CMB-S4 Collaboration Meeting Update

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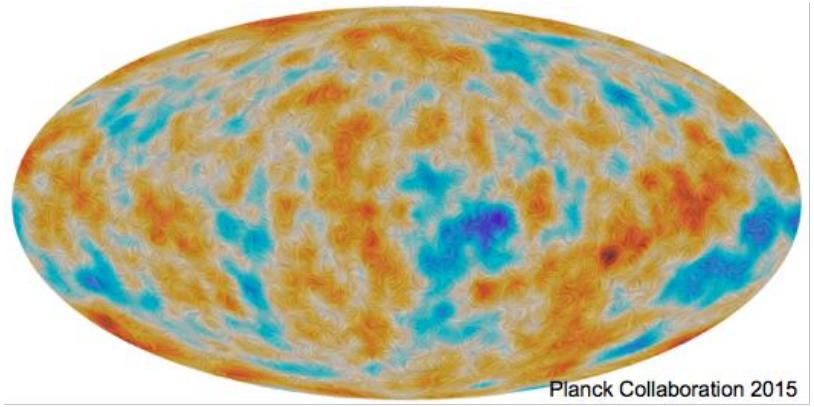
CMB-S4

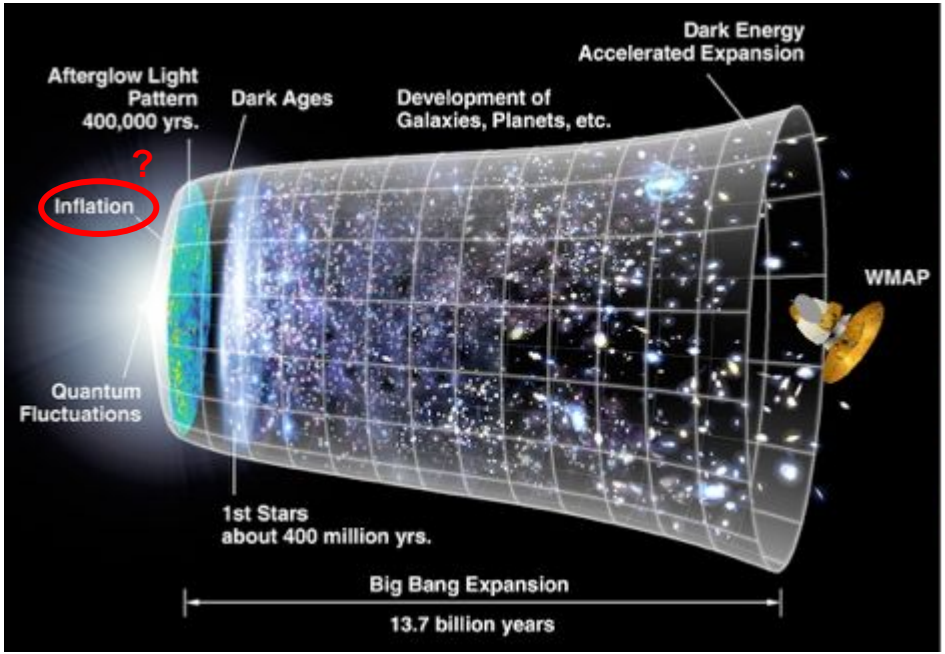
Cosmic Microwave Background (CMB)

- The CMB is the afterglow of the Big Bang
  - Formed ~400,000 years after universe began
  - Snapshot of the early universe→ 10 trillion times the energies of particle accelerators
  - Backlight to the formation and evolution of structure (e.g. galaxies)→ Dark matter, dark energy, particle interactions
- CMB-S4 will be the most sensitive CMB experiment to date
  - Will reach critical scientific thresholds in our understanding of the fundamental physics of the universe



Inflation

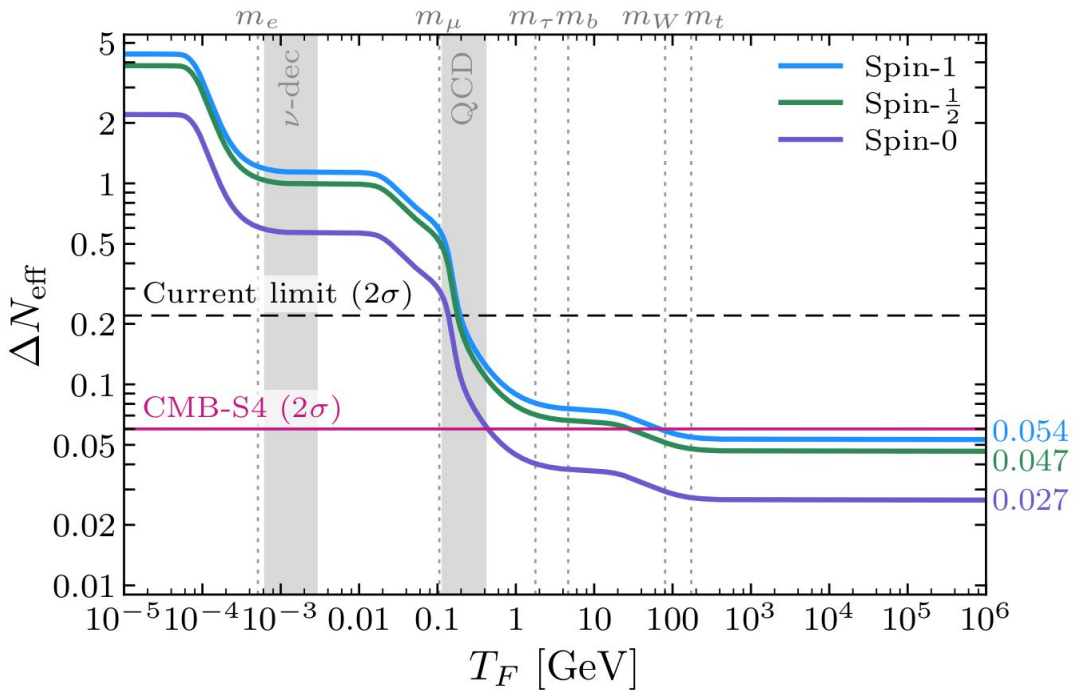
- The signature of inflation has yet to be measured
- CMB-S4 will be ~10x more sensitive to the signature of inflation than current experiments
- No detection would rule out a large number of inflationary models
- One of the few ways to probe early universe ~10^{-36} s after its beginning!



NASA WMAP Science Team

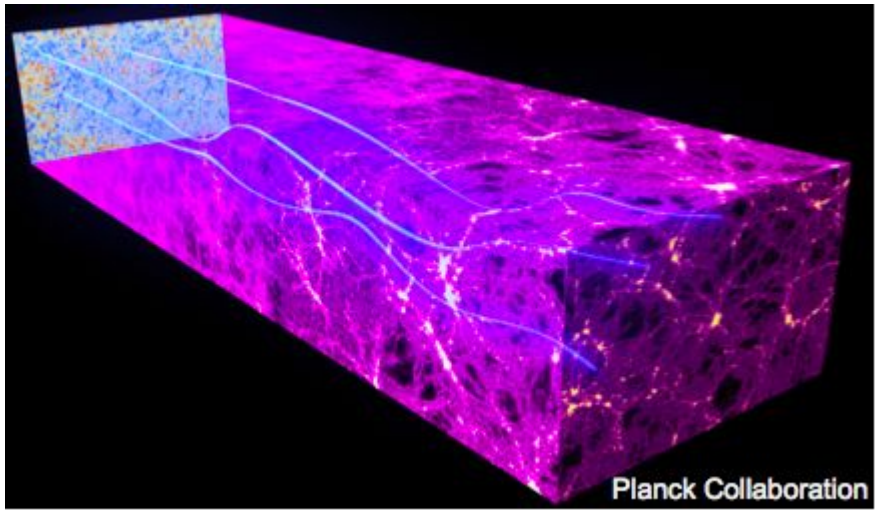
The Dark Universe

- Measure the sum of the neutrino masses ~10x better than ever before→ highly complementary to neutrino oscillation experiments
- First time we can rule out/detect new relativistic particles



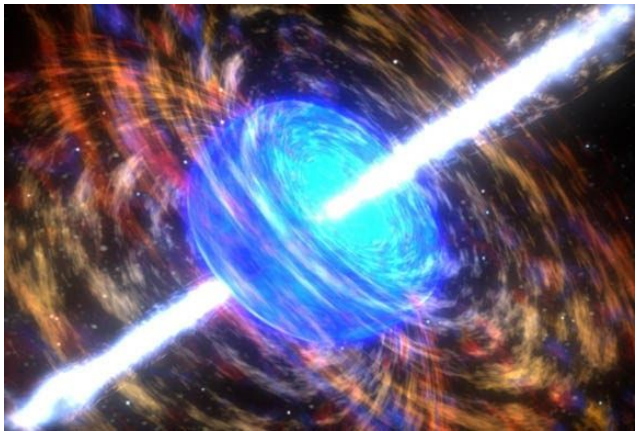
Mapping the Matter in the Cosmos

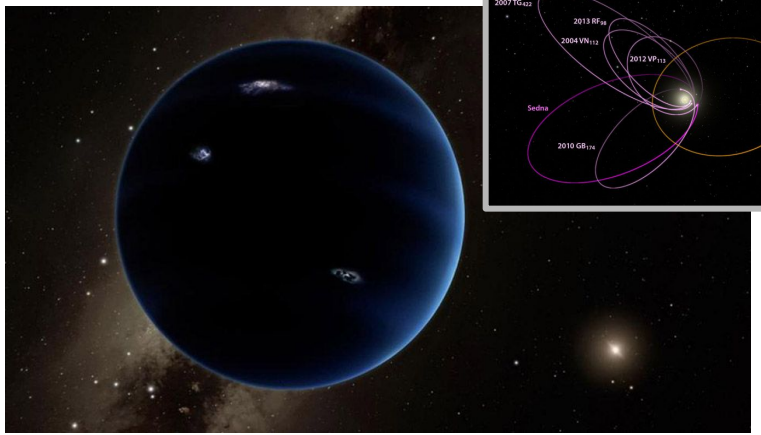
- Highly sensitive probe of dark matter and dark energy through the growth of structure
- Highly complementary to supernovae and large-scale structure studies
- Expect to detect over 100,000 galaxy clusters



The Time-Variable mm-wave Sky

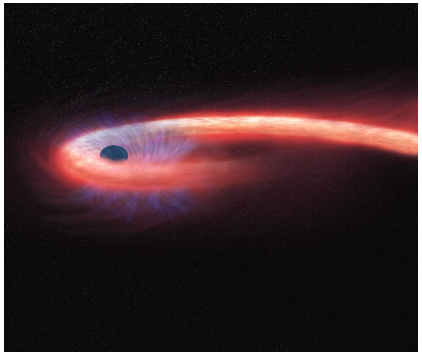
Gamma ray bursts

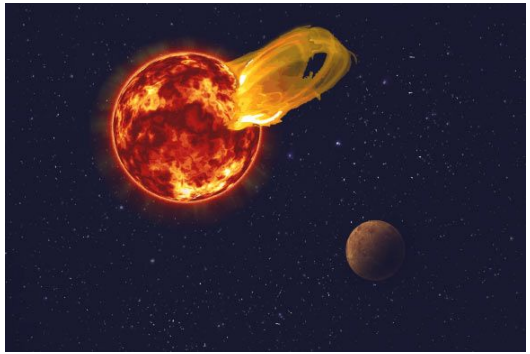




Solar system objects

Tidal disruption events

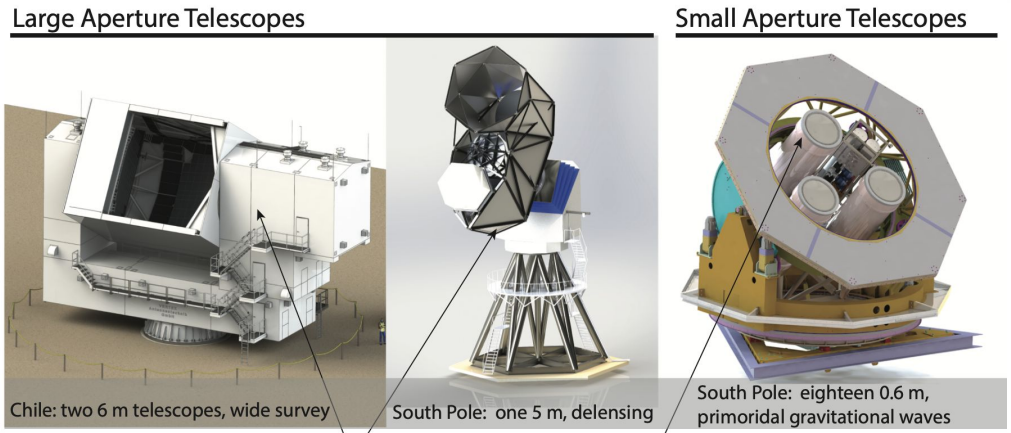




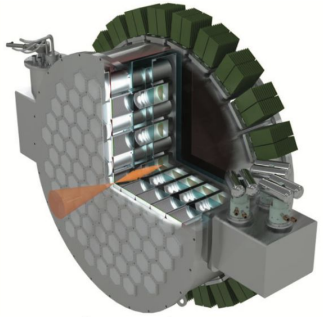
Stellar flares

CMB-S4 Design

- 6 Small Aperture Telescopes and 1 Large Aperture Telescope at the South Pole
- 2 Large Aperture Telescopes in the Atacama Desert in Chile
- ~500,000 detectors
- ~100x the scale of any project we have done before!
- Observation begins late 2020's

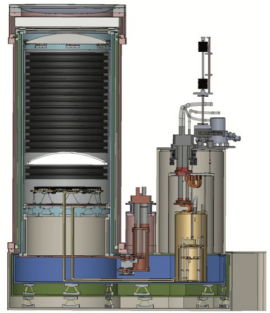


Large Aperture Telescope Receiver



one receiver per telescope
each with 85 independent optical paths
each feeding one detector array

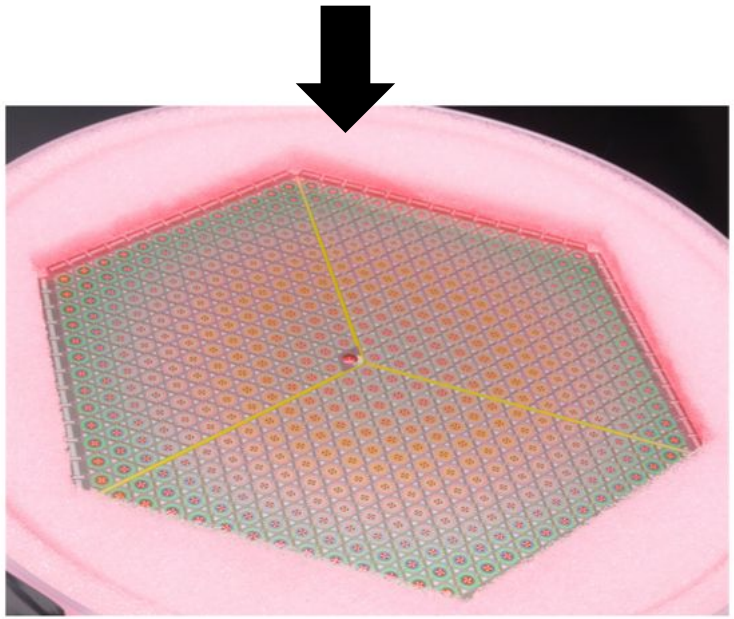
Small Aperture Telescope Receiver



Three receivers per mount
each with one optical path
that feeds 14 detector arrays

CMB-S4 Status

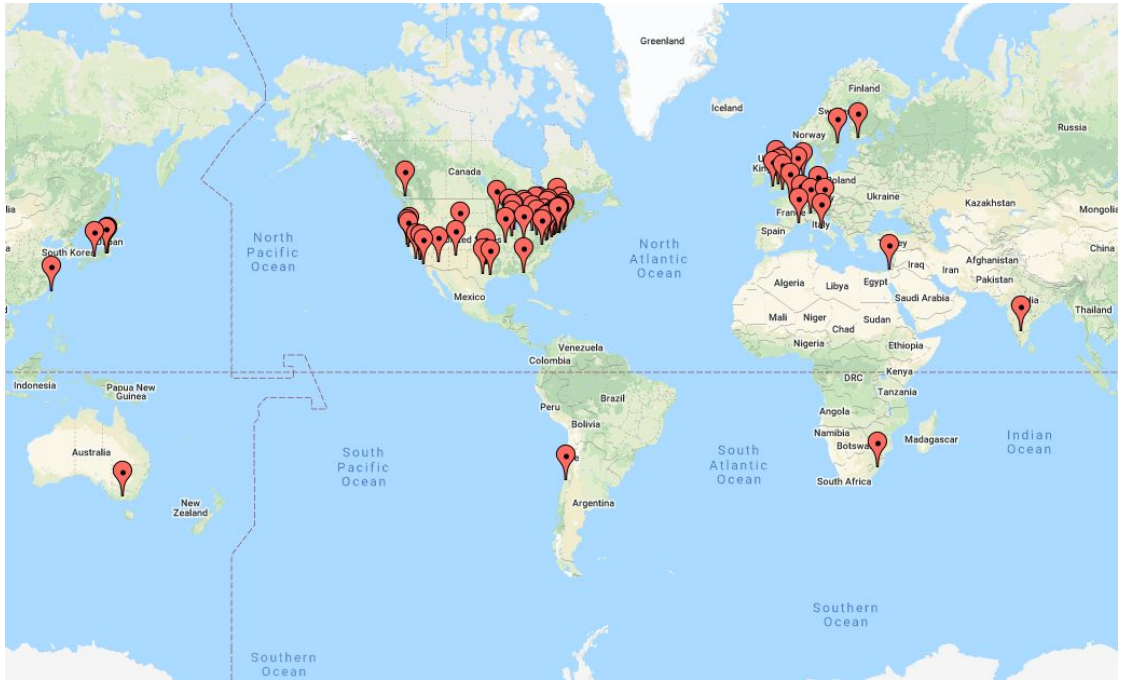
- Basic science cases → Science requirements
- Initial conceptual project design → Mature baseline design that meets the measurement requirements
- Maturing plans on how to validate the technical design
- Making design decisions across the full project
- Preparation for NSF PDR and DOE CD-1 in Fall 2021

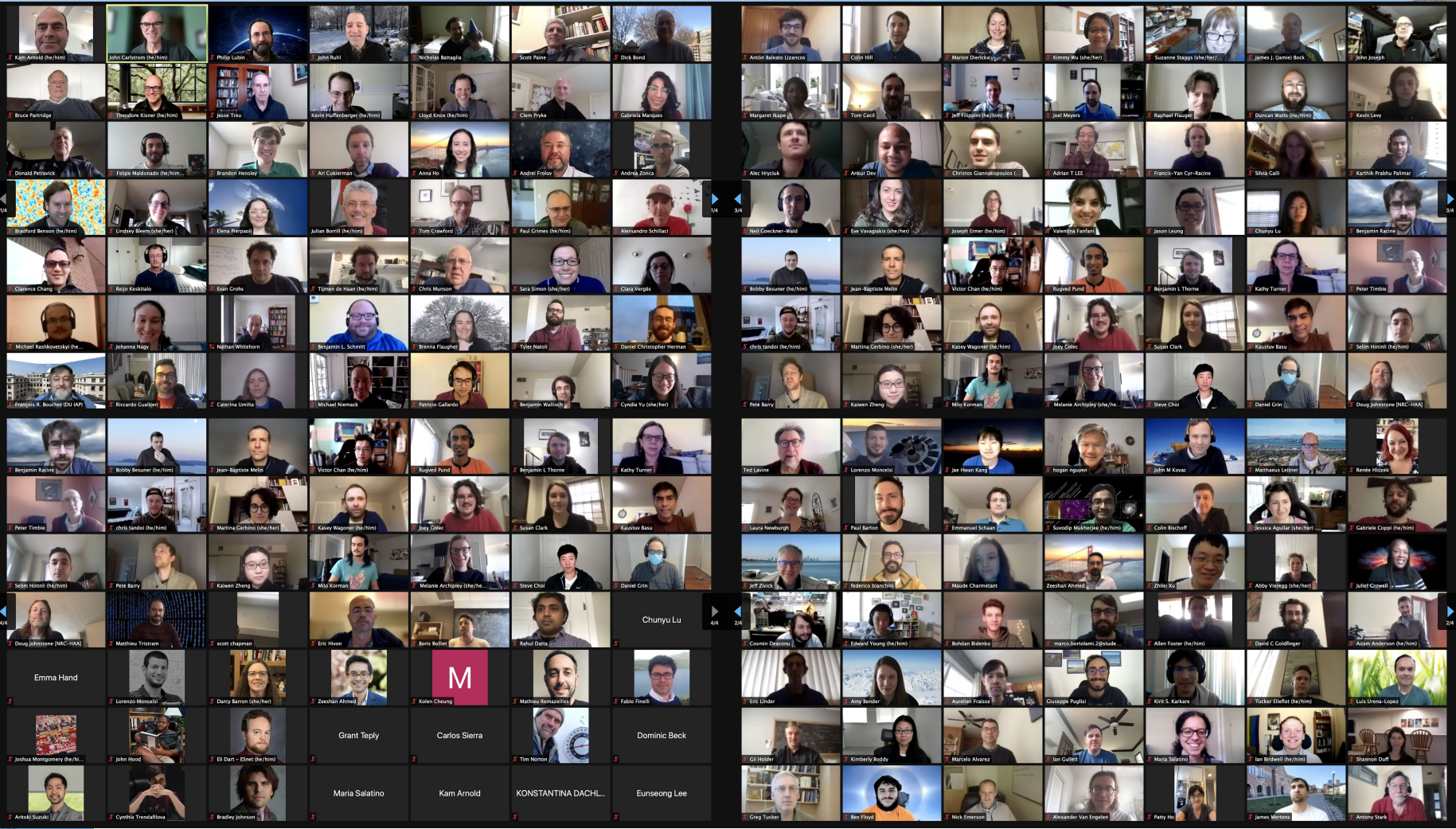


CMB-S4 Collaboration and Meeting

- Collaboration
  - 17 countries
  - 21 US States
  - 99 Institutions
  - 289 Members

- Meeting had 334 registered attendees
  - 210 team (collaboration + project) members: 75% of the entire membership!
  - 124 non-members
  - 5 other experiments on #spring2021 slack channel (ACT, B/K, PB/SA, SPT, SO)
  - DOE and NSF representatives

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John Ruhl
Nicholas Battaglia
Scott Paine
Dick Bond
Bruce Partridge
Theodore Kisner (he/him)
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Kevin Huffenberger (he/him)
Lloyd Knox (he/him)
Clem Pryke
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Ari Cukierman
Anna Ho
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Nathan Whitehorn
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Brenna Flaugher
Tyler Natoli
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Bobby Besuner (he/him)
Jean-Baptiste Melin
Victor Chan (he/him)
Rugved Pund
Benjamin L Thorne
Kathy Turner
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Martina Gerbino (she/her)
Kasey Wagoner (he/him)
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Susan Clark
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Mathieu Remazeilles
Fabio Finelli
Joshua Montgomery (he/hi...
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Eli Dart – ESnet (he/him)
Grant Teply
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Tim Norton
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Antón Baleato Lizancos
Colin Hill
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Margaret Ikape
Tom Cecil
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Joel Meyers
Raphael Flauger
Duncan Watts (He/Him)
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Alec Hryciuk
Ankur Dev
Christos Giannakopoulos (...
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Silvia Galli
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Joseph Eimer (he/him)
Valentina Fanfani
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Amy Bender
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Ian Birdwell (he/him)
Shannon Duff
Greg Tucker
Ben Floyd
Nick Emerson
Alexander Van Engelen
Patty Ho
James Mertens
Antony Stark

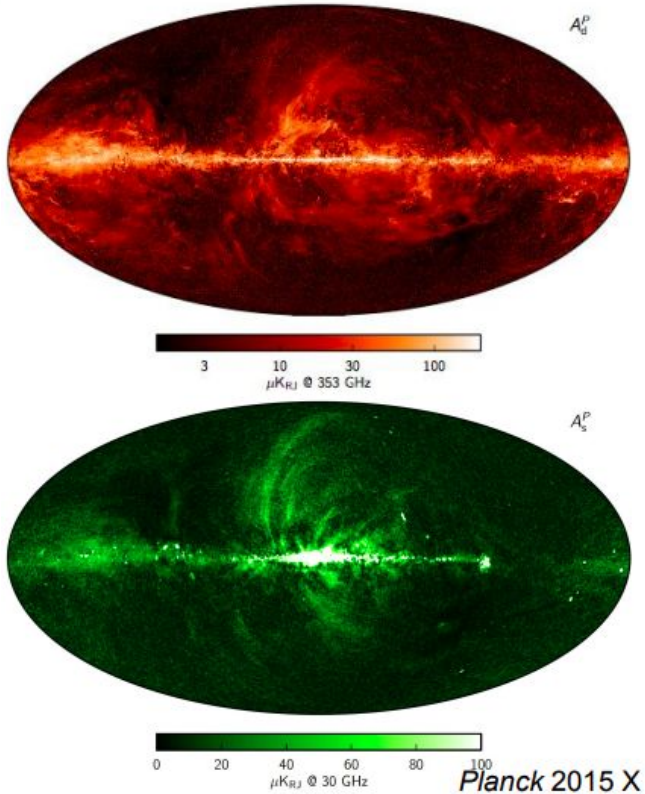
Investing in the future of our field and communities

- Education and Public Outreach (EPO)
  - Goal of expanding collaboration engagement in EPO activities
  - Expert panel discussion on what is important in planning EPO programs
  - Began discussions about what CMB-S4's cornerstone projects could look like

- Junior Scientist Advancement Committee
  - Networking events for early career members
  - Discussions with funding agency representatives
  - Career panel with a number of possible careers represented
  - 1 minute talks about their work
  - Virtual poster sessions

Highlights

- New science opportunities:
  - Galactic science
  - Galaxy cluster dynamics/astrophysics
- New and maturing designs:
  - Improved and simplified optical designs
  - Plans for handling the ~49 PB of data
  - Detector specifications and layout
  - Plans for detector and readout prototypes→ Testing at FNAL in the coming year!
- New challenges:
  - Radio astronomy has protected bands, but CMB observations in unprotected spectrum
  - Large satellite constellations emit in our observation bands
  - Assessing impacts of current and planned interference sources



Incredible progress and growth since the last collaboration meeting!