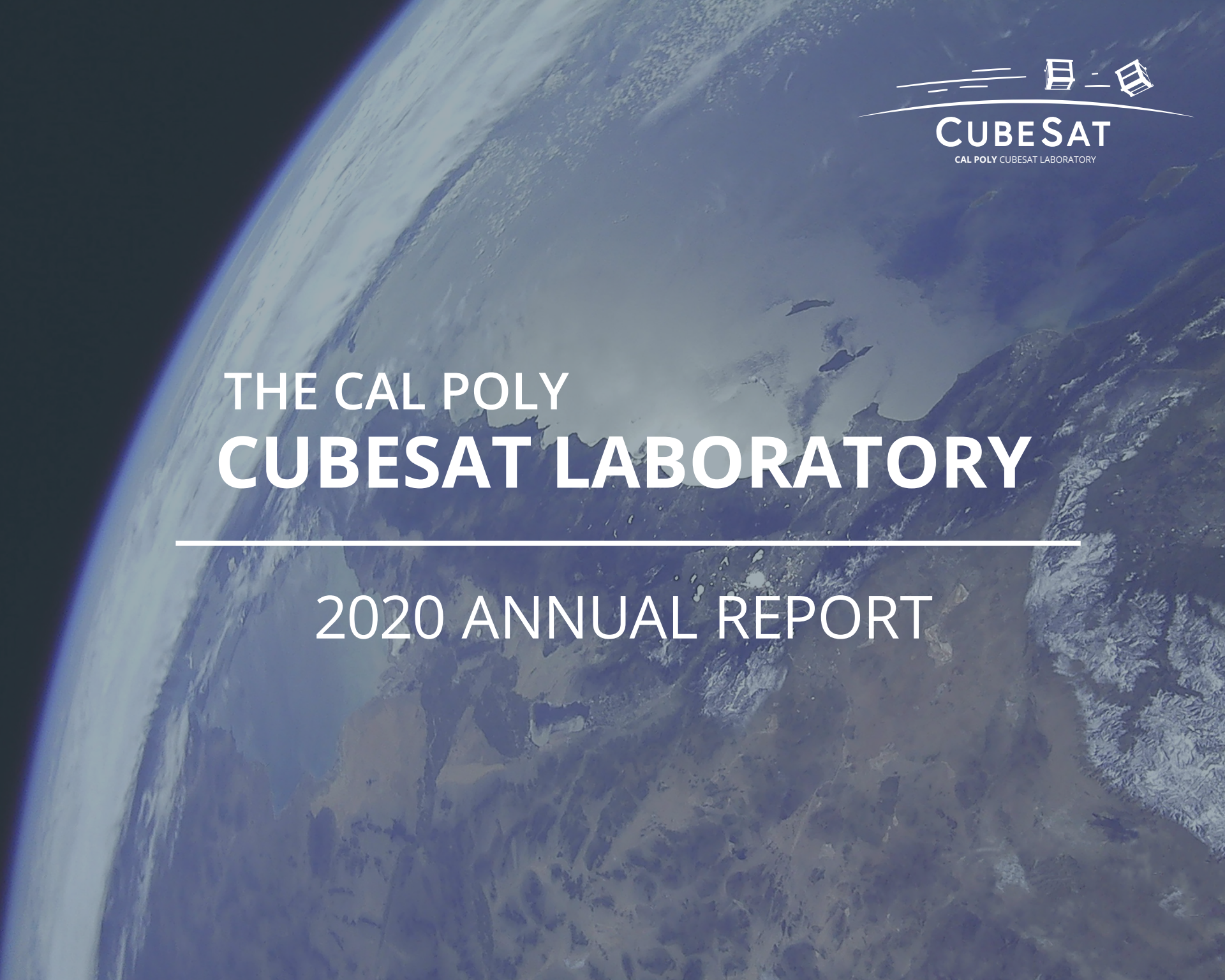

CUBESAT
CAL POLY CUBESAT LABORATORY

# THE CAL POLY CUBESAT LABORATORY

## 2020 ANNUAL REPORT

New Guinea by CubeSat DAVE



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# CUBESAT HISTORY

Developed in 1999 to facilitate student involvement and applied research in spacecraft, the CubeSat standard has become the de facto standard for university satellites. By standardizing a satellite form factor, access to space becomes more affordable and feasible for everyone, particularly for universities which have limited resources. At its essence, the standard defines a CubeSat unit as a 10 cm x 10 cm x 10 cm structure and provides detailed requirements for the satellite including mechanical systems, electrical systems, and operations. Over the last 5 years, CubeSat development has exponentially increased with over 1,000 CubeSats launched between 2014 and 2020, whose missions ranged from education to advance space research. Today, Cal Poly continues to play a key role in the CubeSat community through the development of tomorrow's space workforce and maintaining the CubeSat standard.

The Cal Poly CubeSat Laboratory (CPCL) has given Cal Poly students a robust learn-by-doing experience for almost two decades, supporting students to be day-one ready professionals. During 2020, CPCL was comprised of about 100 students from all majors within the College of Engineering and many students from other colleges on campus such as the College of Science and Math, the College of Business, and the College of Liberal Arts. Around 90% of student lab members are undergraduates with the remaining 10% being graduate students. This makes CPCL a prime hub for undergraduate-led research in space.

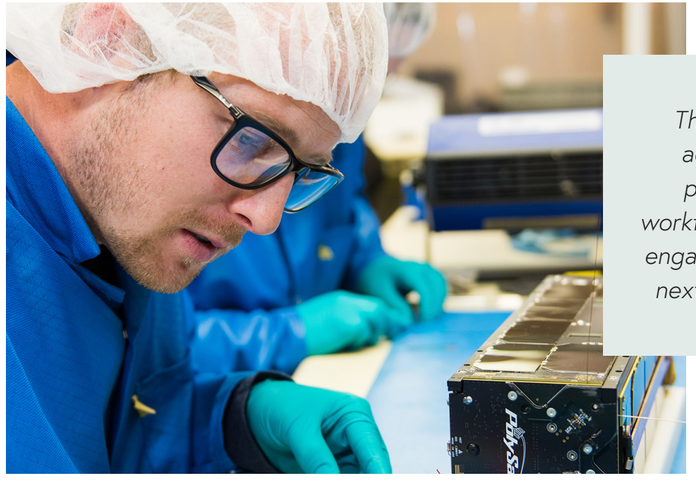
Student involvement in CPCL projects is key to all activities. Cal Poly students have developed and launched eleven spacecraft since the start of the program, with three currently in operation in orbit and four more in development. The students continue to support Lightsail 2 orbital operations, showing the effectiveness of the solar sail which was first proposed by Carl Sagan of The Planetary Society. CPCL students also provided support to NASA's Jet Propulsion Laboratory during operations for the MarCO mission, the first CubeSats to travel beyond Earth's orbit and reach Mars.




