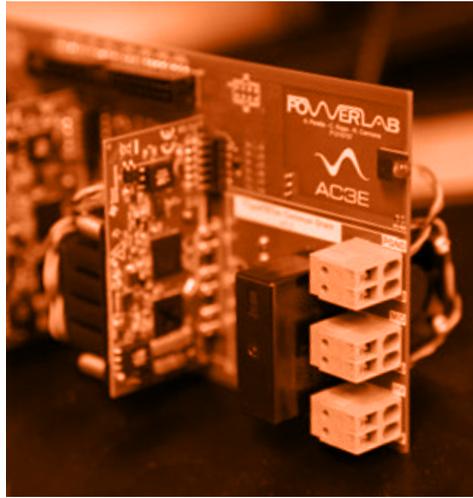UNIVERSIDAD TECNICA
FEDERICO SANTA MARIA

AC3E
Advanced Center for Electrical
and Electronic Engineering

ANNUAL REPORT
October 2023 to September 2024

AC3E Annual Report is a compilation of official information from the Center and the main indicators and activities for Year 10 (October 2023 – September 2024). Valparaíso, Chile.

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www.ac3e.usm.cl

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Director's Message

by Matías Zañartu

AC3E's 10th anniversary is undoubtedly one of its most significant, marking the transition from the initial phase to the beginning of a new one—a stronger research center with greater ambitions and goals. This is thanks to the outstanding results achieved so far, particularly in scientific excellence, the number of undergraduate, master's, and doctoral students; increased female participation; and knowledge transfer and engagement with industry at both national and international levels.

Over these years, the impact of AC3E has become visible and measurable across various areas in the country: the economy, the training of highly qualified human capital, science communication, and research, among others.

> One defining feature of these 10 years has been scientific excellence, with a total output of 965 ISI-indexed articles and over 18,000 citations, reflecting the active participation and sustained growth of our researchers in their fields..

In this 10th year alone, we graduated 88 undergraduate students (131% above target), 32 master's students (145% above target), and 11 doctoral students (183% above target)—a source of great pride in our mission to train future professionals to face the major challenges ahead.

As in previous years, we continue to prioritize gender equity in developing human capital, which has led to significant progress in increasing female participation at all levels—from students to principal investigators. Compared to the previous five-year period, female participation rose over 500% among undergraduates, 350% in postdoctoral positions, and 266% overall. In addition, over the past 16 months, four female researchers—Dr. Claudia Rahmann, Dr. Jocelyn Dunstan, Dr. Constanza Ahumada, and Dr. Melissa Diago—joined our team.

In terms of industry engagement, we're proud to have surpassed the annual target of $300M, reaching $398M linked to national industrial projects and $311M to international sources, such as the ASTRI project and NIH P50.

We continue to successfully carry out initiatives to bring science closer to schoolchildren in the region, reaching more than 400 students this year through talks, guided tours of the Center, and participation in science fairs. This year, for the first time, we also held two Robotics Workshops for teachers, featuring both theoretical and practical sessions led by an AC3E academic and a PhD student, with around 30 participants in total.

These excellent results marked a great conclusion to the first decade of the Center and have fueled our motivation and optimism as we prepare for our renewal phase. We will continue to display the same drive and enthusiasm for growth, to generate national and international impact, strengthen ties between academia and industry, and become a national benchmark in electrical and electronic engineering—while inspiring and motivating future generations.

Here's to another 10 years!

Matías Zañartu S.

General Manager's words

"AC3E can be the strategic R&D partner in the areas of electrical and electronic engineering for the national industry."

by Oscar Solar

This past period marked a phase of significant growth for the Advanced Center for Electrical and Electronic Engineering (AC3E). We celebrated 10 years of hard work, and without a doubt, the results have been positive. We not only met but exceeded, in several areas, the targets we committed to in talks with science authority ANID. We exceeded targets regarding publications, the number of undergraduate and postgraduate students, technology transfer projects in collaboration with the productive sector, outreach, international collaboration, gender gap reduction, and others.

We currently have nearly 20 collaborative applied research projects with industry underway. Over the past three years, we have tripled AC3E's revenue from R&D project and service sales, without increasing the number of projects—indicating a gradual sophistication and increasing value of our work. A highlight is a contract exceeding US$1 million in 2024 with a major local company in the field of smart systems and predictive analytics.

Over the last three years, we've also promoted greater involvement of AC3E's researchers in industry projects, adding strong capabilities in areas such as power electronics, signal processing, advanced control, microelectronics, IoT, advanced analytics, and predictive maintenance. This enables us to take on highly complex, challenging initiatives with greater technological risk and disruptive potential—strengthening one of our core objectives: to change the perception of science and innovation developed in Chile by generating added value and social and economic impact.

Today, our country needs to strengthen its productive capacity in strategic areas and, in doing so, reduce its dependence on imported technological products and services. Chile needs more technology Made

in Chile—technology that adds value to productivity, creates jobs, and incorporates advanced human capital into production. This message is well known, but now is the time to act.

> For that to happen, it's essential that both public and private local companies and institutions trust and use local technological capabilities, instead of buying based solely on price or foreign prestige. Only then will a strong national industry develop.

We must place our confidence in local capabilities—we have science and advanced human capital of the highest level. This encourages students to complete their degrees and postgraduate programs, helps the local industry grow and evolve, and—initially through local demand—lays the groundwork for optimization, scaling, and eventually exporting.

Given how much AC3E has grown since 2014, we are ready to support this deep transformation, serving as the R&D arm in electrical and electronic engineering for national industry.

What lies ahead? We are preparing the Center's renewal—a highly competitive call in which the best research institutions in Chile participate. A major challenge is that for every US$1 in ANID funding, we must raise US$0.50 through industrial R&D project and service sales, which represents a significant hurdle.

Therefore, our projection is to continue advancing cutting-edge science in electrical and electronic engineering, train highly skilled human capital to tackle technological challenges, and transfer this knowledge to the productive sector through bold, high-tech industrial projects that generate greater economic value and lasting impact in Chile and beyond.

Oscar Solar

Director's Special

Being part of AC3E's history elicits tremendous personal but also institutional pride.

For those of us who were part of the initial team of researchers, it was clearly a major challenge to formulate a coherent and ambitious long-term plan that would allow us to bring together our capabilities and, at the same time, invite more colleagues to join a long-term project. Over time, through the execution of that plan, the Center also became an incredible opportunity for learning, growth, and development for everyone who has been part of it.

The systematic work and dedication of every person who has passed through AC3E has borne fruit, turning it into a benchmark at both the institutional and national level. I have no doubt that it will continue to grow and contribute to the country and the world for a long time to come.

Dr. Juan Yuz

Director of AC3E, 2015 - 2019
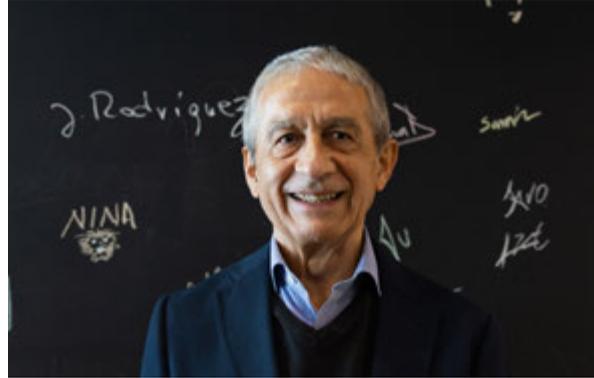
It is very emotional to see everything that AC3E has achieved over these 10 years. The work carried out over all these years and its results across all areas have placed it on par with the best research centers in the world.

Without a doubt, AC3E has fulfilled everything we promised at the beginning of its journey and has far exceeded the original dream we had when we applied for its creation.

I want to highlight the talent and dedication of the researchers, directors, and the entire administrative team, whose work has made it possible to build and bring to life a world-class infrastructure—which is, without question, a source of pride for the region, Federico Santa María Technical University, and indeed, the entire country.

Dr. José Rodríguez

Founder and Director of AC3E, 2014
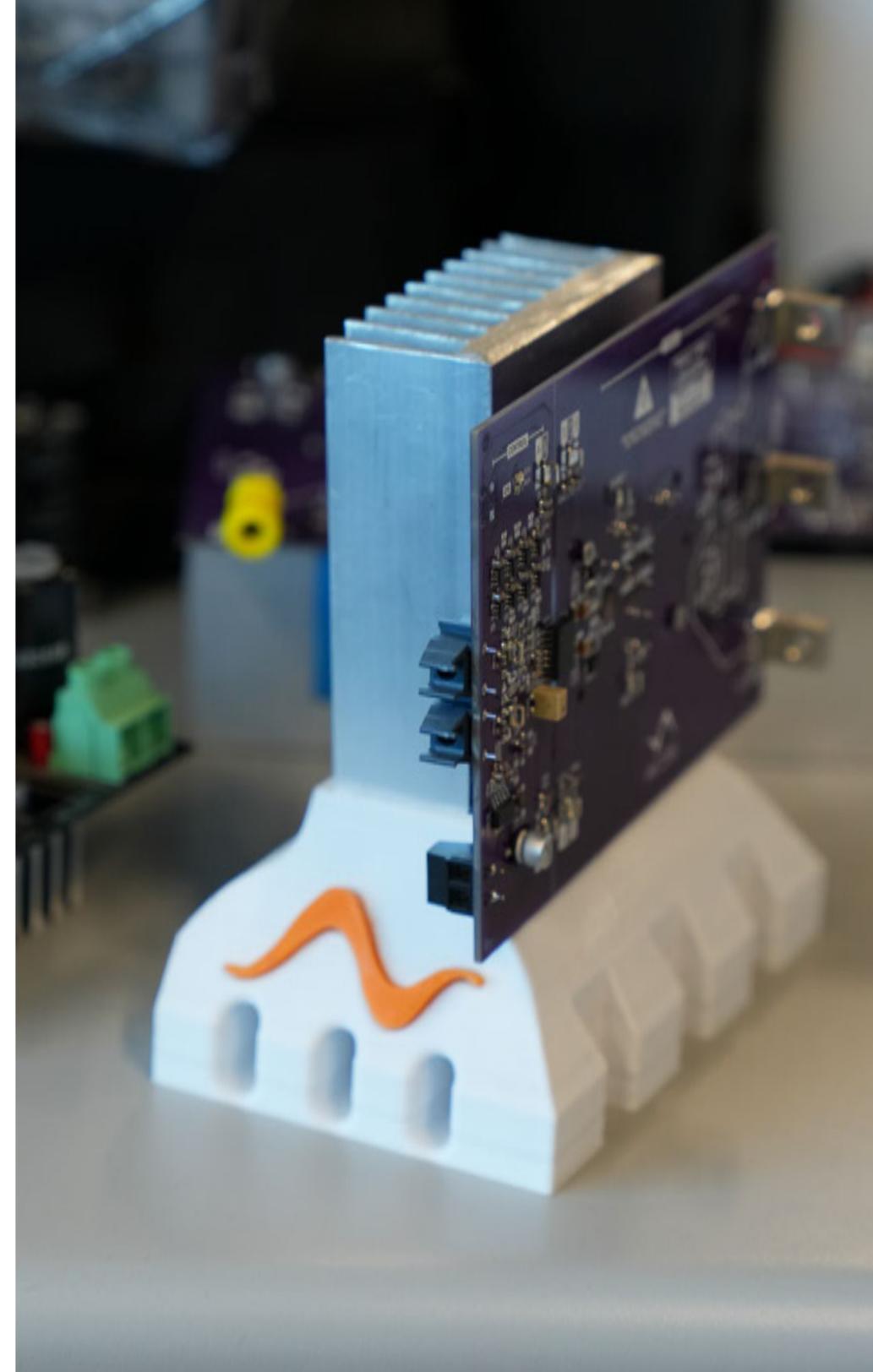
History

In 2014 a group of researchers with recognized experience in their areas and with a robust colla-boration network spanning scientific groups from several countries, decided to build a world-class scientific community for the creation of innovative and enabling technologies, helping the develop-ment of the industry and society of the future.

The Advanced Center of Electrical and Electro-nic Engineering (AC3E) was born when it won the Third National Basal Funding Competition of the Associative Research Program (PIA) of the National Research and Development Agency (ANID).

In 2019 ANID highlighted the Center's performance during its startup period and authorized the Cen-ter to operate for another five years, enabling it to continue work as a research center of excellence in Chile.

Mission

To contribute to the technological development and competitiveness of the chilean economy by achieving excellence in research, fostering knowle-dge exchange, educating advanced human capi-tal, and generating technology transfer in areas of societal impact through the field of electrical and electronic engineering.

Vision

To be a world-class scientific community that crea-tes innovation and enables the development of fu-ture technologies for industry and society.

Board of directors

MATÍAS ZAÑARTU

Representative of the Principal Investigators. Associate Professor, Dept. Electronic Engineering, UTFSM. AC3E Director. Principal Investigator, Biomedical Systems, AC3E. President of the Board of Directors, AC3E.

BLANCA VELASCO

Representative of the entrepreneurial ecosystem Designer of organizations for innovation and entrepreneurship. Founder and current director of Santiago Innova. Founder of Plataforma 360. Former Director of "Programa Pymes Innovadoras" from CORFO. Collaborator in CHILETEC, CeBiB, Open Beauchef U. Chile, MEVOL and BioRed SUR. Lecturer, University of Santiago.

