Spring 2024

PRIMA Community Newsletter

Keep up to date with PRIMA on our redesigned webpage!

Find our latest team publications, presentations, and news about future events online at

https://prima.ipac.caltech.edu

Key Dates:

- **June 16-21 2024** SPIE Meeting (*Yokohama, Japan*)
- **June 24-25 2024** PRIMA Community Workshop (*Japan*)
- **Fall 2024** APEX Step 1 selection

Recent PRIMA Publications

- **Béthermin**, M., et al. (2024) *Confusion of Extragalactic Sources in the Far Infrared: A Baseline Assessment of the Performance of PRIMAger in Intensity and Polarization* **https://arxiv.org/abs/2404.04320**
- **Bisigello**, L., et al. (2024) *Disentangling the Co-evolution of Galaxies and Supermassive Black Holes with PRIMA* **https://arxiv.org/abs/2404.17634**
- **Day**, P.K., et al. (2024) *A 25-micron Single Photon Sensitive Kinetic Inductance Detector* **https://arxiv.org/abs/2404.10246**
- **Donnellan**, J.M.S., et al. (2024) *Overcoming Confusion Noise with Hyperspectral Imaging from PRIMAger* **https://arxiv.org/abs/2404.06935**
- **Dowell**, C.D., Hensley, B.S., and Sauvage, M. (2024) *Simulation of the Far-Infrared Polarimetry Approach Envisioned for the PRIMA Mission* **https://arxiv.org/abs/2404.17050**

News and Updates:

- **PRIMA continues to progress toward Step 1 selection!** Over two weeks in April, the entire PRIMA team came together to respond to the Potential Major Weaknesses identified by the review committee. We are grateful for the hard work of everyone involved, and proud of the advance preparation and planning that made this process overwhelmingly positive and productive!

- **PRIMA Co-Is help shape the future landscape of far-infrared astronomy at an invited Kavli Workshop.** A Kavli–IAU workshop called “Probing the Universe from far-infrared to millimetre wavelengths: future facilities and their synergies” took place from 26 to 28 March 2024 in Pasadena, USA. A summary of the workshop will be presented at the XXXII IAU General Assembly in Cape Town in August 2024 as part of the Global Coordination Working Group sessions.

- **PRIMA’s Jed McKinney receives Hubble fellowship!** McKinney, a member of the PRIMA working group on the Co-evolution of Galaxies and Supermassive Black Holes, will be a Hubble Fellow at UT-Austin, where he will continue to lead projects with JWST and ALMA to uncover the role of dust in galaxy formation and evolution.

- **PRIMA Co-I Elisabeth Mills receives an NSF-CAREER award.** As a professor at the university of Kansas, Mills leads a research group studying nearby galaxy centers. This award will support VLA and ALMA studies that investigate how nearby supermassive black holes gather gas from their surroundings, and will help grow department outreach efforts.

In Memory of Will Fischer

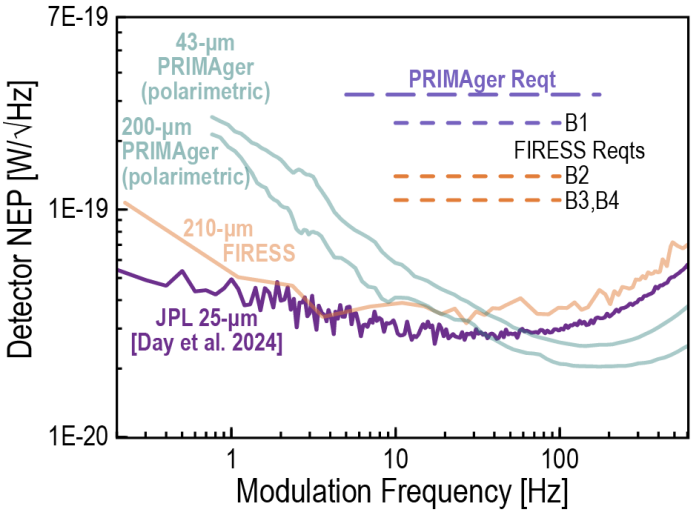
Will was an active contributor to PRIMA, a well-loved collaborator, and a valued member of the entire community. He will be remembered for his kindness and his many scientific accomplishments.

https://www.mariettatimes.com/obituaries/2024/04/william-jack-fischer/

- **Dr. Thomas Stevenson is the recipient of a 2024 Goddard Instrument Systems and Technology Division Engineer Excellence Award for his outstanding work leading the development of microlens arrays for PRIMA.** The microlens arrays and precision bonding them to KID arrays have been a critical development and success for PRIMA, largely because of Dr. Stevenson’s skill and leadership.

