



# ASKAP in the SKA era

CSIRO astronomy and space science (CASS)

[www.csiro.au](http://www.csiro.au)

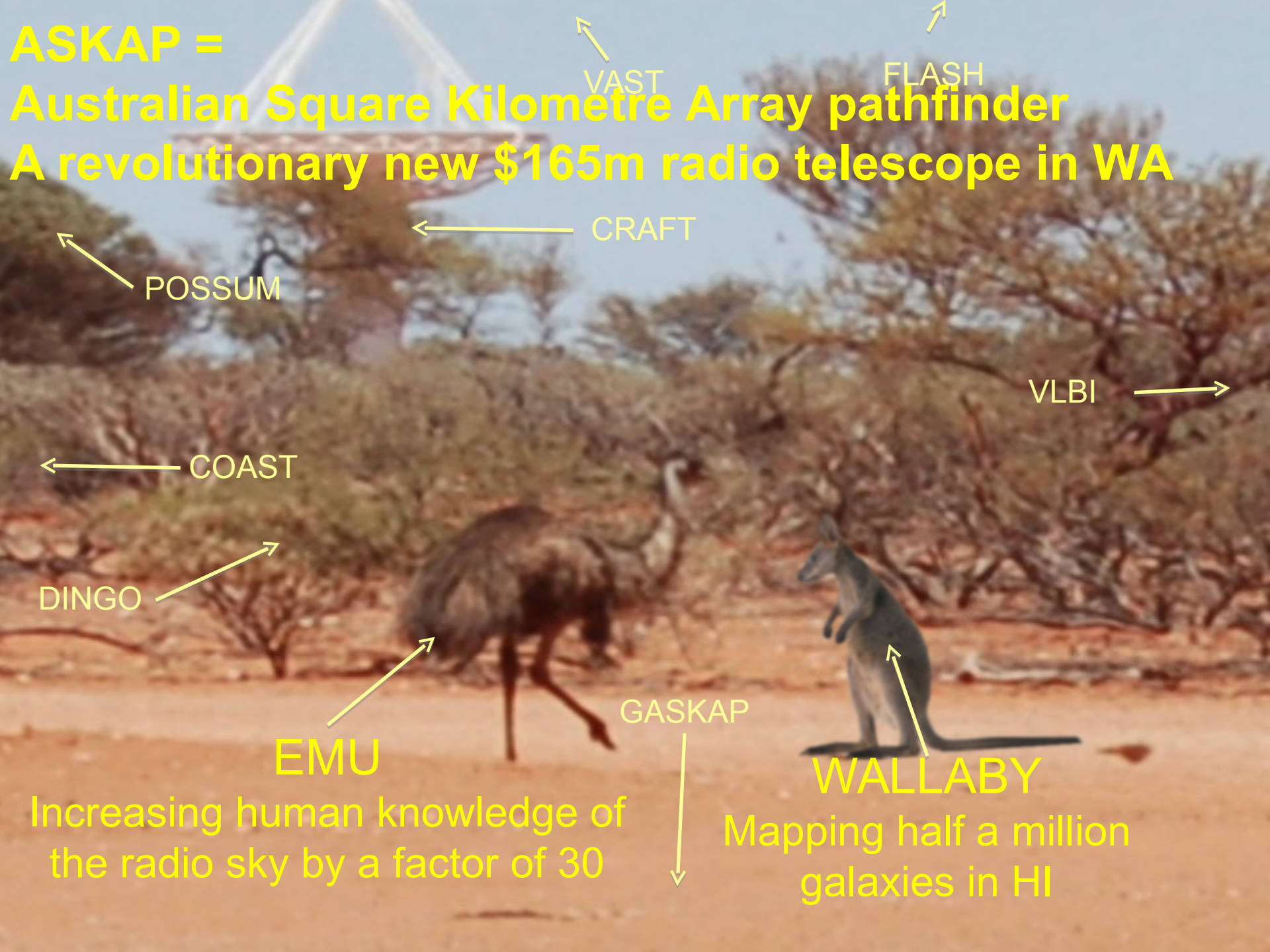


**Ray Norris, CSIRO Astronomy & Space Science**

# Overview

- **ASKAP Overview**
- **ASKAP science in SKA era**

# ASKAP = Australian Square Kilometre Array pathfinder A revolutionary new \$165m radio telescope in WA



VAST

FLASH

CRAFT

POSSUM

VLBI

COAST

DINGO

EMU

GASKAP

WALLABY

