SIMONS OBSERVATORY

A STATUS UPDATE

SIMONE AIOLA FOR THE SO COLLABORATION

(CENTER FOR COMPUTATIONAL ASTROPHYSICS, NY)

SA3CC 05/30/2024

SIMONS FOUNDATION

PARQUE ASTRONÓMICO ATACAMA, CHILE

SIMONS OBSERVATORY

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TOHOKU UNIVERSITY

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The University of Manchester

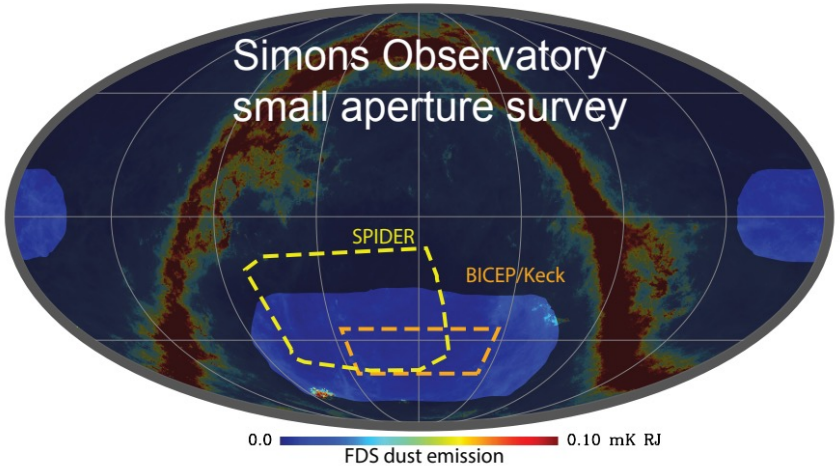
THE UNIVERSITY OF MELBOURNE

UNIVERSITY OF OXFORD

UNIVERSITY OF PITTSBURGH

UNIVERSITY OF SUSSEX

SIMONS OBSERVATORY (SO) — MULTIFREQUENCY MM SURVEY AND SCIENCE GOALS

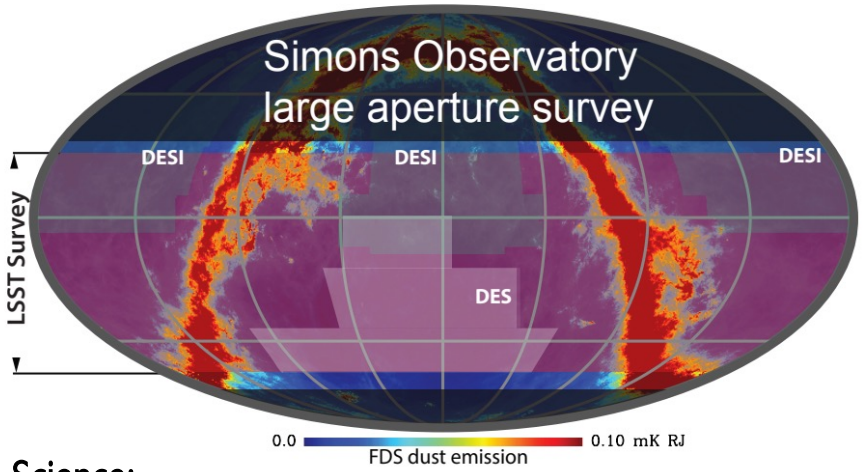


Science:

- high-risk, high-reward
- Signature of inflation

SAT Survey:

- low-dust 10% of the sky
- Large-Scale polarization, B-mode



Science:

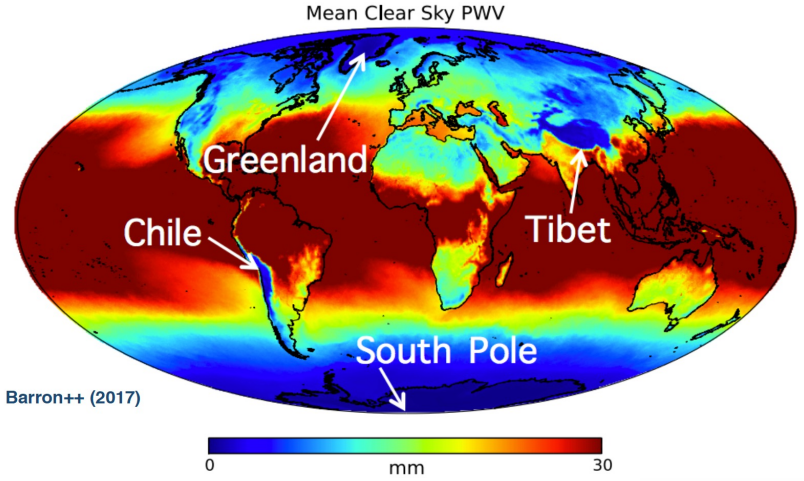
- Primordial perturbation
- Neutrino mass
- Relativistic species
- Reionization
- Dark energy
- Galaxy evolution
- Transients

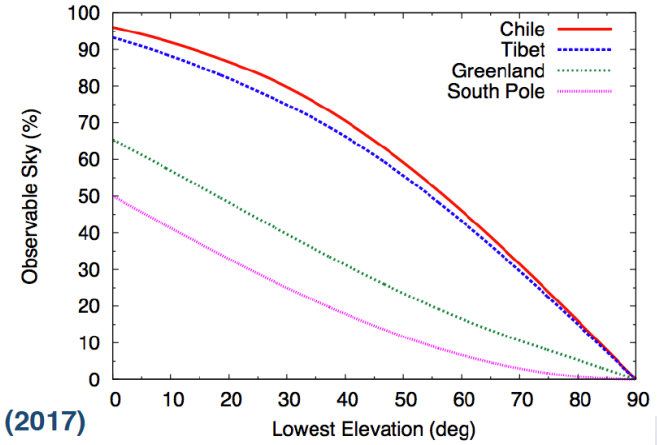
LAT Survey:

- 40% of the sky
- Overlap with Rubin Observatory/LSST and other LSS

Periodic data releases: CMB, lensing maps, source and cluster catalogs, transient events