EDUARDO REITZ

Representative of the electrical and electronics industry and the entrepreneurial ecosystem Member of board of trustees, UTFSM. CEO of EMELTA and Former CEO of RHONA group. Former Director of the Regional Chamber of Commerce and Production of Valparaíso. Founding member of PIENSA foundation. Former Director and former President of AEXA-Valparaíso. Co-Founder and director of real estate businesses.
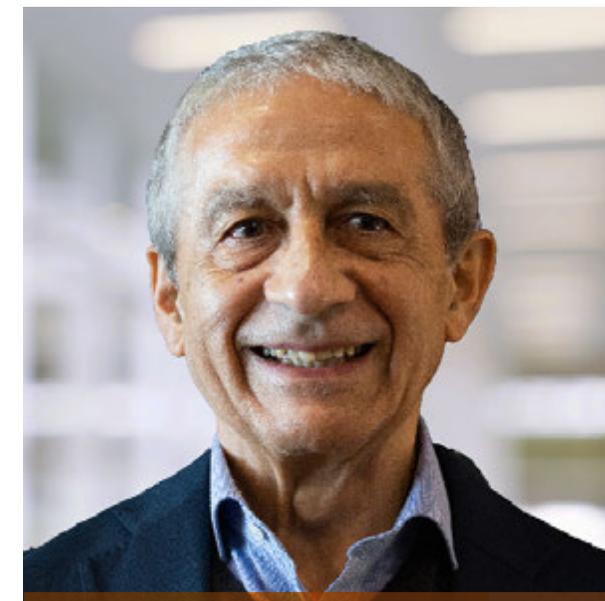
JOSÉ RODRÍGUEZ

Recognized member of the scientific community. National Award of Applied Science and Technology in 2014. Eugene Mittelmann Award, 2018. "Highly Cited Researcher" by Thompson Reuters & Clarivate. Past President of UTFSM for 8 years and UNAB for 4 years. Member of several advisory boards in science and education. Founding Director of AC3E and current Associate Researcher.

CRISTÓBAL FERNÁNDEZ

Representative of the University President Director, Dep. of Industrial Eng. Department, UTFSM. Director of Center of Commercial Engineering at UTFSM. Coordinator of Global Entrepreneurship Monitor of Valparaíso.

VICTOR GRIMBLATT

Representative of the electrical and electronics industry R&D Group Director and General Manager of Synopsys Chile. President of the Chilean Electronic and Electrical Industry Association (AIE). Lecturer, Los Andes University and University of Chile.
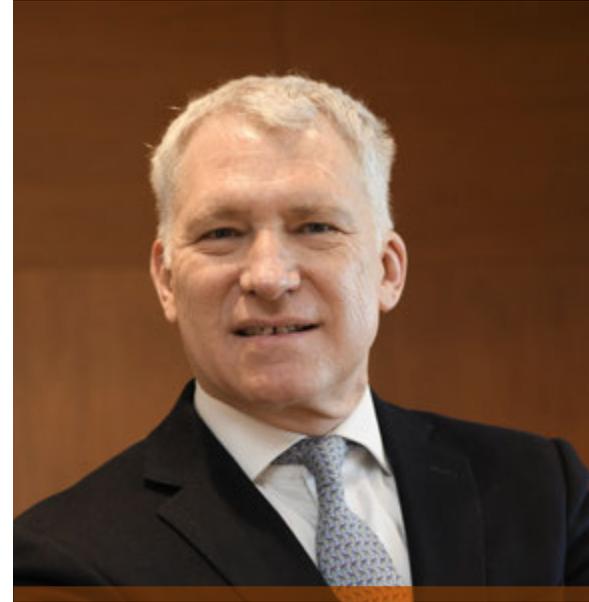
THIERRY DE SAINT PIERRE

Representative of the entrepreneurial ecosystem Chairman, Chilean Association of IT Companies. Co-founder of various entrepreneurships (North Supply Business, Multinet, Cybernet, Navigo Mining, Calcom). Part of the digital transformation program in various Chilean industries.

National Advisory Council

JULIO MORALES

Innovation and Technology
Manager MEIT Group

PABLO BENARIO

General Manager de ICV

ROBERTO MUSSO

CEO Digevo Group

Mª JOSÉ ESCOBAR

Executive Director for Outreach
and Engagement, UTFSM"

CRISTIAN ESTAY

Senior Engineering, Construc-
tion and PEM Manager, Codelco

ANDRÉS ALONSO

Energy & Water Senior Mana-
ger of AMSA

EDMUNDO CASAS

Director of Kahuel

International Scientific Commitee

ABEER ALWAN

Highly distinguished researcher in the field of speech processing. Professor in the Department of Electrical and Computer Engineering at the UCLA Henry Samueli School of Engineering and Applied Science. Additionally, she serves as Vice Chair for Undergraduate Affairs in the same department. Fellow of the International SpeechCommunication Association (ISCA)

### SETH HUTCHINSON

Professor and KUKA Chair for Robotics at the School of Interactive Computing.

Executive Director, Institute for Robotics and Intelligent Machines, Georgia Institute of Technology.

ALBERTO LEÓN-GARCÍA

Distinguished Professor of Electrical and Computer Engineering, University of Toronto, Canada.

Research Chair in Autonomic Service Architecture.
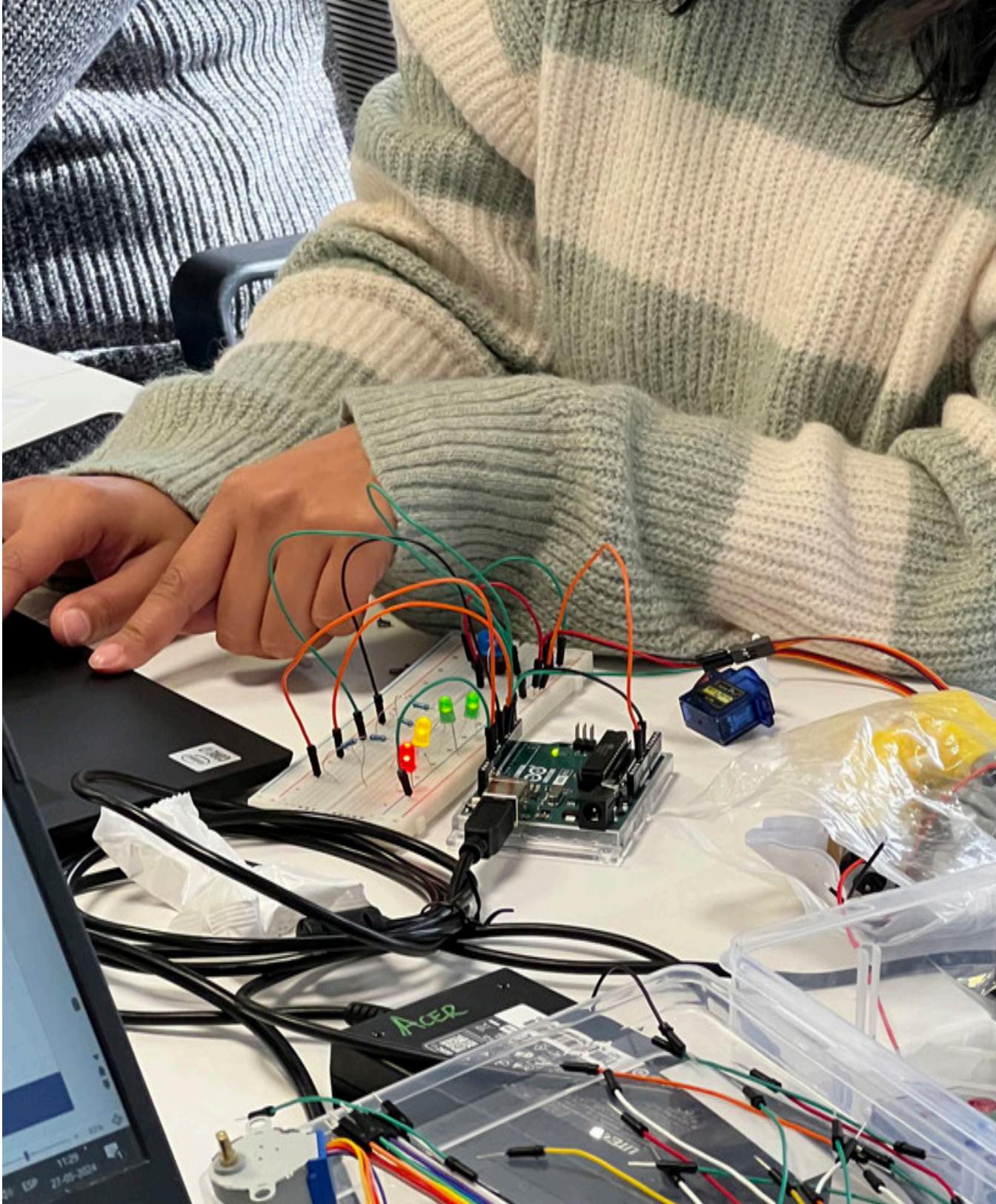
Principal Researchers

Dr. Matías Zañartu

The Director of AC3E and in charge of the Biomedical Systems line, Dr. Zañartu holds a degree as Civil Engineer in Sound and Acoustics from Universidad Vicente Pérez Rosales, Chile, and received his PhD and MSc. in Electrical and Computer Engineering from Purdue University in West Lafayette, USA.

Dr. Zañartu is the first Chilean to obtain a major fund for medical research from the US National Institute of Health (NIH).

Co-founder of Lanek SpA, a technology company dedicated to the development of biomedical devices that has received several awards, among others from CORFO, AIE, and Avonni, he also acquired public and private funding.

In 2023, he won the Outstanding Engineer award by the Chilean Electrical-Electronics Industry Association (AIE) and the Institute of Electrical and Electronics Engineers (IEEE) for his contributions to link engineering and medicine.

Dr. Héctor Ramírez

Deputy director, leading the Control and Automation line, Dr. Ramírez is an Electronic Engineer with an MA in Electrical Engineering from Universidad de Concepción. He received his PhD in Automatic Control from Université Claude Bernard, Lyon, France, was a postdoctoral researcher at Université Bourgogne Franche-Comté, and Assistant Professor at the Department of Automatic Control and Micromechatronic Systems (AS2M) at the FEMTO-ST research institute.

He is a member of the IFAC Technical Committees on Nonlinear Control Systems and Distributed Parameter Systems, and the IEEE CSS Technical Committee on Distributed Parameter Systems (DSPs).

Dra. Pamela Guevara

Dr. Guevara oversees the Biomedical Systems line. An Electronic Civil Engineer, she holds an MA in Information, Systems and Technology, and a PhD in Physics from Université Paris-Sud, France. She was the best Electronic Engineering student and the first woman in the area to win the Universidad de Concepción Award.

Director of Research, Development, Innovation and Entrepreneurship at Universidad de Concepción's Faculty of Engineering, she is a specialist in medical image analysis and has developed methods for the study of brain connectivity.

Her work as an engineer and researcher was recognized by the Biobío Zonal Council of the College of Engineers of Chile and labeled an outstanding contribution to the country and the world.

Dr. Samir Kouro

Founder of and researcher at AC3E, Dr. Kouro is in charge of the Renewable Energies and Power Conversion line. He is an Electronic Civil Engineer, with an MA in Electronic Engineering Sciences and a PhD in Electronic Engineering from Universidad Técnica Federico Santa María.

An academic at the Department of Electronic Engineering, he received the IEEE-AIE 2018 Outstanding Engineer award from the Electrical-Electronics Industry Association (AIE) and IEEE Region 9.

Dr. Kouro is the recipient of the 2016 IEEE Bimal K. Bose Industrial Electronics Award for Industrial Electronics Applications in Energy Systems and the 2015 IEEE Industrial Electronics Society J. David Irwin Early Lifetime Achievement Award.

In 2021, he was ranked by Stanford University, USA, as among the top 2% of academics with the highest number of scientific contributions.

Dr. Marcelo Pérez

Leading the Renewable Energies and Power Conversion line, Dr. Pérez is an Electronic Civil Engineer, holds an MSc in Electrical Engineering, and is a Doctor of Science in Electrical Engineering, Universidad de Concepción.

He was part of a team of researchers at Technische Universität Dresden, Germany.

Since 2015, he has been a professor at the Department of Electronic Engineering.

Dr. Pérez is a co-founder of SunAndPlay SpA, a company that develops energy harvesting solutions, and Electroveja, which develops technological solutions for art and education.

In 2021, he was ranked by Stanford University, USA, as among the top 2% of academics with the highest number of scientific contributions.
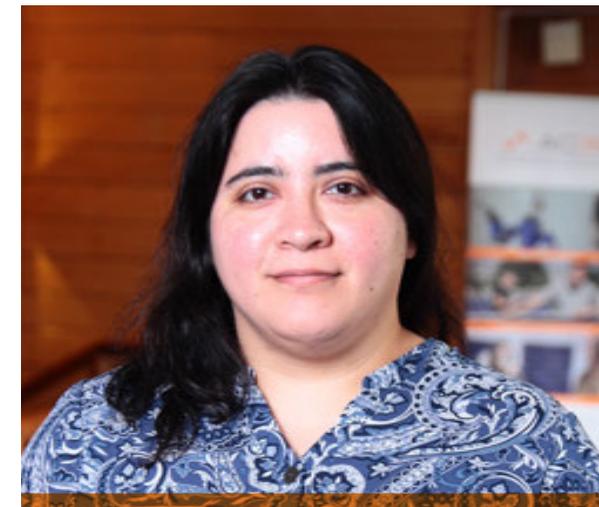
Dra. Margarita Norambuena

In charge of the Electrical Systems line, Dr. Norambuena is an Electrical Engineer, holds an MA in Electrical Engineering, a PhD in Electronic Engineering and a PhD in Engineering from Technische Universität Berlin, Germany.

In 2020, she received a distinction for Best IEEE Student Paper-IES, awarded by the IEEE Industrial Electronics Society, for her contribution in the field of industrial electronics.

