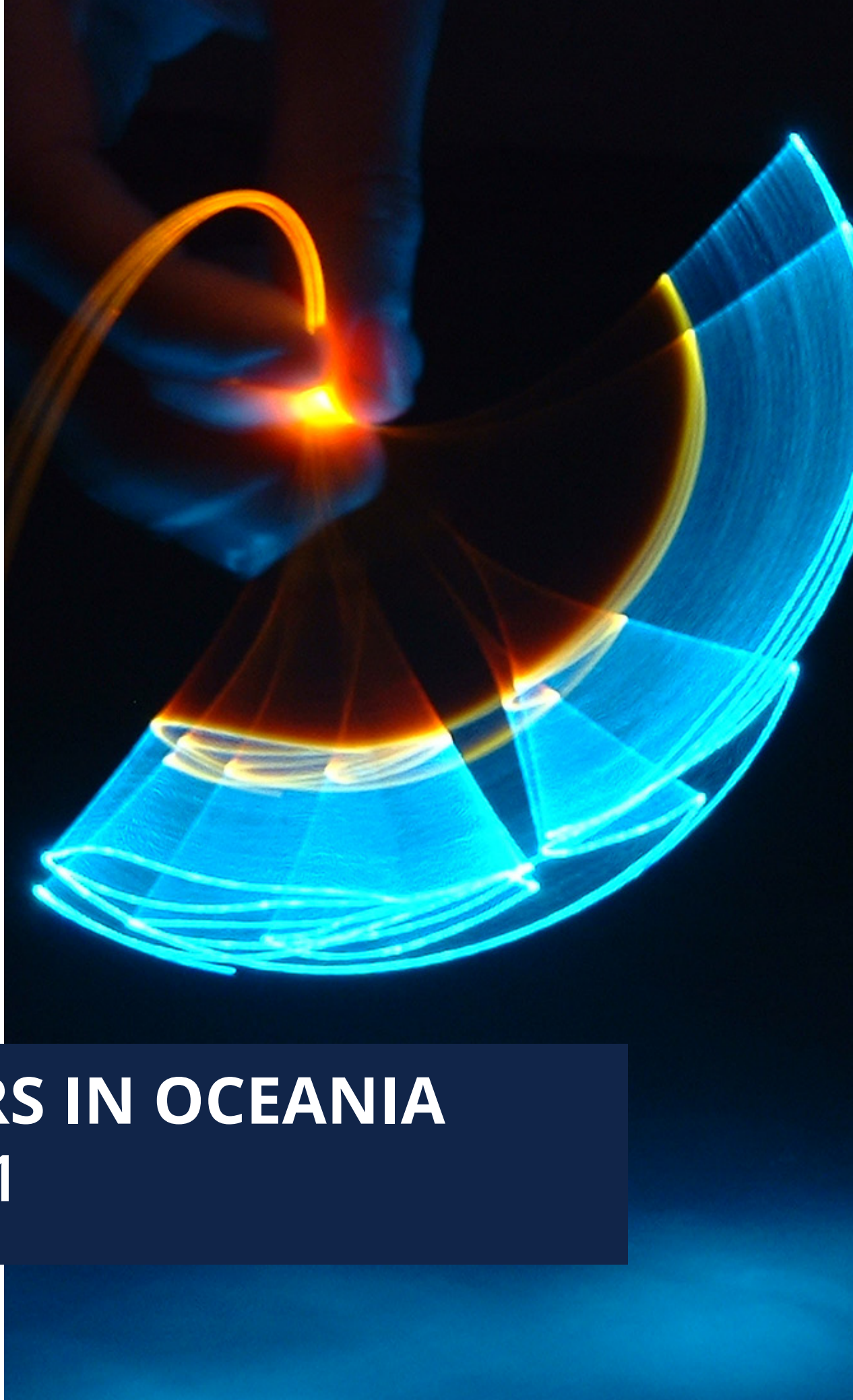


CNRS IN OCEANIA
2021

TABLE OF CONTENTS

OVERVIEW: DERCI DIRECTOR 2

OVERVIEW: CNRS DIRECTOR IN OCEANIA 3

WHAT IS THE CNRS? 4

CNRS: A KEY PLAYER IN GLOBAL SCIENCE 5

CNRS INTERNATIONAL COOPERATION TOOLS 6

OUR CNRS REPRESENTATIVE OFFICE IN OCEANIA 7

CNRS COOPERATIONS WITH AUSTRALIA 8

CNRS COOPERATIONS WITH NEW ZEALAND 11

INTERVIEWS WITH CNRS PROJECT COORDINATORS IN OCEANIA 12

IRL CROSSING: INTERVIEW WITH JEAN-PHILIPPE DIGUET 14

IRP CANECEV: INTERVIEW WITH FREDERIC THOMAS 16

IRP MAITAI: INTERVIEW WITH FREDERIC PAUL 18

IRP FEMIDAL: INTERVIEW WITH PATRICK CAUDAL 20

IRP WALL-IN: INTERVIEW WITH JULIEN FATOME 22

OVERVIEW: CNRS DERCI DIRECTOR

The CNRS (French National Centre for Scientific Research) is part of the worldwide fundamental and applied research landscape, and its activities across the scientific spectrum make it the largest research organisation in Europe. International projects and partnerships are essential for cutting-edge, competitive research. These are top priorities for the CNRS. The indicators tracking the international development and activity of the Centre are many and varied, and each one points to the strong international recognition of the establishment. Every year, almost 30% of its newly recruited researchers come from abroad, alongside almost 5,000 students, post-doctorates, researchers, and professors brought into its laboratories. Moreover, out of 43,000 publications every year, more than half are co-signed with at least one international partner.

Every CNRS assignment and project is designed to increase the Centre's international outreach and cement its position as a leader in research and innovation. The DERCI, the office dedicated to the CNRS international cooperation strategy, is the natural spearhead for these efforts. It is both very close to the Presidency of the CNRS in Paris, and also to strategic research hubs around the world, with offices representing the Centre in ten countries: in Beijing, Brussels, Melbourne, New Delhi, Pretoria, Rio de Janeiro, Singapore, Tokyo, Washington, and Ottawa.

The DERCI also draws on a network of scientific advisers and attachés in French embassies and consulates around the world and works with the relevant ministries in this field: in particular, the MESRI (Ministry of Higher Education, Research and Innovation) and the MEAE (the Ministry for Europe and Foreign Affairs). They help the CNRS in developing its strategies for international and European cooperation, from implementation to oversight, and act as a coordinator for the actions associated with them. Thanks to their presence in the field, the regional offices are a core pillar of the CNRS international policy and strategies. They provide expertise, advice and play a supporting role for the CNRS scientific partners. The opening of its two new offices in Melbourne (2021) and Ottawa (2022) marks a new step forward for the CNRS as it increases its cooperation with its international partners. In both of these cases, the projects associated with these two new offices offer an illustration of how far the CNRS is ready to go in the most strategic scientific fields of today, from quantum and climate science to energy transition, environmental protection and remediation as well as artificial intelligence, to name but a few areas.

This booklet offers a perspective on the partnerships and cooperation developed by our researchers with their partners in Oceania. It showcases the flagship projects supported by the CNRS, in partnership with their partner institutions overseas, and with other members of the French research ecosystem. The CNRS office in Melbourne plays a role in these projects, offering support, assistance, fund-raising, new project initiatives and, above all, representing the CNRS towards its local partners and ensuring that their assignments and projects are a success.

