Introduction

The Cosmic Frontier studies fundamental physics over scales small to cosmic and has yielded compelling new discoveries that form the basis of much of the current HEP program.
The Cosmic Frontier strategy

In order to completely fulfill its science mission:

- CF’s top project priority is to complete the construction of CMB-S4, launch new efforts to delve deep and search wide for dark matter, and to aim high in advancing dark energy and cosmic acceleration research.

- CF seeks increased research support to execute the science goals of all projects in its portfolio, including new funding mechanisms to support cross-survey science and theory, and to leverage projects such as DESI, LSST, and CMB-S4.
Fundamental Questions

Is the inflationary paradigm realized in nature?

Did BSM degrees of freedom influence the thermal history of the universe?

Is dark energy a cosmological constant?

Not shown: Neutrinos, Dark Matter
CMB-S4 is ready to build now:
- CD-0 achieved in 2019
- CD-1 preparations underway

CMB-S4 is at the core of the CF program. It uniquely addresses cosmic inflation and its results will impact the science of many HEP frontiers.

The community consensus is that building and operating CMB-S4 is a top immediate priority.
Spec-S5 will be ready to build soon:
- Pathfinder small project ready now (DESI-II)
- Target CD-0 well before 2030

Spec-S5 will propel us into a new era of precision cosmology, ensuring that the U.S. community will remain a leader in CF science for decades to come.

The community consensus is that building Spec-S5 is our **top near-term priority**.
### Present Generation

- SPO & SO (r)
- Planck (fNL, local)
- LIGO + Virgo ($\Omega_{GW}$)
- SO/SPO (Neff)
- eBOSS & DESI ($Z_{1\%DE}$)

### Ready This Decade

- CMB-S4
- CMB-S4 & DESI
- Spec-S5 & CMB-S4

### Scientific Threshold

- Discover or rule out the natural models of inflation
- Discover or rule out the predicted simple multi-field inflationary non-gaussianity
- Explore a significant portion of uncharted discovery space
- Discover or rule out new light relics to QCD phase transition
- Discover or rule out new light relics to reheating
- Test dark energy to 1% over the dynamically relevant redshift range
Present Generation | Ready This Decade | Pathfinder and Development | Scientific Threshold
---|---|---|---
$\mathbf{r}$ | SPO & SO, 0.003 | CMB-S4, 0.0005 | discover or rule out the natural models of inflation
$f_N L$ (local) | Planck, 5 | CMB-S4, 2 | discover or rule out the predicted simple multi-field inflationary non-gaussianity
$A_{\text{in}}^{\text{primordial features}}$ | Planck, 0.01 | CMB-S4 & DESI, 0.002 | explore a significant portion of uncharted discovery space
$\Omega_{GW}$ | LIGO + Virgo | Spec-S5, 0.1 | discover or rule out new light relics to QCD phase transition
Light Relics | SO/SPO, 0.05 | Spec-S5, 0.03 | discover or rule out new light relics to reheating
High Energy | eBOSS & DESI, 0.7 | Spec-S5, 0.02 | test dark energy to 1% over the dynamically relevant redshift range
$Z_{\text{DE}}^{1\%}$ | LSST & DESI, 1.5 | Spec-S5, 4.5 | |

All values are $1\sigma$ uncertainties.

Marcelle Soares-Santos | Cosmic Frontier Large Projects
Snowmass Community Summer Meeting | Summary Panel | July 26, 2022
Timeline of CF large projects

- 2022-2036: Build & operate CMB-S4 (current large project)
- 2022-2036: Science with DESI, LSST, CMB-S4
- 2022-2025: Pathfinder for 21cm (LuSEE-Night)
- 2024-2027: Pathfinder for Spec-S5 target selection (DESI-II)
- 2024: Target date for CD-0 for Spec-S5 (next large project)
- 2025-2029: Pathfinders for next-generation GW Observatory
- 2027-2029: Pathfinders for 21cm/mm-wave line intensity mapping
- 2029: Begin CD process for LIM, GWO (future large project)