Postdoc Position

Spatial shaping of ultrafast laser beams for FDTD simulations

A postdoctoral position is available for 1 year at Laboratoire Hubert Curien (LabHC) in Saint-Étienne, France. The postdoc will work in the framework of the 3D Hybrid project funded by the Auvergne Rhône-Alpes region (FUI) in collaboration with Manutech USD (Company). LabHC is jointly run by the CNRS (The French National Center for Scientific Research) and Jean Monnet University (member of University of Lyon).

Objectives: The postdoc research program is aimed to calculate light-matter energy coupling during the ultrafast laser pulse interaction with metallic surface. The objective of the 3D Finite Difference Time Domain (FDTD) simulation is to provide an accurate description of the laser energy deposition and propagation close to the irradiated surface for specific vector Bessel beams and spatially inhomogeneous polarization states. It will be performed by modelling the time-dependent Maxwell equations describing the electromagnetic propagation, scattering, diffraction and energy absorption processes. In the numerical code developed at the Hubert Curien Laboratory, the electromagnetic calculation is coupled to equations of state and a Navier-Stokes equation solver to describe the hydrodynamic response. The source term should consist in a realistic spatio-temporal distribution of the experimental laser pulse beam. In particular, vector Bessel beams will be investigated by angular spectrum representation (ASR) method to interpret experimental measurements.

Research program: Surface and bulk structuring by spatial pulse shaping of laser pulse are performed at the Laboratoire Hubert Curien and Manutech USD environment to increase the efficiency of ultrafast laser processing. The postdoc will work closely with the experimentalists to interpret and guide experiments. Two computing strategies will be considered:

- **ASR implementation in FDTD**: In irradiation conditions requiring non-paraxial beam propagation, the generation of Bessel beam sources in three-dimensional finite-difference time-domain has to be implemented based on a vectorial configuration of the beam. The angular spectrum representation of the polarized electric field is then determined by a superposition of plane waves with wavevectors covering a conical surface. Following this approach, a finite collection of plane waves will then be injected into FDTD simulation domain using the total-field/scattered-field (TF/ST) method to reconstruct the non-diffractive beam features.

- **Laser-surface interaction**: The implemented vectorial method will be employed to investigate the removal rate dependence with pulse shaping. The interaction between classical diffractive beams (Gaussian) will be compared with nondiffracting beams (Bessel) but also with general class of structured beams presenting both geometric and dynamic phases.

**Keywords**: FDTD, Electromagnetism, Ultrafast laser, Simulation, Theory

Qualifications: We are seeking a highly motivated candidate for working at the interface between computational physics and photonics. The candidate should hold a PhD in physics or closely related field no later than March 2020. The candidate must have academic records/publications in the field of electromagnetics, optics or nanophotonics. Additional programming skills (C, GPU, Python, Fortran, Matlab, etc.) are requested.

**Start date**: March-April 2020

**Salary conditions**: monthly net salary 2000-2500€ depending on experience and skills.

**How to apply**: Interested candidate should send a CV to:
Pr. Jean-Philippe Colombier [Jean.philippe.colombier@univ-st-etienne.fr](mailto:Jean.philippe.colombier@univ-st-etienne.fr)

**Application deadline**: February 15th, 2020.