While CPCL is currently developing more advanced CubeSat systems, the foundation of CPCL's expertise in the field is based on years of working as CubeSat launch integrators. Cal Poly developed the first flight-proven CubeSat dispenser, Cal Poly's Poly-Picosat Orbital Deployer (P-POD) which has delivered to orbit over 175 CubeSats from around the world. Cal Poly helped launch the very first satellite for 5 separate countries. As CubeSat integrators, CPCL worked with 8 different launch vehicle companies (including Orbital, ULA, SpaceX), various government agencies, and a number of international collaborators.

CPCL was an early leader in the CubeSat industry and since then has strived to develop a diverse knowledge base in all aspects of the small satellite ecosystem. CPCL has used that know-how to develop future generations of engineers, while developing successful working partnerships with a variety of community contributors. We look forward to continuing this role in the industry and further expanding the boundaries of space education and exploration.

# OUR MISSION

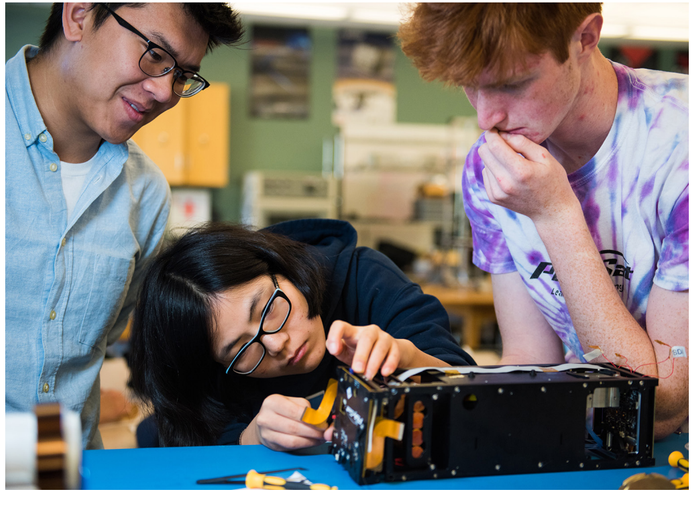


*CPCL member works on ExoCube II [image captured before 2020]*

*The Cal Poly CubeSat Laboratory advances the space industry by providing inclusive, high-quality workforce development and community engagement programs that enable the next generation of space discoveries*



# OUR GOALS



*CPCL members working together in the laboratory [image captured before 2020]*

1. Provide the Cal Poly community with unique learn-by-doing opportunities using small satellite projects
2. Foster and develop innovative satellite technologies
3. Participate in public policy discussions and outreach to ensure space remains both safe and beneficial for future generations
4. Partner with external collaborators to ensure that the Cal Poly CubeSat Laboratory remains productive and sustainable
5. Stimulate learning in a diverse, inclusive, and safe work environment

# STUDENTS PERSPECTIVE

### Cole Gillespie, Laboratory Manager

*4th Year Aerospace Engineering Major*

This year has been very eventful within the laboratory. We have seen several missions approach the end of the development cycle as we prepare for operations. At the same time, we have several new projects getting started. While all of that is going on, we are working to restructure the laboratory to facilitate better processes, training, and engagement. We are also re-evaluating the laboratory values in the spirit of continuous improvement. This is a time of change for the laboratory and I am excited to see how we evolve and apply our new structure and practices to coming missions. Personally, it has been a great learning experience to be a part of these changes. I am looking forward to another great year of development in the laboratory!

### Gagan Thapar, Deputy Laboratory Manager

*3rd Year Aerospace Engineering Major*

The Cal Poly CubeSat Laboratory (CPCL) has been one of the greatest communities I have had the pleasure of being a part of in college. Even with the pandemic, seeing the laboratory quickly accommodate to the unfortunate circumstances was incredible. With a few missions on their way out, a few more getting closer to delivery, and even more just getting started, the laboratory and its 100+ members continue to surpass any expectations placed on them. Having a hand in several projects and missions here is one of the most fulfilling feelings one could ask for. Between working with the incredible members of CPCL to further our missions, restructuring the laboratory to better reflect a mission's life-cycle, and further emphasizing the equity and inclusiveness of CPCL, it would be an understatement to say I am excited for the upcoming year! It has been an incredible time with lots of learning opportunities, and I am ready to learn-by-doing with the rest of CPCL in the next year!



# STUDENTS PERSPECTIVE

### Nayana Tiwari, Diversity, Equity & Inclusion Lead

*3rd Year Computer Engineering and Physics Major*

I have learned so much about space technologies and missions by being directly involved in their development. My software projects at Cal Poly CubeSat Laboratory have extended my computer engineering skills far past my classwork with extensive responsibility and expectations. Although working on flight software is an intimidating task, the people in the laboratory and on my team have been so supportive and helpful whenever I need it. I am also thankful to be a part of a technical community that cares about important topics like diversity, equity, and inclusion (DE&I). Spearheading our lab DE&I task force has taught me so much about fostering open and productive discussion as well as creating community. Being a part of Cal Poly CubeSat Laboratory has been such an incredible hands-on experience to have as an undergraduate student.

### Jessica Steward, Electrical Team Member

*2nd Year Electrical Engineering Major*

My time at the Cal Poly CubeSat Laboratory (CPCL) has been an invaluable experience. The teams balance project deadlines and student stress very well; students are free to take breaks, for example, which has been crucial in finding that balance. I was also moved by the DE&I team created last year. The Diversity, Equity and Inclusion team has allowed me to feel confident and represented in the laboratory. I admired how the DE&I program brought forward serious issues, and immediately focused on addressing those issues. The DE&I has helped start conversations about representation and inclusion in the laboratory, and it has also succeeded in creating an environment where everyone feels mutually respected. Overall, the CPCL environment is very reassuring, and it has set a professional standard of inclusion, respect, and flexibility that I will look for in other professional environments going forward.

