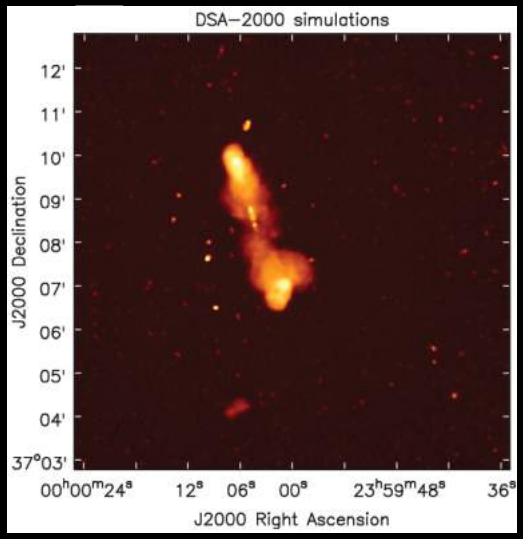
DSA-2000: a 2000-dish radio array



G. Hallinan[1], V. Ravi[1], S. Weinreb[1], J. Kocz[1], Y. Huang[1], D. P. Woody[1], J. Lamb[1], J. Hickish[1], K. L. Bouman[1], L. D'Addario[1], M. W. Hodges[1], M. Catha[1], J. Shi[1], C. Law[1], G. Hellbourg[1], D. Simard[1], M. Fleming[1], S. R. Kulkarni[1], E. S. Phinney[1], H. Sun[1]

M. A. McLaughlin[2], S. M. Ransom[2], X. Siemens[2], J. M. Cordes[2], R. S. Lynch[2], D. L. Kaplan[2], S. Chatterjee[2], J. Lazio[2], A. Brazier[2]

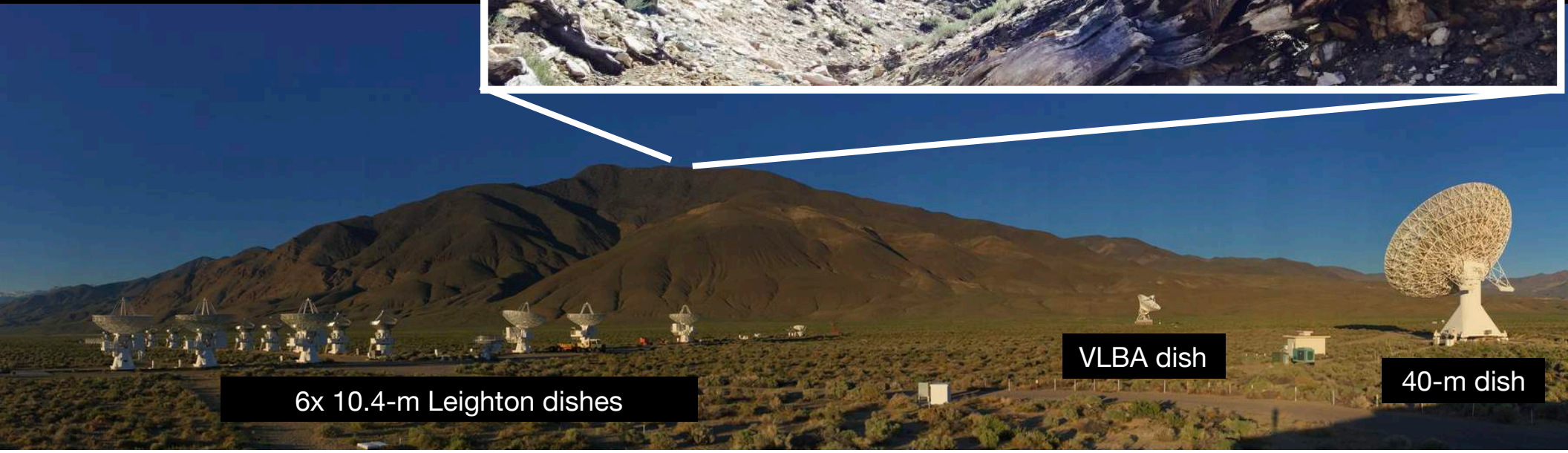
S. Bhatnagar[3], S. T. Myers[3], F. Walter[4,3], B. M. Gaensler[5]

[1]*DSA Collaboration*
[2]*The NANOGrav Collaboration*
[3]*NRAO, 1003 Lopezville Road, Socorro, NM 87801, USA*
[4]*Max Planck Institute for Astronomy, Königstuhl 17, D-69117 Heidelberg, Germany*
[5]*Dunlap Institute, University of Toronto, 50 St. George Street, Toronto, ON M5S 3H4, Canada*

Hallinan, Ravi +19 arXiv:1907.07648

Owens

John Bolton with Caltech's first radio dish (Palomar Mtn, early 1950s)



The Deep Synoptic Array

DSA-1 (2013)

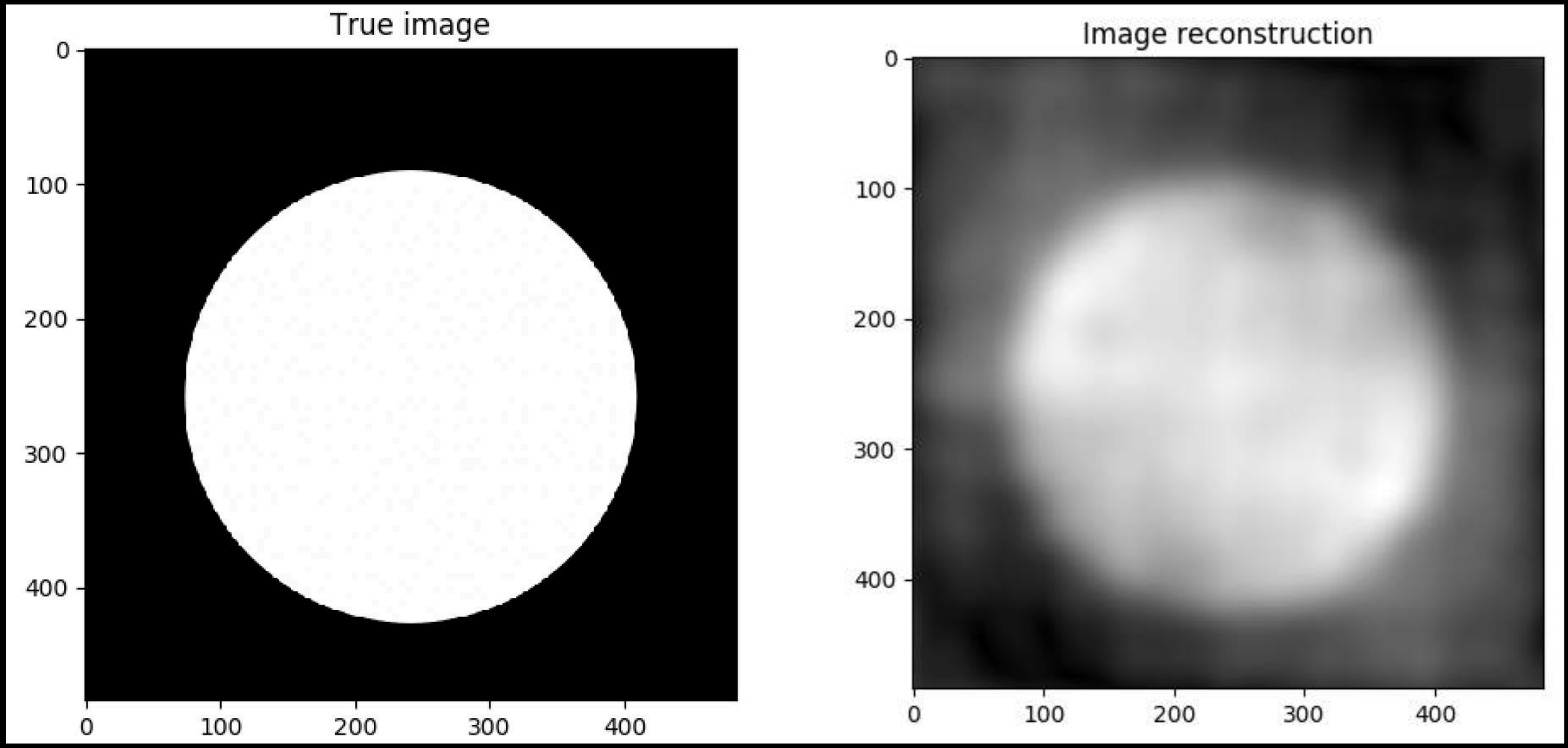
DSA-10 (2017)

