Defence and Security Accelerator

AWE Advanced Electronics and Electromechanical Devices

Webinar

22nd October 2024

DASA INNOVATION FOR A SAFER FUTURE

Innovation for a Safer Future

Introduction to DASA

Dr Mark Helliker

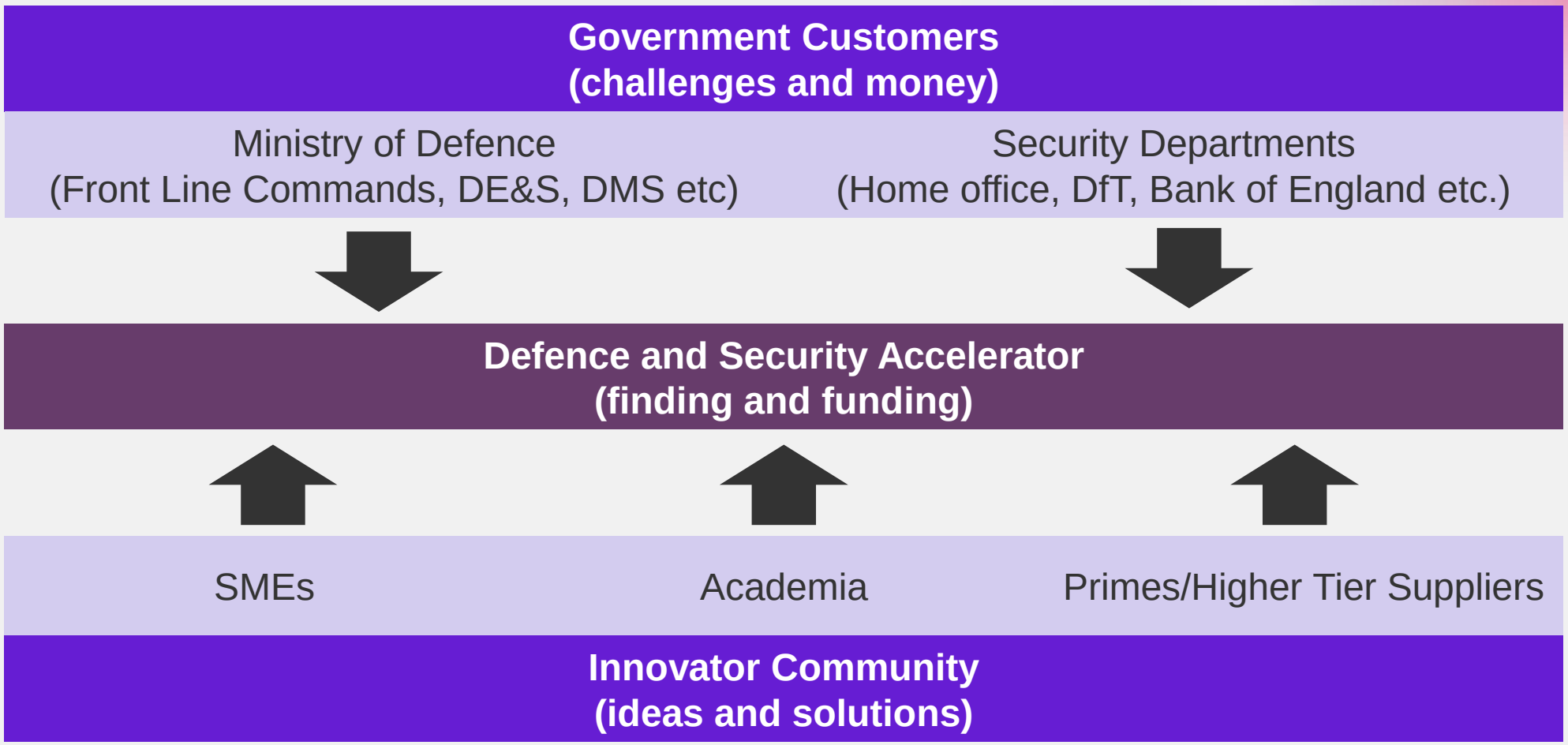
DASA Innovation Partner

DASA INNOVATION FOR A SAFER FUTURE

Our Mission

The Defence and Security Accelerator (DASA) finds and funds exploitable innovation to support UK defence and security quickly and effectively, and support UK prosperity.

How do we work?



Since 2016…

122

Funding Competitions

616

Innovators Supported

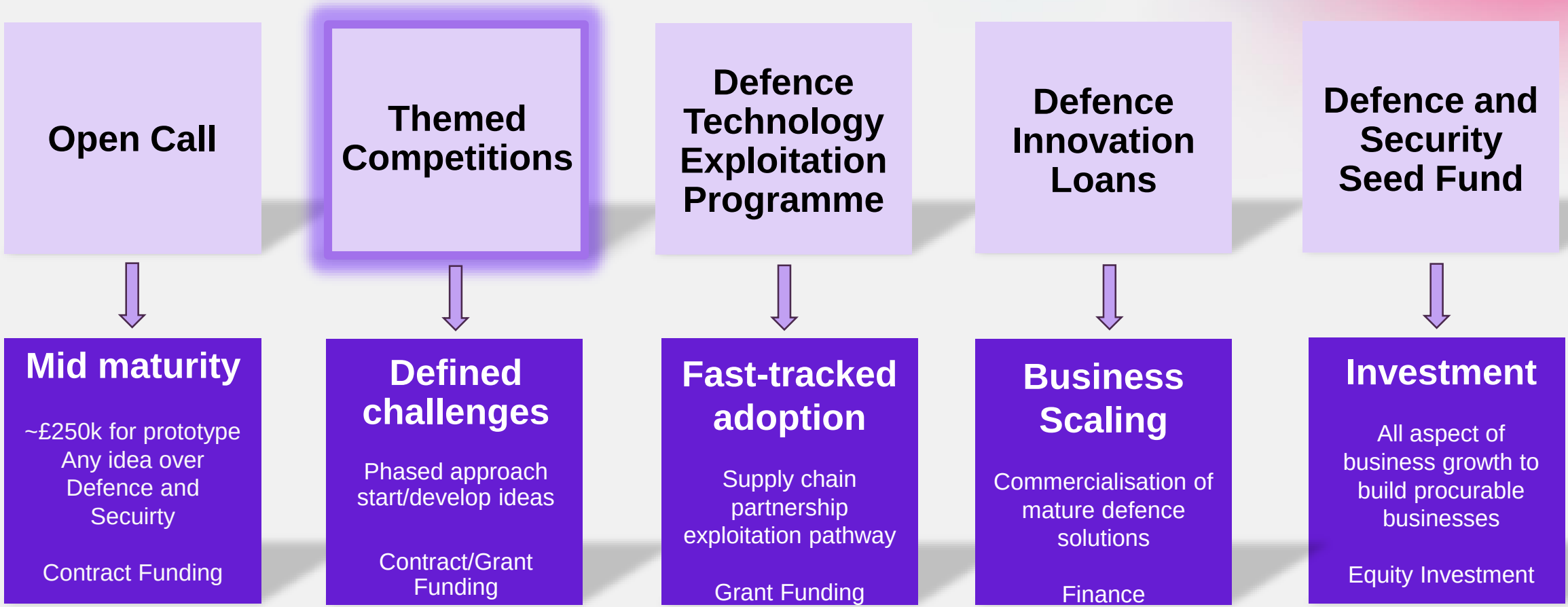
1519

Ideas Accelerated

£285m

Invested in innovation

Funding Innovation



Meet the team

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Defence and Security Accelerator

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AWE NUCLEAR SECURITY TECHNOLOGIES

AWE Technical Challenges – Webinar Brief 22Oct24

Martyn Davidson et al

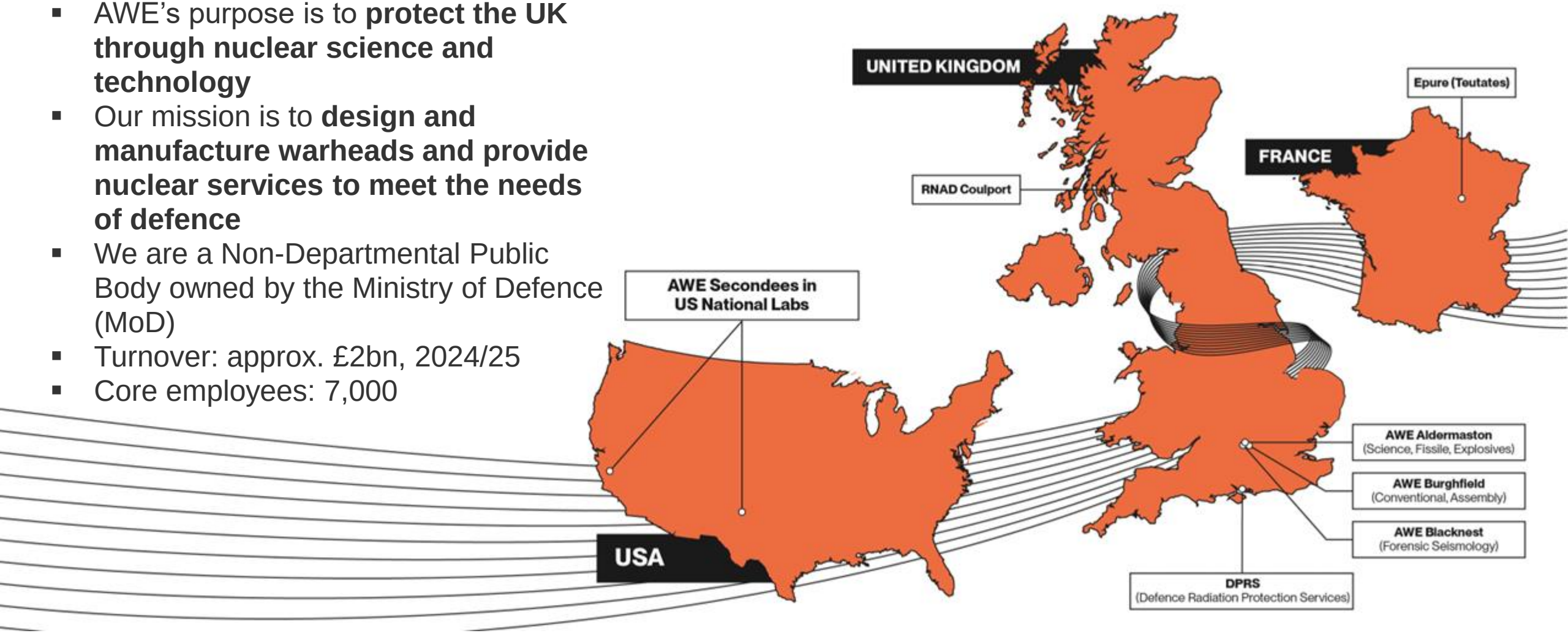
Non-Nuclear Components

OFFICIAL

AWE Overview

AWE
NUCLEAR SECURITY TECHNOLOGIES

- AWE's purpose is to **protect the UK through nuclear science and technology**
- Our mission is to **design and manufacture warheads and provide nuclear services to meet the needs of defence**
- We are a Non-Departmental Public Body owned by the Ministry of Defence (MoD)
- Turnover: approx. £2bn, 2024/25
- Core employees: 7,000



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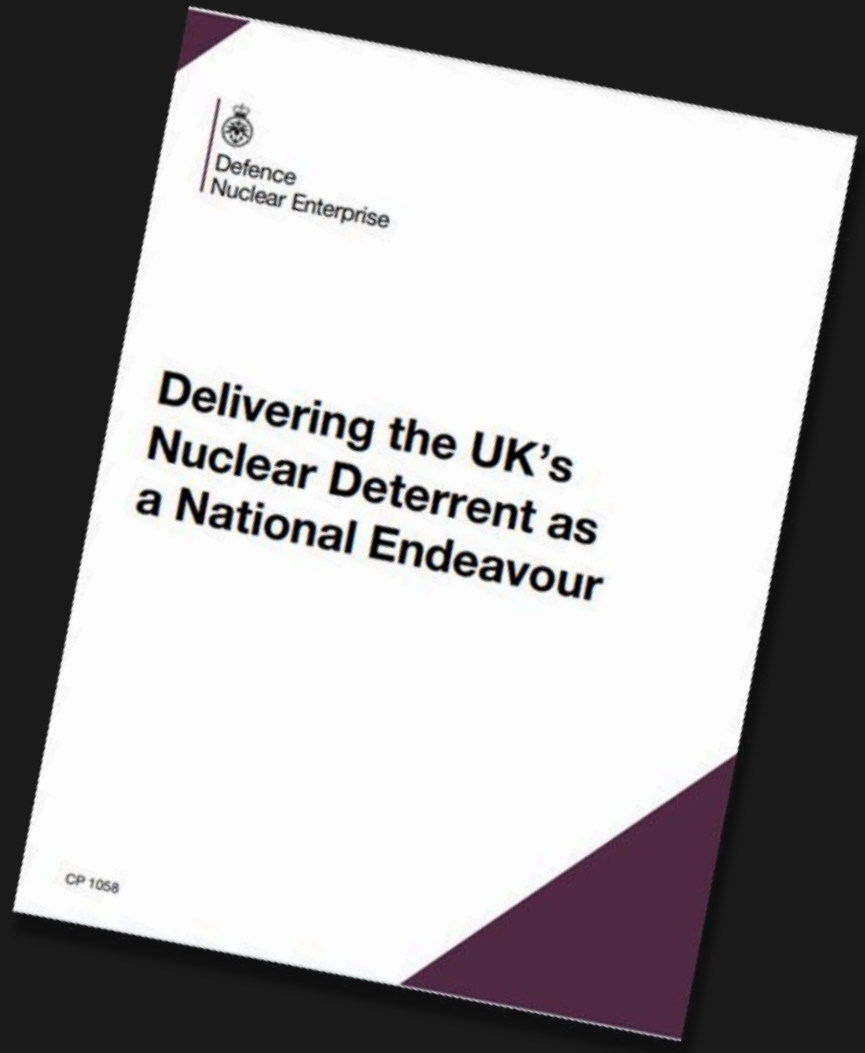
We are more committed than ever to working in partnership with UK industry and academia

AWE
NUCLEAR SECURITY TECHNOLOGIES

- A 2024 MOD Command Paper sets out this commitment - across the whole UK nuclear weapons enterprise.
- AWE is working closely with peers in MOD, UK trade bodies and regional industry clusters – to engage the very best UK capability to fulfil our mission.
- Our partnership with DASA is central to this strategy.



Non-Nuclear Component Overview and Future Strategy

Develop non-nuclear components with increased reliability and resilience to meet future requirements and threats.

- Increase resilience to natural and artificial mechanical, **electrical** and **electromagnetic** environments, in the air and space domains.

Develop resilient UK sovereign capability and options across future component, sub-system and system technology readiness levels.

Develop knowledge, experience and skills across the UK air and space domain thereby promoting recruitment across the industry.

Identify synergy across the defence and commercial space domains that are commercially viable and aligned with associated UK Government strategies.

Competition Objective

We are seeking innovative ways to further enhance UK-sovereign, resilient, demonstrable capabilities for the space and air domains through four technical challenges.

The total possible funding available for Phase 1 of this competition is **£4 million across two years (including VAT).**

It is expected that a number of proposals will be funded through this competition, with values in the region of £50,000 to £600,000. However, proposals of any value within the budget will be considered, if deemed value for money. AWE would like to invest in at least one proposal across each challenge.

AWE is focused on UK-sovereign capability, therefore eligible organisations:

Must be UK owned and UK-registered

Must comply with the National Security and Investments Act if part-foreign owned, and may be subject to pre-contract clarification questions

Must be based in the UK and carry out the project development activity in the UK

Four Technical Challenges

- Challenge 1: Power and data transfer across closed metal barriers
- Challenge 2: Semi-conductor switch for high voltage applications
- Challenge 3: Low delta-T thermo-electric generators
- Challenge 4: Low drift inertial sensors

Challenge 1: Power and Data Transfer Across Closed Metal Barriers

Challenge 1: Power and Data Transfer Across Closed Metal Barriers

Problem Statement

Protecting devices from unwanted electrical insult where there is a high consequence to failure, while simultaneously remaining in contact with said device.

Concepts previously considered:

- Acoustic i.e. piezo-electric transducers.
- Inductive coupling.
- Capacitive coupling.
- Magnetic resonance coupling

Challenge 1: Power and Data Transfer Across Closed Metal Barriers

Potential Defence Applications

Applications where power and information need to be transferred over an electrically insulating environment (e.g. a Faraday cage).

Power and data transmission across physically sealed barriers (e.g. high-pressure vessels, variable chemical environments).

Increased resilience to natural and severe radiological environments, artificial radiological environments, harsh dynamic environments etc.

Challenge 2: Robust Semi-Conductor Switch for High Voltage Applications

Challenge 2: Robust Semi-Conductor Switch for High Voltage Applications

Problem Statement

We have an interest in gaining a UK capability to develop pulsed power switches which are suitable for harsh environments such as radiation & heat.

Solutions - custom semiconductor components.

Alternatives – gas and vacuum gap switches.

Challenge 2: Robust Semi-Conductor Switch for High Voltage Applications

Existing Methods and Limitations

Existing COTS semiconductors suitable for pulsed power use are difficult to acquire due to supply constraints.

Silicon transistor technology is the leading semiconductor material; but thought to be the wrong material for the application (insufficient band gap).

Investigations into robust UK Silicon devices are high cost, lacked momentum and direction.

Silicon much less suited to high voltages, high current power switching, less temperature & radiation tolerant, less resilient.

Challenge 2: Robust Semi-Conductor Switch for High Voltage Applications

Project Vision: Key Attributes

Silicon Carbide (SiC) - wide band gap semiconductor.

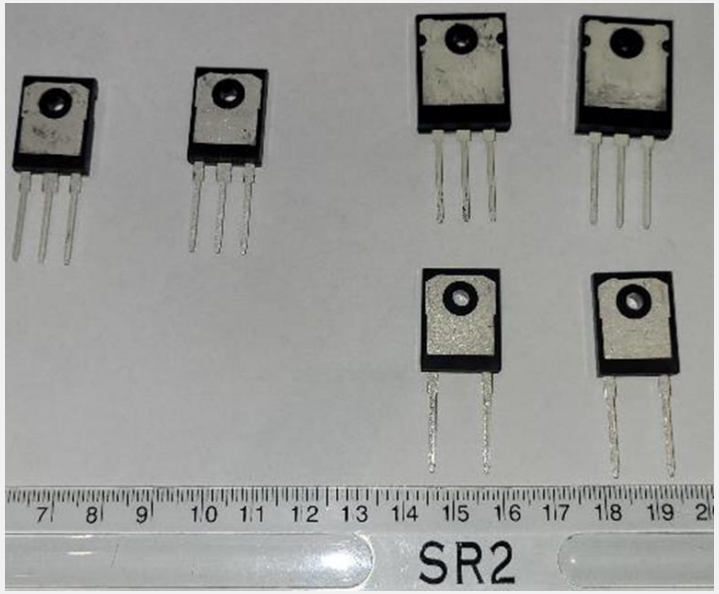
Other materials may be considered.

Semiconductor material of choice for high power switching in last few years (e.g. electric vehicles and their charging infrastructure).

Better suited for high voltage, high current use.

Can operate at far higher temperatures than silicon.

Believed to be a better starting point than silicon for radiation hardness in hostile environments.