That same year, she was appointed mentor at the second Mentoring Program led by Women in Power, an initiative of the IEEE Power and Energy PES Society.

Dr. Jorge Silva

Dr. Silva oversees the Artificial Intelligence and Data Analysis line. An Electrical Engineer trained at Universidad de Chile, he also holds an MSc and a PhD in Electrical Engineering from University of Southern California, USA.

He is Associate Professor of Electrical Engineering at Universidad de Chile.

Dr. Silva is a member of the IEEE Societies for Information Theory and Signal Processing and a reviewer for IEEE journals and conferences.

Previously, he worked as researcher at Microsoft's Speech Research Group.

Dr. Marcos Orchard

Dr. Orchard is in charge of the Robotics line. An Industrial Civil Engineer with a major in Electricity (2001) from Universidad Católica de Chile, he also holds a PhD and an MA from Georgia Institute of Technology, Atlanta.

He is professor at the Department of Electrical Engineering at Universidad de Chile, member of the Prognostics and Health Management Society, and project manager at the Lithium Innovation Center.

His work is internationally recognized in the field of fault diagnosis and prognosis, Bayesian filtering in nonlinear dynamical systems, stochastic processes, and sequential Monte Carlo methods.

Dr. Marcelo Soto

A principal investigator at AC3E, Dr. Soto holds a degree in Electronic Civil Engineering and a Master's in Electronic Engineering Sciences from Universidad Técnica Federico Santa María, as well as a Ph.D. in Innovative ICT Engineering Technologies from Scuola Superiore Sant'Anna, Italy.

He has an outstanding track record in areas related to fiber optics sensors, optical signal processing, and fiber optics communications.

Most notably, he developed technology to detect natural phenomena like earthquakes or tsunamis tens of kilometers out in the ocean. This technology works with distributed fiber optics sensors that use submarine telecommunications cables combined with artificial intelligence tools.

Organizational Chart
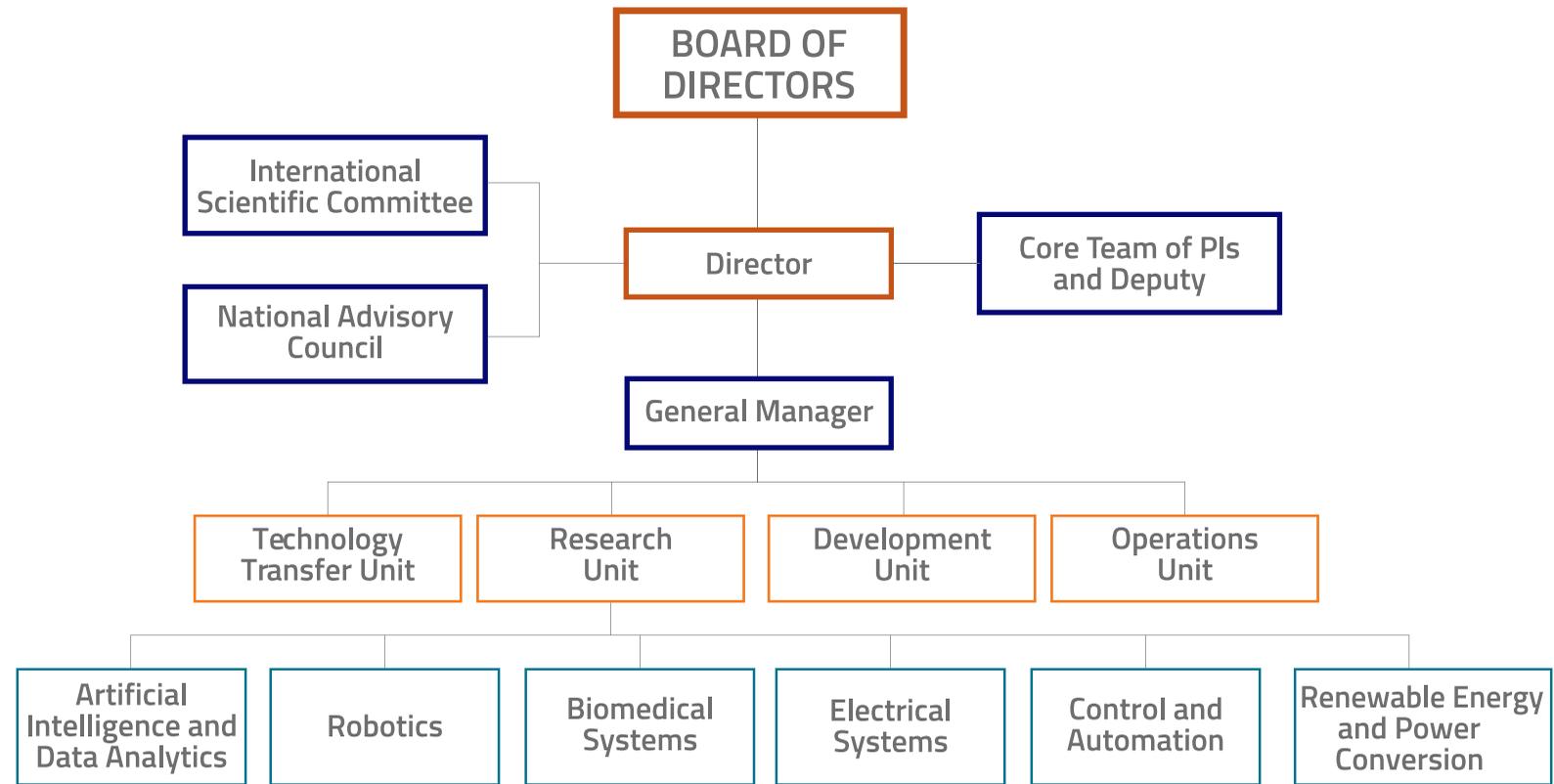
AC3E Units
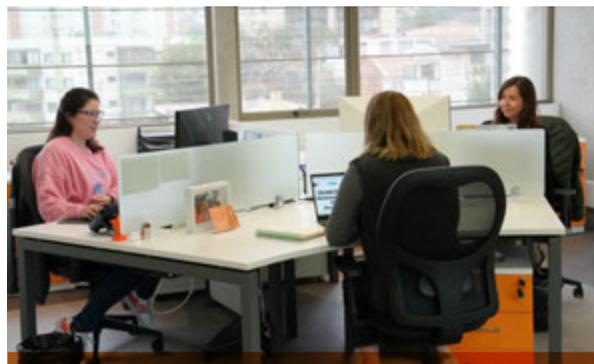
OPERATIONS AND COMMUNICATIONS UNIT

One of the main functions of the unit is related to the operations of the Center, meaning it is responsible for carrying out all operational and financial procedures between the Center and ANID, as well as between the Center and Universidad Técnica Federico Santa María.

In addition, the unit ensures the overall functioning of the Center by managing tasks such as internal and external communications, organizing events (seminars, internal activities, workshops, training sessions), procurement, HR management, inventory management, and accounting for industrial projects.

In terms of communications, the unit links AC3E's work to its key audiences: public institutions, companies, academia, students, and society at large. This is done through various outreach strategies aimed at positioning the Center's work in the media, as well as scientific outreach activities that help bring science closer to the public.
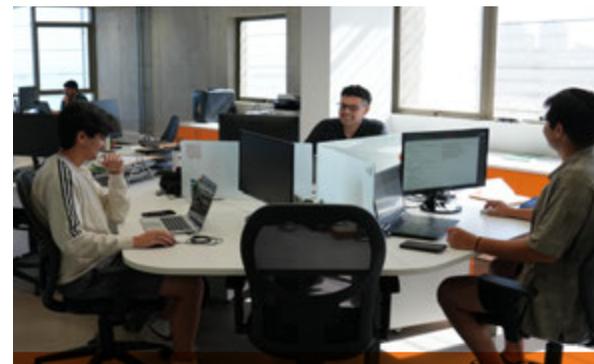
TECHNOLOGY TRANSFER UNIT

This unit is responsible for transferring scientific knowledge and research results from AC3E to industry and society. Key functions include managing the Center's R&D assets, handling intellectual property processes in coordination with the university's Technology Transfer Office, and handling relationships with AC3E spin-off companies

A key focus is the search for industrial R&D projects, identifying needs in the productive sector that can be addressed through the Center's scientific and technological capabilities.

To achieve this, the unit directly employs one project engineer and three key area managers, who constantly engage with industry stakeholders.

Once a project is identified and accepted by a client, it is forwarded to the Development Unit.
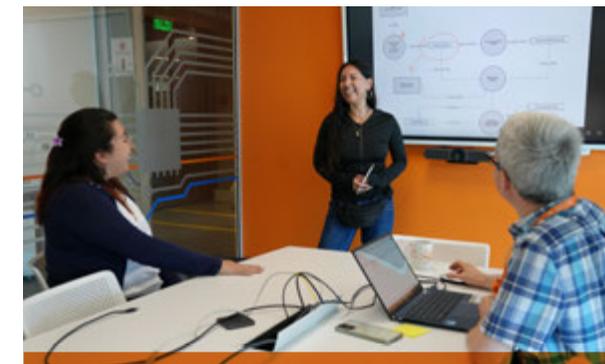
DEVELOPMENT UNIT

The Development Unit supervises and implements industrial projects and developing prototypes and products.

It also manages the electrical and electronic workshops at the Center to enhance the technical skills and capabilities of its members.

During the past year, the unit consisted of 12 R&D engineers, who supported 17 ongoing industrial projects, each of which was 100% privately funded.
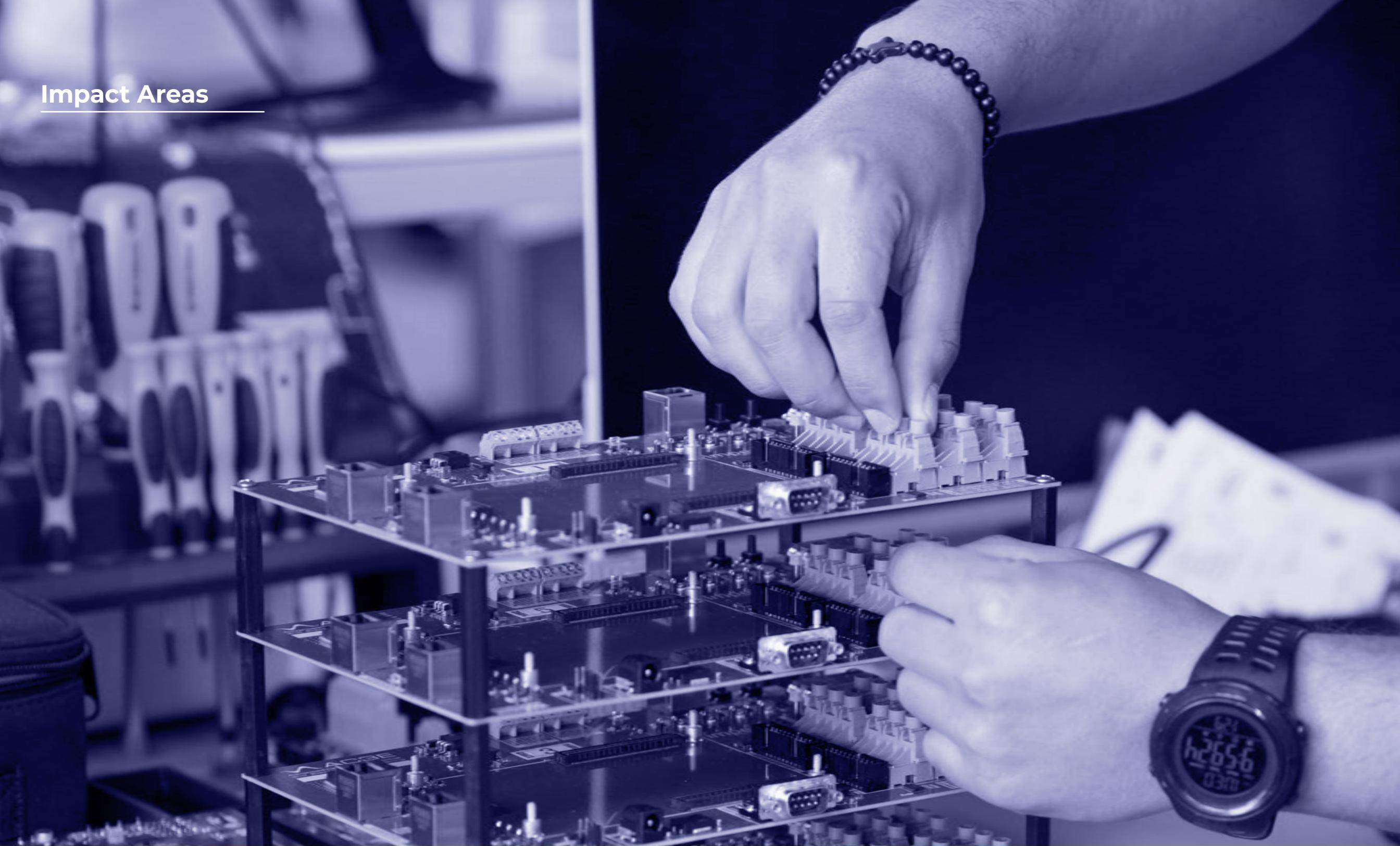
SMART INDUSTRY

This impact area focuses on integrating advanced technologies such as robotics, sensors, control systems, automation, and artificial intelligence (AI) into various industrial processes to enhance productivity, sustainability, and resilience across sectors like agriculture, transportation, and manufacturing.

Since its inception, AC3E's research has led to the development and implementation of innovative solutions including sensors and automation, big data and decision-making, advanced control systems, and intelligent transportation systems.