STARE2

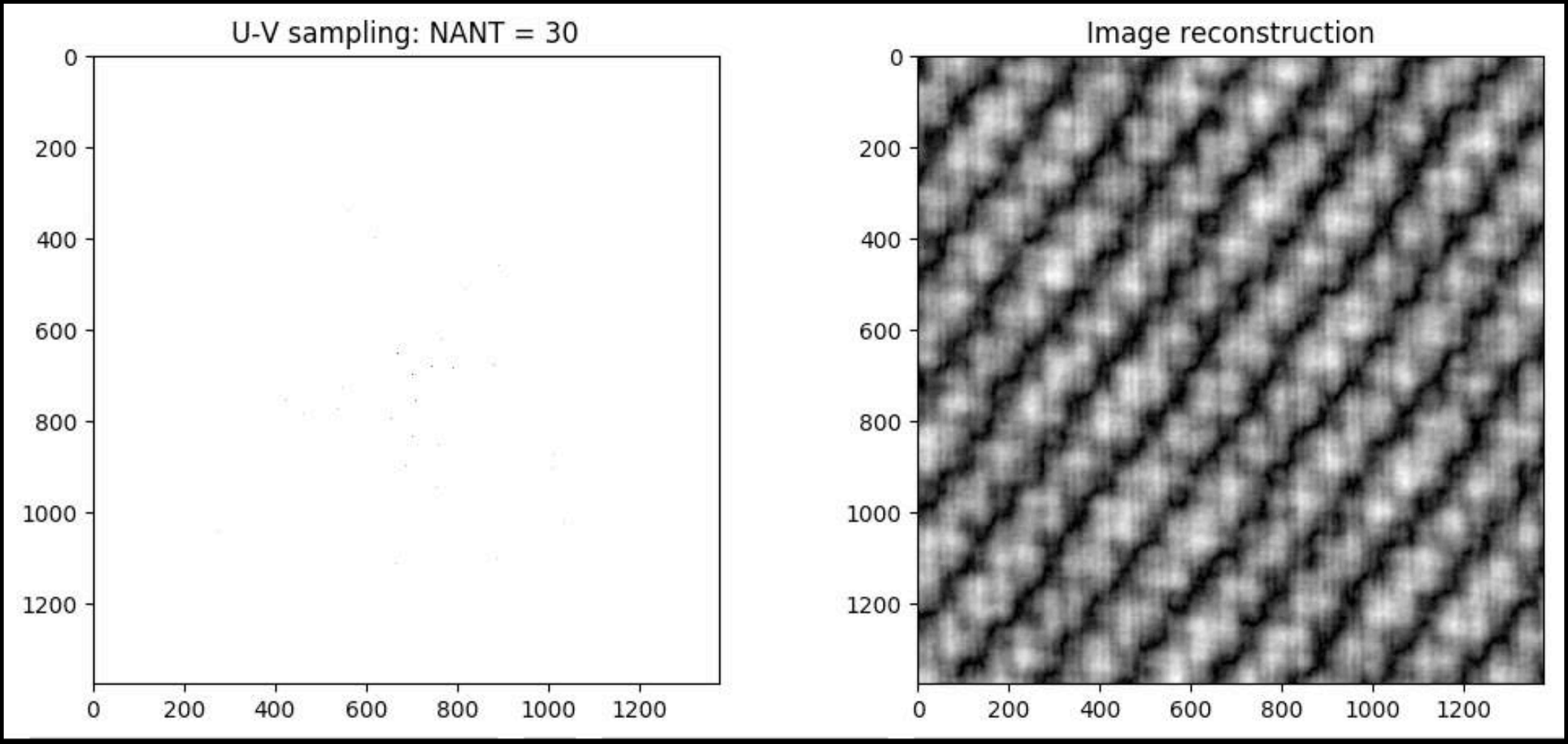
Localized FRB

DSA-110 (2020)

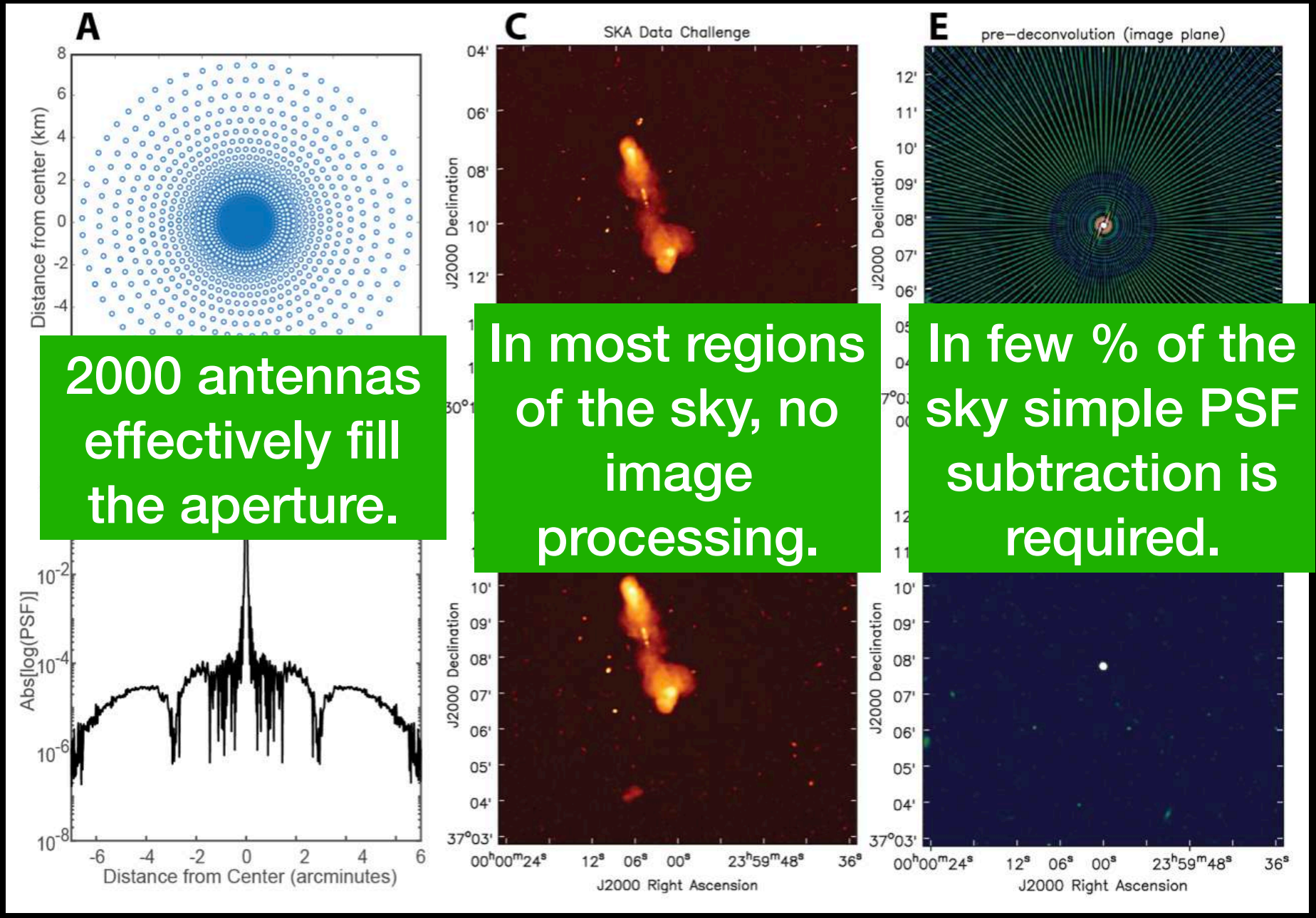
DSA-2000: why 2000 antennas?



