

## EVALUATION REPORT OF THE UNIT FIRST-TF - Formation, Innovation, Recherche, Services et Transfert en Temps-Fréquence

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

Observatoire de Paris - université Paris sciences & lettres - OBS-PSL, Sorbonne Université - Sorbonne U, Centre national de la recherche scientifique - CNRS, Université Sorbonne Paris Nord, UFC - Université de Franche-Comté, École nationale supérieure de mécanique et des microtechniques – ENSMM Besançon, Université Côte d'Azur - UCA, Laboratoire national de métrologie et d'essais - LNE, Observatoire de la Côte d'Azur - OCA, Université Sorbonne Paris Nord, Université Bourgogne Franche-Comté - UBFC, Université de technologie de Belfort-Montbéliard - UTBM

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### **EVALUATION CAMPAIGN 2023-2024** GROUP D

Report published on April, 05 2024



In the name of the expert committee :

Demetrios Matsakis, Chairman of the committee

For the Hcéres :

Stephane Le Boulter, acting president

Pursuant to 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 chairs 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

### **Chairperson:**

Mr. Demetrios Matsakis, Masterclock, Inc., USA

### **Experts:**

Mr. Judah Levine, National Institute of Standards and Technology, USA

Mr. Włodzimierz Lewandowski, National Institute of Telecommunications, Poland

Mr. Gaetano Mileti, Université de Neuchâtel, Switzerland

## HCÉRES REPRESENTATIVE

Mr. Hervé Wozniak

## REPRESENTATIVES OF SUPERVISING INSTITUTIONS AND BODIES

Ms. María-Pilar Benal-Artajona, CNRS

Mr. Mathieu Puech Observatoire de Paris-PSL

Ms. Pascale Molinier, Université Sorbonne Paris Nord

Mr. Phillippe Agard, Sorbonne University

Mr. Morvan Ouisse, ENSMM

## CHARACTERISATION OF THE SUPPORT AND FEDERATIVE STRUCTURE

Name of the federative structure: FIRST-TF Formation, innovation, recherche, services et transfert en temps-fréquence

Acronym of the federative structure: FIRST-TF

Label and number: FR 2038

Composition of the executive team: Yann Le Coq (director) and François Vernotte (deputy director)

## INTRODUCTION

### HISTORY OF THE FEDERATIVE STRUCTURE AND GEOGRAPHICAL LOCATION OF RESEARCHERS

The FIRST-TF Research Federation formally began in 2020 and will terminate in 2024, but it can be considered the successor to a prior effort that began in 2010. The flow of the money comes largely from the Programme Investissements d'Avenir (PIA) to five research units, whose acronyms are FEMTO-ST (Franche-Comté Électronique Mécanique Thermique et Optique - Sciences et Technologies, in Besançon), GEOAZUR (in Nice), LPL (Laboratoire de physique des lasers, in Villetaneuse), SYRTE (Systèmes de Référence Temps-Espace, in Paris), and Institut UTINAM (Univers, Théorie, Interfaces, Nanostructures, Atmosphère et environnement, Molécules, in Besançon). Taking all these efforts into account, a total of 9.6 million euros were allocated for the fields of oscillators, atomic references, time scales, time transfer, measurement metrology, with applications ranging from commercial to fundamental science. About half the funding, 4.6 million euros, was in the years 2017-2022. This includes a small supplement from the parent laboratories. From these numbers, the funding can be considered to be essentially a constant number of euros per year; inflation has reduced the euro's value by roughly 25% since 2017. While it is difficult to define the funding in terms of percentages, a crude estimate would be that FIRST-TF funding amounted to 5-10% of the operating budget of the beneficiary research units. This enabled equipment purchases and provided a way for beginners to enter the field.

The organizational structure consists of a Coordinating Committee which meets weekly for daily management, an Executive Committee that meets monthly, a Steering Committee that meets biannually and makes funding decisions, and a Strategic Committee that meets annually to ratify the Steering Committee's decisions. These committees include the FIRST-TF networks director and codirector, and representatives of the five founding laboratories and other organizations along with scientific experts. The five founding laboratories are represented by their directors in the Steering Committee, while the Strategic Committee is composed of representatives of the parent institutions (hence the five federated laboratories) and non-voting representatives from industry and a broader set of laboratories, who are also invited to the meetings.

### RESEARCH ENVIRONMENT AND POSITION OF THE FEDERATIVE STRUCTURES IN THE SCIENTIFIC ENVIRONMENT OF THE SUPERVISORY BODIES

While the recipients of the funding report directly to their parent institutions, the higher-level institutions only provide the most general form of guidance, so that the FIRST-TF can be considered to have a "bottom-up" structure.

