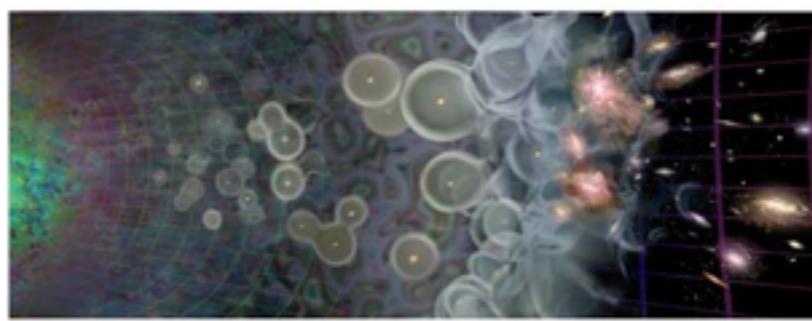
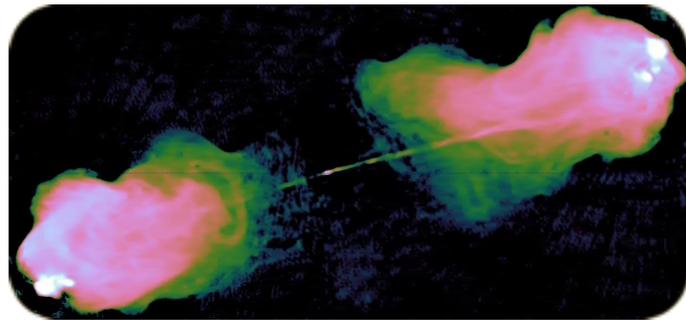


Radio astronomy at Rhodes University



Roger Deane

Senior Research Fellow

Centre for Radio Astronomy Techniques and Technologies



RHODES UNIVERSITY
Where leaders learn

group overview

- oldest radio astronomy group in South Africa
- has always had a strong technical grounding
- major growth point in 2012 (Oleg Smirnov's SKA Research Chair)
- group split between Grahamstown and SKA SA office in Cape Town
- excellent representation from across the African continent (Ghana, Nigeria, Cameroon, Madagascar, Mauritius, Kenya, Zambia)

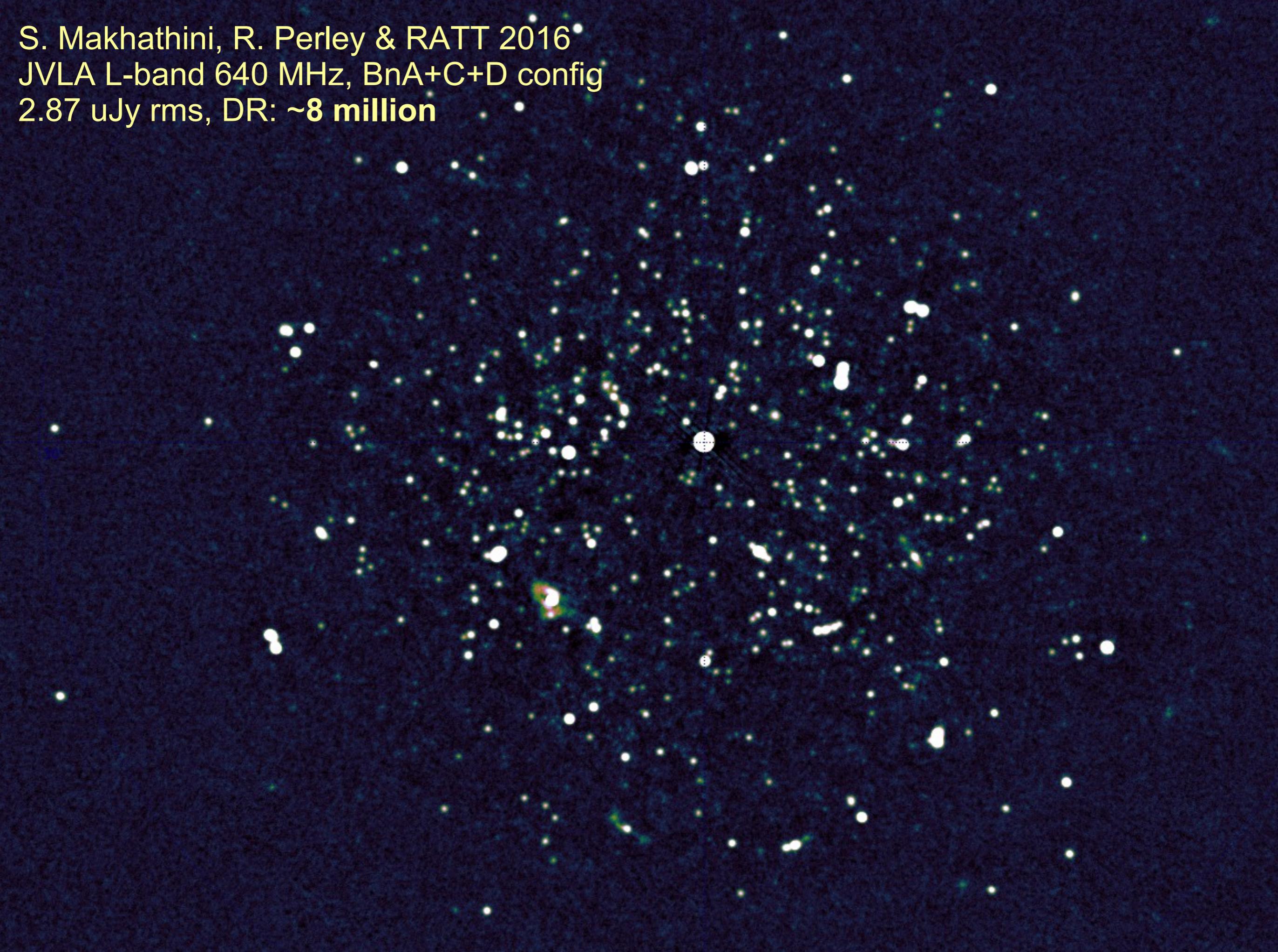
group members

- 4 academic staff
- 9 honorary research associates
- 6 postdocs
- 23 graduate students
- 3 honours students
- 2 visiting professors
- 1 honorary professor

research overview

- **interferometric data post-processing** (novel calibration algorithms, wide-field and high-dynamic range imaging, source finding & modelling, etc.)
- **radio continuum science** (radio galaxies, cluster halos and relics, AGN variability)
- **neutral hydrogen in individual galaxies** (nearby Universe, high-redshift lensed systems)
- **21 cm cosmology** (EoR, Cosmic Dawn, intensity mapping)
- **VLBI** (wide-field surveys, binary supermassive black holes, black hole shadow detection with the Event Horizon telescope)

S. Makhathini, R. Perley & RATT 2016
JVLA L-band 640 MHz, BnA+C+D config
2.87 uJy rms, DR: ~8 million



MeerKAT First Light Image

16 antennas (AR1)