Further advances in PRIMA short-wavelength KID performance.

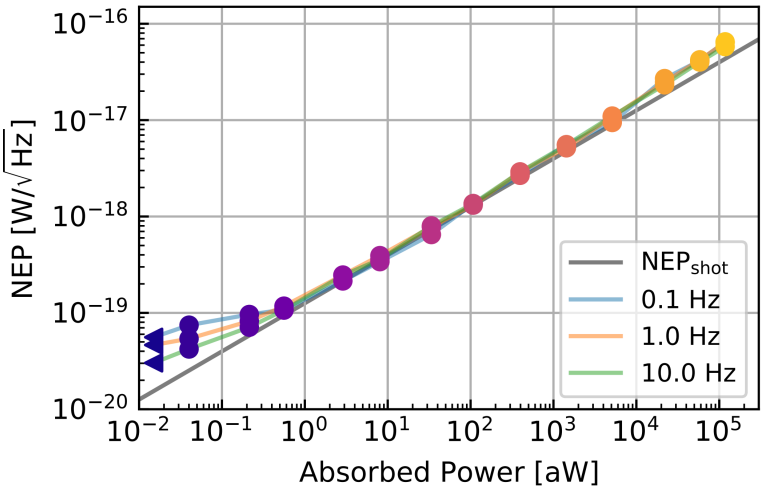
We are pleased to report recent improvements in our short-wavelength KIDs since the Step 1 proposal submission. While the long-wavelength (~200 micron) prototypes have shown excellent sensitivity (noise equivalent power (NEP) below 10^-19 W/sqrt(Hz)) for some time in both SRON and JPL prototypes [1,2], the 25-micron devices for PRIMA began their development later and have been the focus of a dedicated effort in the last 12 months. We have recently demonstrated performance substantially exceeding our requirements in a JPL-built 25-μm prototype PRIMA KID array. The improved sensitivity is shown in the purple curve in the figure at right which plots measured noise equivalent power (lower is better sensitivity) as a function of modulation frequency (the rate of change of signal with either spatial pointing, e.g. with beam steering mirror or frequency sampling; e.g. with fourier transform spectroscopy). The figure below shows measured noise as a function of the applied optical power, demonstrating photon-shot-noise-limited performance. Further information can be found in the article by Day et al., submitted for publication [3], in which we present 3 key attributes of the new detectors:



Measured PRIMA KID noise equivalent power (NEP) as a function of modulation frequency, along with PRIMA requirements, showing large margins. 25 micron sensitivities are shown in purple.

(1) Excellent sensitivity across the PRIMA required signal band. These devices provide factors of 8 sensitivity margin relative to our requirements.

(2) Individual photon detection capability. While not required for any identified science cases, this is an option which may offer operational advantages (e.g. in calibration) for FIRESS for observations of faint sources at short wavelengths.



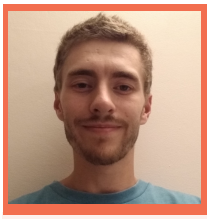
Measured PRIMA KID noise equivalent power (NEP) as a function of absorbed power. The NEP is shot noise limited over nearly six orders of magnitude of absorbed power.

(3) Dramatically improved low-frequency (1/f) noise performance. This is the result of a) the very high response of these devices, and b) improved fabrication processes minimizing the two-level-system (TLS) effects which sometimes affect KIDs. These recipes will be implemented for all the PRIMA KIDs. The very low 1/f noise creates flexibility in signal modulation and translates directly to excellent fidelity in wide-field mapping measurements with both FIRESS and PRIMAger.

[1] https://ui.adsabs.harvard.edu/abs/2022A%26A...665A..17B/abstract

[2] https://ui.adsabs.harvard.edu/abs/2023arXiv231103586H/abstract

PRIMA spotlight Highlighting the people who make PRIMA happen!