Christelle ROY, CNRS DERCI Director
DERCI - European Research and International Cooperation Department of the CNRS

OVERVIEW: CNRS DIRECTOR IN OCEANIA

For a decade now, the CNRS has been building solid partnerships with Oceania. With 1,590 co-publications in 2020 (44% of the entire Franco-Australian co-production), the Centre is Australia's top international academic partner, at the same level as the Chinese Academy of Science and ahead of Harvard University. It is also, with 318 co-publications (45% of the entire Franco-New Zealand co-production), New Zealand's leading non-Oceania academic partner.

This performance is illustrated by the significant development of the CNRS tools in the area, including its first International Research Laboratory, developed with three universities based in Adelaide, IMT-Atlantique as well as the French company Naval Group. The 30 programs from our international cooperation tools (international research laboratories, projects and networks, emerging actions) which have been operating in 2021 are included in this booklet and cover a variety of sectors, from photonics to physics, biology, energy, geoscience, mathematics, robotics, environment and humanities and social sciences. They have been implemented with some thirty academic and civil society partners in Oceania and have helped structure a dense network that has been the foundation for top-level research, intense academic dialogue, and joint training for a large number of doctorate students. The COVID-19 crisis led to a significant drop in scientific dialogue, but these programs allowed us to maintain a remarkable level of interaction and helped us to support our bilateral cooperation.

This is also reflected in our long-term cooperation projects, in fields including ocean science, polar research and astronomy. France, and the CNRS in particular, have deployed considerable resources, e.g. the Astrolabe resupply vessel, deployed for four months every year from Hobart (Australia) and the polar station Concordia. France's decision to join the international SKA Observatory (SKAO), which will operate the future network of radio telescopes installed in Africa and Australia, is a sign of future major developments in our cooperation with Australia.

The agents assigned to the Melbourne office are promoting the CNRS towards intensive research universities, funding and research agencies, regional governments, and French companies embedded in the research ecosystems in Oceania. Moreover, working together with the CNRS institutes, they are mobilising their laboratories and those of potential partners in the area to strengthen current cooperation and encourage new partnerships to emerge. Major scientific developments are expected in certain sectors (energy, hydrogen, artificial intelligence, engineering, environment, astronomy, climate, oceans, etc), ensuring that Australia and New Zealand remain major partners and offer considerable development for the CNRS.

Lastly, we should mention that the Oceania office also covers France's Pacific territories (New Caledonia, French Polynesia) hosting universities and CNRS units. The office will also be supporting partnerships developed by these overseas laboratories with Australia and New Zealand.

Jean-Paul TOUTAIN, CNRS Regional Director
CNRS Representative Office in Oceania

WHAT IS THE CNRS?

The Centre National de la Recherche Scientifique (National Center for Scientific Research) is a public body under the authority of the French Ministry of Education and Research.
Founded in 1939, the CNRS is the largest fundamental research organization in Europe. It carries out research in all fields of knowledge through ten thematic institutes.

With over 32,000 staff (40% of whom are women) spread out over 1,000 laboratories, the CNRS is the second largest research institution in the world in terms of number of scientific publications, registering 55,000 publications in 2020. The CNRS also comes fourth in the international scientific ranking Nature Index.
With a budget of 3.5 billion euro, the CNRS counts 200 joint CNRS/industry joint research structures and nearly 100 start-up created each year.
CNRS researchers have been awarded 22 Nobel Prizes and 12 Fields Medals.

55,000
publications in 2020

3.5
billion euro budget

More than
32,000
staff members

More than
40%
women

More than
1,000
laboratories

2nd
largest research institution in the world in terms of number of scientific publications

More than
200
CNRS/industry joint research structures

22
Nobel Prize laureates

4th
in the Nature Index international scientific ranking table

12
Fields Medal winners

100
start-ups created each year

CNRS: A KEY PLAYER IN GLOBAL SCIENCE

The CNRS is a key player in global science. More than 60% of our publications are co-signed with at least one foreign institution and each year, almost 30% of our newly-recruited researchers come from outside of France.

We, at the CNRS, have an ambitious scientific policy that involves setting up collaborative research all over the world. And it has 5 objectives:
- Conduct scientific research,
- Transfer research results,
- Share knowledge,
- Train through research,
- Contribute to scientific policy.

International Research Laboratories are a fantastic tool to carry out advanced research programs in all fields of knowledge with academic or industrial partners across the world. And they have become iconic of the internationalization of the CNRS. They supplement more than one thousand labs in France which are themselves open to the world.

Today our world faces immense challenges that cannot be tackled without science. The CNRS aims to help find solutions to these emerging issues. But we cannot do this alone. This is why we need to develop international strategic partnerships with universities and research centres in close relationship with stakeholders.

These international strategic partnerships are supported across the world by a network of 10 CNRS regional representative offices, as from January 2022. Located in Beijing, Brussels, Melbourne, New Delhi, Ottawa, Pretoria, Rio de Janeiro, Singapore, Tokyo, Washington, they play an essential role in the CNRS strategy, being a key player in global sciences.

60%

of publications co-signed with at least one foreign laboratory

30%

of our newly-recruited researchers come from outside of France

Nearly
80

international laboratories

10

CNRS Regional representative offices across the world

CNRS INTERNATIONAL COOPERATION TOOLS

International Research Laboratories are international schemes in which research work is jointly conducted around a shared scientific focus. They structure, within an identified location, the significant and lasting presence of scientists from a limited number of French and foreign research institutions (a single foreign partner country). International Research Laboratories are proposed by the scientific Institutes of the CNRS based on structured international collaborations. They involve a high degree of internationalization among the participating teams, as well as a strong concentration of research activity within a partner organization. These IRL last 5 years, and can be extended several times.

International Research Projects are collaborative research projects established between one or more CNRS laboratories and laboratories in one or two foreign countries. They enable the consolidation of already established collaborations through short or medium-term scientific exchanges. Their purpose is the organization of working meetings or seminars, the development of joint research activities including field research, and the supervision of students. French and foreign teams must have already demonstrated their ability to collaborate together (for example through one or more joint publications). These programs last 5 years and can be extended for 5 more years.

International Research Networks aims at structuring an international scientific community around a shared theme or research infrastructure. It promotes the organization of international workshops and seminars or thematic schools organized by the network partners, in France and abroad. It brings together researchers from one or more French laboratories, including at least one CNRS laboratory, and from several partner laboratories abroad for a period of 5 years.

International Emerging Actions are “PI-to-PI” projects whose aim is to explore new fields of research and new international partnerships through: short-term missions, the organization of working meetings, the initiation of initial joint research work around a shared scientific project. These actions have a duration of 2 years.

OUR CNRS REPRESENTATIVE OFFICE IN OCEANIA

The CNRS Representative Office in Oceania was created in September 2021. Oceania was previously included in the CNRS Representative Office in ASEAN & Oceania, located in Singapore. The office, which opened in October 2021, is located in Melbourne, hosted by the University of Melbourne and supported by the Government of Victoria and its agency Invest Victoria. Its regional Director is Jean-Paul Toutain.

