

EMU Pilot Survey

Status of Observations, Data Processing and Validation

Josh Marvil on behalf of EMU
EMU-POSSUM Busy Week | Dec 15, 2019

The Evolutionary Map of the Universe

- Large international team (>100 registered members)
- EMU **Key Science** Projects: Galactic, extra-galactic and cosmology
- EMU **Development** Projects: observing strategy, ASKAPsoft, CASDA, data validation, diffuse source extraction, classification, cross-id, redshifts, machine learning
- EMU **Collaboration** Projects: eRosita, SkyMapper, Taipan, VHS, DES/Oz-DES, DESI, Euclid, CTA, LSST, MWA, VLASS, POSSUM, WALLABY, FLASH

EMU's Management Team



Ray Norris, Western Sydney University
project leader



Anna Kapinska, NRAO
project manager



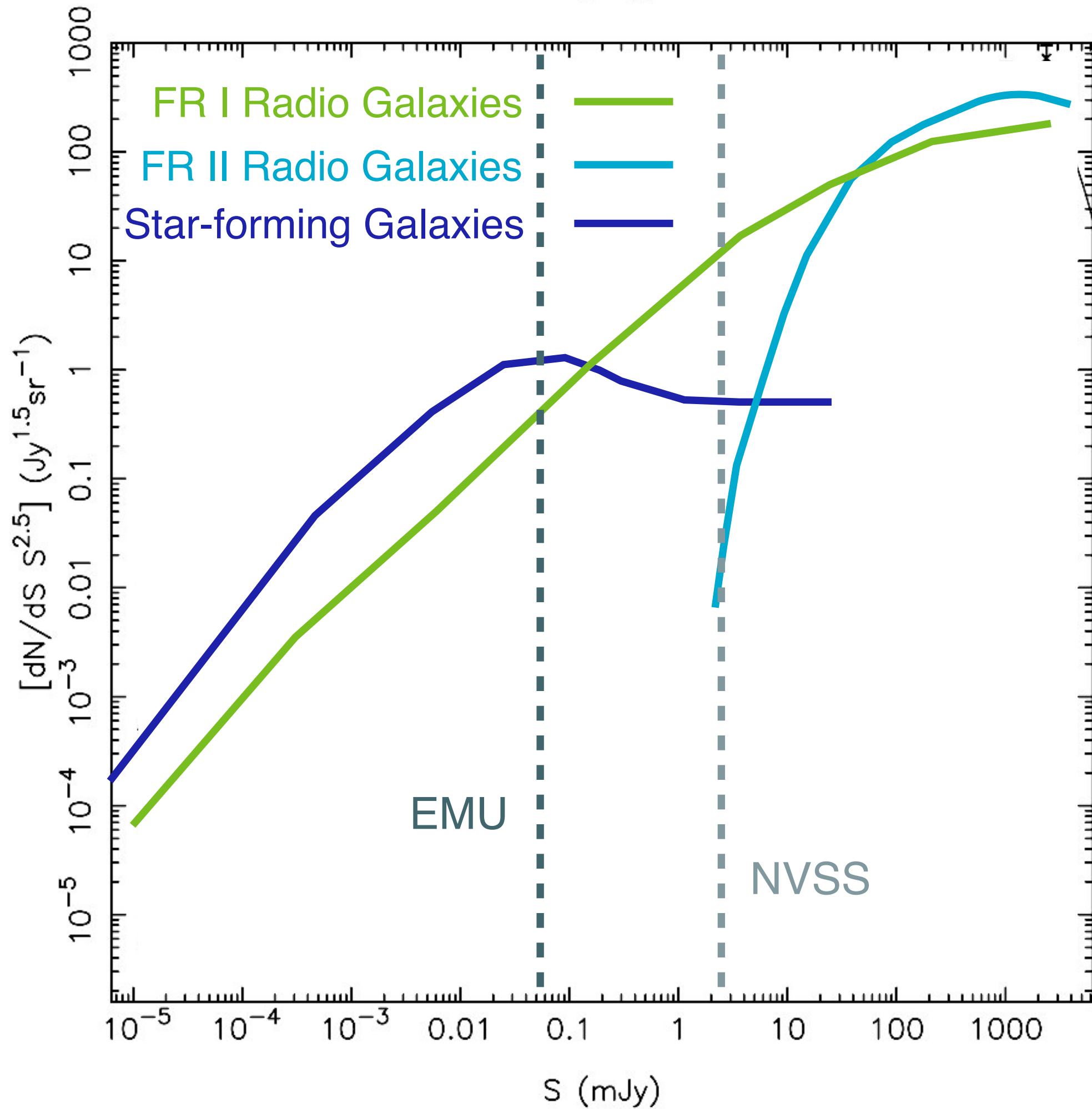
Andrew Hopkins, Macquarie University
project scientist



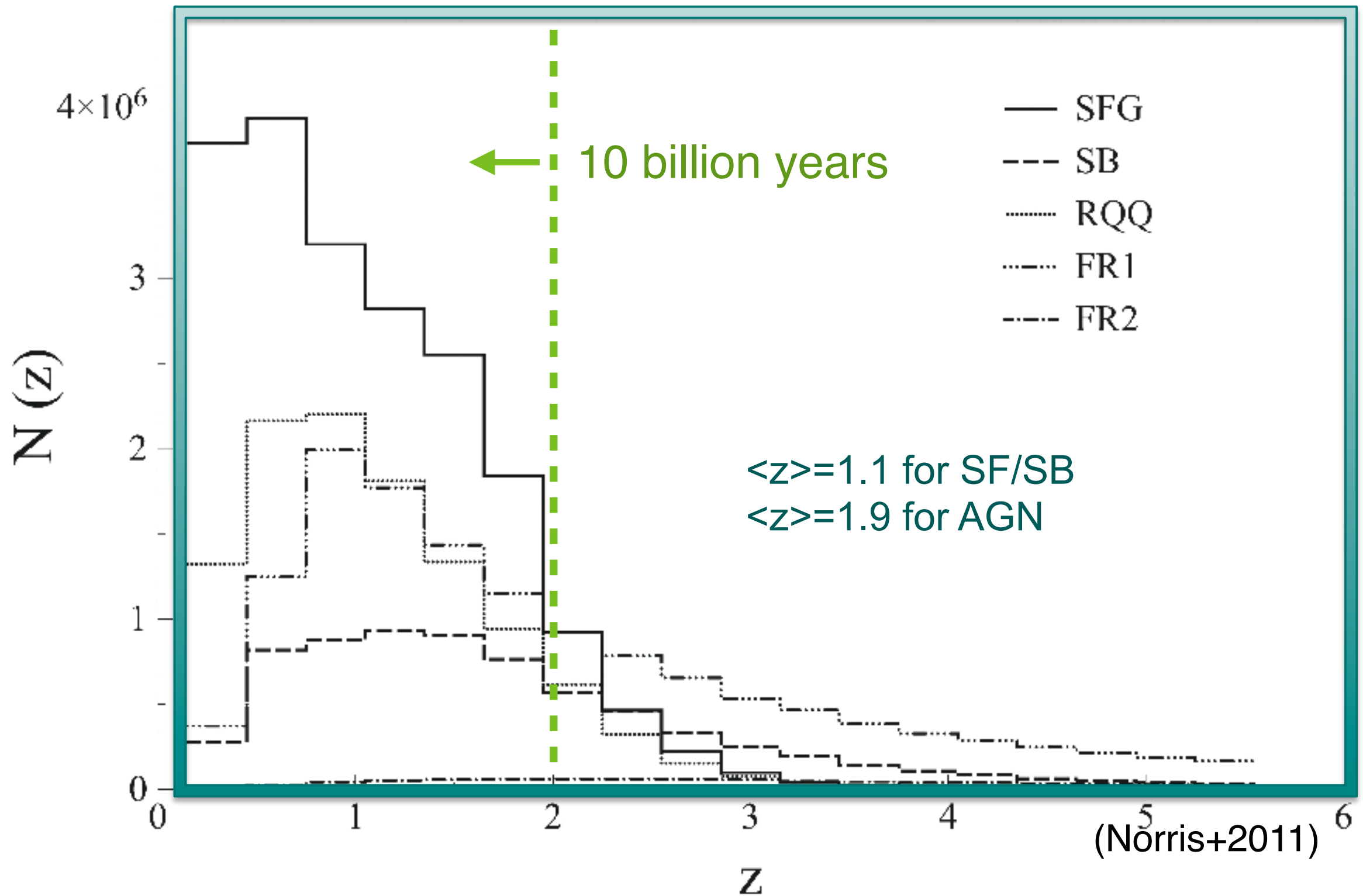
Josh Marvil, NRAO
project technical lead