DSA-2000: why 2000 antennas?



DSA-2000: the concept

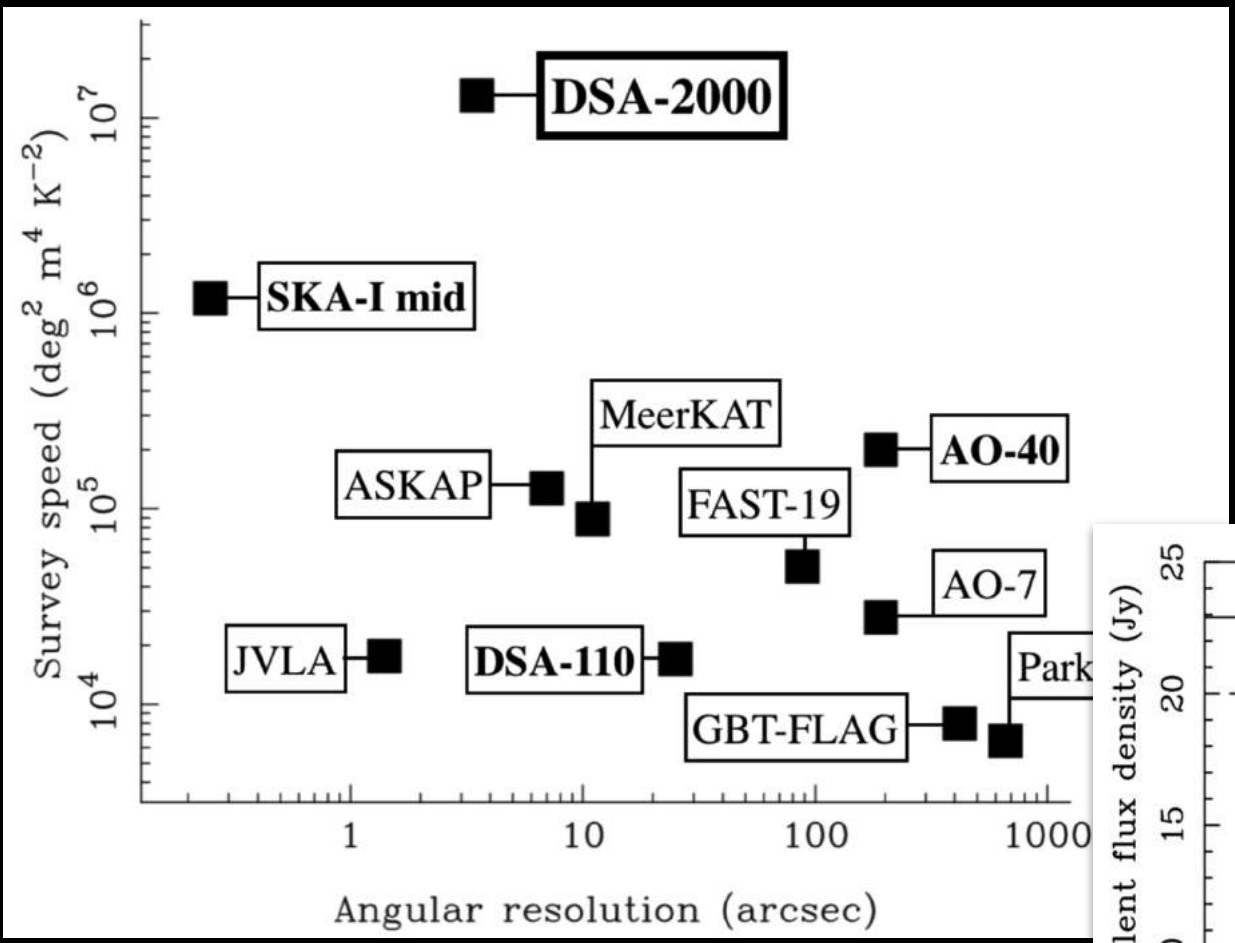


2000 antennas effectively fill the aperture.

In most regions of the sky, no image processing.

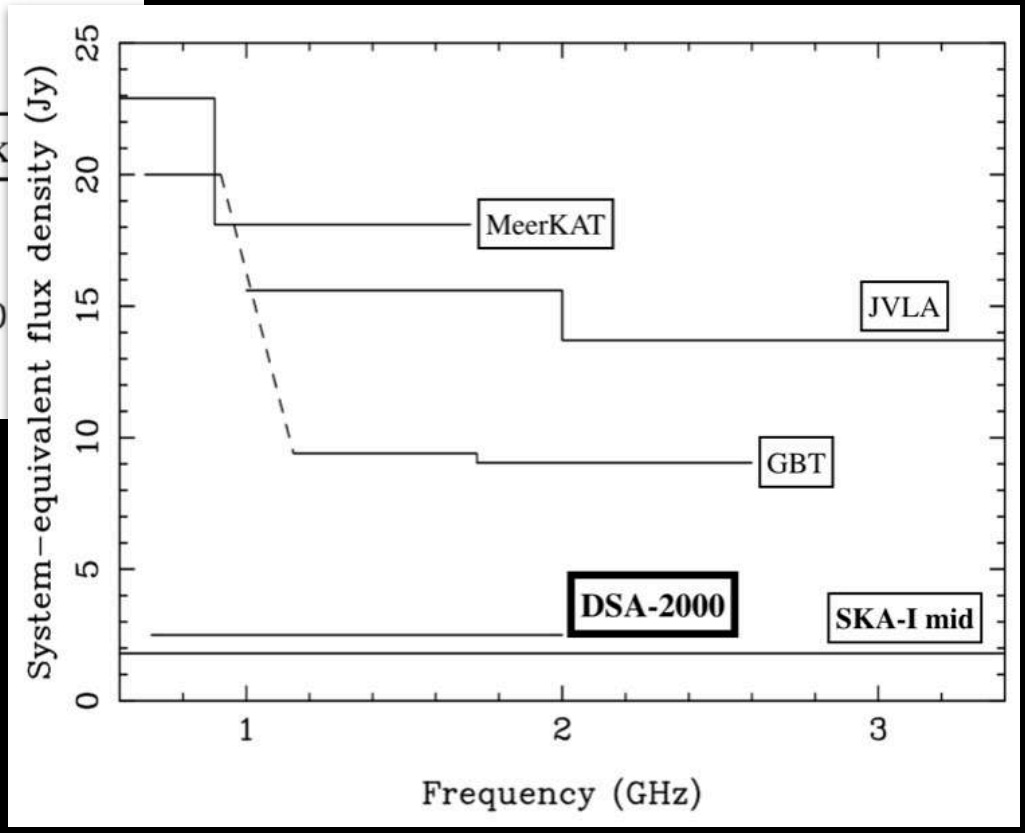
In few % of the sky simple PSF subtraction is required.