900-1670 MHz band

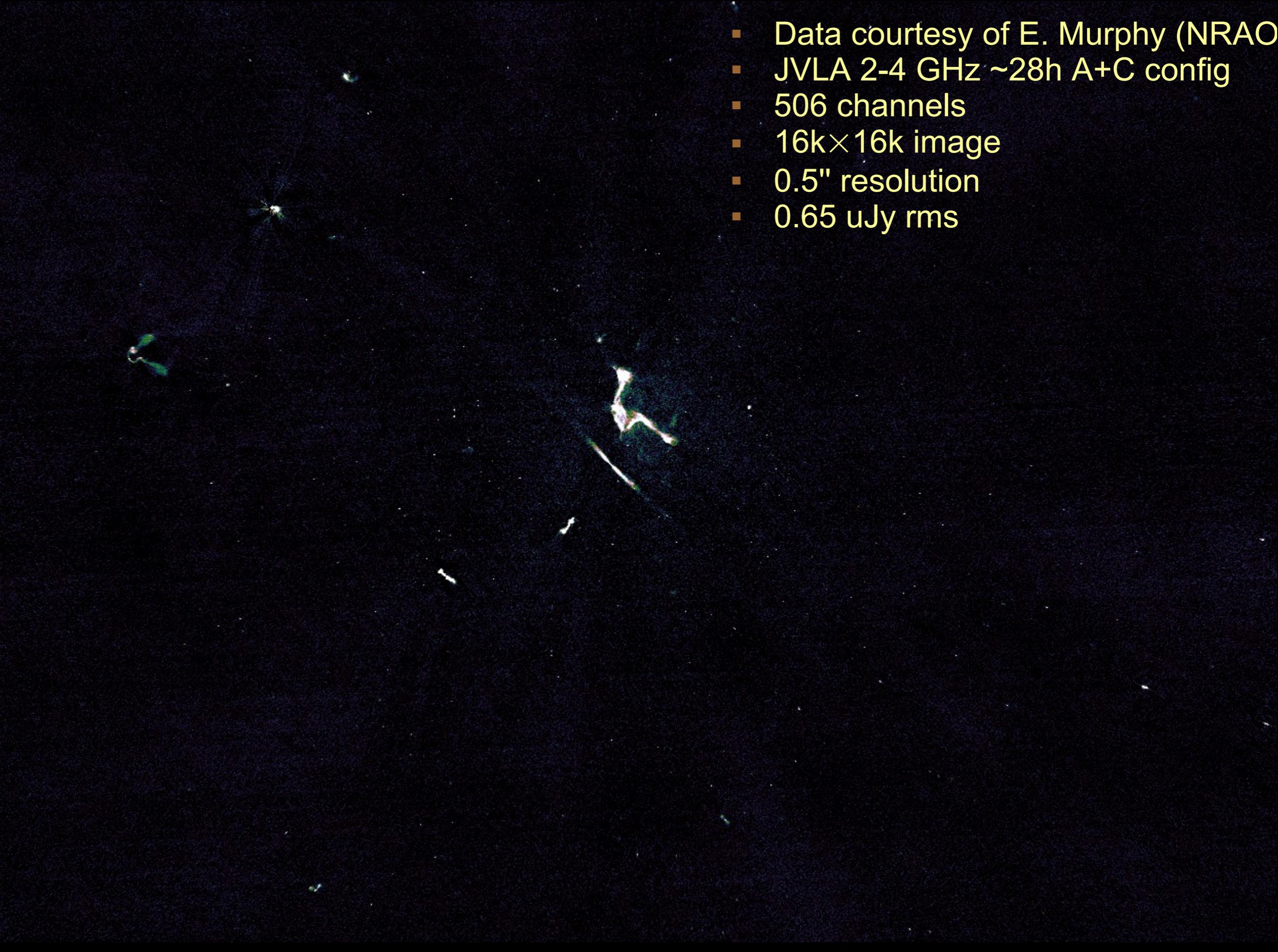
7.5h

~7" resolution

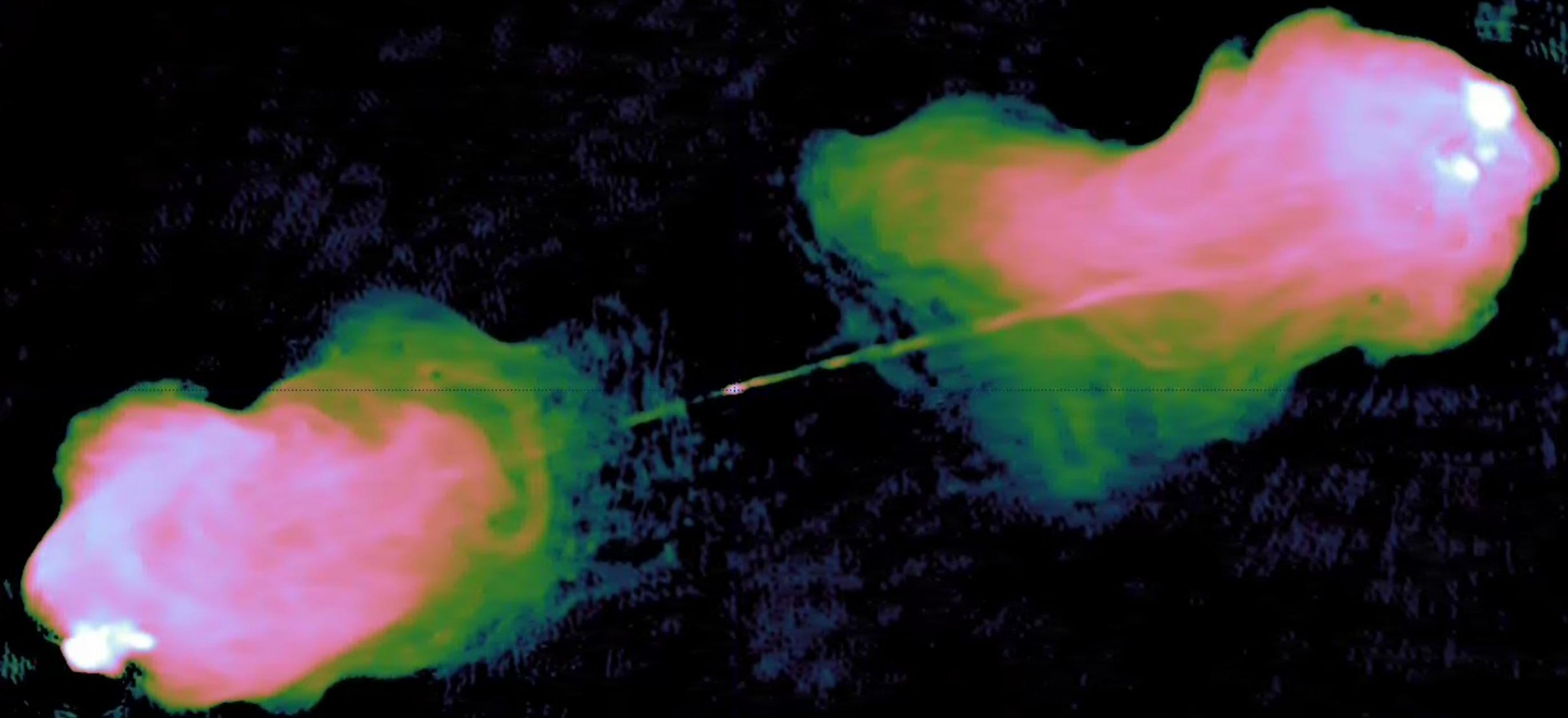
1300+ sources! 10+ sources at 5 σ

towards MeerKAT automated pipelines

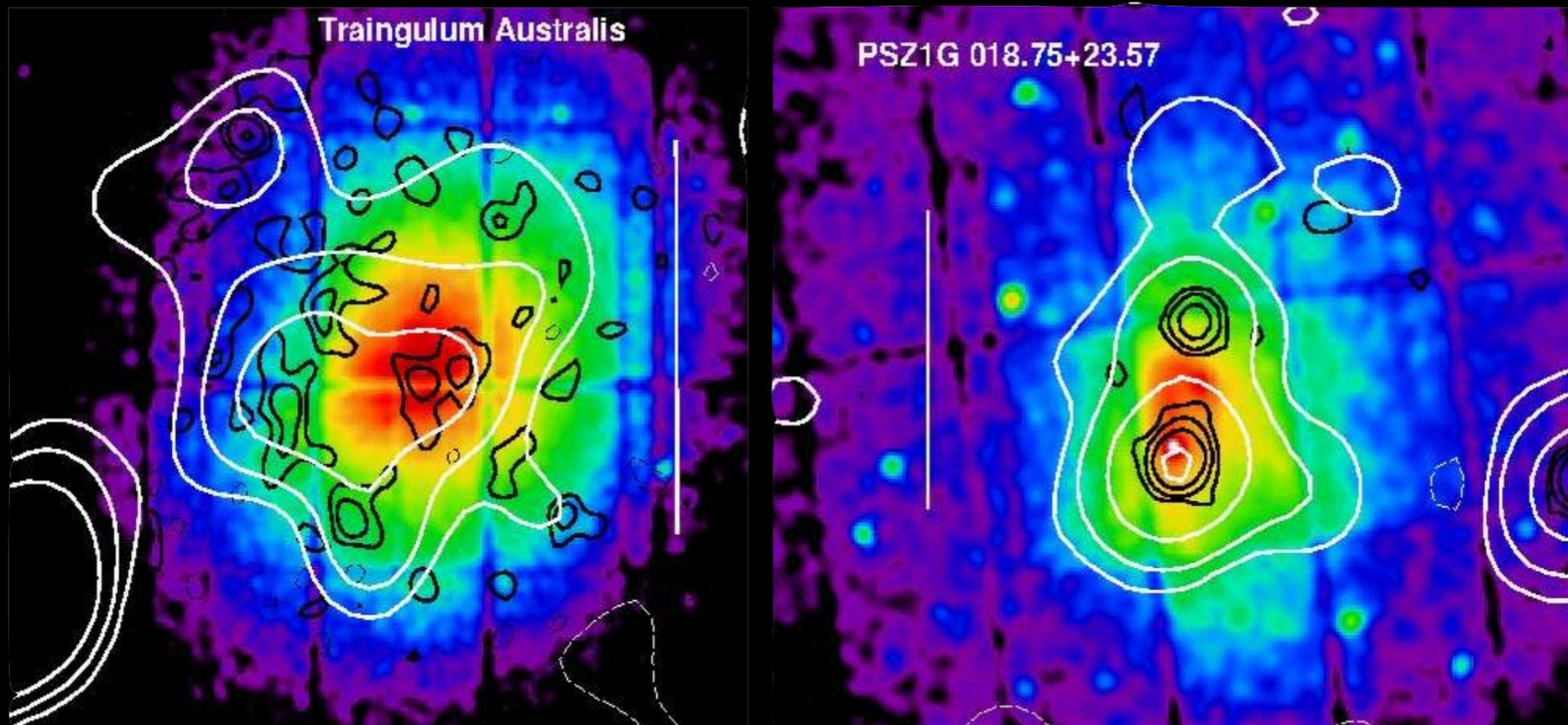
- Data courtesy of E. Murphy (NRAO)
- JVLA 2-4 GHz ~28h A+C config
- 506 channels
- 16k×16k image
- 0.5" resolution
- 0.65 uJy rms



RATT & R. Perley 2016
JVLA S-band, A+B+C config



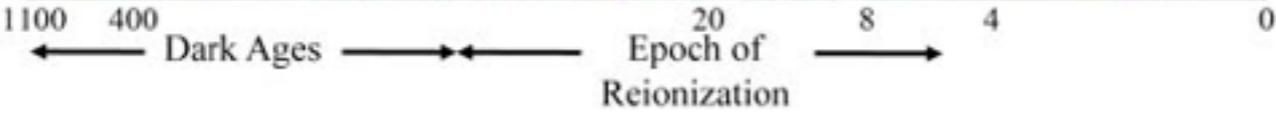
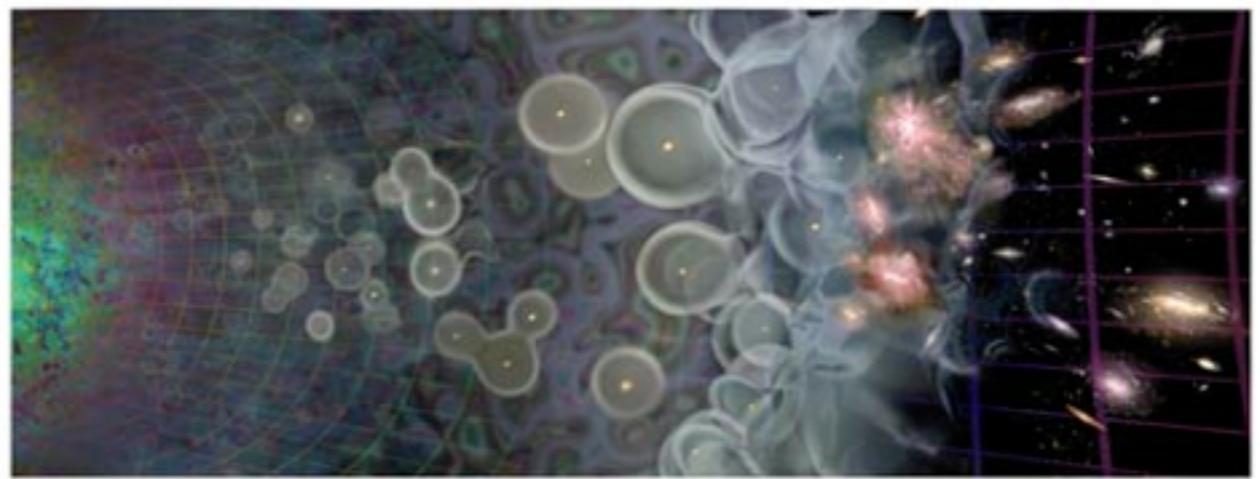
Radio emission from galaxy clusters



- Bernardi et al. survey of mass-selected clusters
- understanding re-acceleration of particles in merging clusters
- KAT-7 calibration pipeline

