Great Observatory for Long Wavelengths

GO-LoW

Mary Knapp, MIT Haystack Observatory
mknapp@mit.edu

Team: Mary Knapp[1] (PI), Lenny Paritsky[2], Kat Kononov[3], Melodie Kao[4], Arthur Lue[3], Jade Wang[3], Jake Turner[5]

[1]MIT Haystack Observatory [2]LeafLabs [3]MIT Lincoln Laboratory [4]Lowell Observatory [5]Cornell University

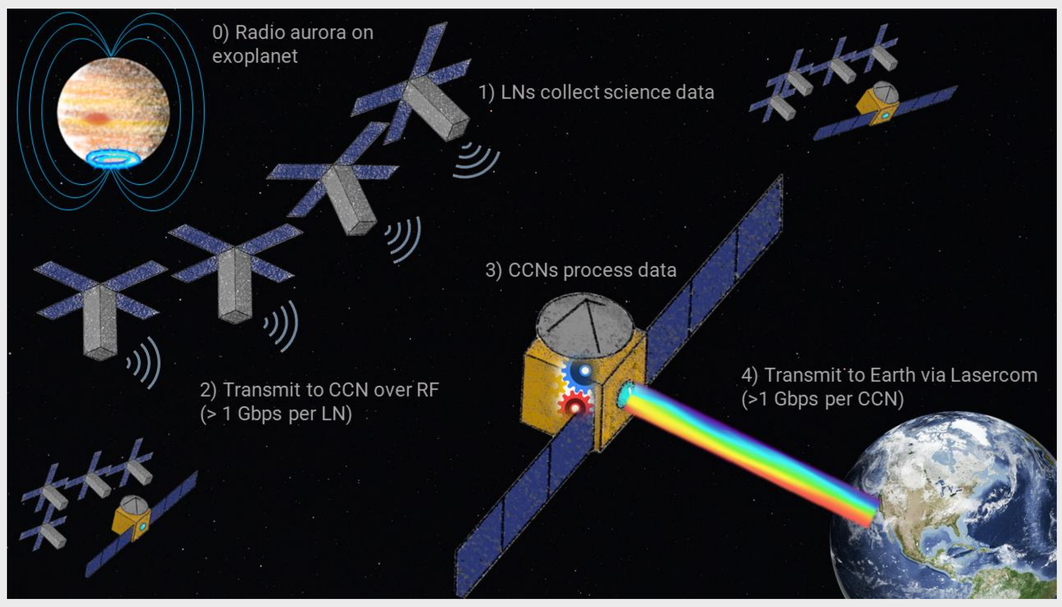
An interferometric mega-constellation, exploring the low-frequency sky from an Earth-Sun Lagrange Point

Innovation

- Instead of a one large, expensive, single-point-of-failure spacecraft use a reconfigurable, upgradable, and fault-tolerant mega-constellation.
- Modify constellation for different science cases; easily replenish failing nodes; gradually upgrade overall instrument capabilities; and more!

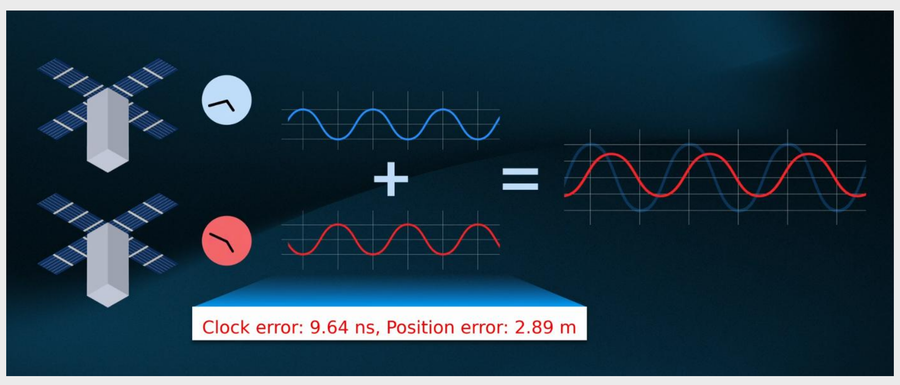
Benefit

- Low frequency sky is largely unexplored, with many compelling, groundbreaking applications ranging from cosmology to exoplanets.
- Case study focuses on survey of exoplanetary magnetic fields in our neighborhood (a key ingredient for understanding habitability).



GO-LoW: Revealing the low-frequency sky

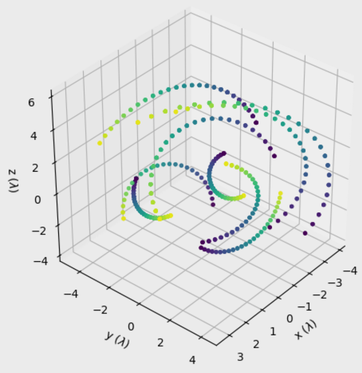
Timing: the key to interferometry

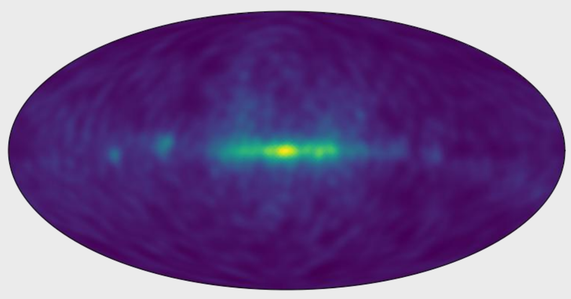


GO-LoW requires 4 nanoseconds timing precision (synchronization of clocks across the array) and 1 meter position knowledge for all spacecraft.

