ICRAR

International Centre for Radio Astronomy Research

WALLABY

Lister Staveley-Smith

Curtin University

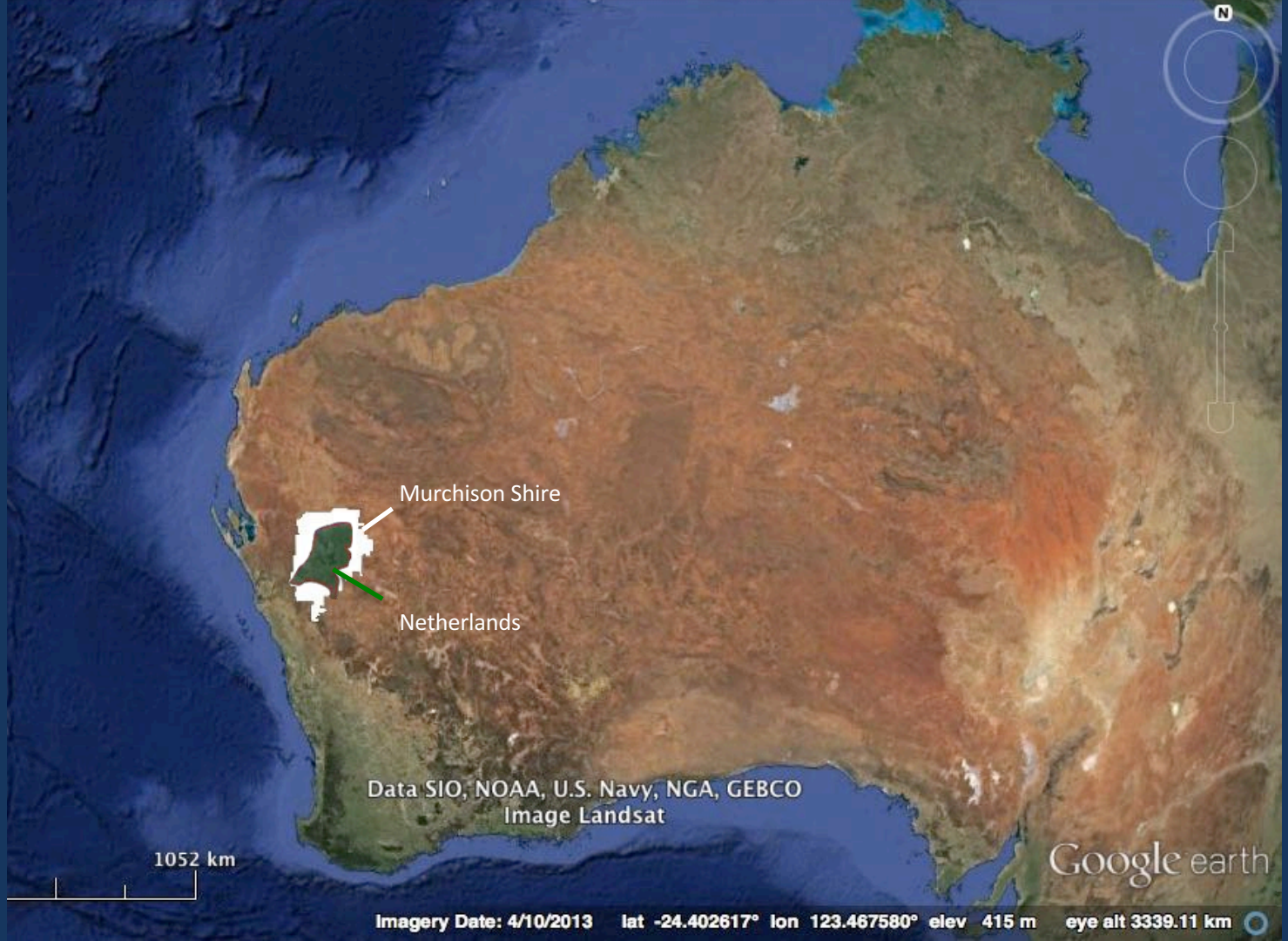
THE UNIVERSITY OF WESTERN AUSTRALIA

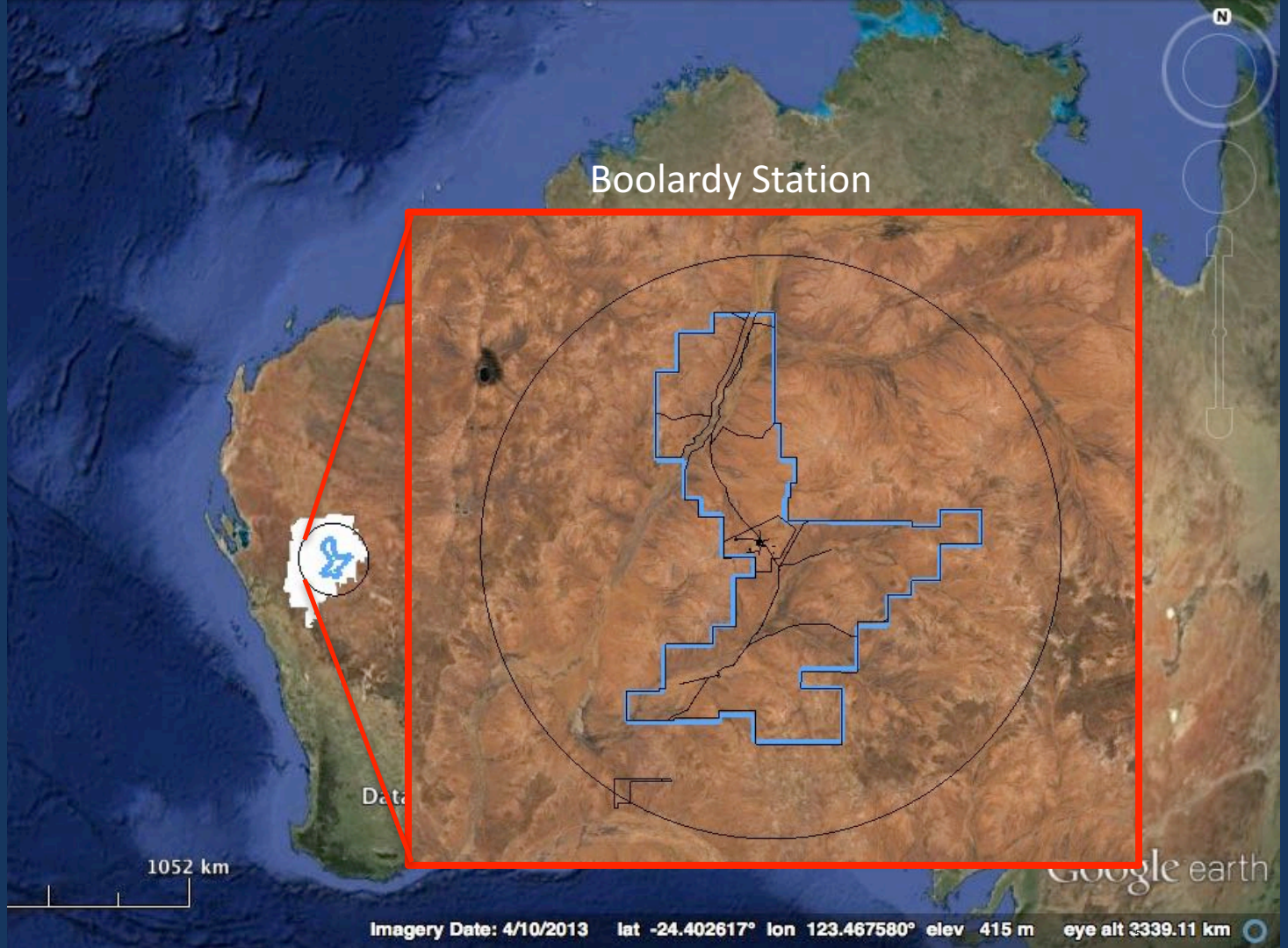
Government of Western Australia
Department of the Premier and Cabinet
Office of Science

Australian SKA Pathfinder (ASKAP)

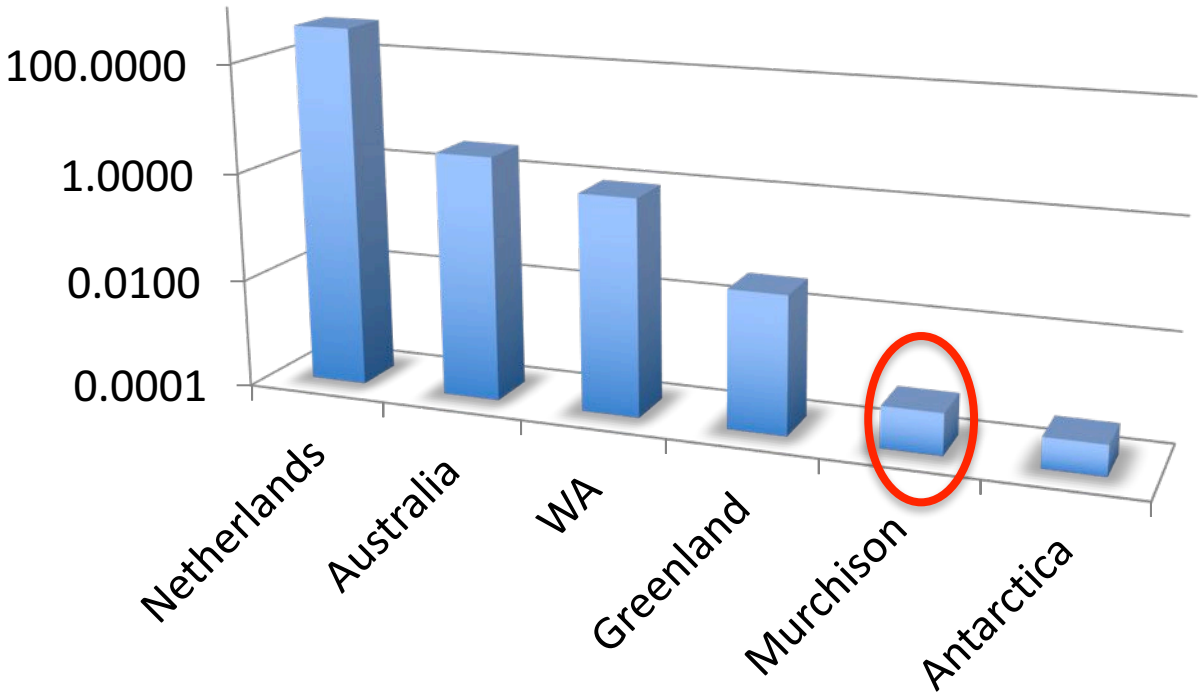
- Radio interferometer – 36 ×12-m dishes
- CSIRO Phased Array Feed (PAF) technology: 36 beams
- Frequency range 700 to 1800 MHz
- Instantaneous bandwidth 300 MHz
- Maximum baseline 6 km
- SKA precursor on a radio-quiet site
- Wallaby (HI) and EMU (continuum) are the two key survey science projects