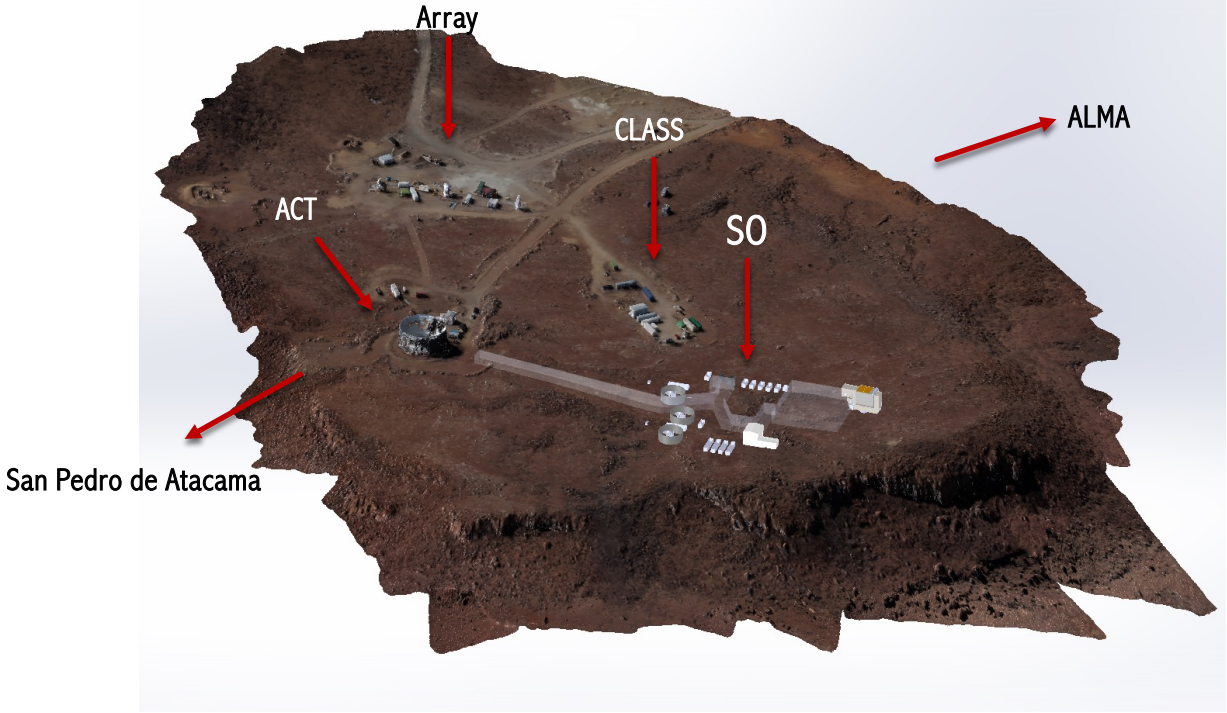
SIMONS OBSERVATORY (SO) — SITE





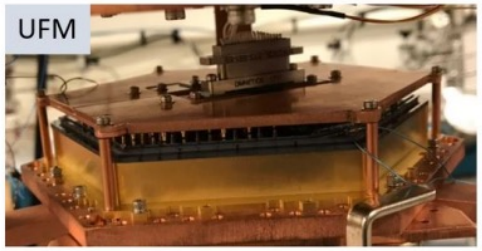
Barron++ (2017)

- Chajnantor platau, Atacama Desert, Chile @5,190m a.s.l.
  - Ideal for ~half-sky measurements
- Median precipitable water vapor ~0.8mm
  - Ideal for 20-280 GHz measurements



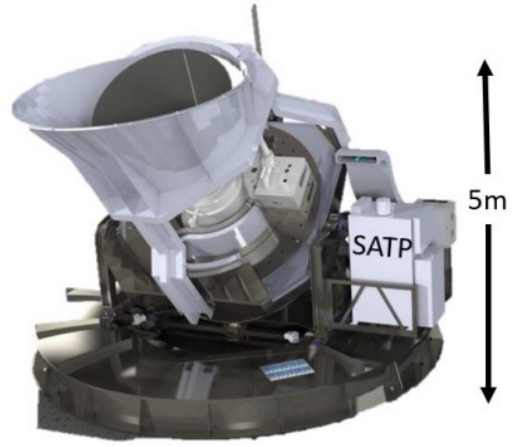
SIMONS OBSERVATORY (SO) — INSTRUMENTATION

Detectors:
70,000 dichroic detectors operating at 100 mK



LF (27/40 GHz), MF(90/150 GHz),
UHF (220/270 GHz)

Large-Aperture Telescope (LAT)
6m primary mirror, 8deg FOV, 1.5' resolution @ 150 GHz
Largest cryogenic camera ever built for CMB experiments, 27-270 GHz detectors



Small-Aperture Telescopes (SATs)
3 telescopes, 42-cm aperture, 35deg FOV, ~0.5deg resolution @ 150GHz
Cryogenic Half-Wave Plate to modulate polarization, 27-270 GHz detectors