Increasing human knowledge of  
the radio sky by a factor of 30

Mapping half a million  
galaxies in HI



**Total bandwidth = 2.1THz per antenna**



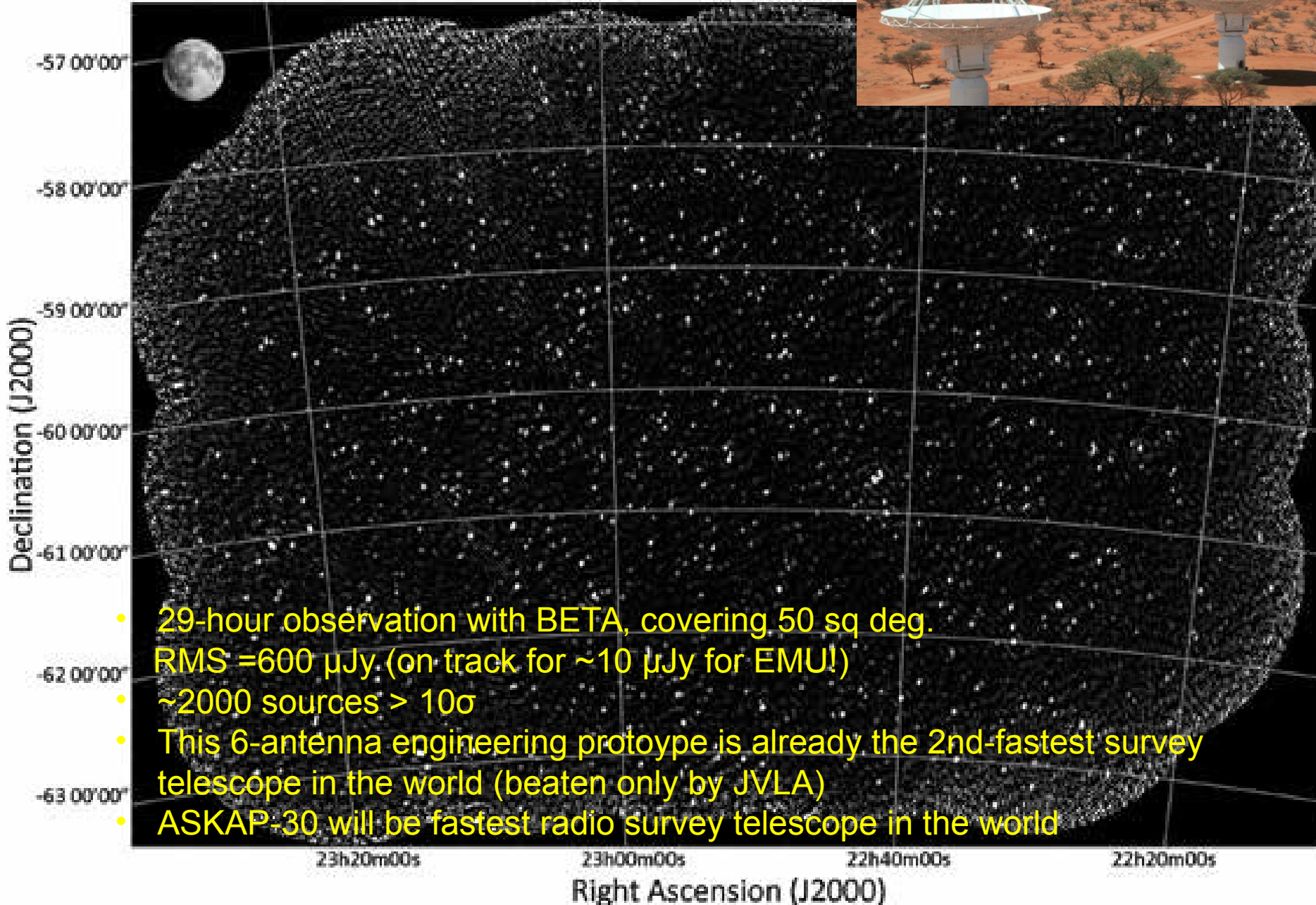
# Current ASKAP status

- All 36 antennas and infrastructure completed,
- Funding in place for 30 PAFs
- Engineering prototype array (“BETA”) currently operating with prototype PAFs on 6 antennas giving 9 beams
- Construction going amazingly well

