ONERA
THE FRENCH AEROSPACE LAB

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PROPOSITION DE POST-DOCTORAT

Title : Development of a pulsed, intense and highly repetitive electron source based on pseudo-spark switch for plasma diagnostics

Beginning of contract: 2023	**Deadline for application:** Dec. 2022
Duration: 12 months - Net salary : about 25 k€ / year – Funding: ONERA grant	
Key words: electron beam, spark gap, plasma, experimental physics	

Profile and skills required

PhD in experimental physics or electrical engineering. Skills in low-pressure plasma or X-ray imaging are preferable. Some knowledge about high voltage circuits is a plus but not required.

Presentation of the post-doctoral project, context and objective

When lightning strikes an aircraft, the structure undergoes significant thermomechanical stresses for about a hundred microseconds due to the formation a high-temperature and high-pressure plasma. To improve our knowledge of these plasmas, ONERA is currently testing an innovative X-ray imaging technique, based on the X-ray phase contrast (XPCI), which is sensitive to refractive index gradients in matter. Currently, these developments are mainly carried out at synchrotrons. However, access is limited to a few days per year, and lightning current generators are difficult to transport over there.

In this context, having an intense, compact and pulsed laboratory X-ray source makes more and more sense. A way to get there is to develop a compact pulsed electron source, delivering a focused electron beam. ONERA, but also the international scene, consider an approach based on pseudo-spark switches. Pseudo-spark discharge is a low-pressure gas discharge (~10^{-2} mbar), initiated by hollow-cathode mechanisms. When electrical breakdown occurs, a diffuse plasma forms allowing the pseudo-spark to conduct currents of several kA with minimal electrode wear. Simultaneously, the pseudo-spark emits a focused electron beam of several tens of keV for a few tens of nanoseconds, reaching kiloAmpere currents. ONERA has developed an expertise in the 2000s on pseudo-sparks (see figure opposite), and wishes to extend its expertise. On the one hand, we aim at increasing the repetition rate of pseudo-sparks, needed for plasma dynamics studies. On the other hand, we aim at making these sources more compact to consider other applications than lightning, for example for in-flight electron beam diagnostics.

Electron beam produced by a pseudo-spark, © ONERA

The goal of the post-doc is to develop and characterise an electron source based on a pseudo-spark switch which is compact, pulsed with a high repetition rate (kHz) and intense (kA). Your first task will be to get familiar with an existing pseudo-spark operating at low repetition rate (100 Hz). After optimizing the triggering electrical circuit, you will be able to develop a high repetition rate model. You will characterise the electron beam and compare with PIC simulations (code developed in the hosting group). Finally, depending on the working progress, a commissioning of the electron source as plasma diagnostics and/or X-ray source can be considered. This will imply to compare the electron beam performance with existing electron guns or to evaluate the quality of the X-ray source in the context of phase contrast imaging.

Collaborations

Collaboration with the optical department of ONERA (DOTA) and the CEA could be considered.

Hosting laboratory at ONERA

Department: DPHY/FPA

Place : Palaiseau

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