Large-area Radio Surveys ~1 GHz

	SUMSS	NVSS	EMU
Frequency (MHz)	843	1400	1280
Sensitivity (uJy)	1000	450	10
Resolution (")	43/cos δ	45	10
Declination ($^{\circ}$)	< -30	> -40	< +30
Area (deg ²)	8,100	34,000	31,000
# of Sources	2E+05	2E+06	7E+07



Redshift distributions of EMU sources



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

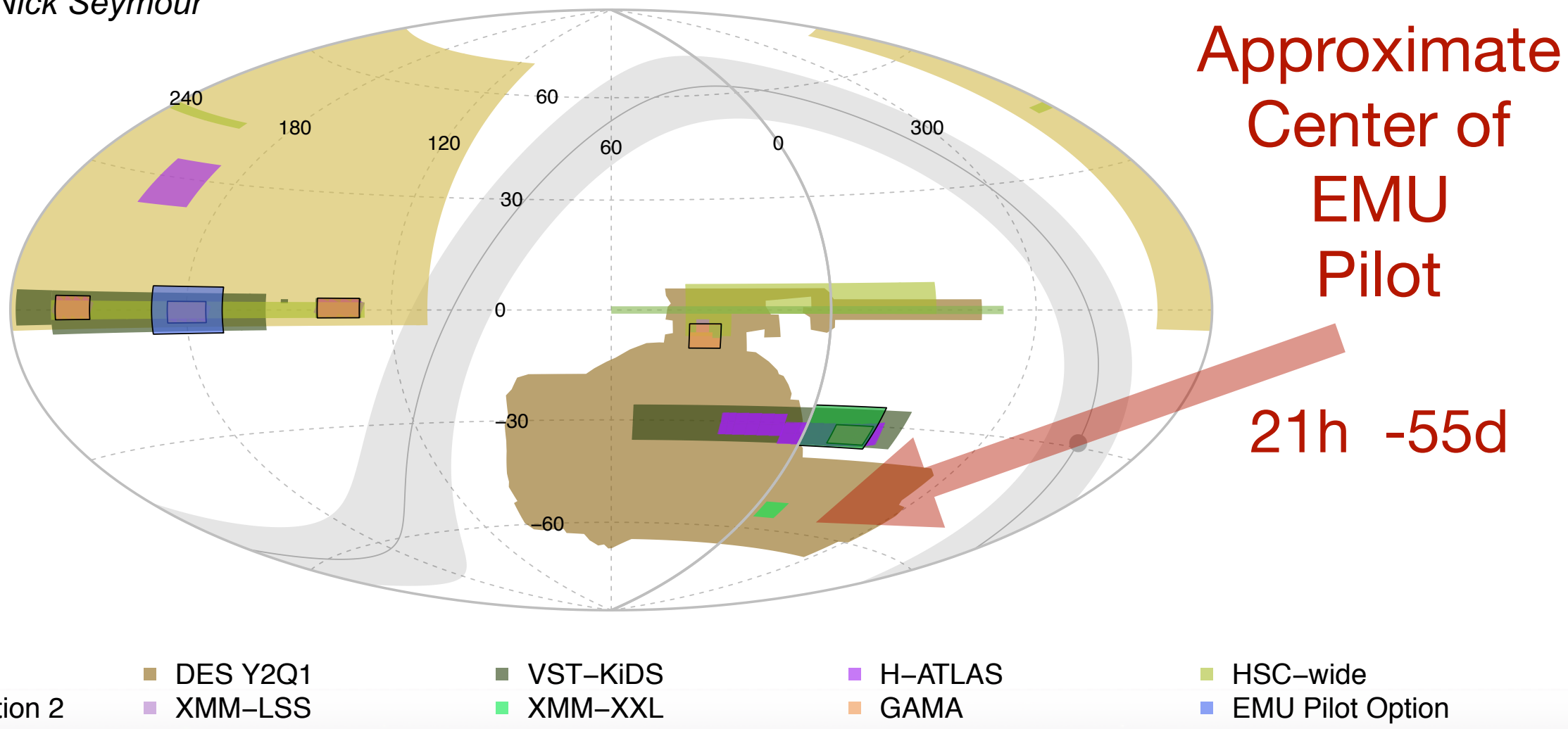
Pilot Survey Planning

- Primary goal is to test survey strategy and pipelines
- Survey a single area of about 250-300 square degrees
- 10 hours/field x 10 contiguous fields
- Uniform beam-to-beam and tile-to-tile sensitivity ($\sim 10\%$)
- Avoid equator, Galaxy, solar interference, RFI
- Preference for fields well-studied at other wavelengths