21 cm cosmology

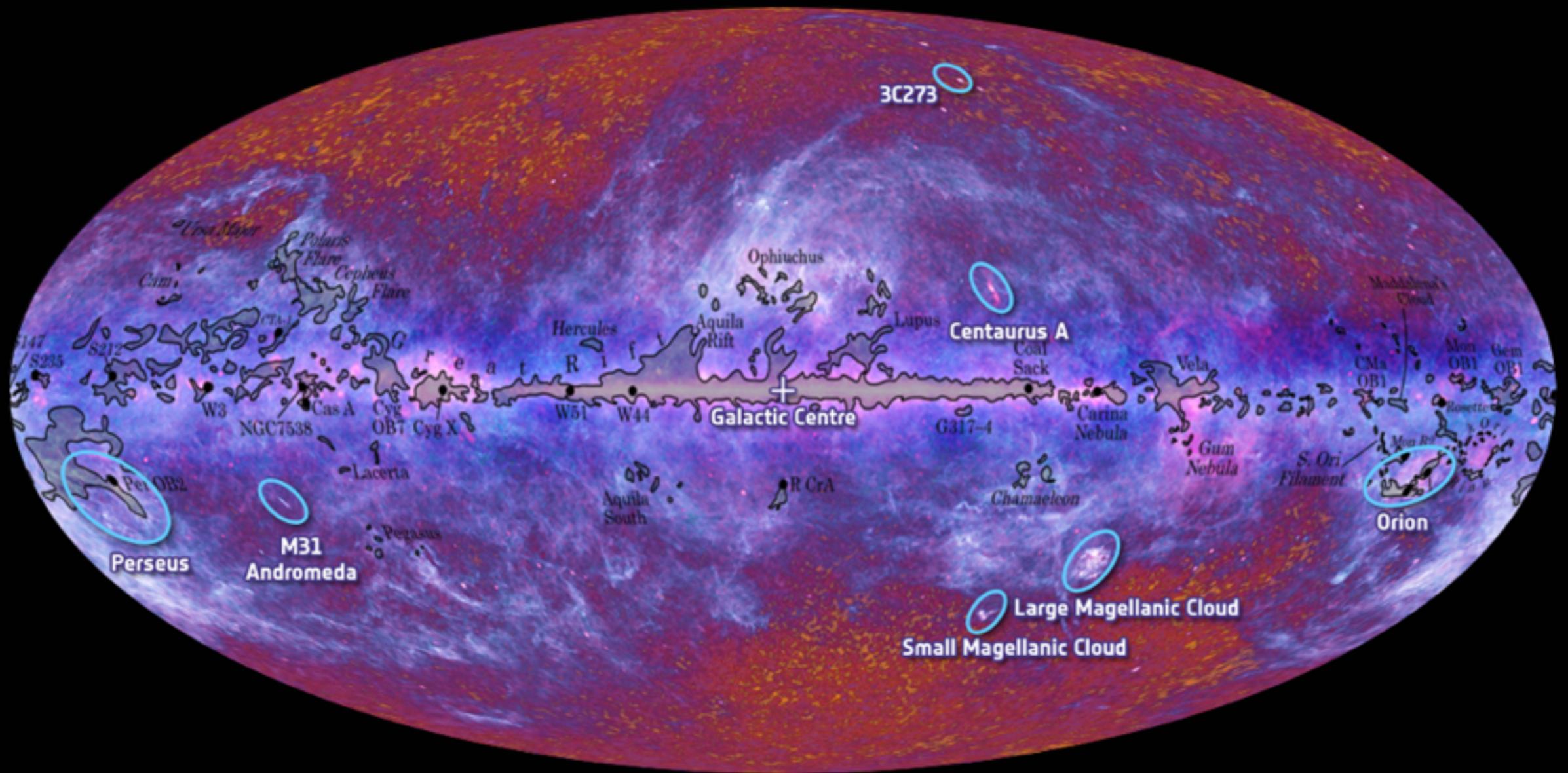
time



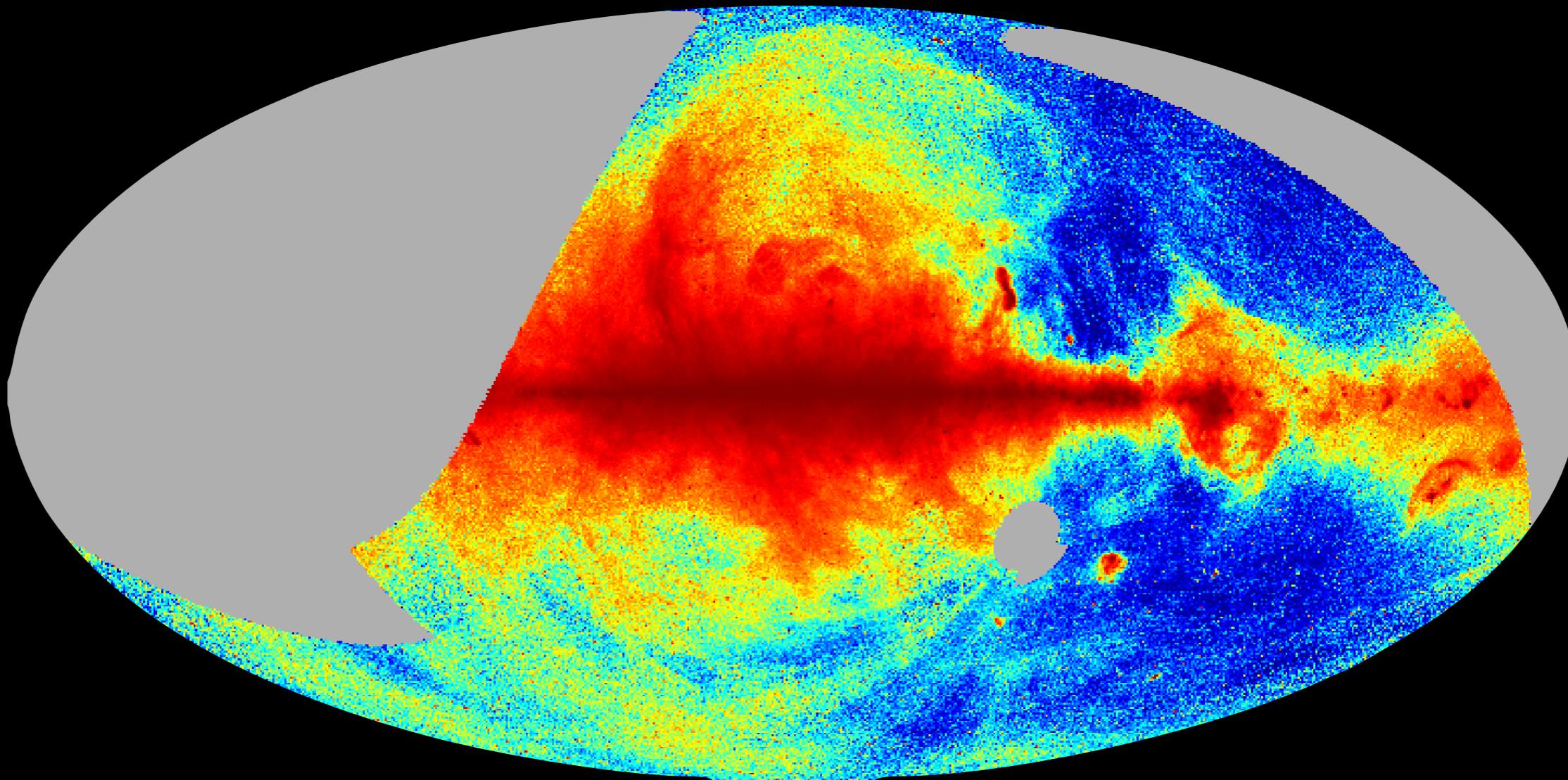
HERA



Galactic foregrounds



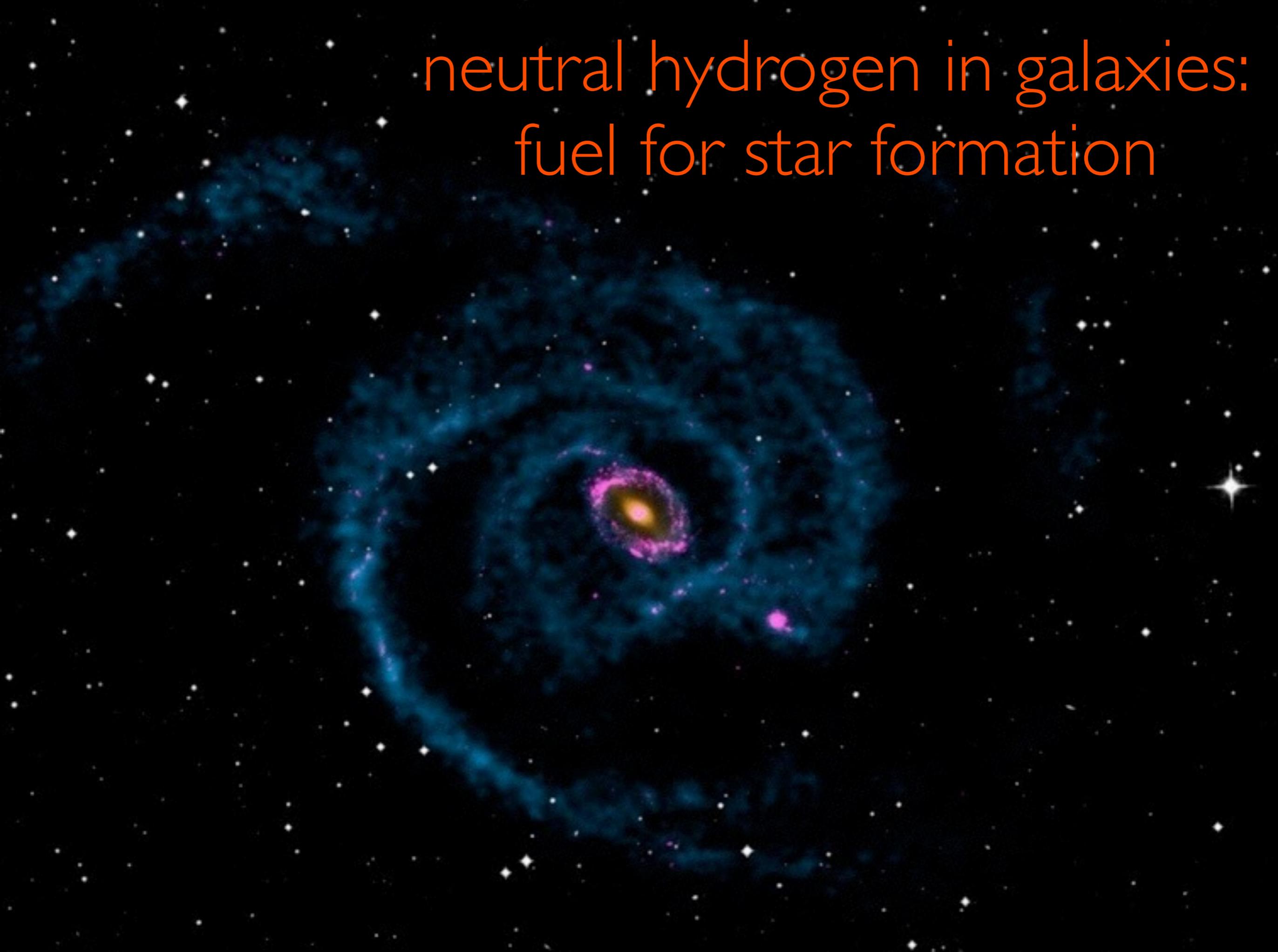
Rhodes/HartRAO 2.3 GHz survey



Jonas+1998

HI in galaxies

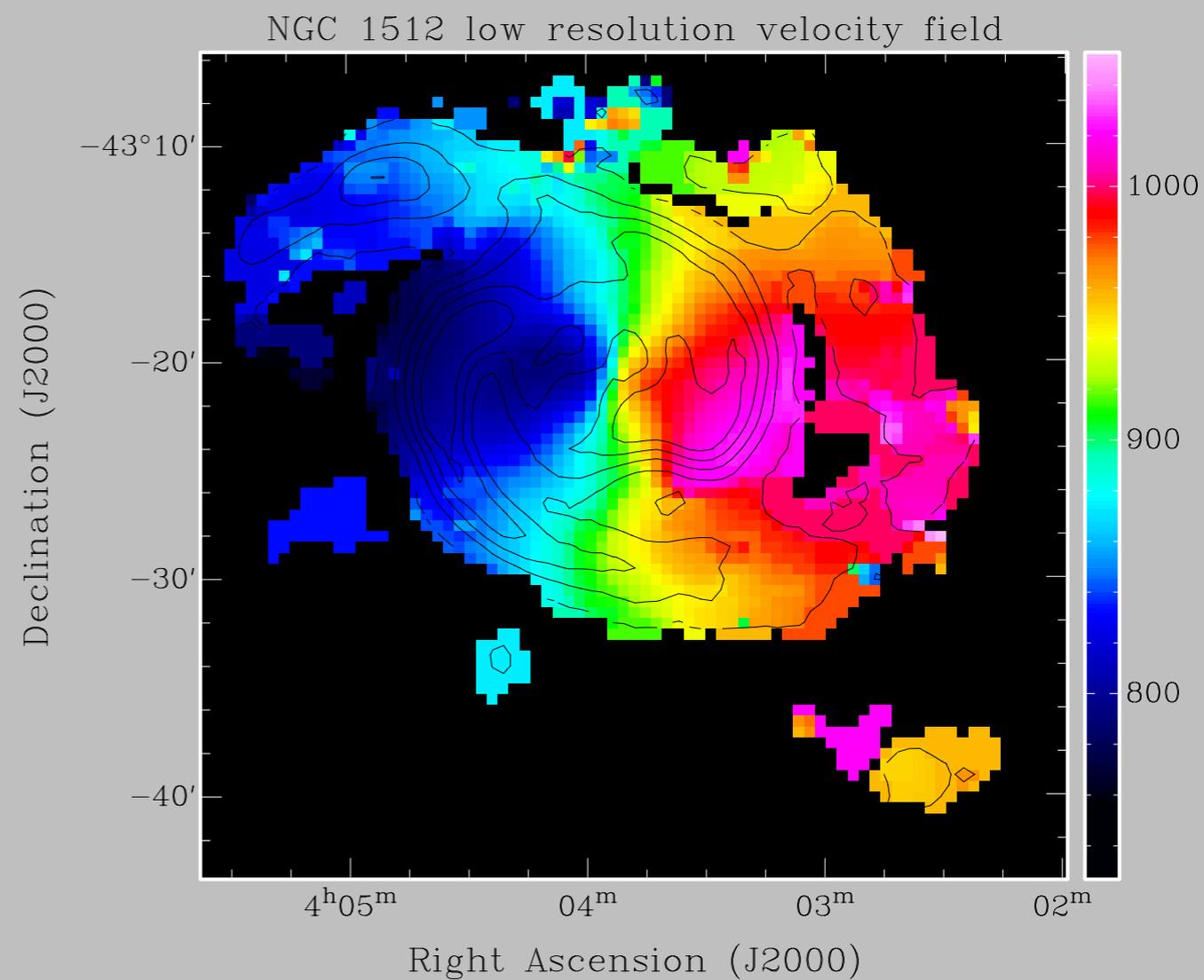
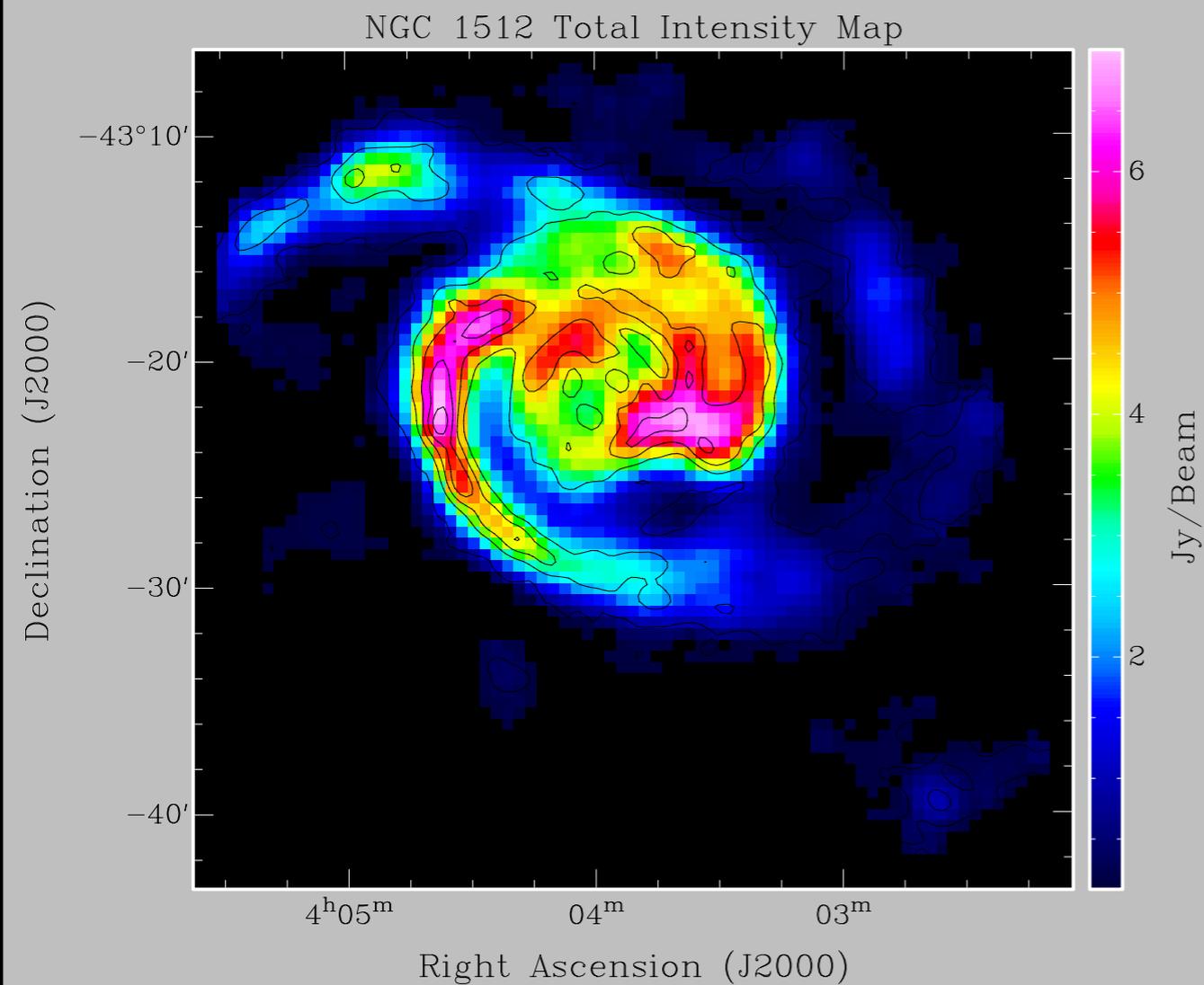
neutral hydrogen in galaxies:
fuel for star formation



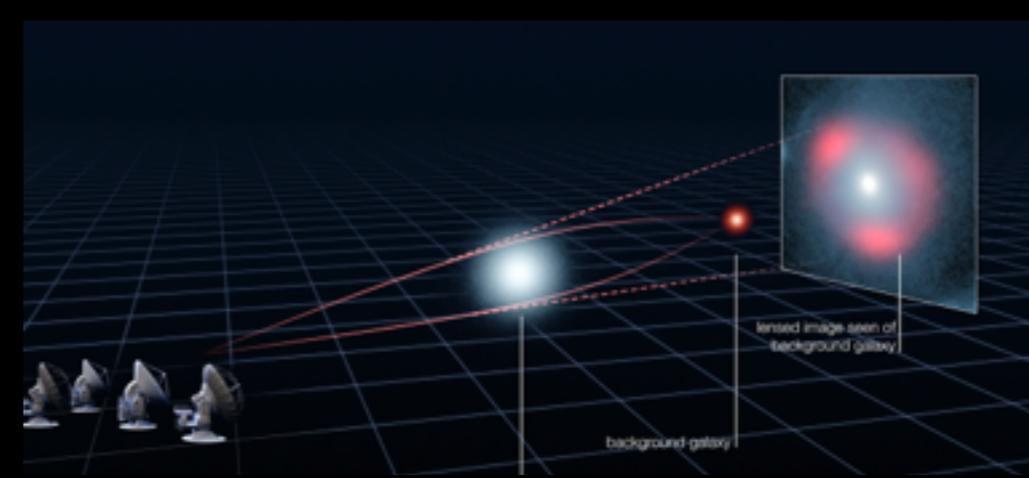
neutral hydrogen in nearby galaxies

total intensity

