

Dear Jim, John and Julian,

This letter declares the intention of ANL, FNAL, LBNL, and SLAC to work together on a single coordinated R&D plan for Detectors & Readout for CMB-S4. This coordinated plan will encompass activities along the following directions:

- 1) Developing detector modules and packaging required for CMB-S4
- 2) Developing multiplexed readout required for CMB-S4
- 3) Developing fabrication with throughput and quality required for CMB-S4
- 4) Developing integrated testing at a level of quality required for CMB-S4

For the next step in R&D proposal process, we will develop this plan in more detail. We expect the development of partnerships with institutions beyond the four labs listed on this letter in the execution of this plan. For the first of the above activities, we expect this plan to cover the more detailed activities, milestones, and timeline below:

Develop detector modules and packaging required for CMB-S4

Activities and Milestones:

- Design detectors and characterize performance
 - 2019 Q3: Define specs for detectors for initial R&D fab.
 - 2020 Q2: Equip and update existing testbeds for single-pixel and array R&D
 - 2020 Q2: Design and fabricate test pixels that demonstrate TES performance (including direct stimulation mitigation) and RF performance
 - 2020 Q2: Design and fabricate prototype CMB-S4 detector array (RF + TES), prioritizing the 90/150 GHz split.
 - 2020 Q2: Define performance requirements of production arrays based on instrument and science requirements.
- Design optical coupling and characterize performance
 - 2019 Q3: Define specs for optical coupling specs for initial R&D fabrication
 - 2019 Q3: Design prototype large-aperture (LT) and small-aperture (ST) pixel designs for the 90/150 GHz split, to begin pixel and wafer fab.
 - 2019 Q4: Design prototype LT and ST pixel designs for other frequency splits
 - 2020 Q2: Test optical coupling and performance on test pixels.
 - 2020 Q3: Test optical coupling and performance of a prototype 90/150 array.
- Design detector module packaging and validate
 - 2019 Q3: Define specs for detector packaging
 - 2019 Q4: Design prototype detector module holder and wafer stack
 - 2020 Q2: Test-fit and bond detector module with prototype detector wafer and readout modules
 - 2020 Q3: Cryogenic tests of detector module assembly, that verifies basic detector readout functionality (e.g., connectivity, TES transition temperature and resistance, EM performance of detectors)

Sincerely,

Zeesh Ahmed (SLAC), Amy Bender (ANL), Brad Benson (FNAL), Clarence Chang (ANL), Aritoki Suzuki (LBNL)