Here is the address of the CNRS Representative Office in Melbourne, Australia:
CNRS Office @ The University of Melbourne
Rooms 314 and 315
Level 3, Building 174 (Infrastructure Engineering, Block C)
Parkville Campus
Parkville VIC 3010
Australia

CNRS COOPERATIONS WITH AUSTRALIA

AUSTRALIA

1 IRL
CROSSING (Computer Science)

10 IRP
AlPhFA (Photonics)
AMHELIE (Materials)
APICOLIPID (Infectious diseases)
CANECEV (Ecology & health)
FEMIDAL (Social sciences)
FUMA (Maths)
IRP-ARS (Robotics)
GEODESIC (Signal processing)
MAITAI (Chemistry)
SoCNetMM (Ecology)

5 IRN
FACES (Energy)
FALCoL (Geology)
I² (Astrophysics)
PhilInBioMed (Philosophy of Science)
WONDER ((Biotechnology)

9 IEA
COMPEX (Chemistry)
ECHAPH (Environment)
MARGEN (Biology)
MIRalPhFA (Engineering)
MECAPOP (Environment)
Nano-mobility (Geochemistry)
PSEUDOSPECS (Chemistry)
QUAP (Physics)
ROSIA (Engineering & health)

Australian National University – ANU. https://www.anu.edu.au/
University of Melbourne. https://www.unimelb.edu.au/
RMIT University. https://www.rmit.edu.au/
Deakin University. https://www.deakin.edu.au/
Monash University. https://www.monash.edu/
Swinburne University of Technology. https://www.swinburne.edu.au/
Flinders University. https://www.flinders.edu.au/
University of South Australia – UNISA. https://www.unisa.edu.au/
University of Tasmania – UTAS. https://www.utas.edu.au/
Macquarie University. https://www.mq.edu.au/
University of New South Wales – UNSW. https://www.unsw.edu.au/
University of Sydney. https://www.sydney.edu.au/
University of Newcastle. https://www.newcastle.edu.au/
University of Queensland. https://www.uq.edu.au/
University of the Sunshine Coast. https://www.usc.edu.au/
Queensland University of Technology. https://www.qut.edu.au/
Curtin University. https://www.curtin.edu.au/
Murdoch University. https://www.murdoch.edu.au/
University of Western Australia – UWA. https://www.uwa.edu.au/
Western Sydney University. https://www.westernsydney.edu.au/

INTERNATIONAL RESEARCH LABORATORY: 1 IRL

CROSSING (Computer science): French Australian laboratory for humans / autonomous agents teaming. **FR:** CNRS, IMT Atlantique, Naval Group **AUS:** University of Adelaide, Flinders University, UNiSA.

INTERNATIONAL RESEARCH PROJECTS: 10 IRP

ALPhFA (Photonics): Associated Laboratory in Photonics between France and Australia. **FR:** INL, Institut Fresnel, FEMTO-ST, C2N. **AUS:** RMIT, Macquarie U., ANU, U. of Sydney, Swinburne U. of Technology.

AMHELIE (Materials): Additive Manufacturing for high performance materials and lattice structures. **FR:** I2M. **AUS:** University of Queensland , Monash University.

APICOLIPID (Infectious deseases): Apicomplexan parasites lipid and membrane biogenesis. **FR:** IAB. **AUS:** University of Melbourne. **USA:** Moffitt Cancer Center.

CANECEV (Ecology & Health): Investigating the ecological and evolutionary dynamics of cancer. **FR:** MIVEGEC. **AUS:** Deakin University, UTAS.

FEMIDAL (Linguistics): Formal/Experimental Methods and In-depth Description of Australian Indigenous Languages. **FR:** LLF. **AUS:** U. of Melbourne, ANU, Western Sydney University, University of Newcastle, UWA.

FUMA (Maths): Fundamental Mathematics in the field of basic and applied mathematics. **FR:** LMO, Institut Camille Jourdan. **AUS:** ANU.

GEODESIC (Signal processing): Geometry-Driven Signal and Image Processing. The lab conducts research in the field of data science, with emphasis in signal and image processing applications. **FR:** GIPSA-lab. **AUS:** University of Melbourne.

IRP-ARS (Robotics): Advanced Autonomy for Robotic Systems. Building an excellence centre to go beyond the state of the art in systems and control theory applied to Unmanned Robotic Systems. **FR:** I3S, CRAN, IRISA. **AUS:** ANU, University of Melbourne, Monash University.

MAITAI (Chemistry): Multiphoton Absorbers in Therapy and Imaging. It primarily focuses on molecular photonics, but also on molecular electronics. **FR:** ISCR, IPR, IBMM, LCPQ, ICMR. **AUS:** ANU, U. of Sydney, Curtin University, UWA.

SocNetMM (Ecology): Social Communication Network in Marine Mammals. **FR:** NeuroPSI, CSGA, CRNL, CEFE. **AUS:** Macquarie University, Taronga Zoo, Taronga Conservation Society Australia, U. of Sydney, Phillip Island Nature Parks

INTERNATIONAL RESEARCH NETWORKS: 5 IRN

FACES (Energy): French-Australian research network on Conversion and Energy Storage for stand-alone & maritime applications. **FR:** ICMPE, ICMCB, IEM, IMN, FEMTO-ST, IMS, LAPLACE, AMPERE. **AUS:** UNSW, Deakin University, UNiSA, Flinders.

FALCoL (Geology): Study of the continental lithosphere transfers from the Mantle to the Critical zone. **FR:** GET, GeoRessources. **AUS:** CET, CSIRO

I² (Astrophysics): The Interstellar Institute studies the structure and complexity in the Universe. (Main) **USA:** STSI, JHU, UWW, Rutgers, Princeton, Harvard, UNC, UMass, UWM, CalTech. **FR:** AIM, IRAP, IAS. **CAN:** UBC, UT, NRC Herzberg. **AUS:** ANU, Macquarie. **GER:** MPIA. **AUSTRIA:** U. Wien. **ITA:** SNS Pisa

PhilInBioMed (Philosophy of Science): The Institute for Philosophy In Biology and Medicine aims at advancing philosophy in the biological and medical sciences. (Main) **USA:** U. Chicago, MBL, ASU, UU, UC, UP. **FR:** ImmunoConcept, IHPST. ; **UK:** Cambridge, Exeter. **AUS:** U. of Sydney. **Austria:** Konrad Lorenz Institute

WONDER (Biotechnology): Biofuel and material production from microalgae. (Main) **JAP:** University of Tsukuba. **FR:** GEPEA. **AUS:** Murdoch University. **USA:** UCLA, UCSD.

INTERNATIONAL EMERGING ACTIONS: 9 IEA

COMPEX (Chemistry): Towards exotic compositions of transition metal oxides used as positive electrode materials for Li or Na batteries. I**FR:** ICMCB. **AUS:** UNSW.

ECHAPH (Environment): Environmental Changes and Heritage in Atlantic and Pacific Hillforts. **FR:** CReAAH. **AUS:** University of the Sunshine Coast.

MARGEN (Biology): Plastic evolution of asexual reproduction and coloniality in benthic marine animals. **FR:** LBDV. **AUS:** University of Queensland.

MECAPOP (Environment): Underlying MEChAnisms of seabird POPulation performances at sea: spatio-temporal prey accessibility. **FR:** IPHC. **AUS:** Phillip Island Nature Parks.

MIR_ALPhFA (Engineering): Integrated medium infrared sources developed within the framework of IRP ALPhFA **FR:** INL. **AUS:** RMIT University.

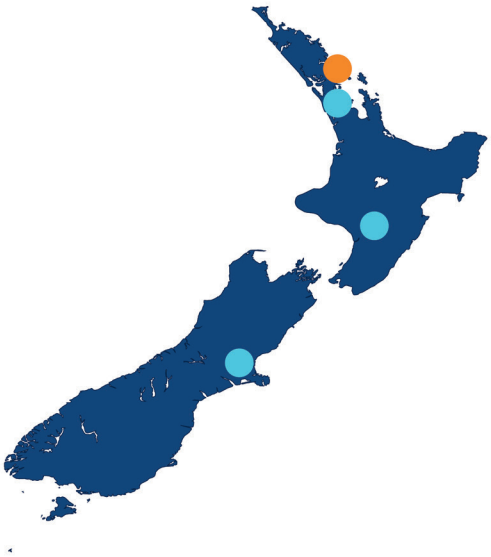
NANOMOBILITY (Geochemistry): Resolving element mobility at the nanoscale in phosphate minerals. **FR:** LGL-GTPE. **AUS:** Curtin University.