velocity field



gravitationally lensed HI



unlensed

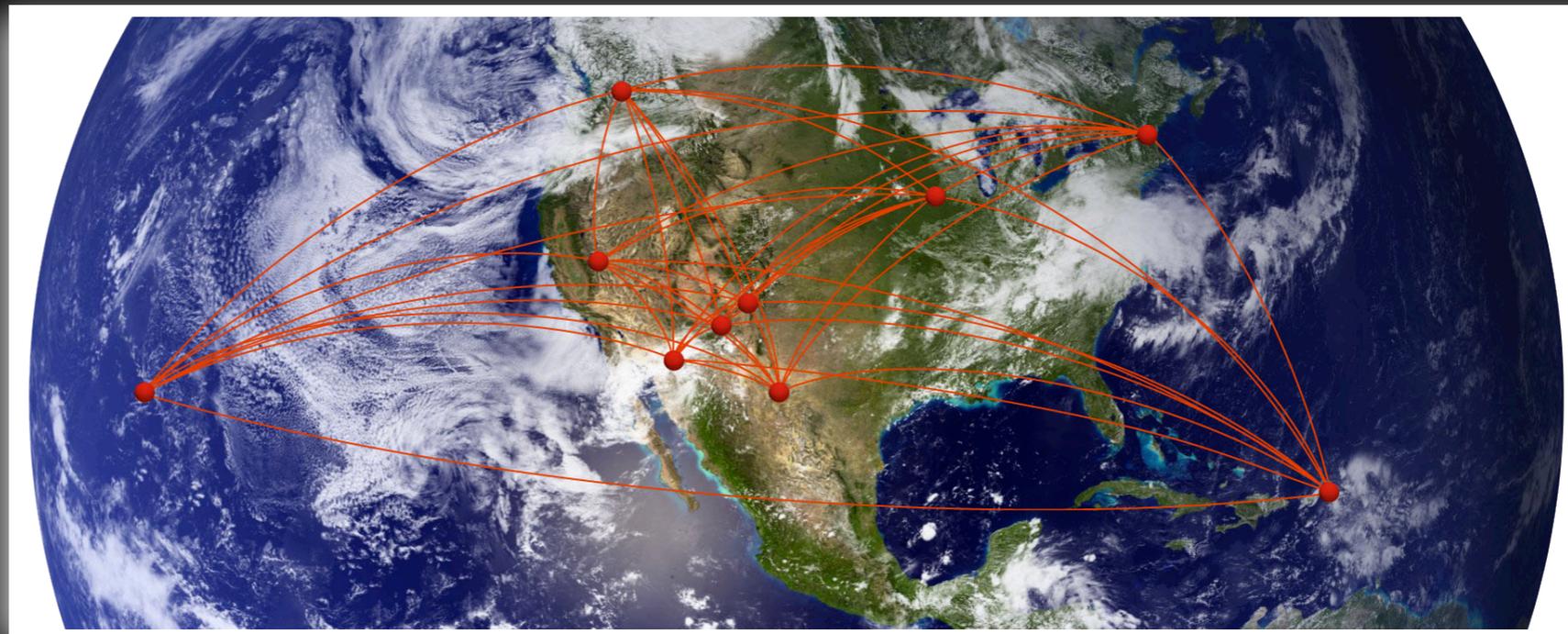
$z=1.69$ magn=2.2	$z=1.78$ magn=3.2	$z=1.82$ magn=2.0	$z=2.06$ magn=3.4	$z=2.10$ magn=4.7
$z=1.43$ magn=2.6	$z=1.40$ magn=2.9	$z=1.48$ magn=3.1	$z=1.49$ magn=3.9	$z=1.52$ magn=2.4
$z=1.02$ magn=2.5	$z=1.08$ magn=2.3	$z=1.16$ magn=2.4	$z=1.31$ magn=3.5	$z=1.37$ magn=2.0
$z=0.49$ magn=2.0	$z=0.79$ magn=2.1	$z=0.90$ magn=3.5	$z=0.92$ magn=2.1	$z=0.99$ magn=2.0