### HCÉRES NOMENCLATURE AND FEDERATIVE STRUCTURE THEMES

ST Science and Technology  
ST3 Earth and Universe Sciences

### FEDERATIVE STRUCTURES OWN WORKFORCE

The parents bodies pay the salaries of the permanent staff of the recipient institutions, including those of the FIRST-TF co-directors Y. Le Coq and F. Verotte. In the last three years FIRST-TF funding was responsible for the salaries of 10.5 PhD students and 194 months of postdoc time.

## OVERALL OPINION ON THE FEDERATIVE STRUCTURE

The structure appears complex to outsiders. Yet it appears to be ideal for the creation and fostering of cooperation between institutions. This is because it guarantees a role for every participating entity, and the series of weekly, monthly, and yearly meetings provides an open forum for resolving issues that inevitably occur when serious people undertake serious ventures. The recent notable increase in the cooperation of French institutions and scientists may perhaps be directly tied to the FIRST-TF process, which includes an annual coordination meeting that has grown to over 100 attendees. The concept of sharing and cooperation is further enhanced by having projects receive partial funding from many different sources.

Sharing is not by definition positive, and steps were taken to avoid cronyism and assure the quality of the funded process. This was achieved by having every proposal reviewed by two experts not associated with the requesting institution. The Steering Committee then made decisions based upon their evaluations, which were

ratified later by the Strategic Committee. This process brings buy-in from the community at large, including the industrial sector.

# EVALUATION OF THE FEDERATIVE STRUCTURES

## RECOMMENDATIONS FROM THE PREVIOUS EVALUATION REPORT TAKEN INTO ACCOUNT

There was no previous evaluation.

## APPROPRIATION OF THE SCIENTIFIC OBJECTIVES DEFINED BY THE SUPERVISORY BODIES

To their credit, the supervisory bodies did not enforce a top-down approach. Instead, funding decisions were made at a lower level, by specialists and experts. In recent years they did introduce priority themes for proposals, but the distribution of publications did not seem to have been affected.

## ASSESSMENT OF SCIENTIFIC ACTIVITY RESULTING FROM FEDERATIVE SYNERGY

As judged by the number of publications and the eight patents filed, the scientific output has been tremendous. Counting refereed publications, there were 23 in 2022 (3 of which did not explicitly acknowledge FIRST funding), 28 in 2021, 26 in 2020 (4 of which did not explicitly acknowledge FIRST funding), 31 in 2019, 72 in 2018 (47 of which did not explicitly acknowledge FIRST funding), and 41 in 2017 (17 of which did not explicitly acknowledge FIRST funding). The approx. 150 papers that did acknowledge funding yield amount to approx. 23,000 euros per paper.

Although ratio of funding to papers is by necessity an often-used metric, it is important to consider the quality of the papers. While it is beyond the scope of the committee to read every paper, it has been found these topics covered the full range of time and frequency activities, including variations of fundamental physical constants, optical frequency comparisons, precision measurements, ion clocks, laser physics, atomic interferometers, time transfer, frequency transfer, gravitational waves, quantum metrology, metrology statistics, optical and microwave links, ring resonators, black hole binaries, superconducting gravimeters, cryogenics, small clocks, molecular spectroscopy, microwave to photonic conversion, GNSS (global navigation satellite systems), resonators, and Raman spectroscopy.

This is remarkable and completely in line with the federation's objectives.

Although the progress and papers were in general only partly funded by FIRST-TF, an unknown amount of funding may have been secured from other sources because FIRST-TF indicated endorsement through its support.

## REALITY AND QUALITY OF SCIENTIFIC LEADERSHIP

It is certainly important to have respected and competent leadership. FIRST-TF benefited from leadership by experts who are well-known to the international community, including the evaluation committee.

## RELEVANCE AND QUALITY OF SHARED TECHNICAL SERVICES

It is notable that 70% of the funded new operations were cooperative between institutions. The main mutualized technical action concerned the redesign of the FIRST-TF web pages. They provide much useful information, and point to many services that go beyond the web pages, such as training opportunities, descriptions of the parent institutions, and job opportunities along with public-level outreach, videos, and popular descriptions of the timekeeping art. The pooling of outreach materials and the availability of many physical devices, from posters to experimental demonstrations, is a significant collective activity. To the committee's knowledge, the database of pictures at <https://first-tf.com/general-public-schools/resources-for-general-public-schools/photos/> is unique. The web pages and the services they point to are an excellent resource.

## RELEVANCE OF SCIENTIFIC STRATEGY, COMPLEMENTARITY / INTEGRATION WITH OTHER FEDERATIVE STRUCTURES ON THE SITE

The scientific strategy has been to fund projects crucial to and of current interest to the time and frequency domain. No one can quarrel with the impressive publication list, nor the cooperation indicated by the joint proposals. FIRST-TF has played a significant role in bringing this about and, with or without future funding from this source, efforts should be made so its past success will extend to the future.