During this period, notable examples include research activities led by Dr. Marcos Orchard in sensors and automation, focusing on Prognostics and Health Management (PHM), particularly predictive maintenance for wind turbines and bearings through fatigue damage monitoring. This enables effective prediction of structural failure probabilities, representing a significant advancement in real-time monitoring of industrial components. This year, collaboration with CMPC, a Chilean forestry company, has yielded promising results from this work.

Concurrently, research led by Dr. Ioannis Vourkas on resistive switching devices (memristors) for edge computing has successfully paved the way for more efficient computing systems with applications across various fields. This work is expected to bring optimized hardware solutions for industrial applications.

In the agricultural domain, year 10 saw advancements in robotics research led by Dr. Fernando Auat Cheein, specifically in dual-arm mobile manipulators and energy-efficient motion controllers for agricultural tasks, contributing to increased productivity in the sector.

Another significant initiative in this impact area is led by Dr. Marcelo Soto, focusing on fiber optic technologies in distributed systems. This research inclu-

des advancements enabling long-range monitoring with high spatial resolution, offering unique capabilities for applications like earthquake detection and structural health monitoring.

The application of AI and data analysis in decision-making has allowed researchers at the Center to develop probabilistic models such as Gaussian Processes, facilitating the creation of tools currently applied in various real-world scenarios, including cutting-edge audio and image processing. This year, novel methodologies have been developed for accelerated model training and Bayesian change point detection, pushing the boundaries of predictive maintenance and industrial monitoring.

Additionally, research on deep learning applications has made significant progress, with key initiatives including image restoration techniques for telescopes, radiology exam segmentation, and astroparticle discrimination. These technologies have the potential to revolutionize sectors like healthcare and astrophysics by providing faster and more accurate analysis and decision-making capabilities.

In the field of astrostatistics, Bayesian frameworks have been applied to improve the estimation of stellar parameters, which is crucial for enhancing our understanding of the universe.

Also noteworthy in this impact area is recent work by Dr. Marcos Orchard and Dr. Jorge Silva on AI-based battery health-aware management systems for electric micromobility, fleet mission planning, and energy backup.

Furthermore, research in control systems led by Dr. Héctor Ramírez has focused on control and observation of infinite-dimensional systems, achieving significant milestones in exponential stabilization methods.

Efforts led by researchers Dr. Alejandro Rojas and Dr. Juan Aguero to combine machine learning and

data analysis for process control have shown promising results, particularly in the context of networked systems and energy management in photovoltaic plants.

Finally, in intelligent transportation, researcher Dr. Sandra Céspedes has worked on congestion control algorithms and safety applications for automated driving scenarios. These efforts are essential for the future of intelligent transportation systems and connected vehicles.

The Smart Industry impact area has also achieved considerable advancements in developing industrial technologies, particularly in sensors, automation, data-driven decision-making, and intelligent transportation.

RENEWABLE ENERGY AND POWER SYSTEMS

The primary goal of this impact area is to drive research and development of energy transition technologies, contributing to a sustainable future. It encompasses four key topics: Power Converter Topologies, Control and Applications; Electric Power Systems and Markets; Electromobility and Energy Storage; and Renewable Energy Conversion Systems. Research in these fields aims to address challenges related to large-scale renewable energy integration, grid infrastructure for electromobility, and sustainable energy storage solutions.

The AC3E research team's work has been fundamental in tackling challenges such as stability and real-time implementation of Model Predictive Control (MPC), utilizing advanced optimization techniques for both continuous and discrete converter models. A significant achievement was the development of model-free MPC strategies using observers instead of precise models to predict system behavior. Additionally, research to enhance MPC with artificial intelligence, particularly neural networks, shows promise in improving robustness and adaptability across various applications.

Moreover, significant research was conducted on power converter topologies during this period. Modular Multilevel Converters (MMC) remain a fundamental research area, leading to innovations in converter structures and control strategies. Several efforts over the past year explored applications ranging from wave energy system interfaces to voltage boosting functions. New developments also include research in microelectronics for aerospace applications, particularly the design of micropower converters for CubeSats.

A team led by Dr. Jorge Marín and Dr. Christian Rojas achieved a breakthrough with a micrometer-level DC-DC converter design, culminating in an international award at the VLSI Symposium 2023.

In Electric Power Systems, research focused on integrating renewable energy into smart grids. MPC was applied to various grid applications, including AC/DC microgrid converters and solid-state transformers. Advances in microgrid control systems, particularly for bipolar DC microgrids, aim to improve voltage balancing for distributed energy resources, electric vehicle charging, and energy storage systems. These developments highlight the growing importance of resilient and flexible grid solutions as renewable energy penetration increases.

In the energy markets domain, a notable contribution was the application of Artificial Neural Networks (ANN) for efficient energy bidding in day-ahead and real-time markets. This approach demonstrated a significant reduction in market revenue variance and improved benchmark tracking performance compared to traditional optimization techniques.

As in previous years, transportation electrification remained a key research focus at AC3E. One of this year's major achievements, led by researchers Dr. Samir Kouro and Dr. Hugues Renaudineau, was the development of partial power converters for fast-charging stations for electric vehicles (EVs). This technology was successfully transferred to the industry, specifically to Dhemax Spa, which is now utilizing these converters for 400 kW fleet chargers in Santiago's electric bus system.

The Center initiated a new project led by Dr. Margarita Norambuena on converter topologies and control strategies aimed at enhancing electromobility performance. Wireless energy transfer for EV charging also made significant strides this year.

Research on multilevel converters for wireless energy transmission continued, with the design of a safe and efficient charging station underway. These innovations are crucial for overcoming challenges posed by the high-power demands of electric vehicles and their associated charging infrastructure.

AC3E's research in renewable energy systems has been particularly impactful in recent years, highlighted by the publication of a special issue led by Dr. José Rodríguez in Proceedings of the IEEE on energy transition technologies. This work garnered international attention and led to a series of online seminars with Center researchers.

Photovoltaic energy remains a strategic focus for Chile, given the country's potential for solar power generation. Significant contributions were made in control strategies for photovoltaic inverters, optimizing their performance in real-world applications. A project in collaboration with TMEIC Japan led to the development of an impedance model for photovoltaic inverters, providing valuable insights for grid integration.

Undoubtedly, advancements in power converter technology, smart grid integration, electromobility, and renewable energy systems are not only contributing to academic knowledge but also driving real-world applications, particularly in industrial partnerships and sustainable infrastructure development..

HEALTH TECHNOLOGIES

This impact area of AC3E has continued to make significant strides in recent years. The focus is on Biomedical Signals, Sensors, and Devices; Neural and Rehabilitation Engineering; Physiological Modeling; and Biomedical Data Analysis. These areas aim to develop medical devices, treatment protocols, and data-driven tools to assist in disease diagnosis and treatment.

During this period, efforts in biomedical signals and devices experienced significant developments. A key milestone was the 5-year renewal of the NIH P50 grant led by researcher Dr. Matías Zañartu, focusing on vocal hyperfunction. This grant involves key institutions such as Massachusetts General Hospital (MGH), Harvard Medical School, and MIT, further establishing AC3E's prominence in biomechanical and aeroacoustic research.

An important milestone was Dr. Paul Delano's research on cochlear dysfunction, revealing an association with structural changes in the hippocampus, supported by the development of algorithms to predict cognitive decline in elderly patients. Also noteworthy is the interdisciplinary work with researcher Dr. Jorge Silva on predictive models for cochlear implant users using AI to enhance patient outcomes.

Additionally, Dr. Alejandro Weinstein's research in electromyography (EMG) and EEG signal processing has resulted in significant findings related to muscle activation during running and fatigue estimation. This contributed to the development of several medical devices and patent applications.

Research in neural and rehabilitation engineering delves into brain oscillations and synchronization, vital for understanding sensory and cognitive processing. Center researchers continued developing innovative models of brain activity and connectivity, leveraging machine learning techniques. Dr. Pamela Guevara's work in diffusion MRI has fur-

ther advanced cortical parcellation techniques, revealing critical insights into brain connectivity and contributing to the detection of rare cancer boundaries through federated learning.

Furthermore, physiological modeling has produced key advances in understanding neuronal dynamics, with Dr. Patricio Orio's whole-brain models providing new insights into neuromodulator systems and their effects on brain connectivity. This year, our work focused on context-dependent effects of nicotine on brain function, with implications for understanding cognitive decline and functional connectivity in elderly populations.

In the realm of voice production, Dr. Matías Zañartu's modeling efforts explored the impact of extrinsic musculature on vocal fold dynamics and the role of swelling size and nodules on vocal fold behavior. These studies provide a deeper understanding of the biomechanics of voice disorders, with potential applications in clinical treatment.

Biomedical data analysis continued to grow with notable developments in AI applications for medical diagnosis. Research on the humanoid robot iCub, led by Dr. Mauricio Araya, focuses on tactile exploration tasks using reinforcement learning algorithms, simulating cognitive development on a robotic platform. This work lays the groundwork for future developments in human-robot interaction and rehabilitation technologies. Dr. Mauricio Araya's efforts also include developing an interoperable medical image repository, advancing AI integration into clinical workflows. This project exemplifies the impactful intersection of AI and healthcare, driving improvements in medical data management and analysis.

Over the past year, the Health Technology impact area has achieved significant advancements in its mission to integrate engineering principles with medical applications. All of this not only contributes to the scientific community but also to the incorporation of practical medical applications, enhancing

diagnostic and treatment options for a variety of pathologies.

The AC3E Research Unit comprises 40 principal and associate researchers from different universities across the country. These researchers are organized into six Research Groups: Control and Automation, Renewable Energies and Power Conversion, Artificial Intelligence and Data Analysis, Robotics, Biomedical Systems, and Electrical Systems.

The goal of the Center's research team is to improve scientific productivity, train undergraduate, Master's, and doctoral students, supervise postdoctoral researchers, and meet intellectual property and industrial collaboration indicators at national and international levels

CONTROL AND AUTOMATION

This research area is constantly evolving, seeking new technologies and innovative solutions for the control and automation of industrial processes. The goal is to contribute to the development of a more efficient, sustainable, and safe industry that positively impacts society. It addresses issues related to the operation and communication of industrial systems and identifies technologies and instruments oriented toward control.

Principal Investigator

Héctor Ramírez,
UTFSM

Researchers

Alejandro Rojas
UdeC

Ronny Vallejos
UTFSM

Juan Carlos Aguero
UTFSM

Constanza Ahumada
UCh

Miguel Figueroa
UDEC

Melisa Diago
UTFSM

Jorge Marín
UTFSM

Postdoctoral Researcher

Ángel Cedeño, UTFSM

PhD Students

Cristobal Ponce, UTFSM / UBFC
Javier Caballería, UTFSM / UBFC
Yaime Fernández, U. de Concepción
Juna Felipe González, U. de Concepción
Bárbaro López – Portilla, U. de Concepción

Master's Students

Javier Cepeda, UTFSM
Ignacio Díaz, UTFSM
Rodrigo Graves, UTFSM
Michel Azua, UTFSM
Carolina Gallardo-Pavesi, U. de Concepción
Nelson Cáceres, U. de Chile
José Cifuentes, U. de Concepción

Undergraduate Students

Sebastián Vial, UTFSM
Bastián Sepúlveda, UTFSM
Rodrigo Graves, UTFSM
Sebastián Vidal, UTFSM
Javier Pizarro, UTFSM
Daniel Gajardo, UTFSM
Clemente Ferrer, UTFSM
Hernán Urzúa, UTFSM
Oscar Villarroel, UTFSM
Diego Cruz Carreño, UTFSM
Cristóbal Caqueo, UTFSM
Joel Rivera, UTFSM
Gustavo Fernández, UTFSM
Michel Azúa, UTFSM
Sebastian Céspedes, PUC
Polet Castillo, UTFSM
Álvaro Villagra, U. de Concepción
Ralitza Mancilla, USACH

RENEWABLE ENERGIES AND POWER CONVERSION

This group focuses on power converters, renewable energy systems, HVDC transmission, electromobility, and energy storage, aligned with Chile's needs and environmental challenges.