## Planned schedule

- 12 MkII PAFS installed by ~Dec 2015
- Early 2016: “shared risk” ASKAP early science
- All PAFs installed by mid-2016
- 2017: Full EMU / WALLABY / other surveys start ???????

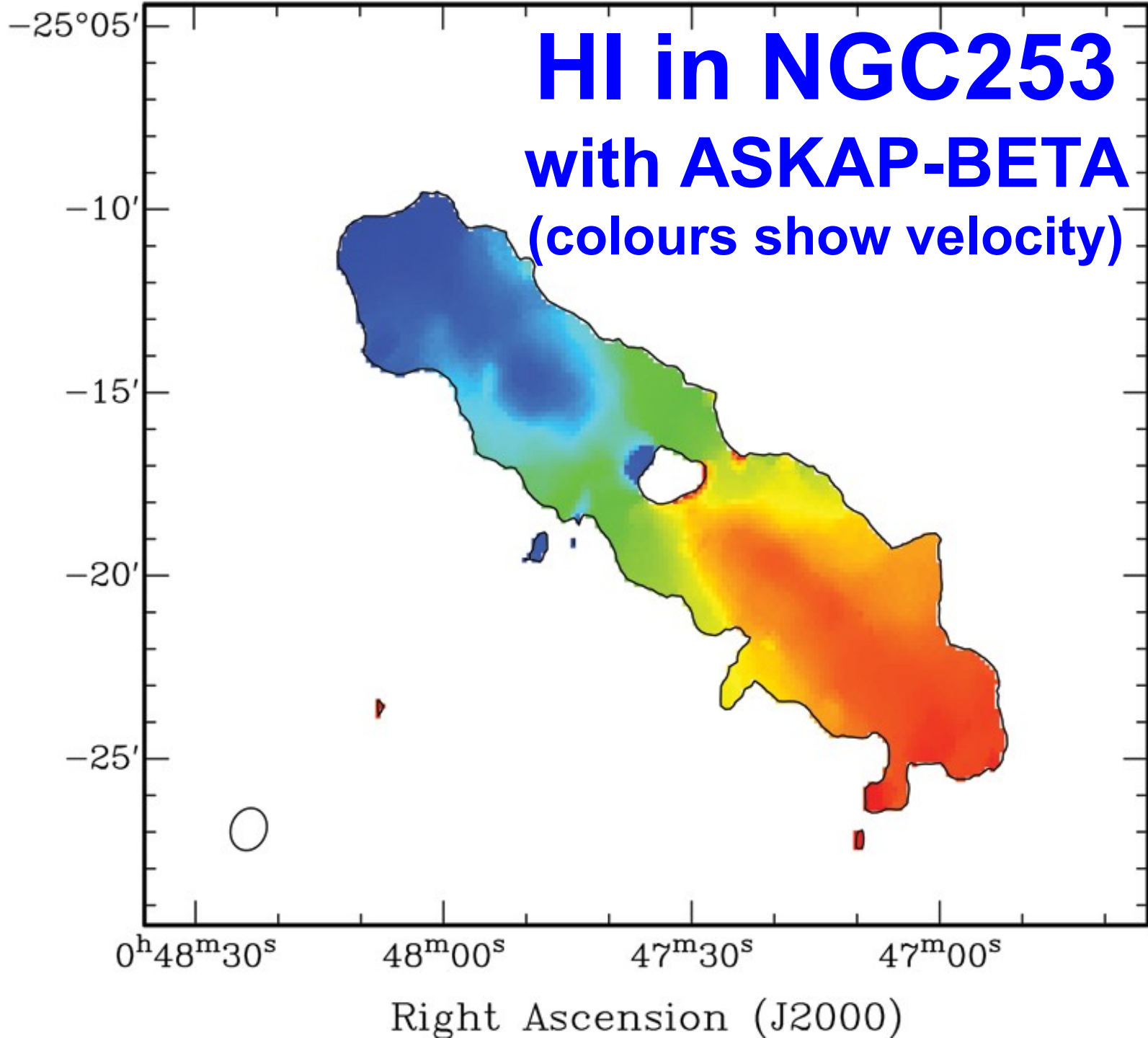
# PAFs work (even with only 6 antennas)!



