

## EVALUATION REPORT OF THE UNIT

BCPLM - Biologie du Chloroplaste et Perception  
de la Lumière chez les Microalgues

### UNDER THE SUPERVISION OF THE FOLLOWING ESTABLISHMENTS AND ORGANISMS:

Sorbonne Université

Centre national de la recherche scientifique -  
CNRS

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**EVALUATION CAMPAIGN 2023-2024**  
GROUP D

Report published on February, 09 2024

High Council for evaluation of research and higher education



In the name of the expert committee<sup>1</sup> :

Felix Kessler, Chairman of the committee

For the Hcéres<sup>2</sup> :

Stéphane Le Bouler, acting president

In accordance with articles R. 114-15 and R. 114-10 of the Research Code, the evaluation reports drawn up by the expert committees are signed by the chairmen of these committees and countersigned by the president of Hcéres.

To make the document easier to read, the names used in this report to designate functions, professions or responsibilities (expert, researcher, teacher-researcher, professor, lecturer, engineer, technician, director, doctoral student, etc.) are used in a generic sense and have a neutral value.

This report is the result of the unit's evaluation by the expert committee, the composition of which is specified below. The appreciations it contains are the expression of the independent and collegial deliberation of this committee. The numbers in this report are the certified exact data extracted from the deposited files by the supervising body on behalf of the unit.

## MEMBERS OF THE EXPERT COMMITTEE

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Mr Stéphane Régnier, Sorbonne Université  
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## CHARACTERISATION OF THE UNIT

- Name: Biologie du Chloroplaste et Perception de la Lumière chez les Microalgues
- Acronym: BCPLM
- Label and number: UMR 7141
- Composition of the executive team: Director of the unit: Mr Francis-André Wollman (1997-2019), Ms Angela Falciatore (2019-present), Deputy Director: Mr Yves Choquet (2021-present)

## SCIENTIFIC PANELS OF THE UNIT

SVE Sciences du vivant et environnement

SVE2 Productions végétales et animales (agronomie), biologie végétale et animale, biotechnologie et ingénierie des biosystèmes

## THEMES OF THE UNIT

The laboratory "Chloroplast Biology and Light-sensing in Microalgae" studies multiple aspects of the life of phototrophs, focusing on two interrelated processes: photosynthesis and light perception. The distinctive feature of this laboratory is that during the last contract it developed an integrative vision of photosynthesis and light perception, from the molecular events of photosynthesis studied at the nanosecond scale using cutting-edge biophysics approaches, to the regulation of photosynthesis and response to light at the scale of marine diatom communities.

The laboratory is organized around six research themes, each member of the laboratory being involved in several research themes. Among these research topics, three explore the regulation of the photosynthetic apparatus at different scales, from the molecule to the physiology of the cell. It combines biophysics, for which the research unit is internationally and historically renowned (since the early days under Professor Pierre Joliot), molecular biology and genetic approaches to understand the biogenesis of chloroplasts and the photosynthetic apparatus, as well as the regulation of photosynthetic activity. Of note is the diversity of organisms used in the laboratory to tackle these questions. The alga *Chlamydomonas reinhardtii* and to a lesser extent cyanobacteria have served as model systems for decades whereas diatoms have been included in research projects just during the last contract. The unit uses its biophysics expertise now also on the diatoms, highlighting the successful integration of old and new research areas. Moreover, this has allowed the laboratory to probe the diversity of mechanisms involved in the regulation of photosynthesis in ecologically relevant species and to become a clear leader in the field. As another indication of leadership, the research unit has successfully established *Cyclotella cryptica* as a new molecular genetic model for the study of photosynthesis in diatoms. *C. cryptica* is a facultative phototrophic centric diatom species whose genome has been recently sequenced. Taking advantage of its ability to grow heterotrophically in the presence of glucose, they have isolated the first photosynthetic mutant in this organism, opening the way for the genetic dissection of chloroplast function in diatoms. A complementary research axis is the study of light perception in photosynthetic organisms, and how microalgae adapt to changing light conditions. In this theme, the laboratory has studied novel photoreceptors in diatoms, and investigated how photosynthesis is modulated in the field, in response to biotic interactions, or to abiotic factors.

The research unit also integrates an evolutionary perspective on its research on photosynthesis and light perception. Thanks to the dramatic expansion in available genomic information for many microalgae species, they have implemented bioinformatic approaches to trace the evolution of photosynthesis-related mechanisms and identify novel light receptors.

Finally, all these research projects strongly benefit from the sixth research theme "Genetics and Genomics of Microalgae." Over the years, the laboratory has built considerable resources in terms of mutant collections and databases that are invaluable tools for their own research as well as for the scientific community.

In the strategically designed vision of the next contract, the current six research themes will be concentrated to three and the research unit renamed "Photobiology and Physiology of Plastids and Microalgae" (P3M): the first will integrate current Themes 1 to 3 providing strength in the biophysics and function of the photosynthetic apparatus, the second will focus on the genomics and evolution of microalgae (diatoms), and the third will address the interaction of microalgae in their environment. The "classic" Theme 1 will continue its integrative role and provide its expertise to the innovating Themes 2 and 3. The three research themes will be accompanied by two resource centers ("Genetic Resources," "Biophysical Resources"). This will allow for extending the services and resources of the research unit not only to the inside but also far more effectively to the outside where they are in high demand.