Chosen Survey Region

— MW Plane
• MW Center

Image courtesy Nick Seymour



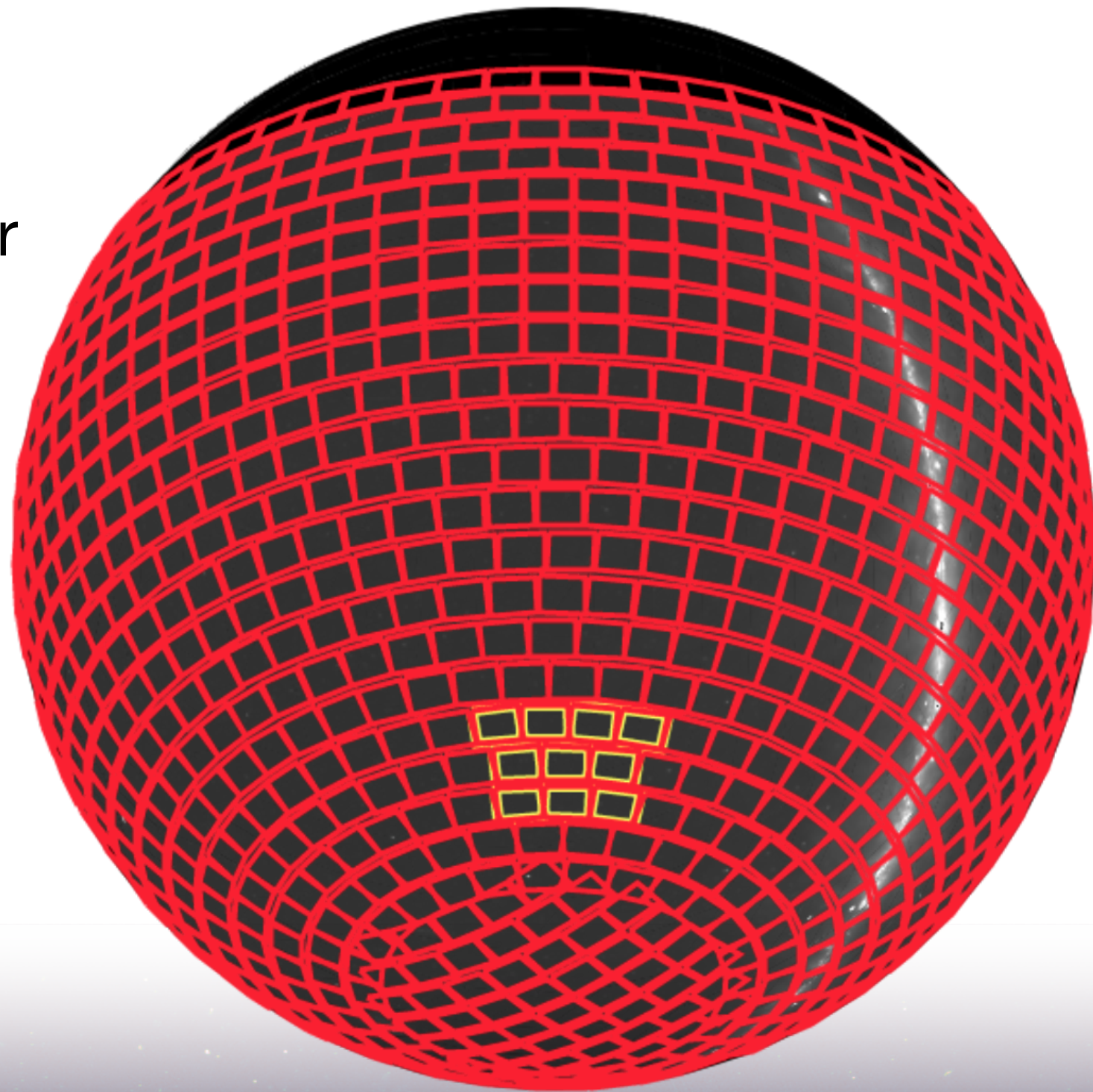
Pilot Tiles

Contiguous, quasi-rectangular region chosen as a subset of the all-sky tiling strategy

