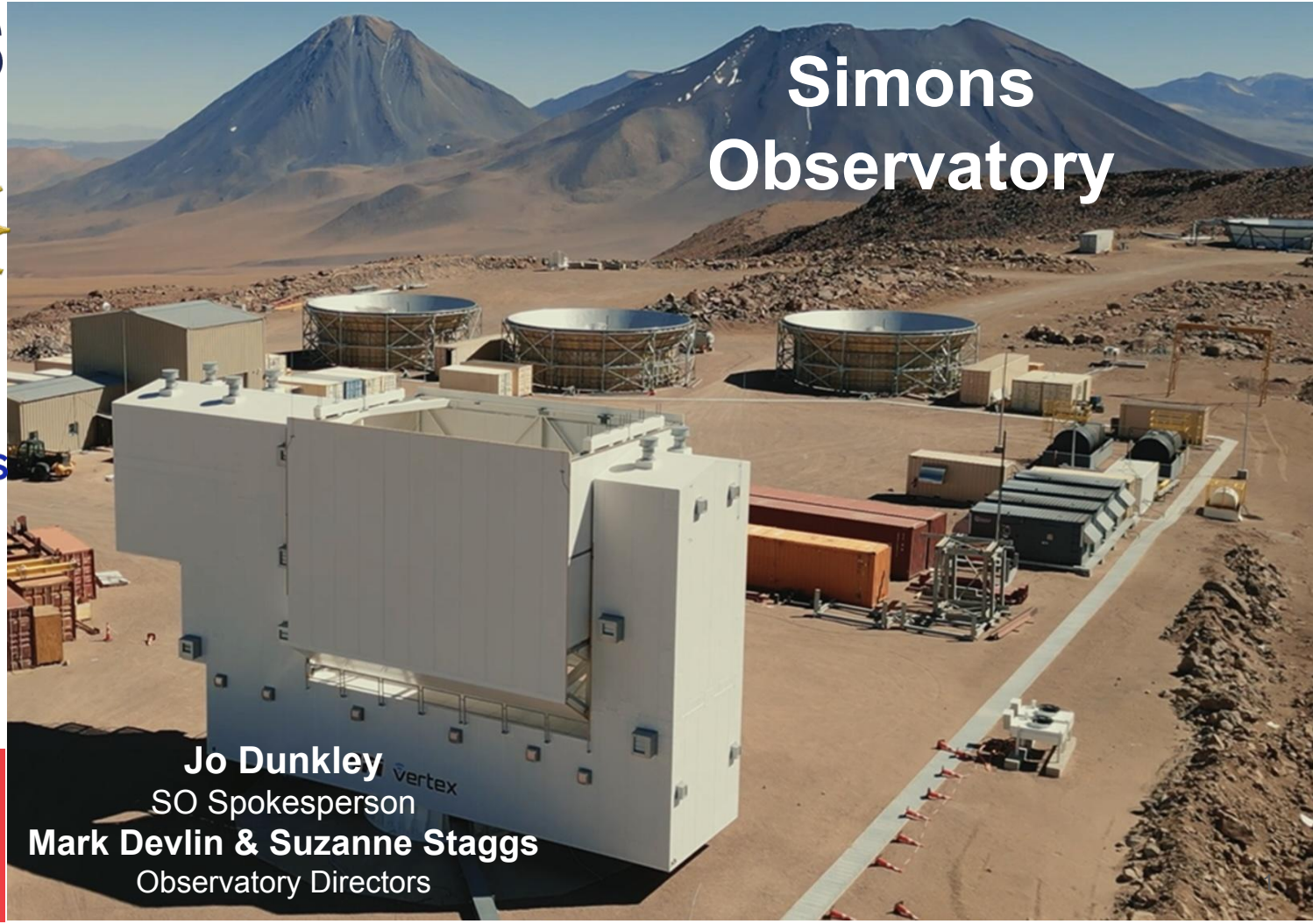

Simons Observatory
Jo Dunkley
SO Spokesperson
Mark Devlin & Suzanne Staggs
Observatory Directors

Updates Since Astro2020

DOE/NSF no longer supporting CMB-S4; access to the South Pole is now restricted/limited