- 29-hour observation with BETA, covering 50 sq deg.  
RMS = 600  $\mu$ Jy (on track for  $\sim$ 10  $\mu$ Jy for EMU!)
- $\sim$ 2000 sources  $>$   $10\sigma$
- This 6-antenna engineering prototype is already the 2nd-fastest survey telescope in the world (beaten only by JVLA)
- ASKAP-30 will be fastest radio survey telescope in the world

# HI in NGC253 with ASKAP-BETA (colours show velocity)

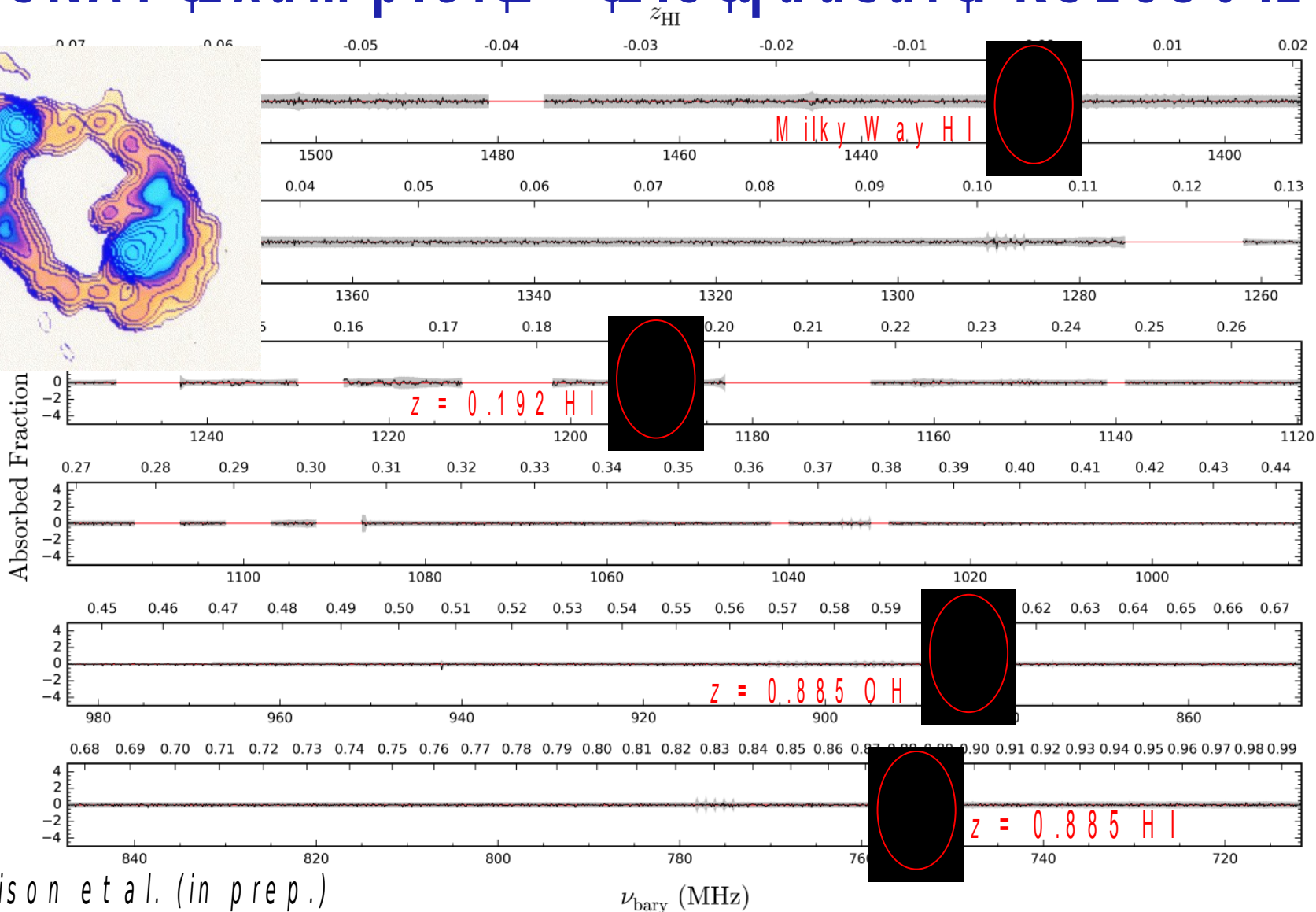
Declination (J2000)