## HISTORIC AND GEOGRAPHICAL LOCATION OF THE UNIT

The “*Chloroplast Biology and Light-sensing in Microalgae*” research unit (UMR7141) belongs to the “Institut de Biologie Physico-Chimique” (IBPC) created in 1930 by the Edmond de Rothschild Foundation. This institute aimed to promote multidisciplinary research in biology. The IBPC has five platforms available to its units: protein crystallization, mass spectrography, NMR and bioinformatics platforms and a visualization wall (a facility that offers high-dimension display wall with stereoscopic 3D representations for a semi-immersive experience).

The UMR7141 is one of the five research units of this institute. The laboratory started its activities in 1967. It was initially named (1967-97) « *Laboratoire de Photosynthèse* » and was the *Service de Photosynthèse* of IBPC and Unité Propre de Recherche of CNRS. Pierre Joliot was the director during that period. In 1997, the unit was renamed *Physiologie Membranaire et Moléculaire du Chloroplaste* » and was directed by Francis-André Wollman until 2018. It became during this period a joint research unit (UMR) under the supervision of the CNRS and the University Pierre and Marie Curie, now Sorbonne Université (SU), located in Paris (Campus Curie – 5th district). Between 2012 and 2018 the unit was organized as a multitheme laboratory (single team research unit) including four themes: Physiological Regulation of Photosynthesis, Genomic and Bioinformatics approaches to Photosynthetic metabolism, Chloroplast Gene Expression and Protein Assembly and Post-translational modifications in the chloroplast.

The arrival of Angela Falciatore at the head of UMR7141 in 2019 corresponded to a new phase for the laboratory with the transfer of Angela Falciatore’s team “*Génomique Fonctionnelle des Diatomées*” from the Laboratory « *Biologie computationnelle et quantitative* » (UMR7238 SU-CNRS) of the Jussieu Campus (Sorbonne University). This restructuration was motivated by shared interests in photosynthesis, photoperception and chloroplast biology, and led to the development of a joint project and a renamed unit “*Biologie du Chloroplaste et Perception de la Lumière chez les Microalgues*” in 2019. This project for a new laboratory was funded (laboratory, infrastructure and offices) by the Bettencourt Schueller Foundation and the CNRS. The unit has maintained a multithemes laboratory organization including six themes: Functional Regulation of Photosynthesis in Microalgae, Regulation of Chloroplast Gene Expression, Chloroplast Biogenesis and Assembly, Responses of Photosynthetic Organisms to the Environment, Evolution of Photosynthetic Functions and Genome Dynamics in Microalgae and Genetics and genomics of microalgae.

Currently, the unit is composed of eighteen permanent members (11 from CNRS and 7 from Sorbonne University) and two Emeritus scientists.

## RESEARCH ENVIRONMENT OF THE UNIT

The research unit UMR7141 “*Chloroplast Biology and Light-sensing in Microalgae*” operates under the oversight of Sorbonne University (SU, CNU section 64) and the CNRS (Institute of Biological Sciences, section 23). The unit is one of five research units at the Institute of Physico-Chemical Biology (IBPC), a multidisciplinary institute that studies the structural, genetic, and physico-chemical basis of living organisms. The IBPC, situated on a single site on rue Pierre et Marie Curie in Paris, is governed as a research federation (FR550) by the CNRS Institutes of Biological Sciences and Chemistry with backing from the Edmond de Rothschild Foundation.

UMR7141 is currently associated with three doctoral schools: Complexity of Life (SU, ED515), Plant Biology (University of Paris Saclay, ED567) and Physical and Analytical Chemistry (SU, ED388). The unit is a member of labex Dynamo, a funding initiative supporting research on the biogenesis and function of energy transducing membranes. Dynamo regroups the IBPC and two nearby chemistry research units, and recently received additional support from the European COFUND program. Dynamo, along with Equipex CACSICE, also contributes to the operation and maintenance of shared IBPC facilities for protein crystallography, NMR, mass spectrometry, functional genomics, and data visualization.

UMR7141 members are active in scientific societies including the French Photosynthesis Society, the French Photobiology Society, the French Bioenergy Group, the French Phycology Society and the French Bioinformatics Society. Members of the unit also participate in national research groups (GDR) for photosynthesis, molecular evolution, algal toxicology, and marine biology. Internationally, the UMR7141 participates in European networks for the promotion of marine biology, a European sustainable agriculture consortium, the Marine Microbiology Initiative supported by the Gordon and Betty Moore Foundation, the Community Science Project of the US Joint Genome Initiative, and the 100 Diatom Genomes Project.

## UNIT WORKFORCE: in physical persons at 31/12/2022

Catégories de personnel	Effectifs
Professeurs et assimilés	1
Maîtres de conférences et assimilés	5
Directeurs de recherche et assimilés	4
Chargés de recherche et assimilés	3
Personnels d'appui à la recherche	5
<b>Sous-total personnels permanents en activité</b>	<b>18</b>
Enseignants-chercheurs et chercheurs non permanents et assimilés	2
Personnels d'appui non permanents	0
Post-doctorants	3
Doctorants	9
<b>Sous-total personnels non permanents en activité</b>	<b>14</b>
<b>Total personnels</b>	<b>32</b>

DISTRIBUTION OF THE UNIT'S PERMANENTS BY EMPLOYER: in physical persons at 31/12/2022. Non-tutorship employers are grouped under the heading "others".