1280 tiles below +30 dec

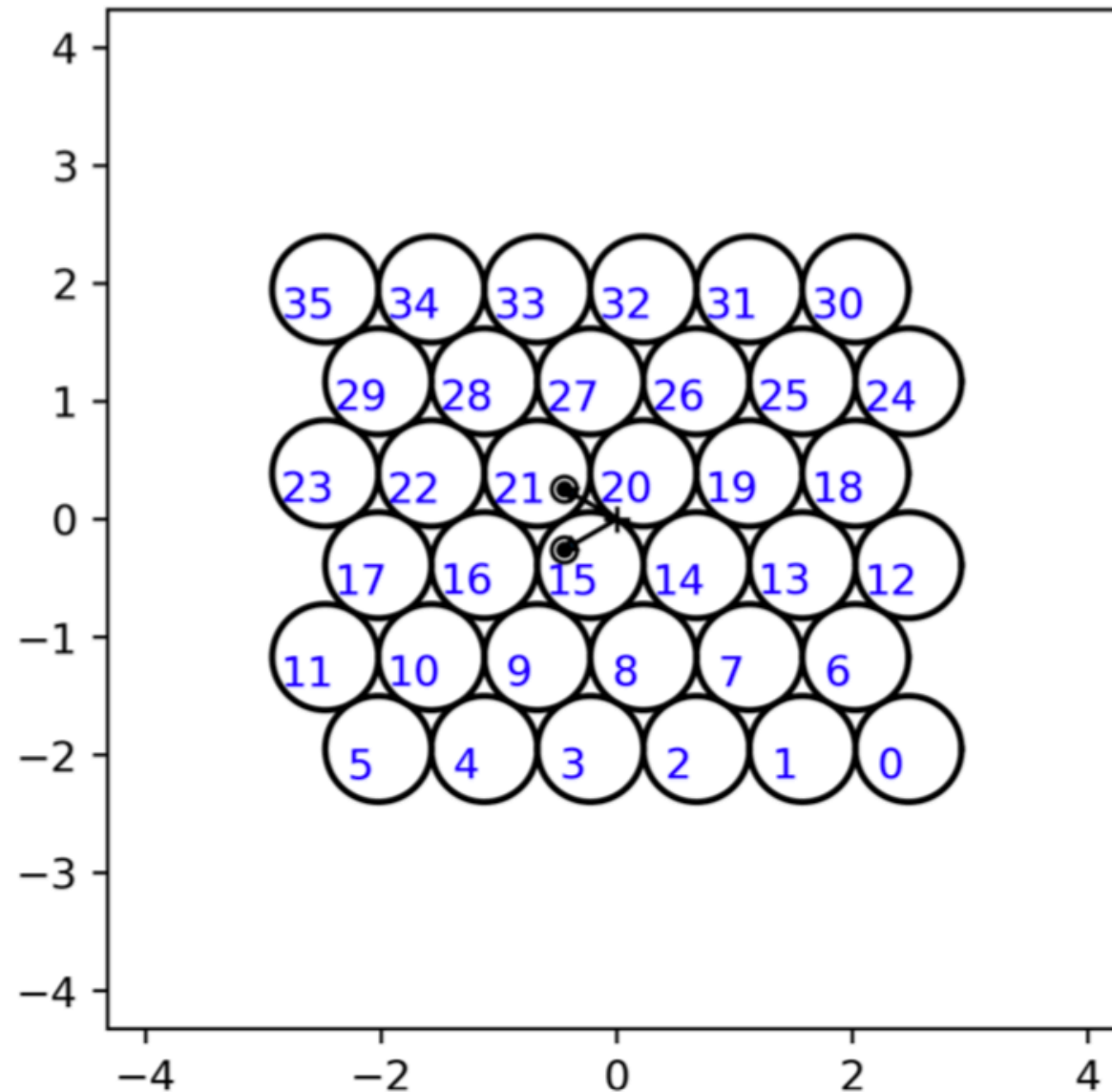
Polar boundary : -71.81

Overlapping area: $\lesssim 5\%$



'closepack36' beam footprint

from ASKAP Science Observation Guide, McConnell et. al. 2019



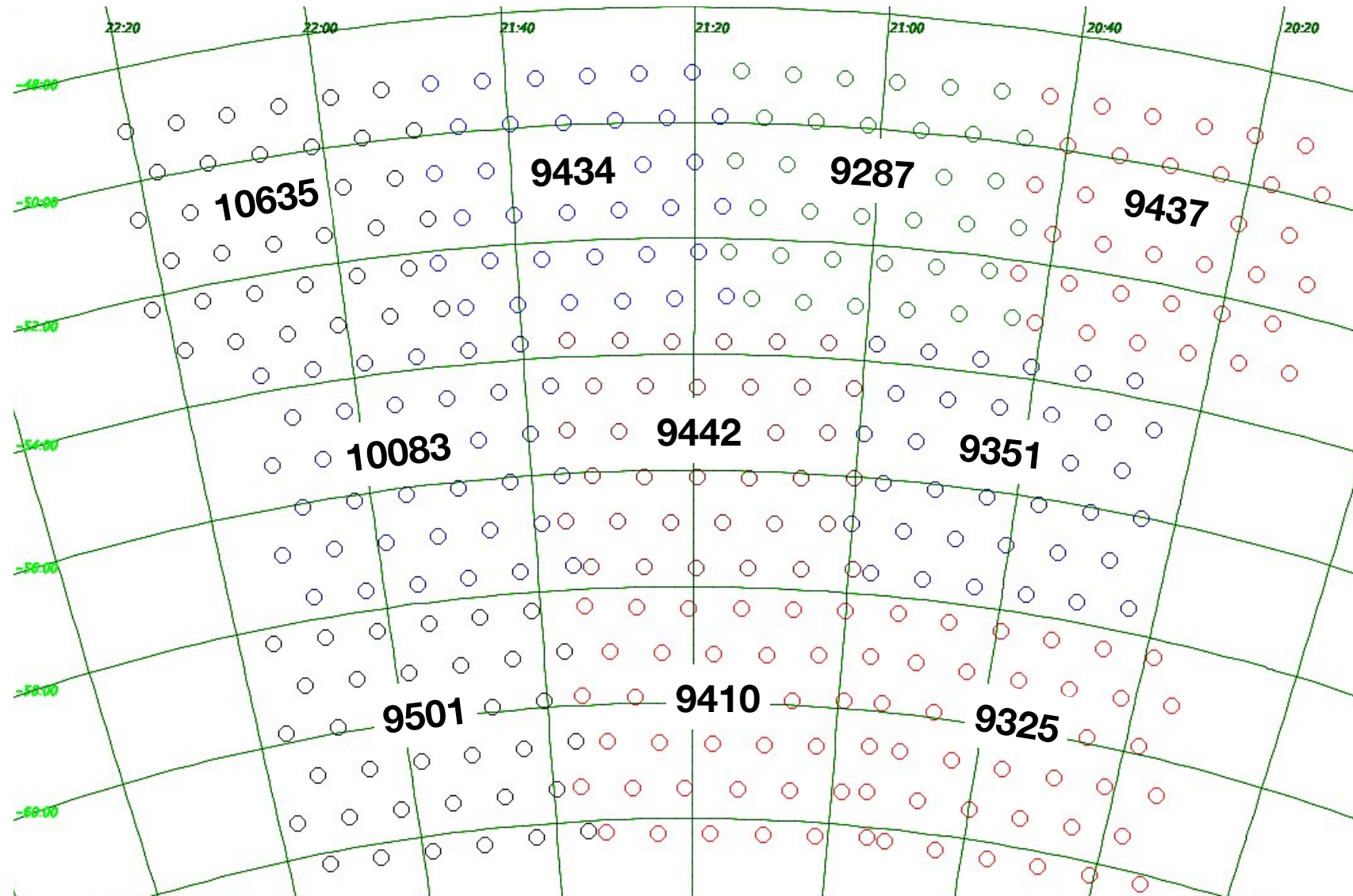
The two commonly-used footprints: `square_6x6` (left) and `closepack36` (right). In this case both have beam spacings (pitch) of 0.9° and a position angle of zero. The scales are in degrees, and celestial north (west) is to the top (right) of both diagrams.

Pilot Beams

hexagonal beam
footprint *closepack36*

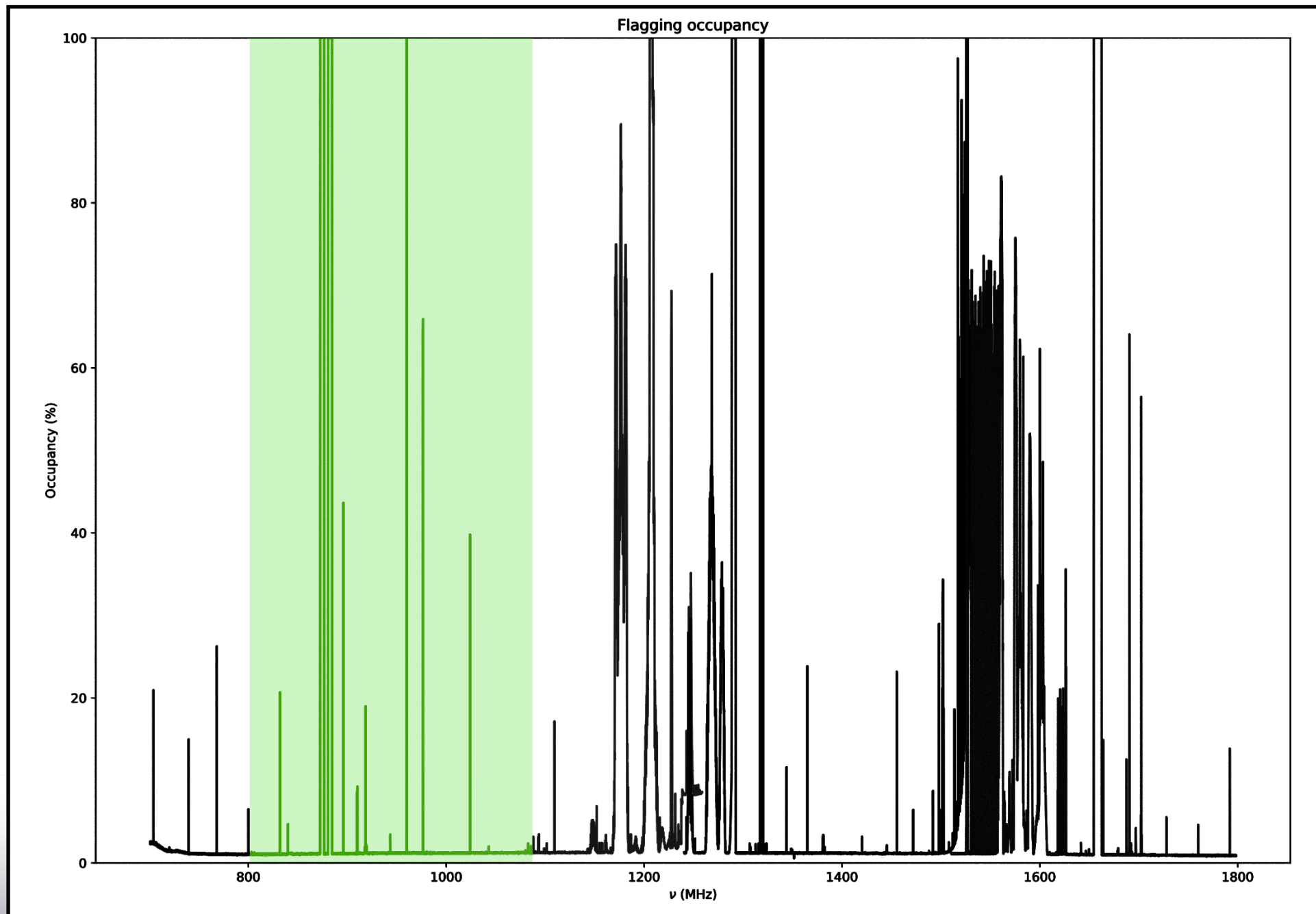
beam spacing of 0.9
degrees (pitch angle)

no interleaving of
beam footprints



Pilot Frequency: 800-1088 MHz

Avoid RFI > 1140 MHz; Avoid Tsys increase < 800 MHz



Pilot Observations

All 10 fields observed 15 July - 2 August

2 fields re-observed 3-4 October

1 field re-re-observed 24 November

Observational issues not fully understood--

Fringe rotator instabilities suspected

Pilot Processing Parameters

Wide-band: 2 Taylor terms

Large images: 3x3 degrees

Wide-field: 557 planes

Small cell size: 2" (~6x over)

Multiscale: 6 scales up to
10x the clean beam size

Masking at 250 uJy

Phase-only self-calibration

Deep cleaning to 30 uJy

Briggs weighting (robust=0)

Linear mosaic of 36 beams

Pilot Data Products

Calibrated visibilities @ 1 MHz resolution (1 MS per beam)

MFS image products: restored, model residuals and weights for both TT0 and TT1, and for both Stokes I and V

Alternate MFS images restored with a 30" Gaussian taper

Stokes I image cubes: restored, model, residuals and weights

Selavy component and island catalogs

Pilot Archive Access

Search CASDA for EMU Pilot
project code: **AS101**

data.csiro.au/collections/#domain/casdaObservation/search

Search for 'Released' data - **8 SBs currently available**

Download of images and visibilities requires OPAL

Validation of Data Products

These data represent the current state of the telescope and software

Pilot data are released as '**uncertain**' without addressing underlying deficiencies

Important to understand known data quality issues prior to scientific analysis

Validation of Data Products

Validation efforts will continue after pilot data have been released

EMU will document known issues and offer temporary workarounds

Feedback will be sent to CSIRO to improve future observations

Pilot Known Issues

~30% of data is missing or flagged

Restoring beam varies with position and frequency

Primary beam model is too large outside ~30% PB

Deconvolution is relatively shallow but also overcleans

Additive and convolutional image artifacts

Catalog spectral index of faint sources is too steep

Other misc. issues related to catalogs

Additional Information

Pilot page of EMU wiki:

askap.pbworks.com/PilotSurvey

Pilot page of CSIRO wiki:

confluence.csiro.au/display/askapsst/EMU

New EMU website:

emu-survey.org/pilot/

EMU 2059–51 Stokes I MFS

30'' Gaussian uv-taper

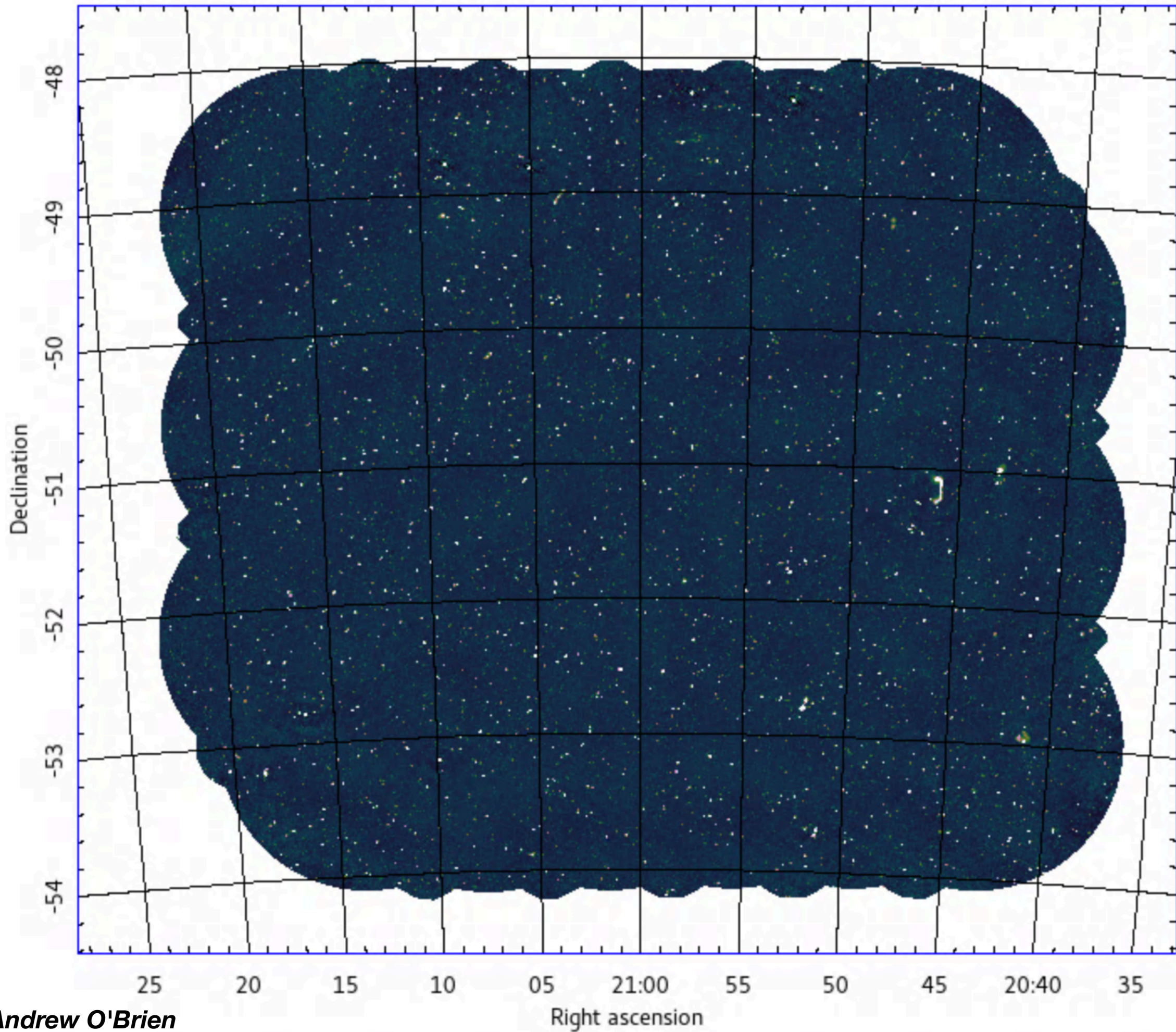
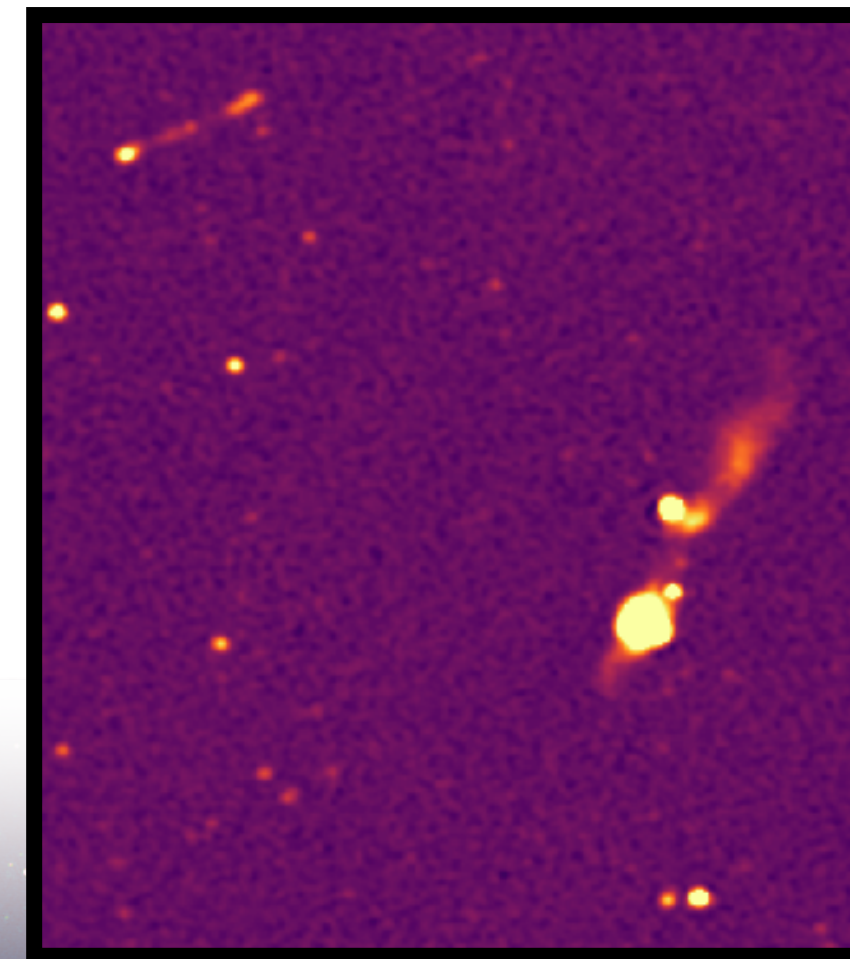
