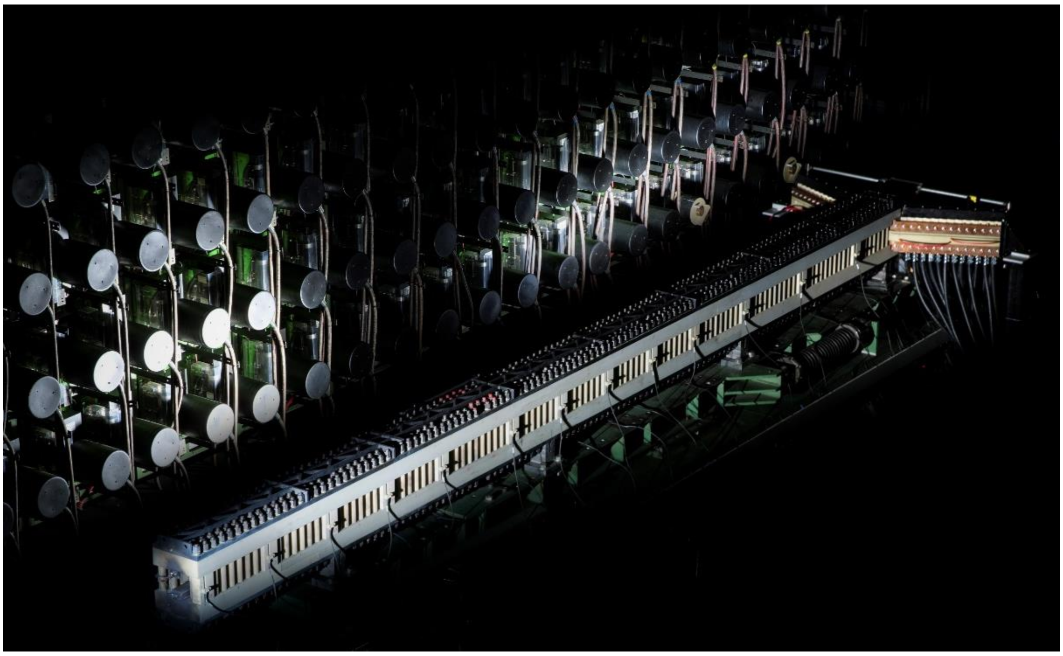
Key words: Electromagnetic launchers, Electric arc, Plasma, Optical diagnostics, Electrical diagnostics

Research field:

Electromagnetic acceleration, Electric arcs

Experimental and theoretical study of muzzle arcs in the context of electromagnetic launcher operation



Electromagnetic launcher NGL-60

Context:

Railgun is the electromagnetic energy conversion-based propulsion technology featuring the most outstanding performances in terms of acceleration and muzzle velocity for projectiles with a mass in the range of g to kg. This technology has already been studied and developed for a wide range of applications including military development, launch of aircraft and micro-satellites, impact-fusion, lightning strikes on aircrafts and high velocity impact on materials. In Europe, this technology is mainly developed at the French-German Institute ISL that possesses an energy bank of 10 MJ that has been proved to launch kg projectiles at a speed exceeding 2 km/s within 6 meters of acceleration.

During a railgun launch, a sliding electric contact featuring a current of a few MA is maintained between a metallic armature and the constitutive rails of the launcher and provides acceleration to the armature. When the armature exits the rails, successive electric arcs are formed at the muzzle to evacuate the current remaining in the rails. As this phenomenon does not significantly deteriorate the kinetic energy of the projectile and the longevity of the rails for the range of electric current flowing into the rails experimentally achieved, this issue has not been entirely investigated, with little dedicated simulation models or experiments published in the literature. However, for the sake of energy storage compactness, the resort to inductive sources of energy is estimated to provoke the formation of muzzle arcs reaching up several 100 kA, whereas up to now, muzzle arcs with a maximum current of less than 100 kA have been produced. Thus, a better comprehension of the physical parameters driving the apparition and the elongation of the muzzle arc would enable us to define and operate muzzle arc suppression devices. It is worth saying that these electric arcs are amongst the more intensive arcs that do occur for a physical application.

In collaboration with the laboratory GeePs of CentraleSupelec which possesses important knowledge and experimental means in the characterization of electric arcs, the objective of this PhD work is to characterize the hydrodynamical, thermodynamical, and electrical behaviour of such muzzle arcs for different ranges of energy. For this study, several diagnostics are already foreseen to be developed by the PhD candidate, including optical measurements (high-speed imaging, spectroscopy, Schlieren, and PIV systems) and electrical measurements (voltage and electric probes).

Candidate profile: (e.g.)

- Possession of a master's degree (or equivalent) in Plasma Physics, Optical and/or Electrical Engineering
- A strong interest in experimental work, data acquisition and analysis
- Appeal for the study of highly multi-physical phenomenon
- Good knowledge of computer programming languages (Matlab, Python / C, C++, …)
- Experience or basic knowledge in electromagnetic launchers is a plus
- Proficiency in English, with strong written and spoken communication skills
- Strong initiative, collaborative abilities and effective interpersonal skills

What we offer:

- A PhD project within a dynamic and international collaborative environment
- Access to state-of-the-art experimental facilities
- Assistance to develop experimental and theoretical abilities in a highly multi-physics application
- Competitive salary

Localization:

The project is carried out in cooperation between the French-German Research Institute of Saint-Louis (ISL) in Saint-Louis (68300 France) and the GeePs laboratory (Paris-Saclay University) in Gif-sur-Yvette (91190).

Contact

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