DSA-2000: a radio survey telescope

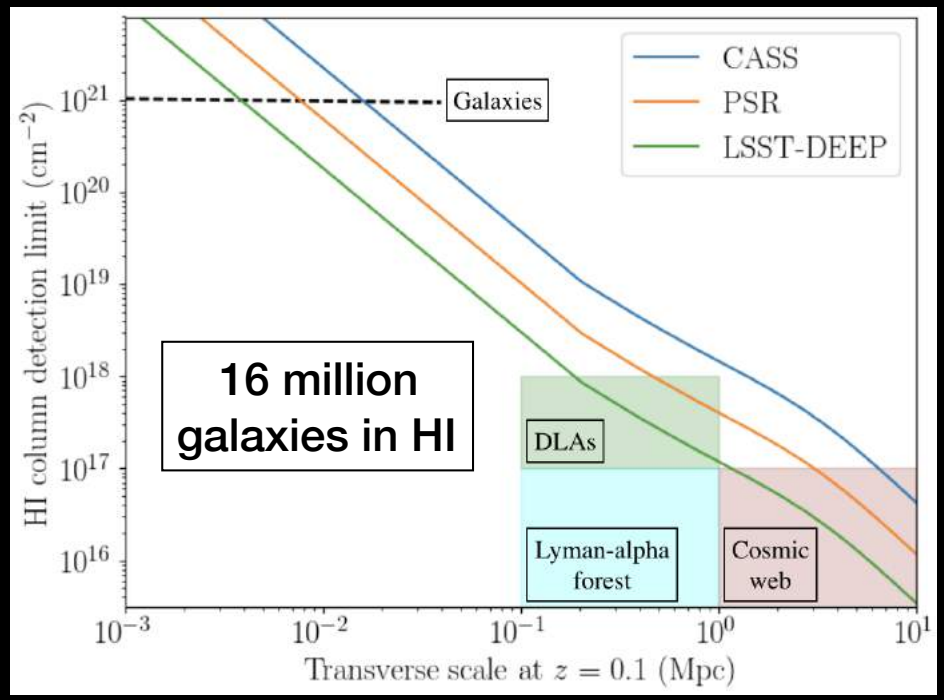


Sensitivity comparable to Arecibo and SKA-I mid

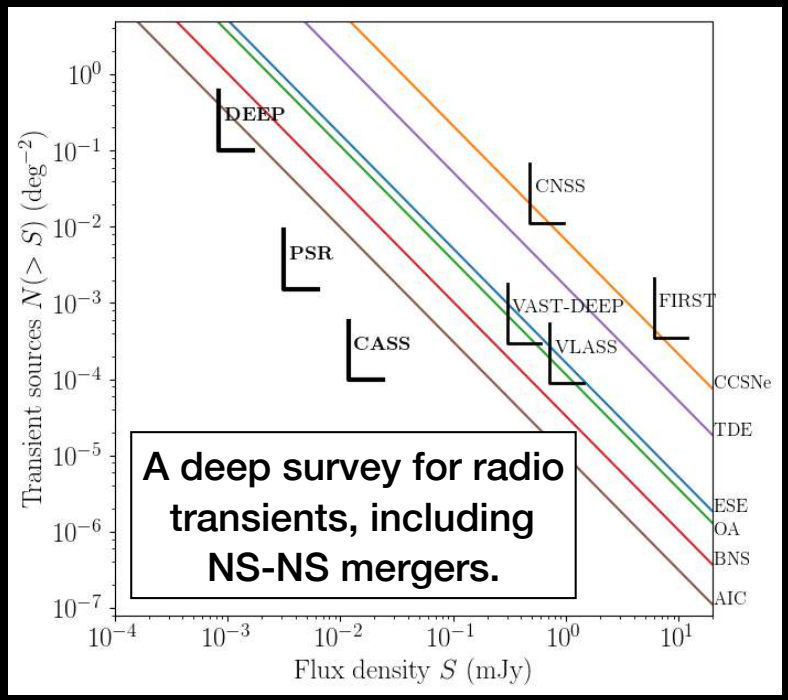
Survey speed 10x SKA-I mid



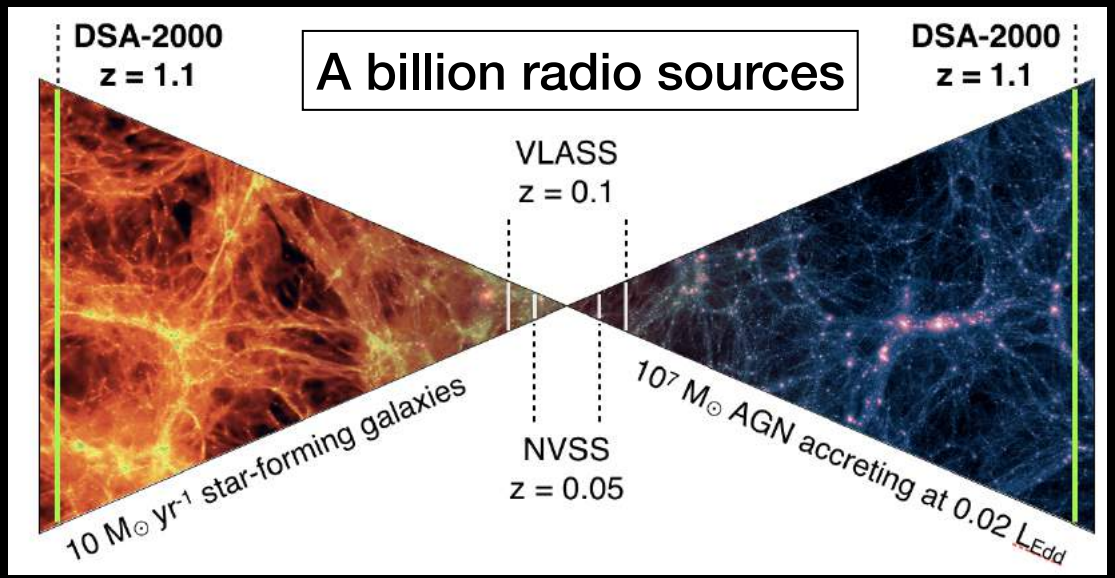
DSA-2000: science cases

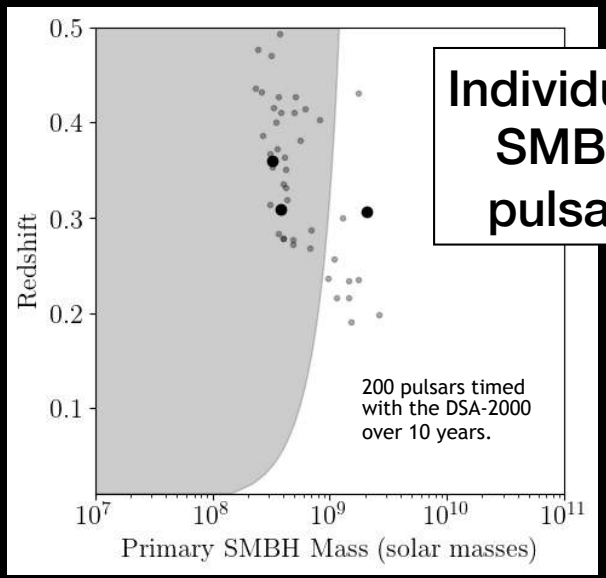


16 million galaxies in HI



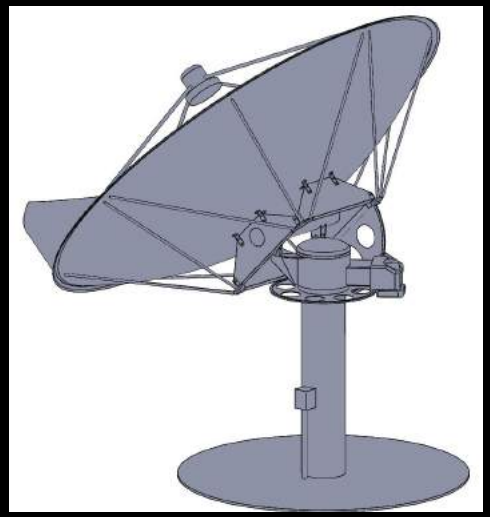
A deep survey for radio transients, including NS-NS mergers.

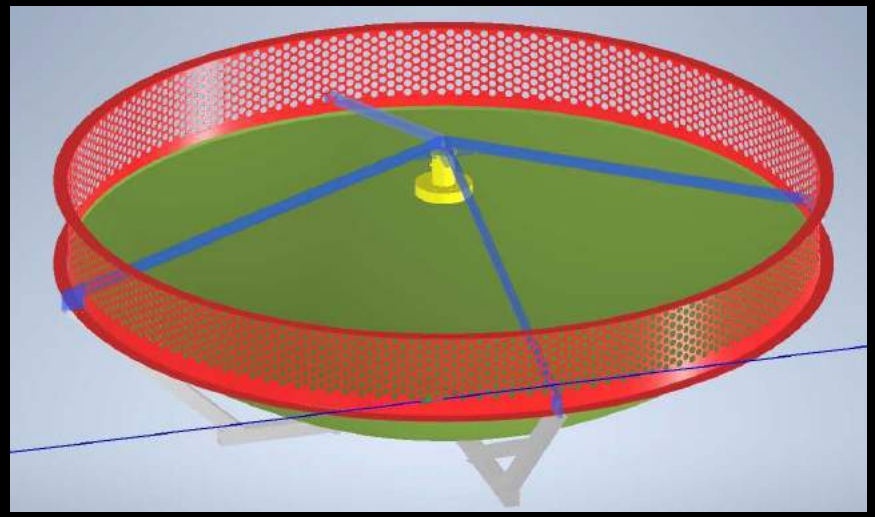