# ACCOMPLISHMENTS

- Awarded Phase I NSF/STTR with Maverick Space Systems
- Four projects selected by Cal Poly's CENG for the Summer Undergraduate Research Program
    - "Concept development of nano-reaction control system for small satellites" won the "Notable Project" award in the aerospace category
- Awarded funds through Cal Poly's Strategic Research Initiative to spearhead the establishment of activities to enable classified aerospace projects
- Workforce Development Summer Program for 20+ students
- Delivered ExoCube 2 for launch on Virgin Orbit's Launch Demo 2 flight
- Delivered Spinnaker3 for launch on Firefly's maiden flight
- Implemented COVID-19 protocols with minimal interruption of project work
- Awarded a 2 year grant from NASA to further develop Variable Specific Impulse Electrospray Thrusters in collaboration with UCI, JPL, and UCLA
- Awarded a 2 year grant from NASA to further develop and test an Additively Manufactured Deployable Radiator with Oscillating Heat Pipes in collaboration with Cal State LA and JPL



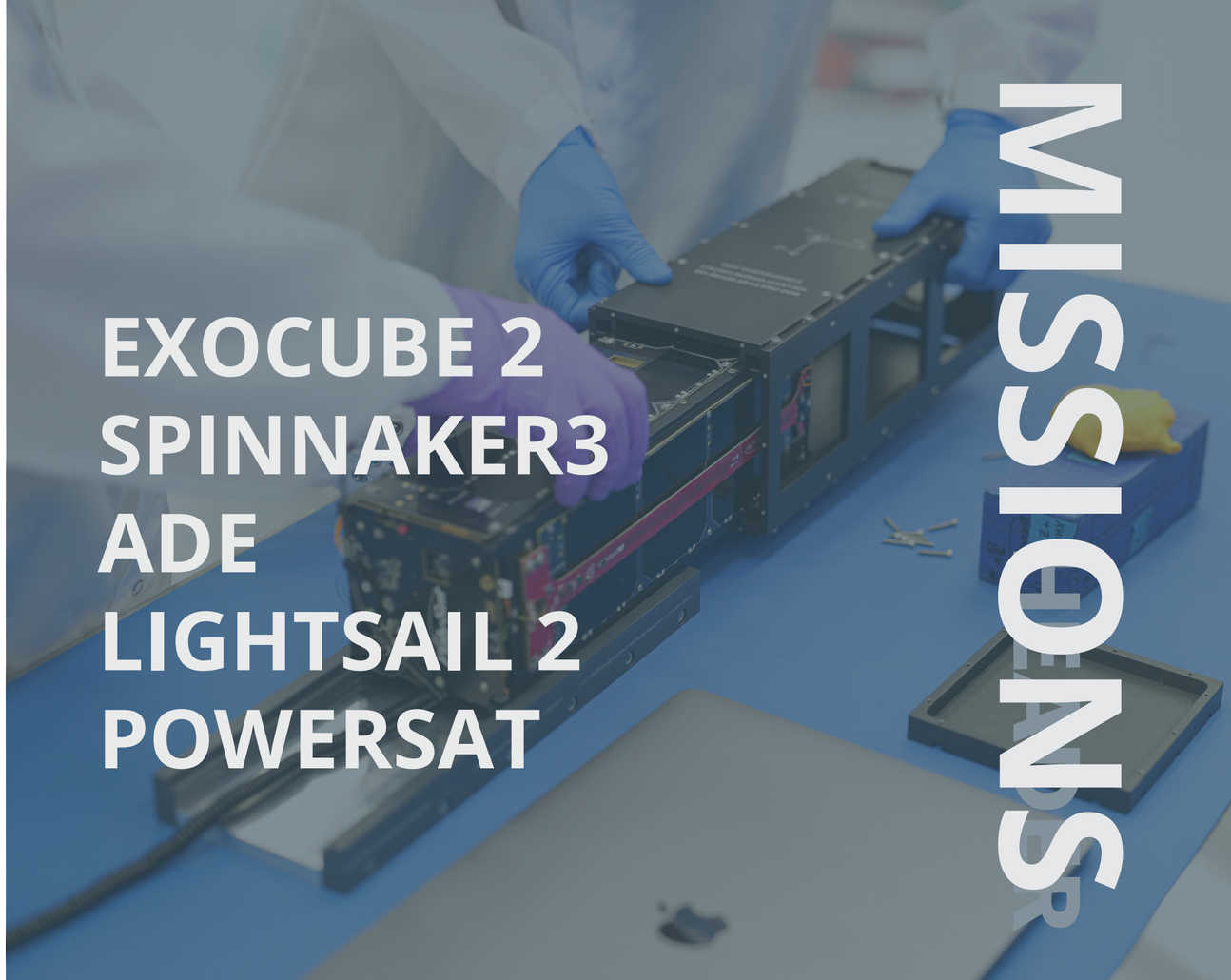
# LOOKING FORWARD

- Introduce the Cal Poly CubeSat Kit
- Expand the CubeSat Training Course offerings
- Host the 18th Annual CubeSat Developers Workshop
- Provide technical support for Cambodia's first CubeSat
- Launch and operate flight missions
    - ExoCube 2
    - XCube
    - Spinnaker3
    - ADE
- Develop deep space communications system for small spacecraft
- Develop high power electrical system for small spacecraft
- Expand micro-propulsion testing capabilities

THE CAL POLY

# CUBESAT LABORATORY

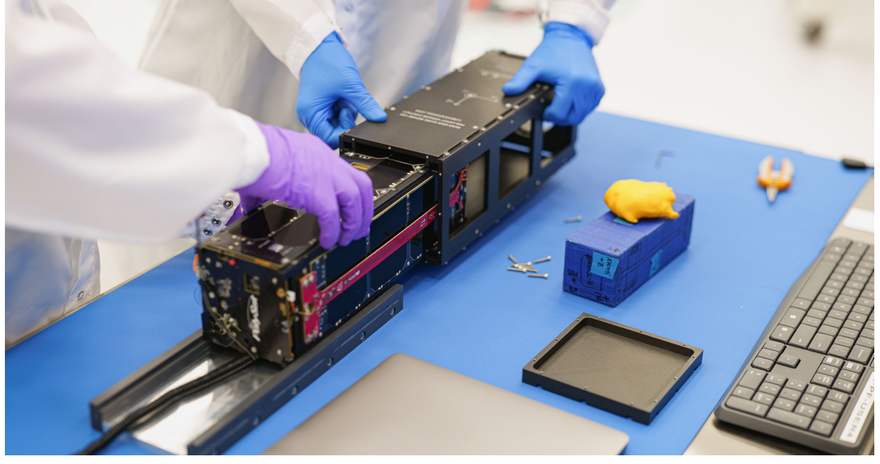
2020 MISSIONS + PROJECTS



## MISSIONS

EXOCUBE 2
SPINNAKER3
ADE
LIGHTSAIL 2
POWERSAT

# EXOCUBE 2



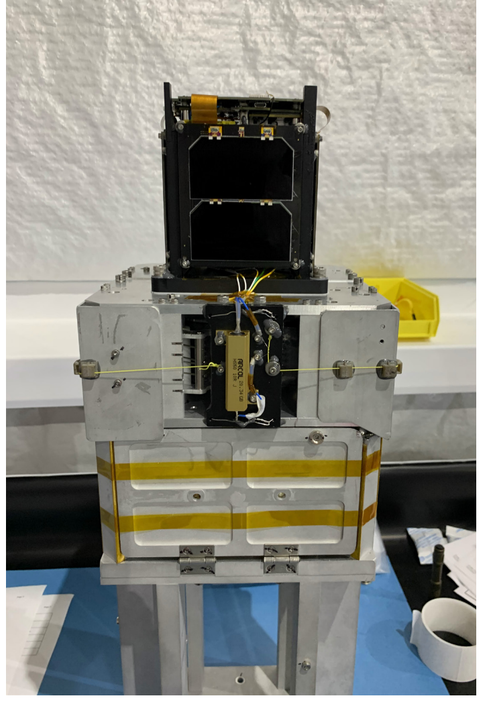
*The flight unit of CP-12, Exocube 2, during delivery*

