



South Pole Observatory MSRI-1:

Infrastructure for CMB Observations at the South Pole

Plan and Scope

CMB-S4, LNAL 13 March 2019



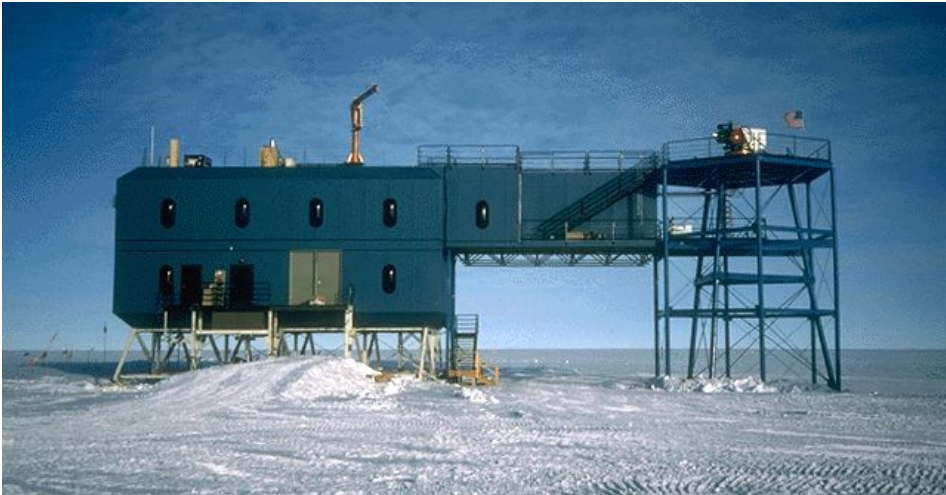
from MSRI 1-page summary:

Project Summary

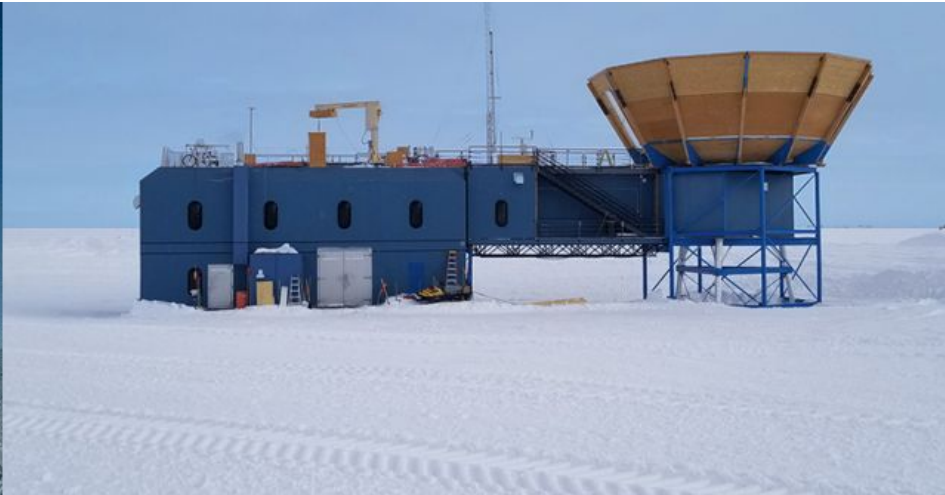
Overview: This proposal is most relevant for review by GEO/Polar Programs. It provides critically-needed upgrades to Mid-Scale Research Infrastructure at the NSF South Pole Station to enable the continuing and future support of CMB observations there that search for primordial gravitational waves. We propose:

- Immediate construction of new infrastructure adjacent to the core MAPO observatory (built 1994) but built well above current snow grade, comprising a new tower, ground shield, and receiver service bay designed to support BICEP Array operations, and also capable of supporting planned future projects.
- Design activities needed to prepare for the wide-field, large-aperture CMB telescope needed for ultra-deep lensing measurements. These will deliver prototypes of a monolithic mirror and other key components, and the engineering needed to produce a “shovel-ready” design appropriate for South Pole, culminating in a coordinated review and public report within 2 years.
- Upgrade of the core MAPO lab itself by raising it above current snow grade and connecting it to the new observing infrastructure, thereby extending its lifecycle to support current and future projects.

MAPO upgrade: a long-recognized infrastructure need



1995



2019

- Local snow grade accumulates ~1 foot per year
- Lifecycle success: reused sequence of 6 major telescopes
- By 2006, refurb action plan was already being developed
- MAPO replacement & refurbishment has been subject of
 - South Pole Long Range Plan, 2008
 - Astrophysics from South Pole community workshop, 2011
 - NRC Antarctic Strategic Vision, 2015
 - OPP BICEP Array & CMB Facilities Planning Initiative, 2017
- Long recognized “identified need of the research community”
- 2017 pre-MSRI “Infrastructure Survey”: **MAPO upgrade** was identified as South Pole priority, **already needed to support Stage 3 efforts**

Large telescope design activity

- Goal: Develop/deliver shovel-ready designs within 2 years for:
 - 3-axis mount, environmental and building interfaces -- appropriate for Pole operation!
 - Monolithic mirror demo (potential advantages esp. for deep delensing survey)
 - Full engineering for the TMA optics design, allows complete evaluation/costing

→ many aspects of proposed design (operation at Pole, boresight rotation, monolithic mirrors) are of interest for any optics configuration
- Co-designing telescopes and support facilities is **essential** at Pole
- Design Activity ends in 2 years with a public Review & Report
 - Evaluate all deliverables of design activity
 - Include technical comparison of TMA and Cross Dragone (CD) optical design alternatives
 - Coordinated: to include representatives from CMB-S4 project office and NSF

MAPO upgrade implementation

- “BICEP Array Replacement Tower” → based on previous designs, but sized to accommodate both BICEP Array and CMB-S4 ref design (the BA mount *is* current SAT mount S4 reference design)
- Receiver assembly / service bay → adds much-needed capability to assemble large receivers
- Ice pad and building layout planned for future expansion (multiple towers, including large telescope)
- MAPO to be raised in 2022 and connected
 - Lifecycle extended for at least 15 years, i.e. 2037... a good fit to S4’s
- Coordination with S4 Project Office to ensure compatibility