N
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
1052 km
Google earth
Imagery Date: 4/10/2013 lat -24.402617° lon 123.467580° elev 415 m eye alt 3339.11 km


Murchison Shire
Netherlands
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
1052 km
Google earth
Imagery Date: 4/10/2013 lat -24.402617° lon 123.467580° elev 415 m eye alt 3339.11 km

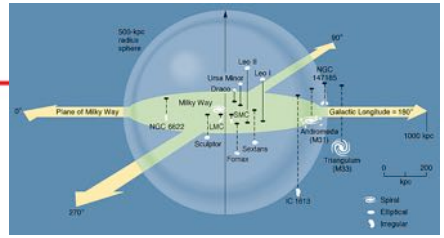

Boolardy Station
1052 km
Google earth
Imagery Date: 4/10/2013 lat -24.402617° lon 123.467580° elev 415 m eye alt 3339.11 km

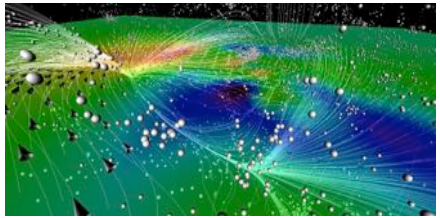
Population density (people/km^2)

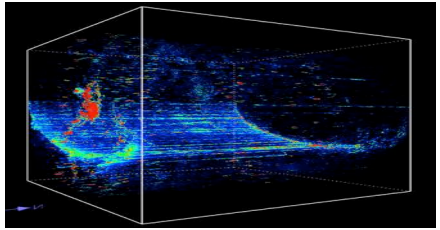


Wallaby goals

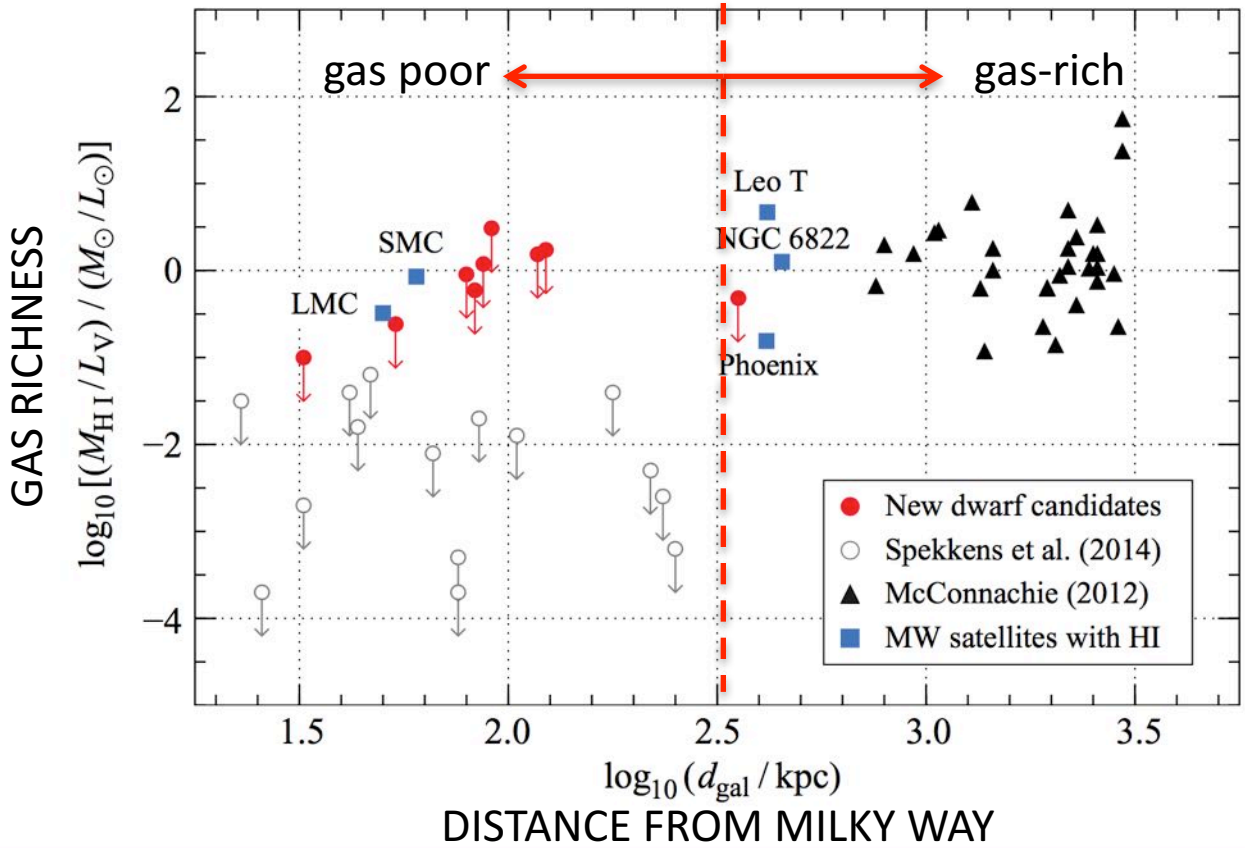
- **Local Group/Volume**
- Understanding Galaxies
- Cosmology
- Legacy







Environmental suppression



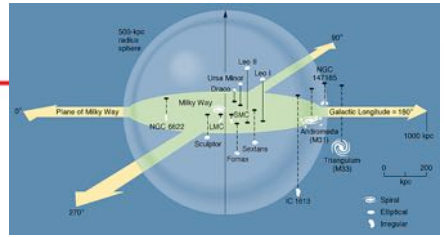
No transition (gas-bearing) galaxies within 300 kpc of Milky Way:

- stripping or ionization?

(Westmeier et al. 2015; Spekkens et al. 2014)