# 700-1500 MHz spectrum of the Einstein Lens quasar

ASKAP Example:  $z = 2.5$  quasar PKS 1830-211



Allison et al. (in prep.)

$\nu_{\text{bary}}$  (MHz)

# ASKAP Science

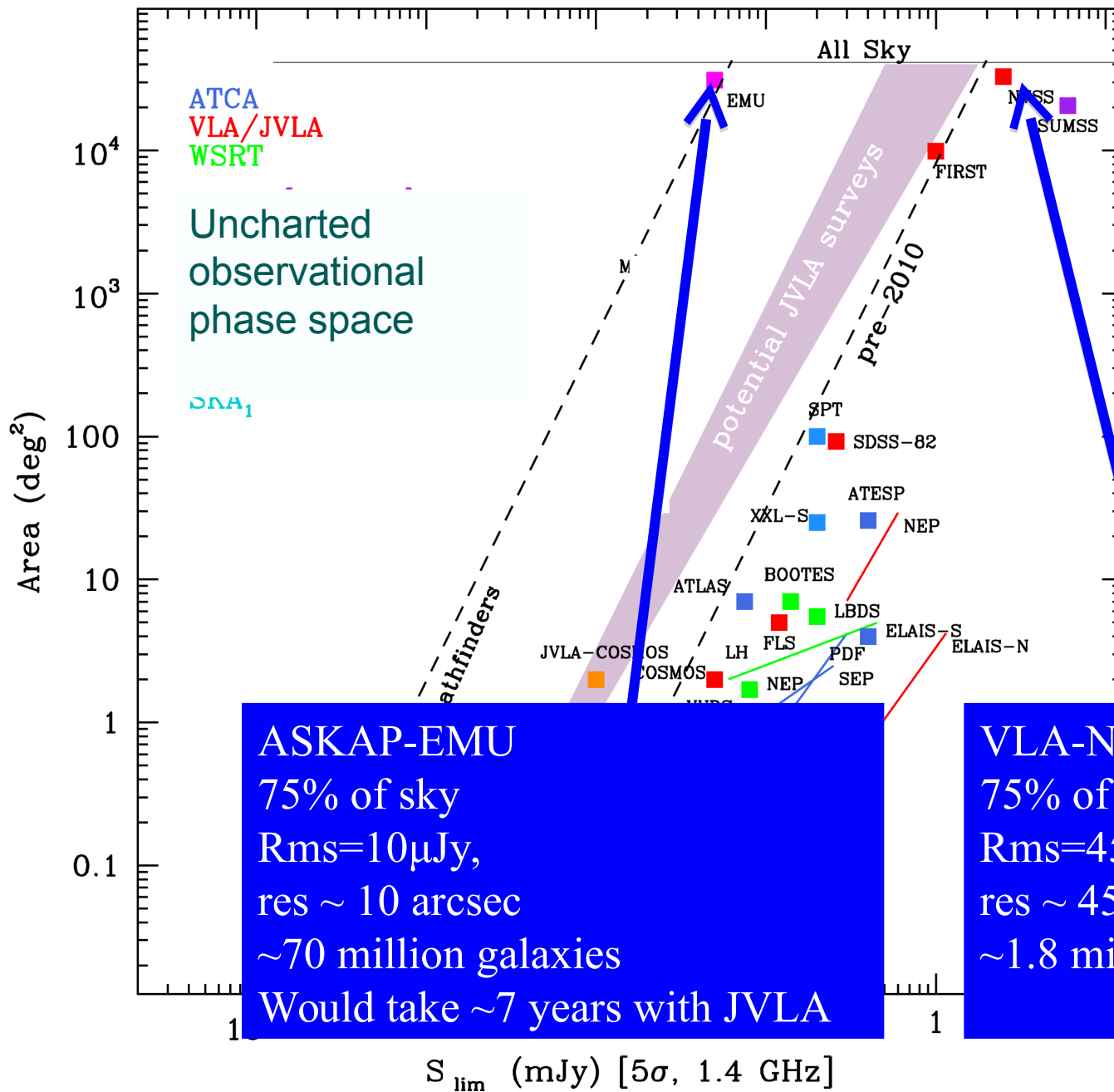
38 proposals submitted to ASKAP

2 selected as being highest priority

**See talks by  
Lister Staveley-Smith  
and Paolo Serra**

8 others supported at a lower priority