Simons Observatory

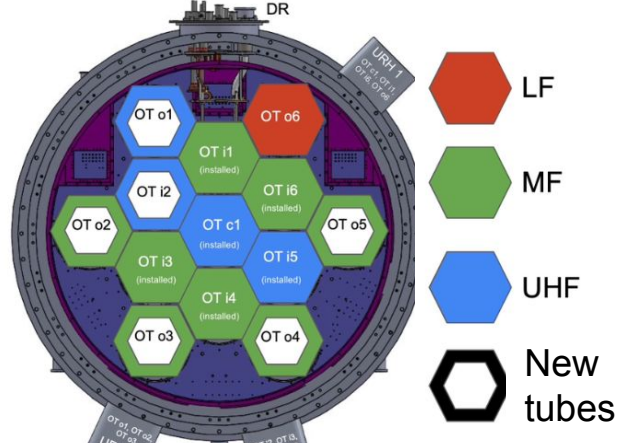
- **There is strong progress towards all the CMB Decadal and P5 goals**, faster than anticipated, with SO taking data. This will benefit the broad astronomical community.
- **SO is now a Public/Private Partnership** ($200M program: Simons Foundation, NSF, UKRI, Japan, and beginning to work with DOE). Huge leveraging and efficient use of tax dollars.
- Exciting progress!

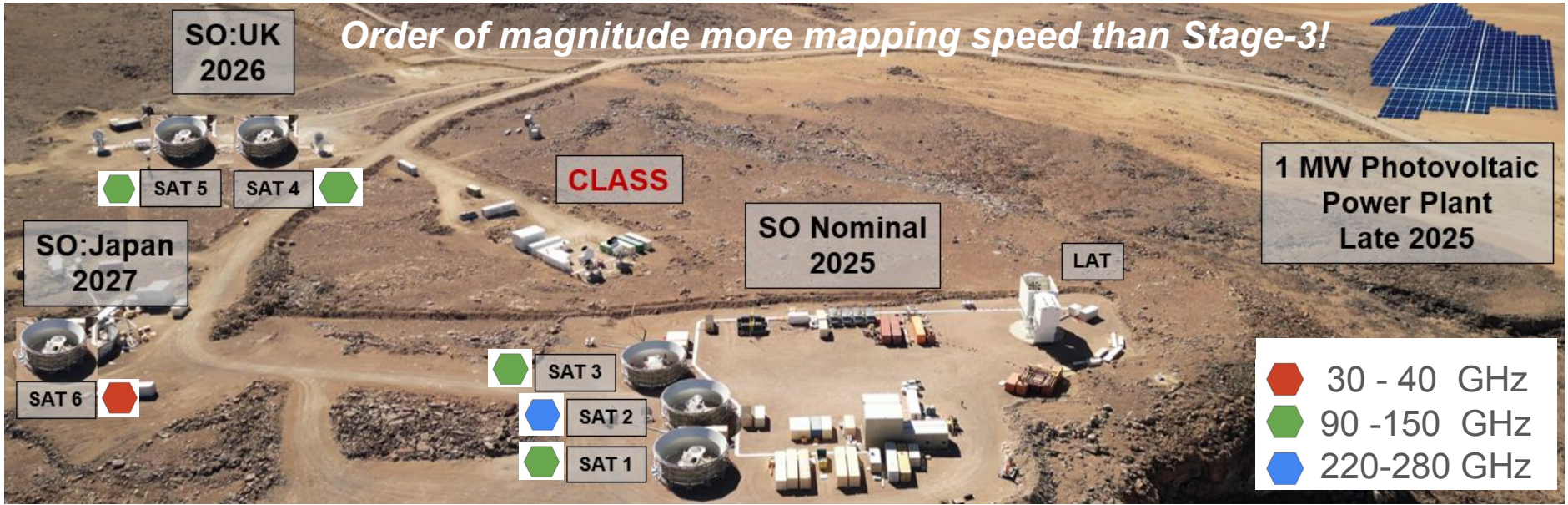
>450 SO collaboration members

Funded SO Enhancements Under Way

- Photovoltaic array for energy security (NSF, UKRI, 2025)
- Doubling LAT detectors/mapping speed (NSF) - 2026-28
- 3 new SATs from UK and Japan (by 2027)
- Major expansion of community data delivery (NSF,DOE,UK)

Recent news: DOE scientists officially participating in SO; FY25 funds for computing & data management in support of SO operations.