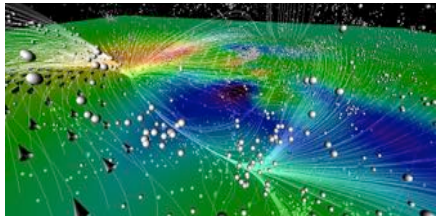
ASKAP Wallaby

- Local Group/Volume

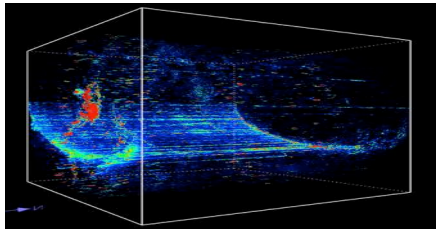


- **Understanding Galaxies**

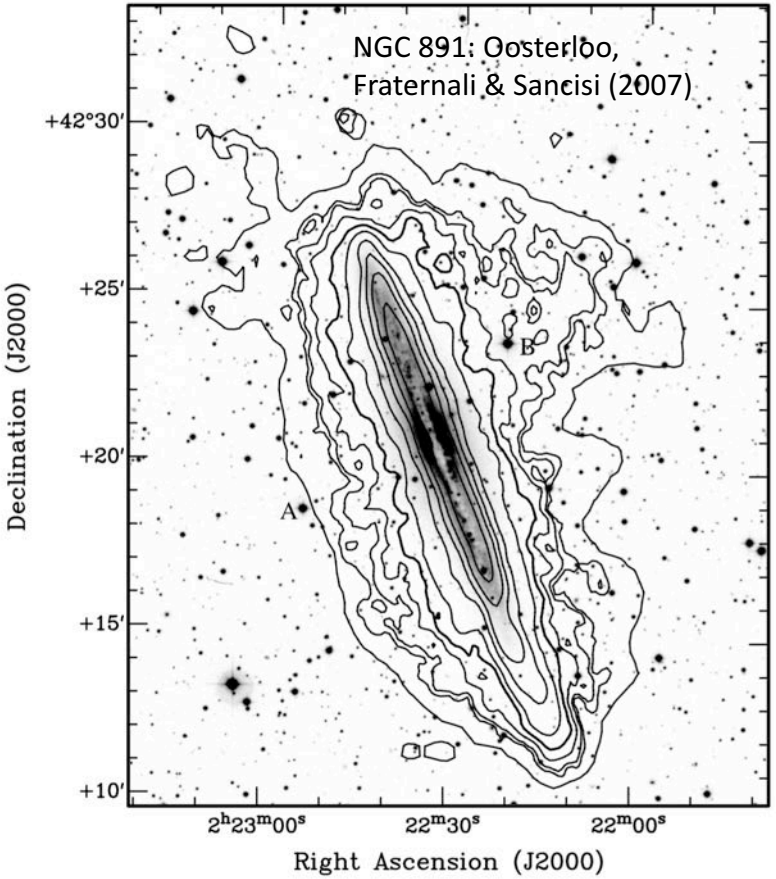
- Cosmology

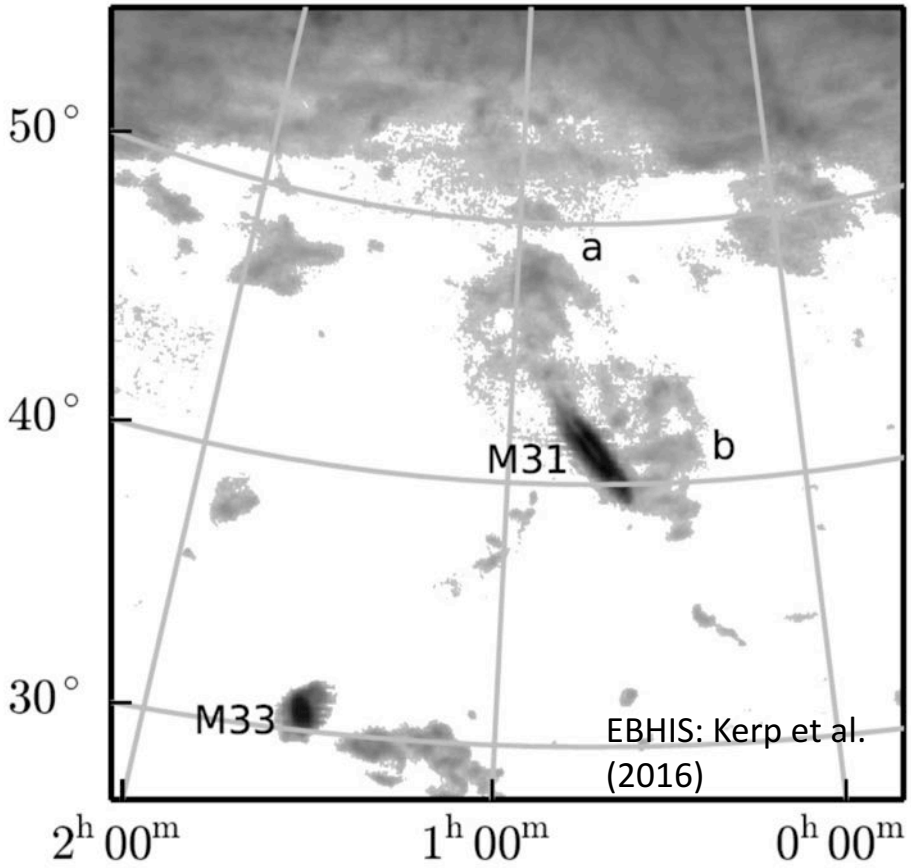


- Legacy



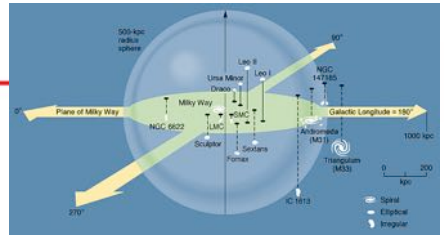
Gas accretion onto galaxies





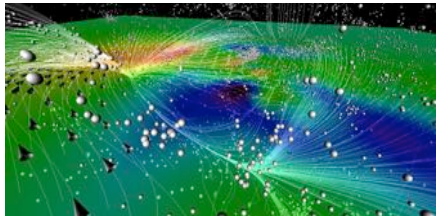
ASKAP Wallaby

- Local Group/Volume

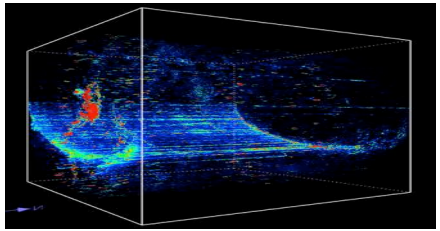


- Understanding Galaxies

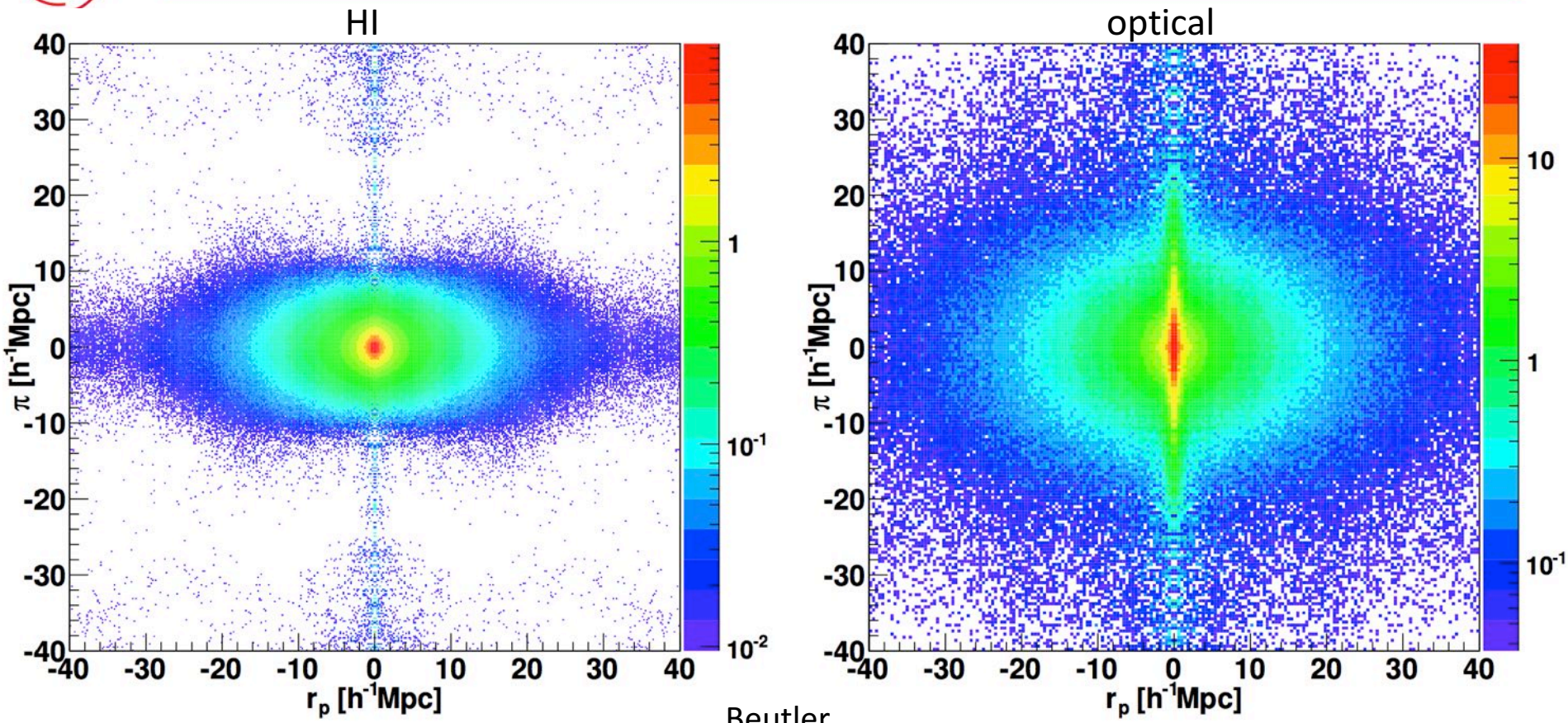
- **Cosmology**



- Legacy



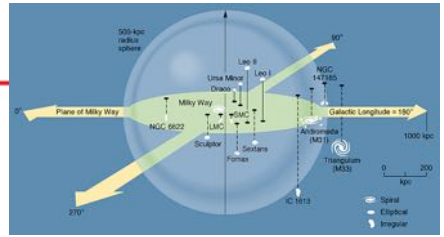
Redshift-space distortions



Beutler

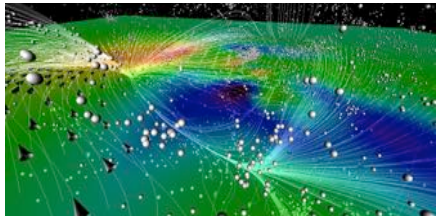
ASKAP Wallaby

- Local Group/Volume

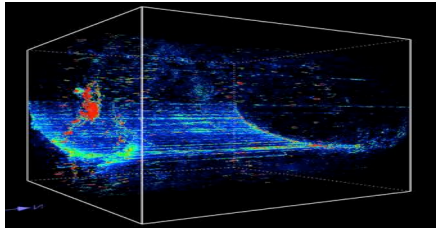


- Understanding Galaxies

- Cosmology



- **Legacy**



Comparison with other HI surveys

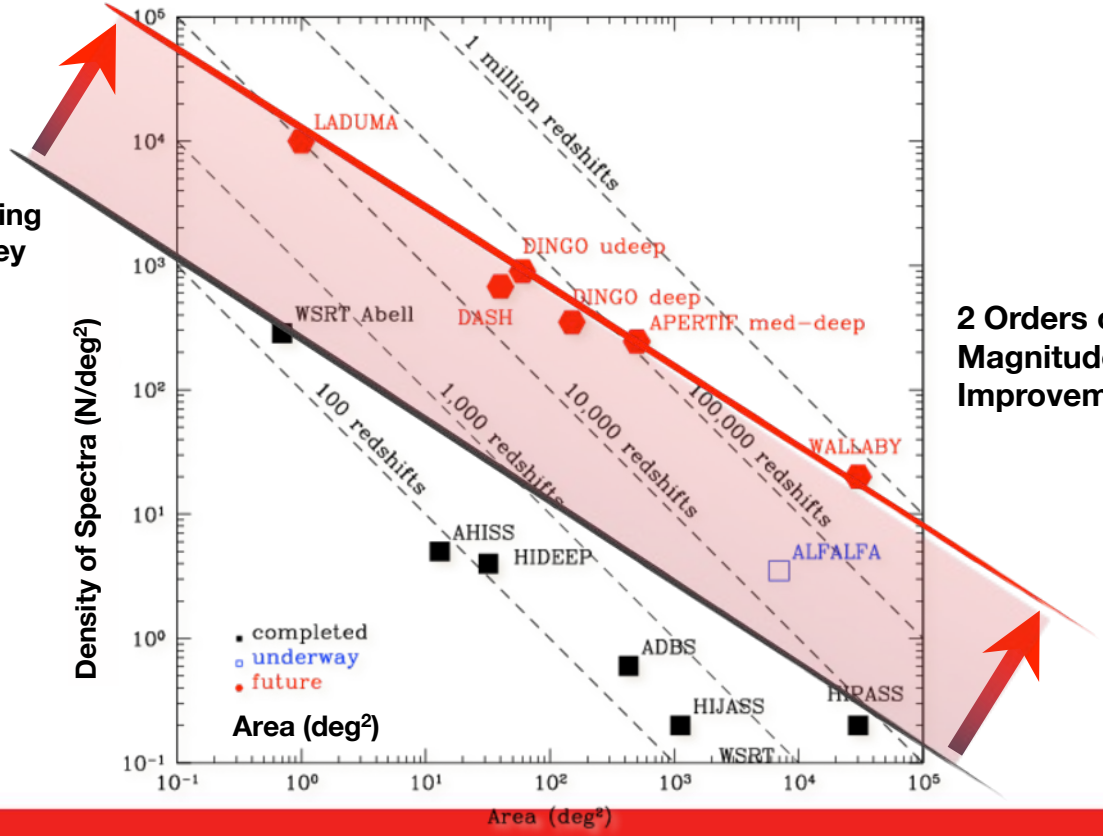
	WALLABY	HIPASS	ALFALFA
Area	3 π	2.8 π	0.7 π
Redshift	0 - 0.26	0 - 0.04	0 - 0.06
$rms_{20\ km/s}$	0.7 mJy/beam	13 mJy/beam	1.5 mJy/beam
Res	30 arcsec, 4 km/s	15 arcmin, 18 km/s	3.5 arcmin, 5 km/s
N_{det}	500,000	5,000	30,000

Wallaby = Widefield ASKAP L-band Legacy All-sky Blind surveY

PIs: B.S. Koribalski & L Staveley-Smith

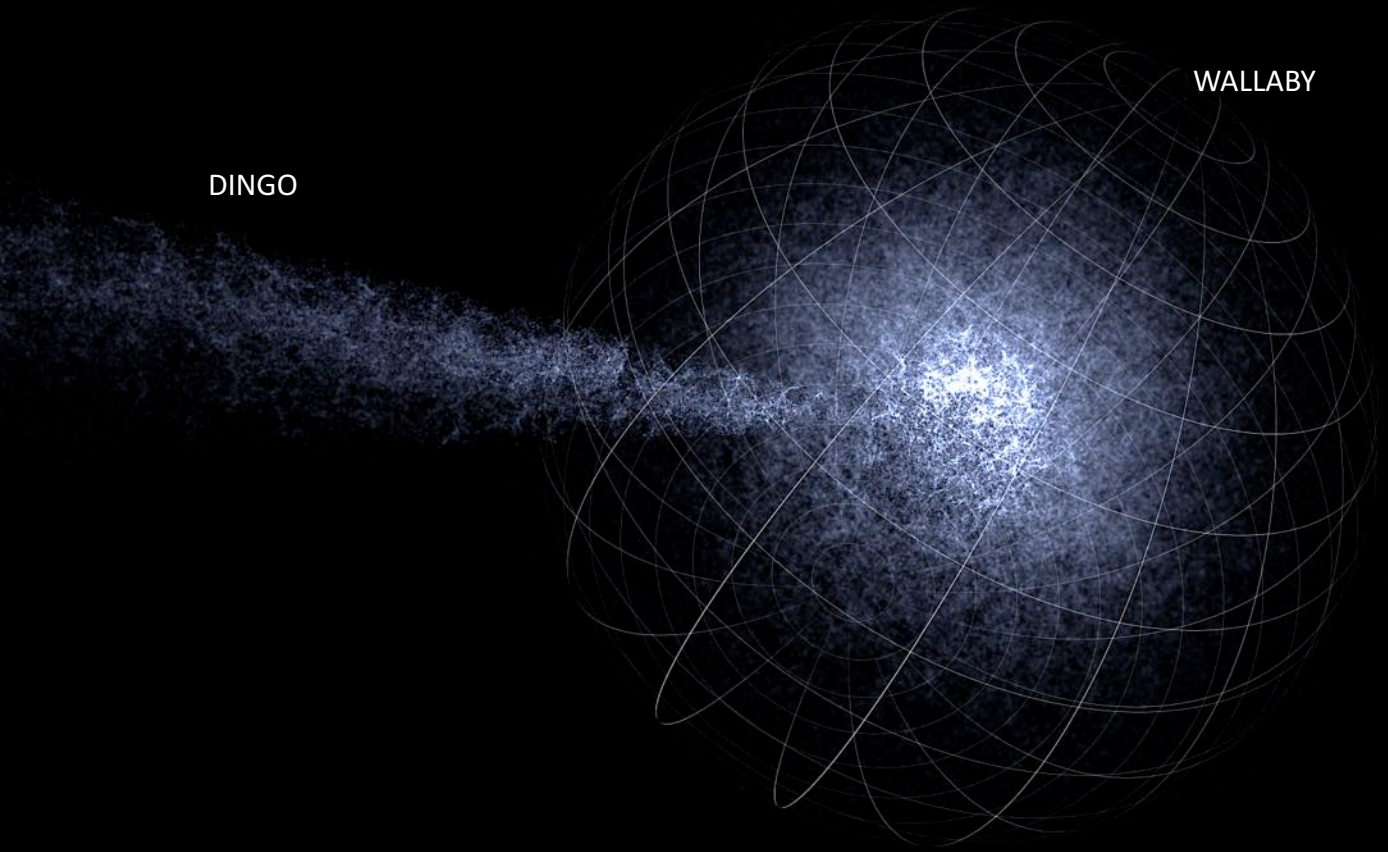
SKA pathfinder HI surveys:

Existing Survey Limit



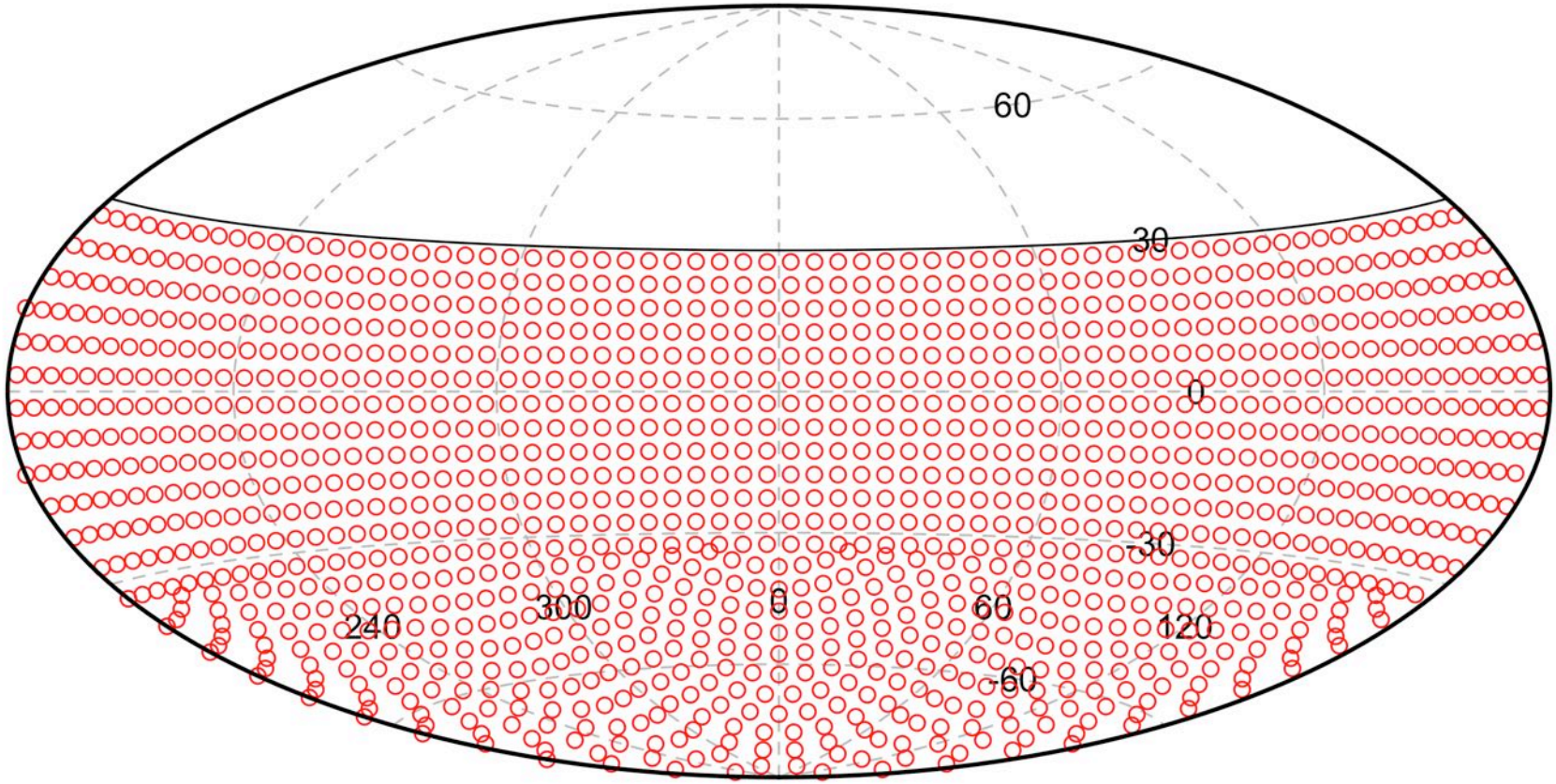
2 Orders of Magnitude Improvement

Meyer

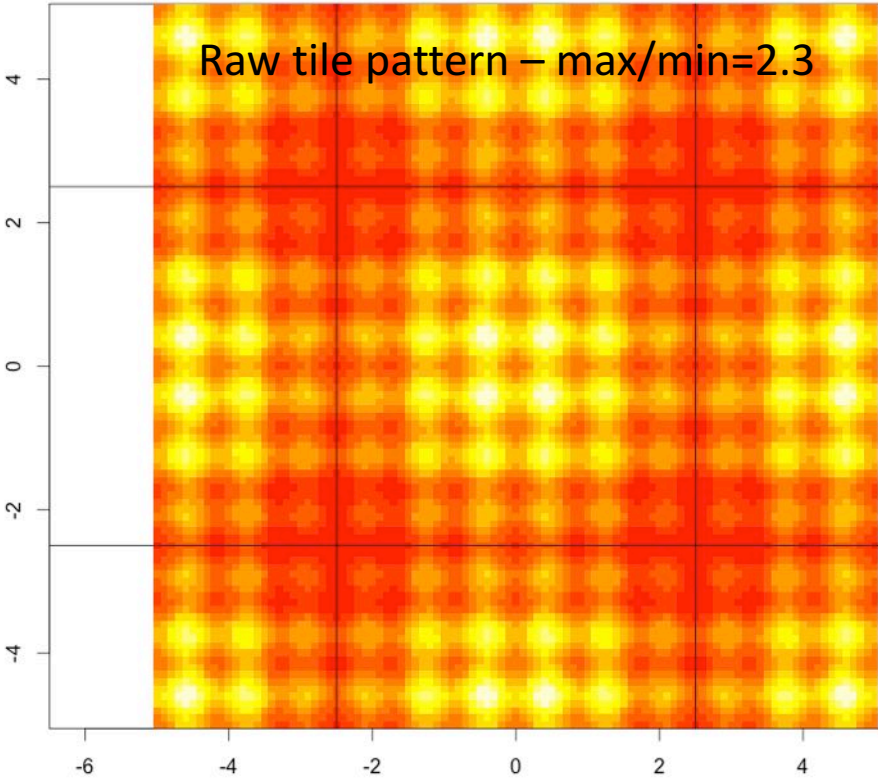


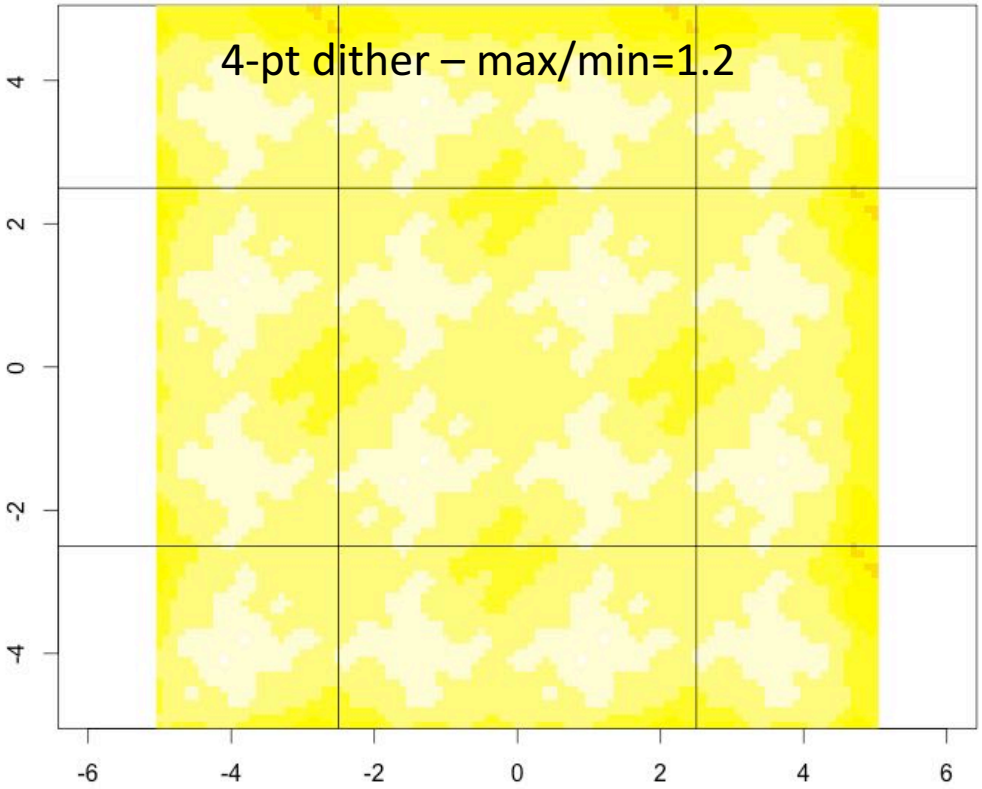
Duffy, Gerstmann

Spherical cap tiling (Robotham)



Sensitivity images (Robotham)

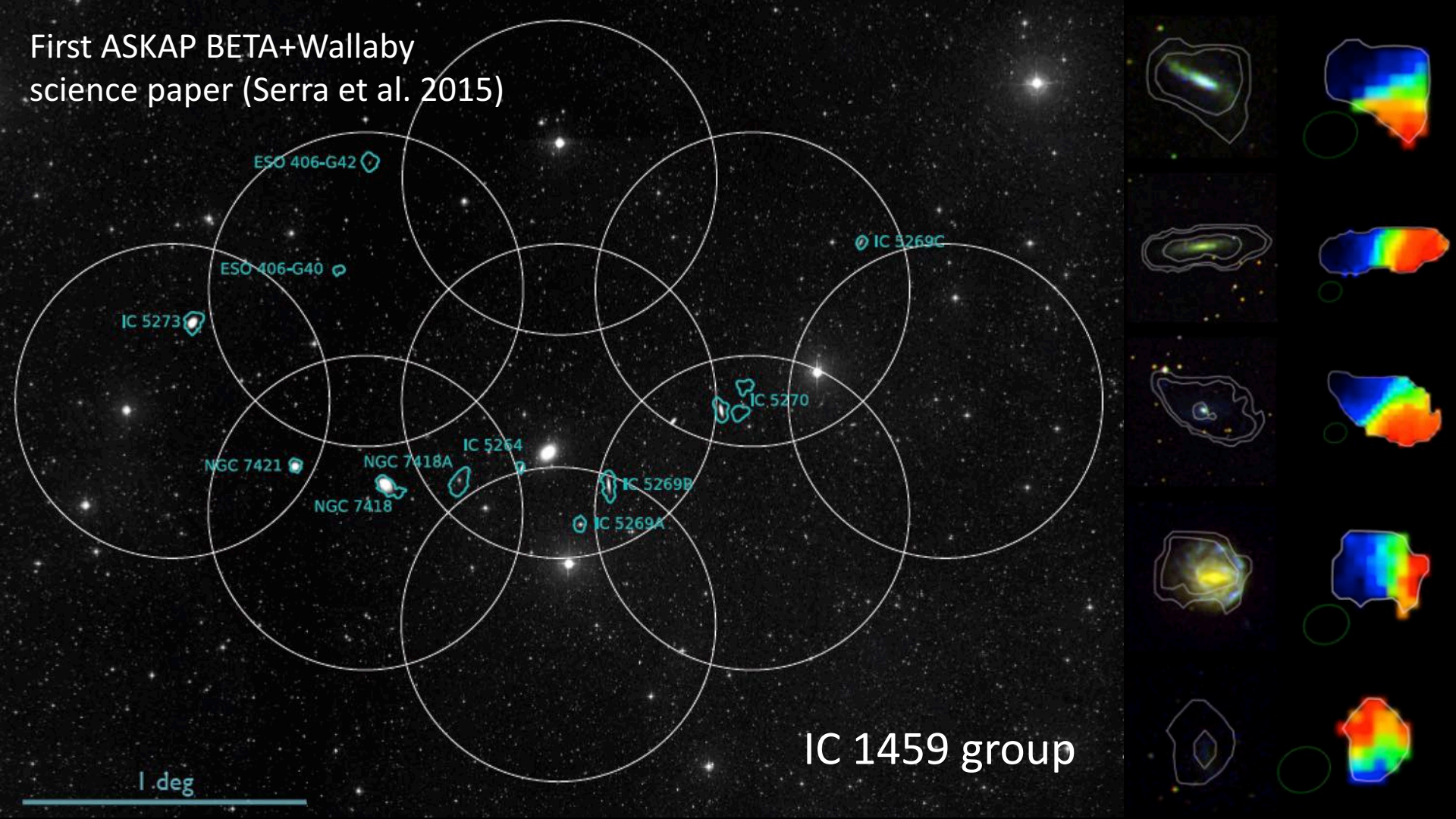




Wallaby timeline

- Sept 2014: commissioning science with BETA (6 antennas)
- Oct 2016: early science commenced with 12 antennas, 48 MHz
- Dec 2016: bandwidth increased to 192 MHz
- Sept 2017: bandwidth increased to 240 MHz
- Oct 2016: 16 antennas
- Apr 2018: 36 ASKAP antennas expected
- Dec 2018: full survey begins

First ASKAP BETA+Wallaby science paper (Serra et al. 2015)



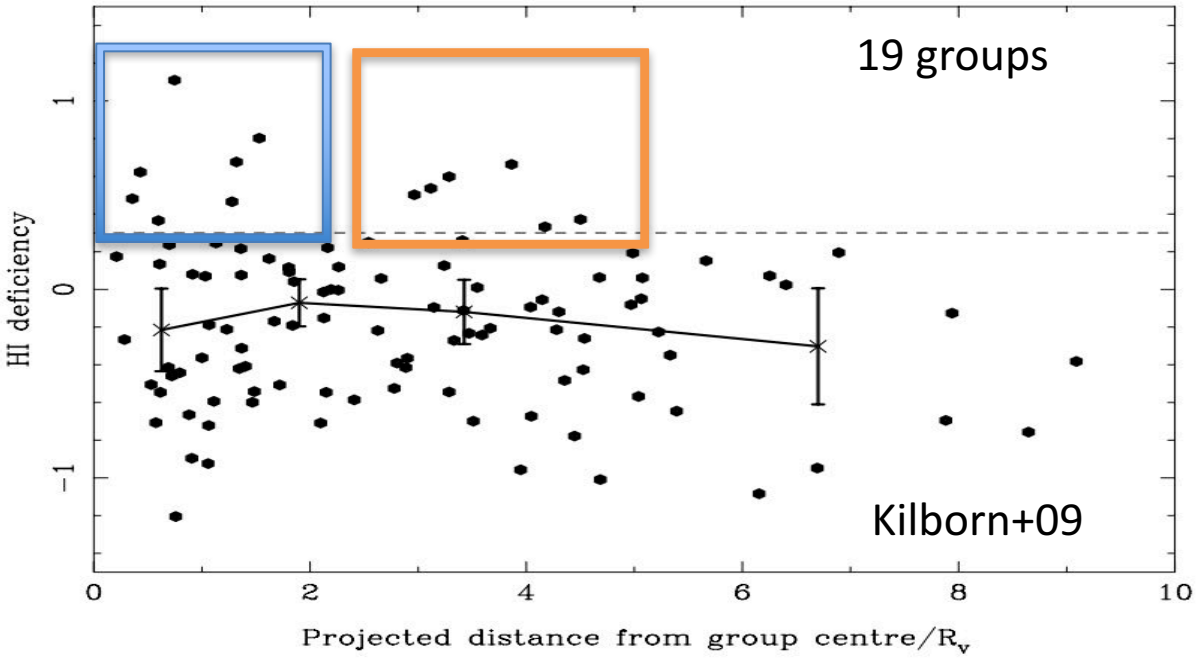
IC 1459 group

Wallaby timeline

- Sept 2014: commissioning science with BETA (6 antennas)
- Oct 2016: early science commenced with 12 antennas, 48 MHz
- Dec 2016: bandwidth increased to 192 MHz
- Sept 2017: bandwidth increased to 240 MHz
- Oct 2016: 16 antennas
- Apr 2018: 36 ASKAP antennas expected
- Dec 2018: full survey begins

Early Science (ES) focus: environment

When did galaxies lose their gas?