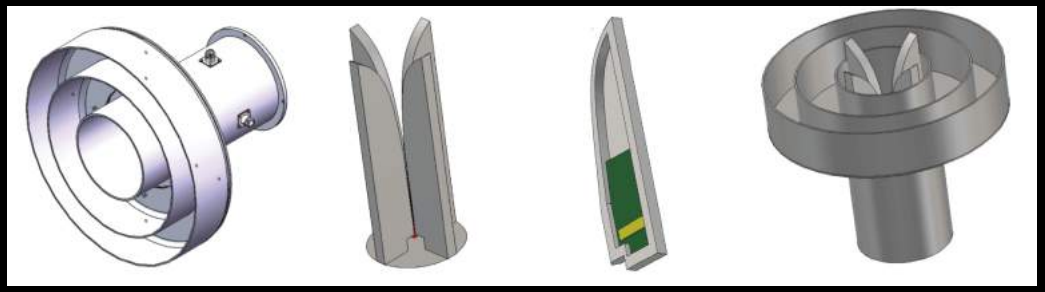
Individual binary SMBHs with pulsar timing

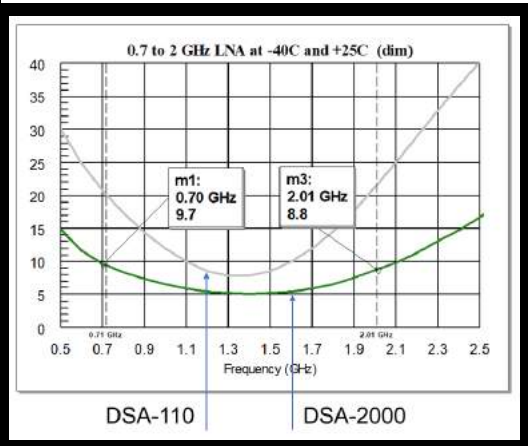
DSA-2000: how is this possible?



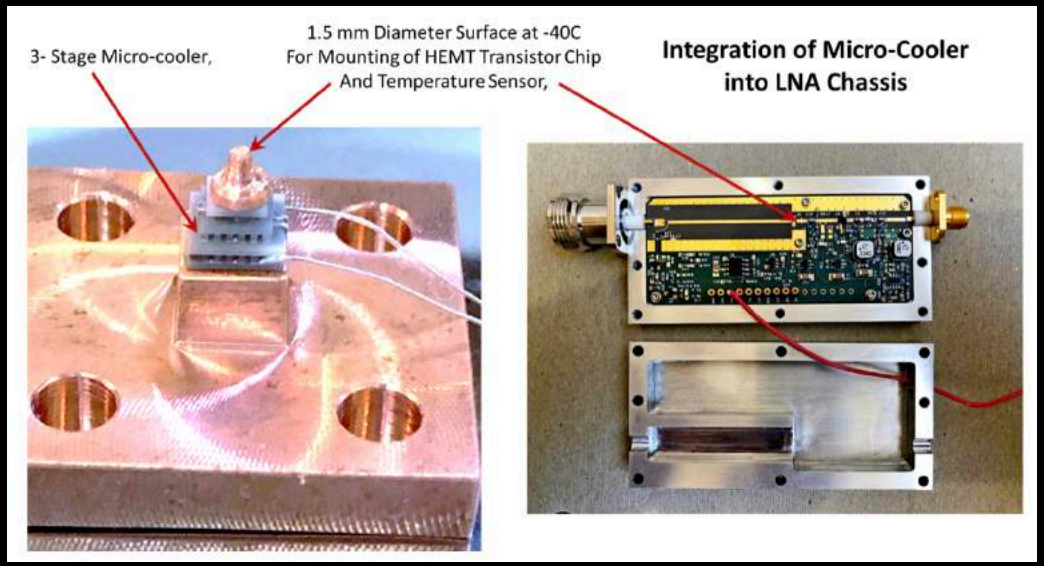


Antenna design by Dave Woody and Matt Fleming - **$20k** for antenna/mount/drive package. 5-m solid spun rim-supported f=0.33 reflector, fab on site. Roller chain mechanism for alt/az drive.





Feed/LNA design by Sandy Weinreb, Jonas Flygare, Jun Shi - **$2k** per package.