ExoCube 2 (CP-12) is a reflight of ExoCube, which was launched in 2015 but experienced antenna failure. ExoCube 2 is designed to measure ions' mass and density in the lower exosphere through the use of the Ion Neutral Mass Spectrometer (INMS) developed by NASA Goddard Space Flight Center.

ExoCube 2's mission is to provide global profiles of various species in the upper atmosphere so that they can be studied. This is to determine how our upper atmosphere is changing over time. There is sparse data available for this portion of the atmosphere so it is an exciting scientific mission for Cal Poly.

ExoCube 2 is a 3U spacecraft that was developed by Cal Poly to support the INMS, which provides some new challenges for the Cal Poly CubeSat Laboratory. The largest of which is that the INMS requires pointing in the ram direction (direction of motion) so that the species can be captured by the INMS. This is accomplished by gravity gradient booms to passively stabilize along the Z axis (longitudinal axis). The booms are used in conjunction with a momentum wheel and numerous sensors to determine the position of the spacecraft and point accordingly.

*ExoCube 2 was delivered in Winter 2020.*



*Spinnaker3 during pre-flight integration at VAFB*

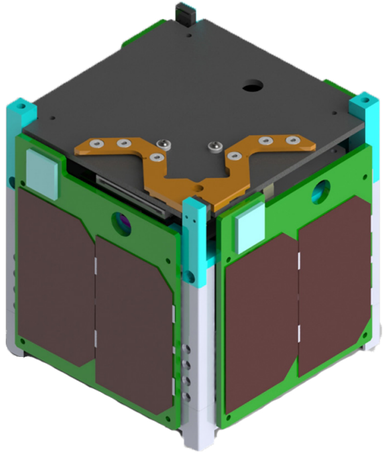


# SPINNAKER3

There has been rapid growth in the number of satellites deployed into low Earth orbit, driven by small satellites for commercial applications, government agencies, and universities. Most small satellites that launch into orbits of 500 km or lower naturally deorbit within 25 years. However, at orbit altitudes of 500 km or higher, small satellites may not meet the 25 year deorbit guideline established by the Inter-Agency Space Debris Coordination Committee without a deorbit device. Passive deorbit methods, including deployable drag devices, inflatables, and tethers, require no active control following initiation. Spinnaker3 is a technology demonstration mission to assess the efficacy of dragsails for passive deorbit. The development of a dragsail system with straightforward mechanical and electrical interfaces for CubeSat and small satellite applications represents an important advancement for space debris mitigation.

The Spinnaker3 payload will deploy an 18 $m^2$ dragsail to provide deorbit capability for the Firefly Alpha launch vehicle upper stage. The payload is composed of an 8U dragsail device with a 1U avionics box and a 12U stilt system. The dragsail device consists of four 3 m carbon fiber booms wrapped around a single hub and four transparent sail quadrants. Tracking and mission operations will be conducted at Purdue University and Cal Poly San Luis Obispo.

# ADE



*Rendering of CP-14, ADE*

ADE (CP-14), Aerodynamic Deorbit Experiment, is a 1U CubeSat with a deployable drag sail payload that will be deployed into a geostationary transfer orbit (GTO). The primary mission objective for ADE is to provide flight qualification for the dragsail and determine its viability. The deployable drag sail is designed to take advantage of the aerodynamic drag forces experienced by the spacecraft near its orbital perigee. The drag it experiences will reduce its velocity, and in turn decrease the time it will take to deorbit.

A successful demonstration of ADE's payload would be a step closer in addressing the mitigation of orbital debris. In addition to demonstrating an aerodynamic deorbit technology, ADE will attempt to characterize the radiation environment in GTO, and provide data for future small satellite missions in radiation-heavy trajectories.

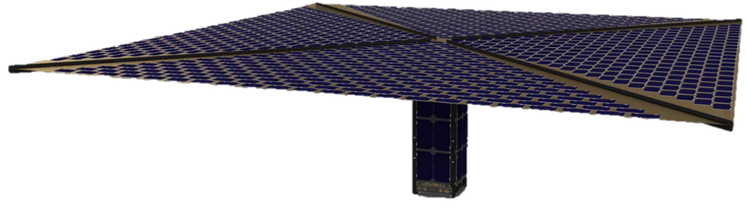
In the past year, ADE has advanced from the preliminary design phase to the detailed design phase. Components in the spacecraft's avionics will be ready for procurement, fabrication, and testing during the first half of 2021. The payload design is also planned to be complete during the first half of 2021, which will mark a milestone in the spacecraft development. The earliest possible launch date for ADE is quarter 2 of 2021.



# POWERSAT

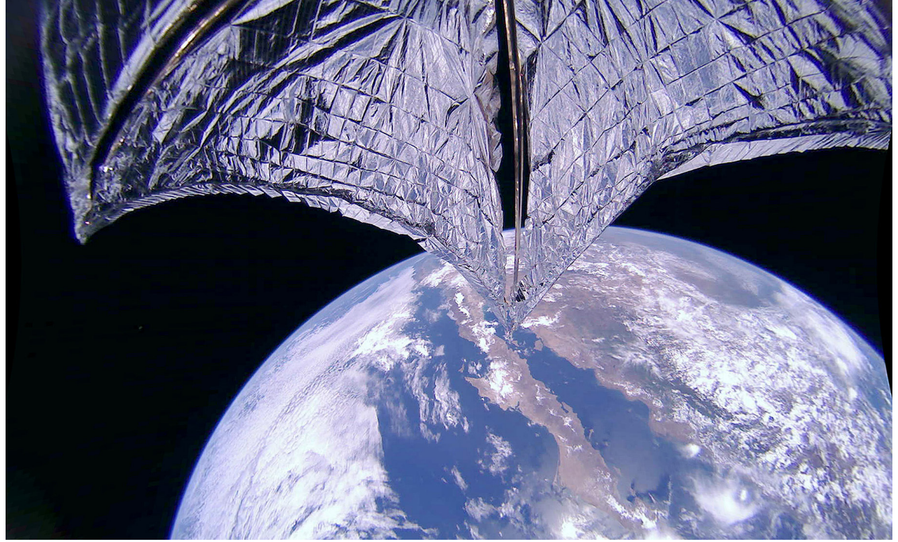
PowerSat is a mission in partnership with Deployables Cubed GmbH, Germany. PowerSat aims at demonstrating the deployment of a large solar array capable of producing up to 100 W. The power generated will be handled by a Maximum Power Point Tracking (MPPT) based electrical power subsystem being developed in-house by the Cal Poly CubeSat Laboratory (CPCL). Following launch, the solar array stowed in a 1U volume will unfurl like origami to a 4 $m^2$ area and pictures will be taken from space to validate the solar array deployment.