Preprocessing in and outside groups

Wallaby SWG3 pre-processing workshop – Swinburne March 8-10 (Kilborn and Wong)

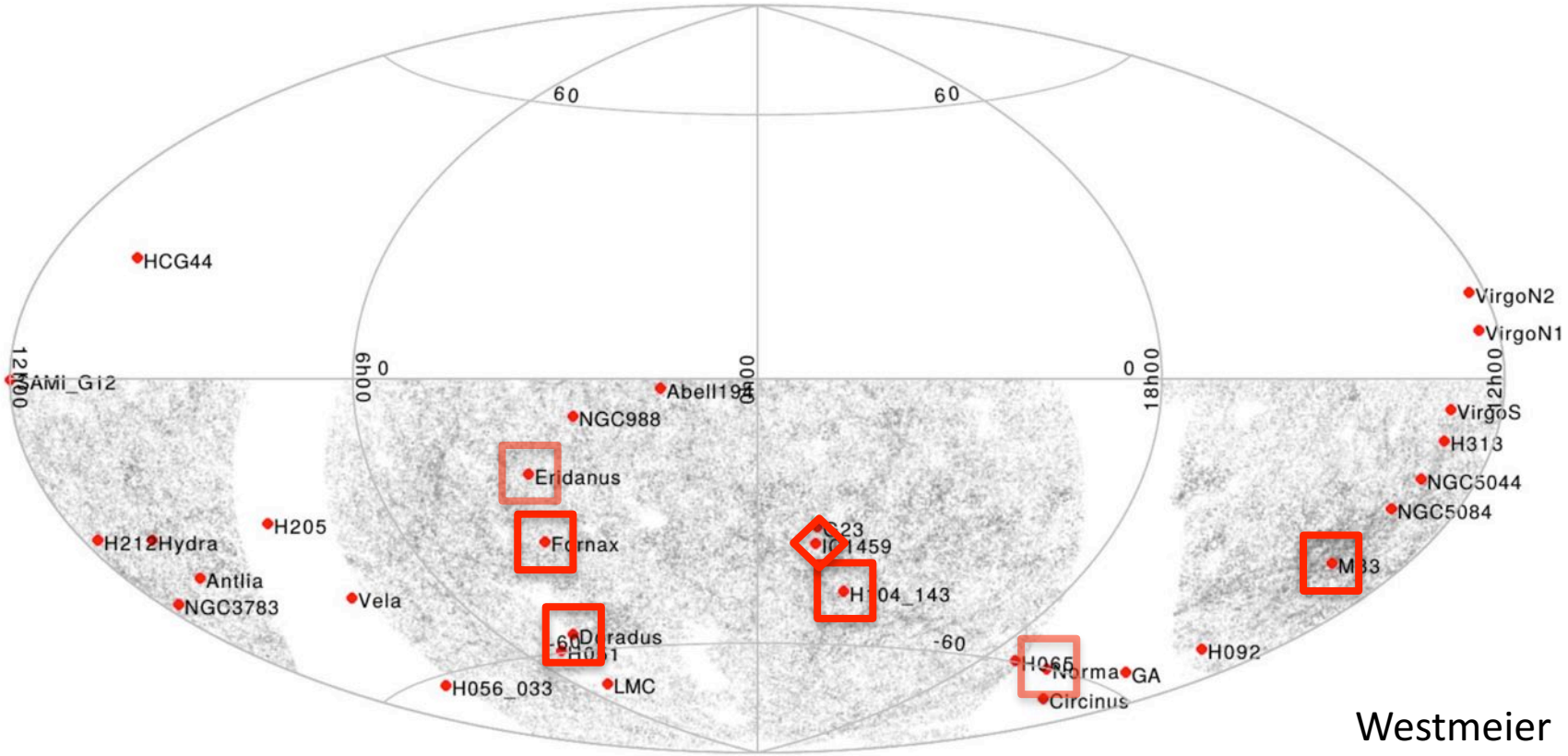
Early Science progress

WALLABY Early Science * Observations with ASKAP-12

No	Field name	Date	Bandwidth [MHz]	Antennas	Flagged [%]	Total time [hours]
Field 1	NGC 7232 Group	Aug to Sep-16	48	10 - 12	16 - 43	43.6
"	"	Oct-16	48	10 - 12	11 - 28	136.8
Field 2	Fornax Cluster	Oct to Dec-16	48/144/168	10 - 12	20 - 34	59.3
"	"	Dec-16	192	10 - 12	11 - 30	163.9
Field 3	Dorado Group	Dec-16/Jan-17	192	9 - 10	tbd	72.9
"	"	Sep-17	192/240	12	tbd	64
Field 4	M 83 Group	Dec-16/Jan-17	192	9 - 10	tbd	80.8
"	"	Sep-17	192/240	12	tbd	31.5

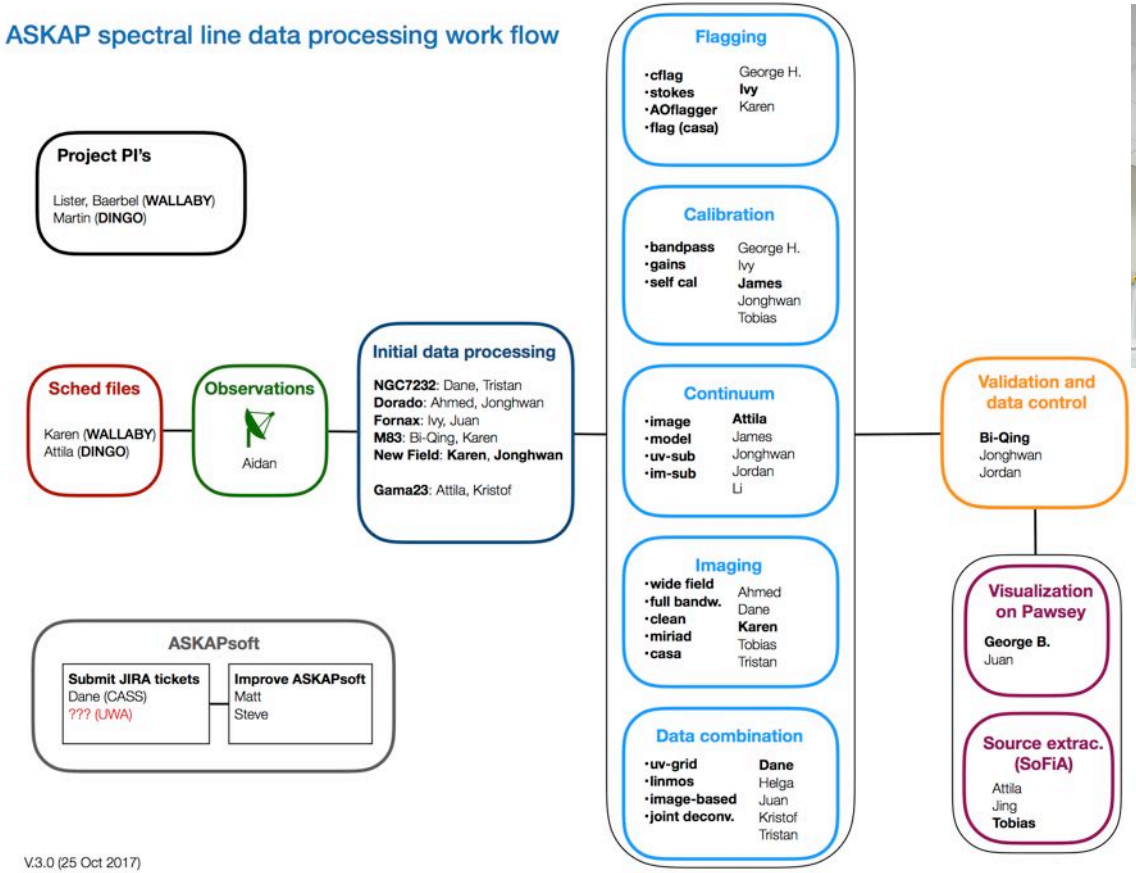
ES data is virtually identical to the Wallaby main survey data in resolution and sensitivity