- EMU all-sky continuum (PI Norris)
- WALLABY all-sky HI (PI Koribalski & Staveley-Smith)
- COAST pulsars etc
- CRAFT fast variability
- DINGO deep HI
- FLASH HI absorption
- GASKAP Galactic
- POSSUM polarisation
- VAST slow variability
- VLBI

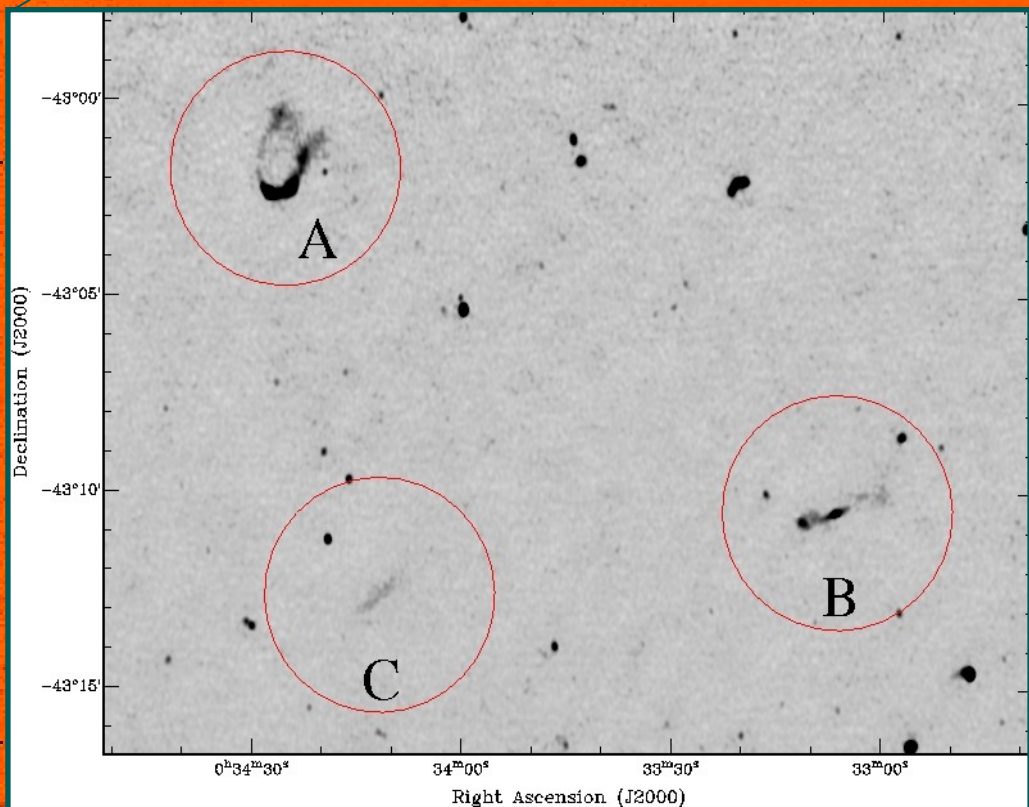


**ASKAP-EMU**  
 75% of sky  
 Rms=10 $\mu$ Jy,  
 res ~ 10 arcsec  
 ~70 million galaxies  
 Would take ~7 years with JVLA