PSEUDOSPECS (Chemistry): dedicated to the use of a new method (SPECS) to unveil the pseudocapacitive behavior of electrode materials. **FR:** IMN. **AUS:** University of Newcastle.

QUAP (Physics): Quantum Polaritonics. The aim of QUAP is to explore an alternative strategy in which the electronic confinement is not required. **FR:** Institut Néel. **AUS:** Macquarie University.

ROSIA (Engineering & Health): Bone remodeling and adolescent idiopathic scoliosis: to better understand the mechanisms of the disease through coupled experimental & theoretical approaches. **FR:** MSME. **AUS:** Queensland University of Technology.

CNRS COOPERATIONS WITH NEW ZEALAND



LEGEND
- 3 IRP : International Research Projects
- 1 IEA : International Emerging Actions

NEW ZEALAND

3 IRP
AntarctPlantAdapt (Environment)
VinAdapt (Agrosystems & climate)
WALL-IN (Physics)

1 IEA
QIWI (Geophysics)

University of Auckland. https://www.auckland.ac.nz/
University of Canterbury. https://www.canterbury.ac.nz/
Massey University. https://www.massey.ac.nz/
University of Otago. https://www.otago.ac.nz/
Lincoln University. https://www.lincoln.ac.nz/
New Zealand Institute for Plant & Food Research Limited. https://www.plantandfood.com/
Bragato Research Institute. https://bri.co.nz/

INTERNATIONAL RESEARCH PROJECTS: 3 IRP

VINADAPT (Agrosystems & Climate): High-resolution scenarios for adapting agrosystems to climate change: application to viticulture. **FR:** LETG, Biogéoscience, EGFV, AGROCLIM. **NZ:** University of Canterbury, Lincoln University, New Zealand Institute for Plant & Food Research Limited, Bragato Research Institute.

AntarctPlantAdapt (Environment): Adaptation of Antarctic Plants to Climate Change. **FR:** ECOBIO, ESE. **NZ:** Massey University, University of Otago.

WALL-IN (Physics): Confining walls-of-Light in nonlinear Kerr resonators. Study of nonlinear dynamics occurring in optical Kerr resonators. **FR:** ICB. **NZ:** University of Auckland.

INTERNATIONAL EMERGING ACTION: 1 IEA

QIWI (Geophysics): Quantitative Imaging of Water-column Inhomogeneities using backscatter acoustic signal. **FR:** Géosciences Rennes, IFREMER. **NZ:** NIWA. **AUS:** CSIRO; IMAS-UTAS.

INTERVIEWS WITH SOME CNRS PROJECT COORDINATORS IN OCEANIA

AUSTRALIA

International Research Laboratory CROSSING,
Jean-Philippe DIGUET, DR CNRS
Director of CROSSING, IRL CNRS 2010
crossing.cnrs.fr

International Research Project CANECEV,
Frédéric Thomas, MIVEGEC UMR 5290 –
IRD CNRS University of Montpellier,
cnrssingapore.cnrs.fr/project/irp-canecev/

International Research Project FEMIDAL,
Patrick Caudal, CR HC, LLF, UMR 7110,
CNRS & University of Paris,
cnrssingapore.cnrs.fr/project/irp-femidal/

International Research Project MAITAI,
Frédéric Paul, (DR CNRS, PI),
UMR CNRS 6226 (ISCR-COrInt Team),
cnrssingapore.cnrs.fr/project/irp-maitai/

NEW ZEALAND

International Research Project WALL-IN,
Julien Fatome, ICB UMR 6303
CNRS-University of Bourgogne,
cnrssingapore.cnrs.fr/project/irp-wall-in/

Photo: IEA MARGEN. Colony of Clavelina lepadiformis. Credits: Alexandre Jan

IRL CROSSING. "We brought together an exciting multidisciplinary team"

The CNRS International Research Laboratory CROSSING stands for frenCh austRalian labOratory for humanS / autonomouS agents teamING. Jean-Philippe Diguet, DR CNRS and Director of the IRL CROSSING, gives us an insight into this new laboratory and the collaborative research happening there.

Can you explain the general context of your research in Australia within a CNRS International Research Laboratory?
Jean-Philippe Diguet: The work of CROSSING addresses a key question for our future: how can humans effectively work and interact with artificial intelligence agents? Across the CNRS network and our partners in Australia, we have brought together an exciting multidisciplinary team not only from computer science, engineering, artificial intelligence and machine learning but also biological psychology, human factors and behavioural neuroscience. In Adelaide, we have access to outstanding research facilities at the University of Adelaide (AI/Computer vision, active vision), UniSA (Sleep and Fatigue Lab., Augmented/Virtual reality) and Flinders University (Autonomous marine vehicles, Line zero).

What types of applications do your research activities lead to, and which fields would they suit to?
Any application field where AI and humans may today or one day interact, share tasks and responsibilities. We have considered several real world use cases – for example, how teams within an industry workplace interact, the scheduling of health workers, assistive systems at home and operational mission systems. Consider, for example, a search and rescue mission. Using results from CROSSING work, members of a hybrid team could share information within a common workspace using mixed reality. This would increase the team's understanding of which areas to explore next, the state of equipment and help to assess the state of the human operators (e.g. workload) and artificial agents (e.g. battery level, CPU load). Then a mission management plan could be tasked to a human assisted by an AI and vice-versa.

The IRL CROSSING has been created in 2021 with one of the focuses being artificial intelligence. Why is AI so important these days?
The presence of AI is growing in all domains with the aim to automatize and reduce execution time of tasks as well as to optimize processes in working, living and leisure environments. But a real challenge for the future is to find the best way to dynamically balance tasks and roles between humans and AIs. It is crucial to get the best of the two worlds while keeping the human in the decision and training loops. First humans must keep the understanding of (background and foreground) knowledge in order to able to make well-informed strategic decisions in all domains. Secondly it's important to keep in mind that we want an effective hybrid team and that means making sure we use each where they are most effective. So while AI agents are faster than humans to compute a sheer volume of information, humans are much better at making inferences on the basis of sparse data, humans are also much more energy efficient and very adept at thinking using analogies and making generalisations.

Why are multidisciplinary collaborations important towards research in finding new ways for systems and humans to work together?
The scientific question is by definition multidisciplinary since we must find new ways of representing and analysing human behaviour, developing AI algorithms that work and learn from humans, as well as new forms of interaction environments. Of course, a key part of this work will be to devise ways of implementing these approaches on energy efficient hardware that can be used in complex environments.
CROSSING can rely on experts in human factors, biological psychology, behavioural neuroscience, AI, Computer vision, Robotics, AR/VR, Ergonomics, Embedded systems. CROSSING welcomes French researchers keen to collaborate on such topics but is also open to new fields such as Philosophy, Ethics or Mathematicians for instance. We encourage anyone with interest in these topics to contact us – at the very least it will be a good conversation!