Principal Investigators

Samir Kouro,
UTFSM

Marcelo Pérez,
UTFSM

Researchers
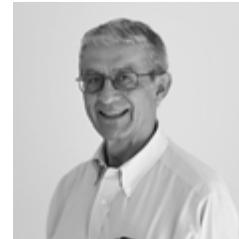
José Rodríguez,
U. San Sebastián

Roberto Cardenas,
U. de Chile

Sebastián Rivera,
TUDelft

Christian Rojas,
UTFSM

Hugues
Renaudineau,
UTFSM

Postdoctoral Researcher

Alan Wilson, UTFSM

Engineers:

Alejandro Peralta
Polidoro Canales

PhD Students

Diego Concha, UTFSM
Daniel Pesántez, UTFSM
Matías Veillón, UTFSM
Patricio Pizarro, U. de Chile
Matías Uriarte, U. de Chile
Felipe Herrera, U. de Chile
Diego Ñauñay, U. de Chile

Master's Students

Felipe Fierro, U. Católica de la Santísima Concepción
Alexander Palacios, UTFSM
Sebastian Jimenez, UTFSM
Ignacio Ortiz, Uch
Benjamín Moreno, UCh
Sofía Franco, UTFSM
Iván Choque, UTFSM
Jhonattan Berger, UTFSM
Alejandro Stowhas, UTFSM
Ronald Carmona, UTFSM

Nelson Vergara, UTFSM
Juan José Porras, UTFSM
Francisco González, UTFSM
Aldo Rizo, U. Industrial de Santander (Colombia)
Nicolás Rivera, UTFSM
Eduardo Escobar, UTFSM
Andrés Martínez, UTFSM
Felipe Torres, UTFSM
Nelson Salvador, UTFSM
Daniel Arévalos, UTFSM

Undergraduate Students

Diego Alfaro, UTFSM
Iván Choque, UTFSM
Sebastián Arenas, UTFSM
Benjamín Ortega, UTFSM
Matías Fuentes
Felipe Salgado, UTFSM
Claudio Zúñiga, UTFSM
Pablo Cid, UTFSM
Julio Montecino, UTFSM
Pablo Cid, UTFSM

Ítalo Muñoz, UTFSM
Matías Fuentes, UTFSM
Simón Garrido, UTFSM
Mauricio Olivares, ULA
Eduardo Richard, UTFSM
Alexander Palacios, UTFSM
Juan Jose Porras, UTFSM
Agustin Montoya, UTFSM
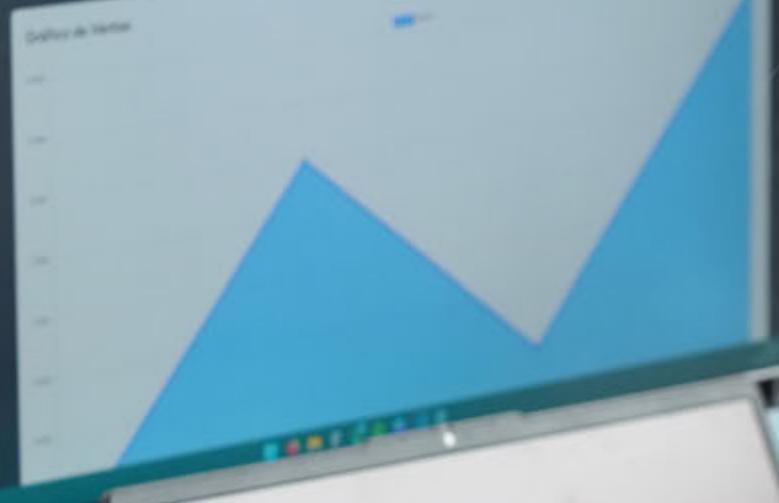
ROBOTICS

The robotics team conducts both scientific and applied research, addressing all key aspects of robotics: hardware development, integration, programming, statistics, experimental validation, and final product/prototype design. Main focus areas include:

autonomous machinery, sensor data processing, mechatronic design, navigation strategies, human-robot interaction, GPS-free localization, advanced mapping, and 3D modeling/visualization.

Principal Investigator

Marcos Orchard,
U. de Chile

Researchers

Fernando Auat
Cheein, HAU

Miguel Torres,
PUC

José Delpiano, U.
de Los Andes

Marcelo Soto,
UTFSM

Postdoctoral Researcher

Nahuel Deniz, UTFSM
Xiaopeng Xi, UTFSM

Master's Students

Octavio Águila, Pontifica Universidad Católica
Diego Muñoz, Pontificia Universidad Católica
José Moreno, Pontificia Universidad Católica
Jorge Cantillana, U. de Chile
Sebastián San Martín, UTFSM

Undergraduate Students

Alberto Castro, Pontificia Universidad Católica
Felipe Mejías, UTFSM
Felipe Díaz, UTFSM
Pablo Arce, UTFSM
Boris Villavlobos, UTFSM
Mauricio Cáceres, UTFSM
Javier Chacón, UTFSM

BIOMEDICAL SYSTEMS

This interdisciplinary group engages in a wide range of biomedical research: wearable monitoring systems, biomedical signal processing, physiological modeling, computational neuroscience, neuropsychology, and biorobotics—mainly applied to vision, voice, and hearing. These efforts aim to detect and treat diseases more precisely, improving quality of life for affected individuals.

Principal Investigators

Pamela Guevara,
U. de Concepción

Matías Zañartu,
UTFSM

Researchers

Alejandro Weinstein,
UTFSM

Paul Delano,
U. de Chile

Wael El-Deredy,
U. de Valparaíso

Patricio Orio,
U. de Valparaíso

Jocelyn Dunstan
PUC

Postdoctoral Researcher

Grace Whitaker, U. de Valparaíso

PhD Students

David Araya, U. de Valparaíso
Sebastián Orellana, U. de Valparaíso
Fernando Lehue, U. de Valparaíso
Alejandro Ibacache, U. de Valparaíso
Pamela Illescas, U. de Valparaíso
Diego Becerra, U. de Valparaíso
Rodrigo Donoso, Pontificia Universidad Católica
Matías Uriarte, U. de Chile
Simón San Martín, U. de Chile

Master's Students

Cristina de Gatica, U. de Chile
Gabriela Mora, U. de Chile
Carlos Saldivia, UTFSM
Sebastián Espinoza, UTFSM
Johanna Dahm, UTFSM
Pablo Vega, U. de Concepción

Undergraduate Students

Javier Díaz, UTFSM
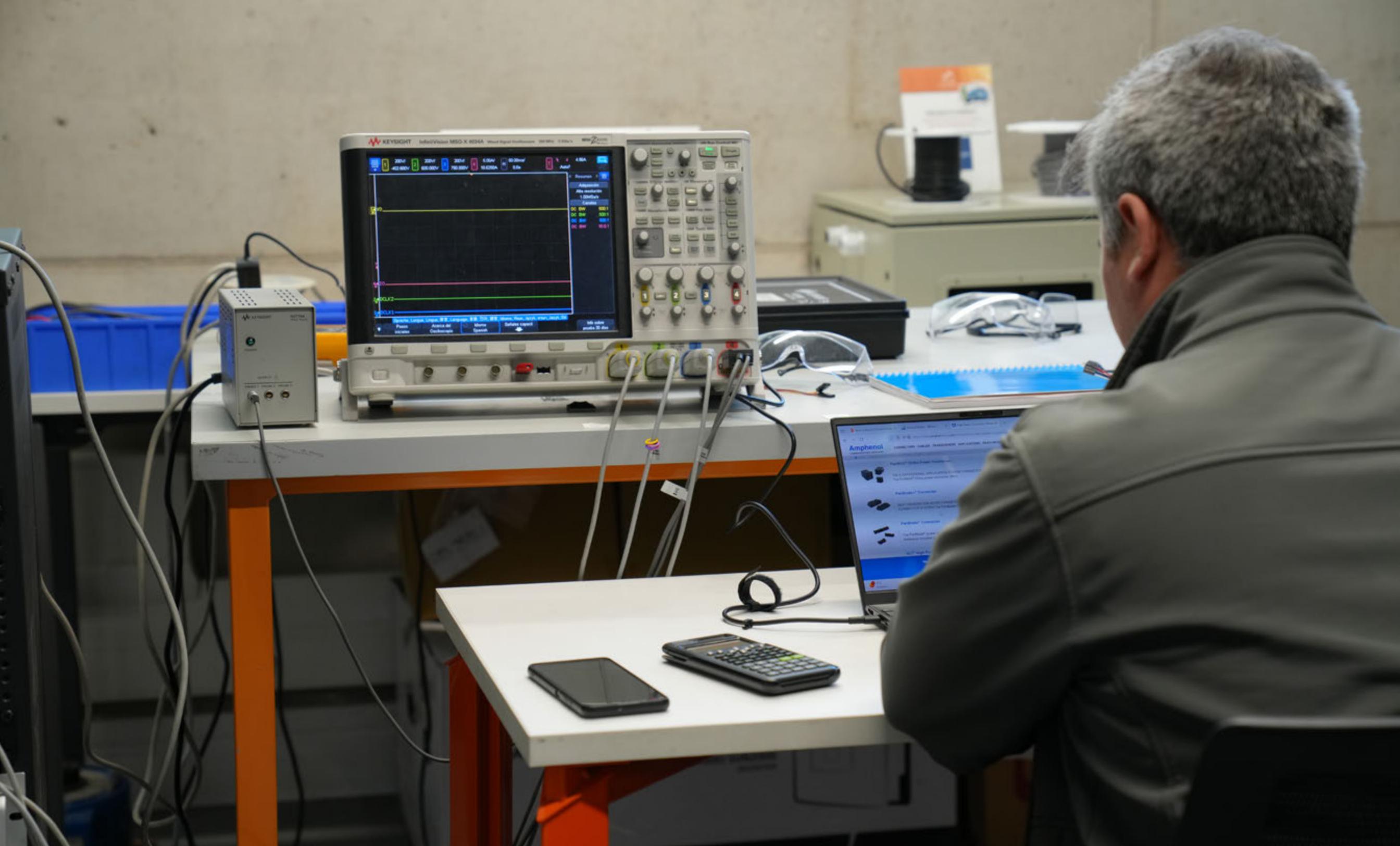
ELECTRICAL SYSTEMS

This group works on new operational models to optimize distribution systems with high penetration of photovoltaic generation, improving power supply reliability. Technologies developed at AC3E play a key role in repurposing infrastructure, including hardware, firmware, software for converter control, and tools for system planning, market design, and regulatory analysis.

Principal Investigator

Margarita Norambuena, UTFSM

Researchers

Pablo Lezana, UTFSM

Esteban Gil UTFSM

Andrés Mora, UTFSM

Alejandro Angulo, UTFSM

Cristián García, U. de Talca

Claudia Rahmann, U. de Chile

PhD Students

Cristian Castillo, U. de Talca
Daniel Sánchez, U. de Talca
Julio Pacher, UTFSM

Master's Students

Víctor Cabezas, U. de Talca
Cristóbal Palma, UTFSM
Baldomero Araya, UTFSM
Adolfo Veliz, UTFSM
Matías Correa, UTFSM
Sebastián Rivero, UTFSM
Cristóbal Castillo, UTFSM

Undergraduate Students

Anais Vattier, UTFSM
Matías Mediano, UTFSM
Pablo Vera, UTFSM
Patricio Huaiquin, UTFSM
Braulio Vera, UTFSM
Miguel Salinas, UTFSM
Fernando Ruiz, UTFSM
Benjamín Troncoso, UTFSM

ARTIFICIAL INTELLIGENCE AND DATA ANALYSIS

El Centro trabaja en el desarrollo de proyectos y productos de la mano de la IA para brindar a la industria y sociedad soluciones para sus distintas necesidades.

La labor de esta línea abarca la extracción y procesamiento de señales de sensores, el diseño de dispositivos y procesadores de datos no convencionales; la digitalización (codificación) y representación (compresión) de la información; las comunicaciones entre dispositivos y agentes de datos; las interpretaciones y extracción de significado de los datos (minería de datos), el uso de métodos de aprendizaje automático, aprendizaje estadístico, inferencia y decisión.

Principal Investigator

Jorge Silva
U. de Chile

Researchers

Mauricio Araya,
UTFSM

Ioannis Vourkas,
UTFSM

Sandra Céspedes,
UW

Felipe Tobar, U. de
Chile

PhD Students

Alexis Yáñez, U. de Chile
Jorge Sandoval, U. de Chile
Rodrigo Muñoz, U. de Chile
Benjamín Pizarro, U. de Chile
David Bonilla, Concordia University
Jason Gerard, Concordia University
Maryam Hatami, Concordia University
Andre Ibrahim, Concordia University

Master's Students

Gabriel Flores, U. de Chile
Gabriela Mora, U. de Chile
Augusto Tagle, U. de Chile
Fernando Fetis, U. de Chile
Gonzalo Aichele, UTFSM
Sebastián Bórquez, UTFSM
Daniel Muñoz, UTFSM
Miguel Andrade, UTFSM
Kevin Pizarro, UTFSM
Patricio Carrasco, UTFSM
Benjamín Villegas, UTFSM
Mauricio Aravena, UTFSM
Camilo Carvajal, U. de Chile
Gianina Salomo, U. de Chile
Diego Cortés, U. de Chile
Stefano Schiappacasse, U. de Chile
Tomás Valencia, U. de Chile
Cristóbal Alcázar, U. de Chile
Joaquín Barceló, U. de Chile

Undergraduate Students

Camilo Carvajal, U. de Chile
Tomás Valencia, U. de Chile
Joaquín Barceló, U. de Chile

Empirical modeling of wireless channels for smart agriculture scenarios using frequencies up to millimeter waves

Research Line: Control and Automation
Researcher: Dr. Melissa Diago

This project focuses on the characterization of mmWave frequencies, i.e., 5G wireless communication technology that uses high-frequency electromagnetic waves from 28GHz to 170GHz. These frequencies are transmitting data on variables such as temperature, solar radiation, wind speed, soil moisture, and water quality to aid decision-making in agricultural production.

The goal is to provide a comprehensive characterization of wireless channels essential for the connectivity of smart agriculture systems in olive groves, vineyards, and citrus farms. This enables accurate remote crop monitoring while reducing retransmissions, energy consumption, and costs, ultimately creating an optimal environment for precision agriculture.

Often, the installation of these wireless transmission components results in signal obstructions or weakening due to crop growth, blocking the frequencies. Hence, it becomes necessary to accurately model the communication channel propagation, establishing a strong and efficient wireless infrastructure. These frequencies are very similar to those used by technologies like 5G and 6G, so understanding what elements can attenuate these signals is key for the future of telecommunications.

AC-link partial power DC-DC converters without transformers for photovoltaic green hydrogen production

Research Line: Renewable Energy and Power Conversion
Researcher: Dr. Hugues Renaudineau

Green hydrogen is expected to play a major role in the future global energy mix. Water electrolysis systems powered by photovoltaic (PV) energy are among the leading solutions for its production. In these systems, advancements in power electronics are crucial for large-scale implementation.

To date, commercial systems connect PV sources and water electrolyzers via the alternate current (AC) power grid. However, due to their direct current (DC) nature, direct interconnection through DC-DC converters is seen as an optimal option, with expected improvements in cost and efficiency.