**VLA-NVSS**  
 75% of sky  
 Rms=450 $\mu$ Jy,  
 res ~ 45 arcsec  
 ~1.8 million galaxies

Diagram courtesy of Isabella Prandoni

# The EMU Pathfinder: ATLAS=Australia Telescope Large Area Survey 7 sq deg to rms=15 $\mu$ Jy



# How does EMU differ from earlier radio surveys?

- **Scale** – increases the number of known radio sources by a factor of  $\sim 30$
- **About half the sources are star-forming galaxies**
  - 50  $\mu$ Jy equiv to  $R \sim 21.5$  for SF galaxy
- **Ambition – includes:**
  - Cross-identification with optical/IR catalogues
  - Ancillary data (redshifts etc)
  - Key science projects as an integral part of the project
- **Explicitly includes “discovering the unexpected”**

## ASKAP in the SKA era

- **SKA-MID has somewhat higher survey speed than ASKAP (but higher spatial resolution)**
- **Difficult to justify multi-year SKA-MID all-sky survey incrementally better than EMU/WALLABY**
- **SKA-MID is better suited to doing deeper surveys over a smaller area**
- **So EMU and WALLABY may remain the premier all-sky surveys in continuum and HI**
- **ASKAP complements SKA-MID and SKA-LOW**

## SKA-era options (with **NO** upgrades)

**After the current science survey projects (EMU, WALLABY, etc) are finished, ASKAP is still the worlds best survey radiotelescope, so what next?**

- **Continuum: survey the whole sky from 700-1800 MHz to measure spectral shape, rotation measures, etc.**

- Approach (but not reach) upper limit of SKA-LOW (350MHz) and MWA (300 MHz)

- Can go deeper than EMU at highest frequency

- **HI: integrate longer to go deeper**

## SKA-era options (with upgrades)

- Intimate relationship between ASKAP & SKA?
- Upgrade PAFs to double the sensitivity
- Extend baselines to increase continuum resolution:
  - Beat down confusion limit
  - Better optical ID's
  - Resolved images of millions of SF (small scale difference!)
- Extend frequency range to meet the 350 MHz of SKA-LOW?
- Wide-field VLBI to Parkes and ATCA?