SO Covers *All* of A2020/P5 Science

Search for B-modes from the infant universe & inflation signatures

Study the dark universe

Matter mapping

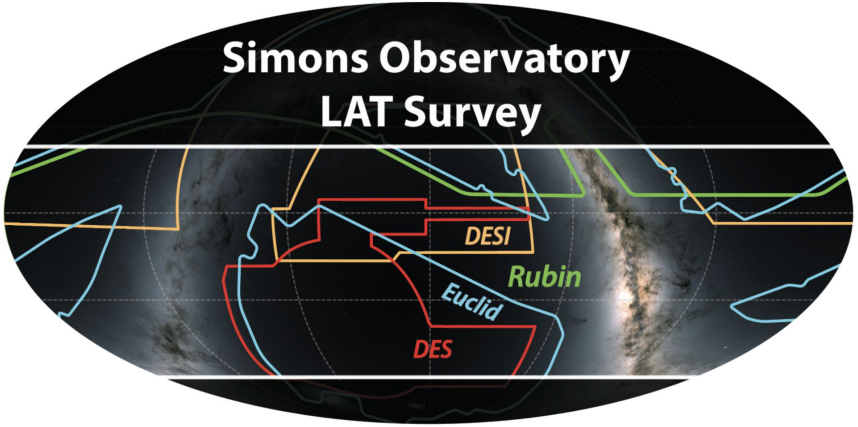
Time-variable mm sky

Numbers show 1-σ unless catalog no. or distances	Current	**SO 2025-2034**	CMB-S4	Using Rubin, DESI, or *Euclid*
Primordial perturbations				
r ($A_L = 0.3$)	0.01	0.0012	0.0005	✓
n_s	0.003	0.002	0.002	-
$e^{-2\tau}\mathcal{P}(k = 0.2/\mathrm{Mpc})$	1%	0.4%	✓	-
$f_{\mathrm{NL}}^{\mathrm{local}}$	5	1	∼1	✓
Relativistic species				
$N_{\mathrm{eff.}}$	0.13	0.045	0.03	-
Neutrino mass				
m_ν (eV, $\sigma(\tau) = 0.01$)	0.06	0.03	0.03	✓
m_ν (eV, $\sigma(\tau) = 0.002$)		0.015	0.015	✓
Accelerated expansion				
$\sigma_8(z = 1 - 2)$	7%	1%	1%	✓
Galaxy evolution				
η_{feedback}	50-100%	2%	✓	✓
p_{nt}	50-100%	4%	✓	✓
Reionization				
Δz	∼1.4	0.3	0.25	-
τ	0.007	0.0035	0.003	-
Cluster catalog	10000	33,000	$> 70,000$	✓
AGN catalog	20000	96,000	$> 100,000$	-
Galactic science				
Molecular cloud B-fields	10s	> 860	✓	-
$\sigma(\beta_{dust})$	0.02	0.005	✓	-
Solar System Science				
Distance limit for 5 $M_\oplus$ Planet 9	500 AU	900 AU	✓	✓
Asteroid detections		$\sim 10,000$	✓	
Transient detection distance				
Long GRBs, on-axis		1300 Mpc	✓	-
Low-luminosity GRBs		70–210 Mpc	✓	-
TDEs, on-axis		670 Mpc	✓	-

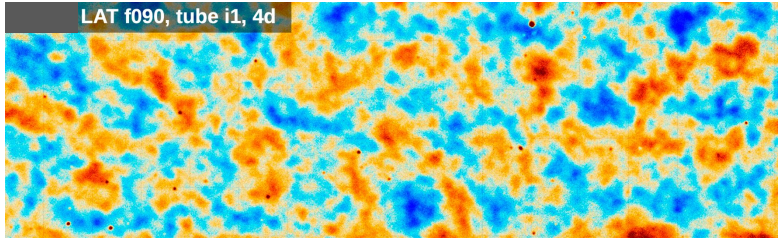
https://arxiv.org/abs/1808.07445
https://arxiv.org/abs/2503.00636
& SAT white paper, in prep