In this context, Partial Power Converters (PPCs) emerge as a highly attractive alternative for PV-H_2 applications, achieving high efficiency, high power density, and cost reduction by processing only a fraction of the total power delivered to the load. However, traditional PPCs require a transformer, even in solutions that do not require galvanic isolation.

This project aims to contribute to the research and development of transformerless partial power converters based on AC links, for interconnecting photovoltaic sources with water electrolyzers in the production of green hydrogen.

This image illustrate the project: Empirical modeling of wireless channels for smart agriculture scenarios using frequencies up to millimeter waves
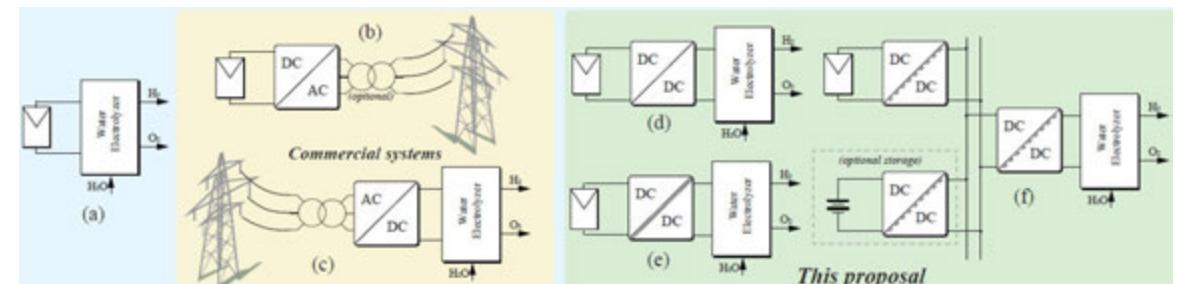
This image corresponds to the project: AC-link partial power DC-DC converters without transformers for photovoltaic green hydrogen production

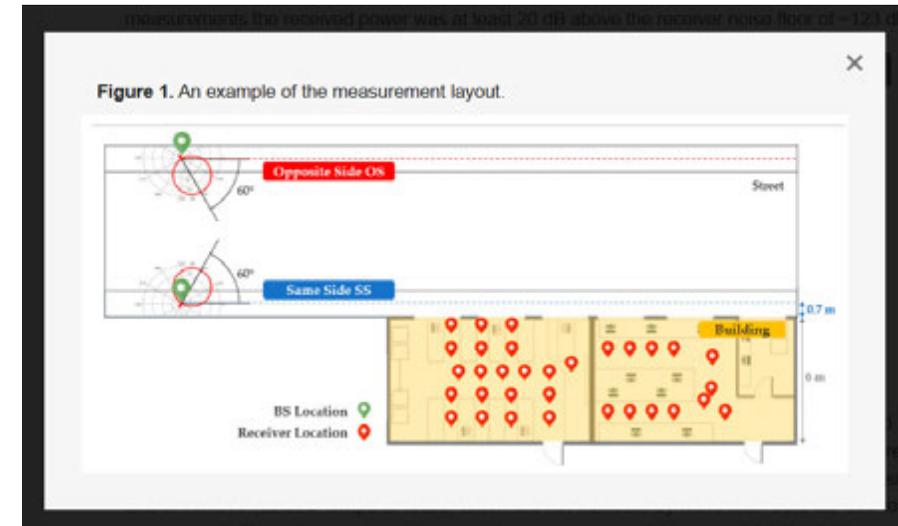## Integrated energy converter for green hydrogen production using renewable energy and high-cycle energy storage

Research Line: Electrical Systems
Researcher: Dr. Andrés Mora

This research project proposes implementing an autonomous green hydrogen system capable of efficiently operating an electrolyzer without relying on the main power grid.

The core of the solution is a multiport energy converter that interconnects the three system elements using a simplified topology, minimizing the number of components needed to regulate energy flow between the three ports.

This solution allows for the use of flywheel energy storage (FESS) as a buffer to smooth out power variations from the renewable source that should not reach the electrolyzer port, as they could reduce the system's lifespan.

The advantages of FESS over battery energy storage systems (BESS) include longer life cycles, faster response, lower environmental impact, and reduced maintenance.

Thus, the project presents an integrated solution for producing hydrogen in off-grid facilities, making it viable for remote regions without access to the main power grid.

Emergence of collective behavior in learning neural networks

Research Line: Biomedical Systems
Researcher: Dr. Patricio Orio

Understanding how complex systems develop collective behaviors is a topic of great interest, with implications in fields such as neuroscience and artificial intelligence.

This project explores how the task assigned to a neural network determines the type of high-order statistics (collective statistics) that can be observed. Recurrent continuous-time neural networks will be trained to perform cognitive tasks of varying complexity. The hypothesis is that more complex tasks require stronger synergistic interactions among neurons in the network's hidden layer.

The project also includes the analysis of high-detail simulations of realistic networks inspired by cortical architectures. Again, the hypothesis is that in simulations where networks perform complex tasks, synergy will be predominant.
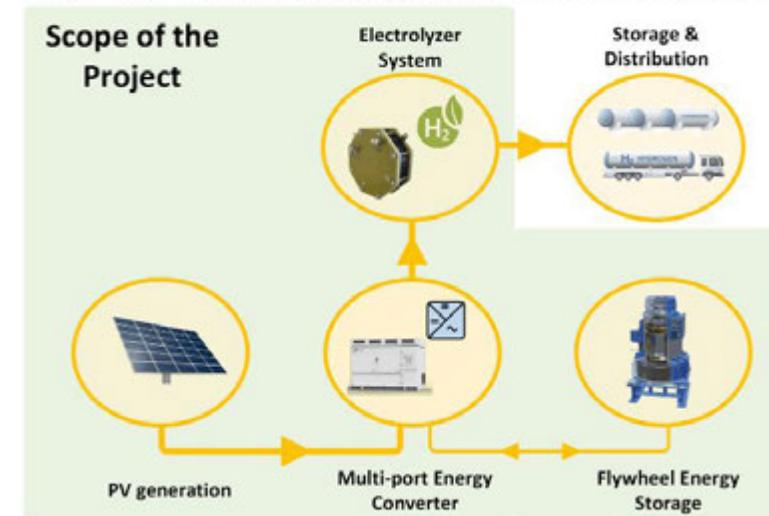
This image illustrate the project: Integrated energy converter for green hydrogen production using renewable energy and high-cycle energy storage
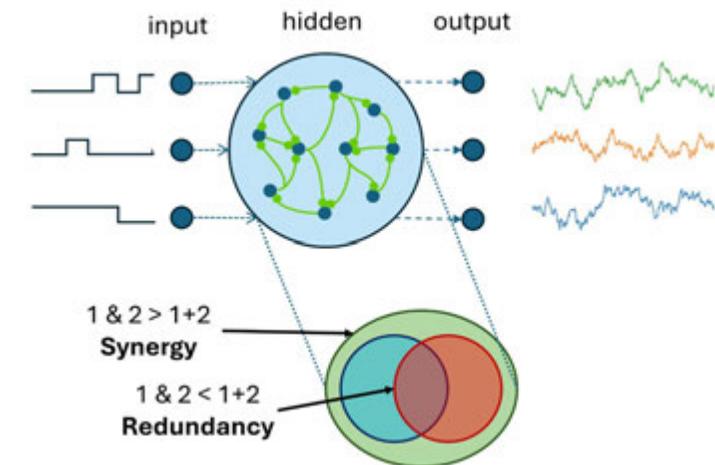
This image illustrate the project: Emergence of collective behavior in learning neural networks

Using artificial intelligence (AI) for differential diagnoses with medical images

Research Line: Artificial Intelligence and Data Analysis
Researcher: Dr. Mauricio Araya

One goal of this project is to demonstrate that the local industry can create AI applications using complex national medical image repositories in an interoperable manner. The prototype application "Proximity" fulfills this purpose. It is a search tool for chest CT scans based on image content.

The search engine works with any interoperable repository using deep learning directed by labels auto-extracted from diagnostic reports using large language models like GPT.

This medical image repository for AI training also ensures interoperability, availability of HPC compute time, storage, and above all, data privacy and anonymity.

The project results from a multidisciplinary collaboration between UTFSM, Universidad de Chile, the Clinical Hospital of Universidad de Chile, and partner institutions like CENS and INRIA.

The expected impact includes better training for radiology specialists, contributions to cutting-edge scientific research in differential diagnosis, and eventual clinical use to reduce reporting time. This would allow healthcare systems to create locally-based AI applications without needing lengthy tech research phases, enabling quick decision-making for patient care.

Improving the capabilities of long-range distributed acoustic sensors (DAS) for operation on telecommunications optical fiber cables

Research Line: Robotics
Researcher: Dr. Marcelo Soto

Distributed optical fiber sensors have significant capabilities for spatially monitoring environmental variables such as temperature, strain, deformation, and pressure. This technology uses an optical fiber as both a transmission line and a sensor element, where light properties are modulated by environmental conditions.

Distributed Acoustic Sensors (DAS) have attracted considerable attention in the past decade due to their ability to measure the amplitude, frequency, and phase of mechanical vibrations.

Among a wide range of applications, DAS has emerged as a promising technology in seismology, offering unique monitoring features and spatial information that traditional seismic sensors like geophones, seismographs, or accelerometers cannot provide.

The potential to use existing telecommunications optical cables worldwide is seen as a promising solution for developing cost-effective seismic monitoring networks, especially in

remote or hard-to-reach areas such as oceans, where deploying large arrays of traditional broadband seismometers is not feasible.

This project investigates advanced interrogation and signal processing techniques to enhance DAS systems and enable their operation on optical fibers with live telecommunications traffic.

The project is expected to have international impact by advancing DAS interrogation methods and signal processing approaches, allowing this technology to operate on data-carrying optical fibers.
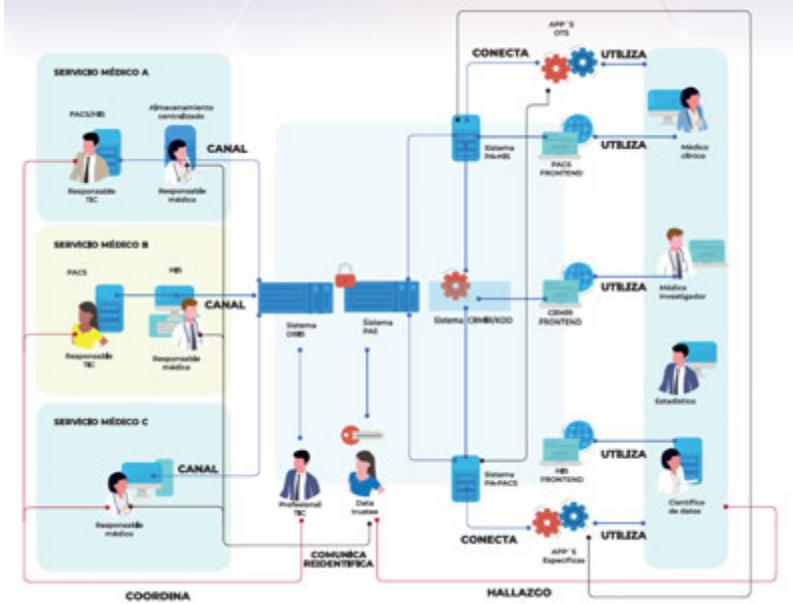
This image illustrate the project: Using artificial intelligence (AI) for differential diagnoses with medical images
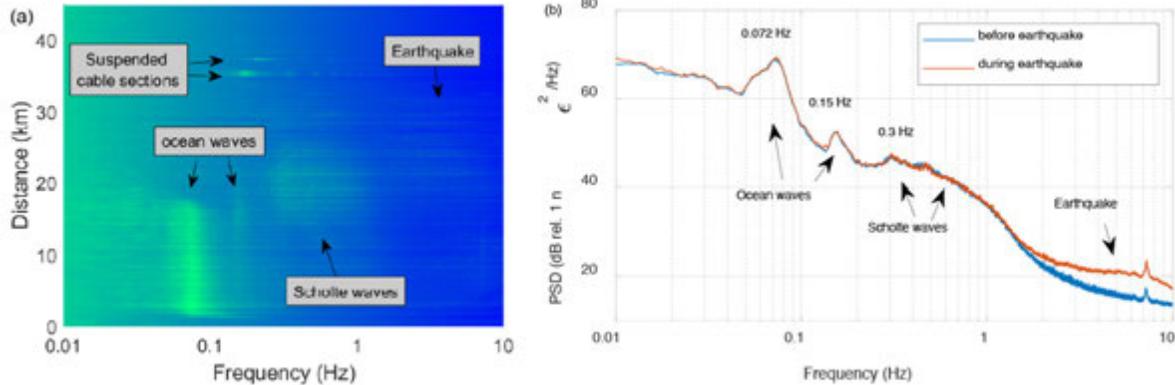
This image illustrate the project: Improving the capabilities of long-range distributed acoustic sensors (DAS) for operation on telecommunications optical fiber cables