Nom de l'employeur	EC	C	PAR
Sorbonne Université	6	0	1
CNRS	0	7	4
<b>Total personnels</b>	<b>6</b>	<b>7</b>	<b>5</b>

## GLOBAL ASSESSMENT

Successful transition towards a much larger portfolio (from four to six themes) after the integration of the Falciatore lab into UMR7141 in 2019 has been achieved. The concomitant revision of its scientific strategy places UMR7141 in a strong position to investigate the perception and utilisation of light by microalgae and cyanobacteria in addition to the existing and strong biophysical and molecular themes. The laboratory now positions itself in a leading role in microalgal biology. The aim to broaden objectives by integrating world-class, long-standing research activities based on model species with environmental research and multiple non-model species is timely and highly promising.

The unit has produced some remarkable results or hypotheses, such as chloroplast protein-targeting peptides derived from ancestral antimicrobial peptides, and the first identification of the catalytic subunit of telomerase in *C. reinhardtii*. The activity of the BCPLM unit was essential for the exploitation of data generated by the Tara Oceans expedition for the study of phytochrome photoreceptors in diatoms. In addition, three researchers took part in the "Dark Edge Expedition" to Baffin Bay in October 2021 to understand how phytoplankton prepares for the polar night. The scientific production is excellent to outstanding, meeting the quality standard not only by presentations at prestigious international scientific meetings but also at the level of the publications (both generalist and specialist) that appeared in journals of the highest international level (*Science*, *Science advance*, *PNAS*, *Nucleic Acid Research*, *Nat. Comm.*, etc.). However, the distribution of publications among the new research themes was somewhat uneven, favoring the established themes over the new ones.

The highly diversified work is underpinned by an excellent to outstanding portfolio of projects offering a wide diversity of funding sources providing more than two thirds of its budget: seven projects funded by ANR, funds from charitable organizations (Fondation Bettencourt-Schueller, Moore Foundation), labex Dynamo, ERC Starting Grant, etc.

UMR7141 provides evidence for excellent functioning at the level of human resources (respect of gender equality, recruitment strategy, security and safety, continuity plan during the pandemic). The number of permanent lab members has increased during the last contract, but care must be taken during the next contract to assure replacements of retiring researchers. Three current CNRS research directors leading the three themes will retire in 2025, 2026 and 2027 and UMR7141 has put in place a strategy to recruit strong junior researchers.

The unit has maintained and even further developed its already outstanding international reputation. This is evident from the large numbers of visiting scientists (18 foreign visiting scientists during the period). UMR7141 members are regularly invited as speakers at international conferences and junior members also present their work. UMR7141 members have also organized or co-organized scientific meetings.

The contribution of the UMR7141 research activities to society can be considered very good. The strength with regard to its interaction with society lies in the strong implication of all lab members in outreach activities towards the general public. By contrast, interactions with the private sector remain little developed.

## DETAILED EVALUATION OF THE UNIT

### A - CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

All "recommendations to the unit" were addressed and the required information can be found in the Self-Evaluation Document and its annexes. The recommendations have largely been taken into account.

A

#### - **Maintain excellent scientific productivity.**

Evaluation area 3. Scientific production states, "...all research themes of UMR7141 contributed to the scientific production of the unit and all permanent researchers contributed to several articles or chapters during the last term... UMR7141 published 83 articles (76 research articles, 11 book chapters) including publications in high-ranking generalist and plant journals (see Annex II). 28 papers with the lab as first, 35 as corresponding authors and 50 papers coauthored with other laboratories.

Conclusion: the productivity was maintained. The distribution of publications is slightly uneven (fewer in new themes 4, 5 and 6).

#### - **Get external grants and try to diversify funding sources.**

Response: "Despite the increase in laboratory activity and the expansion of research areas, none of the topics suffered from a lack of financial support. The laboratory was successful in securing financial support for all proposed research, both through new grants and its resource sharing strategy." Fig. 6 shows increasing support and grant amounts obtained from 2017 to 2022 (2017 outlier due to ERC SG). Yearly available funds peak in 2022 (well above 2017) with a decrease in 2023. Projected amounts from 2024 to 2026 appear low but only show already granted funds and are likely to increase. See also Evaluation area 2 Standard 4 (p31) and Annex 5. The site visit indicated that additional funding has become available for years 2024 to 2026.

Conclusion: this recommendation was successfully addressed. UMR7141 can continue on a similar trajectory.

B

#### - **New director needs to be supported to ensure that lab runs well over the next 5 years.**

The self-evaluation document indicates in several instances "the abnormal complication of our administration, which often seems blind to the reality of our work" (e.g., p29 Evaluation area 1. Synthetic self-evaluation).

Conclusion: The "abnormal complication" suggests that the new director is not optimally supported in all aspects of her work.

#### - **The lab's web presence needs to be improved.**

Response: "The web site of the lab has been improved and the lab activity is also more visible on the IBPC Twitter account."

Conclusion: "interaction with the outside world" has been improved but has further potential (also see the last evaluation report). The main interaction with the outside world is at the level of science produced by UMR7141.

C

#### - **Capabilities in Theme 1 critical to support, underpins all detailed mechanistic studies that make this lab unique. Critical mass is an issue.**

Response: "This concern was our priority in this contract, addressed with the recruitment in 2017 of J. Sellés (IR CNRS) in charge of scientific instrumentation and of W. Nawrocki (CR CNRS) in 2022."

Conclusion: Personnel issue was resolved but care must be taken to assure future recruitment and replacement of retiring lab members.

#### - **Arrival of new director with new themes means new equipment is needed. Plan to find money for equipment is needed.**

Evaluation area 2. Attractiveness. Standard 4 states: "A new chamber to grow diatom cells at 19 °C has been set up to accommodate the Falciatore's collaborators activity, along with a new photobiology room dedicated to studies of photoreceptors and circadian rhythms".

Conclusion: the equipment issue was resolved at least in part.