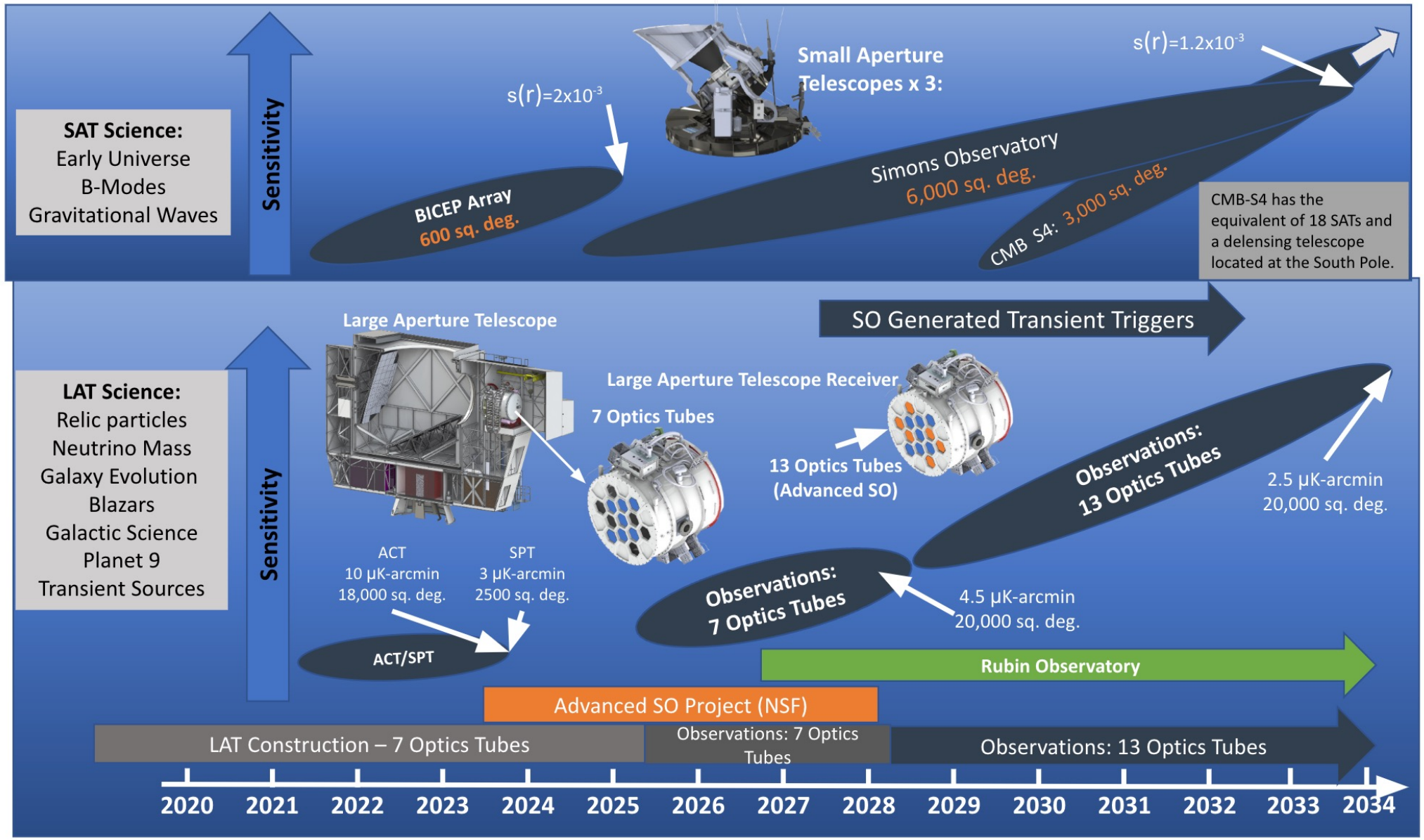
SIMONS OBSERVATORY (SO) — LAT/LATR AT THE SITE

Mirrors are delayed, expected science observations to start in 2025

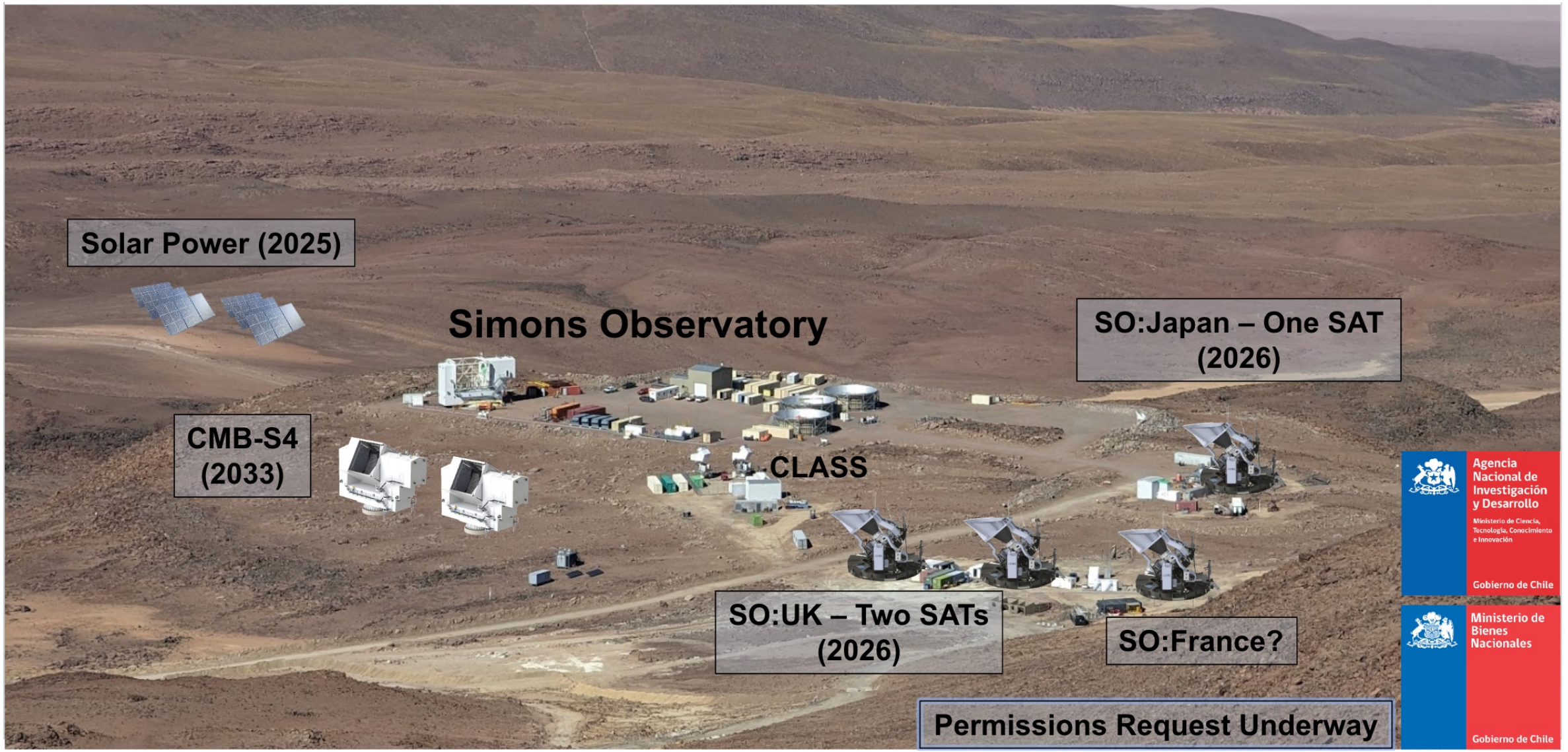
SIMONS OBSERVATORY (SO) — 3 SATP AT THE SITE

- All 3 cameras are installed on the platforms!
- 2 had first-light and undergoing commissioning and testing
- 1 started deployment