Large Aperture Telescope

Arcminute resolution, timed well with Rubin, Euclid, Roman, DESI for x-correlations, and with Rubin for mm transients (2-3 day cadence)

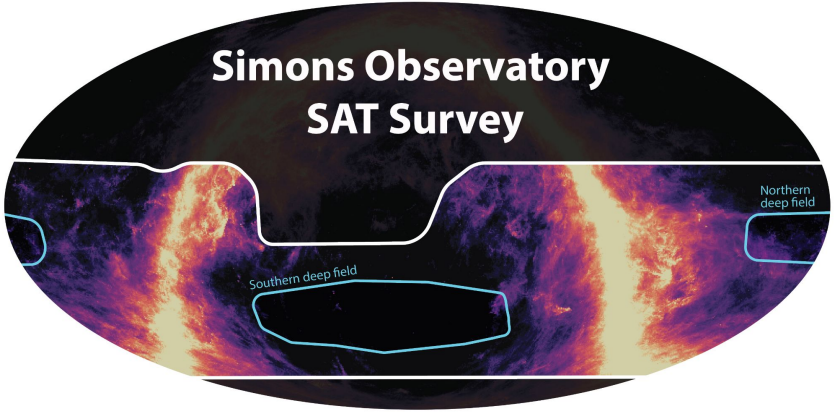


Early CMB intensity map from 2 weeks of data from ~1/10 of full LAT.
Single-observation maps reaching <5 mJy in an hour. Already detected lensing.

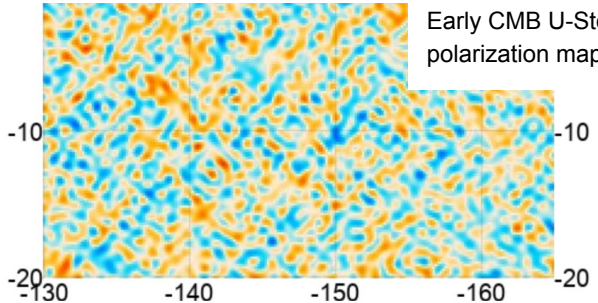


Small Aperture Telescopes

Targeting degree-scale gravitational wave signal detection at or above r=0.005. Preparing for robust detection; access to multiple sky regions



Early CMB U-Stokes polarization map from one SAT



Making full use of Chile and South Pole data

'It is essential that CMB-S4 produce transient alerts, as well as calibrated maps in all bands and on all angular scales that are openly usable and accessible on as rapid a cadence as practical.' (Astro2020)

SO team: expertise in data delivery from ACT, Planck & WMAP. ACT has shown how ground-based CMB experiments can make all map products public in a timely way. SO will continue in this vein. **Delivery of data is a core part of SO's mission.**

To maximize science return, the Chile and South Pole projects **should commit to making accessible all the data** and tools needed for comparisons and joint analysis from the two sites.

Other ways to collaborate:

Continue the cross-experiment community efforts started by CMB-S4: e.g. job listings and career information sessions.

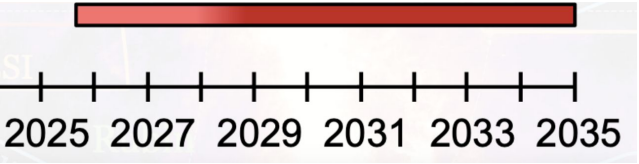
How to deliver Astro2020/P5 without CMB-S4?