Very Long Baseline Interferometry

EVN

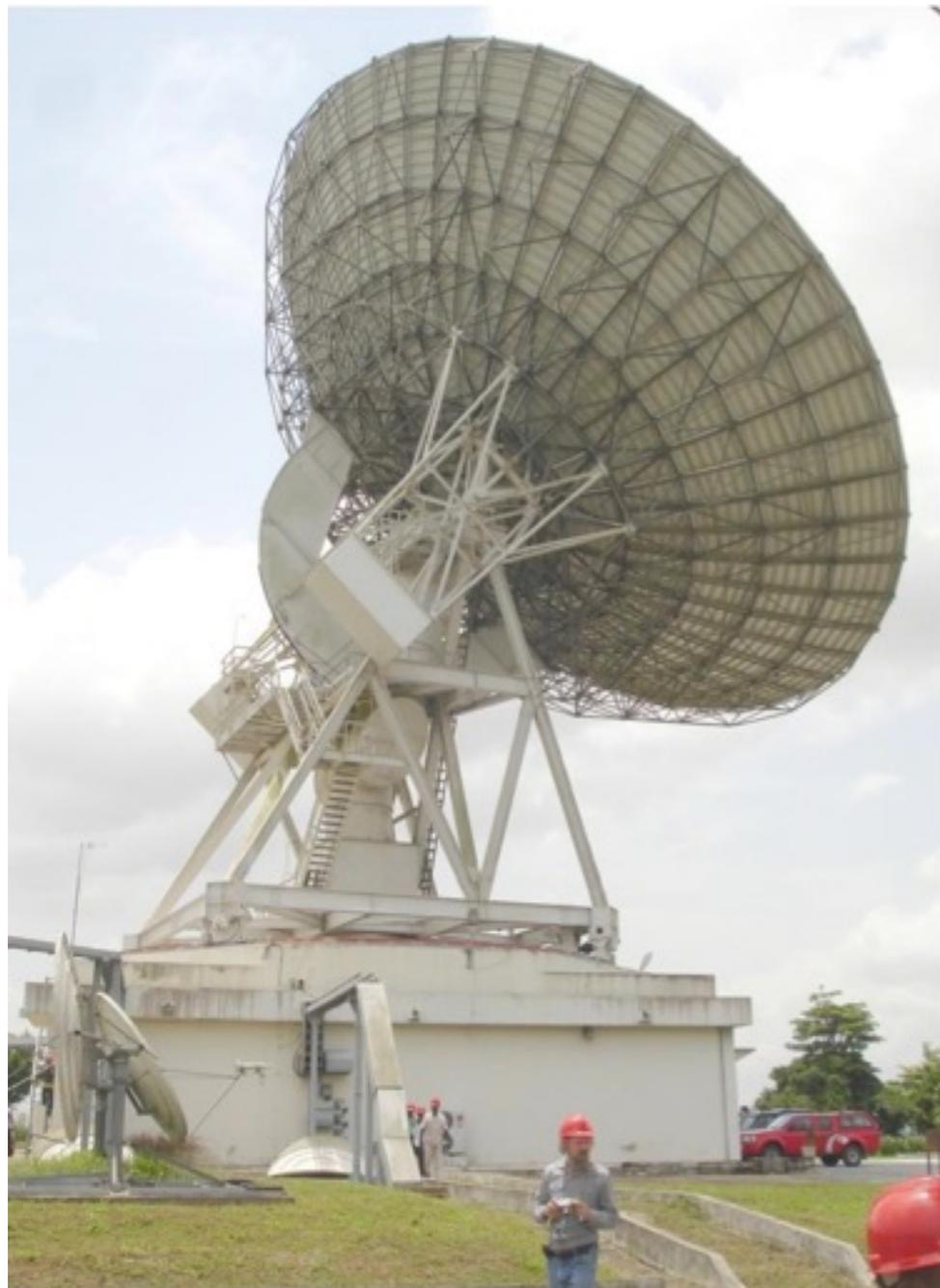


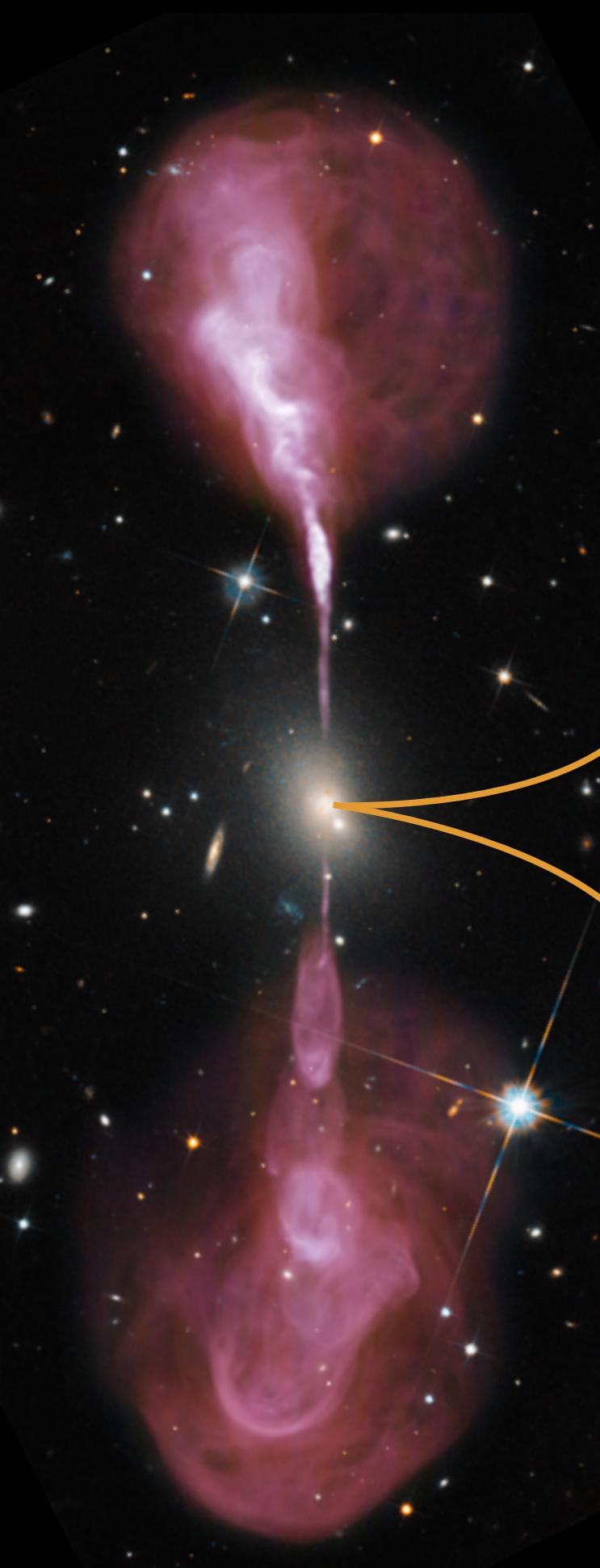
VLBA



future: African VLBI Network

Nkutunse - Ghana





GOODS-North 1.6 GHz VLBA survey

F105W→landscape.fits

deep

wide

VLBA 'FoV'



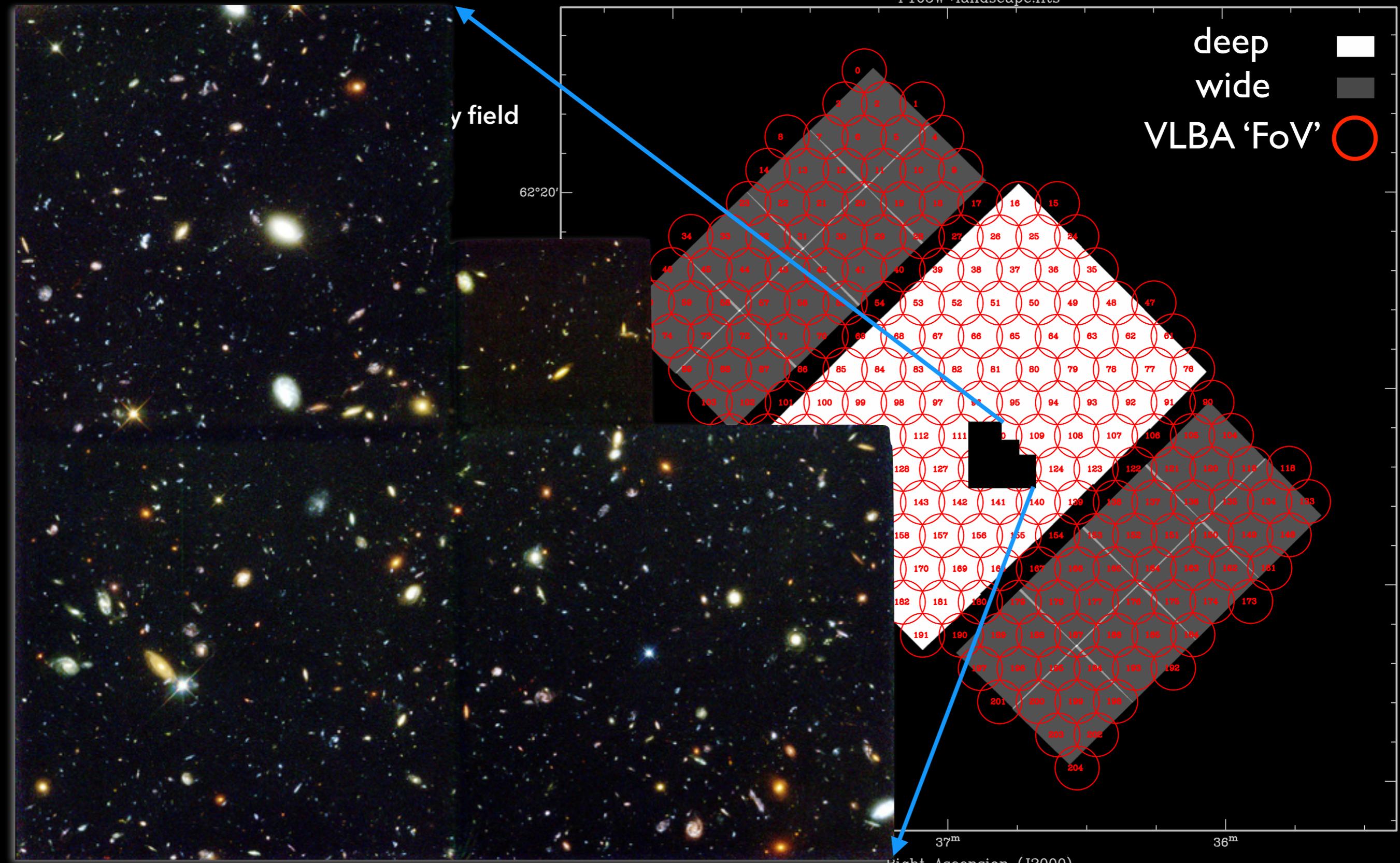
y field

62°20'

37^m

36^m

Right Ascension (J2000)