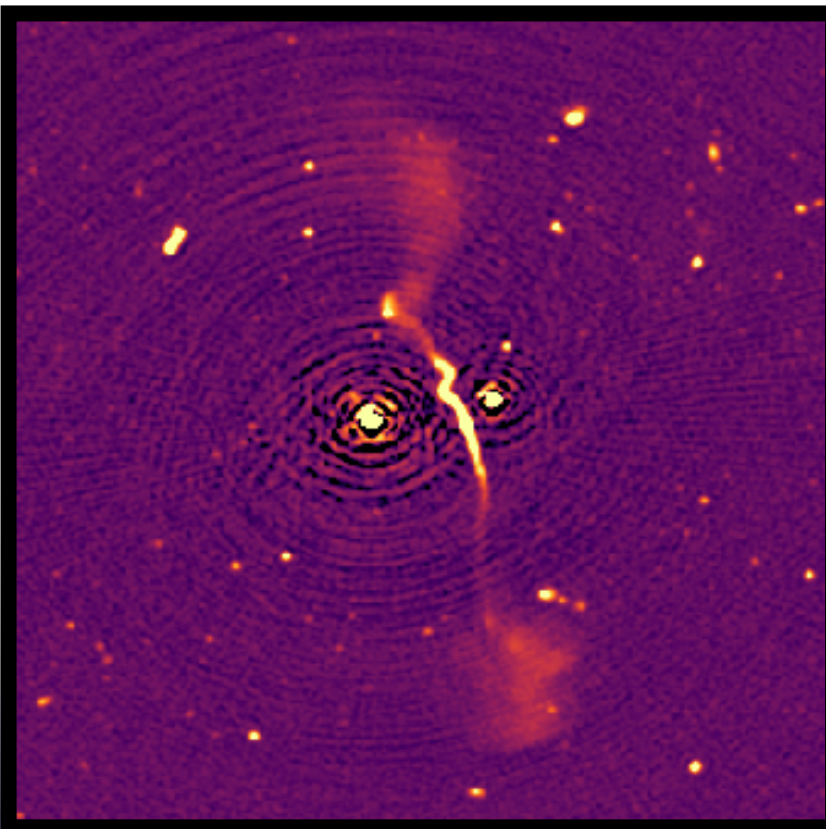
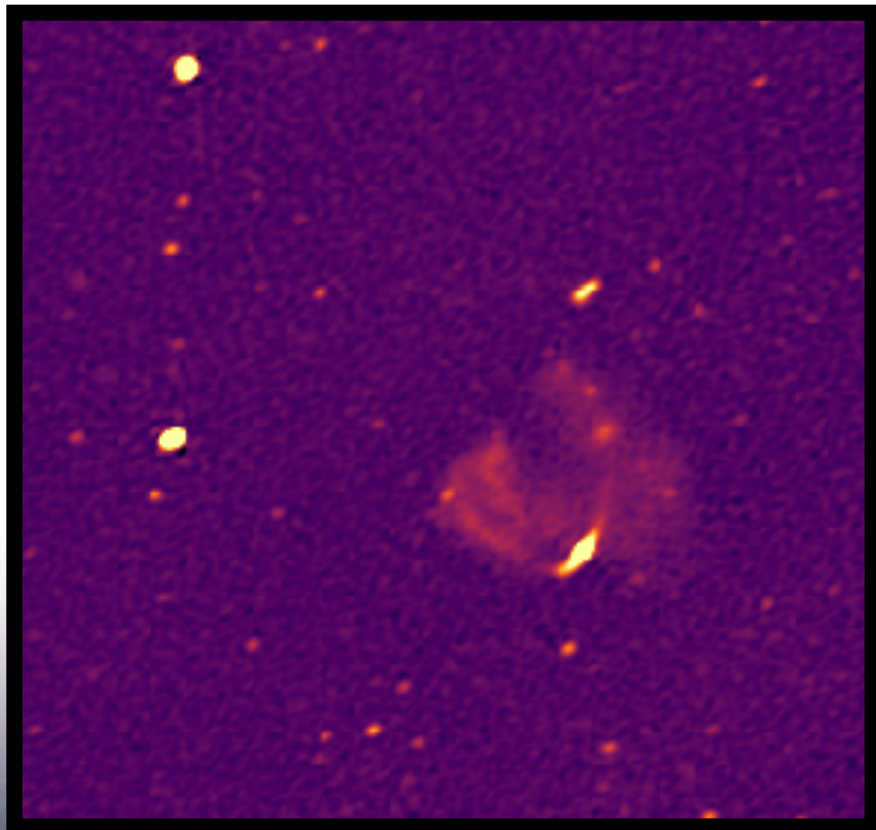
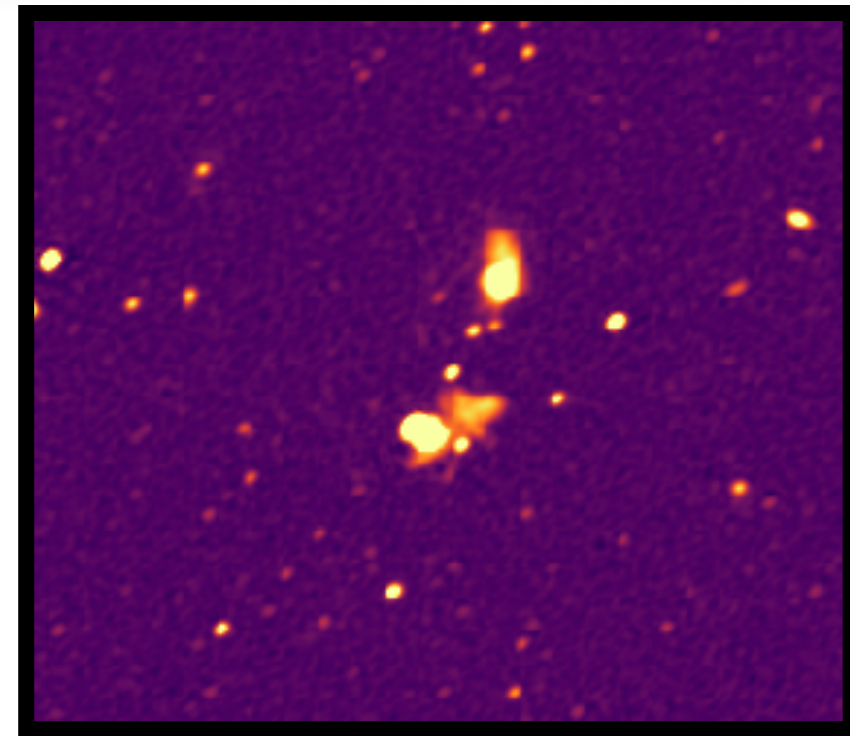
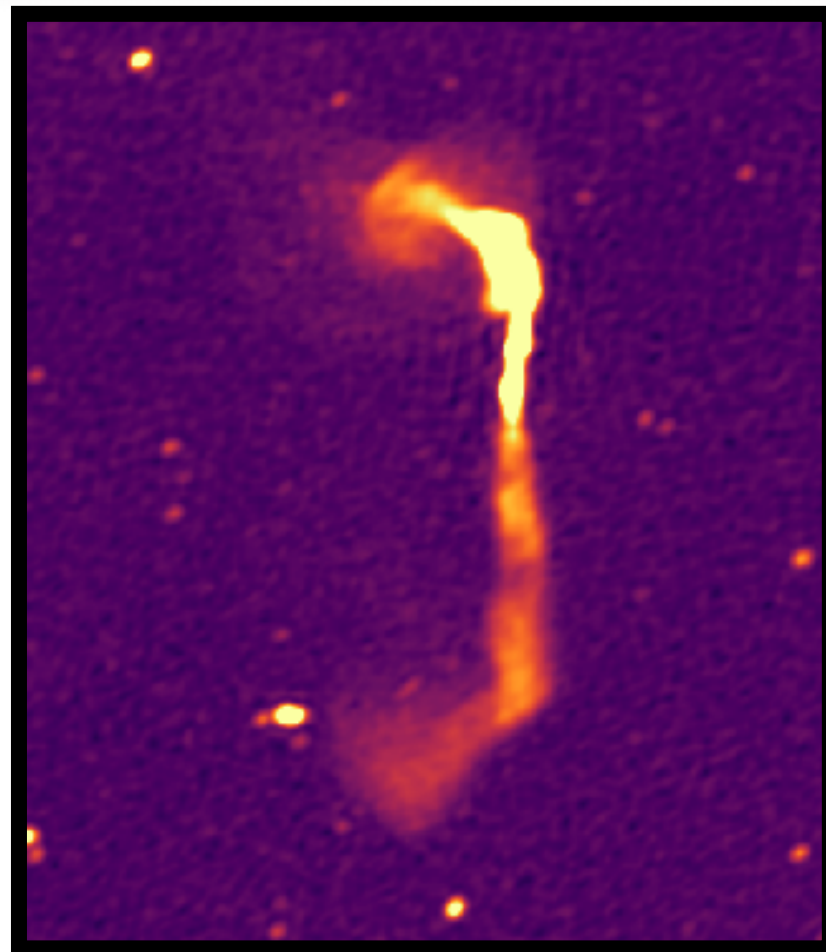
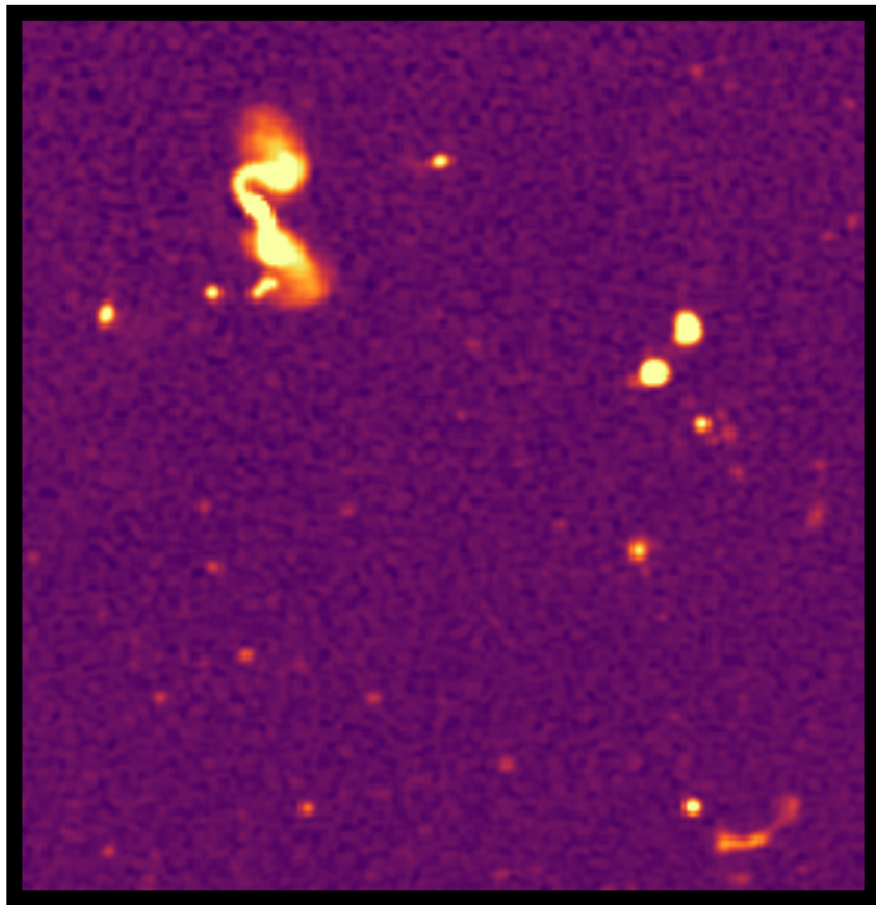