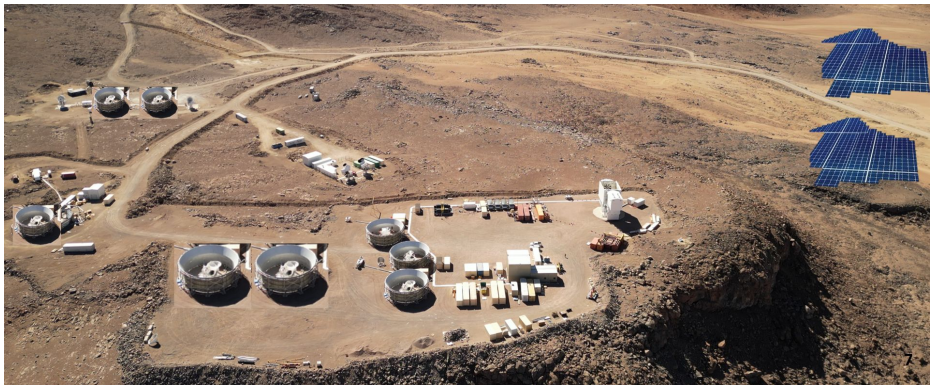
- Continued NSF/DOE support for CMB science efforts
- SO's highest priority: operations support, including for data management and public delivery

- NSF/DOE support for science exploitation by US community

- Further SO observatory upgrades:
  Doubling SATs - enhance robustness of a detection at r~0.005; push further to CMB-S4 limits
  Second LAT - enhance sensitivity for SZ & transient science, enhance delensing capabilities for r
  Phased with detector improvements

Timeline for SO operations





Backup slides

SO Science: Inflation

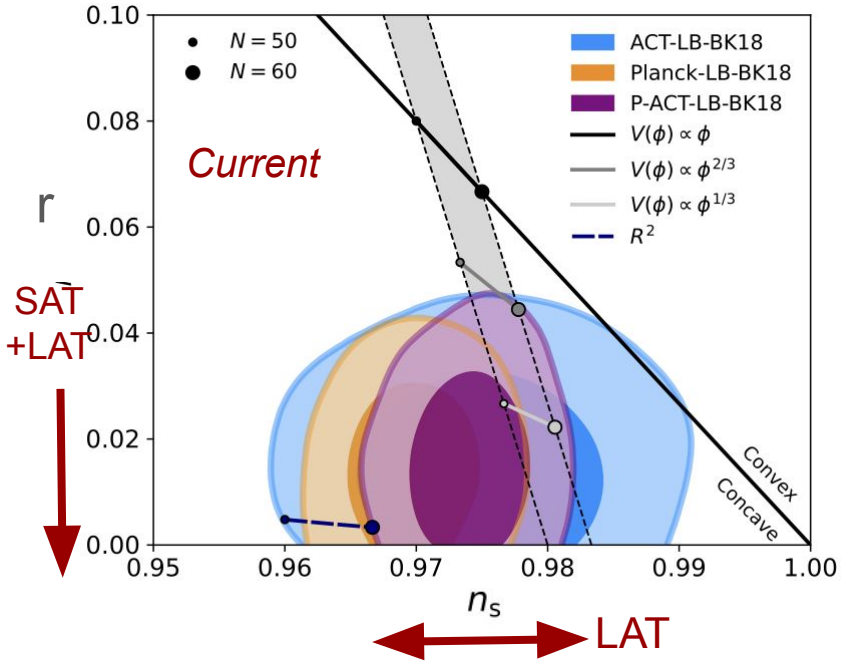
How did the initial expansion of space take place?

Measure r to σ~0.001:
Prepare to robustly detect models with r>0.005

Scalar slope, n_s, to 0.002:
Scalar adiabatic power law
By measuring P(k) at 0.2 Mpc-1 to 0.4%

Non-Gaussianity: to f_{NL}^{loc}=1 (+ uniquely non-local f_{NL})
Through CMB bispectrum &
Correlations of lensing and kSZ with DESI & Rubin

The next decade of observations with SO will push down an order of magnitude in r.



n_s is crucial for distinguishing between models. The SO LAT in Chile is already doing this.

The Chile site

- Year-round access via commercial airline in 1-2 days; flexible housing.
- Major mining center; access to skilled workforce & large machinery.
- High-bandwidth internet allowing data transfer, remote observation, and software maintenance.
- Easy for international collaboration and augmentations
- History of working with Chilean universities
- Independent of US infrastructure; costs clear.