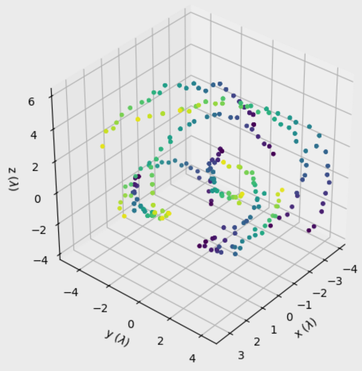
Effect of position errors on image quality

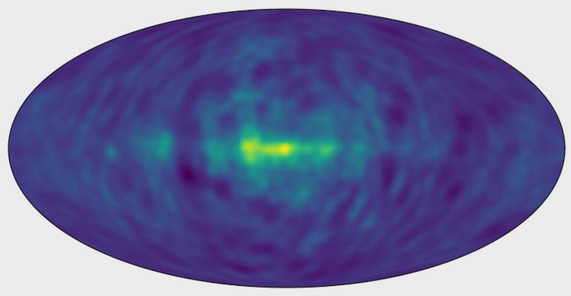
Ideal Positions





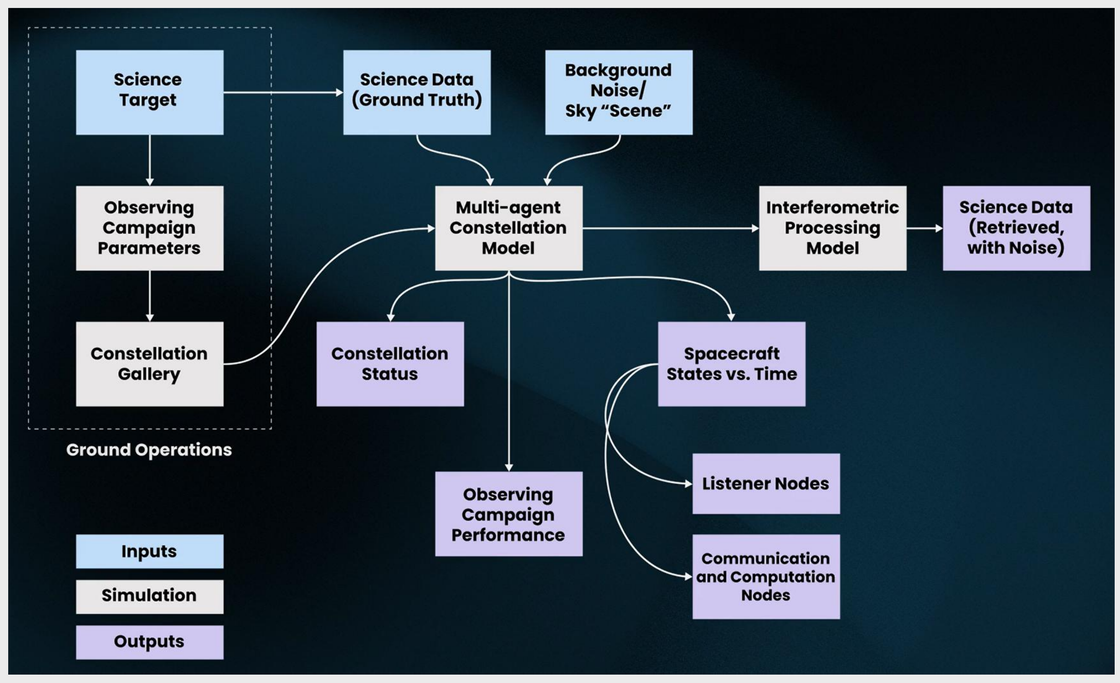
Perturbed Positions





These simulated all-sky maps show the effect of errors in spacecraft position. The lower map was simulated with position errors that exceeded the 1 m requirement, resulting in higher background noise and some features lost.

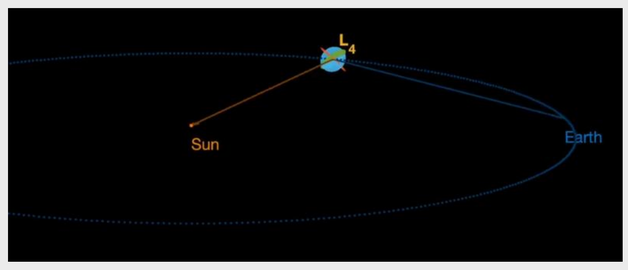
Multi-agent model for autonomy



The Phase I study showed that while all component technologies are available, it is the "system of systems" architecture that makes GO-LoW both innovative and challenging.

In Phase II, we are simulating:

- Mission planning and execution: turning high-level science goals into specific constellation tasks within well-defined constraints.
- Distributed decision making: collaboratively building a model of constellation geometry and dynamically changing subgroupings of spacecraft positions as orbital trajectories evolve.
- Orbits and fuel budgets in the Lagrange point environment.



LN clustering algorithm example (left); and Earth-Sun L4 configuration (right)

Read more about the interferometry simulation here:

https://academic.oup.com/rasti/advance-article/doi/10.1093/rasti/rzaf038/8242172
https://arxiv.org/abs/2508.18046

Our Phase I Report: