

Zeeshan Ahmed

CONTACT INFORMATION	2575 Sand Hill Rd. Menlo Park, CA 94025	office: (650) 926-3408 zeesh@slac.stanford.edu
APPOINTMENTS	Associate Professor of Particle Physics and Astrophysics (without tenure) <i>Kavli Institute for Particle Astrophysics and Cosmology (KIPAC)</i> <i>SLAC National Accelerator Laboratory and Stanford University</i>	2023-Present
	CMB Department Head <i>Fundamental Physics Directorate, SLAC National Accelerator Laboratory</i>	2019-Present
	Lead Scientist Wolfgang Panofsky Fellow and Project Scientist <i>Fundamental Physics Directorate, SLAC National Accelerator Laboratory</i>	2020-2023 2015-2020
EDUCATION & TRAINING	Senior Postdoctoral Fellow Postdoctoral Fellow <i>Kavli Institute for Particle Astrophysics and Cosmology (KIPAC), Stanford University</i> <i>Advisor: Prof. Chao-Lin Kuo</i>	2014-2015 2011-2014
	Ph.D., Physics <i>California Institute of Technology, Pasadena, CA</i> <i>Title: A Dark-Matter Search Using The Final CDMS II Dataset And A Novel Detector Of Surface Radiocontamination</i> <i>Advisor: Prof. Sunil Golwala</i> <i>Committee: Prof. Fiona Harrison, Prof. Marc Kamionkowski, Prof. Brad Filippone</i>	2012
	M.S., Physics <i>California Institute of Technology, Pasadena, CA</i>	2008
	B.S., Aerospace Engineering <i>University of Southern California, Los Angeles, CA</i>	2005
RESEARCH ACTIVITY	South Pole Observatory: BICEP Array and SPT-3G+ <i>A coordinated observing and analysis program of the BICEP and SPT collaborations at South Pole Research Station, targeting a sensitivity of $\sigma(r) = 0.001$ on the tensor-to-scalar ratio. Arrays of compact small-aperture BICEP polarimeters deeply integrate $\sim 1\%$ of the sky to search for primordial gravitational waves, while the 10 meter South Pole Telescope supplies the high-resolution lensing maps used to delens those B-mode data.</i> • DOE Principal Investigator of the BICEP Array Upgrade Project (2025-present) to populate the fourth BICEP Array receiver with CMB-S4-style detector modules prior to its installation and commissioning at the South Pole. • SLAC Principal Investigator and Readout L2 manager for SPT-3G+ (2025-present), leading the microwave SQUID multiplexed readout for a receiver of 24,080 transition-edge sensors at 90 and 150 GHz, planned for installation on the 10 meter South Pole Telescope in early 2029. • Led the design, construction, testing and deployment (2011-2015) of BICEP's third generation receiver, BICEP3, with 10 times greater optical throughput than the previous generation. • Coordinated BICEP/Keck science observations at South Pole Research Station and oversaw low-level reduction, map making and data quality assurance (2015-2018). This dataset (BK18) placed the tightest published constraint on the tensor-to-scalar ratio, $r_{0.05} < 0.036$ at 95% confidence.	2011-Present

- Supervised development of analysis and first published constraints on ultralight axionlike fuzzy dark matter by searching for polarization oscillations in BICEP/Keck CMB data.

Simons Observatory and Advanced Simons Observatory

2016-Present

A CMB scientific collaboration and observatory in the Parque Astronómico de Atacama in Chile to survey the southern sky. The first small-aperture telescope began observing in 2023; the 6 meter large-aperture telescope achieved first light in February 2025.

- Co-Investigator on the NSF-funded Advanced Simons Observatory project (2023–present), leading the SLAC scope for the build-out and delivery of the detector readout system for the expanded observatory.
- Fabricated and delivered SMuRF warm readout electronics for the observatory and for the NSF-funded Advanced Simons Observatory expansion.
- Led optimization of camera sensor and readout chains for the observatory’s 6 meter telescope for initial science observations.
- Our group leads a comprehensive study of instrument systematic effects on CMB lensing reconstruction with large-aperture telescope data (2025–present), including readout crosstalk studies to quantify the level and impact of that systematic on map making and lensing reconstruction.
- Contributed source removal, null tests and results validation for lensing reconstruction with the large-aperture telescope’s Initial Science Observations; publications in preparation.
- Served as L3 scientist for Readout (2018–2022), leading the conceptual design and prototyping of the microwave-multiplexed superconducting sensor readout system for the observatory’s cameras.

High-density microwave-multiplexed readout of superconducting sensors

2016-Present

SLAC Microresonator RF (SMuRF) Electronics is a high-density, low-noise system for excitation, manipulation and readout of cryogenic superconducting GHz microresonators for CMB bolometry, X-ray calorimetry, particle detection and quantum computing

- Scientific and Project lead for SMuRF. Guided the design and prototyping effort, and led the lab testing and validation effort for SMuRF architecture with CMB Transition Edge Sensor Bolometers. Achieved 1000x multiplexing factor for TES bolometers.
- SMuRF is now deployed across CMB and X-ray instruments, reading out 98,000 transition-edge sensors at Simons Observatory, the largest deployment of microwave SQUID multiplexing for TES bolometers as of 2026.
- Leading development of SPECTRA, an open-source RFSoc-based readout platform (SLAC, Fermilab and U. Chicago) that pairs SMuRF tone tracking with QICK firmware to span high-channel-density resonator arrays and MHz-bandwidth quantum sensor readout, serving future CMB and submillimeter surveys alongside dark matter, coherent neutrino scattering and rare-event searches.

Quantum sensors for entanglement distribution and rare-event searches

2022-Present

Superconducting photon counters and high-kinetic-inductance devices that enable distribution of entanglement over quantum networks, and low-threshold sensing for dark matter and other rare-event searches.

- Lead of the Photon Sensors project within the Sensors for Entanglement thrust of Q-NEXT (2025–2030), a DOE National Quantum Information Science Research Center.
- Directing development of high-speed superconducting nanowire single-photon detectors for entanglement distribution, targeting high detection efficiency and low timing jitter at telecommunication wavelengths.
- Principal Investigator of an LDRD program (2027–2029) on high-kinetic-inductance thin films for amplification, sensing and quantum information, extending the same materials platform to low-threshold detectors for dark matter and rare-event searches.

- Directed construction of the SLAC Detector Microfabrication Facility (2022–2025), a \$49M Class-100, 5,500 sq. ft. superconducting quantum foundry for niobium, aluminum and silicon oxides and nitrides. Devices for the projects above are fabricated in this facility.

Cosmic Microwave Background Stage-4 (CMB-S4)

2015–2025

A fourth-generation ground-based cosmic microwave background (CMB) observatory project, proposed for the 2030s and jointly supported by the US DOE and NSF to probe inflation, light relics, large-scale structure, dark matter, dark energy, and mm-wave transients. The project was cancelled in 2025.

- Served as L2 science lead for Detector Readout from Summer 2019 to 2025. Led the design of transition-edge sensor bolometer multiplexing and readout for CMB-S4, and provided technical leadership of the \$75M instrument subsystem.
- Served as Senior Team Lead for all CMB-S4 effort at SLAC, spanning Detectors, Readout, Data Acquisition, Small Aperture Telescopes, Data Management and Inflation Science Working Group.
- Developed with our team internal linear combination foreground cleaning techniques for CMB-S4 inflation-search data challenges in the Inflation Science Working Group

GRANTS

PI, Laboratory Directed Research and Development (\$485K), DOE	2027-29
High Kinetic Inductance Thin Films for Amplification, Sensing and Quantum Information	
PI, South Pole Observatory Upgrades R&D at SLAC (\$650K), DOE	2025-Present
Readout and detector R&D for South Pole Observatory upgrades (BICEP Array and SPT-3G+)	
Co-I, Q-NEXT 2.0 National QIS Research Center (\$1.5M of \$37M), DOE	2025-30
Photon counters for quantum entanglement	
Co-I, Advanced Simons Observatory/U. Penn subaward (\$1.5M of \$52M), NSF	2023-28
Build out of detector readout system for Advanced Simons Observatory	
PI, Laboratory Directed Research and Development (\$1.5M), DOE	2023-26
Experimental Research in Cosmic Inflation and Growth of Structure	
PI, DMF Quantum Foundry Construction (\$49M), DOE & Stanford	2022-25
Build out of a Class-100 5,500 sq. ft. clean room with photolithography tooling for microfabrication of niobium, aluminum and silicon oxides and nitrides	
PI, CMB-S4 MIE Project at SLAC (\$4.8M), DOE	2020-25
Readout, Data Acquisition & Control, Module Assembly & Test prototyping	
PI, Laboratory Directed Research and Development (\$119K), DOE	2020-21
Superconducting Resonators for Next-Generation Cosmological Probes	
Co-I, CMB-S4 R&D at SLAC (\$250K of \$840K), DOE	2020-21
Detectors and Readout research and development	
Science PI, Strategic Astrophysics Technology (\$1.9M), NASA	2019-22
Microwave Multiplexing Readout Development for Lynx X-ray Observatory	
Co-PI, Simons Observatory Center at UCSD (\$3.0M of \$109M), Simons Foundation	2018-22
Design and Fabrication of detector readout system for Simons Observatory	
Co-I, US-Japan Cooperative Research in High Energy Physics (\$144K of \$250K), DOE	2018-22
Next Generation of Superconducting Devices for Photon and Particle Sensing: Universal Detector and Readout Systems for Large-Format Arrays	
PI, Early Career Research Program (\$2.5M), DOE	2017-22
Development of High-density Microwave-multiplexed Transition Edge Sensor Bolometers for next-generation CMB Cameras	
PI, Wolfgang Panofsky Fellowship (\$1.25M), DOE	2015-20
BICEP and CMB-S4 program development at SLAC	

PROFESSIONAL SERVICE

Member of Detector Microfabrication Facility (DMF) process review committee at SLAC	2026–
---	-------

	Present	
	Member of Program Committee for Applied Superconductivity Conference	2026
	Member of CMB-S4 Survey of Experiments committee, commissioned by DOE and NSF to assess the landscape of CMB experiments in the 2030s	2024–2025
	Chair of Readout session at Applied Superconductivity Conference	2024
	Member of Fermi National Accelerator Laboratory Physics Advisory Committee	2021–2024
	Member of Astro2020 Decadal Survey Early Career Focus Group	2018
	Member of Governing Board, CMB-S4 Science collaboration	2018–2020
	Member of Scientific Organizing Committee for Coordinating Panel for Advanced Detectors (CPAD) Instrumentation Frontier Workshop	2018
	Chair of Local Organizing Committee for 5th CMB-S4 workshop at SLAC	2017
	Organizer and chair of CMB science and technologies session at the Kavli/NRAO Radio/mm/submm Futures II meeting	2016
	Peer Reviewer for Journal of Low Temperature Physics, and Proceedings of Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy	
	Reviewer on various DOE, NSF and NASA proposal review panels	
HONORS & AWARDS	Early Career Award, Department of Energy, Office of Science	2017
	Wolfgang Panofsky Fellowship, SLAC	2015
	Antarctic Service Medal And Commendation, National Science Foundation	2014
	Graduate Fellow, Phi Kappa Phi Honor Society	2006
	Archimedes Circle Award for Outstanding Scholarship, USC	2005
	Valedictorian, Viterbi School of Engineering, USC	2005
MENTORING & TEACHING	Undergraduate students mentored	
	Abdulla AlShirawi, Stanford Physics Undergraduate Research	2024–25
	Andy Durham, Stanford Physics Undergraduate Research	2024–25
	Haley Gonella, Summer Undergraduate Lab Internship, SLAC	2023
	David Koon Concepcion, Stanford Physics Undergraduate Summer Research	2023
	Raymond Llata, Stanford Physics Undergraduate Summer Research	2023
	Pariya Samandi, Summer Undergraduate Lab Internship, SLAC	2018
	Betty Hu, Summer Undergraduate Lab Internship, SLAC	2017
	Jennifer Smith, Summer Undergraduate Lab Internship, SLAC	2016
	PhD Thesis advisees	
	Brianna Cantrall, Stanford University	2024–Present
	<i>Research Area: Cosmic inflation search with BICEP Array and characterization of galactic foregrounds</i>	
	Thomas Satterthwaite, Stanford University	2023–Present
	<i>Research Area: CMB lensing reconstruction with Simons Observatory and commissioning of the Simons Observatory Camera Readout System</i>	
	Cyndia Yu, Stanford University	2016–2023
	<i>Dissertation: Large-Scale Observations of the Cosmic Microwave Background</i>	
	PhD students mentored	
	Max Silva-Feaver, UC San Diego, <i>Microwave multiplexing for Simons Observatory</i>	2016–2023
	Stephen Kuenstner, Stanford University, <i>Microwave multiplexing development</i>	2016–2018
	Postdoctoral advisees and fellows	
	Rui ‘Ray’ Shi, Stanford University, <i>BICEP Array galactic foreground studies and time-division readout electronics</i>	2025–Present
	Carlos Sierra, KIPAC Fellow, Stanford University, <i>mm-wave line intensity mapping simulations and experiment design</i>	2024–Present
	Jia ‘Frank’ Qu, Stanford University, <i>Simons Observatory CMB lensing</i>	

<i>reconstruction</i>	2023-Present
<i>Einstein Fellow</i>	2026-Present
Tristan Pinsonneault-Marotte, Stanford University, <i>Simons Observatory Readout Subsystem and CMB-LSS cross correlations</i>	2023-Present
David Goldfinger, Stanford University, <i>CMB-S4 detector readout system development</i>	2022-2023
Federico Bianchini, Stanford University, <i>CMB inflation foreground cleaning</i>	2020-2024
Ari Cukierman, Stanford University, <i>Ultralight axion searches with CMB polarization, and BICEP/Keck microwave multiplexing demonstrator</i>	2018-2022
Ed Young, Stanford University, <i>X-ray calorimetry with microwave multiplexing</i>	2018-2021
Sarah Kernasovskiy, Stanford University, <i>Development of SMuRF for microwave multiplexing</i>	2016-2018

Staff scientists

Emmanuel Schaan, SLAC, <i>Simons Observatory large-scale structure studies, Rubin</i>	2022-Present
Shawn Henderson, SLAC, <i>CMB detector readout systems; Simons Observatory, BICEP</i>	2017-Present

Research scientists

Cheng Zhang, Stanford University, <i>Design, modeling and fabrication of superconducting and qubit-based sensors</i>	2025-Present
Dominic Beck, Stanford University, <i>AI techniques for improved CMB data quality and data processing pipeline speedup</i>	2025-Present
Former members: W.L. Kimmy Wu (Asst. Professor, California Institute of Technology), Kirit Karkare (Asst. Professor, Boston University), Josef Frisch (Sr. Engineer, Google)	

Course instruction

Instructor, Physics 50: Astronomy Laboratory and Observational Astronomy 2015
Introductory Astronomy lab course for undergraduates at Stanford University. 3 hours of lecture and 4 hours of student observatory lab per week. Supervised 3 teaching assistants.

OUTREACH

Stanford/SLAC KIPAC Community Outreach 2013–2018, 2023
Participation in running demonstrations and explaining our research to visitors at KIPAC’s community outreach events

Public lectures: “Viewing the beginning of time from the most remote places on Earth”
Randall Museum Lecture, San Francisco Amateur Astronomers 2018
SLAC Public Lecture Series 2017, 2020

Caltech Classroom Connection 2006–2010
Worked with physics teachers at Pasadena High School and John Marshall Fundamental School to enhance classroom content for their courses. Assisted with labs and classroom activities, gave special topics lectures and arranged physics demos typically unavailable at high schools

REFERENCES

Prof. Suzanne Staggs, Princeton University, staggs@princeton.edu
Prof. John Kovac, Harvard University, jmkovac@cfa.harvard.edu
Prof. John Carlstrom, University of Chicago and Argonne Lab, jc@kicp.uchicago.edu
Prof. Eva Silverstein, Stanford University, evas@stanford.edu
Prof. Steven Kahn, UC Berkeley, stevkahn@berkeley.edu
Prof. Kent Irwin, Stanford University and SLAC, irwin@stanford.edu

1. Chime Collaboration *et al.* The Squeezed Bispectrum from CHIME H I Emission and Planck Cosmic Microwave Background Lensing: Current Sensitivity and Forecasts. *ApJ* **1005**, 73. doi:10.3847/1538-4357/ae77e6. arXiv: 2601.03240 [astro-ph.CO] (July 2026).
2. Ade, P. A. R. *et al.* BICEP/Keck XXI: Constraints on early-Universe parity violation from multipole-dependent birefringence. *Phys. Rev. D* **113**, 123536. doi:10.1103/v8y3-m75b. arXiv: 2603.06812 [astro-ph.CO] (June 2026).
3. Ade, P. A. R. *et al.* BICEP/Keck. XIX. Extremely Thin Composite Polymer Vacuum Windows for BICEP and Other High-throughput Millimeter-wave Telescopes. *ApJ* **1000**, 238. doi:10.3847/1538-4357/ae486d. arXiv: 2411.10428 [astro-ph.IM] (Apr. 2026).
4. Ade, P. A. R. *et al.* BICEP/Keck. XX. Component-separated Maps of the Polarized Cosmic Microwave Background and Thermal Dust Emission Using Planck and BICEP/Keck Observations through the 2018 Observing Season. *ApJ* **999**, 89. doi:10.3847/1538-4357/ae3e53. arXiv: 2509.21648 [astro-ph.CO] (Mar. 2026).
5. Qu, F. J. *et al.* Unified and Consistent Structure Growth Measurements from Joint ACT, SPT, and Planck CMB Lensing. *Phys. Rev. Lett.* **136**, 021001. doi:10.1103/k5yr-3h6d. arXiv: 2504.20038 [astro-ph.CO] (Jan. 2026).
6. Satterthwaite, T. P. *et al.* The Simons Observatory: Studies of Phase Drift in RF Transmission Lines From the First Large-Scale Deployment of Microwave Frequency Multiplexing for Cosmology. *IEEE Transactions on Applied Superconductivity* **36**, TASC.2026. doi:10.1109/TASC.2026.3657136. arXiv: 2509.25726 [astro-ph.IM] (Jan. 2026).
7. Steiger, A. *et al.* Design and Performance of 220 and 270 GHz Bandpass Filters for BICEP Array. *IEEE Transactions on Applied Superconductivity* **36**, TASC.2026. doi:10.1109/TASC.2026.3677818. arXiv: 2608.00324 [astro-ph.IM] (Jan. 2026).
8. Cantrall, B. *et al.* First Integration of Two-Level Time-Division Multiplexed Differential Readout With a Prototype CMB-S4 Detector Array. *IEEE Transactions on Applied Superconductivity* **36**, 2503505–2503505. doi:10.1109/TASC.2026.3718237 (Jan. 2026).
9. Dominguez, W. *et al.* Thermal and Electrical Properties of Prototype Readout Components for CMB-S4. *IEEE Transactions on Applied Superconductivity* **36**, 2502807–2502807. doi:10.1109/TASC.2026.3682450. arXiv: 2511.02173 [astro-ph.IM] (Jan. 2026).
10. Zhang, S. *et al.* Performance and Sensitivity of the BICEP Array 150 GHz Receiver. *IEEE Transactions on Applied Superconductivity* **36**, 2103707–2103707. doi:10.1109/TASC.2026.3698692 (Jan. 2026).
11. Bianchini, F. *et al.* CMB-S4: Foreground-cleaning Pipeline Comparison for Measuring Primordial Gravitational Waves. *ApJ* **993**, 105. doi:10.3847/1538-4357/ae03be. arXiv: 2502.04300 [astro-ph.CO] (Nov. 2025).
12. Groh, J. C. *et al.* Demonstration of a 1820 channel multiplexer for transition-edge sensor bolometers. *Applied Physics Letters* **127**, 152602. doi:10.1063/5.0290914. arXiv: 2507.10929 [physics.ins-det] (Oct. 2025).
13. Abitbol, M. *et al.* The Simons Observatory: science goals and forecasts for the enhanced Large Aperture Telescope. *J. Cosmology Astropart. Phys.* **2025**, 034. doi:10.1088/1475-7516/2025/08/034. arXiv: 2503.00636 [astro-ph.IM] (Aug. 2025).
14. Bhandarkar, T. *et al.* Simons Observatory: Characterization of the Large Aperture Telescope Receiver. *ApJS* **279**, 34. doi:10.3847/1538-4357/ade0bd. arXiv: 2501.09241 [astro-ph.IM] (Aug. 2025).
15. Ade, P. A. R. *et al.* BICEP/Keck XVIII: Measurement of BICEP3 polarization angles and consequences for constraining cosmic birefringence and inflation. *Phys. Rev. D* **111**, 063505. doi:10.1103/PhysRevD.111.063505 (Mar. 2025).
16. Coerver, A. *et al.* Measurement and Modeling of Polarized Atmosphere at the South Pole with SPT-3G. *ApJ* **982**, 15. doi:10.3847/1538-4357/ada35d (Mar. 2025).
17. Groh, J. C. *et al.* Crosstalk Effects in Microwave SQUID Multiplexed TES Bolometer Readout. *Journal of Low Temperature Physics*. doi:10.1007/s10909-024-03126-w (May 2024).
18. Goldfinger, D. C. *et al.* End-to-End Modeling of the TDM Readout System for CMB-S4. *Journal of Low Temperature Physics* **215**, 143–151. doi:10.1007/s10909-024-03077-2 (May 2024).

19. Fatigoni, S. *et al.* Results and Limits of Time-Division Multiplexing for the BICEP Array High-Frequency Receivers. *Journal of Low Temperature Physics*. doi:10.1007/s10909-024-03100-6 (Apr. 2024).
20. Schillaci, A. *et al.* BICEP Array: 150 GHz Detector Module Development. *Journal of Low Temperature Physics* **213**, 317–326. doi:10.1007/s10909-023-03005-w (Dec. 2023).
21. Pan, Z. *et al.* Measurement of gravitational lensing of the cosmic microwave background using SPT-3G 2018 data. *Phys. Rev. D* **108**, 122005. doi:10.1103/PhysRevD.108.122005 (Dec. 2023).
22. Ade, P. A. R. *et al.* BICEP/Keck. XVII. Line-of-sight Distortion Analysis: Estimates of Gravitational Lensing, Anisotropic Cosmic Birefringence, Patchy Reionization, and Systematic Errors. *ApJ* **949**, 43. doi:10.3847/1538-4357/acc85c (June 2023).
23. Dierickx, M. *et al.* Plastic Laminate Antireflective Coatings for Millimeter-Wave Optics in BICEP Array. *Journal of Low Temperature Physics* **211**, 366–374. doi:10.1007/s10909-023-02967-1 (June 2023).
24. BICEP/Keck Collaboration *et al.* BICEP/Keck. XVI. Characterizing Dust Polarization through Correlations with Neutral Hydrogen. *ApJ* **945**, 72. doi:10.3847/1538-4357/acb64c (Mar. 2023).
25. Yu, C. *et al.* SLAC microresonator RF (SMuRF) electronics: A tone-tracking readout system for superconducting microwave resonator arrays. *Review of Scientific Instruments* **94**, 014712. doi:10.1063/5.0125084 (Jan. 2023).
26. Yu, C. *et al.* Bandwidth and Aliasing in the Microwave SQUID Multiplexer. *Journal of Low Temperature Physics* **209**, 589–597. doi:10.1007/s10909-022-02783-z (Nov. 2022).
27. Connors, J. A. *et al.* Magnetic Field Sensitivity of Microwave SQUID Multiplexers. *Journal of Low Temperature Physics* **209**, 710–717. doi:10.1007/s10909-022-02806-9 (Nov. 2022).
28. BICEP/Keck Collaboration *et al.* BICEP/Keck XV: The BICEP3 Cosmic Microwave Background Polarimeter and the First Three-year Data Set. *ApJ* **927**, 77. doi:10.3847/1538-4357/ac4886 (Mar. 2022).
29. CMB-S4 Collaboration *et al.* CMB-S4: Forecasting Constraints on Primordial Gravitational Waves. *ApJ* **926**, 54. doi:10.3847/1538-4357/ac1596 (Feb. 2022).
30. BICEP/Keck Collaboration *et al.* BICEP/Keck XIV: Improved constraints on axionlike polarization oscillations in the cosmic microwave background. *Phys. Rev. D* **105**, 022006. doi:10.1103/PhysRevD.105.022006 (Jan. 2022).
31. Montgomery, J. *et al.* Performance and characterization of the SPT-3G digital frequency-domain multiplexed readout system using an improved noise and crosstalk model. *Journal of Astronomical Telescopes, Instruments, and Systems* **8**, 014001. doi:10.1117/1.JATIS.8.1.014001. arXiv: 2103.16017 [astro-ph.IM] (Jan. 2022).
32. McCarrick, H. *et al.* The Simons Observatory Microwave SQUID Multiplexing Detector Module Design. *ApJ* **922**, 38. doi:10.3847/1538-4357/ac2232 (Nov. 2021).
33. Ade, P. A. R. *et al.* Improved Constraints on Primordial Gravitational Waves using Planck, WMAP, and BICEP/Keck Observations through the 2018 Observing Season. *Phys. Rev. Lett.* **127**, 151301. doi:10.1103/PhysRevLett.127.151301. arXiv: 2110.00483 [astro-ph.CO] (Oct. 2021).
34. Vavagiakis, E. M. *et al.* The Simons Observatory: Magnetic Sensitivity Measurements of Microwave SQUID Multiplexers. *IEEE Transactions on Applied Superconductivity* **31**, TASC.2021. doi:10.1109/TASC.2021.3069294. arXiv: 2012.04532 [astro-ph.IM] (Aug. 2021).
35. Dober, B. *et al.* A microwave SQUID multiplexer optimized for bolometric applications. *Applied Physics Letters* **118**, 062601. doi:10.1063/5.0033416 (Feb. 2021).
36. BICEP/Keck Collaboration *et al.* BICEP/Keck XII: Constraints on axionlike polarization oscillations in the cosmic microwave background. *Phys. Rev. D* **103**, 042002. doi:10.1103/PhysRevD.103.042002 (Feb. 2021).
37. BICEP/Keck and SPTpol Collaborations *et al.* A demonstration of improved constraints on primordial gravitational waves with delensing. *Phys. Rev. D* **103**, 022004. doi:10.1103/PhysRevD.103.022004 (Jan. 2021).
38. Cukierman, A. *et al.* Microwave Multiplexing on the Keck Array. *Journal of Low Temperature Physics* **199**, 858–866. doi:10.1007/s10909-019-02296-2 (May 2020).

39. Bender, A. N. *et al.* On-Sky Performance of the SPT-3G Frequency-Domain Multiplexed Read-out. *Journal of Low Temperature Physics* **199**, 182–191. doi:10.1007/s10909-019-02280-w (Apr. 2020).
40. Anderson, A. J. *et al.* Performance of Al-Mn Transition-Edge Sensor Bolometers in SPT-3G. *Journal of Low Temperature Physics* **199**, 320–329. doi:10.1007/s10909-019-02259-7 (Apr. 2020).
41. Zhang, C. *et al.* Characterizing the Sensitivity of 40 GHz TES Bolometers for BICEP Array. *Journal of Low Temperature Physics* **199**, 968–975. doi:10.1007/s10909-020-02411-8 (Feb. 2020).
42. Schillaci, A. *et al.* Design and Performance of the First BICEP Array Receiver. *Journal of Low Temperature Physics* **199**, 976–984. doi:10.1007/s10909-020-02394-6 (Feb. 2020).
43. St Germaine, T. *et al.* Optical Characterization of the Keck Array and BICEP3 CMB Polarimeters from 2016 to 2019. *Journal of Low Temperature Physics* **199**, 824–832. doi:10.1007/s10909-020-02392-8 (Feb. 2020).
44. Soliman, A. *et al.* Optical Design and Characterization of 40-GHz Detector and Module for the BICEP Array. *Journal of Low Temperature Physics* **199**, 1118–1126. doi:10.1007/s10909-019-02299-z (Feb. 2020).
45. BICEP2 and Keck Array Collaborations *et al.* BICEP2/Keck Array XI: Beam Characterization and Temperature-to-Polarization Leakage in the BK15 Data Set. *ApJ* **884**, 114. doi:10.3847/1538-4357/ab391d (Oct. 2019).
46. Ade, P. *et al.* The Simons Observatory: science goals and forecasts. *J. Cosmology Astropart. Phys.* **2019**, 056. doi:10.1088/1475-7516/2019/02/056 (Feb. 2019).
47. Everett, W. *et al.* Design and Bolometer Characterization of the SPT-3G First-Year Focal Plane. *Journal of Low Temperature Physics* **193**, 1085–1093. doi:10.1007/s10909-018-2057-2 (Dec. 2018).
48. Posada, C. M. *et al.* Fabrication of Detector Arrays for the SPT-3G Receiver. *Journal of Low Temperature Physics* **193**, 703–711. doi:10.1007/s10909-018-1924-1 (Dec. 2018).
49. Yefremenko, V. *et al.* Impact of Electrical Contacts Design and Materials on the Stability of Ti Superconducting Transition Shape. *Journal of Low Temperature Physics* **193**, 732–738. doi:10.1007/s10909-018-2040-y (Dec. 2018).
50. Anderson, A. J. *et al.* SPT-3G: A Multichroic Receiver for the South Pole Telescope. *Journal of Low Temperature Physics* **193**, 1057–1065. doi:10.1007/s10909-018-2007-z (Dec. 2018).
51. Ding, J. *et al.* Thermal Links and Microstrip Transmission Lines in SPT-3G Bolometers. *Journal of Low Temperature Physics* **193**, 712–719. doi:10.1007/s10909-018-1907-2 (Dec. 2018).
52. Carter, F. W. *et al.* Tuning SPT-3G Transition-Edge-Sensor Electrical Properties with a Four-Layer Ti-Au-Ti-Au Thin-Film Stack. *Journal of Low Temperature Physics* **193**, 695–702. doi:10.1007/s10909-018-1910-7 (Dec. 2018).
53. Avva, J. S. *et al.* Design and Assembly of SPT-3G Cold Readout Hardware. *Journal of Low Temperature Physics* **193**, 547–555. doi:10.1007/s10909-018-1965-5 (Nov. 2018).
54. Pan, Z. *et al.* Optical Characterization of the SPT-3G Camera. *Journal of Low Temperature Physics* **193**, 305–313. doi:10.1007/s10909-018-1935-y (Nov. 2018).
55. Kernasovskiy, S. A. *et al.* SLAC Microresonator Radio Frequency (SMuRF) Electronics for Read Out of Frequency-Division-Multiplexed Cryogenic Sensors. *Journal of Low Temperature Physics* **193**, 570–577. doi:10.1007/s10909-018-1981-5 (Nov. 2018).
56. BICEP2 and Keck Array Collaboration *et al.* BICEP2/Keck Array VIII: Measurement of Gravitational Lensing from Large-scale B-mode Polarization. *ApJ* **833**, 228. doi:10.3847/1538-4357/833/2/228 (Dec. 2016).
57. Wu, W. L. K. *et al.* Initial Performance of Bicep3: A Degree Angular Scale 95 GHz Band Polarimeter. *Journal of Low Temperature Physics* **184**, 765–771. doi:10.1007/s10909-015-1403-x (Aug. 2016).
58. BICEP2 and Keck Array Collaborations *et al.* BICEP2/Keck Array. VII. Matrix Based E/B Separation Applied to Bicep2 and the Keck Array. *ApJ* **825**, 66. doi:10.3847/0004-637X/825/1/66 (July 2016).
59. BICEP2 and Keck Array Collaborations *et al.* Improved Constraints on Cosmology and Foregrounds from BICEP2 and Keck Array Cosmic Microwave Background Data with Inclusion of 95 GHz Band. *Phys. Rev. Lett.* **116**, 031302. doi:10.1103/PhysRevLett.116.031302 (Jan. 2016).

60. BICEP2 and Keck Array Collaborations *et al.* BICEP2/Keck Array V: Measurements of B-mode Polarization at Degree Angular Scales and 150 GHz by the Keck Array. *ApJ* **811**, 126. doi:10.1088/0004-637X/811/2/126 (Oct. 2015).
61. Posada, C. M. *et al.* Fabrication of large dual-polarized multichroic TES bolometer arrays for CMB measurements with the SPT-3G camera. *Superconductor Science Technology* **28**, 094002. doi:10.1088/0953-2048/28/9/094002 (Sept. 2015).
62. BICEP2, Keck and Planck Collaborations *et al.* Joint Analysis of BICEP2/Keck Array and Planck Data. *Phys. Rev. Lett.* **114**, 101301. doi:10.1103/PhysRevLett.114.101301 (Mar. 2015).
63. Ahmed, Z. *et al.* Large-Area Reflective Infrared Filters for Millimeter/Sub-mm Telescopes. *Journal of Low Temperature Physics* **176**, 835–840. doi:10.1007/s10909-014-1141-5 (Sept. 2014).
64. Ahmed, Z. *et al.* A prototype low-background multiwire proportional chamber. *Journal of Instrumentation* **9**, P01009. doi:10.1088/1748-0221/9/01/P01009 (Jan. 2014).
65. Agnese, R. *et al.* Silicon Detector Dark Matter Results from the Final Exposure of CDMS II. *Phys. Rev. Lett.* **111**, 251301. doi:10.1103/PhysRevLett.111.251301 (Dec. 2013).
66. Agnese, R. *et al.* Silicon detector results from the first five-tower run of CDMS II. *Phys. Rev. D* **88**, 031104. doi:10.1103/PhysRevD.88.031104 (Aug. 2013).
67. Ahmed, Z. *et al.* Combined limits on WIMPs from the CDMS and EDELWEISS experiments. *Phys. Rev. D* **84**, 011102. doi:10.1103/PhysRevD.84.011102 (July 2011).
68. Ahmed, Z. *et al.* Search for inelastic dark matter with the CDMS II experiment. *Phys. Rev. D* **83**, 112002. doi:10.1103/PhysRevD.83.112002 (June 2011).
69. Ahmed, Z. *et al.* Results from a Low-Energy Analysis of the CDMS II Germanium Data. *Phys. Rev. Lett.* **106**, 131302. doi:10.1103/PhysRevLett.106.131302 (Apr. 2011).
70. Ahmed, Z. *et al.* Dark Matter Search Results from the CDMS II Experiment. *Science* **327**, 1619. doi:10.1126/science.1186112. arXiv: 0912.3592 [astro-ph.CO] (Mar. 2010).
71. Ahmed, Z. *et al.* Analysis of the low-energy electron-recoil spectrum of the CDMS experiment. *Phys. Rev. D* **81**, 042002. doi:10.1103/PhysRevD.81.042002 (Feb. 2010).
72. Ahmed, Z. *et al.* Search for Axions with the CDMS Experiment. *Phys. Rev. Lett.* **103**, 141802. doi:10.1103/PhysRevLett.103.141802 (Oct. 2009).
73. Ahmed, Z. *et al.* Search for Weakly Interacting Massive Particles with the First Five-Tower Data from the Cryogenic Dark Matter Search at the Soudan Underground Laboratory. *Phys. Rev. Lett.* **102**, 011301. doi:10.1103/PhysRevLett.102.011301 (Jan. 2009).
74. Ahmed, Z. *et al.* Status of the Cryogenic Dark Matter Search Experiment. *Journal of Low Temperature Physics* **151**, 800–805. doi:10.1007/s10909-008-9741-6 (May 2008).
75. Bailey, C. N. *et al.* Detector Development for the Next Phases of the Cryogenic Dark Matter Search: Results from 1 Inch Ge and Si Detectors. *Journal of Low Temperature Physics* **151**, 211–215. doi:10.1007/s10909-007-9645-x (Apr. 2008).

PROCEEDINGS

1. Polish, A. R. *et al.* Improved Absolute Polarization Calibrator for BICEP CMB Polarimeters in European Physical Journal Web of Conferences **353** (EDP, Jan. 2026), 01013. doi:10.1051/epjconf/202635301013. arXiv: 2510.13032 [astro-ph.IM].
2. Besuner, R. *et al.* CMB-S4 systems engineering in Modeling, Systems Engineering, and Project Management for Astronomy XI (eds Egner, S. E. & Roberts, S.) **13099** (Aug. 2024), 130992N. doi:10.1117/12.3017697.
3. Liu, C. *et al.* Development of RFSoc-based direct sampling highly multiplexed microwave SQUID read-out for CMB and submillimeter surveys in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII (eds Zmuidzinas, J. & Gao, J.-R.) **13102** (Aug. 2024), 1310211. doi:10.1117/12.3019317.
4. Leitner, M. *et al.* Project overview of the Stage-4 Cosmic Microwave Background experiment (CMB-S4) in Ground-based and Airborne Telescopes X (eds Marshall, H. K., Spyromilio, J. & Usuda, T.) **13094** (Aug. 2024), 130941N. doi:10.1117/12.3018095.
5. Petroff, M. A. *et al.* The Precursor Small Aperture Telescope (PreSAT) CMB polarimeter in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII (eds Zmuidzinas, J. & Gao, J.-R.) **13102** (Aug. 2024), 131022P. doi:10.1117/12.3018421.

6. Haridas, S. K. *et al.* *The Simons Observatory: dark characterization of the large aperture telescope in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII* (eds Zmuidzinas, J. & Gao, J.-R.) **13102** (Aug. 2024), 131022S. doi:10.1117/12.3019247.
7. Satterthwaite, T. P. *et al.* *The Simons Observatory: studies of detector yield and readout noise from the first large-scale deployment of microwave multiplexing at the large aperture telescope in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII* (eds Zmuidzinas, J. & Gao, J.-R.) **13102** (Aug. 2024), 1310223. doi:10.1117/12.3019196.
8. Giannakopoulos, C. *et al.* *Calibration Measurements of the BICEP3 and BICEP Array CMB Polarimeters from 2017 to 2024 in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII* (eds Zmuidzinas, J. & Gao, J.-R.) **13102** (Aug. 2024), PC1310219. doi:10.1117/12.3020443. arXiv: 2409.16440 [astro-ph.CO].
9. Bicep/Keck Collaboration *et al.* *Development of the 220/270 GHz Receiver of BICEP Array in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII* (eds Zmuidzinas, J. & Gao, J.-R.) **13102** (Aug. 2024), PC1310207. doi:10.1117/12.3018462. arXiv: 2409.02296 [astro-ph.IM].
10. Groh, J. C. *et al.* *A 1,820 channel microwave SQUID multiplexer for TES bolometer readout in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XII* (eds Zmuidzinas, J. & Gao, J.-R.) **13102** (Aug. 2024), 54. doi:10.1117/12.3017677.
11. Reese, B. *et al.* *A Modular Time Division Multiplexed Warm Readout System for CMB-S4 in 2023 IEEE Nuclear Science Symposium, Medical Imaging Conference and International Symposium on Room-Temperature Semiconductor Detectors (NSS MIC RTSD)* (IEEE, Nov. 2023), 55. doi:10.1109/NSSMICRTSD49126.2023.10338696.
12. Mishra, N. *et al.* *An RF Electronics Subsystem for Microwave Multiplexed Cryogenic Transition-Edge Sensor Readout in 2023 IEEE USNC-URSI Radio Science Meeting (Joint with AP-S Symposium)* (IEEE, July 2023), 69. doi:10.23919/USNC-URSI54200.2023.10289361.
13. Soliman, A. *et al.* *2022 upgrade and improved low frequency camera sensitivity for CMB observation at the South Pole in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI* (eds Zmuidzinas, J. & Gao, J.-R.) **12190** (Aug. 2022), 1219014. doi:10.1117/12.2628058.
14. Yu, C. *et al.* *A simulation suite for readout with SMuRF tone-tracking electronics in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI* (eds Zmuidzinas, J. & Gao, J.-R.) **12190** (Aug. 2022), 121900V. doi:10.1117/12.2629718.
15. Henderson, S. W. *et al.* *Advanced RFSoc readout for space-based superconducting sensor arrays in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI* (eds Zmuidzinas, J. & Gao, J.-R.) **12190** (Aug. 2022), 121900N. doi:10.1117/12.2630412.
16. Barron, D. R. *et al.* *Conceptual design of the modular detector and readout system for the CMB-S4 survey experiment in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI* (eds Zmuidzinas, J. & Gao, J.-R.) **12190** (Aug. 2022), 121900B. doi:10.1117/12.2630494.
17. Cornelison, J. *et al.* *Improved polarization calibration of the BICEP3 CMB polarimeter at the South Pole in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI* (eds Zmuidzinas, J. & Gao, J.-R.) **12190** (Aug. 2022), 121901X. doi:10.1117/12.2620212.
18. Silva-Feaver, M. *et al.* *Phase drift monitoring for tone tracking readout of superconducting microwave resonators in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI* (eds Zmuidzinas, J. & Gao, J.-R.) **12190** (Aug. 2022), 121900U. doi:10.1117/12.2629024.
19. Goldfinger, D. C. *et al.* *Thermal testing for cryogenic CMB instrument optical design in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy XI* (eds Zmuidzinas, J. & Gao, J.-R.) **12190** (Aug. 2022), 121901V. doi:10.1117/12.2629490.
20. St. Germaine, T. *et al.* *Analysis of Temperature-to-Polarization Leakage in BICEP3 and Keck CMB Data from 2016 to 2018 in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X* (eds Zmuidzinas, J. & Gao, J.-R.) **11453** (Dec. 2020), 114532E. doi:10.1117/12.2562729.

21. Kang, J. H. *et al.* *Observing low elevation sky and the CMB Cold Spot with BICEP3 at the South Pole in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X* (eds Zmuidzinas, J. & Gao, J.-R.) **11453** (Dec. 2020), 114532D. doi:10.1117/12.2562066.
22. Cornelison, J. *et al.* *Polarization calibration of the BICEP3 CMB polarimeter at the South Pole in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy X* (eds Zmuidzinas, J. & Gao, J.-R.) **11453** (Dec. 2020), 1145327. doi:10.1117/12.2562905.
23. Carlstrom, J. *et al.* *CMB-S4 in Bulletin of the American Astronomical Society* **51** (Sept. 2019), 209. arXiv: 1908.01062 [astro-ph.IM].
24. Slosar, A. *et al.* *Packed Ultra-wideband Mapping Array (PUMA): A Radio Telescope for Cosmology and Transients in Bulletin of the American Astronomical Society* **51** (Sept. 2019), 53. arXiv: 1907.12559 [astro-ph.IM].
25. Timbie, P. *et al.* *Research and Development for HI Intensity Mapping in Bulletin of the American Astronomical Society* **51** (Sept. 2019), 71.
26. Lee, A. *et al.* *The Simons Observatory in Bulletin of the American Astronomical Society* **51** (Sept. 2019), 147. arXiv: 1907.08284 [astro-ph.IM].
27. Green, D. *et al.* *Messengers from the Early Universe: Cosmic Neutrinos and Other Light Relics in Bulletin of the American Astronomical Society* **51** (May 2019), 159. arXiv: 1903.04763 [astro-ph.CO].
28. Mantz, A. *et al.* *The Future Landscape of High-Redshift Galaxy Cluster Science in Bulletin of the American Astronomical Society* **51** (May 2019), 279. arXiv: 1903.05606 [astro-ph.CO].
29. Kang, J. H. *et al.* *2017 upgrade and performance of BICEP3: a 95GHz refracting telescope for degree-scale CMB polarization in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 107082N. doi:10.1117/12.2313854.
30. Hui, H. *et al.* *BICEP Array: a multi-frequency degree-scale CMB polarimeter in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 1070807. doi:10.1117/12.2311725.
31. Crumrine, M. *et al.* *BICEP Array cryostat and mount design in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 107082D. doi:10.1117/12.2312829.
32. Nadolski, A. *et al.* *Broadband anti-reflective coatings for cosmic microwave background experiments in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 1070843. doi:10.1117/12.2315674.
33. Dutcher, D. *et al.* *Characterization and performance of the second-year SPT-3G focal plane in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 107081Z. doi:10.1117/12.2312451.
34. Sobrin, J. A. *et al.* *Design and characterization of the SPT-3G receiver in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 107081H. doi:10.1117/12.2314366.
35. Soliman, A. *et al.* *Design and performance of wide-band corrugated walls for the BICEP Array detector modules at 30/40 GHz in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 107082G. doi:10.1117/12.2312942.
36. Henderson, S. W. *et al.* *Highly-multiplexed microwave SQUID readout using the SLAC Microresonator Radio Frequency (SMuRF) electronics for future CMB and sub-millimeter surveys in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 1070819. doi:10.1117/12.2314435.
37. Thompson, K. L., Kuo, C.-L., Yoon, K. W. & Ahmed, Z. *Next-generation small CMB telescopes in Ground-based and Airborne Telescopes VII* (eds Marshall, H. K. & Spyromilio, J.) **10700** (July 2018), 107004K. doi:10.1117/12.2313927.
38. Vavagiakis, E. M. *et al.* *Prime-Cam: a first-light instrument for the CCAT-prime telescope in Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 107081U. doi:10.1117/12.2313868.

39. Barkats, D. *et al.* Ultra-thin large-aperture vacuum windows for millimeter wavelengths receivers in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 107082K. doi:10.1117/12.2312585.
40. Bender, A. N. *et al.* Year two instrument status of the SPT-3G cosmic microwave background receiver in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy IX* (eds Zmuidzinas, J. & Gao, J.-R.) **10708** (July 2018), 1070803. doi:10.1117/12.2312426.
41. Hui, H. *et al.* BICEP3 focal plane design and detector performance in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII* (eds Holland, W. S. & Zmuidzinas, J.) **9914** (July 2016), 99140T. doi:10.1117/12.2232986.
42. Grayson, J. A. *et al.* BICEP3 performance overview and planned Keck Array upgrade in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII* (eds Holland, W. S. & Zmuidzinas, J.) **9914** (July 2016), 99140S. doi:10.1117/12.2233894.
43. Bender, A. N. *et al.* Integrated performance of a frequency domain multiplexing readout in the SPT-3G receiver in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII* (eds Holland, W. S. & Zmuidzinas, J.) **9914** (July 2016), 99141D. doi:10.1117/12.2232146.
44. Posada, C. M. *et al.* Large arrays of dual-polarized multichroic TES detectors for CMB measurements with the SPT-3G receiver in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII* (eds Holland, W. S. & Zmuidzinas, J.) **9914** (July 2016), 991417. doi:10.1117/12.2232912.
45. Karkare, K. S. *et al.* Optical characterization of the BICEP3 CMB polarimeter at the South Pole in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VIII* (eds Holland, W. S. & Zmuidzinas, J.) **9914** (July 2016), 991430. doi:10.1117/12.2231747.
46. Buder, I. *et al.* BICEP2 and Keck array: upgrades and improved beam characterization in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VII* (eds Holland, W. S. & Zmuidzinas, J.) **9153** (Aug. 2014), 915312. doi:10.1117/12.2055713.
47. Ahmed, Z. *et al.* BICEP3: a 95GHz refracting telescope for degree-scale CMB polarization in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VII* (eds Holland, W. S. & Zmuidzinas, J.) **9153** (Aug. 2014), 91531N. doi:10.1117/12.2057224.
48. Karkare, K. S. *et al.* Keck array and BICEP3: spectral characterization of 5000+ detectors in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VII* (eds Holland, W. S. & Zmuidzinas, J.) **9153** (Aug. 2014), 91533B. doi:10.1117/12.2056779.
49. Benson, B. A. *et al.* SPT-3G: a next-generation cosmic microwave background polarization experiment on the South Pole telescope in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VII* (eds Holland, W. S. & Zmuidzinas, J.) **9153** (July 2014), 91531P. doi:10.1117/12.2057305.
50. Bunker, R. *et al.* The BetaCage, an ultra-sensitive screener for surface contamination in *Low Radioactivity Techniques 2013 (LRT 2013)* (eds Miramonti, L. & Pandola, L.) **1549** (Aug. 2013), 132–135. doi:10.1063/1.4818093.
51. Sander, J. *et al.* SuperCDMS status from Soudan and plans for SNOlab in *Workshop on Dark Matter, Unification and Neutrino Physics: CETUP* 2012* (eds Szczerbinska, B., Babu, K., Balantekin, B., Dutta, B. & Mohapatra, R. N.) **1534** (May 2013), 129–135. doi:10.1063/1.4807350.
52. O'Brient, R. *et al.* Antenna-coupled TES bolometers for the Keck array, Spider, and Polar-1 in *Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VI* (eds Holland, W. S. & Zmuidzinas, J.) **8452** (Sept. 2012), 84521G. doi:10.1117/12.927214.
53. Ahmed, Z. *et al.* Status of BetaCage: an Ultra-sensitive Screener for Surface Contamination in *Topical Workshop on Low Radioactivity Techniques: LRT-2010* (ed Ford, R.) **1338** (Apr. 2011), 88–92. doi:10.1063/1.3579564.
54. Ahmed, Z. Recent Results from Wimp-Search Analysis of CdmS-II Data in *Physics Beyond the Standard Models of Particles, Cosmology and Astrophysics* (eds Klapdor-Kleingrothaus, H. V., Krivosheina, I. V. & Viollier, R.) (Mar. 2011), 530–536. doi:10.1142/9789814340861_0049.
55. Bailey, C. N. *et al.* Bulk and Surface Charge Collection: CDMS Detector Performance and Design Implications in *The Thirteenth International Workshop on Low Temperature Detectors - LTD13* (eds Young, B., Cabrera, B. & Miller, A.) **1185** (Dec. 2009), 643–646. doi:10.1063/1.3292423.

56. Ahmed, Z. *et al.* *Characterization of SuperCDMS 1-inch Ge Detectors in The Thirteenth International Workshop on Low Temperature Detectors - LTD13* (eds Young, B., Cabrera, B. & Miller, A.) **1185** (Dec. 2009), 659–662. doi:10.1063/1.3292428.
57. Brink, P. L. *et al.* *SuperCDMS Detector Fabrication Advances in The Thirteenth International Workshop on Low Temperature Detectors - LTD13* (eds Young, B., Cabrera, B. & Miller, A.) **1185** (Dec. 2009), 655–658. doi:10.1063/1.3292427.
58. Seitz, D. N. *et al.* *SuperCDMS Detector Readout Cryogenic Hardware in The Thirteenth International Workshop on Low Temperature Detectors - LTD13* (eds Young, B., Cabrera, B. & Miller, A.) **1185** (Dec. 2009), 282–285. doi:10.1063/1.3292334.
59. Brink, P. L. *et al.* *The Cryogenic Dark Matter Search (CDMS) : Present Status and Future in 10th Conference on the Intersections of Particle and Nuclear Physics* (ed Marshak, M. L.) **1182** (Dec. 2009), 260–263. doi:10.1063/1.3293795.
60. Mirabolfathi, N. *et al.* *The Cryogenic Dark Matter Search (CDMS) experiment: Results, status and perspective in The Thirteenth International Workshop on Low Temperature Detectors - LTD13* (eds Young, B., Cabrera, B. & Miller, A.) **1185** (Dec. 2009), 623–626. doi:10.1063/1.3292418.
61. Brink, P. L. *et al.* *The Cryogenic Dark Matter Search (CDMS) experiment: Results and prospects in Journal of Physics Conference Series* **150** (Feb. 2009), 012006. doi:10.1088/1742-6596/150/1/012006.
62. Schnee, R. W., Ahmed, Z., Golwala, S. R., Grant, D. R. & Poinar, K. *Screening Surface Contamination with BetaCage in Topical Workshop on Low Radioactivity Techniques: Lrt 2006* (ed Loaiza, P.) **897** (Mar. 2007), 20–25. doi:10.1063/1.2722063.

TECHNICAL REPORTS & WHITE PAPERS

1. Chang, C. L. *et al.* *Snowmass2021 Cosmic Frontier: Cosmic Microwave Background Measurements White Paper*. arXiv: 2203.07638 [astro-ph.CO] (Mar. 2022).
2. BICEP/Keck Collaboration *et al.* *The Latest Constraints on Inflationary B-modes from the BICEP/Keck Telescopes*. arXiv: 2203.16556 [astro-ph.CO] (Mar. 2022).
3. Abazajian, K. *et al.* *Snowmass 2021 CMB-S4 White Paper*. arXiv: 2203.08024 [astro-ph.CO] (Mar. 2022).
4. CMB-S4 Collaboration *et al.* *CMB-S4 Decadal Survey APC White Paper* tech. rep. (U.S. Department of Energy Office of Scientific and Technical Information, July 2019). doi:10.2172/1556957.
5. CMB-S4 Collaboration *et al.* *CMB-S4 Technology Book, First Edition* tech. rep. (U.S. Department of Energy Office of Scientific and Technical Information, June 2017). doi:10.2172/1414402.

INVITED TALKS

1. “From CMB to Qubits: Shared Frontiers in Superconducting Sensing,” *CECI Workshop on Detector Science, University of California, Riverside*, July 1, 2026
2. “SMuRF and SPECTRA: Scalable Warm Electronics for Superconducting Dark Matter Sensors,” *Superconducting Technologies for Dark Matter 2026, Sapienza University of Rome*, May 12, 2026
3. “Updates from the BICEP Inflation Search Program,” *Rencontres de Moriond — Cosmology*, March 24, 2026
4. “Investigating cosmic origin and evolution with the oldest photons: CMB science and technology in the 2020’s and 30’s,” *Seminar at Pontificia Universidad Católica de Chile*, January 19, 2026
5. “Investigating Cosmic Origin and Evolution with the Oldest Photons,” *Physics Colloquium at University of Wisconsin, Madison*, March 7, 2025
6. “Multiplexed Readout Detector Technology for CMB-S4,” *Special Session at 2025 National Radio Science Meeting*, January 9, 2025
7. “Investigating Cosmic Origin and Evolution with the Cosmic Microwave Background,” *PPC 2024: XVII International Conference on Interconnections between Particle Physics and Cosmology*, October 17, 2024
8. “Cosmic Evolution: The Early Universe,” *2024 Meeting of the APS Division of Particles & Fields joint with the Annual Phenomenology Symposium DPF-PHENO 2024*, May 15, 2024
9. “Investigating Cosmic Origin and Evolution with CMB-S4,” *Colloquium at SLAC National Accelerator Laboratory*, April 15, 2024

10. "Time-division multiplexed readout for CMB-S4," *Princeton University CMB Group Seminar*, November 20, 2023
11. "Latest results from the BICEP/Keck Collaboration," *14th Conference on the Intersections of Particle and Nuclear Physics*, August 31, 2022
12. "Investigating Cosmic Origin and Evolution with the Oldest Photons," *KIPAC Colloquium at SLAC National Accelerator Laboratory*, February 10, 2022
13. "New BICEP/Keck results," *Astronomy Colloquium at Stanford University*, October 21, 2021
14. "Measuring the almost invisibles in the CMB," *Lecture at 48th SLAC Summer Institute*, August 14, 2020
15. "CMB-S4," *SLAC Science Council*, May 17, 2019
16. "A next-generation search for inflation, light relics and neutrino mass with the Cosmic Microwave Background: CMB-S4," *Colloquium at SLAC National Accelerator Laboratory*, April 1, 2019
17. "Next-generation CMB cosmology with high-density superconducting sensor readouts," *Seminar at Washington University in St. Louis*, February 19, 2019
18. "Searching for Evidence of Inflation in the Cosmic Microwave Background," *Colloquium at Washington University in St. Louis*, February 18, 2019
19. "CMB-S4," *Cosmology: The Next Decade Conference at International Center for Theoretical Sciences*, January 24, 2019
20. "Standard Model and BSM Particle Physics from the CMB," *Lecture at 46th SLAC Summer Institute*, August 3, 2018
21. "CMB-S4 Technology Development – Progress since the Harvard workshop: Input to the NSF/DOE Concept Definition Team," *7th CMB-S4 workshop*, March 5, 2018
22. "Instrument Technology for CMB space missions," *Workshop on assessing the prospects for frontier CMB space experiments from India*, January 9, 2018
23. "Readout for CMB detection," *Workshop on Quantum Sensing in High Energy Physics*, December 13, 2017
24. "News from BICEP/Keck and progress towards CMB-S4," *Post-Planck Cosmology Conference*, October 10, 2017
25. "CMB-S4: A next-generation CMB Experiment," *NRAO US RMS Futures – III*, August 2, 2017
26. "News from the BICEP/Keck CMB program," *APS DPF*, August 1, 2017
27. "Overview of CMB-S4 Technology Book," *5th CMB-S4 Workshop*, February 28, 2017
28. "Multiplexing Readout for Large format TES & MKID arrays," *CPAD Instrumentation Frontier Meeting 2016: New Technologies for Discovery II*, October 9, 2016
29. "Sensors, multiplexing, readout – survey of current technologies and areas of focus for CMB-S4," *4th CMB-S4 Workshop*, September 19, 2016
30. "CMB in the next decade," *CMB session at NRAO US RMS Futures – II*, August 5, 2016
31. "News from the BICEP/Keck Array CMB telescopes," *Seminar at Southern Methodist University*, March 14, 2016
32. "Updates on South Pole Astronomy," *3rd workshop of the Scientific Committee on Antarctic Research: Astronomy and Astrophysics from Antarctica*, August 9, 2015
33. "CMB Polarization at 90° ," *3rd workshop of the Scientific Committee on Antarctic Research: Astronomy and Astrophysics from Antarctica*, August 8, 2015
34. "Updates from the BICEP/Keck Array Experiments," *Plenary at the String Phenomenology 2015 Conference*, June 8, 2015
35. "Updates from the BICEP/Keck Array Experiments," *27th Rencontres de Blois: Particle Physics and Cosmology Conference*, June 3, 2015
36. "More BICEP! Keck Array, B3, and life after the BICEP2 results," *Seminar at the Laboratory for Particle Physics and Cosmology, Harvard University*, May 21, 2014
37. "Results from the final exposure of CDMS-II," *Seminar at the Caltech-JPL Association for Gravitational Wave Research*, March 9, 2010

OTHER
PRESENTATIONS

1. "The South Pole Observatory: A Combined Inflation Search Program Targeting $\sigma(r) \sim 0.001$," *New Frontiers in Cosmology 2026, A Coruña*, August 10, 2026

2. "The South Pole Observatory: A Combined Inflation Search Program Targeting $\sigma(r) \sim 0.001$," *2026 Meeting of the APS Division of Particles & Fields*, July 21, 2026
3. "The Simons Observatory: Large Aperture Telescope Update and Instrument Systematics for CMB secondaries," *New Physics from Old Light: Illuminating the Universe with CMB Secondaries Workshop*, September 18, 2024
4. "Status of uMUX R&D for CMB-S4," *9th CMB-S4 workshop, Fermilab*, March 14, 2019
5. "BICEP3: A 95 GHz Refracting Telescope for Degree-Scale CMB Polarization," *SPIE Astronomical Telescopes and Instrumentation 2014: Millimeter, Submillimeter, and Far-Infrared Detectors and Instrumentation for Astronomy VII*, June 27, 2014
6. "Large-Area Reflective Infrared Filters for Millimeter/sub-mm Telescopes," *Poster at the 15th International Workshop on Low Temperature Detectors*, June 26, 2013
7. "CMB polarization survey with POLAR Array," *SCAR Open Science Conference*, July 18, 2012
8. "POLAR-1: a next-generation CMB polarimeter," *Stanford KIPAC Tea*, April 10, 2012
9. "BetaCage: an ultra-sensitive screener for surface contaminants," *APS April Meeting*, May 1, 2011
10. "BetaCage: an ultra-sensitive screener for radioactive surface contamination," *Topical Workshop in Low Radioactivity Techniques*, August 28, 2010
11. "Highlights from the new CDMS-II result," *Caltech Dark Matter Discussion group*, January 12, 2010
12. "Results from the final exposure of CDMS-II," *Beyond the Standard Models of Particle Physics, Cosmology and Astrophysics*, February 4, 2010
13. "Characterization of SuperCDMS 1-inch Germanium Detectors," *13th International Workshop on Low Temperature Detectors*, July 24, 2009
14. "Recent results from WIMP-search analysis of CDMS-II data," *2009 Europhysics Conference on High Energy Physics*, July 16, 2009