What criteria led to involving these Australian Universities in particular?
The conversations arose around exchanges between our two countries. Scientists from CNRS had many conversations with interested collaborators from these domains in Adelaide and in France. We realized that we were lucky enough to have found a group of researchers from diverse backgrounds who were curious

Some members of the CROSSING team (front left to right: Cédric Buche, Philippe Rauffet, Mathieu Issartel, Anna Ma-Wyatt, Thomas Chaffre, Margaret Law, Karl Sammut) in Adelaide. Credits: Jean-Philippe Diguet

about the same kinds of questions and open to collaborating on these multidisciplinary topics. Several workshops helped a lot with the development of our collaborations, and we are grateful to the French Embassy, Brittany Region and the government of South Australia, as well as the University of Adelaide, UniSA and Flinders University for supporting our work.
We are lucky to count amongst our number here in Adelaide experts from computer science, engineering and human factors at the University of Adelaide (including the Australian Institute for Machine Learning and the Active Vision Lab), as well as experts in computer science and biological psychology from UniSA (including the Australian Centre for Interactive Virtual Environments and the Brain-Behaviour-Body Lab) and high level facilities in maritime engineering and industry 4.0 at Flinders University (including the Centre for Maritime Engineering, and Line Zero).

Naval Group is a member of CROSSING IRL, what are the benefits of such a collaboration on your research?
Naval Group provides the industrial vision that includes current challenges especially in the maritime domain. It means the design, the use and the maintenance of various equipment and devices. As discussed before, automation of systems and sensors is increasing and becoming more complex in many domains. Naval Group understand that human-AI interaction and cooperation represents a significant challenge and opportunity for our industrial future. These new ways of using AI and new forms of human-AI interaction could have a significant impact on how major platforms are designed and operated.

Tell us more about the next chapters for CROSSING in terms of cooperation between France and Australia?
So far, we have 3 PhD on-going cotutelle PhD thesis and 3 to start in 2021 that are / will be co-supervised by Australian and French researchers. We are currently working on multiple multidisciplinary projects related to the 4 pillars of our scientific roadmap and these will be submitted to Australian or French research agencies for funding. We are also working with the French Embassy, CNRS and our Australian and French partners to identify opportunities for PhD and postdoctoral students to visit CROSSING, and for students in Adelaide to work with French labs. We have already started to meet with stakeholders in application domains to better understand how we can use our results effectively in the field.

IRP CANECEV. "We consider all oncogenic processes"

The CNRS International Research Project CANECEV (for CANcer in Ecology and EVolution) is a French-Australian collaboration on the roles of cancer in Ecology and Evolution and vice versa. Frédéric Thomas, MIVEGEC UMR 5290 – IRD CNRS University of Montpellier, gives us an insight of the research and achievements happening within the IRP CANECEV.

Can you explain the general context of your research in Australia within a CNRS International Research Project?

Frédéric Thomas: Oncology as a scientific field has, until very recently, developed in relative isolation from ecological and evolutionary sciences. This is unfortunate because links between these disciplines have the mutual potential to reveal new perspectives and lines of research. For instance, while cancer is traditionally considered as a distinct pathology from a medical point of view, interdisciplinary approaches reveal that it is instead an unavoidable dynamic phenomenon governed by evolutionary principles and ecological relationships. This is not a semantic problem, but rather a fundamental necessity to transform our understanding of cancer, its origin, the possible ways to control neoplastic progression and, probably most importantly, to prevent therapeutic failures. Similarly, while ecologists have ignored oncogenic phenomena, their roles on ecosystem functioning could in fact be significant due to carcinogenesis influencing individual competitive and dispersal abilities, susceptibility to pathogens and vulnerability to predation. These processes are exacerbated nowadays given that most, if not all, ecosystems of our planet are polluted with mutagenic substances. Despite recent progress towards greater convergence and dialogue between scientists working on oncology, ecology and evolutionary sciences much remains to be done to achieve full integration of these disciplines. Beata Ujvari (Deakin University), Rodrigo Hamede (University of Tasmania) and Frédéric Thomas (CNRS) have a strong common interest for this topic, it was thus natural to have the ambition to bring our institutions together into an international Research Project.

By combining approaches on different biological models, we expand the perspective of our understanding to various ecological and evolutionary scales. Our IRP aims at filling an important gap in ecology and evolution, exploring research directions never explored before.

Another reason to develop this IRP with Australian universities is also that there are in Australia highly relevant and original model systems, especially a transmissible cancer in an emblematic species (Tasmanian devil).

This partnership has been going on since 2017. In your opinion, how is the research evolving in Australia since then and how has evolved your particular partnership with Australia?

Our partnership was initially focused on researches concerning the influence of oncogenic processes in animal ecology. During these last years we have expanded our interests. Now our scientific objectives are to perform a large diversity of research on cancer, provided they rely on ecological and evolutionary approaches.

For instance, our five main projects at the moment are: to improve our understanding of the origin and the evolution of cancer since the dawn of multicellularity, and decipher the rules that govern the differential vulnerability of animal species to cancer (Comparative ecology);

to improve our understanding of the ecology of host-tumor interactions along the tumorigenesis process (Life-history traits, behavior ecology, chemical ecology);

to determine why transmissible cancers emerge? How do they evolve? What are their ecological and evolutionary impacts and how to manage/mitigate them? (Field and molecular work on Tasmanian devils and on a transmissible leukemia in bivalves);

to apply evolutionary principles to help predict emergence and metastatic progression with the aim of improving, or even designing novel, evolutionary based therapies (Mathematical modelling and collaborations with oncologists and cancer researchers);

to determine how oncogenic processes interfere with biotic interactions that govern ecosystems (competition, predation, parasitism, symbiosis), and to predict the outcomes of mutagenic pollutions for biodiversity and ecosystem stability (Field and experimental studies, Mathematical modelling).

What makes this IRP CANECEV project so particular in terms of transdisciplinary?

The French and Australian scientists with different expertise form an interdisciplinary team with complementary skills and experience on the various approaches to be developed in the IRP. Our center will also act as an organization open to all, and a

The International Research Project CANECEV leads experimental studies involving Hydra and Tasmanian devils. Credits: F. Thomas and J. Boutry

place to facilitate and encourage exchanges and collaborations between national and international specialists in various disciplines (mathematics, cellular biology, evolutionary biology, conservation biology, and clinical research), with the main focus on cancer.

What is the main difference between this project and other projects studying animal cancers?

Although theories of cancer initiation and progression are deeply rooted in evolutionary and ecological concepts, many promising opportunities for the application of evolutionary biology to carcinogenesis and oncology remain unexplored. This is true for human cancers but also for animal cancers. Thus, a first and major difference between CANECEV researches and other projects studying animal cancers is that we consider malignant progression as ecological and evolutionary processes. A second major difference in our approach is that we consider all oncogenic processes, from premalignant lesions to metastatic cancers because we are convinced that even sub-clinical cancers are likely to influence key variables in ecology and evolution (competitiveness, resistance to parasites, to predators, ability to disperse). Our approach is novel since at the moment researchers in ecology and evolution have ignored oncogenic processes in their studies.

Our research is also very timely because, as said before, cancer incidence in animal species should increase significantly in a near future given that most, if not all, ecosystems on our planet are now polluted by mutagenic substances to a greater extent than ever before.

Tell us more about the next chapters for the IRP CANECEV?

CANECEV-2, in the continuity of CANECEV-1, will provide an ideal scientific environment for collaborative projects between CREEC, Deakin University and the University of Tasmania. Following the success of CANECEV-1, it is easy to anticipate that this fruitful collaboration between our institutions will be again successful. Through the CANECEV-2 IRP it will be a possible to continue conceptual and modelling works, but also to further our collaboration by co-supervising students on experimental studies involving Tasmanian devils, bivalves, hydra and mice. We will continue to submit our finest work to the leading generalist journals, while also targeting very high impact factor journals in the fields of cancer and evolution. We will also present our results at international conferences on cancer and/or evolutionary biology.