## B - EVALUATION AREAS

### EVALUATION AREA 1: PROFILE, RESOURCES AND ORGANISATION OF THE UNIT

#### Assessment on the scientific objectives of the unit

The laboratory's scientific objectives are outstanding. The laboratory positions itself as a trailblazer in microalgal biology. The aim to broaden objectives by integrating world-class, long-standing research activities based on model species with environmental research and multiple non-model species is timely and highly promising, not only in the context of basic science but also for applied and environmental sciences. The laboratory is also committed to pushing scientific boundaries by developing innovative tools to study environmental stress on diverse species in their natural habitats, and leveraging the potential of single-cell technologies. This approach will bring new opportunities for attracting national and international funding and increase the visibility of the lab to the scientific community and general public at large.

#### Assessment on the unit's resources

The unit's resources are based on an excellent to outstanding portfolio of projects (international 31%, national 39% and local 17%) offering a wide diversity of funding sources (ERC, FP, ANR, Europe, labex, Chair senior, Bettencourt-Schueller Foundation and others) providing the vast majority of its budget (87%, excluding salaries of permanent staff funded by CNRS and Sorbonne University, i.e., estimated 49 k€ of own resources per scientist per year).

UMR basic support (12.4%) of its resource is provided by CNRS (72%) and Sorbonne University (28%).

Numerous projects have budgets of more than 100 000 euros, which is very favorable for attracting young scientists, particularly foreign fellows. The unit does not carry out enough ambitious projects that promote attractiveness for European partners. No significant funds are provided by industrial partners through collaborations. All funds collected by UMR7141 excluding salaries, are mutualized to build a long-term scientific strategy. This merging of resources seems effective and virtuous to ensure a collective scientific strategy notably for younger scientists. They also give free access to IBPC platforms. However, the activity and dynamism of each permanent and theme of the unit in terms of lead of projects is heterogeneous.

#### Assessment on the functioning of the unit

Functioning of UMR7141 unit overall is excellent. Human resources policy is excellent and complies with the principles of CNRS and SU. Respect of Gender equality is excellent.

Recruitment strategy is excellent as younger researchers are promoted internally to leaders and new young investigators (example two engineers) are attracted to become staff members.

Respect of Security and Safety regulations is excellent: several lab members are involved; yearly risk assessments to CNRS and SU; training of lab members. Informatics security is ensured at the level IBPC (daily backups, passwords, encryption).

Sustainable development is addressed in an excellent fashion (reduced carbon foot print).

Implementation of continuity plan was excellent and allowed to maintain scientific activity during the pandemic. Visiting scientist and young researchers were well taken care of during the pandemic.

*1/ The unit has set itself relevant scientific objectives.*

#### Strengths and possibilities linked to the context

The integration of the Falciatore lab into UMR7141 in 2019 and the concomitant revision of its scientific strategy place the lab in a strong position to investigate the perception and utilisation of light by microalgae and cyanobacteria. The conceptual background of this strategy and its importance for understanding the functional biodiversity of aquatic phototrophs in the context of global change were communicated to the broader

research community in a publication (Falciatore et al. 2022, <https://doi.org/10.5802/crbiol.80>) and as a plenary lecture by Dr. Falciatore during the 8th European Phycological Congress in Brest (August 2023). With its research program, the lab positions itself as an innovative and leading player in the domain of microalgal biology, both at the national and international level. This is further underscored by the publication of two books, the establishment of *C. cryptica* as a new model for photosynthetic research, participation to international field-based research projects as well as applied projects on bioremediation and sustainable production of microalgae.

The aim to further integrate world-class, long-standing research activities based on model species with environmental research and multiple non-model species within the overall framework of functional biodiversity is timely and is highly promising, not only in the context of basic science but also for applied and environmental sciences. This will also bring new opportunities for attracting national and international funding and help increase the visibility of the lab to the scientific community and general public at large.

Apart from the prospect of a rewarding cross-fertilisation of models, insights and ideas, the aim to develop novel tools for studying stress in species diverse communities in situ is very exciting and will generate multiple benefits for basic and applied research as well as for industry. In line with this, the ongoing thinking about the use of single-cell approaches sounds very promising.

The three research themes and the establishment of two resources centers promote strong interactions among permanent and non-permanent staff members, and takes into account recent and future changes in the staff composition. They should also facilitate the identification of and participate to new research opportunities.

The contribution and organization of teaching and training activities via EvoGEM, the annual IBPC course and their foreseen integration into broader programs at the European (4EU+) or national levels (Institut de l'Océan) is well integrated in the lab's research vision to train students and early career researchers, to increase the lab's visibility and to create opportunities to attract lab new members.

## Weaknesses and risks linked to the context

With the broadening of the lab's research vision, it will be important to carefully assess future possibilities for new (applied) research directions so as not to dilute its core research expertise and interests and to focus on high-gain projects.

So far, most environmental research is planned/ongoing in other laboratories of national and international collaborators. While this partially solves potential issues regarding available lab space and equipment, it also brings the risk of increased dependency on host labs and weakening interactions among lab members.

Space availability remains a serious obstacle to the performance of the lab, especially seen its broadened research objectives.

Timely hiring of new staff members will be a high priority to ensure continuation of lab activities.