SIMONS OBSERVATORY (SO) — SO TIMELINE AND EXPANSIONS

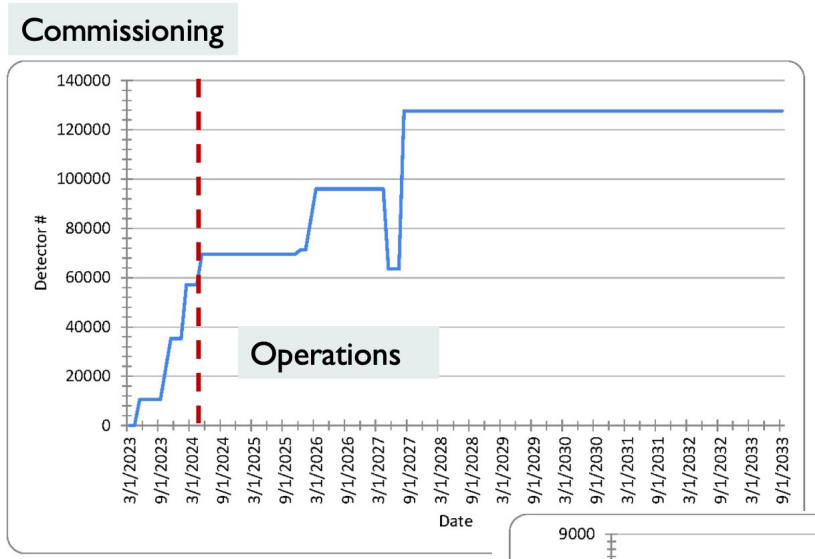


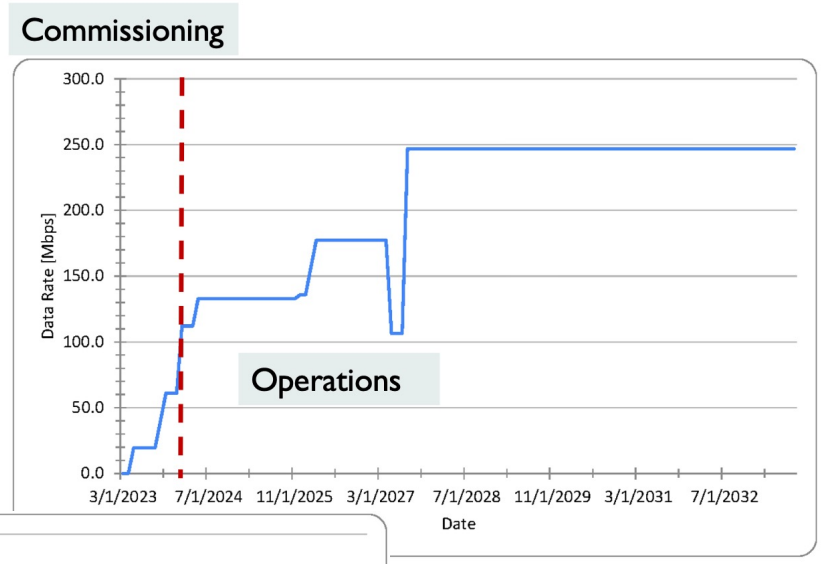
SIMONS OBSERVATORY (SO) — SO TIMELINE AND EXPANSIONS

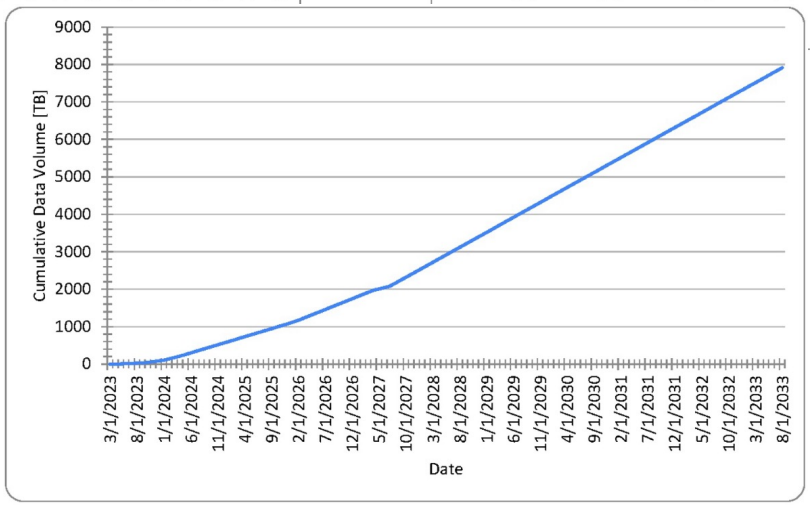


DATA RATES AND DATA VOLUME

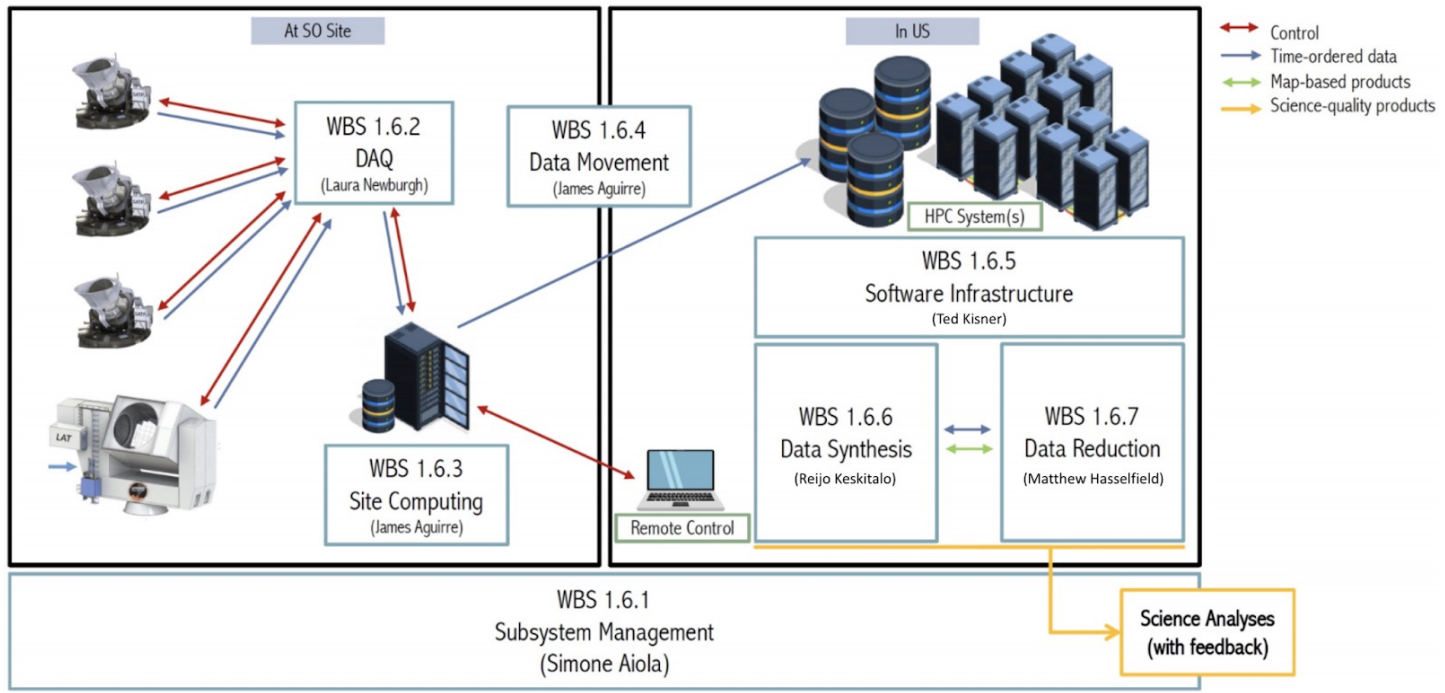
- The data rate is dominated by detector time-streams (127,774 detectors) → **247 Mbps**
- We baseline the higher data rate (red curve), but we could reduce it during operations depending on the instrument characterization