Several participants in this IRP are involved in teaching activities. We plan to publish a second edition of our book Ecology and Evolution of Cancer (Elsevier), as our objectives remain to communicate our results to the broad scientific community and to the general public. Finally, several applied perspectives are possible, such as conservation biology, improving our knowledge of the interactions between oncogenic processes, intra/interspecific interactions and animal behaviour and searching for novel therapeutic solutions against cancer.

The IRP CANECEV-2 has recently received a strong financial support from André Hoffmann, via the MAVA Foundation.

IRP MAITAI. "Developing molecular-sized multiphotonic absorbers is an exciting challenge"

The CNRS International Research Project MAITAI (for Multiphoton Absorbers In Therapy And Imaging) is a French-Australian collaboration in chemistry. Frédéric Paul, (DR CNRS, PI), UMR CNRS 6226 (ISCR-COrInt Team), tells us more about the IRP MAITAI.

Can you explain the general context of your research in Australia within a CNRS International Research Project?

Frédéric Paul: In collaboration with the group of our principal partner Mark Humphrey, at the Australian National University (ANU) in Canberra, we develop original molecules endowed with multiphotonic absorption properties, called "multiphotonic absorbers". The design and synthesis of prototypical multiphotonic absorbers is initiated in our group at the University of Rennes 1 (UR1) in France.

In a second step, based on the experimental measurements of their linear optical (LO) properties done at the UR1, the synthesis of analogues with improved NLO properties and their experimental evaluation is done at the ANU. These two steps are backed by computational modeling of their electronic structure and of their relevant key properties obtained in collaboration with local theoretical chemists at both universities. Finally, biological (in vivo and in vitro) testing or selected structural modifications can be required on these molecules, requiring specific expertise in synthesis. These are done in collaboration with other universities in Australia (Perth, Curtin, Sydney) and France (Reims, Montpellier Toulouse).

Thus, whereas the overall work is coordinated by both the French (F. Paul) and the Australian (M. G. Humphrey) leaders of this IRP, the genesis of an efficient multiphotonic absorber adapted to a given need stems from a collective effort involving the combination of widely differing skills present within the current research consortium of MAITAI.

Tell us more about the storyline of the IRP MAITAI. Why are multiphotonic absorption (MPA) and organometallics at the core of this IRP MAITAI?

This IRP results from a long-standing collaboration between the group of Mark G. Humphrey and ours, which goes back to the early 2000's when both of us were working on redox-active metal-alkynyl d8 complexes. Since his arrival at ANU in the late 90's, Mark started to systematically investigate the nonlinear optical (NLO) properties of various organometallic species, thanks to his unique NLO platform developed at the ANU in collaboration with a local physicist, Marek Samoc.

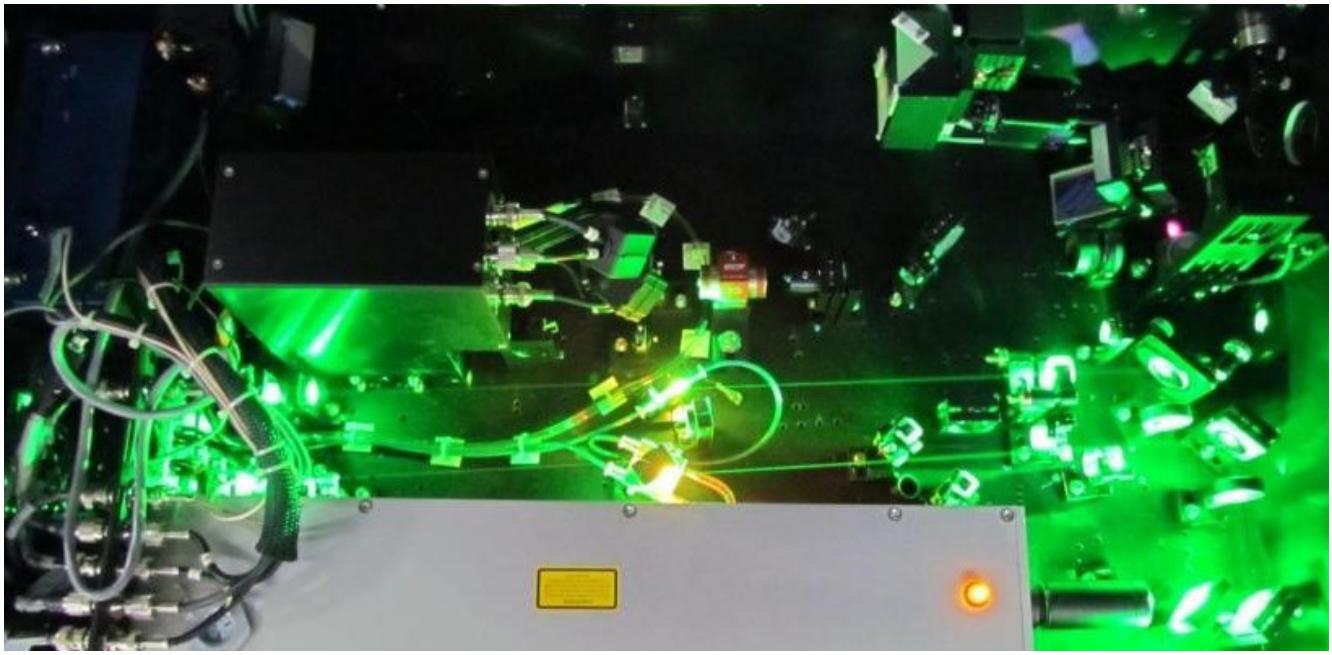
In the frame of a French-Australian Science & Technology (FAST) project started in 2003, we disclosed together the 3rd-order NLO properties of a set of original organoiron derivatives, showing the promoting effect of the polarizable iron center on their NLO properties.

In the frame of several short-term bilateral (PAI) or PICS projects we continued our investigations and were the first to report original multinuclear heterometallic assemblies featuring redox-switchable third-order NLO properties between three states or more. We then pursued our work on NLO-active organometallics. More recently, during the Redochrom LIA, we were more focused on multiphotonic absorption, a specific 3rd-order NLO phenomena also positively impacted by the presence of transition metal atoms. Finally, given the impressive range of innovative applications supported by multiphotonic absorbers in the medical field, the new IRP MAITAI was specially focused on the study of selected organometallic derivatives of that kind.

What types of applications do your research activities lead to, and which fields would they suit to?

Multiphotonic absorption has emerged as a remarkable photo-physical process with very promising societal applications, from improved information processing or storage to innovative medical applications. Furthermore, only NLO-active molecules offer the most promising prospects in terms of ultimate miniaturization.

In this context, developing new and very active molecular-sized multiphotonic absorbers is an exciting challenge. It presents an important fundamental facet, since the role of transition metal centers on MPA is still not very well understood. One of our objectives is to define design criteria for the various families of these molecules, allowing to enhance their MPA properties. In parallel, in order to demonstrate some applied outcomes, we have focused our interest primarily on health-related issues. We will try to develop new multiphotonic absorbers for bio-imaging and photodynamic (cancer) therapy. In this respect, some purely organic derivatives will also be included in the pool of molecules of interest.



Checking the laser beaum alignment on a Z-scan optical bench at the Australian National University. Credits: Hendrik Maat, 2016.

In your opinion, how is the research evolving in Australia since then? And how has evolved your particular partnership with Australia?