**ATCA strategy  
workshop on 1 June**





# Conclusion

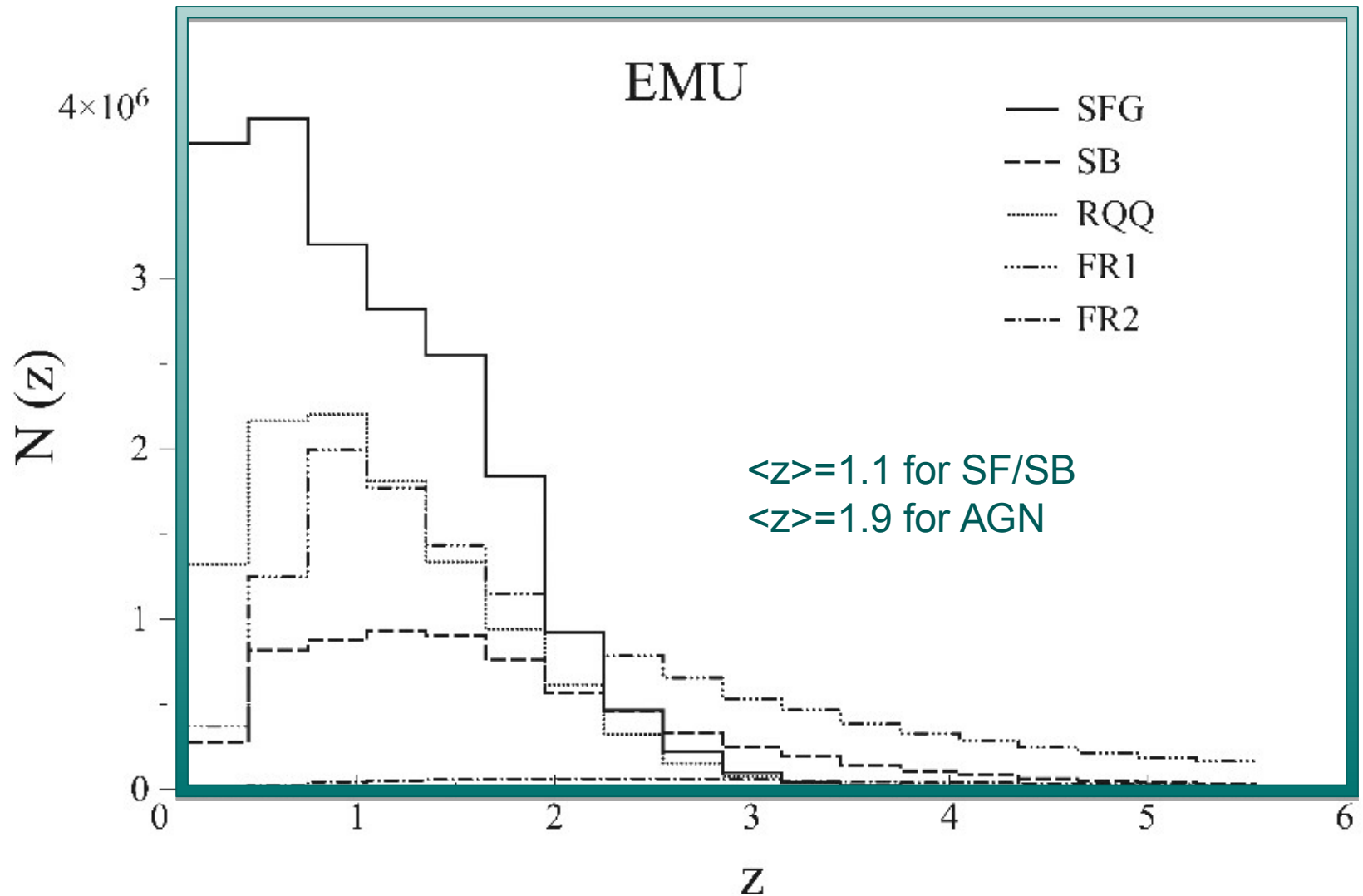
- **SKA rebaselining means that ASKAP's role will be even more significant in the SKA era**
  - E.g. all-sky radio continuum cosmology
- **Even with no upgrades, ASKAP will be a valuable complement to SKA-LOW and SKA-MID**
- **With upgrades, it effectively becomes a rebaselined SKA-SURVEY**
- **Possible (RPN, not CSIRO!) timeline:**
  - 2016-2019?: ASKAP completes current SSPs
  - 2020? on: upgraded ASKAP becomes part of SKA

**YOU ARE NOW LEAVING THE  
MURCHISON RADIO-ASTRONOMY  
OBSERVATORY**

**THANK YOU FOR BEING RADIO QUIET**



# Redshift distribution of EMU sources



Based on SKADS (Wilman et al; 2006, 2008)

<b>EMU Key Science Projects</b>	<b>Project Leader</b>
<b>EMU Value-Added Catalogue</b>	Nick Seymour
<b>Characterising the Radio Sky</b>	Ian Heywood
<b>EMU Cosmology</b>	David Parkinson
<b>Cosmic Web</b>	Shea Brown
<b>Clusters of Galaxies</b>	Melanie Johnston-Hollitt & Chiara Ferrari
<b>Cosmic star formation history</b>	Andrew Hopkins
<b>Radio-loud AGN</b>	Anna Kapinska
<b>Radio AGN in the EoR</b>	Jose Afonso
<b>Radio-quiet AGN</b>	Isabella Prandoni
<b>Local Universe</b>	Josh Marvil
<b>The Galactic Plane</b>	Roland Kothes
<b>SCORPIO: Radio Stars</b>	Grazia Umata
<b>WTF: Mining Data for the Unexpected</b>	Ray Norris

See <http://askap.powers.com/KeyProjects> for details