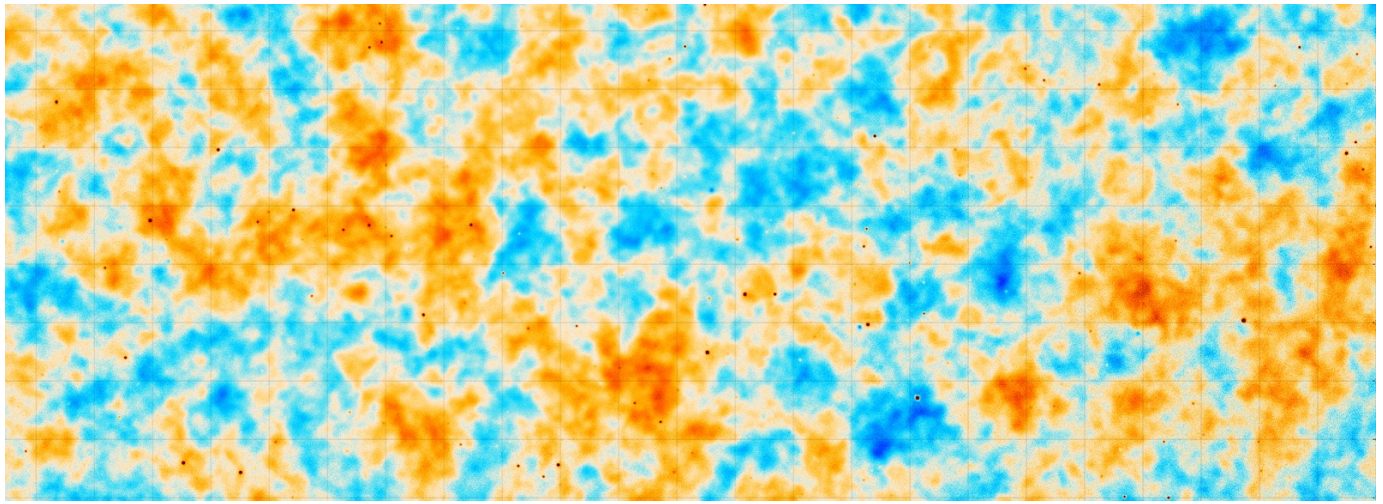






DATA MANAGEMENT





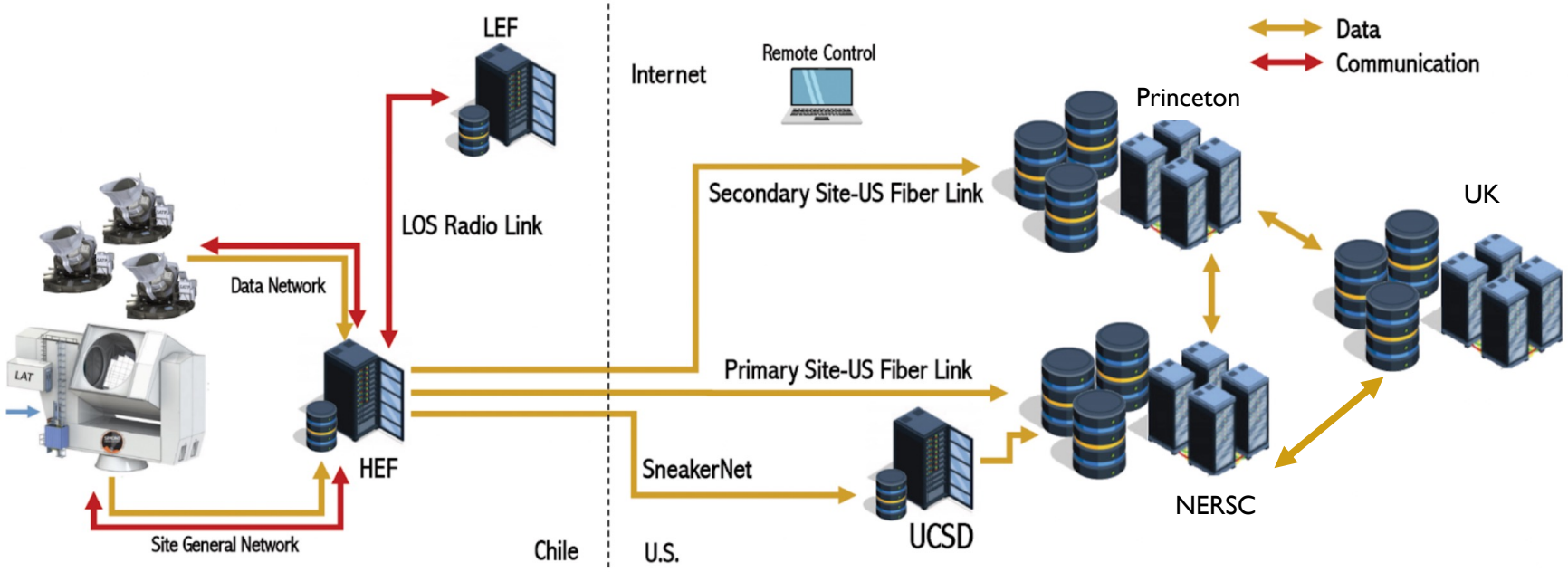
Open source philosophy. Most software is public on the `simonsobs' GitHub account; Software Developers' Guide.

- An observatory control system to monitor and acquire data; software for live data viewing.
- Hardware infrastructure for computing at the SO site, and use of CMB community resources at NERSC.
- A software library to process raw time-ordered-data.
- A simulator of time-ordered-data, and simulations of observed sky maps.
- Software to perform quality cuts and calibrations.