Both novel technologies hold potential for the CubeSat industry and have yet to be proven at this scale and capability by any previous missions. If a successful demonstration is executed, PowerSat will serve as a pathfinder mission for future CubeSats to expand the applications of high power systems in small satellites, such as improved communication systems, electric propulsion, and lunar exploration. PowerSat's 3U bus is being developed by an interdisciplinary team of undergraduate and graduate students at CPCL, who are actively involved in the design work and oversight of the mission's full life-cycle.



*Rendering of PowerSat with its deployed solar array*

# LIGHTSAIL 2



*The first high resolution picture downlinked by LightSail 2. This image was captured just moments after deployment*

LightSail 2 is a citizen funded 3U CubeSat created in partnership with The Planetary Society that aims to demonstrate controlled solar sailing propulsion on a small satellite platform. LightSail 2 is equipped with a 32 $m^2$ aluminized mylar solar sail that provides a large surface area for photons to strike and bounce off, giving the spacecraft a small push.

Most propulsion systems involve the storage of fuel, a limited resource, to produce the desired push. Once all the fuel is used, the spacecraft can no longer propel itself. Using the sun as its fuel source, solar sailing provides a unique alternative to traditional methods. This promises a nearly endless supply of energy, and enables us to go even farther than we have before.

# PROJECTS

XCUBE
FAUXSAT
AMDROHP
C-SPOT
STICKCUBE
STMD PROP
CUBESAT KIT
X-BAND
ISP-POD
GOOSE

# XCUBE

XCube is a collaboration project between NASA's Ames Research Center, NASA's Armstrong Flight Research Center, and the University Space Research Association. NASA's high-altitude ER-2 has unused space in its payload bay. XCube offers a standardized mounting solution, communication protocol set, and a wide variety of power options, allowing organizations to develop smaller payloads according to the CubeSat standard and piggyback on ER-2 flights, maximizing the payload bay usage.

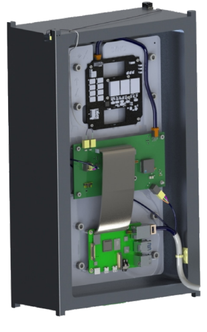
As of December 2020, XCube is developing harnessing for the ER-2 electrical interface and developing and testing communication and actuation protocols. XCube is expected to fly no later than June 2021.

*XCube structure*

# FAUXSAT

FAUXSAT stands for the First At-Altitude Use of XCube and Sync Acquisition of Telemetry. This project is being developed as a proof of concept payload for the XCube platform with the goal being to fly FAUXSAT onboard XCube's first flight with NASA's ER-2 aircraft to demonstrate XCube's functionalities.

In addition, FAUXSAT is implementing a payload called Sync. Sync is a payload designed to measure the vibrations of the launch environment of a rocket, but will be implemented on FAUXSAT to measure the vibration environment on the XCube carrier.

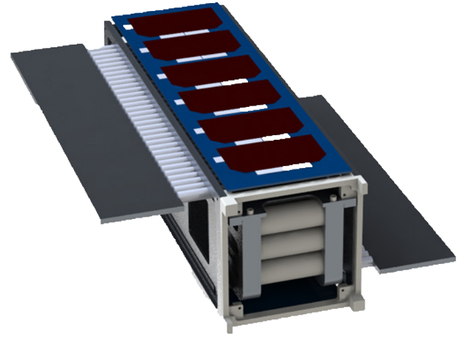


*Rendering of FAUXSAT electrical components*



# AMDROHP

The AMDROHP mission is a technology demonstration for an Additively Manufactured Deployable Radiator with Oscillating Heat Pipes (AMDROHP). This mission is a collaboration with Cal State LA (principal investigator), NASA's Jet Propulsion Laboratory and the Cal Poly CubeSat Laboratory. In addition to performing radiator validating experiments, the AMDROHP mission will serve as the foundation of CubeSat capabilities at Cal State LA and an educational opportunity for several graduate and undergraduate students. The development of this radiator technology will aid addressing the thermal challenges presented by high powered CubeSats on future lunar missions.



*AMDROHP rendering with deployed radiators*

# C-SPOT

C-SPOT stands for CubeSat Solid Propulsion Orbital Test, and is a mission for the U.S. government in collaboration with Exquadrum, Inc in southern California. The CubeSat's mission is to raise the technology readiness level of Exquadrum's propulsion system design. The spacecraft is not yet manifested on any flight and its engineering units are in the assembly and test phase. The propulsion system is unique in its design, and provides a very high impulse, relative to other available systems. This high impulse is available on demand, which enables rapid orbital adjustments.

# STICKCUBE

Stickcube is an internal project intended to be both: a learning project to get members of the Cal Poly CubeSat Laboratory (CPCL) more familiar and comfortable designing control systems and filters for future missions involving Attitude Determination and Control Subsystem (ADCS); and a testing bed for ADCS algorithms and hardware. Stickcube's intended design is an inverted pendulum with a microcontroller (Arduino UNO), Initial Measurement Unit (IMU), and reaction wheels atop a threaded metal shaft. The Arduino UNO will take accelerometer, gyroscope rate, and magnetic field vector readings from the IMU and implement an attitude determination algorithm to calculate the device's current attitude. The microcontroller will then implement a proportional-integral-derivative control law to control the reaction wheels to reject the torques due to gravity or any other disturbances put into the system.

Stickcube is in the preliminary design phase, with simulations being run to verify requirements and structural components. The wheels and physical structure will be manufactured by CPCL; all other components will be off-the-shelf.

# STMD PROP

STMD Prop is a two-year project in collaboration with UCI, UCLA and NASA's Jet Propulsion Laboratory. The final product of the mission is to have a design for an electrospray thruster module.

The Cal Poly CubeSat Laboratory (CPCL) has two main tasks. The first task consists in the design of a CubeSat-class electrical power subsystem (EPS) for operation of the thrusters. There are different types of thrusters and the EPS must be able to switch between two power thrusters that have different operating characteristics. The EPS must also be able to individually control the different thrusters as well as control a solenoid valve that controls the flow of the propellant.

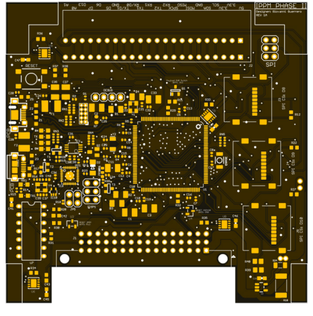
The second task consists of designing a 3U CubeSat bus to accommodate the electrospray thruster. During this second phase, CPCL will focus on the development of a number of engineering deliverables, such as overall system architecture, overall flight software architecture, as well as CubeSat layout and CAD models.



# CUBESAT KIT

The CubeSat Kit project aims to develop an educational platform with modular subsystem components so individuals can learn more about CubeSat operations and systems. The Kit serves to enable external training capabilities and can contribute to capacity building efforts domestically and internationally.

With the first revision underway, the CubeSat Kit is being designed to consist of an integrated payload processing module, electrical power subsystem, backplane, and structure. The second version will add an on-board computer, communication subsystem, and attitude determination subsystem. The design of the structure enables manufacture using subtractive or additive methodologies. Moreover, the backplane allows subsystems to communicate and be interfaced in any order within the structure. Overall, the CubeSat Kit is a new and promising platform for the CubeSat community!



*Left: CubeSat Kit render showing structure with integrated subsystems and backplane*

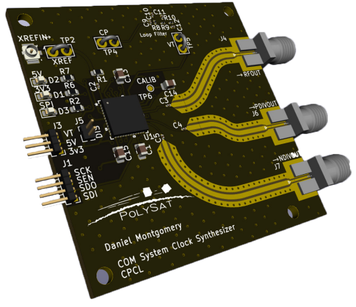
*Right: Integrated Payload Processing Module Version 1*

# X-BAND

In 2020, the CubeSat Laboratory initiated the development of a deep space communication system for small spacecraft using X-band.

The project overall goal is to establish the design of a low power consuming and low cost deep space communication system that will enable small spacecraft to expand their on-orbit capabilities and enable a larger number of players access to space-based deep space research. The development of the X-band radio and antenna are based on commercial off-the-shelf components and is at a technology readiness level of 3 as of December 2020.

Since its inception, the project has engaged three undergraduate and graduate students from electrical and aerospace engineering. For 2021, the team will pursue its work to support additional functional and integration verifications as well as to develop the ground segment aspect of the X-band communication system.




*X-band system's clock synthesizer development board*

# ISP-POD

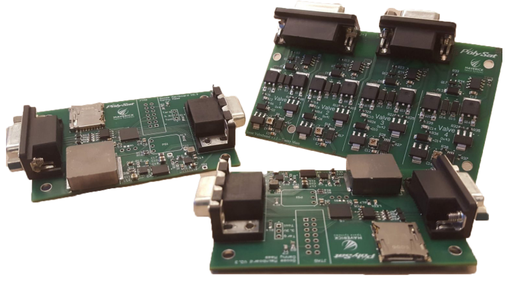
The Interplanetary Spacecraft Poly-Picosatellite Orbital Deployer, or ISP-POD was developed by the Cal Poly CubeSat Laboratory (CPCL) to expand the capabilities of CubeSats to travel beyond the orbit of Earth. This deployer functions as a carrier, supporting CubeSats on their interplanetary journeys and deploying them into space when the time comes. With these tasks, comes the challenge of managing the extremes of the interplanetary thermal environment. CPCL is doing research to understand interplanetary thermal environment and its effect. The research outcomes will then be implemented into the design of a thermal subsystem capable of protecting the ISP-POD and its CubeSat payloads on their interplanetary journey.



# GOOSE

GOOSE is a nano reaction control system for small satellites that will use resistojets to flash water propellant to steam. GOOSE is being developed by Maverick Space Systems in collaboration with the Cal Poly CubeSat Laboratory. As CubeSats go further than low Earth orbit, reaction control systems are necessary to control the attitude of the spacecraft and perform orbital maneuvers. The CubeSat Laboratory is tasked with the development of the avionics that will control the valves and heaters of the system, accepting commands, and relaying telemetry and sensor readings back to the spacecraft's onboard computer.

The collaboration began during the Summer 2020 when Maverick Space Systems was rewarded with a Phase I Small Business Technology Transfer grant by the National Science Foundation.



*The avionics boards developed by the Cal Poly CubeSat Laboratory*


Image captured before 2020
2020 CAL POLY
CUBESAT LABORATORY

# LAB IMPROVEMENT
# INITIATIVES

In 2020, the Cal Poly CubeSat Laboratory started a restructuring initiative. At the beginning of the year, laboratory managers identified some areas of improvement regarding the training and design processes. They met with industry experts to evaluate CPCL's processes and look for ways to improve them. The first step that the laboratory has taken is to de-emphasize the discipline team structure and create new subsystem teams. This allows for more specialized trainings within the laboratory and across projects. Moreover, it allows discipline teams to shift their focus towards recruitment and new member on-boarding.

Subsystem teams are being created one-by-one. So far, the systems engineering, attitude determination and control, electrical power, and structures and mechanisms teams have established meetings, trainings, and project assignments. In 2021, the testing and facilities, communications, and space environments teams will follow.

In addition to the implementation of subsystems, a Diversity, Equity and Inclusion (DE&I) task force was created at the beginning of 2020 to make the application process more accessible and ensure that CPCL is a safe space for all students. The DE&I task force has worked on changing CPCL's core values to actionable items so the climate in the laboratory is more inclusive and implementing more resources for members, such as anonymous reporting and surveys.

# STAFF

With a combined 30+ years of experience, the staff members of the Cal Poly CubeSat Laboratory (CPCL) advise students in all aspects of small spacecraft development, including design, manufacturing, and research projects exploring new methods and technologies. In addition to advising students in technical engineering work, staff members work closely with the students to teach best practices with regard to project management, as well as general laboratory management.

The staff provides much needed continuity for laboratory operations, allowing for smooth transition of institutional knowledge in an environment that has high turnover in the student workforce. Without such continuity, knowledge cannot be transferred efficiently from generation to generation, hindering the growth of CPCL.

Over the course of their careers, CPCL staff members have integrated over 160 CubeSats on 25 missions and 12 different launch vehicles. They are able to take advantage of this specific CubeSat experience to provide support services to the greater CubeSat community. These services include environmental testing, regulatory consulting, design consulting, CubeSat training courses, and anything else a CubeSat developer might need help with.