The way research was funded was drastically different in both countries when we started collaborating together in the 2000's, but with the progressive disappearance of recurrent funding in France, the French way has now become more similar to the Australian one, with the necessity of applying regularly to various funding agencies to obtain financial support. However, fundamental research has kept a dominant share in the way Australian research projects are evaluated. Whereas in France, the need to show short term connections with applicative outcomes has become predominant.

In parallel to this evolution, I think that Australian students are realizing that the future scientific challenges are global ones. As a result, they start opening themselves even more to the outside world. Especially now that exchanges with China are becoming more complicated, they realize that lots of interesting research is happening in Europe and they are ready to spend some time there.

At least this is was what we experienced with our collaboration before the COVID pandemic shut down every physical exchange two years ago.

Tell us more about the next chapters for the IRP MAITAI?

On the applied side, the challenge of this IRP will be to demonstrate that transition metals can be profitably used to make new active principles for imaging or cancer therapy based on enhanced MPA. We hope we will be able to interest and embark some companies in this ambitious project within the coming years.

Then, on the more fundamental side, the project is also really exciting, because, by taking advantage of the interplay between the redox-multistability brought by some transition metal centers, which leads to a marked linear (and nonlinear) redochromism, and an enhanced nonlinear activity at selected wavelengths, unexpected perspectives for controlling the photonic activity via electron exchange at the molecular level are opened.

These will require the unique instrumental pool and scientific expertise gathered around our IRP to be pursued and realized.

Then, beside health concerns, the new molecules and corresponding molecular materials that might result from these studies could also be of interest for other strategic technological fields currently concerned by MPA (all-optical light switching, ultradense information storage, light beam shaping and filtering, etc).

Finally, a "dream" that we share with our Australian partners would be to manage developing in the frame of this IRP a common international course focused on the peculiar photonic and electronic molecular aspects which underlies our collaborative research. However, given the huge differences in timeframe and motivations between the teaching in French and Australian universities, clearly some more work will be needed there.

For all these goals, the support of the CNRS in France and of the corresponding state research agencies in Australia will prove essential.

IRP FEMIDAL. "Developing joint descriptive and theoretical, formal, experimental works on Australian languages"

The CNRS International Research Project FEMIDAL (Formal/Experimental Methods and In-depth Description of Australian Indigenous Languages) is a French-Australian collaboration focused on the study of Australian indigenous languages. Patrick Caudal, (CR HC, LLF, UMR 7110, CNRS & U. Paris), gives us an insight of the research and achievements happening within the IRP FEMIDAL.

Can you explain the general context of your research in Australia within a CNRS International Research Project?

FEMIDAL is a collaborative research program bringing together Australian academics from Europe and Australia working on formal and experimental linguistics, and/or Indigenous Australian languages. While members of the project belong to a dozen different research institutions, FEMIDAL is spearheaded by the Laboratoire de Linguistique Formelle (UMR CNRS 7110) at the Université de Paris, and the School of Languages and Linguistics at the University of Melbourne.

Its aim is to contribute to developing joint descriptive and theoretical / formal / experimental works on Australian languages, especially non-Pama-Nyungan languages spoken in Northern Australia, and to strengthen existing links between French / European and Australian institutions in this domain. Non-Pama-Nyungan languages, and Australian languages in general, possess many typologically rare and complex features, and are also critically endangered. They can be therefore regarded as a priority for linguistic research, be it descriptive, theoretical or typological.

What types of applications do your research activities lead to, and which fields would they suit to?

Our research activities are mainly dedicated at documenting, analyzing and construing theoretical, experimental and formal models for under-described Indigenous languages spoken in Australia. Not only will they contribute to bolstering our knowledge of these typologically remarkable languages, but they will also have practical benefits for communities associated with the studied languages, in the middle to long run.

Direct benefits comprise helping preserving key knowledge related to (often critically) endangered languages and generally documenting not only linguistic phenomena, but also ethnolinguistic matters of cultural significance – project outcomes (including scholarly publications such as sketch grammars, theoretical articles, etc., but also field recordings and annotated corpora) will of course be made available to the relevant communities in various forms (both as printed and electronic material).

FEMIDAL will thus indirectly benefit said communities by developing linguistic and ethnolinguistic resources upon which revitalization programmes and other types of cultural development programmes will be able to capitalize.

Why is Australia a perfect match for this IRP FEMIDAL collaboration?

As the IRP focuses on Australian Indigenous languages, collaborating with Australian institutions was an obvious choice.

Melbourne University stood out as a potential partner, both in terms of expertise, man power for research, and existing scientific links with both the CNRS in general, the Laboratoire de Linguistique Formelle in particular.

Indeed, LLF and the School of Languages and Linguistics at the University of Melbourne have been engaged in collaborative work for well over a decade now.

Tell us more about the next chapters for the IRP FEMIDAL?

We are eagerly awaiting the end of the current sanitary crisis, which has had a significant impact on planned secondments, as well as fieldwork – Indigenous Australians living in remote communities are often disadvantaged in terms of access to healthcare, and are regarded as at-risk populations with respect to infectious diseases such as covid, so access to field site has been severely restricted for the past eighteen months.

Confronted with these obstacles, the project is looking at remote collaborative actions to maintain a substantial level of activity, including yearly online workshops and monthly seminars.

Our main target for the next couple of years will be to initiate the creation of an areal typological online database for Australian languages, comparable to the SAILS database for Indigenous languages of the Americas.

In spite of the covid crisis, the project has already been instrumental in setting up two jointly directed PhDs, including one cotutelle PhD, and it is our hope that it will provide a fruitful environment for fostering additional collaborative PhD and joint postdoc research projects.

Senior language officer Judy Lalara (Groote Eylandt Language Center, Angurugu, N.T.) being interviewed by Patrick Caudal at Umbakumba boat ramp, Umbakumba community, Groote Eylandt, N.T., 07/07/2016.
Credits: Patrick Caudal.

IRP WALL-IN. "WALL-IN benefits from our complementary expertise"

The CNRS International Research Project WALL-IN (confining walls-of-Light in nonlinear Kerr resonators) is a French-New Zealand collaboration focused on the study of nonlinear dynamics occurring in optical Kerr resonators. Julien Fatome, ICB UMR 6303 CNRS-Université de Bourgogne, gives us an insight of the research and achievements happening within the IRP WALL-IN.

Can you explain the general context of your research in New Zealand within a CNRS International Research Project?

Julien Fatome: The WALL-IN project is an International Research Project (IRP) focused on the development of future photonic devices based on the confinement of light in optical resonators. This international partnership has started in early 2021 and relies on a close collaboration between the Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB) located in Dijon and the photonics group of The University of Auckland in New Zealand (UoA). The WALL-IN project is managed by Julien Fatome (CNRS Research Engineer in ICB) and Stéphane Coen (Associate Professor in UoA).

Our leitmotiv is to combine the complementary expertise in nonlinear optics of our two groups to carry out experimental, numerical and theoretical research around the physics and applications of coherently driven nonlinear resonators, such as macroscopic fiber loops and integrated microresonators.

What are optical frequency combs (OFCs) and what will be your approach to them within this IRP WALL-IN?

Optical frequency combs (OFCs) are light sources which emit a broad and coherent spectrum made of thousands of discrete and evenly spaced frequency lines. They can act as "spectral optical rulers" that enable measurements of unknown optical frequencies with astonishing precision. Frequency comb systems commercially available mainly rely on bulky ultrashort-pulse lasers or supercontinuum technologies. However, a fundamentally different approach has been demonstrated in 2007, for which a single frequency laser beam was shown to be transformed into an evenly-spaced comb when confined into a whispering gallery mode microresonator, a tiny sub-millimetre optical ring. It is now well understood that such OFCs in nonlinear resonators are based on the emergence of robust, localized and short pulses of light called dissipative cavity solitons.

