Title of the topic	Characterisation and compensation of atmospheric turbulence effects on Laser Telemetry and free-space optical telecommunications.
Financial partners	Thales Alénia Space, Labex First-TF, CNES, OCA.
Host laboratory	Lagrange-UMR7293 – GeoAzur UMR 7329, OCA/CNRS/UNS
Responsible in the laboratory	Ziad Aziz , Laboratoire Lagrange-UMR 7293, Parc Valrose, 06108 Nice Cedex 2 Tél : 04 92 07 63 38. Email : ziad@unice.fr;
Financial partner	Région Provence Alpes Côte d'Azur (PACA)
Profile of applicant	Physics, Optics, Lasers.
Short description of the topic : context of the spatial experience, applied methodology, expected results.	The Observatoire de la Côte d'Azur (OCA) via the GeoAzur laboratory and the laser station MeO is involved in several projects implementing ground-space optical links with high-performance. These projects are: - T2L2: Time Transfer by Laser Link, which was developed in the framework of a partnership between the Centre National d'Etudes Spatiales (CNES) and the OCA . The T2L2 instrument is integrated with the Jason 2 satellite launched on June 20, 2008. The principle of T2L2 is based on the propagation of very short laser signals between clocks to compare. - Laser Telemetry on the Moon and on a Satellite, is essential to estimate satellite and planetary (Earth-Moon-Sun) ephemerides. This technique requires a better link budget than currently obtained (1 photon received for 10^{19} emitted). - Optical Telecom: Laser Link demonstrator between a satellite and MeO station in collaboration with CNES, ONERA and industry. The objective of this project is to validate an optical link for high-speed data transfer. The limiting factor for these optical links is the atmospheric turbulence which introduces a random variation in time and space of the refraction index of air. These fluctuations induce random perturbations of the wavefront which are added to the signal at low frequency. These fluctuations are sometimes very high and can cause signal loss. The objective of this proposed thesis is to study finely the problematic of the atmospheric turbulence impact on Laser Telemetry and free-space optical telecommunications. This consists in a first step, of the atmospheric turbulence characterization of the Calern site where the MeO station is installed. Specific equipment will be implemented on this site to study the evolution of the optical turbulence in space (altitude), time (day, night, seasons) and direction (line of sight). Then, a study based on measurements of atmospheric turbulence simultaneously with laser links will conclude on the impact of the atmospheric turbulence on laser propagation. We will take advantage of the T2L2 instrument which embeds a device for measuring the density of surface energy of laser pulses emitted from the earth. Associated with the ground measurement ability, it will be possible to study finely the link performance. This study will identify the appropriate periods according to the turbulence parameters for successful measurements by laser telemetry. It will also possible from the accumulated data on atmospheric turbulence to study by numerical simulation the definition of an Adaptive Optics (OA) system to compensate the atmospheric turbulence effects on the laser transmission and reception. The performance of the AO system will also be studied to determine the usefulness of such equipment within the laser telemetry on the Calern site. The student will be integrated within two teams recognized for many years in the field of Atmospheric Optics and Laser Telemetry. Both teams are fully complementary; the Lagrange laboratory has an expertise internationally recognized in the characterization of atmospheric turbulence, the GeoAzur laboratory has a team of specialists on Laser Telemetry. The student will benefit of many instruments to characterize atmospheric turbulence and modelling tools developed within these teams. The student will participate to data expoitation of many campaigns for measuring atmospheric turbulence by means of PBL and G-DIMM instruments of CATS station installed at the Calern site near the MeO station.