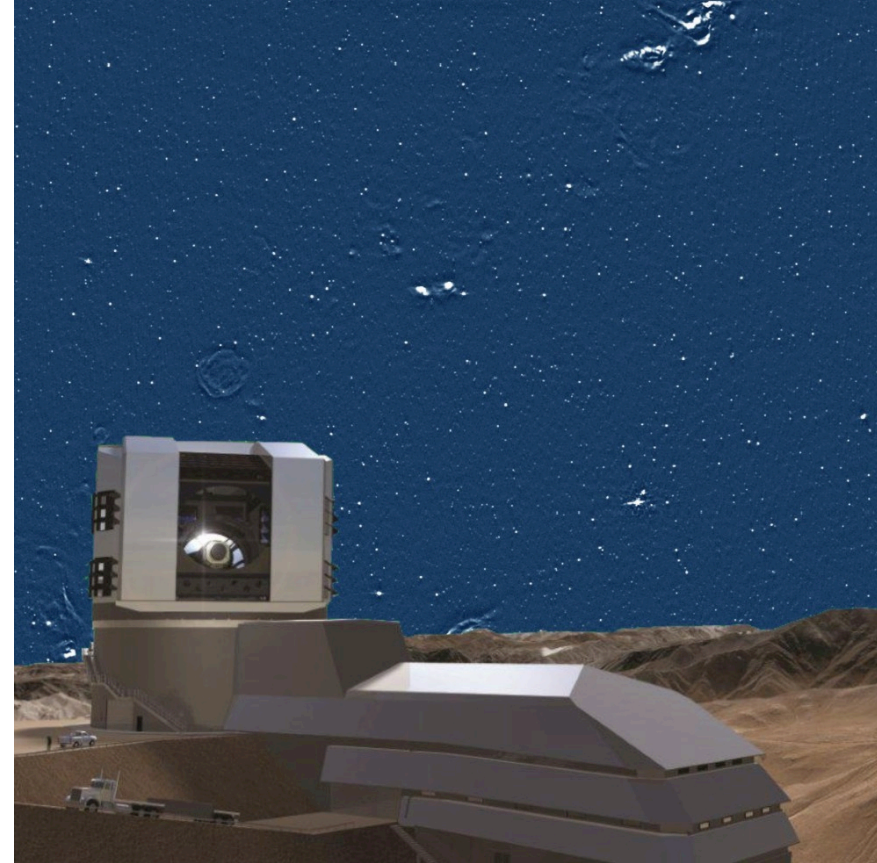
Decimeter and centimeter
wavelength
interferometers



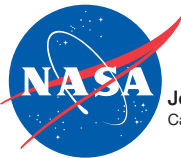
$\nu < \sim 50$ GHz

Radio Astronomy in the LSST Era

- **Community workshop**
Charlottesville, VA; May 6--8
- **Themes**
 - Time Domain
 - Sky Surveys
- **White paper *in press* at *PASP***
Appears on astro-ph on
Monday
- **Presentations available
online**



<http://science.nrao.edu/science/event/RALSST2013>

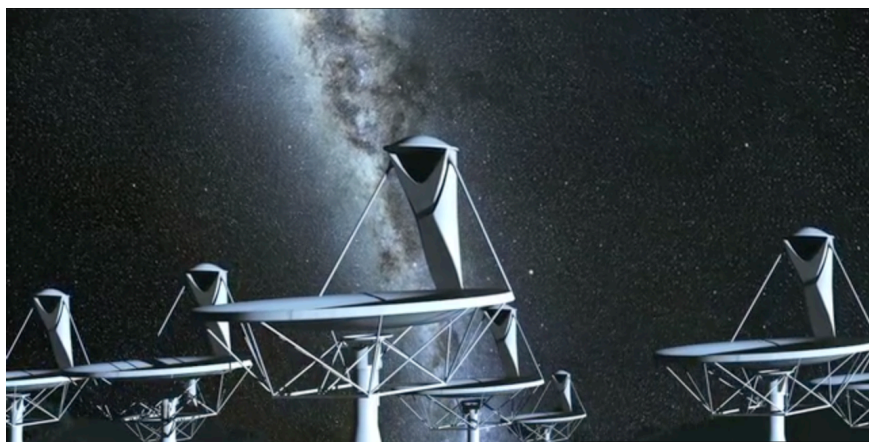


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Context for VLASS



Jansky Very Large Array
(~ 1 – 50 GHz)



SKA1
(<~ 1 GHz?)



ALMA
(> 50 GHz)



Summary



- Surveys have been an integral part of radio observations
- Well-designed and executed survey can have considerable “staying power”
- Current generation of surveys have explored parts of traditional “wedding cake” (in continuum)
 - All-sky, 1.4 GHz ~ 1 mJy
 - Deep Fields, mostly 1.4 GHz ~ 10 μ Jy
- VLASS
 - Explore intermediate tier? (~ 30 deg²)
 - Explore 3 to 10 GHz sky?
 - Polarization?
 - Time-domain?