GOODS-North 1.6 GHz VLBA survey

8 μ Jy/beam, 160 arcmin²

deep Hubble Space Telescope legacy field

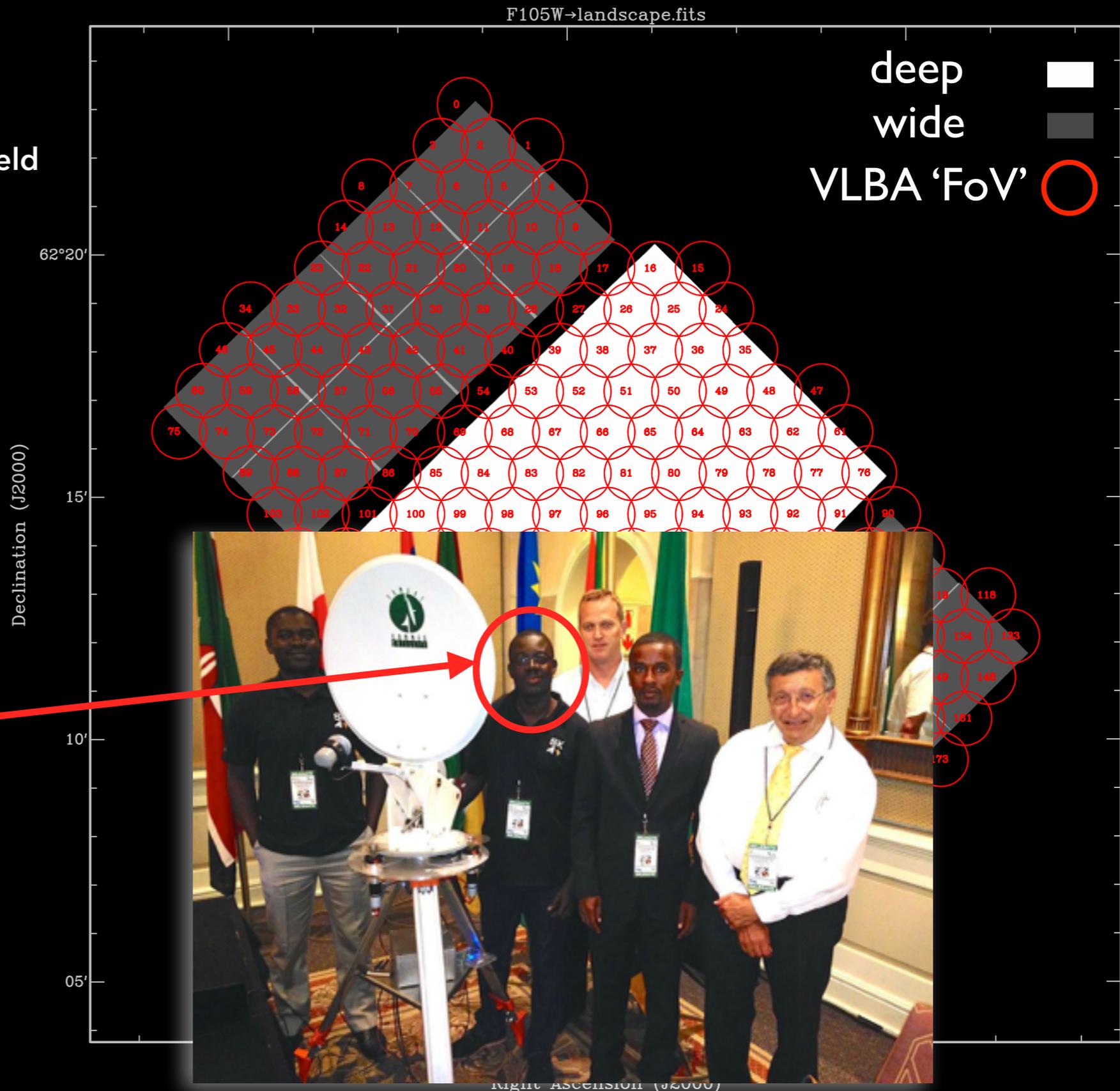
4 Terabytes of raw data

205 phase centres

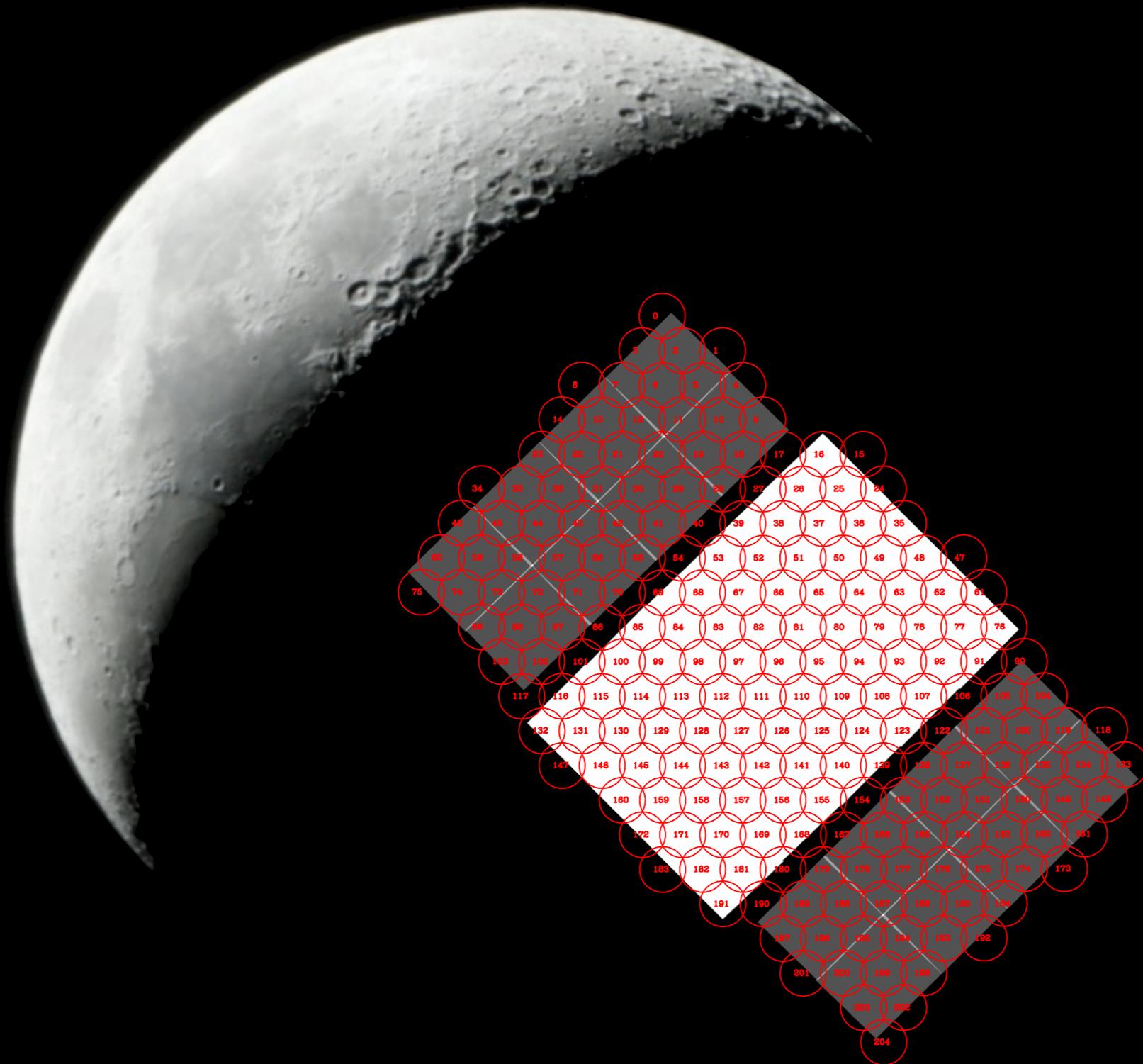
~1 Terapixel image (205 x 64k x 64k)

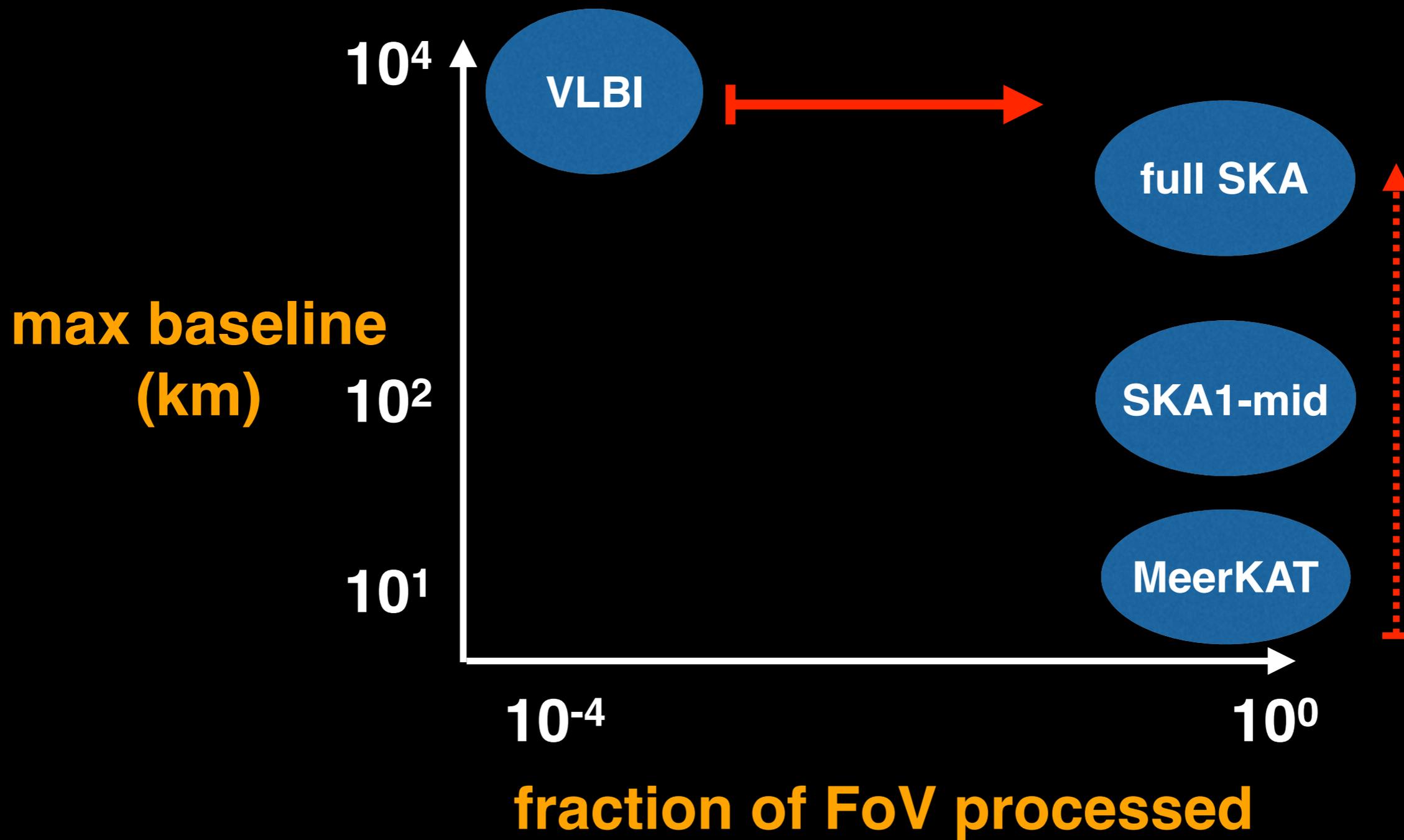
Team:

- Roger Deane (PI, Rhodes) 
- Alexander Akoto-Danso (Rhodes) 
- Oleg Smirnov (Rhodes) 
- Gianni Bernardi (Rhodes) 
- Matt Jarvis (Oxford/UWC)  
- Zsolt Paragi (JIVE) 
- Mike Garrett (Manchester) 
- Tom Mauch (SKA-SA) 
- Stephen Bourke (Caltech) 
- Ian Heywood (ATNF/Rhodes)   
- Peter Barthel (Groningen) 



survey area approximately 1 quarter of the moon
final image size ~ 1 Terapixels (125 000 iPhone 6 photos)