- Software to turn time-ordered data into maps.

DATA MANAGEMENT

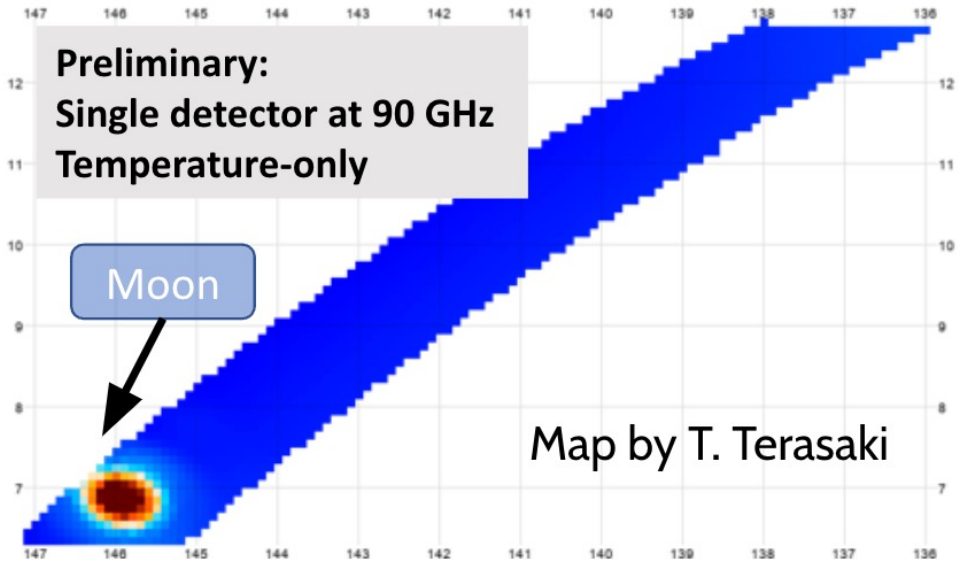
Data collection, data registration, and data transport

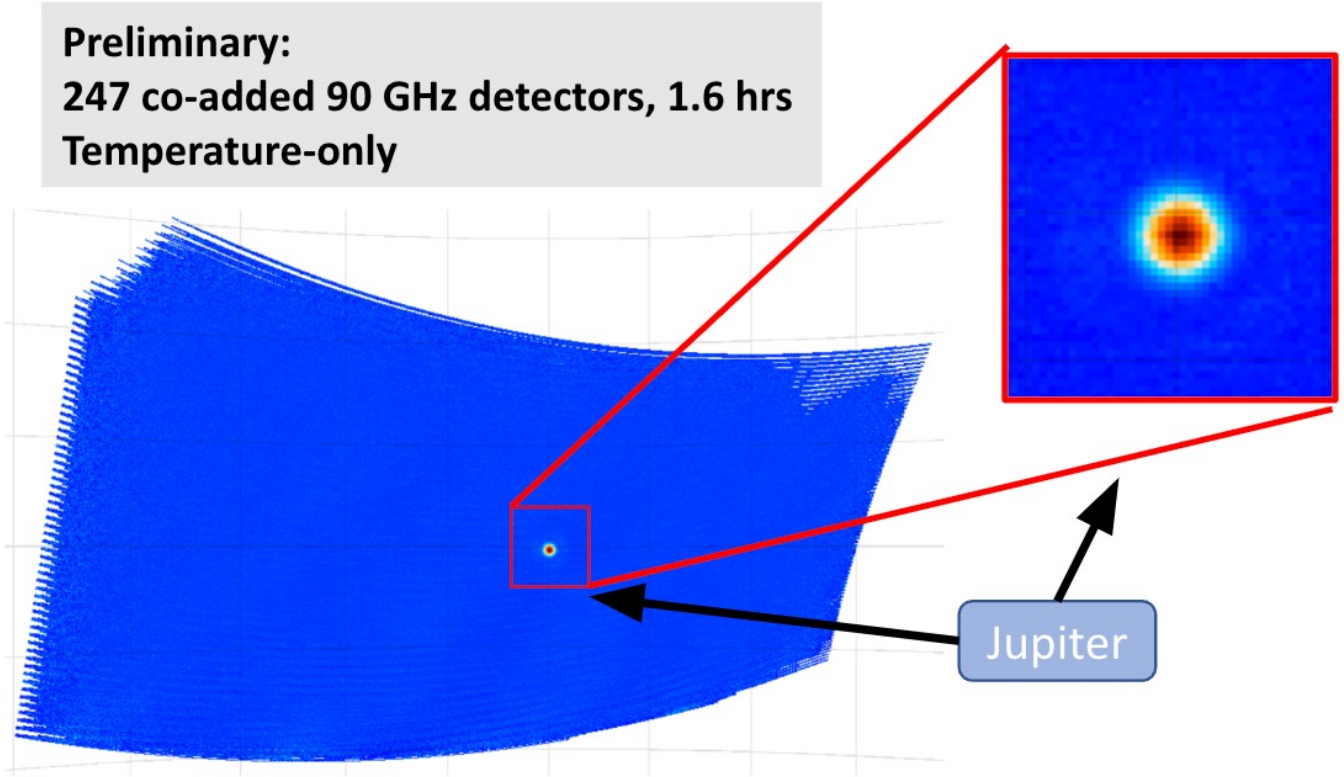
- *Current Status:* data transfer manager software into testing phase (Librarian on SO GitHub).
  - Will manage: two 1-month copies at the site, three full copies in US, transfer from Site to US and US to US.
- Implemented SneakerNet (manual transport of disk) and also transfer via fiber. All handled by the same software
- Cross-development group with CMB-S4 who will need a scaled version of this implementation.