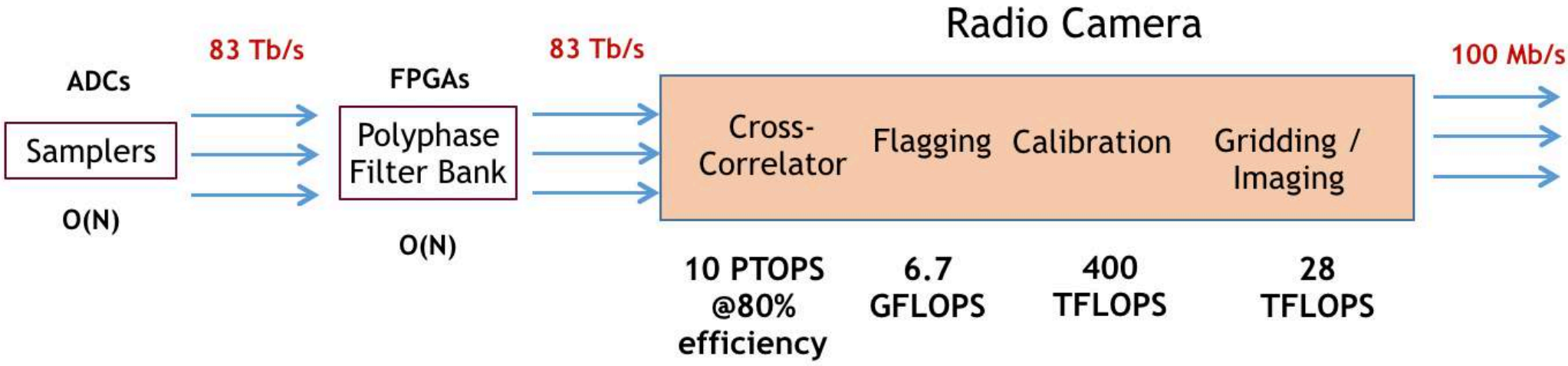
Quad-ridge “cakepan” feed, with embedded, Peltier-cooled LNA. Builds on 7K ambient-temperature DSA-110 LNA.

