2.2.2. EDF-2022-LS-RA-DIS-EAD Electromagnetic artillery demonstrator

Budget

The Union is considering a contribution of up to EUR 15 000 000 for this topic under the call EDF-2022-LS-RA-DIS

Number of actions to be funded: Several actions, addressing different solutions, may be funded for this topic.

Objectives

The combination of electromagnetic artillery guns with smart ammunition can provide long- range precision strikes, as well as increased air defence and anti-surface warfare capabilities. Such combination is expected to improve the effectiveness and the protection of future European land and naval systems. Electromagnetic guns might provide a drastic superiority over conventional guns due to its hypersonic muzzle velocities, while guided projectiles will provide higher accuracy and precision. This topic complements ongoing projects, in particular following the 2019 PADR call on emerging technologies for defence.

General objective

Long-range effects are a substantial contributor to capability priorities concerning sea surface superiority and ground combat capabilities to maintain indirect / over-the-horizon fire support over large distances for precision strikes against a brought spectrum of targets. Physical limits of existing artillery systems in highly agile symmetric warfare scenarios call for exploring radical game-changing concepts, that combine increased performance and safety on the battlefield and that cannot be achieved with conventional (chemical) propellants and launchers. These will allow European technology and industry to remain at the leading-edge, contributing to technological supremacy and European Strategic Autonomy in the defence sector.

Specific objective

Considering the requirements for enhanced precision and extended range of ammunition, while seeking affordable costs, Electromagnetic accelerators, or guns (EMG) represent a disruptive technology to launch projectiles over extremely long distance (> 200 km) and muzzle velocities. Thus, an EMG system is a promising option to fill the gap between conventional artillery (cost effective but limited to 70 km range) and missiles (long-range but expensive and therefore limited to high-level targets).

An EMG system consists of the three major components, the accelerator or electromagnetic gun itself, the conversion and storage unit, and the projectile. These components present different technology maturity levels and affect the total system efficiency. Two basic concepts have been investigated for military applications, the railgun (EMRG) and the coilgun (EMCG).

In Europe, the technological maturity of the EMG systems system is currently located in the range between TRL 3 and TRL 4, which means that the experimental proof of concept is done and the technology is being validated in a laboratory environment.

Feeding the EMG with a large amount of energy in a very short time is a challenge. The electric pulsed power, that is needed to supply the EMG, requires storage space close to the gun barrel. Electrical storage is under the constraint of at least two parameters: the first parameter is the

volume needed for the hardware (related to the energy density of the storage, that is to say, to the storage weight); the second parameter is the capability of the storage to deliver the energy in a very short duration.

The projectile and the electromagnetic launcher have to be co-developed. In the case that electronic parts and other electromagnetically sensitive parts has to be integrated into the projectile magnetic shielding has to be taken into account for the system-specific projectile design. EMG are most frequently working with square calibres. Rectangular or round calibres can also be used, which are more challenging because of the need for sabots or laborious constructive measures This means that a large variety of projectile shapes are possible and offer the opportunity to develop out-of-the-box aerodynamic concepts.

A large calibre weapon with an extremely high muzzle velocity, achieved by electromagnetic propulsion (hypervelocity regime), has major benefits like longer ranges and shorter time-to-target, compared to conventional artillery systems or missiles.

However, developing a large calibre electromagnetic gun is an ambitious goal that will require time to achieve. An intermediate step is required. Besides, considering the emergence of new air threats such as swarms of drones or hypersonic missiles, novel capabilities for air defence missions will be key assets. This is why a medium calibre electromagnetic gun that can be used for air defence and anti-surface warfare is seen as an important goal and also as a milestone in the global roadmap for the development of electromagnetic guns.

Taking into consideration that the electromagnetic gun will be integrated in a naval or land platform, the size and weight of the different components (e.g., components for conversion and storage of energy) are considered a challenge, which needs to be addressed.

Scope and types of activities

Scope

The objective of the topic is to solve the current technical challenges and increase the maturity of the critical components required to develop a medium calibre electromagnetic artillery system.

The focus is set on the following tasks:

A. Requirement analysis and system specifications of a medium calibre electromagnetic gun dedicated to air defence (primary mission) and anti-surface warfare (secondary mission);

B. Improved design and development of the critical system components, namely (1) the electromagnetic gun, (2) the pulsed power supply and (3) the hypervelocity projectile, according to the overall system specifications;

C. Assessment of the components at laboratory level (minimum TRL 4), including their performance validation and the feasibility of their integration at system level.

The priority of this call is to work on the critical components and to make progress on their maturity (B and C), especially for the pulsed power supply.

The whole system development and demonstration (TRL > = 6) is beyond the scope of the current topic.