Nonetheless, cavity solitons are mostly restricted to optical platforms characterized by anomalous group velocity dispersion, which dramatically limits the range of available materials and thus potential applications. The main idea of the WALL-IN project is therefore to exploit the vectorial nature of light in two-component resonators to counter-intuitively generate ultra-short bright temporal structures in normally dispersive cavities, hence associated to the emergence of broad coherent frequency combs.

What types of applications do your research activities lead to, and which fields would they suit to?

Since their respective experimental observations in 2007 and 2010, generation of frequency combs and cavity solitons in optical resonators has become one of the most active fields of research in the nonlinear optics community all around the world.

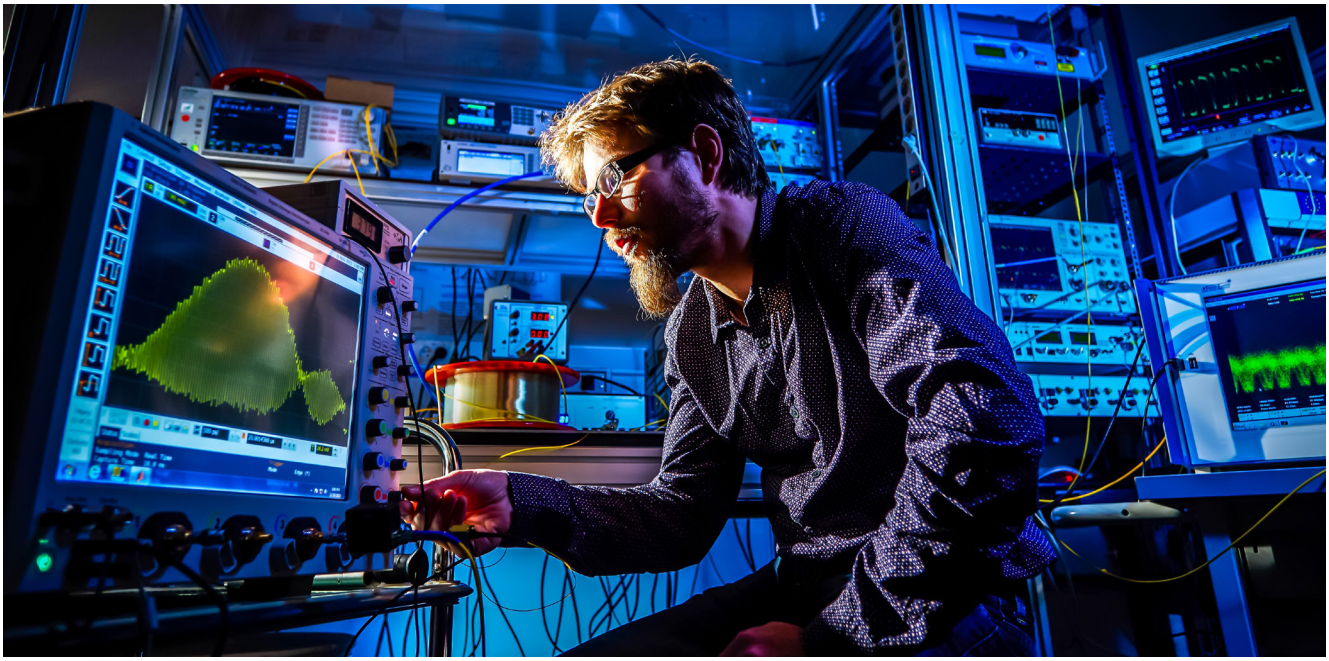
Indeed, because of their unique properties, such ultra-stable OFCs have the potential to revolutionize a number of applications ranging from massively multiplexed optical communications, optical buffering, metrology, detection of extra-solar planets, medical diagnostics, pollution monitoring or spectroscopy.

In the framework of the Wall-IN project, we are currently focusing our research on the development of novel all-optical functionalities such as flip-flop memories, random number generation and combinatorial optimization.

Two members of the IRP WALL-IN have received prizes for their research. What is the impact of these prizes for the IRP WALL-IN?

Two researchers involved in the Wall-IN project have recently received prestigious prizes for their achievements in the early stage of their career. On the one hand, Dr Miro Erkintalo, Associate Professor at the University of Auckland, was awarded the 2019 New Zealand Prime Minister's MacDiarmid prize for his outstanding contribution in the field of nonlinear optics. On the other hand, Dr Bertrand Kibler, CNRS researcher at the ICB laboratory was awarded the 2020 Fabry-de Gramont prize for his pioneering contribution to a better understanding of the formation of rogue waves in nonlinear optics and hydrodynamics.

Even though these prizes award 10 years of outstanding research contributions from Miro and Bertrand, their achievements would not be possible without a



Julien Fatome in the photonics lab at the Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB) in Dijon, France. Credits: Alexis Chézière

team. Consequently, these prizes translate in an international recognition of the quality and expertise of both groups involved in the WALL-IN project, pushing further our motivation to perform breakthrough research all-together.

How does the collaboration between New Zealand and France make the IRP WALL-IN research thrive?

As part of the most productive research groups in the nonlinear fiber optics community, researchers from the ICB laboratory and UoA have known each other for over 10 years. We have occasionally collaborated on several topics dealing with nonlinear dynamics in optical fibers. Often initiated through informal discussions during meetings, workshops or international conferences, those topics cover a wide range of applications such as supercontinuum, rogue waves or dispersive shock waves.

More recently, we have pushed this collaboration further by working together on the highly internationally relevant topic of cavity solitons and related OFCs.

In that context, our project benefits from our complementary expertise in, respectively, temporal cavity solitons (UoA) and polarization nonlinear dynamics (ICB).

Additionally, our collaboration has been strongly reinforced by two 3-months-long academic stays at UoA in 2015 and 2017, as well as the hiring of a former ICB postdoc Dr Gang Xu at UoA for a 2-years position.

In January 2020, I started a third stay at the UoA through a different funding mechanism co-funded by the CNRS, the Conseil Régional de Bourgogne Franche-Comté and UoA. This long stay has a strong impact on my career and on our collaboration, already highlighted by 20 common scientific contributions.

More generally, it represents an outstanding opportunity for a career, as well as for the CNRS to establish long-term international collaborations.

Tell us more about the next chapters for the IRP WALL-IN?

Short-term, I have extended my stay at UoA until February 2022, under a CNRS "mise à disposition" mechanism in order to start the second stage of our research program dealing with the generation of localized structures in normally dispersive Kerr resonators.

On a mid-term perspective, we hope that the WALL-IN project will benefit from the lifting of pandemic-related travel restrictions to involve more students and young researchers from both sides in this collaborative project.

Finally, in the long-term vision, I am really convinced that reinforcing collaborations through structural partnerships such as International Research Laboratories (IRL) with the photonics community in Oceania represents a strong opportunity for the CNRS and a win-win two-way transfer of knowledge. Indeed, research in science has become a worldwide, strategic, ultra-competitive activity (unveiled even more by the COVID pandemic crisis) and clearly, we are much stronger all together.

In this context, the CNRS should push in that direction by encouraging and facilitating further the mobility of researchers and engineers.

Notes

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Front cover photo
Transmission of an Argon laser light beam in an optical fiber.

Credits: *J. Fatome & S. Pitois.*

Back cover photo
Large Magellanic Cloud in visible light showing active star forming regions.

Credits: *Ciel Austral.*