

Ph'D student contract in Time/Frequency Metrology

Subject title:

Time and Distance Metrology base on free-space laser Communication link

Laboratory: Pôle R&D – Géoazur – Observatoire de la Côte d'Azur

Address: Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, IRD, Géoazur, 2130 route de l'Observatoire, 06460 Caussols, France

Contact: julien.chabe@geoazur.unice.fr, duy-ha.phung@geoazur.unice.fr

Financing : CNES

Deadline for application: 31 March 2021

Subject description:

The proposed thesis is in the field of free-Space Optical (FSO) telecom links, particularly dedicated to ground-space links. It consists in development and demonstration of a metrology system that carries out time & frequency (or distance) measurements based on a high-debit FSO telecom link. The thesis objectives are to identify the elementary bricks needed for the implementation of this new metrology technique (MetroCom) and to demonstrate metrology performance on a real 10Gbps FSO telecom link at 1550nm. The expected performances are a few tens of femtosecond in time measurement stability (or a few tens of microns in distance) over an integration time of a few seconds.

General scientific context and Summary of the PhD project:

The Grasse station (base on 1.5 m telescope), part of the International Laser Ranging Service (ILRS) network, participates to various laser applications including Satellite Laser Ranging (SLR), Lunar Laser Ranging, Time Transfer by Laser Link (T2L2). Since 2014, the France Space Agency (CNES) has identified laser communication (lasercom) as key technologies for future high data rate transmissions between Space and Ground. In addition, in collaboration with Geoazur, CNES is investigating the use of optics both for high data rate between satellites and ground and for future telecommunications applications. Several campaigns have been performed successfully and planned since 2015 between Grasse station and lasercom terminal at low Earth orbit. Rapid improvement on optical power of modulated laser source allows integrating Gbps lasercom terminal in a small satellite. Several satellites for 10 Gbps downlink lasercom demonstrations are planned to be launched in 2021 – 2022: OSIRISv3 developed by Germany and HICALI developed by Japan. Multiples Gbps data-rates mean tens picoseconds laser pulse-width at GHz repetition rate, x1000 improvement comparing to a classical SLR system. With a high-speed measurement process using coherent heterodyne detection, MetroCom is expected to improve our actual performance on time and frequency synchronization.

Currently, the devices used for telecom field are not intrinsically designed for precise synchronization information extraction from distant segments (detectors, stability of modulation frequency, long-term drift elimination process...). The work proposed in this PhD thesis will be positioned in double tasks: participation to the design/simulation of timing measurement/calibration process & devices characterization and to the experiment demonstration of two-way timing synchronization based on lasercom link (ground-to-ground and ground-to-space if possible). The subject of this thesis work thus addresses two themes that are currently important for space navigation, clock synchronization and satellite orbitography.

Competencies required:

Physics (Photonics). Strong background in metrology, data analysis and programming (Matlab & C++).

He/she have received a solid training in Photonics, Lasers and Metrology. He/she will hold a Master 2 (or equivalent) in Physics. He/she will have good experimental work skills as well as good oral and written communication skills to present his/her work in seminars and conferences.

Application should include a detailed CV, a letter of motivation, letters of reference if possible, transcripts of the two years of Master's and Bachelor's (or engineering school) degrees (to be sent to: Julien Chabé, julien.chabe@geoazur.unice.fr, and Duy-Hà Phung, duy-ha.phung@geoazur.unice.fr).

Laboratory presentation:

The Pôle R&D (<https://geoazur.oca.eu/fr/organ-geoazur/pol-ing-tech-geoazur/745-pole-r-et-d-geoazur>) of the Geoazur laboratory (<https://geoazur.oca.eu/fr>) is composed of about fifteen people, one of four laboratories of Côte d'Azur Observatory (<https://www.oca.eu/fr/>) and it is joint research unit (UMR 0007) of CNRS (<http://www.cnrs.fr/>), of IRD (<https://www.ird.fr/>) and Côte d'Azur University (<https://univ-cotedazur.fr/>). The research team is located in an Observatory's observation site near Caussols-France, based on 1.54 m telescope platform (MeO telescope - Grasse Station, <https://www.oca.eu/fr/meo>).

To carry out the PhD thesis works, the student will work in Calern observation site (20 km from Grasse-France) and benefit from a favorable environment within the laboratory (optical/electrical/mechanical atelier, restaurant & hotel on site). His/her works will be done in the context of a research group of about 5 people including the co-supervisors of the thesis. For information, a complete optical bench (in the coudé of the telescope) and a platform with reflector (5 km away) have been developed and upgraded to establish two-way 10 Gbps telecom link. The student will perform all test/development/demonstration with this bench.