Types of activities

The following types of activities are eligible for this topic:

	Types of activities (art 10(3) EDF Regulation)	Eligible?
(a)	Activities that aim to create, underpin and improve knowledge, products and technologies, including disruptive technologies, which can achieve significant effects in the area of defence (**generating knowledge**)	Yes (mandatory)
(b)	Activities that aim to increase interoperability and resilience, including secured production and exchange of data, to master critical defence technologies, to strengthen the security of supply or to enable the effective exploitation of results for defence products and technologies (**integrating knowledge**)	Yes (mandatory)
(c)	**Studies**, such as feasibility studies to explore the feasibility of new or upgraded products, technologies, processes, services and solutions	Yes (mandatory)
(d)	**Design** of a defence product, tangible or intangible component or technology as well as the definition of the technical specifications on which such design has been developed, including partial tests for risk reduction in an industrial or representative environment	Yes (mandatory)
(e)	System prototyping of a defence product, tangible or intangible component or technology (**prototype**)	No
(f)	**Testing** of a defence product, tangible or intangible component or technology	No
(g)	**Qualification** of a defence product, tangible or intangible component or technology	No
(h)	**Certification** of a defence product, tangible or intangible component or technology	No
(i)	Development of technologies or assets **increasing efficiency** across the life cycle of defence products and technologies	No

The following tasks must be performed as part of the mandatory activities of the project:

- Definition of the operational requirements of the artillery system: in-depth analysis of the use case scenarios for the following missions:
    - o Primary mission: air defence operations, in particular anti-missile warfare and C-RAM (Counter-Rocket, Artillery, Mortar);
    - o Secondary mission: anti-surface warfare.
- System analysis and specification of an electromagnetic artillery system that complies with the physical and functional integration on military platforms comprising a medium calibre electromagnetic gun a pulsed power supply and hypervelocity projectiles to meet the operational requirements.
- Design of a modular inductive power supply based on XRAM technology, development and test of two modules: the focus is set on size, weight and performance parameters.
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- For power supply technologies: comparing of the two modules and demonstration of the feasibility of modules integration at system level to meet the full system specifications.
- Design, development and test of a medium calibre EMG:
    - Electrical and mechanical architecture;
    - Reduction of the gun wear to increase the bore life;
    - Concept for the EMG loading system according to the firing rate.
- Design, development and test of the sabot and the armature required to accelerate and guide the projectile along the gun bore, search for low-density/high-performance structure to reduce the parasitic mass.
- Design, development and test at short range of instrumented hypervelocity projectiles:
    - Aerodynamic design: low-drag and heat-resistant aerodynamic architecture;
    - Investigation of lethality mechanism: kinetic penetrator or airburst/fragmentation warhead;
    - Hardening of the projectile structure with respect to acceleration, heat and electromagnetic constraints, search for low-density/high-performance structure to optimize space for embedded components such as fuse, explosive, pre-formatted fragment, course control actuators, etc.;
    - Investigation of course correction devices and GNC (Guidance, Navigation and Control) devices.

<u>Functional requirements</u>

The proposals should meet the following functional requirements:

- Medium calibre electromagnetic artillery system:
    - Primary mission: air defence, in particular anti-missile warfare and C-RAM;
    - Secondary mission: anti-surface warfare.
- The system should operate with both naval and ground forces.
- Medium calibre electromagnetic gun:
    - Total launched mass: from 3 kg to 5 kg (to be refined during the system analysis phase);
    - Muzzle velocity $\geq$ 2000m/s
- Pulsed power supply:
    - Energy density $\geq$ 1 MJ/m3
    - Modular design: development of two modules, to demonstrate that the upscaling capability meet the full system specifications.
- Medium calibre hypervelocity projectile:
    - Low-drag and heat-resistant aerodynamic profile;
    - Lethality mechanism: kinetic penetrator or airburst/fragmentation warhead;
    - Mission-specific fuse, explosive, course correction or GNC capabilities.

Expected impact

- Technologies identified in this topic directly contribute to the development of "next generation precision strike capabilities", under the CDP priority "Ground Combat Capabilities".

- They also contribute to "Naval Manoeuvrability" CDP priority, by providing disruptive technologies for surface superiority and power projection from sea.

- Concerning CDP "Air Superiority", EMG technology will enhance "Suppression of Enemy Air Defence (SEAD)" capability, in order to mitigate adversary Air Defence systems.

- These technologies are further in compliance with European Defence Agency (EDA)'s Overarching Strategic Research Agenda (OSRA) results.

- Contribution to the defence and security interests of the EU, its Member States and Norway:

    - o Contribution to EU strategic autonomy;
    - o Increased protection of critical assets as well as ground and naval units;
    - o Reduced life-cycle cost compared to current systems.

- Contribution to European technological sovereignty:

    - o Reinforcement of innovation capabilities through the investigation of new and disruptive concepts and technologies;
    - o Strengthening of the EU's Defence Technological and Industrial Base (EDTIB).s, decreasing the number of combat casualties.