WALLABY ES fields



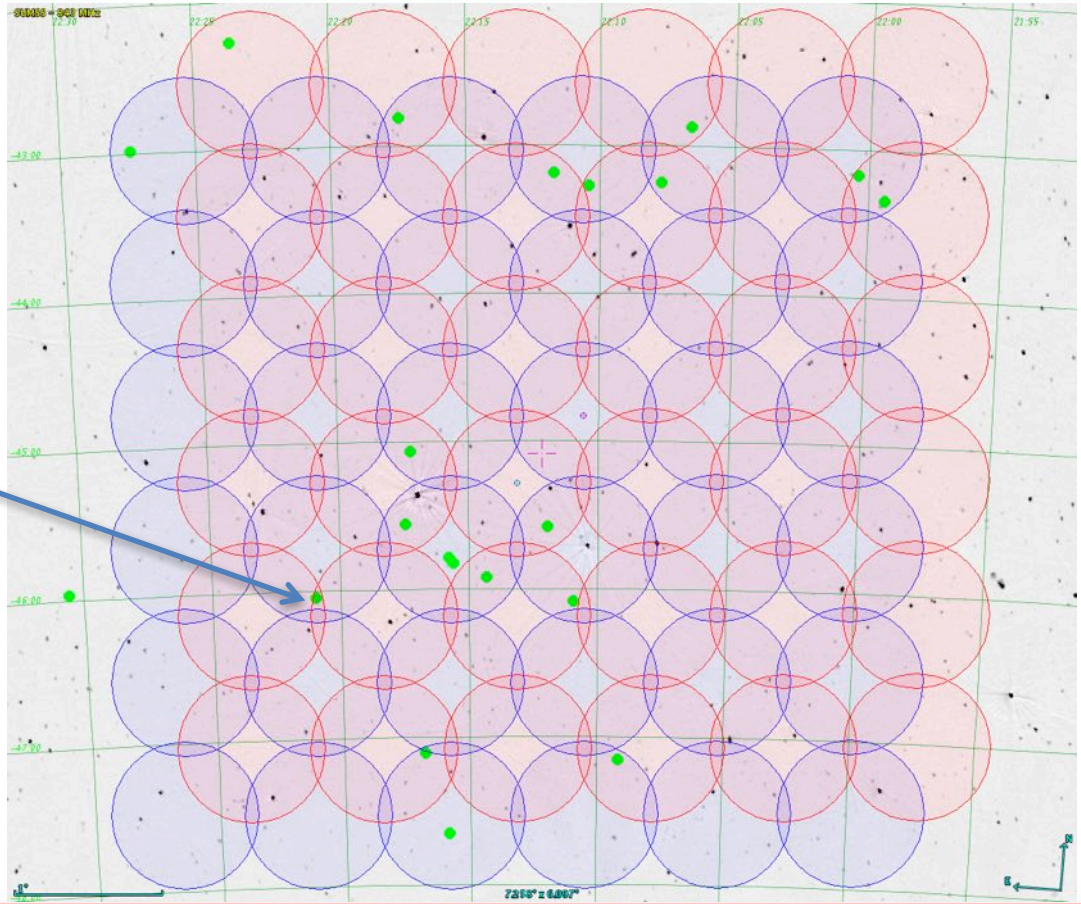
Westmeier

WALLABY/DINGO workflow



ES1 coverage

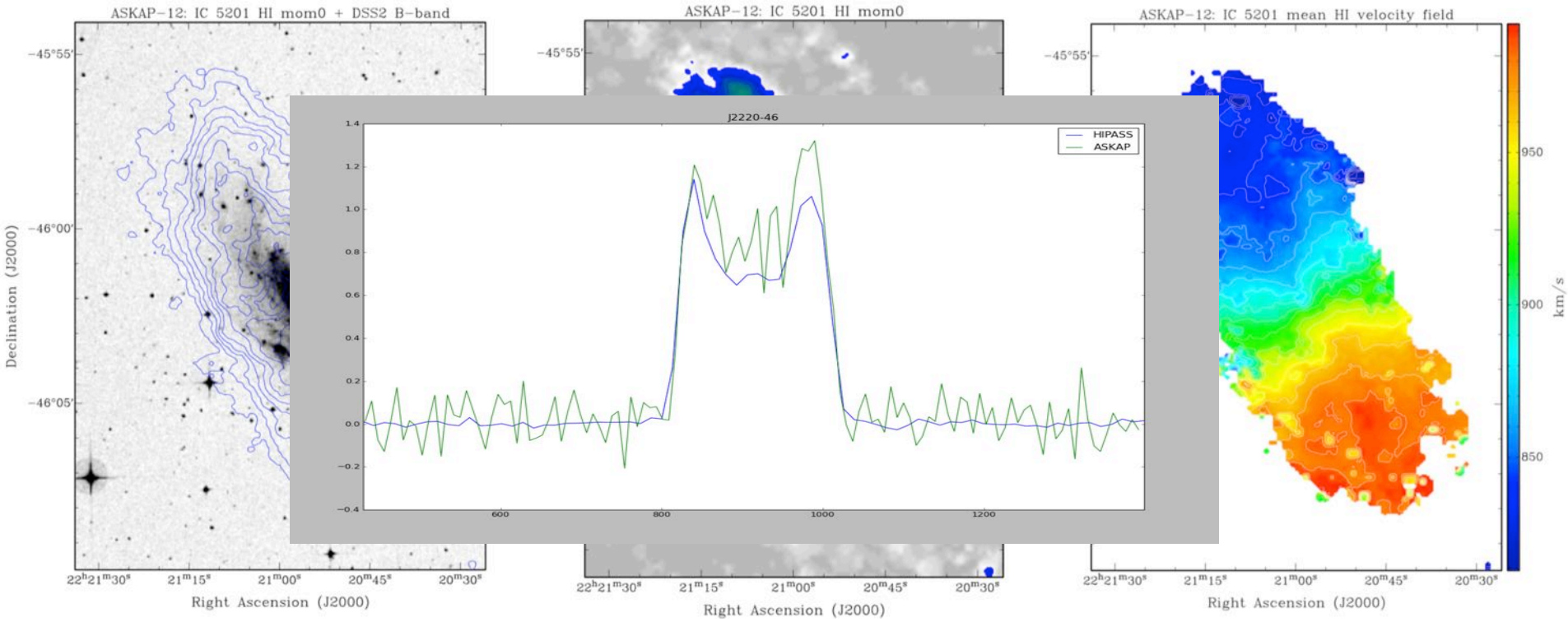
IC 5201



ES1

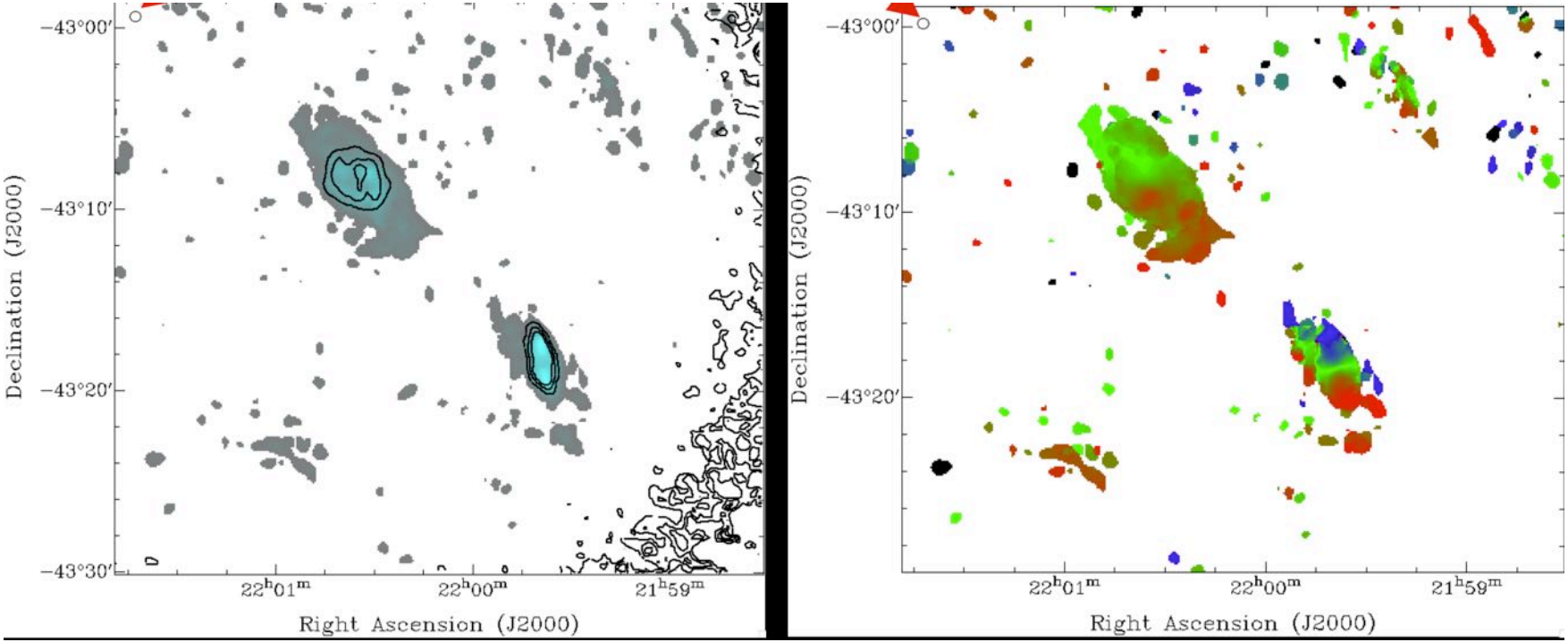
NGC 7232 field and beam pattern on coloured DSS