https://www.radiocamera.io/seminars

DSA-2000: the Radio Camera Initiative

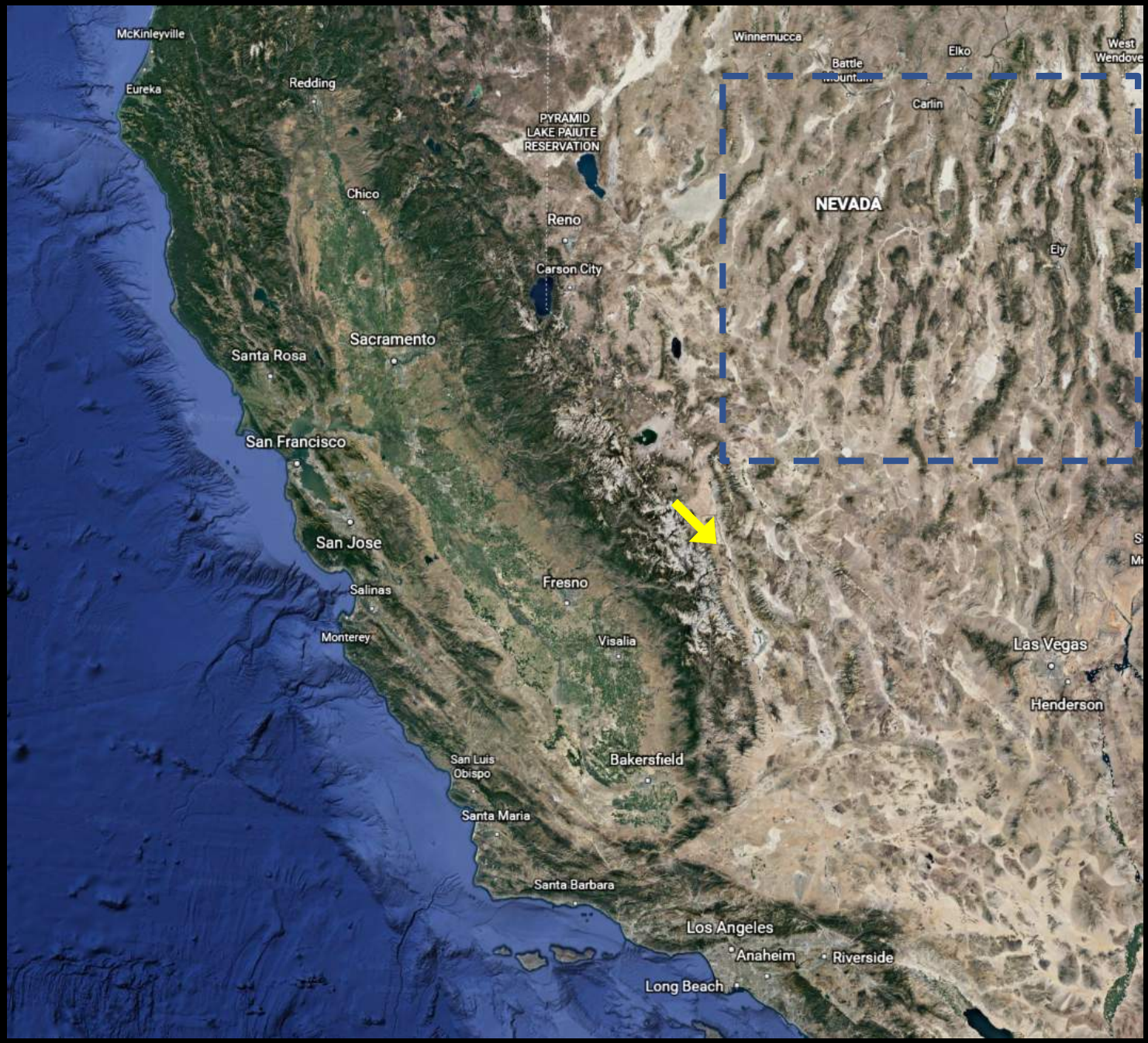
SCHMIDT FUTURES

N = 2000

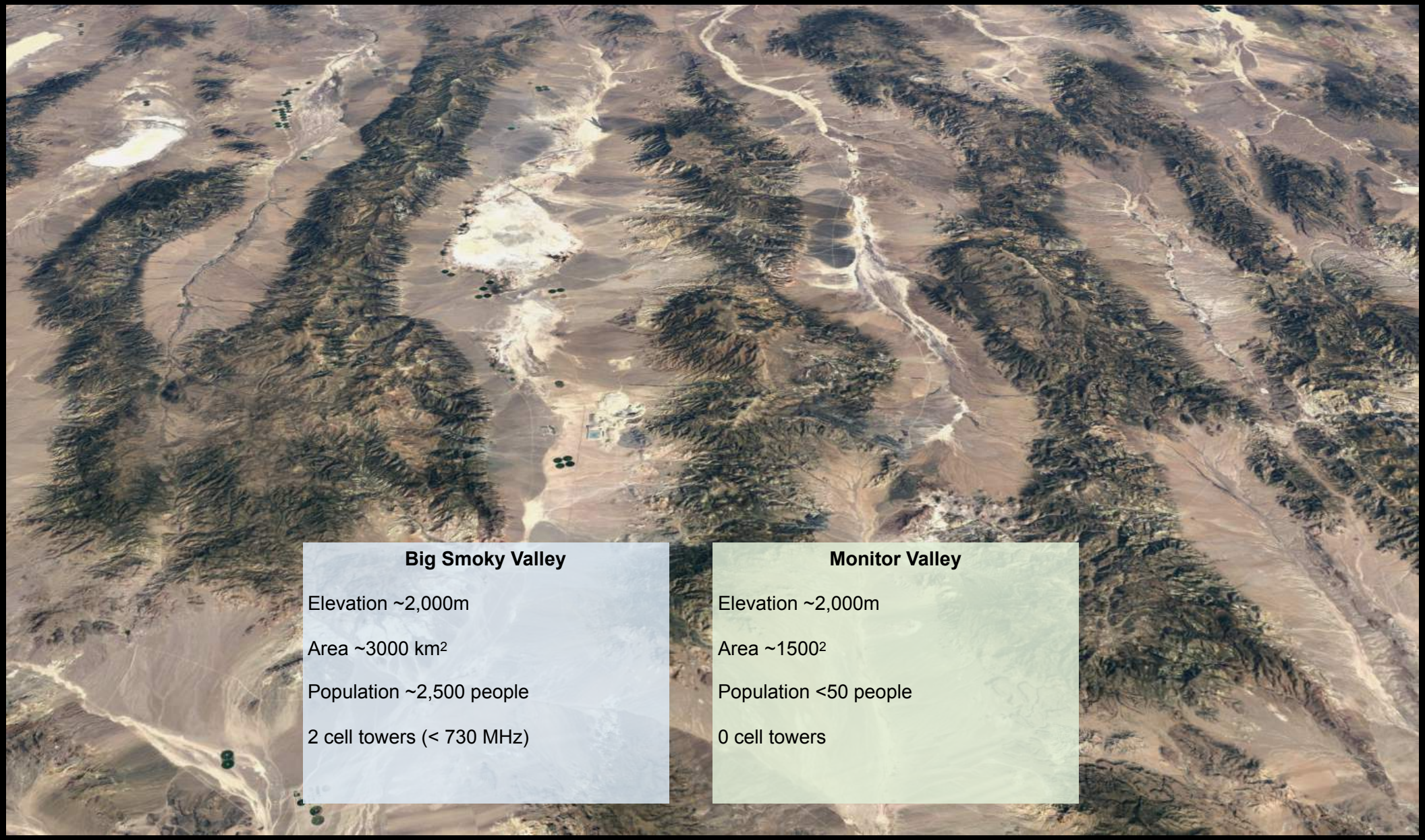


The RCI is developing a software solution for real-time correlation, flagging, calibration, gridding and imaging of visibilities. Continuum and spectral-line **image products** will then be served directly to the community.

DSA-2000: Site selection



DSA-2000: Site selection



Big Smoky Valley

Elevation ~2,000m

Area ~3000 km^2

Population ~2,500 people

2 cell towers (< 730 MHz)