*2/ The unit has resources that are suited to its activity profile and research environment and mobilises them.*

## Strengths and possibilities linked to the context

UMR7141 saw robust growth in permanent (13 in 2017, 17 in 2022) and contractual staff (8 in 2017, 11 in 2022) due to the recruitment of an engineer (CNRS IR), the arrival of the new director with three permanent members (1 CNRS DR, 2 SU MC, 1 SU IE), the recruitment of a scientist in 2022 (CNRS CR), and a healthy funding environment. These changes show preparation for senior scientist retirement and successful integration of new research themes. Contractual staff contributed to all six themes. Despite growth the support staff / researcher ratio is maintained (0.38), although it could be improved.

UMR7141 successfully secured funding from diverse sources, with the majority (87%, 6 124 K€) from national and international grants. The rest (13%, 760 K€) came from recurrent funding (SU, CNRS). National sources (60% of external funds) include ten ANR research contracts (1 931 K€), labex Dynamo (870 K€), and the Bettencourt-Schueller Foundation (250 K€). International funding (40%) includes an ERC starting grant (1 212 K€), other European contracts (745 K€), and a Moore Foundation grant (1 10 K€).

Mutualising funds enables a coherent long-term scientific strategy at UMR7141. Excluding salaries, available collected funds are shared among unit members and go to support early career researchers, aiding the emergence of theme-coordinators, and access to IBPC core facilities. Resources are also allocated for facility upgrades, including culture and photobiology rooms for diatom research.

### Weaknesses and risks linked to the context

The IBPC building where UMR7141 is located requires modernisation. Care will be needed to navigate the renovations without interrupting research activities or diminishing the capacity to welcome new researchers.

Can UMR7141 maintain its excellent international funding rate? This will be a challenge for the future, especially as a single EU ERC starting grant (PhotoPHYTOMICS: Photosynthesis in PHYTOplankton Mixtures to Investigate Community Structuration) accounts for almost 60% of international funding during the evaluated period and that it came to an end on December 31<sup>st</sup>, 2022.

*3/ The unit's practices comply with the rules and directives laid down by its supervisory bodies in terms of human resources management, safety, environment, ethical protocols and protection of data and scientific heritage.*

### Strengths and possibilities linked to the context

Human resources in the laboratory are efficiently managed, and gender parity is globally respected. The commitment to technical staff has been acknowledged by promotions, and the laboratory has also taken care to support early-career scientists through the supervision of PhD students and encouragement to defend their HDR. During the last four years, the laboratory has managed to recruit a research engineer and a young CNRS researcher to support its activity in biophysics and instrument development, which was indispensable to maintain this unique scientific expertise.

Due to its relatively small size, the unit is easily managed in a very collegial manner. Weekly meetings allow discussing administrative, financial, logistics and technical issues. Mutualization of grants inside the laboratory has proven very efficient to share resources and allow fruitful development of all research themes. This model is definitely a strength of the unit.

The laboratory has two reference persons for sustainable developments, who have started assessing the laboratory's carbon emissions, and taking action to reduce them.

The unit is very attractive for students and postdocs from all over the world, which is an asset for recruiting talented young researchers in the coming years.

### Weaknesses and risks linked to the context

Although the number of permanent staff has increased from thirteen to seventeen during the last five years, one threat for the unit, and the continuation of its very diverse research project is the upcoming retirement of several lab members.

Another source of concern is the infrastructure. Issues with electricity and air-conditioning have delayed the settlement of marine diatoms culture at IBPC until now.

Data security and long-term storage could be more efficiently addressed through the implementation of a Data Management Plan and Research ethics by a charter of ethics.

Other issues negatively impacting human resources have been the pandemic and its consequences, complicated administrative procedures as well as the departure of a network administrator. The consequences of the pandemic have been dire (motivation loss, anxiety, depression; resignation of an assistant professor and more). The pandemic has made the transition during the new contract much more difficult (implementation of new research projects, etc.) and can only gradually be consolidated.

## EVALUATION AREA 2: ATTRACTIVENESS

### Assessment on the attractiveness of the unit

The unit has an outstanding international scientific reputation and is renowned for its expertise in the development of biophysical instrumentation to which excellence in microalgae research is being added. The lab maintains an excellent staff supporting policy and its success rate in obtaining national and international funding has been excellent to outstanding. The unit's attractiveness for the quality of its major equipment and technical skills is outstanding.

- 1/ The unit has an attractive scientific reputation and is part of the European research area.*
- 2/ The unit is attractive because for the quality of its staff support policy.*
- 3/ The unit is attractive through its success in competitive calls for projects.*
- 4/ The unit is attractive for the quality of its major equipment and technical skills.*

### Strengths and possibilities linked to the context for the four references above

The unit has an outstanding international reputation. Lab members are regularly invited as speakers in international conferences. Importantly, PhDs and postdocs are encouraged to present their work in research conferences. In addition, lab members organized or co-organized several scientific meetings, both at the national and European level. They have also been major contributors to the writing of two reference books: "the Chlamydomonas source book" and the "Molecular life of Diatoms."

Several lab members have also received prestigious scientific prizes, and the former and current directors are EMBO members.

Lab members are also strongly involved in institutional activities at SU and CNRS (Chargé de mission INSB of the CNRS, different councils at SU).

Over the past term, the unit has attracted thirteen postdocs and seventeen PhDs from nine different countries. They have benefited from an excellent hosting policy with access to French courses for foreigners, encouragement to participate to international meetings, and close mentoring by their supervisors. The unit has also been very successful in the recruitment of young scientists: they recruited a research engineer for biophysics instrumentation and a CNRS researcher in biophysics. These recruitments were key to maintain the lab's expertise in biophysics that is one major component of its international reputation. Finally, the laboratory regularly hosts international scientists (18 during the evaluated period) as part of collaborative projects.