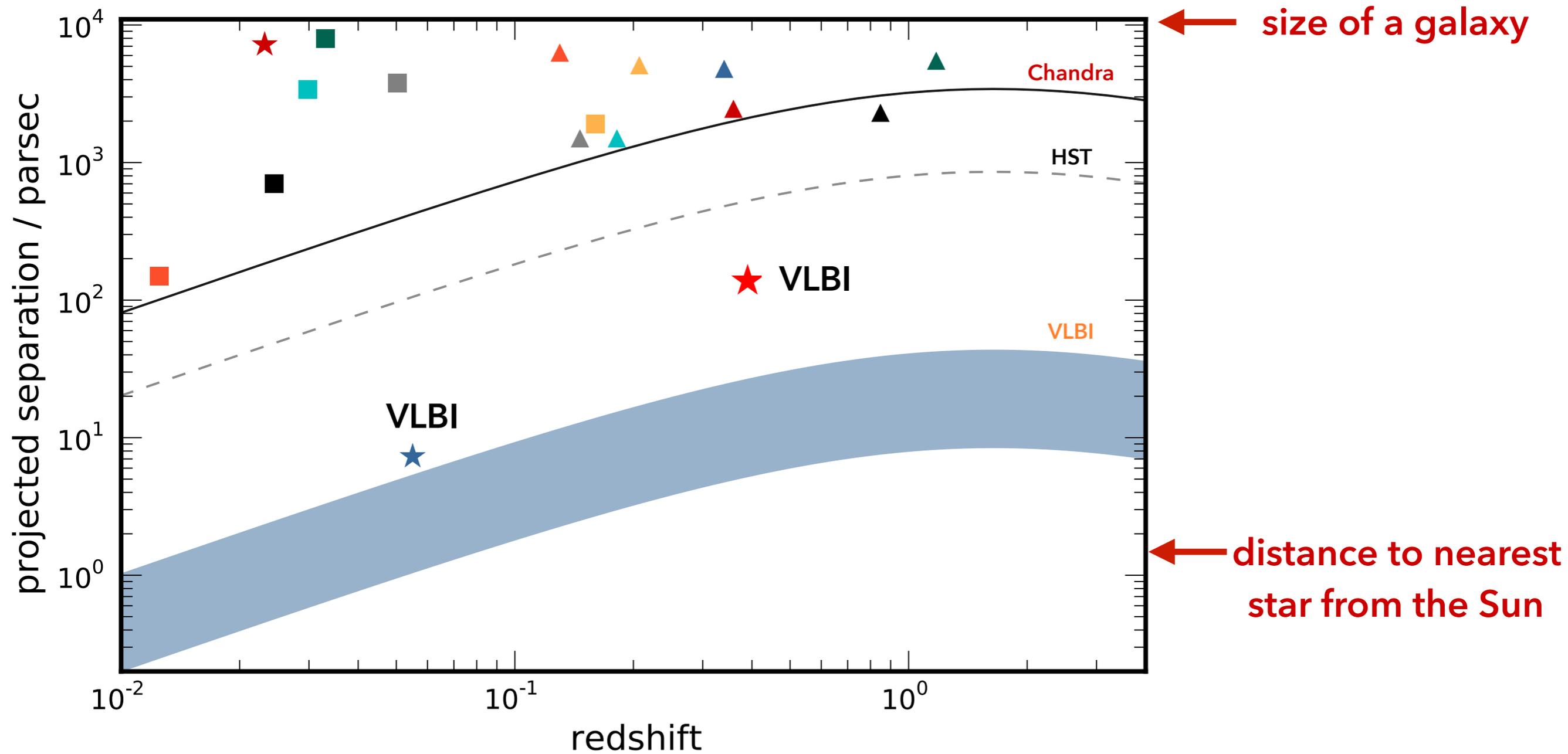


survey science and search for exotic objects



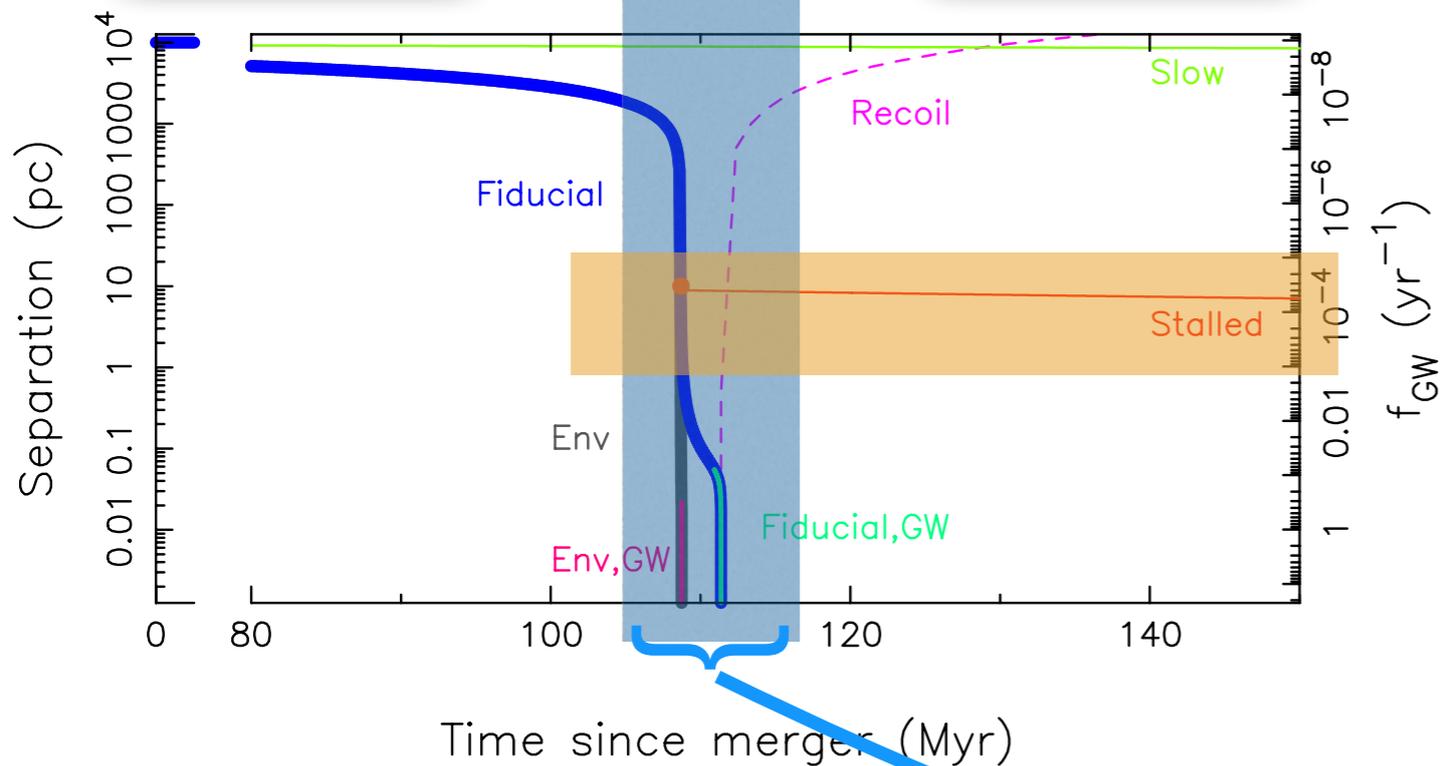
strong binary supermassive black hole candidates

confirmed with direct imaging



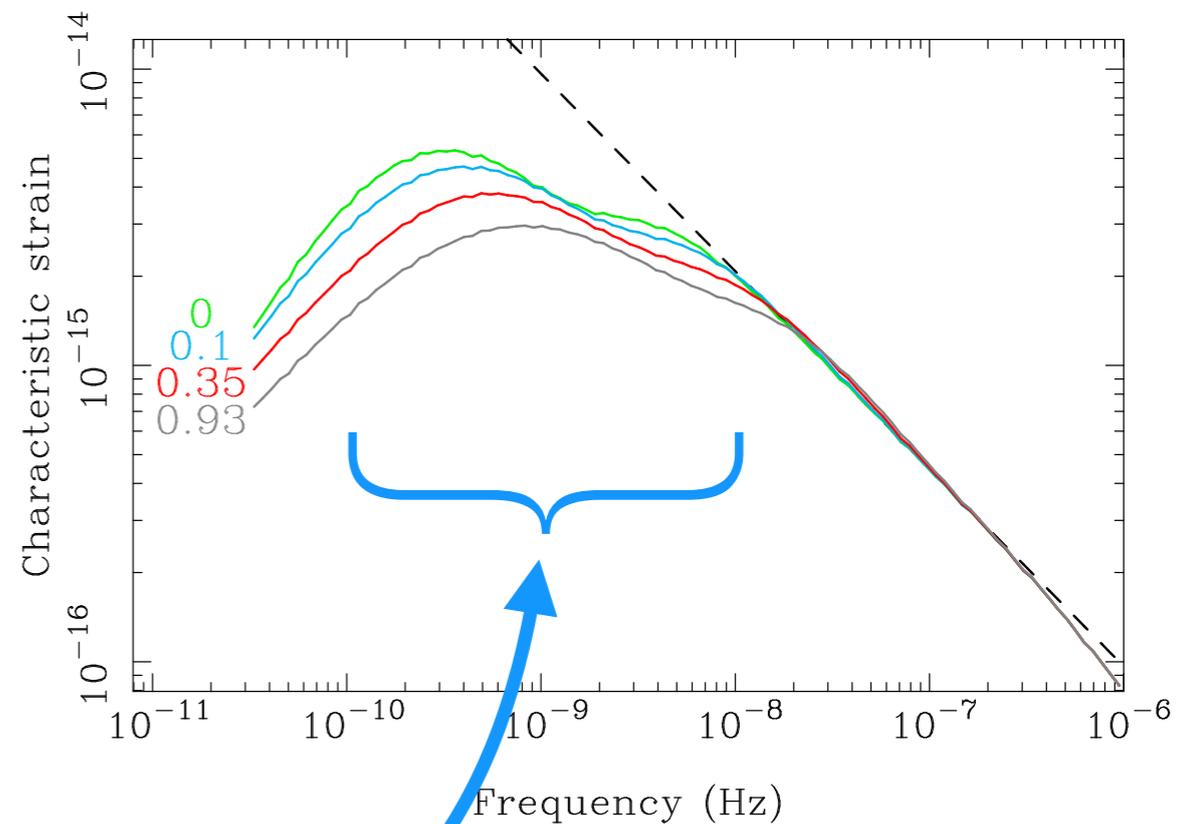
VLBI and pulsar timing array gravitational wave complementarity

binary SMBH evolution



Shannon+2015

stochastic gravitational wave
background spectrum



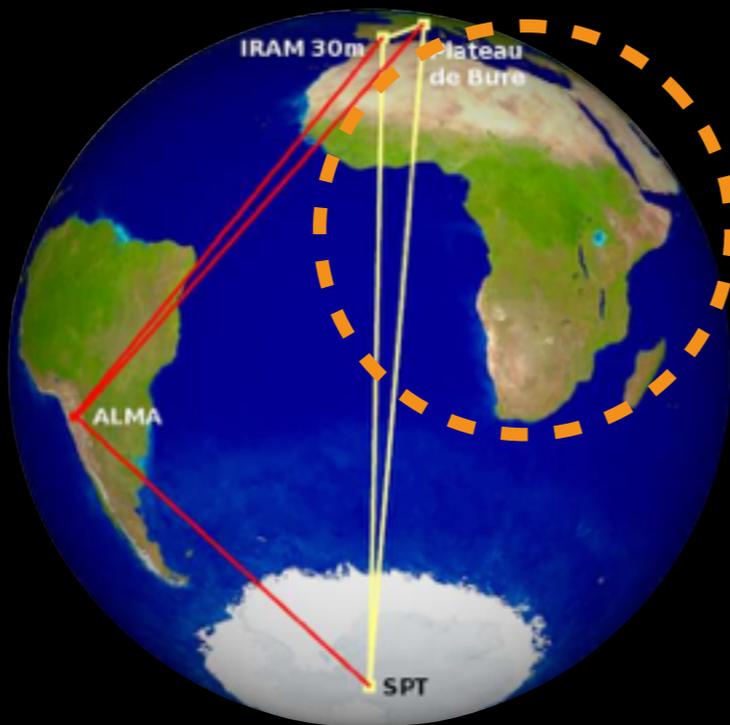
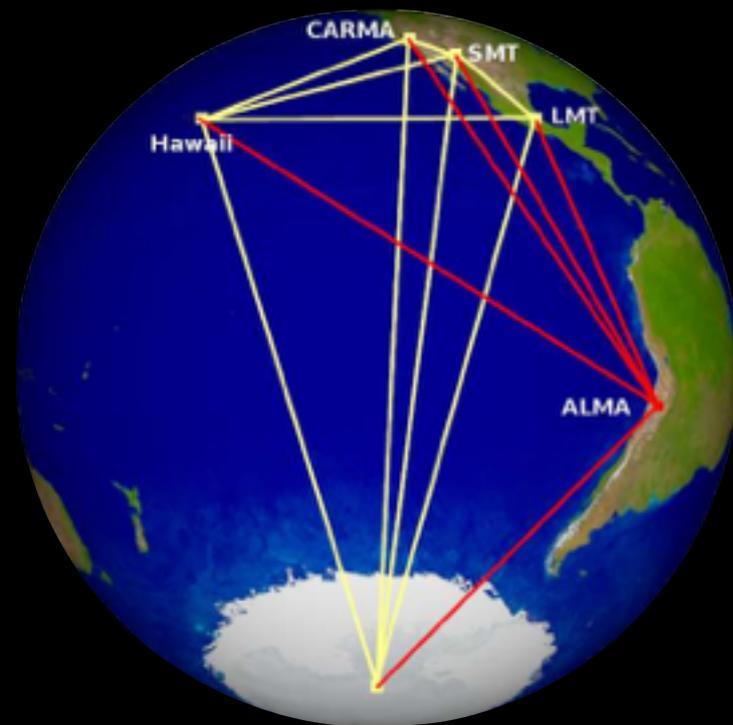
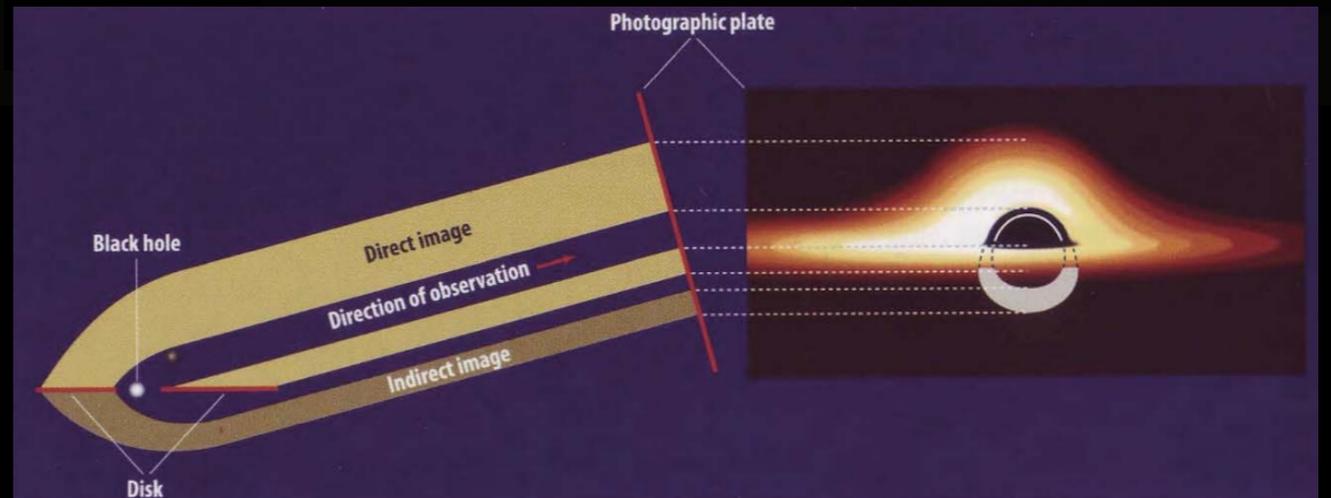
Ravi+2014