IC 5201 in the NGC 7232 group



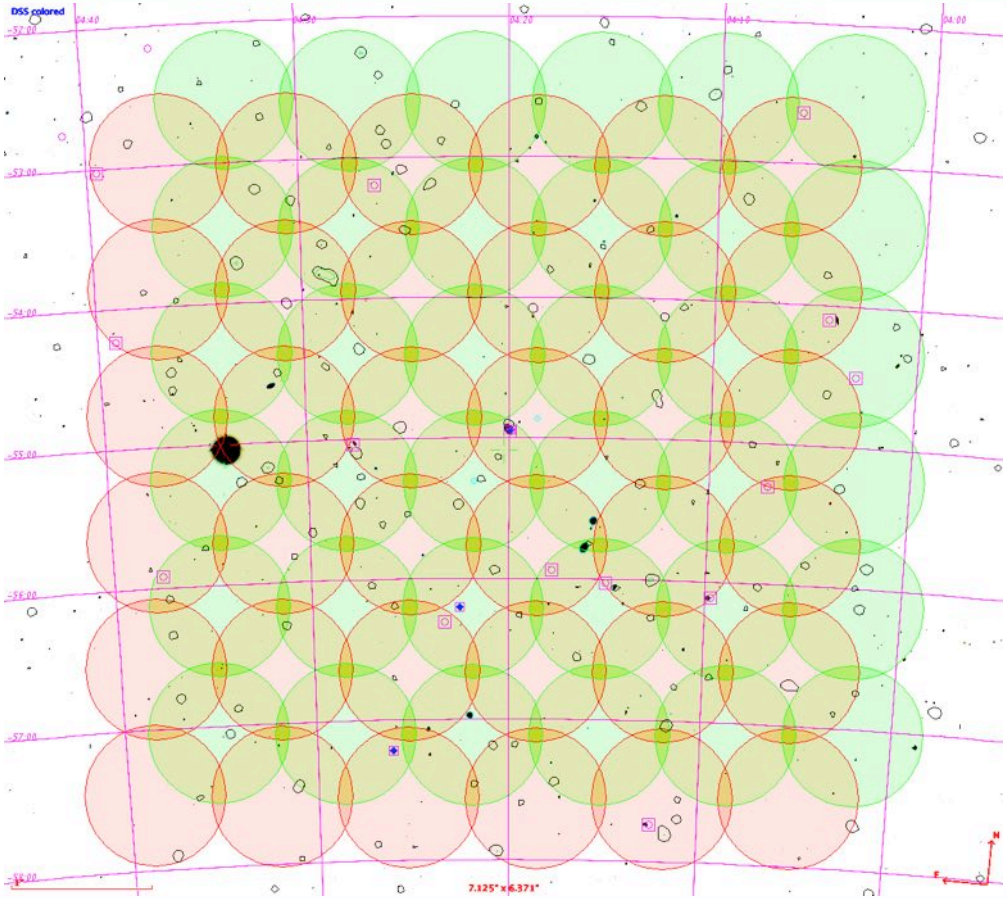
credit: Whiting, Lee-Waddell, Madrid

NGC 7162/A in the NGC 7232 group



Credit: Tristan Reynolds

ES3 coverage

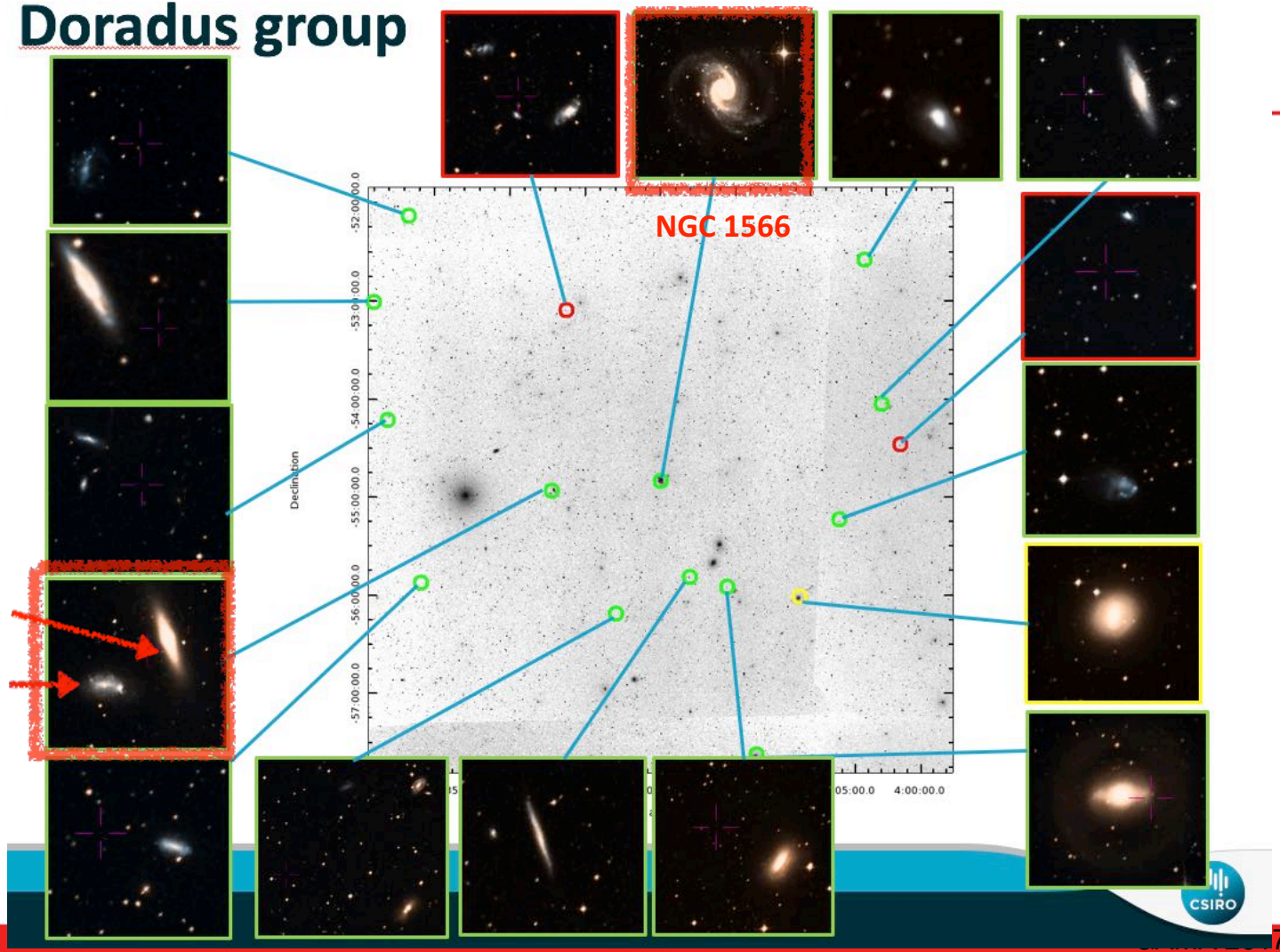


6 deg

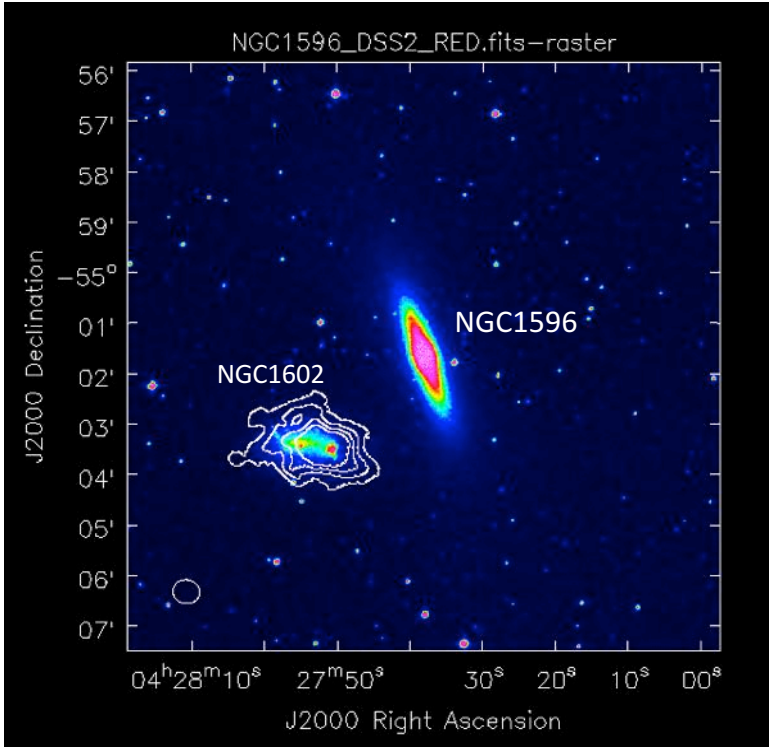
ES3

Dorado field
and beam pattern
on coloured DSS

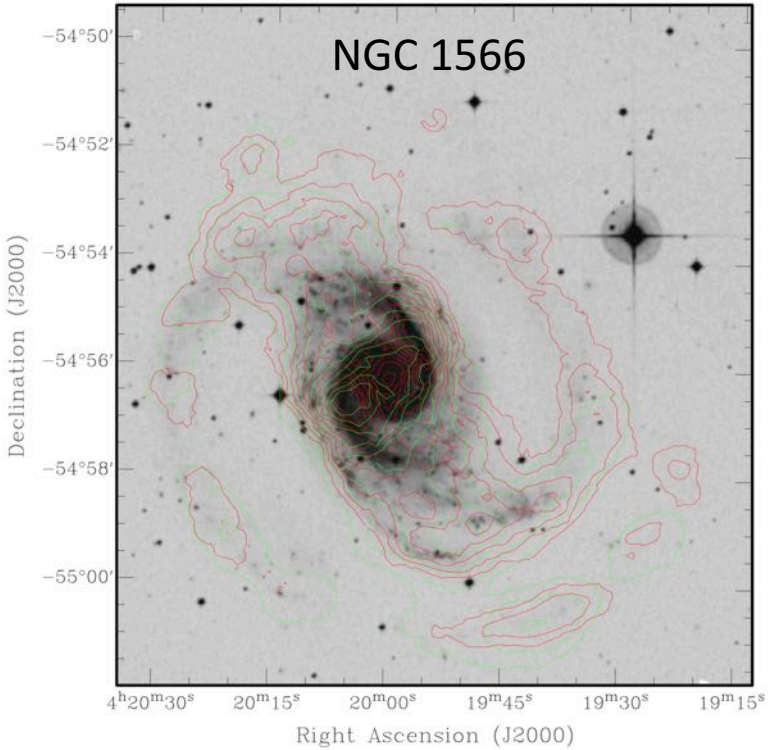
Doradus group



10% depth images from Dorado



1 night



1-3 nights

Credit: Egali, Kleiner, Rhee

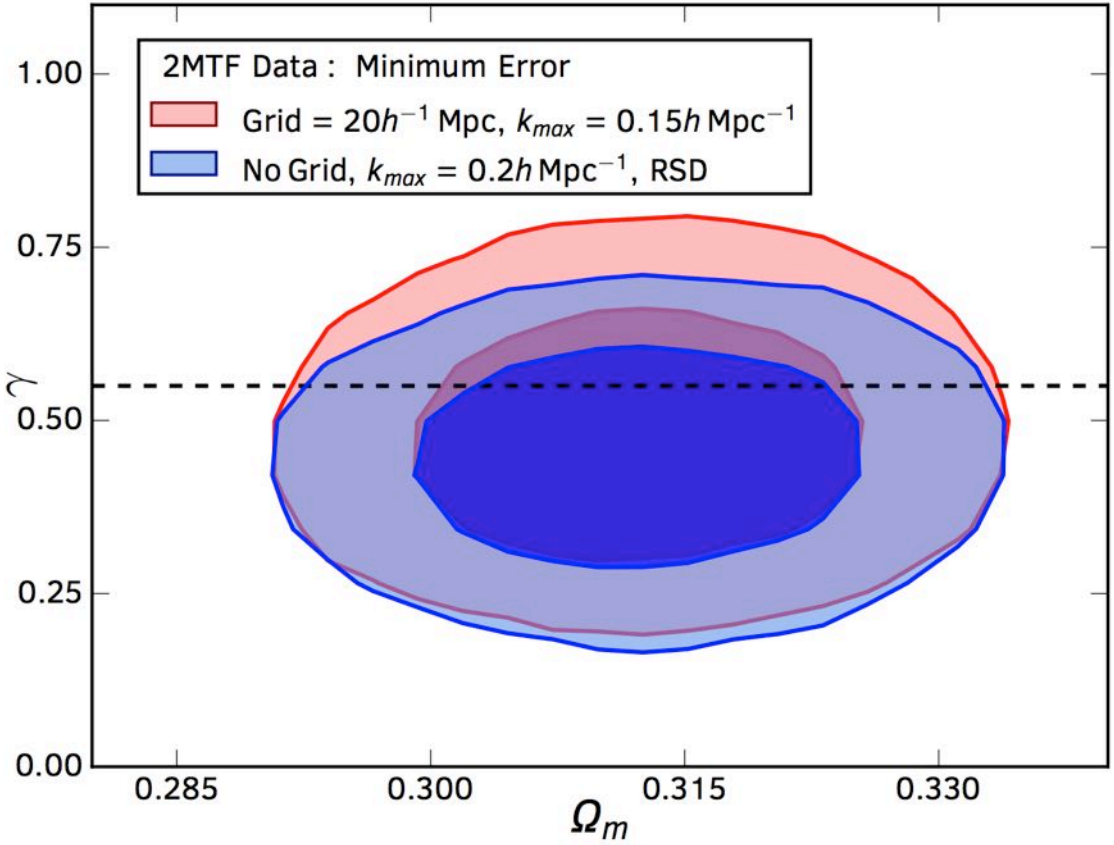
NGC 1566: Slicer

Jonghwan Rhee

Summary

- Wallaby science has started (4+2 ES fields - same area, resolution and sensitivity as ASKAP-36)
- Initial science focus: pre-processing in group environment
- Wallaby is zero-redshift, all-sky ‘anchor’ for high-z studies – most O/IR synergy with TAIPAN, SkyMapper, VISTA, VST, LSST
- Expected completion 2020/21

Parameterizing ΛCDM + testing GR



2MTF velocity power spectrum (2062 galaxies with TF distances) + Planck: Howlett et al. (2017)