Monitor Valley

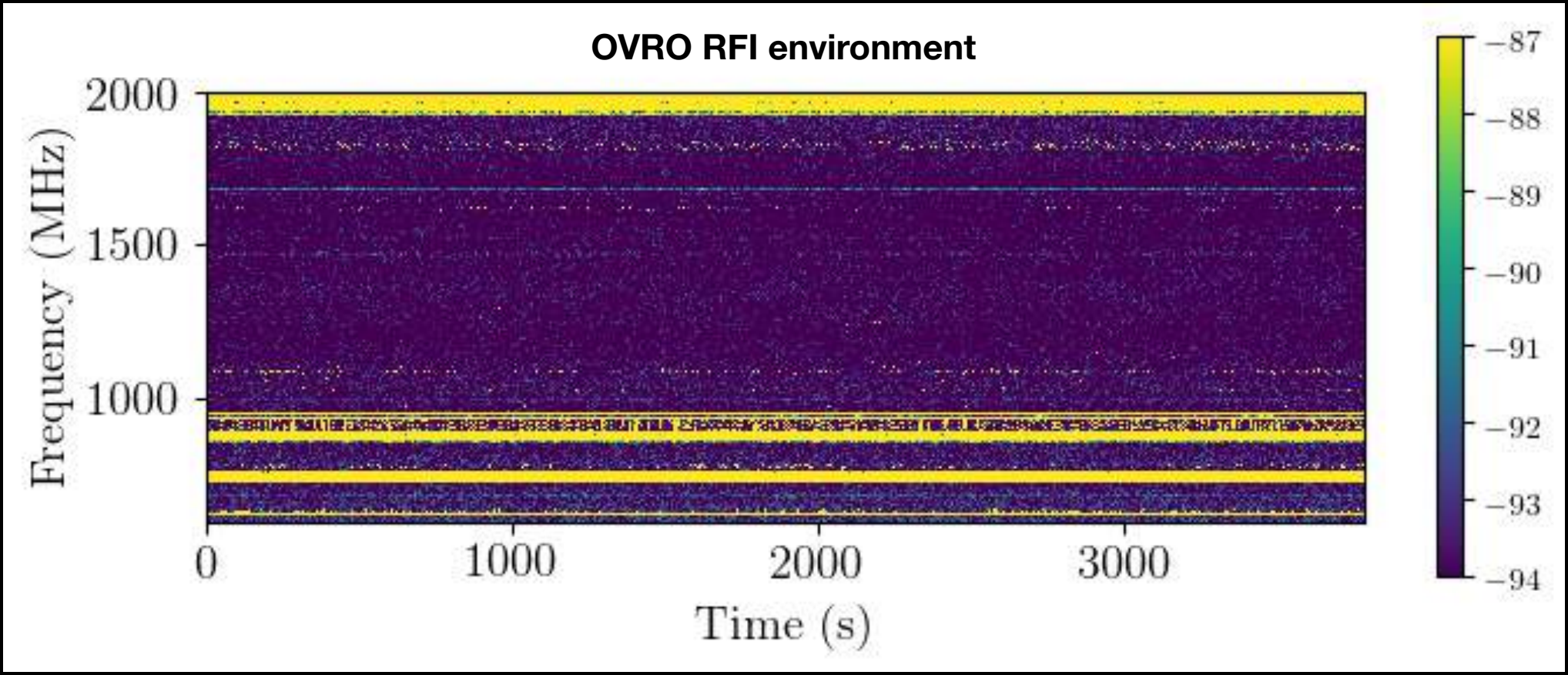
Elevation ~2,000m

Area ~1500^2

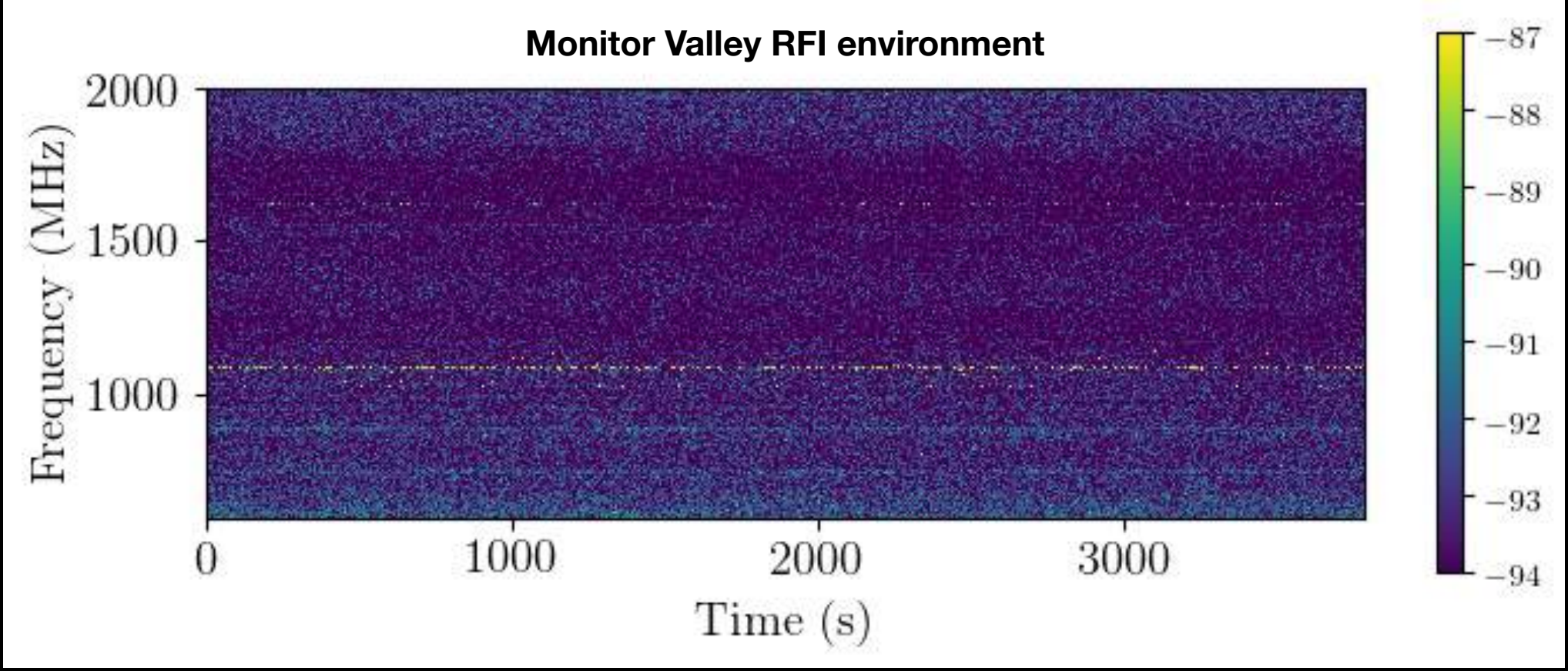
Population <50 people

0 cell towers

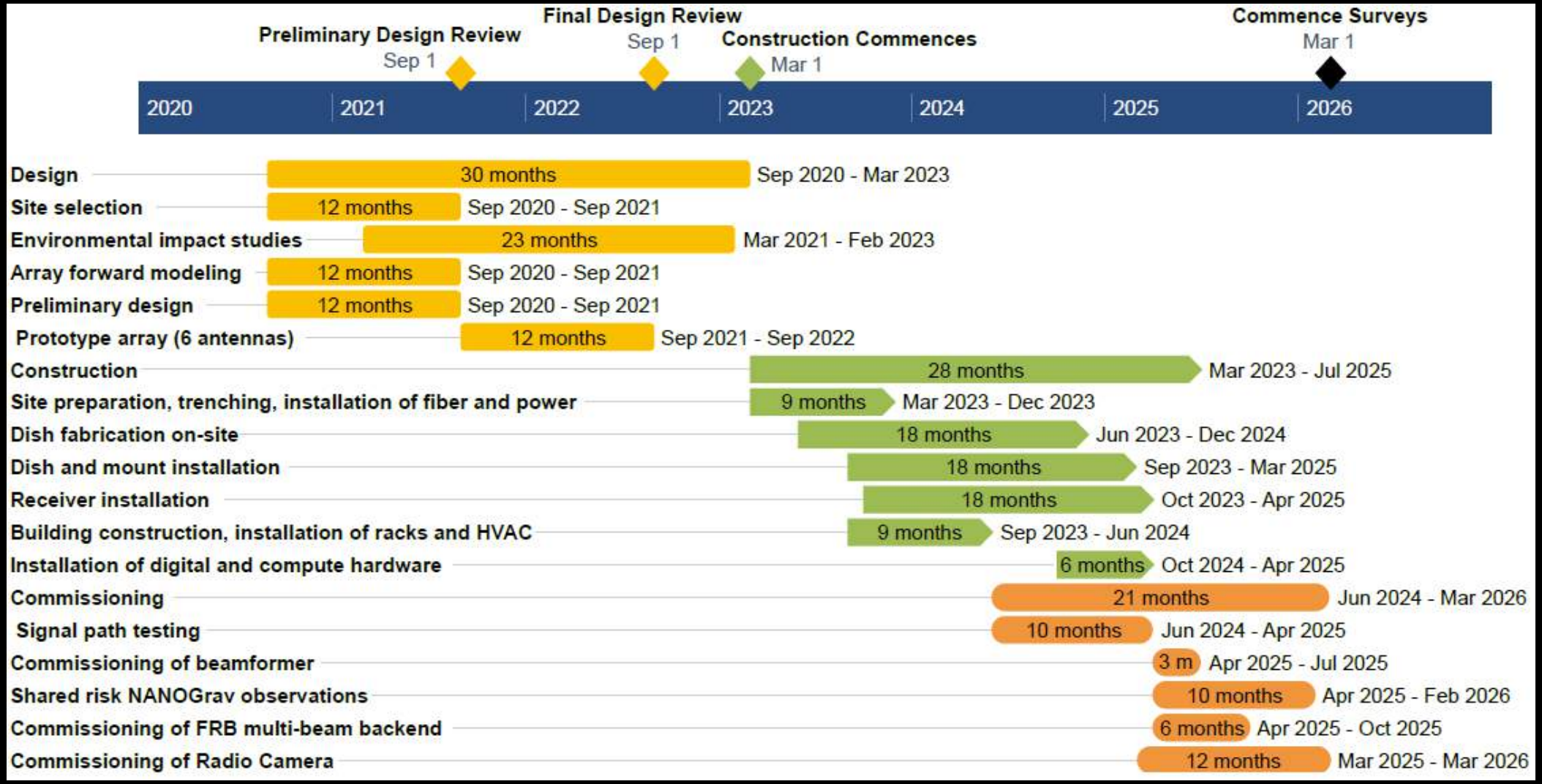
DSA-2000: Site selection



DSA-2000: Site selection



DSA-2000: Timeline and Budget



DSA-2000: Timeline and Budget

	Estimated Cost	Contingency	Total
Design/Development	**$5 million**	**25%**	**$6.25 million**
Antennas, Mounts and Drives	$33.4 million	20%	$40.6 million
Receivers	$6.2 million	40%	$8.6 million
Infrastructure, Buildings	$17.3 million	41%	$23 million
Environmental Impact Statement	$1 million	50%	$1.5 million
Monitor/Control Hardware	$2.65 million	20%	$3.2 million
Radio Camera and Storage	$27.1 million	0%	$27.1 million
Public Archive	$2.3 million	50%	$3.5 million
Total Construction	**$88.9 million**	**20%**	**$107.5 million**
Operations/yr	**$5.3 million**	**25%**	**$6.6 million**

- Caltech and NANOGrav has funded hardware design and development and initial project management.
- Schmidt Futures has funded RCI development (Hallinan, Ravi, Bouman)
- Full funding model is NSF (MSRI R-2) + partners.
- Anticipate US Astro2020 Decadal Survey results in early 2021.

DSA-2000: Summary

- 2000 5-m steerable antennas spread over 15 km; 0.7-2 GHz; imaging + pulsar timing + fast transients.
- Survey speed 10x SKA-I mid, and Arecibo sensitivity.
- Approx. $US 110M construction, $US 7M/yr operations
- Five-year prime mission, survey data served to community
- Anticipate construction beginning by 2024.