Year Achievements

4,4%
UTFSM

29,1%
COUNTERPART CONTRIBUITION INDUSTRY

20,8%
OTHER OVERMENT OURSES

45,7%
BASAL FUNDING
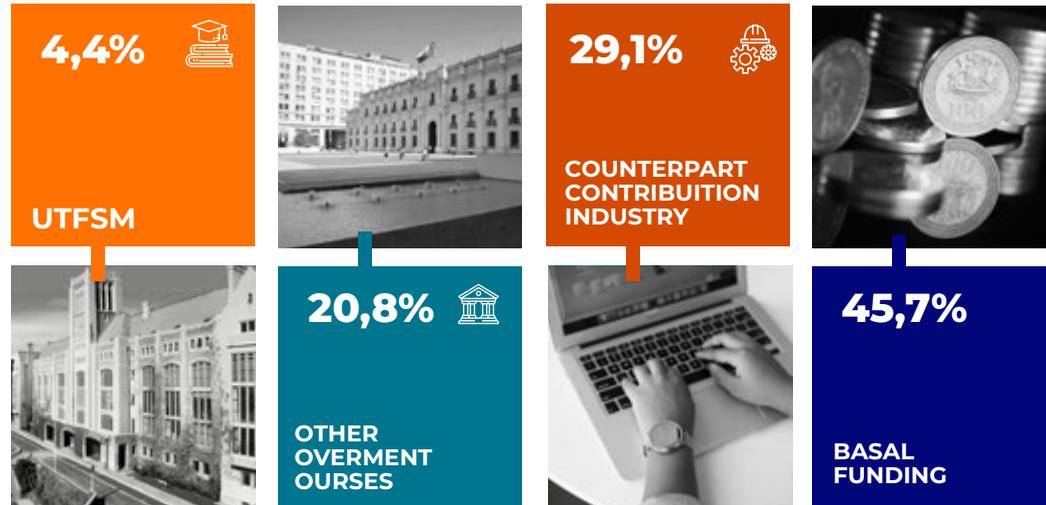
Total: $3.021.144.441

Awards
11

Graduates

Master	PhD	Undergraduate
45	13	76

Magazines and Publications
140	152
ISI Publications	Non-ISI Publications

Projects
18
Projects with the industry

Licenses
1	4
Licenses Applied	Licenses Grantes

Outreach
68	352.041
Outreach (Includes appearences in magazines, newspaper and TV programs)	Attendees at outreach activities

Total Achievements

Magazines and Publications		Projects	Awards
965	**1116**	**205**	**199**
ISI Publications	Non-ISI Publications	Projects with the industry	Awards

Licenses
36	19
Licenses Applied for	Licenses Granted

Outreach
546	732.185
Outreach (Includes appearences in magazines, newspaper and TV programs)	Attendees at outreach activities

Scientific Outreach

AC3E carried out various activities in its 10th year, helping to bring our work closer to the general public. Activities included presentations in public spaces where our engineers shared their knowledge.

Regarding STEM+ education, we hosted 26 visits, eight talks, and five school science fairs, involving students from rural and urban areas across the region. Children and youth aged 3-18 enjoyed learning about science and technology, and their many applications.

Press

AC3E deems it essential to share its projects, technological developments, and perspectives on current innovation-related issues through various outlets, including television, radio, and both digital and print media.

This approach allows both decision-makers and the general public to gain insight into the impact of the Center's work.

	TV	WRITTEN PRESS	WEB	RADIO	TOTAL
OCTOBER	–	4	6	2	12
NOVEMBER	–	3	6	–	9
DECEMBER	–	1	8	–	9
JANUARY	2	1	7	–	10
FEBRUARY	–	–	2	–	2
MARCH	–	–	9	–	9
APRIL	–	1	6	–	7
MAY	1	0	8	–	9
JUNE	–	2	21	–	23
JULY	–	–	4	1	5
AUGUST	–	2	5	–	7
SEPTEMBER	1	1	1	–	3
TOTAL	4	15	83	3	105

Signature Industry Projects

Beanforming DAS
Office of Naval Research (ONR), Gobierno de Estados Unidos

Objective: From the beginning, AC3E's history has been marked by various events and achievements that have allowed it to position itself today as one of the country's most important research centers in electrical and electronics..

Problem Solved: In terms of application, this development targets the identification of static and dynamic "objects" in the near and far range of fiber optics cables installed on the seafloor. The proposed challenge is centered on detecting and identifying underwater objects (both in the water and on the seabed).

Description: Description: The project is based on studying signal processing methods using beamforming arrays to image the acoustic field surrounding a fiber optics cable based on DAS measurements. Expected outcomes include:

• Identification of optimal signal processing techniques based on near-field beamforming to produce accurate images of the acoustic field surrounding the optical cable.

• Evaluation of various processing methods tailored to different DAS technologies, with spatial resolutions ranging from millimeters to tens of meters.

• Identification of real-time imaging processing approaches.

CDP+
HRA Ingenieros

Objective: To develop a technological system for the control and operation of water extraction wells, building upon the technological base of the existing CDP device. The system will incorporate telemetry, sensorization, data transmission, and analysis technologies, allowing for optimized water extraction, periodic reporting to interested parties, and leak detection.

Problem Solved: CDP+ addresses the need for controlling and optimizing water resource management in rural areas.

Description: CDP+ involves the development of the following modules:

• Hardware Module: Based on the current CDP device, electronic hardware will be developed and optimized for data capture. Actuators will be added to interact with the pump and other sensors to detect water losses, to smooth start-up/shutdown operations, and enable data transmission.

• Data Transmission Module: This will define protocols and integrate technologies that allow bidirectional data transmission between the hardware device and the online platform.

• Visualization and Management Platform Module: Developed on both front-end and back-end levels, it allows for visualizing historical flow data and sending commands to operate the pump and other integrated hardware components.

LaceClips Investigación y Desarrollo de Métodos y Algoritmos para el Dispositivo vestible LaceClips

LaceClips LCC, en colaboración con Siana Systems.

Objective: To enhance the sophistication of the wearable LaceClips device by researching and developing new algorithms for detecting and monitoring kinematic events of interest during individual and team sports activities.

Problem Solved: The LaceClips device, designed to monitor sports performance through motion and acceleration sensors attached to the user's footwear, is being upgraded at the hardware level. This enables the integration of new and more comprehensive movement and workload indicators to better characterize the practice of a given sport and its progression over time.

Description: The project focuses on developing a new series of algorithms to detect and analyze motion events in the new version of the LaceClips device.

BBac – Water Analyzer
[pH] Gestión Transversal SpA

Objective: To develop a hardware and software platform for detecting variations in darkening in the supernatant or water base of the BBAC Experimental Unit, through:

• •Developing a Hardware Minimum Viable Product (HW MVP) water analyzer using a photosensor to detect darkening levels in the supernatant or BBAC experimental unit and sending this data to an online platform via 3G/4G network.

• •Developing a Software Minimum Viable Product (SW MVP) of an online data platform that receives, stores, and displays the information from the HW MVP(s) on a website.

• Manufacturing up to three HW MVPs connected to the developed SW MVP platform.

• Producing technical documentation to enable replicability and support the commercial scalability of the solution

Problem Solved: Measures water quality in rural areas.

Description: BBAC is a self-monitoring system for bacteriological water quality consisting of two components:

• Experimental Unit: A container with a chemical compound developed by the company that reacts when in contact with bacterially contaminated water.

• Rural Sanitary Self-Control System: An incubator device that maintains a constant temperature for the sample from the Experimental Unit.
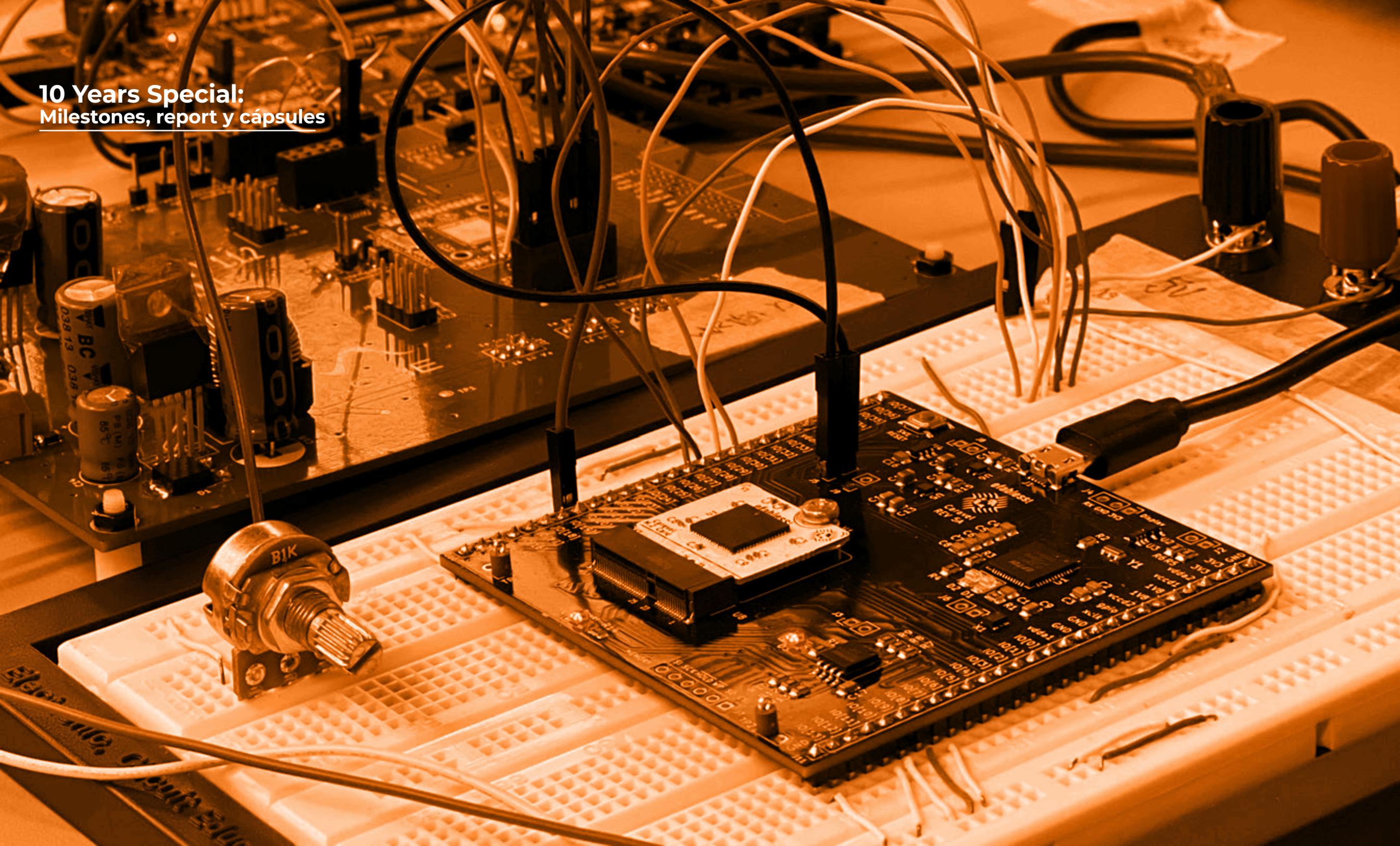
AC3E's Milestones

From the beginning, AC3E's history has been marked by various events and achievements that have allowed it to position itself today as one of the country's most important research centers in electrical and electronics.

2014

AC3E Director, Dr. José Rodríguez, received the National Award for Applied and Technological Sciences, granted by the Education Ministry, recognizing him as the most acclaimed national researcher in all engineering fields.

2016

In August, AC3E moved its offices to Av. Matta 222, Cerro Placeres, Valparaíso, a 700m2 space housing administrative staff, project engineers, postdoctoral researchers, and laboratories.

2017

AC3E was officially registered as an R&D center under the Tax Incentive Law. This recognition reflects the high standards and quality of research and development at the Center and facilitates collaboration with companies, allowing them to access significant tax benefits.

AC3E researcher and current Director Dr. Matías Zañartu became the first Chilean to win the prestigious P50 grant from the U.S. National Institutes of Health—one of the most competitive funding sources in the world, highlighting the Center's top-tier, high-impact research.

2018

Principal researcher Samir Kouro was honored for his extraordinary career and contributions to electrical and electronic engineering with the Outstanding Engineer IEEE-AIE 2018 Award by the Chilean Association of the Electrical and Electronic Industry (AIE) and IEEE Region 9.

The global ranking of the most influential researchers featured AC3E researchers Samir Kouro and José Rodríguez—two of three Chileans listed by Clarivate Analytics as being among the top 1% most cited worldwide.

2019

AC3E established its International Scientific Committee, composed of high-level scientists with extensive research experience, to advise the Center on strategic decisions, particularly scientific development, to provide feedback and to suggest best practices.

In March, UTFSM professor and AC3E principal investigator Matías Zañartu was appointed as the new director for the 2019-2024 period, marking the formal start of AC3E's second phase, characterized by the consolidation of early-stage initiatives and long-term vision.

UTFSM academic and AC3E researcher María José Escobar became the first woman to lead the Artificial Intelligence and Data Analysis research line, reinforcing female presence and promoting women's participation in science, engineering, and technology.

In September, AC3E undergraduate students, led by researcher Fernando Auat Cheein, successfully tested Chile's first fully automated commercial electric vehicle.

2020

AC3E received the Recyclápolis National Environmental Award in the Electromobility category, recognizing its commitment to sustainability and environmental protection, and its role in Chile's energy transition through research, development, and technological impact.

The "Advanced Voice Monitor" project, led by AC3E Director and Electronics Department researchers Dr. Matías Zañartu, was selected a finalist for the Avonni National Innovation Award in the Health category, one of Chile's most prestigious honors for value-creating innovative projects.

Between 2018 and 2020, AC3E successfully launched spin-off companies: Lanek, Electroveja, Sun and Play, and Simbiotica. These are science- and knowledge-based businesses with strong innovation and social impact potential.

AC3E won AIE's Best Innovation or Technological Development Award for the fourth time, thanks to the project "AI-Based Otolaryngology Learning Platform for Doctors and Students" (PAOME), led by researcher Fernando Auat Cheein, PhD candidate Michelle Viscaino, and student Matías Contreras.