SATS HAD FIRST LIGHT!

- All 3 cameras are installed on the platforms!
  - 2 had first-light and undergoing commissioning and testing
  - 1 started deployment
- Data is moved over the internet/SneakerNet and/or analysis done at the site.
  - We are looking forward to start flowing the data through the fiber link!





BACKUP

DATA MANAGEMENT

Observatory Control System + Data Acquisition (DAQ) system:

- *Current status:* OCS Fully developed (general + SO specific hooks), tested, documented and public on GitHub
- Adopted as DAQ baseline for CMB-S4
- Used in SO labs for testing and soon deployed at the site
- Includes: control and monitoring of hardware and site, data aggregation and collection, real-time visualization

The Simons Observatory: Overview of data acquisition, control, monitoring, and computer infrastructure
https://arxiv.org/abs/2012.10345

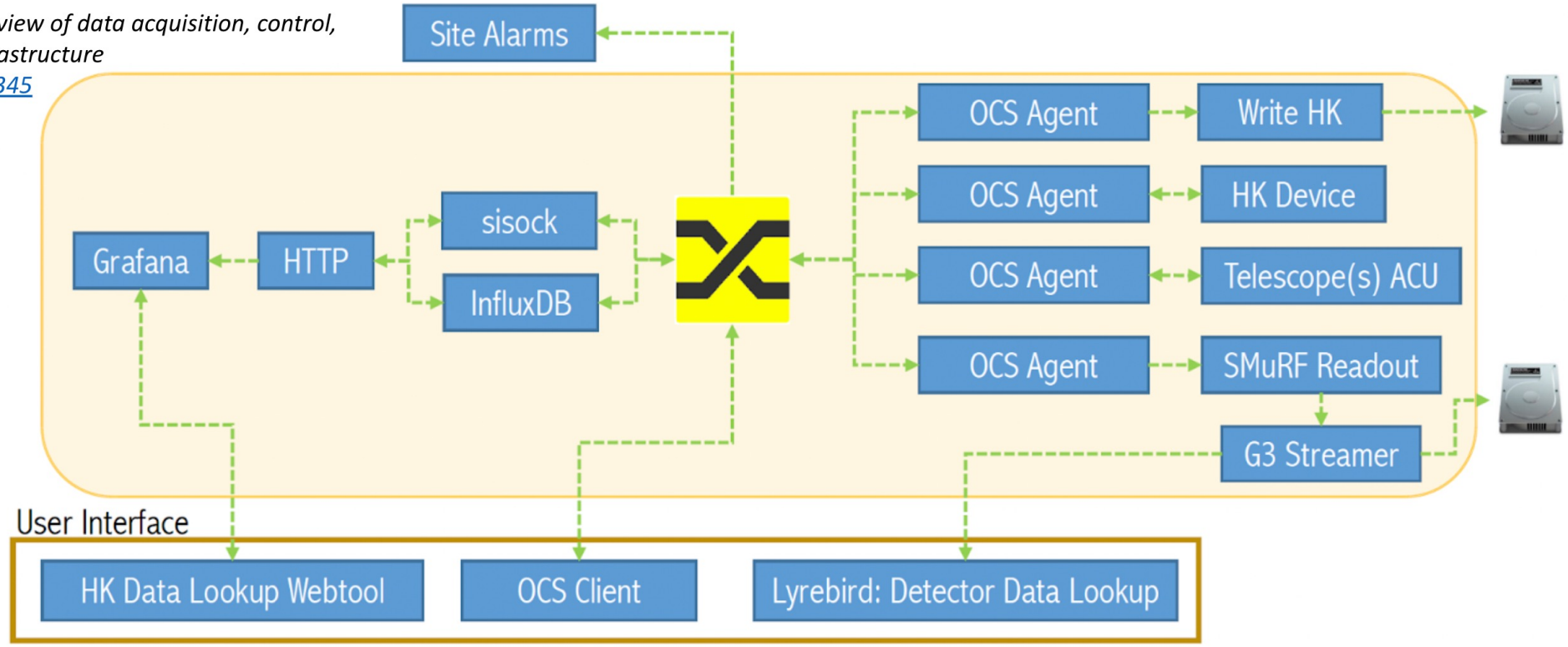
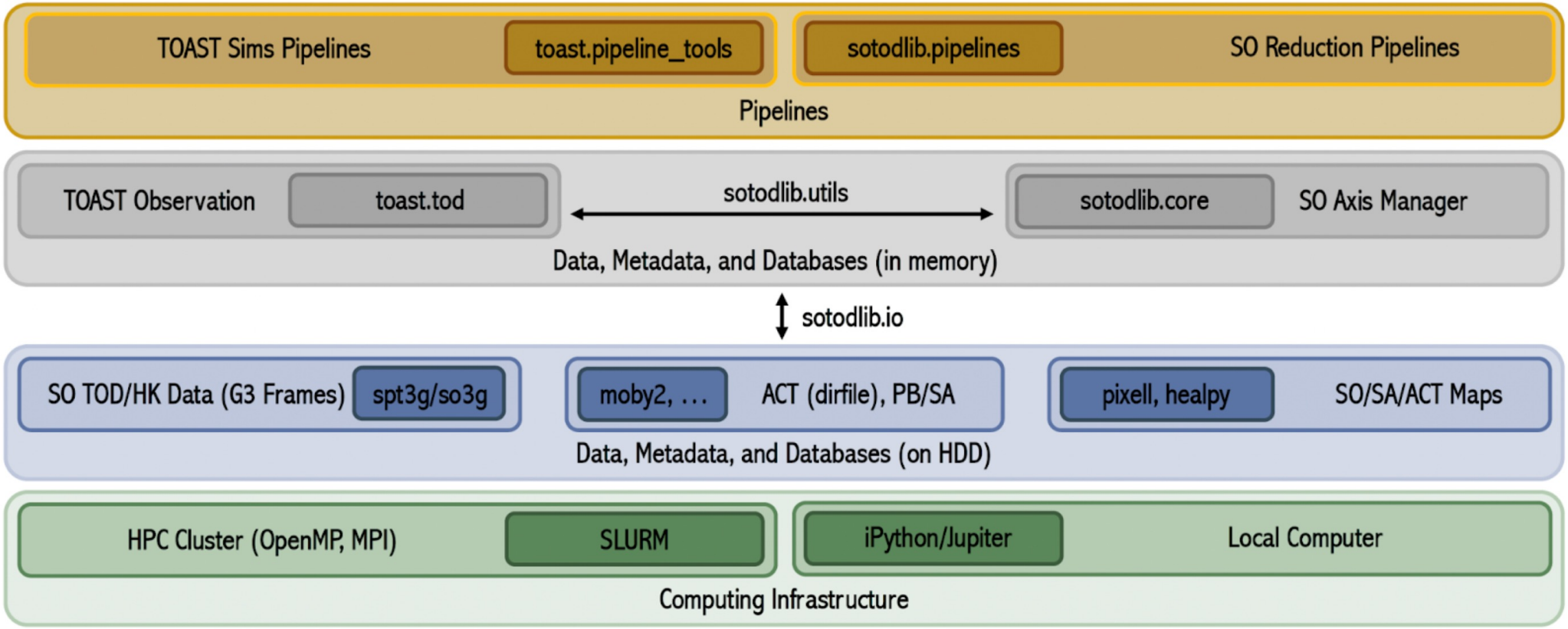