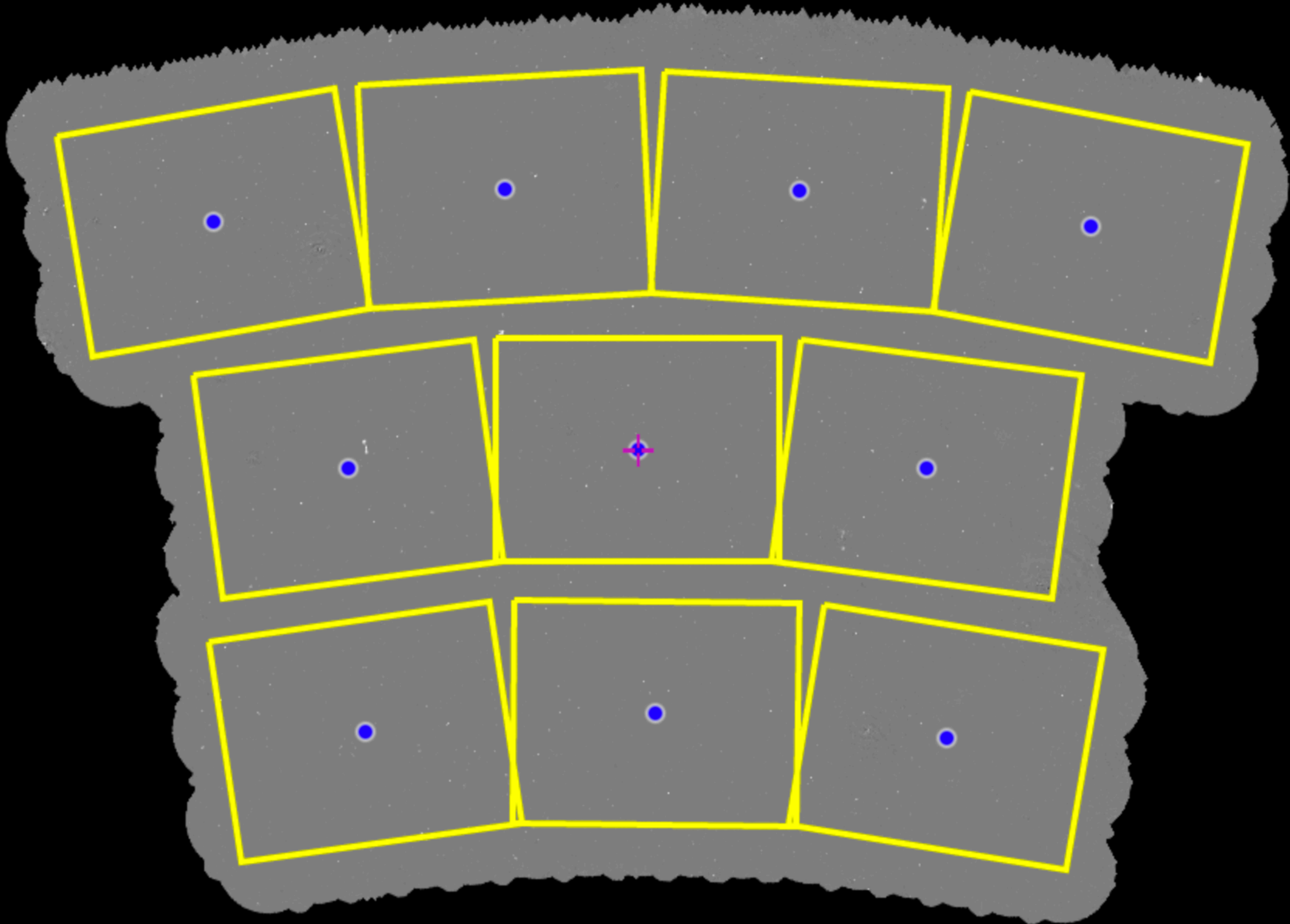


Image courtesy Andrew O'Brien



Evolutionary Map of the Universe



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