VLBI at mm wavelengths (230 GHz)

primary objective: image black hole shadow

1000x better resolution than Hubble
(20 micro-arcseconds)



**BlackHoleCam exploring construction
of an African millimetre Telescope**

IMAGING THE EVENT HORIZON OF BLACK HOLES

PRINCIPAL INVESTIGATORS (PI)



HEINO FALCKE

PI Radboud University Nijmegen
(NL)



MICHAEL KRAMER

PI MPIFR Bonn
(Germany)



LUCIANO REZZOLLA

PI Goethe University Frankfurt
(Germany)

CO-INVESTIGATORS



ROBERT LAING

ESO



HUIB VAN LANGEVELDE

JIVE



FRANK EISENHAUER

MPI

ASSOCIATED PARTNERS



SERA MARKOFF

University of
Amsterdam



KARL SCHUSTER

IRAM



ANTON ZENSUS

MPIFR-VLBI



ROGER DEANE

Rhodes University

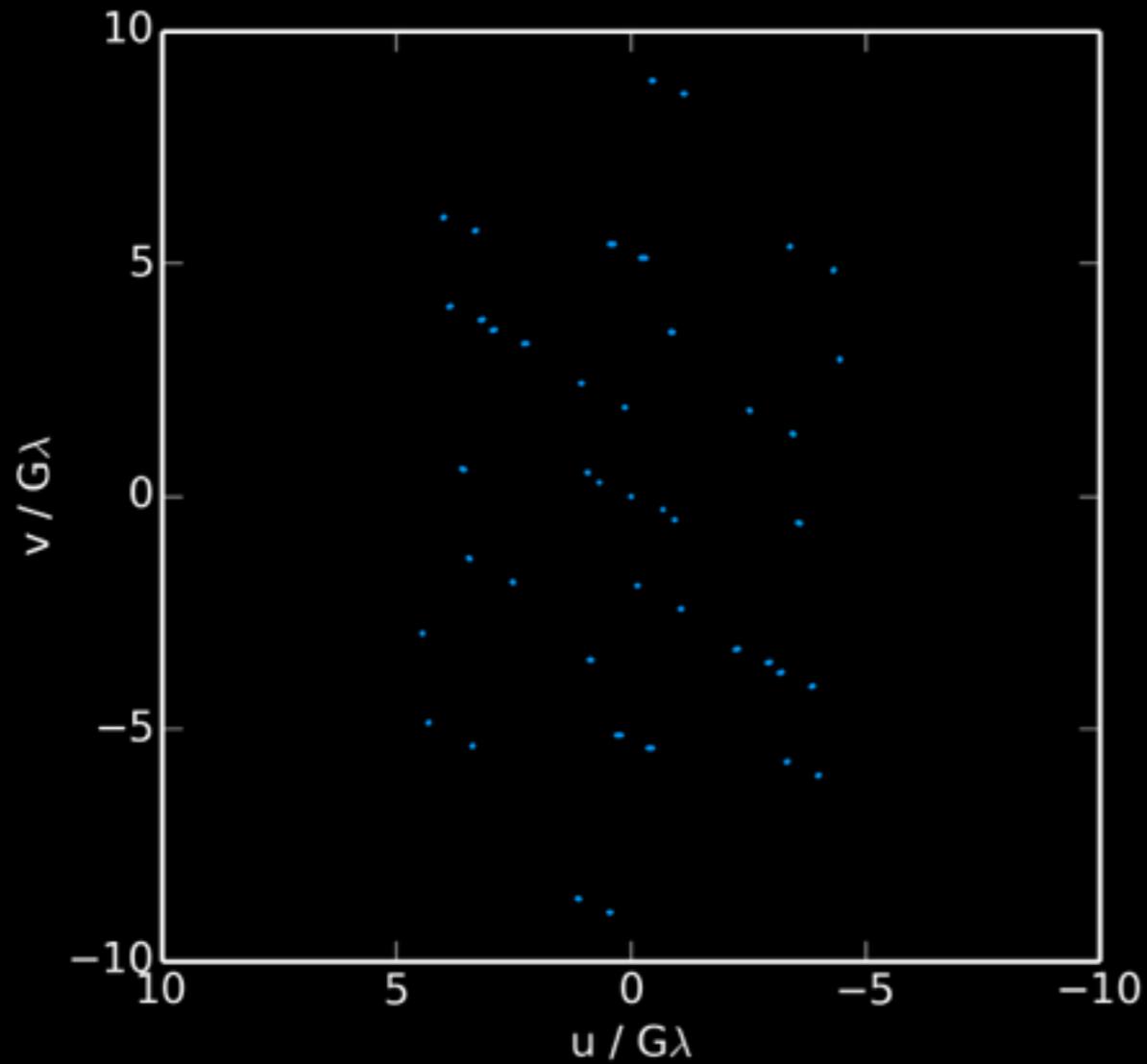


CORNELIA MUELLER

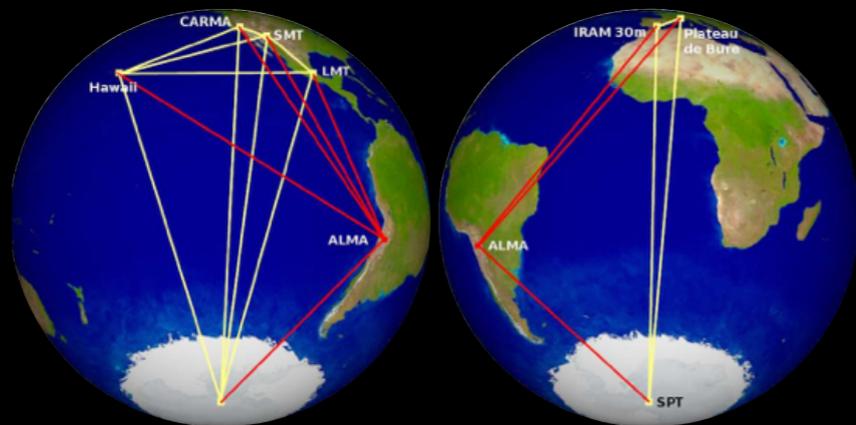
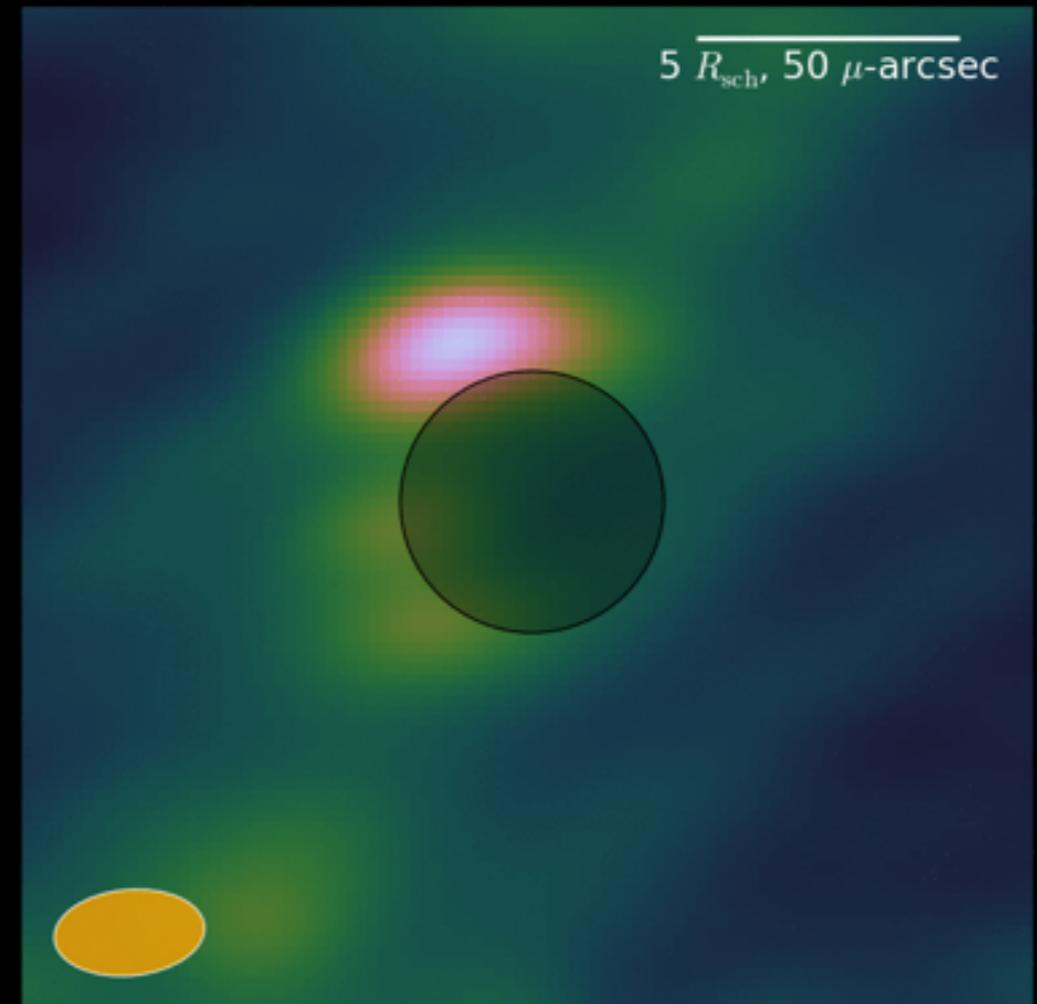
Africa Millimetre
Telescope

realistic EHT simulations

uv-coverage: 200 sec integrations, 2 hour run



interferometric snapshots



understand systematic uncertainties
develop EHT Bayesian toolkit
optimise calibration and imaging algorithms

summary

- diverse radio astronomy research profile
- well-represented, growing group
- highly aligned with, and direct contributor to, MeerKAT/SKA science and technical development
- group members share strong scientific and technical synergy