PhD Position at the Swiss Federal Institute of Technology (EPFL)
Competitive salary, coverage of conference costs, a dynamic and inspiring scientific community

Start Date: January 1st 2021
Duration: 4 years
Supervisors: Profs. Farhad Rachidi and Marcos Rubinstein
Funding: Swiss National Science Foundation

Required Profile: Electrical Engineering, Physics
Desirable skills: Physics, electromagnetism, Measurement technology, computational electromagnetics

Upward Lightning Initiation and Development

Abstract - The characteristics of upward lightning have been measured using tall structures for almost a century and they have been widely reported in the literature. However, the initiation mechanisms of upward lighting discharges and their development are not well understood and are therefore still under investigation.

In our previous and ongoing projects, we instrumented a new station on the Säntis telecommunications tower for the measurement of lightning current parameters using advanced sensors and equipment with remote monitoring capabilities and GPS synchronization. The site is operational since June 2010 and, as of today, more than 1000 flashes have been successfully recorded by the system. The data collected to date constitute the largest dataset for upward negative flashes available worldwide. Since the instrumentation of the tower, the facility has been recurrently updated and expanded, and it has become a major experimental research center on lightning.

The aim of this project is to improve our understanding of upward lightning discharges, particularly their initiation mechanisms and their development. To achieve this task, we will adapt and enhance the instrumentation of the unique experimental facility deployed at the Säntis tower and its surroundings over a decade ago. We will develop the first multi-band spectrum lightning measurement station from VLF to LF, VHF, microwaves, light, and X-rays. Sources involved in the initiation of the discharge will be identified and located using an interferometer. The new measuring equipment will be synchronized with the existing sensors and it will be integrated into the remote monitoring, data transfer and storage system deployed at the Säntis tower.

The experiments to be conducted at the Säntis tower will provide an opportunity to study X-ray emissions from upward lightning in great detail and to shed light on the reasons for their lower intensity compared to downward flashes.

Discharge processes associated with upward flashes with emphasis on the initiation and the propagation of the discharge will be identified and characterized thanks to the simultaneous and synchronized multiple-station measurements including low frequency, wideband, microwave electromagnetic field sensors, interferometric radiation source location, and X-ray measurements.

The simultaneous observations using high-speed video images, interferometer data, lightning current and electric fields will allow us to better understand the formation of recoil leaders and their role in the different mechanisms at play in the development of upward discharges.

The foreseen experimental data and theoretical investigations will allow a better understanding of the characteristics of upward flashes from tall structures and the mechanism of their initiation, which is essential for the design of lightning protection systems for tall structures including wind turbines.

The research will be performed in close collaboration with the following national and international partners of the project, namely Swisscom Broadcast and Säntis engineering staff, Prof. Vernon Cooray, The Lightning Research group of Uppsala University, Prof. David M. Smith, Physics Department of the University of California, Santa Cruz, Prof. William Rison and Dr. Mark Stanley, New Mexico Tech, Dr. Gerhard Diendorfer, ALDIS (Austrian Lightning Detection and Information System), Austria, and MeteoSwiss (Federal Office of Meteorology and Climatology) who will provide us with the meteorological data at the Säntis and polarimetric radar data from the Albis Station.

Applications to be submitted to:
Farhad.rachidi@epfl.ch
Marcos.rubinstein@heig-vd.ch