Overall, the unit has been very successful in obtaining funding at the national level (seven ANR project, and CNRS MITI project), and benefited from the Dynamo labex that will end in 2024. It is also involved in three PEPR projects, which is very impressive given the size of the unit.

The laboratory is internationally renowned for its home-made instrumentation in biophysics. This specificity of the lab is now secured by the recruitment of a research engineer and a young CNRS researcher. The lab also possesses a unique collection of Chlamydomonas and Phaeodactylum mutants, as well as several algal strains.

### Weaknesses and risks linked to the context for the four references above

The unit has been very successful in attracting doctoral students and postdoctoral researchers. It seems, however, that many of the doctoral students have not yet published their PhD work as the first author. This can decrease their chances of obtaining permanent positions. It is a delicate equilibrium to achieve high quality publications without too much delay, but long publication delays may in the long run negatively impact the attractiveness of the unit for young collaborators.

During the previous term, the unit had been very successful in obtaining European contracts (1 ERC-Starting grant project, 2 Europeans projects, 1 COFUND project). During the evaluated term, the lab obtained funding predominantly at the national level. This decrease in European funding may represent a threat for the attractiveness of the lab, both because it may negatively impact funding of their scientific activities, and because it may decrease the number of international PhDs and Postdocs in the lab. Likewise, the Dynamo labex will end in 2024. It represented an important financial resource for the unit that may be difficult to compensate through ANR.

The unit has developed collections of natural strains and mutants that are a precious resource for themselves and the international community. These collections nevertheless require both space and manpower to be efficiently handled and shared with colleagues, which would require recruiting dedicated staff.

### EVALUATION AREA 3: SCIENTIFIC PRODUCTION

#### Assessment on the scientific production of the unit

The scientific production of the lab is excellent to outstanding, both by publications in journals of general interest as well as specialized leading journals and contributions at scientific conferences.

- 1/ The scientific production of the unit meets quality criteria.*
- 2/ The unit's scientific production is proportionate to its research potential and properly shared out between its personnel.*
- 3/ The scientific production of the unit complies with the principles of research integrity, ethics and open science. It complies with the directives applicable in this field.*

Strengths and possibilities linked to the context for the three references above

**Reference 1:** the scientific production meets the quality standard both at the level of publications that appeared in journals of the highest international level (both generalist and specialist journals) as well the presentations by the permanent and non-permanent members of UMR7141 at prestigious international scientific meetings. The journals of the highest international level include: Science, Science Advances, PNAS, NAR, Plant Cell, Nature Comms, Mol Biol Evo, Nature Plant, Nature Microbiol, Mol Plant, Plant Physiol.

Also notable is the fact that some very interesting and innovative discoveries were published in lower-ranking journals. Examples are the finding that chloroplast targeting peptides may be derived from ancestral antimicrobial peptides (Plant Comms), the first identification of the catalytic subunit of telomerase in *C. reinhardtii* (Life Science Alliance) or the existence of an escape pathway for light harvesting protein insertion independent of Alb3.1 and cpSRP43 (BBA).

The invitations to and (co-)organisation of conferences and workshops include: European Congress on Photosynthesis Research, 7th European Phycological Congress, 84th annual Meeting of the Botanical Society of Japan, International Symposium on Photosynthesis and Chloroplast Biogenesis, Kurashiki, Japan, 2018, Microbiology Society Annual Conference, International Conference on the Cell and Molecular Biology of Chlamydomonas.

**Reference 2:** All research themes of UMR7141 contributed to scientific production. All permanent researchers contributed to several articles or chapters. All younger researchers have published and contributed to high-level publications even after their departure from the unit. Permanent younger researchers demonstrated their research capability in their role as corresponding authors. The publication production remained similar to the level achieved in the previous evaluation period although UMR7141 now has a few more researchers due to additional research themes. A "pandemic bonus" should probably be given as scientific productivity in general dipped during this period.

**Reference 3:** An effort is being made by the unit at this level. With regard to principles of scientific integrity and ethics the self-evaluation document summarily states "all newcomers are sensitized to the principles of honesty, scientific integrity and responsibility, as are all permanent researchers. Raw experimental data are carefully discussed with the experienced scientist in charge of a research program, when they are produced and again before being used for publication figures." With regard to open science, it is stated that published articles are deposited on the HAL open archive and all strains and materials constructed during research are freely available upon request to the scientific community after publication, while the generated genomic and proteomic data are sent to the appropriate repositories.

Weaknesses and risks linked to the context for the three references above

**Reference 1:** while quality standards are excellent to outstanding, a significant proportion of publications are the results of collaborations. These collaborations are excellent but may represent a risk of losing lead positions on publications.

**Reference 2:** the distribution appears somewhat uneven, a large proportion of the publications were produced by Theme 1 that has been very strong historically. Themes 2 and 3 which are also pre-existing do not quite match Theme 1 either. Unsurprisingly, the new Themes 4-6 need time to become fully established.

**Reference 3:** This reference was dealt with summarily on six lines but would have deserved more attention. This applies to research ethics for instance. There is no reference to Data Management and Security which in these times of cyber attacks become more and more important. There is no mention of how data are recorded (e-lab notebooks?), whether and how data and reagents remain accessible after the departure of lab members. The departure of a network administrator compounds these issues.

## EVALUATION AREA 4: CONTRIBUTION OF RESEARCH ACTIVITIES TO SOCIETY

### Assessment on the inclusion of the unit's research in society

The contribution of the unit's research activities to society is ranked very good. The strength of the unit regarding its interaction with society lies within the strong implication of all lab members in outreach activities towards the general public. By contrast, interactions with the private sector remain little developed, although partnerships have recently been initiated.