*Left to right: Ryan Nugent, Dave Pignatelli, Alicia Johnstone**



## Ryan Nugent

Ryan Nugent is a Co-Principal Investigator of the CubeSat Laboratory at Cal Poly in San Luis Obispo, CA. Ryan has spent 13 years with the program, starting as an undergraduate student and continuing as a graduate student in Aerospace Engineering. Ryan took a staff position at Cal Poly in 2011. He has lead development efforts for Cal Poly dispenser designs, developing the processes required to support NASA, the U.S. Department of Defense, European Space Agency, and Commercial Organizations in certifying CubeSats and CubeSat dispensers for domestic and international launches. Overall, Ryan has supported 23 orbital launches in the U.S. and internationally involving over 155 satellites, including the MarCO CubeSats. Ryan is currently managing the CubeSat Program at Cal Poly, which manages the CubeSat Standard and is currently working on additional launch campaigns and supporting the development of three different satellite projects at Cal Poly.

## Dave Pignatelli

Dave Pignatelli graduated from Cal Poly with an M.S. in Aerospace Engineering in Fall 2014. During his time as an undergraduate and graduate student at Cal Poly, he supplemented his academic experience by supporting the Cal Poly CubeSat Laboratory (CPCL) in integrating and launching CubeSat payloads on a number of different launch vehicles. Upon graduating with his degree, he elected to stay on as CPCL Staff full-time. Since then, he has assumed both technical engineering roles as well as project management roles for a variety of projects, including spacecraft missions and technical research projects. Additionally, he has participated in outreach efforts, including presenting research and design results at conferences both in the United States and abroad. His aspirations include continuing to develop his skills alongside helping students gain practical knowledge of the spacecraft design and launch processes, with the hopes that these contributions will develop the workforce as a whole in the space industry.

## Alicia Johnstone

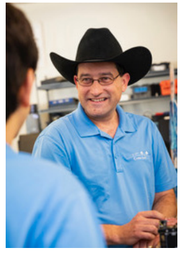
Alicia started with the Cal Poly CubeSat Laboratory (CPCL) working with the launch integration team while she was a student in the ME department. Since graduating and accepting a full-time position, she has become the in-house expert on spacecraft licensing and regulations to help prepare Cal Poly CubeSats, as well as the CubeSats of external partners and customers, for flight. Prior to her arrival at Cal Poly, Alicia spent six years as a satellite communications technician in the US Army where she gained knowledge and experience that she has applied to working with the ground station equipment that is being used by CPCL to communicate with CubeSats. In addition to working with communications, Alicia is responsible for maintaining CPCL's compliance with ITAR regulations and maintaining the CubeSat Standard. Alicia also oversees the general running of the CPCL with the student laboratory managers to include organizational-level laboratory improvements, DE&I, and public relations.

### Dr. Pauline Faure

Dr. Faure has over 10 years experience in managing international small spacecraft projects. Since joining Cal Poly in 2018, Dr. Faure has been leading the efforts of the CubeSat Laboratory for the development of the CubeSat Kit, deep space communication and high power electrical subsystems. Moreover, Dr. Faure is an advocate for the implementation of systems' engineering's good practices for the development of small satellites programs. Within the aerospace department, Dr. Faure teaches among others, the seniors' capstone course on Spacecraft Design.

Dr. Pauline Faure obtained her undergraduate degree from the Ecole Européene d'Ingénieurs en Génie des Matériaux (EEIGM), France, in Engineering Sciences, a double master degree from the EEIGM in Material Sciences and from Kyushu Institute of Technology (Kyutech), Japan, in Mechanical Engineering, and her Ph.D. from Kyutech in Mechanical Engineering. Dr. Faure's thesis dealt with decision-making processes in non-traditional satellites program management of assembly, integration, and testing activities.

### Dr. John Bellardo



Dr. John Bellardo joined Cal Poly's Computer Science and Software Engineering Department in 2006, after completing his Ph.D. at UC San Diego. While at UCSD he researched the security and efficiency of wireless networks under the direction of Dr. Stefan Savage. Dr. Bellardo earned his B.S. degree in Computer Science from Cal Poly in 1999.  In 2019 he received a joint appoint in the Aerospace department and became the Director of the Cal Poly CubeSat Laboratory. He was honored with the Cal Poly Distinguished Scholarship Award in 2020.

Dr. Bellardo began working with CPCL in 2008, when the laboratory was transitioning to a new generation of embedded linux spacecraft. Since then he has been involved in the design, development, and operation of five CPCL CubeSats, and also assisted with high profile missions such as the MarCO mission to Mars with NASA's Jet Propulsion Laboratory and LightSail 2, with the Planetary Society and Bill Nye. He has helped two high school teams reach space with their first satellites and been involved in numerous additional laboratory activities.



# MECHANICAL TEAM

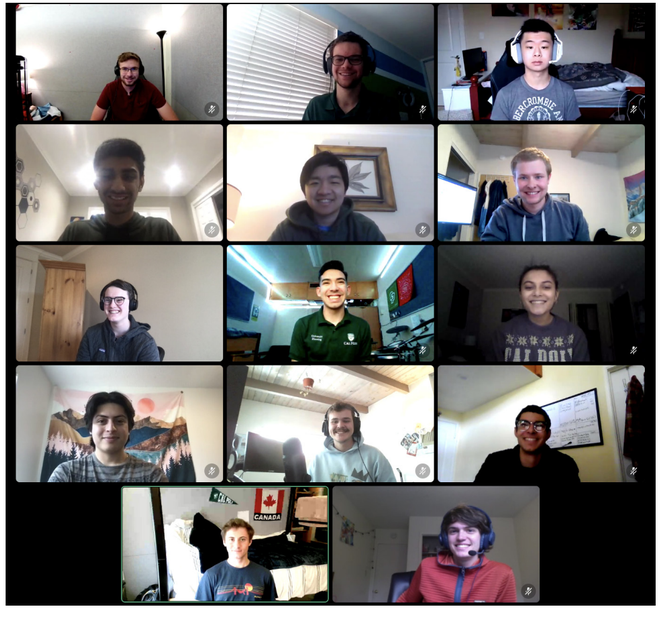
*First Row (L to R): Alex Lee, Aviv Maish, Daniel Leon, Harrison Pomerantz, Jered Bell*
*Second Row (L to R): Laura Russell, Leticia Mezzetti, Lucas Martos-Repath, Christopher Pablo Casillas, Peter Van Ness*
*Third Row (L to R): Ricardo Contreras, Rose McCarver, Savannah Cheney, Zachary Stednitz*

# ELECTRICAL TEAM


*First Row (L to R): Colt Whitley, Drew Evans, Daniel Montgomery, Austin Gnecco, Jack Ellingson*
*Second Row: (L to R): Spencer Drewry, Helen Zhang, Brayden Burkhardt, Lorenzo Pedroza, Ben Clark*
*Third Row (L to R): Mark Wu, Jack McGuigan, Jessica Steward, Jeffrey Romeo, Lucas Lucia*
*Fourth Row (L to R): Nicholas Arner, Siddhi Upadhyaya, Kunj Shah, Douglas Liu, Danny Maas*