## TRAJECTORY

The chief concerns from the parent institution representatives were the uncertainty of future funding. It is a historical fact that advances in timekeeping have mostly been funded by government sources - from the towering Cathedral Clocks of medieval times to the chip-scale atomic clocks now on the Moon. The community has shown itself to be cooperative and productive, and it would be tragic if future funding could not be found. It is particularly important that the funding of graduate students and post-docs continue, because they will be the ones to ensure progress in all areas.

## RECOMMENDATIONS TO THE FEDERATIVE STRUCTURE

The committee recommends that some extra formal consideration be given to high-risk but high-reward projects that can meet future needs. The funded program of molecular clocks can be included in this category, as well as cooperation with industry. For instance, with only 10% of the funding, seven new cooperative projects were started from the 100 requested, and there were three industrial start-ups. Since the proposal format surely must provide an opportunity to outline the benefits, the proposal evaluations could have sub-ratings for risk and benefits (if they do not already). A larger proportion of industrial support could be considered.

Outreach is important for many reasons and must to be fully supported - from the general public to the technical. An example of a highly successful effort in this direction is the initial support of the European Time and Frequency Seminar, which is now a self-funded yearly event. Support was also provided to the annual Science Festivals, the International Conference on Quantum Metrology and Sensors, and the 25<sup>th</sup> General Congress of the French Physical Society, and the Franco-Chinese Symposium on Quantum Metrology and Sensors.

The importance of training can not be overstated. The timekeeping art in itself is too specialized for university-level emphasis, so that even people who have obtained a PhD in one aspect, such as atomic or molecular physics, may know little about other aspects, such as photonics or analysis of GNSS data. Beyond the need for introducing beginners to the full diversity and complexity of time and frequency activities, there is also the need for all specialists in this rapidly evolving field to communicate and learn from each other. It has been observed that after one person made a point at one meeting, everybody started making the same observation at subsequent meetings. In that sense the cooperation goal of the FIRST-TF project can be considered a group training, and all forms of training should be supported in the future, independently of the funding source.

One example of industrial support would be useful involves the increase in the tolerance on  $|UT1 - UTC|$  (difference between Universal Time 1 and Coordinated Universal Time) that the General Conference of Weights and Measures (CGPM) is slated determine. The effects are assumed by many to be important only in that they may require astronomical code to be examined and slightly rewritten, but perhaps there is more to it. Industry needs to be kept informed of developments and be encouraged to provide input to the CGPM.

As noted above, the FIRST-TF web pages provide much useful information, and it would be a shame if they are closed down should FIRST-TF not continue. A very few of the links have not yet been fleshed out, and it is recommended they be removed for now.

Concerns have been expressed that future funding is uncertain. While alleviating ever-present funding issues is not the purpose of this committee, it urges that the relevant institutions continue their efforts to undertake cooperative projects, to provide training, and to emphasize key projects while supporting some high-risk, high-reward proposals.

## CONDUCT OF THE INTERVIEWS

### Dates

**Start:** January 16 (5 pm)

**End:** January 16 (8 pm)

**Interview conducted: online**

### INTERVIEW SCHEDULE

December 18, 2023

Public introductory meeting with Mr. Le Coq and Mr. Vernotte

January 16, 2024

17.00 – 18.00: Meeting with the management (or representative) of the member research units

FEMTO-ST: Michaël Gauthier

GeoAzur: Clément Courde (resp. TF activities, on behalf unit's head)

LPL: Anne Amy-Klein

SYRTE: Arnaud Landragin

UTINAM: François Meyer (resp. TF activities, on behalf unit's head)

18.00 – 19.00: Meeting with the supervisory bodies

19.00 - 20.00: Meeting with the management team of the FIRST-TF federation



## GENERAL OBSERVATIONS OF THE SUPERVISORS

**Arnaud TOURIN**

Vice-président recherche, sciences et société

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M. Eric SAINT-AMAN  
Director  
Research Evaluation Department  
HCÉRES

Paris, March 29, 2024

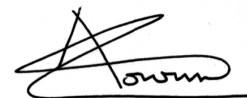
**Subject: DER-PUR250024390 - FIRST-TF - Formation, Innovation, Recherche, Services et Transfert en Temps-Fréquence**

Dear Director,

The supervising bodies of the federative structure FIRST-TF thank all the Committee's experts for their positive evaluation.

They have no comments to make on their report.

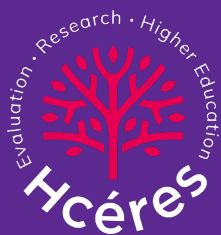
Yours sincerely.



Arnaud Tourin

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