- 1/ *The unit stands out for the quality and the amount of its interactions with the non-academic world.*
- 2/ *The unit develops products for the cultural, economic and social world.*
- 3/ *The unit shares its knowledge with the general public and takes part in debates in society.*

Strengths and possibilities linked to the context for the three references above

The unit has established some partnerships related to societal issues and applied research in the field of environmental concerns (EIIIC-Pathfinder DREAM, ANR Phosphalgue or BluRemediomics). The members of the unit participate and lead several networks (Groupe Français de Bioenergetique, Société française de Photobiologie, GDR).

The partners and collaborations are entirely in line with the unit's research themes. Research on fundamental aspects concerns societal issues (management of organic materials and fertilizers or the low carbon label). The understanding of scientific questions to respond to the challenges of the cultivation practices is good.

A patent is in preparation to exploit the achieved genetic transformation of diatom plastids for the production of added value products.

The committee notes that the unit presents a very good level of activity in sharing its knowledge with the general public and disseminating its products using a wide variety of media such as articles (2) published in *Le Monde* and another one in *Le Nouvel Observateur* in reference to an article signed in 2020 in *Nature* by a member of the unit, visit (1) in Lycée Condorcet, collaborations with journalists of « *Science et vie* » (2), seminars in primary and secondary school students (2), one video for the Prix Bettencourt and one radio broadcast for Radio France. These actions thus concerned a targeted audience corresponding to young people in middle and high schools (including welcoming of and supervision of observation internships), students from CPGE (Classe Préparatoire aux Grandes Écoles) and general public. The current unit director is strongly implicated in discussions on gender equality. In 2020 she participated in the selection of top-level international women scientists for the Helmholtz association of the German research center. A member of the unit organized in 2022 the event "Marie Curie, les femmes et les sciences" at the Académie des Sciences.

### Weaknesses and risks linked to the context for the three references above

An effort in partnerships with the non-academic world is observed notably with a close collaboration with the start-up Immunrise Biocontrol, but it remains modest (0 full partnerships over the period, 0,5 % (3 keuros) of own resources) given the UMR's research fields. No PhD funding by the CIFRE system was obtained over the period. The added value of partnerships in research providing elements to technological and environmental challenges is not obvious. Staff exchanges within companies are low.

Despite the potential of the unit and the support that the CNRS can provide via its valorization structure, no patent was filed between 2017 and 2022. In addition, even if agreed partnerships have been put in place, interactions with manufacturers remain modest.

Activities related to communication to the general public and the discovery of science are very present but interventions in the general media are poorly developed. The committee was not able to evaluate the initiatives by research themes based on the information provided in the report.

## ANALYSIS OF THE UNIT'S TRAJECTORY

The research project of the unit aims to address fundamental questions focusing on functional biodiversity of phototrophs. It aims to address a better understanding of links between physiological functions of microalgae (*Chlamydomonas* and some diatoms) and evolutionary mechanisms leading to their successful adaptation in some environments. This research will be integrated in already funded national and European actions. During the next contract, the unit also aims to lead new collaborative actions in the field of functional diversity in microalgae and other marine systems in coordination with French marine stations. Locally the unit also aims to participate to calls from Sorbonne University as its "Resources for a sustainable world" program with the objective to collaborate with other Sorbonne University laboratories. The reinforcement of its participation in the Evogem Master is also planned. All these projects remain in the field of fundamental research and no future ambitious applied projects were noted by the committee even though the laboratory would like to initiate applied thematic and participate in several collaborative projects in relation with the environmental transition of our economy. The laboratory will be renamed (Photobiology and physiology of plastids and microalgae – P3M) and reorganized in the next contract. It will be structured around three themes of research: Biogenesis and function of the photosynthetic apparatus (Theme 1), Genomics and evolution of microalgae (Theme 2) and Microalgae in their environment (Theme 3). The new themes are in continuation and further evolution of the current ones. This reorganization in three themes instead of six appears beneficial for the structuring of the eighteen permanent members. Each theme will be led by two members of the unit, a senior and a junior, to prepare next generation turnover. Most of the unit members will contribute to several themes.

The sizes of the themes are heterogeneous as the Theme 1 is composed of thirteen permanent members whereas Themes 2 and 3 have nine and seven members, respectively. One of the researchers of the unit will be an invited researcher in the Station Biologique de Roscoff (50% of his time) to reinforce the collaboration between the Roscoff culture collection and the UMR7144 (Adaptation et Diversité en Milieu Marin). One priority of the unit in the next contract will be to integrate young scientists. For that, the unit aims to recruit two young researchers and one senior scientist using notably the "Chaire de Professeur Junior" program. These future recruitments should be monitored vigilantly throughout the execution of the next contract as three current CNRS research directors leading the three themes will retire in 2025, 2026 and 2027. The unit takes into account the limited space at IBPC in its recruitment strategy.



## RECOMMENDATIONS TO THE UNIT

### Recommendations regarding the Evaluation Area 1: Profile, Resources and Organisation of the Unit

The unit is trying to support professors and assistant professors through ATER contracts to liberate more research time in the face of increasing teaching loads, and encourages them to apply for delegation or CRCT. The committee encourages this strategy that should help them strengthen their publication record, thereby increasing their competitiveness for obtaining grants in their name and prestigious positions such as IUF and then ERC.