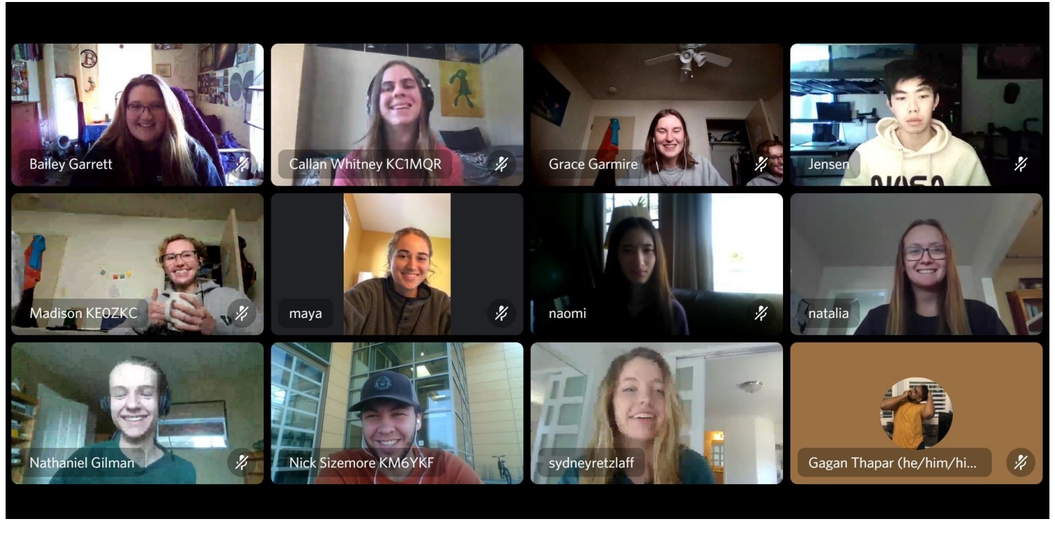


# SOFTWARE TEAM



*First Row, Second Row (L to R): Chris Lawson, Daniel Montgomery, David Yu, Dev Masrani, Edward Du, Ian Gallagher*
*Third Row (L to R): Josh Grace, Luis Magana, Nayana Tiwari*
*Fourth Row, Fifth Row (L to R): Ricardo Beltran, Ryan Hunter, Sam Cole, Braeden Kennedy, Walden Hillegass*

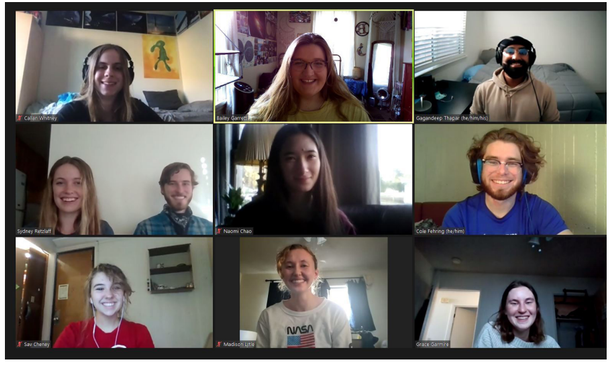
# AEROSPACE TEAM




*First Row (L to R): Bailey Garrett, Callan Whitney, Grace Garmire, Jensen Lam*
*Second Row (L to R): Madison Lytle, Maya Gordon, Naomi Chao, Natalia Cieply*
*Third Row (L to R): Nathaniel Gilman, Nick Sizemore, Sydney Retzlaff, Gagan Thapar*



# SUBSYSTEMS



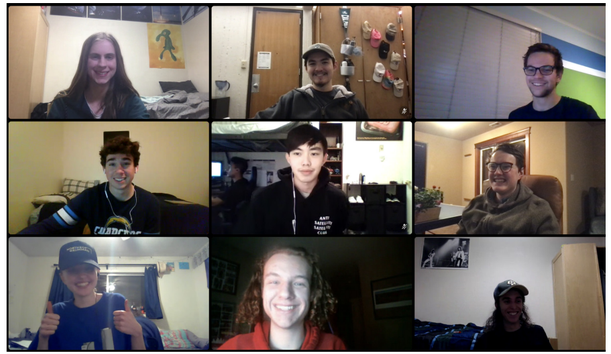
## SYSTEMS ENGINEERING

*First Row (L to R): Callan Whitney, Bailey Garett, Gagan Thapar*
*Second Row (L to R): Sydney Retzlaff, Cole Gillespie, Naomi Chao, Cole Fehring*
*Third Row (L to R): Savannah Cheney, Madison Lytle, Grace Garmire*

## STRUCTURES + MECHANISMS

*First Row (L to R): Peter Van Ness, Aviv Maish, Christopher Pablo Casillas, Alex Lee*
*Second Row (L to R): Jered Bell, Harrison Pomerantz, Zachary Stednitz, Sophia Tiu*
*Third Row (L to R): Tanner Wells, Roxy Jackson-Gain, Berent Baysal, Lucas Martos-Repath*

# SUBSYSTEMS



## ATTITUDE DETERMINATION + CONTROL

*First Row (L to R): Callan Whitney, Colton Crosby, Daniel Montgomery*
*Second Row (L to R): Gavin Goddard, Jensen Lam, Josh Grace*
*Third Row (L to R): Madison Lytle, Nathaniel Gilman, Trevor Loe*

## ELECTRICAL POWER SUBSYSTEM

*First Row (L to R): Callan Whitney, Colt Whitley, Eric Qian*
*Second Row (L to R): Jessica Steward, Kunj Shah, Lucas Lucia*
*Third Row (L to R): Mark Wu, Nicholas Arner*

*Ground station student lead works on repairing the Marconi ground station on the Cal Poly campus.*

# HOW TO GET INVOLVED

If you are interested in collaborating or partnering with the Cal Poly CubeSat Laboratory for a CubeSat mission or any small satellite related project, please contact cubesat@calpoly.edu. We have a wide variety of resources and are interested in pursuing a broad range of projects. For details, please visit: cubesat.org.

Cal Poly students interested in joining CPCL, visit polysat.org for an application and details on how to apply. We accept applications from all majors, so as long as you have an interest in science, engineering, or space feel free to apply!

If you would like to support the Cal Poly CubeSat Laboratory in providing learn-by-doing educational opportunities for the space industry please visit polysat.org/donate.

**Instagram: @cppolysat**

**Twitter: @PolySat**

**Facebook: PolySat**