James Donnellan (University of Sussex)

Lead author of paper on confusion mitigation with PRIMAger

James is a graduate student at the University of Sussex working with Seb Oliver. He has led the application of the XID+ Bayesian deblending tool to accurately measure fluxes with PRIMA in otherwise confused fields. Using XID+, PRIMAger will be able to detect and measure source fluxes at least a factor of 2-3 below the classical confusion limit, and even an order of magnitude below with appropriate catalogs.

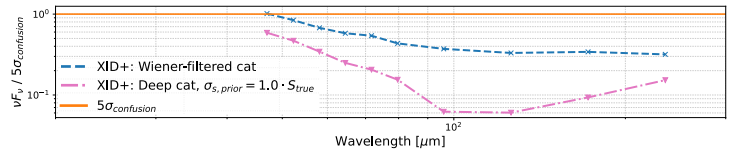
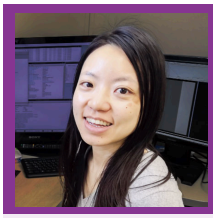


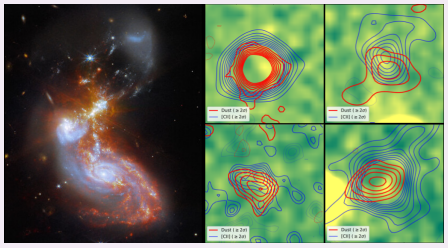
*Figure 7 from **Donnellan et al. 2024**: Limiting flux density reached by XID+ in the 10 reddest PRIMAger channels relative to the classical confusion limits from **Béthermin et al. 2024***



Hanae Inami (Hiroshima University)

Coordinating engagement with the Japanese astronomical community

Hanae is an assistant professor at Hiroshima University, and is leading the Japanese team collaborating on PRIMA science and instrument development. She recently used JWST and ALMA to explore the dusty Universe at z=0 and z~7 and hopes to fill this redshift gap with PRIMA. She and her colleagues in Japan organized a fine-structure line workshop last year and are holding a PRIMA Science Workshop in June in Japan to engage the local community. She is also co-chairing an international conference "Evolution of Dust and Gas throughout Cosmic Time" in Hiroshima in December 2024.



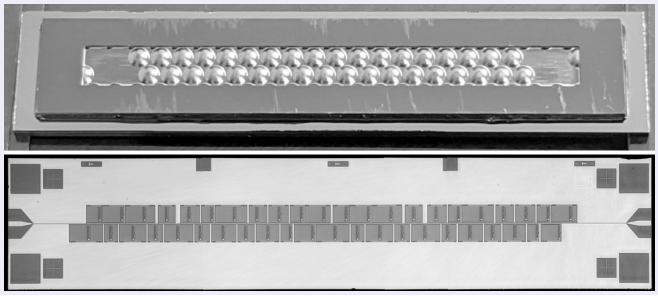
[Left] Merging luminous infrared galaxies at z=0 from the GOALS project. (c) ESA/ Webb, NASA & CSA, L. Armus, A. Evans [Right] Dust continuum (red) and [C II]158μm emission of galaxies at z~7 from the REBELS ALMA project (Inami et al. 2022).

Nicholas Cothard (GSFC)

Leading development and testing of detectors and microlens arrays for PRIMA

As a NASA Postdoctoral Fellow, Nick interfaces the Goddard microlens team and the JPL FIRESS detector team to produce and characterize prototype hybridized detector arrays.

Pictured: Microscope images of a hybridized microlens array (upper) and far-IR kinetic inductance detector array (lower).



Reinier Janssen (JPL)

Leading design and development of large format kinetic inductance detector arrays for PRIMA/FIRESS

Reinier is a scientist developing large-format arrays of high-sensitivity detectors for far-infrared astrophysics applications. He designed the high-performance prototype detector arrays for FIRESS and is also the JPL-lead for the Terahertz Intensity Mapper (TIM; PI: J. Vieira) balloon mission, a scientific precursor and technology demonstrator for PRIMA. Reinier has a keen interest in the co-evolution of galaxies and their central black holes.

Pictured: Two 1008-pixel KID prototype arrays for FIRESS Band 4.