The committee supports the unit's research strategy to maintain a successful scientific profile and the integrity of core research expertise while integrating new themes. The unit has anticipated the retirement of leading researchers by organizing co-animation of research themes by duos of younger and more experienced researchers. We approve of this strategy, and encourage the unit to continue its efforts to attract talented young researchers to reinforce the historical and new themes of the laboratory.

The laboratory should effectively allocate or find new space to accommodate the increasing number of organisms under study, while also managing renovations to minimize disruption to essential research activities. While the unit strongly adheres to the principles of research integrity, ethics and open science, an explicit ethics charter and data management plan supported by a skilled administrator would strengthen the operation of the lab's research.

### Recommendations regarding the Evaluation Area 2: Attractiveness

While the support for young staff members is excellent, the unit should reflect on strategies to improve the career opportunities of early career researchers, especially in terms of strengthening and speeding up their publication record. While the revised focus on photosynthesis and light perception in microalgae offers new funding opportunities, securing adequate funding via national and international sources will be an important concern for the future, and also for the Genetic resource center.

### Recommendations regarding Evaluation Area 3: Scientific Production

Overall scientific production is excellent to outstanding and should be maintained or even increased. Notably, the unit should try as much as possible to reduce the publication delays for their younger colleagues (PhD candidates and postdocs). This would also help permanent researchers obtain more publications as senior authors. Participation in and organization of scientific conferences and workshops should be maintained at a similar level during the next contract. While the research output has remained stable compared to the previous reporting period due to the Covid pandemic and the reorganisation of the unit, careful monitoring of the progress of longstanding research themes and emerging themes can further improve scientific production and quality.

### Recommendations regarding Evaluation Area 4: Contribution of Research Activities to Society

The unit should develop partnerships between with non-academic partners where possible, valorising research and developing intellectual property.

The unit should promote its participation in outreach activities more effectively for example via its website.

## CONDUCT OF THE INTERVIEWS

### Date

**Start:** November 10<sup>th</sup>, 2023, at 08:30 am

**End:** November 10<sup>th</sup>, 2023, à 06:30 pm

**Interview conducted: on-site**

### INTERVIEW SCHEDULE

#### **Part 1: Scientific presentations (participation of all members of the unit is possible)**

- 08h30 - 08h45 Introduction (Hcéres Scientific Advisor)**
- 08h45 - 09h25** Organization, scientific policy and trajectory of the unit (**A. Falciatore**)  
**09h25 - 09h55** Discussion with the **committee**
- 09h55 - 10h05** **Theme 1** Functional Regulation of Photosynthesis in Microalgae (**B. Bailleul**)  
**10h05 - 10h20** Discussion with the **committee**
- 10h20 - 10h35** **Theme 2** Regulation of Chloroplast Gene Expression (**Y. Choquet**)  
**10h35 - 10h50** Discussion with the **committee**
- 10h50- 11h00** **Theme 3** Chloroplast Biogenesis and Assembly (**C. de Vitry**)  
**11h00 - 11h15** Discussion with the **committee**
- 11h15 – 11h45** **BREAK + committee debriefing (closed)**
- 11h45 - 12h00** **Theme 4** Responses of Photosynthetic Organisms to the Environment (**A. Falciatore**)  
**12h00 - 12h15** Discussion with the **committee**
- 12h15 - 12h40** **Theme 5 + 6** Evolution of Photosynthetic Functions and Genome Dynamics in Microalgae (**I. Lafontaine**)  
**12h40 - 13h00** Discussion with the **committee**
- 13h00 - 14h00** **LUNCH BREAK + visit of BCPLM premises**

#### **Part 2: Meetings with lab members (closed meetings)**

- 14h00 - 14h30** Meeting with **teacher-researchers and researchers (without the direction of the unit)**
- 14h30 - 15h00** Meeting with **the technical & administrative staff**
- 15h00 - 15h30** Meeting with **PhD students & postdocs (without supervisors)**

#### **Part 3: Meetings with funding bodies' representatives and unit direction (closed meetings)**

- 15h30 - 16h00** Meeting with the CNRS (Cecile Bousquet-Antonelli, DAS section 23 ; Marjolaine Robillard Déléguée Régionale Adjointe DR02) and SU (Stéphane Régnier dean of the Faculty of Sciences and Engineering – by videoconference)
- 16h00 - 16h30** Meeting with the direction of the unit (**A. Falciatore, Y. Choquet**)
- 16h30 - 18h30** **Final debriefing of the committee (closed)**
- 18h30** **DEPARTURE**

## GENERAL OBSERVATIONS OF THE SUPERVISORS

Marie-Aude Vitrani  
Vice-Présidente Vie institutionnelle et démarche  
participative  
Sorbonne Université

à

Monsieur Eric Saint-Aman  
Directeur du Département d'évaluation de la recherche  
HCERES – Haut conseil de l'évaluation de la recherche  
et de l'enseignement supérieur  
2 rue Albert Einstein  
75013 Paris

Paris, le 26 janvier 2024

Objet : Rapport d'évaluation BCPLM - Biologie du chloroplaste et perception de la lumière chez les microalgues

Cher Collègue,

Sorbonne Université vous remercie ainsi que tous les membres du comité HCERES pour le travail d'expertise réalisé sur l'unité de recherche « BCPLM ».

Sorbonne Université n'a aucune observation de portée générale à formuler sur le rapport d'évaluation transmis.

Je vous prie d'agréer, Cher Collègue, l'expression de mes cordiales salutations

**Marie-Aude Vitrani**  
Vice-Présidente Vie institutionnelle  
et démarche participative



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2 rue Albert Einstein  
75013 Paris, France  
T.33 (0)1 55 55 60 10

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