2021

Researchers Dr. Margarita Norambuena and Dr. Pamela Guevara joined AC3E's core team, leading the Electric Systems and Biomedical Systems research lines, respectively. The participation of both researchers with outstanding track records and achievements represents a historic milestone, demonstrating the increasing role of women in science and engineering, specifically in the electric and electronic fields.

On October 29, 2021, the Technological Innovation Building was opened, located adjacent to the main UTFSM campus in Valparaíso. Several university and government officials took part in the ceremony and toured the premises, now home to AC3E, facilitating collaboration between research lines, impact areas, and industry.

The AMIRA project, focused on smart diagnosis of ENT diseases, led by Dr. Fernando Auat Cheein, won the Avonni 2021 National Innovation Award for Best Regional Innovation in Chile's central zone. The project uses AI to diagnose nine ear conditions with over 90% accuracy.

Principal investigator Dr. Pamela Guevara was featured in the December issue of Inside Signal Processing published by the IEEE Signal Processing Society, in recognition of her contributions to signal and image analysis and as a leading female scientist in the field.

2022

AC3E inaugurated its PCB Laboratory, dedicated to the production of printed circuit boards—the heart of electronic or electric devices. The facility features state-of-the-art equipment to produce high-quality PCB prototypes in less time.

In June, AC3E researchers and students were selected to participate in the SSCS Chipathon 2022 International Microchip Design Competition, a first step toward training analog microchip designers at the Center.

AC3E acquired a Real-Time Digital Simulator (RTDS) from RTDS Technologies Inc., a flexible testing platform that enables cutting-edge research and aids the electric industry's energy transition, currently underway in Chile and world.

In October, AC3E launched the Control System for the ASTRI mini array (CCS – Central Control System), commissioned by Italy's National Institute of Astrophysics (INAF). It is planned to remotely operate nine telescopes at an Italian observatory on Tenerife, Spain. The system provides precise information on data flow, weather stations, datacenters, energy management, and others.

In late, the AC3E Donation Mural was inaugurated, recognizing the individuals and companies that contributed to equipping the Technological Innovation Building's facilities, which form a scientific and technological hub in the V. Region, dedicated to research, innovation, and technology transfer. The donations allowed setting up the building, which is now home to around 80 professionals, benefiting from modern facilities and world-class equipment.

2023

In April, AC3E launched the "Amazing Science for Curious Minds" initiative to bring science closer to schoolchildren in the V. Region. Activities include lab tours and school talks by researchers on topics such as electronics, climate change, health tech, and renewable energy, creating opportunities for engagement and dialogue.

In late 2023, AC3E Director Dr. Matías Zañartu received the "Outstanding Engineer" award from AIE and IEEE, recognizing his professional achievements and contributions to both medicine and engineering research.

2024

In January, AC3E participated for the first time in Congreso Futuro, Chile's top free science, tech, and art dissemination platform, showcasing its research to thousands of visitors through interactive experiences over seven days.

AC3E launched the Inspirational Women in Engineering calendar, featuring 12 global engineers, including Center researchers, to highlight their contributions and visions for increasing female participation in engineering.

In May, AC3E researcher Dr. Héctor Ramírez was appointed Deputy Director of the Center, playing a key role in planning and preparing for the next 10-year phase.

In May 2024, AC3E hosted its first School Robotics Workshop for teachers from Valparaíso and Santiago Metropolitan regions, aiming to provide basic robotics knowledge and enhance learning opportunities for children.
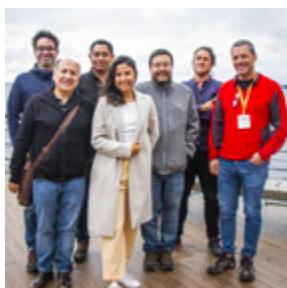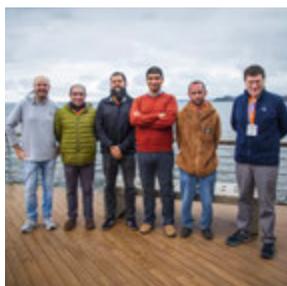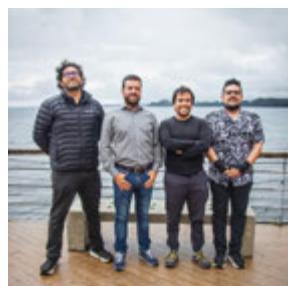
AC3E: A decade contributing to the country's scientific and technological development

Since its creation, the Advanced Center for Electrical and Electronic Engineering (AC3E) at Universidad Técnica Federico Santa María (UTSFM) has worked to bring university lab research closer to the private sector, turning it into technological developments that improve industrial processes. This is reflected in nearly 200 projects with regional, local, and international industries.

This ANID (National Research and Development Agency) basal center was founded in 2014 with the mission to contribute to technological development and the competitiveness of the Chilean economy through research excellence. Its focus includes promoting knowledge exchange, training advanced human capital, and generating technological transfer in socially impactful areas through the field of electrical and electronic engineering.

"For our university, it's a source of pride to have a research center celebrating 10 years of work, consolidating and expanding a team capable of tackling challenges, articulating research lines and development areas that respond to industry needs. This has enabled a significant contribution to the country's scientific and technological development, as well as the training of highly specialized human capital. The Center reflects our commitment to go beyond what is taught in classrooms and laboratories, by assuming the responsibility of contributing to national development, in collaboration with students and supported by state resources," highlighted UTSFM Rec-

tor Dr. Juan Yuz, who was AC3E director between 2015 and 2019.

Over its 10 years, AC3E has achieved major milestones in research, technology transfer, advanced human capital training, and science communication, positioning it as one of Chile's centers of research excellence. Highlights include strong industry collaboration, over 950 research articles, 530 science outreach activities, four spin-off companies, 1,000 students trained, and a 266% increase in women's participation in roles ranging from principal investigators to students.

"The results achieved allow us to dream big and continue acting as a bridge between academia and industry. We aim to remain a center of excellence and a national benchmark in electrical and electronic engineering, keep generating advanced human capital, promote gender policies in engineering, and inspire future generations through various activities with local schools to build a better future and quality of life from within academia," said AC3E Director Dr. Héctor Ramírez.

The Center's trajectory has been characterized by a significant impact across various dimensions: the national economy, the training of future professionals, research, technology transfer to the productive sector, and the dissemination of science across different sectors of society, making it a key player in the country's development.

Capsules

Cápsula:
Impacto Económico

VER VIDEO

ECONOMIC IMPACT

The Center's impact on the Chilean economy is estimated at 51 billion pesos. This means that, when considering the initial contribution of 11.88 billion pesos by research agency ANID, AC3E has more than quadrupled that amount over the last 10 years. Such growth was achieved through job creation and the establishment of companies based on the Center's technological developments, among others.

Cápsula:
Impacto Formación Capital Humano

VER VIDEO

HUMAN CAPITAL DEVELOPMENT IMPACT

AC3E contributes to the training of advanced human capital to face future challenges. Since its inception, it has graduated over 800 students, providing them with experience and tools for rapid entry into the workforce, mainly in fields such as technology and innovation, research and development, higher education, and consulting.

Cápsula:
Impacto Investigación

VER VIDEO

RESEARCH IMPACT

The Center brings together top talent in electrical and electronic engineering from eight Chilean universities. These researchers have a strong scientific track record, as reflected in the quality of their publications, which rank in the top quartiles of the most prestigious scientific journals, and in the Center's sustained growth in research excellence.

Cápsula:
Impacto Outreach

VER VIDEO

OUTREACH IMPACT

Part of its mission to bring science closer to society, AC3E has promoted a wide range of scientific outreach initiatives aimed at showcasing its work and inspiring future generations to explore the fields of science and engineering. The Center has also actively participated in expert committees and technical roundtables on public policy. All these efforts have enabled AC3E to demonstrate that Chile has the talent and tools to produce world-class science with meaningful impact on industry and quality of life.

Global Network

Canadá
- McMaster University
- Queen's University at Kingston
- Universite de Moncton
- Universite de Sherbrooke
- University of Toronto
- University of Waterloo
- University of Montreal
- Concordia Universityt
- Boston University

Estados Unidos
- Harvard University
- University of Colorado-Denver
- UC Denver
- Duke University
- Sandia National Laboratories
- University of Arizona
- Boston University
- NIMH (National Institute of Mental Health)
- Massachusetts General Hospital
- Carnegie Mellon University
- University of Texas at Austin
- Georgia Institute of Technology
- Fort Valley State University
- The Center for Technology
- Transfer to Commercialization, Hampton University
- Massachusetts Institute of Technology
- Prognostics Center of Excellence, NASA Ames Research Center
- University of Illinois
- State University of New York (SUNY) Downstatet
- Massachusetts General Hospital
- FERMILAB
- Purdue University
- Rochester Institute of Technology
- University of New Mexico

Cuba
- Centro de Neurociencias de Cuba

Colombia
- Pontifícia. Universidad Javeriana
- Universidad Militar Nueva Granada

Ecuador
- Universidad Técnica del Norte (Ibarra)
- Escuela Politécnica Nacional (Quito)
- Universidad San Francisco de Quito (Quito)

Brasil
- Universidade Federal de Pernambuco
- Pontifícia Universidade Católica do Rio de Janeiro
- Pontifícia Universidade Católica do Rio Grande do Sul
- Centro de Pesquisas de Energia Elétrica

Argentina
- Universidad Nacional Entre Ríos
- Universidad Nacional de San Martín
- Universidad de Buenos Aires
- Universidad Nacional de Córdoba
- Centro Atómico Bariloche, Instituto Balseiro

Portugal
- Life and Health Sciences
- Research Institute, University of Minho

Reino Unido
- University of Edinburgh
- Liverpool John Moores University
- University of Manchester
- University of Nottingham
- Imperial College London
- University of Liverpool
- Cranfield University

Paises Bajos
- Universiteit Maastricht
- Eindhoven University of Technology

Alemania
- Fraunhofer Institute for Integrated Systems and Device Technology IISB
- IHP: Leibniz Institute for High Performance MicroelectronicsTU Dresden
- Technical University of Munich
- University of Wurzburg
- Technische Universität Ilmenau

Lituania
- Vilnius university

Polonia
- Poznan University of Technology
- Agricultural Cracow University
- Warsaw University of Technology

República Checa
- University of West Bohemia

Croacia
- Bedalov d.o.o, Split
- University of split

Austria
- Silicon Austria Lab (SAL)

Italia
- Int. Centre for Theoretical Physics
- Istituto Nazionale di Astrofisica, INAF
- Scuola Italiana Superiore Sant'Ana
- University of Bologna

España
- Universidad Politecnica de Cataluña
- Universidad de Sevilla
- Universidad de Salamanca
- Universidad de Barcelona
- Universitat Rovira i Virgili
- Biocruces-Bizkaia Health Research Institute
- Universidad de Jaent
- Universidad Politecnica de Madrid
- University of Valencia

Francia
- Universite de Franche-Comte (Besacon)
- FEMTO-ST Institute
- CentraleSupelec
- Institut de Neurosciences de la Timone
- Ecole Normale Superieure de Paris
- Observatoire de Paris
- Gipsa-lab, CNRS
- Biovision team, INRIA Sophia Antipolis
- Ecole Nationale d'ingenieurs de Tarbes
- Power Electronic Group of Laplace laboratory.
- Insitut National Polytechnique de Toulouse
- Institut National Des Sciences Appliquees LYON
- INRIA
- IMT Atlantique
- NeuroSpin (CEA)
- Ecole Nationale d'ingenieurs de Tarbes
- LAAS-CNRS
- University of Lorraine
- Institut de Recherche en Informatique de Toulouse (IRIT)
- Sigfox
- LAPLACE Laboratory, Univ. of Toulouse
- Paris Brain Institute (ICM), INSERM, ICM institute, Pitie-Salpetriere Hospital
- Institut supérieur de l'aéronautique et de l'espace (ISAE-SUPAERO)
- Schlumberger Limited (SLB)
- Univ. Grenoble Alpes, Grenoble INP-Esisar
- Institute for Systems Neuroscience, Aix-Marseille University

Australia
- University of Melbourne
- University of New South Wales
- University of Sydney
- Macquarie University
- University of Newcastle
- University of Macquarie
- University of Technology Sydneyt

Nueva Zelanda
- Lincoln University

Partners

Challenges

In the upcoming period, we aim to continue driving technological advancement and the competitiveness of the Chilean economy, with a positive impact on societal well-being through excellence in applied and interdisciplinary research in Electrical and Electronic Engineering.

The Center promotes innovation, develops human capital, and fosters technology transfer, with a strong focus on sustainability, gender equity, global collaboration, and the promotion of science and technology to address critical challenges and deliver impactful solutions.

We will continue to promote gender equality, supporting the participation and leadership of women in STEM fields and creating an inclusive environment where innovation can thrive through diverse perspectives. We believe these efforts not only strengthen societal engagement but also contribute to building a more equitable and diverse technological workforce in Chile.

On the industrial front, our projection for the next period is to stay on the path of pursuing more challenging industrial projects, with higher technological risk and greater economic value, where AC3E's knowledge and capabilities can be effectively transferred to industry.

We also want to continue strengthening the connection between society and science, breaking down the barriers that separate them through activities that foster interest in and appreciation for scientific work—helping to create a cultural shift that transforms the perception of science and research in our country.

Visits

We received several visits from groups interested in exploring cooperation. Our mission is to promote technological advancement and the competitiveness of the Chilean economy, with a positive impact on societal well-being.

These visits included representatives from government institutions, companies, universities, research centers, and local schools.

Each visit featured a presentation on What is AC3E?, an overview of key projects, and a guided tour of our laboratories and facilities. The goal was to showcase the Center's capabilities in developing high-impact technologies for both industry and society.