Figure credit: inspired by B. Koopman

DATA MANAGEMENT

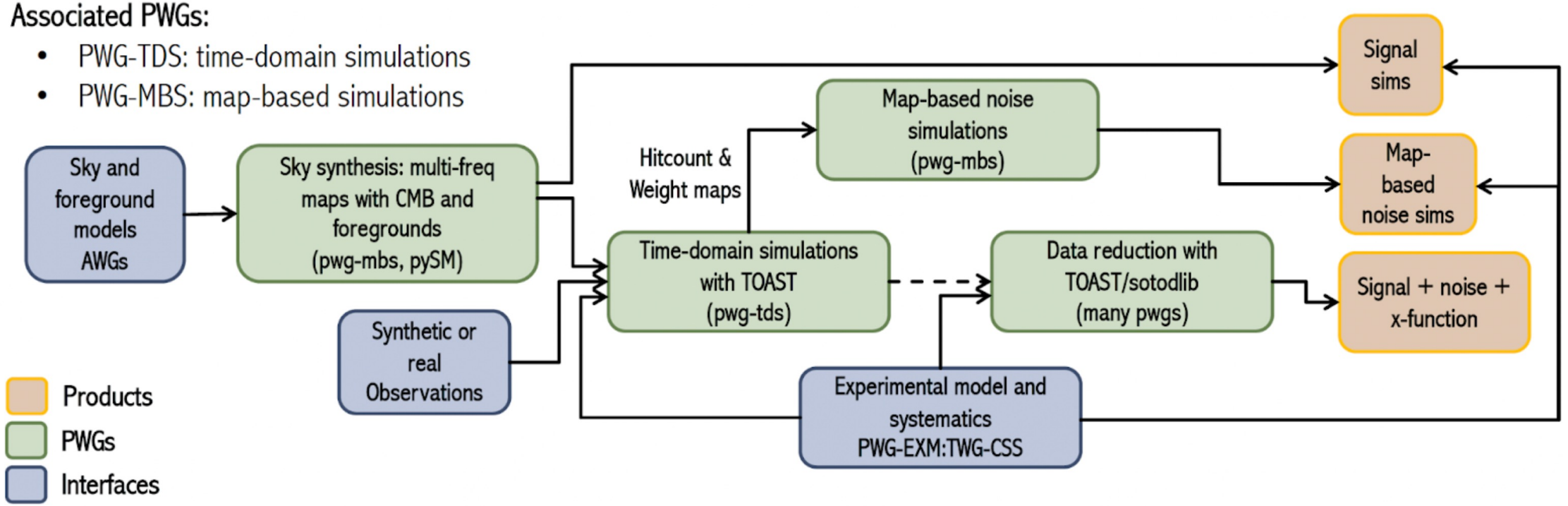
Data reduction and simulation unified framework

- SOTODLIB: Public library to characterize and reduce real and simulated data. Also used in labs for data manipulation
- TOAST: suite of simulation and reduction pipelines optimized for HPC
- Unified framework to simulate+reduce data on-the-fly



DATA MANAGEMENT

Simulations

- Two methods implemented: map-based and time-domain simulations
- Used to test/benchmark reduction pipelines and deliver SO-like data to AWGs (science groups)
- Planned released before end of SO project
- *Current Status:* pipelines are mature and should deliver products in 2022-2023

- Associated PWGs:
  - PWG-TDS: time-domain simulations
  - PWG-MBS: map-based simulations