Challenge 2: Robust Semi-Conductor Switch for High Voltage Applications

Potential Defence Applications

Switching of high-power applications, including possibly:

- High powered radar systems.
- Hypersonic weapons – high temperatures.
- Directed energy weapons.
- Conventional weapon firing circuits.
- Commercial market, UK design of solid-state switching components, EV's? Charging infrastructure etc.
- Other agencies interested in radiation hardness.

Challenge 3: Low Delta-T Thermo-Electric Generators

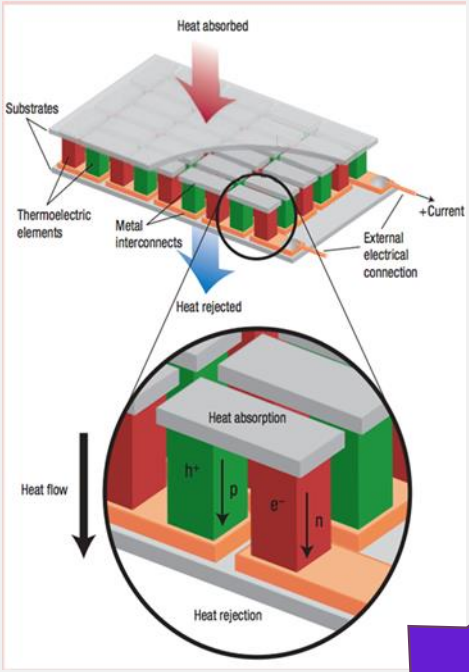
Challenge 3: Low Delta-T Thermo-Electric Generators

Problem Statement

Value in use of passive electrical energy sources that make use of residual system heat to power diagnostic and functional hardware.

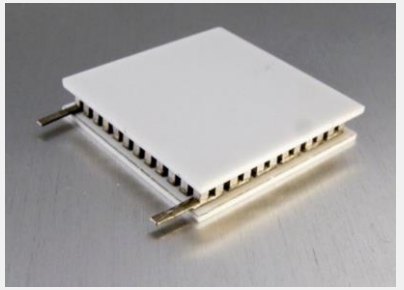
$$PF = S^2\sigma \qquad ZT = \frac{(S^2\sigma)T}{\kappa}$$

- PF = Power Factor
- ZT = Figure of Merit
- S = Seebeck coefficient
- σ = Electrical conductivity
- κ = Thermal conductivity



Challenge 3

Challenge 3: Low Delta-T Thermo-Electric Generators



Existing Methods and Limitations

Skutterudites

General chemical formula: LA_4Q_{12}

Used in Radioisotope Thermoelectric Generators (RTGs) for space missions by NASA.

Half-Heusler Compounds

- General chemical formula: ABZ
- Can be used in high and widely varying temperatures.

Tellurides and Chalcogenides

- General chemical formula: $(X_l)Y_mTe_n$
- High PF and ZT values at low delta-T.
- Tellurides are toxic and in limited natural supply.

Element Notation

- L = Rare Earth.
- A/B = Transition Metal.
- Q = Pnictogen Metalloid.
- Z = P Block Chalcogen.
- X = High Atomic No. (Z) Pnictogen.
- Y = High Z Dopant.
- Te = Tellurium
- l/m/n = Arbitrary Molar Ratios.

Challenge 3: Low Delta-T Thermo-Electric Generators

Project Vision: Key Attributes

- Research into more sustainable thermoelectric materials from a perspective of health and safety, potential environmental hazards, and supply chain robustness.
- Research into the different materials and methods required to fabricate TEGs (e.g., effects of different soldering junctions between TE materials and generator PCBs).
- The development of TEG designs to optimise electrical power levels needed for low and high voltage applications.
- Pursue research into TE materials with external UK industry and/or academia.

Challenge 3: Low Delta-T Thermo-Electric Generators

Potential Defence Applications

When system not in use: sufficient for diagnostic applications.

When system is in use: potentially able to harvest excess thermal energy to charge higher power applications.

Could be of use in service for thermal management by producing high electrical power and acting as source of thermal insulation to system.

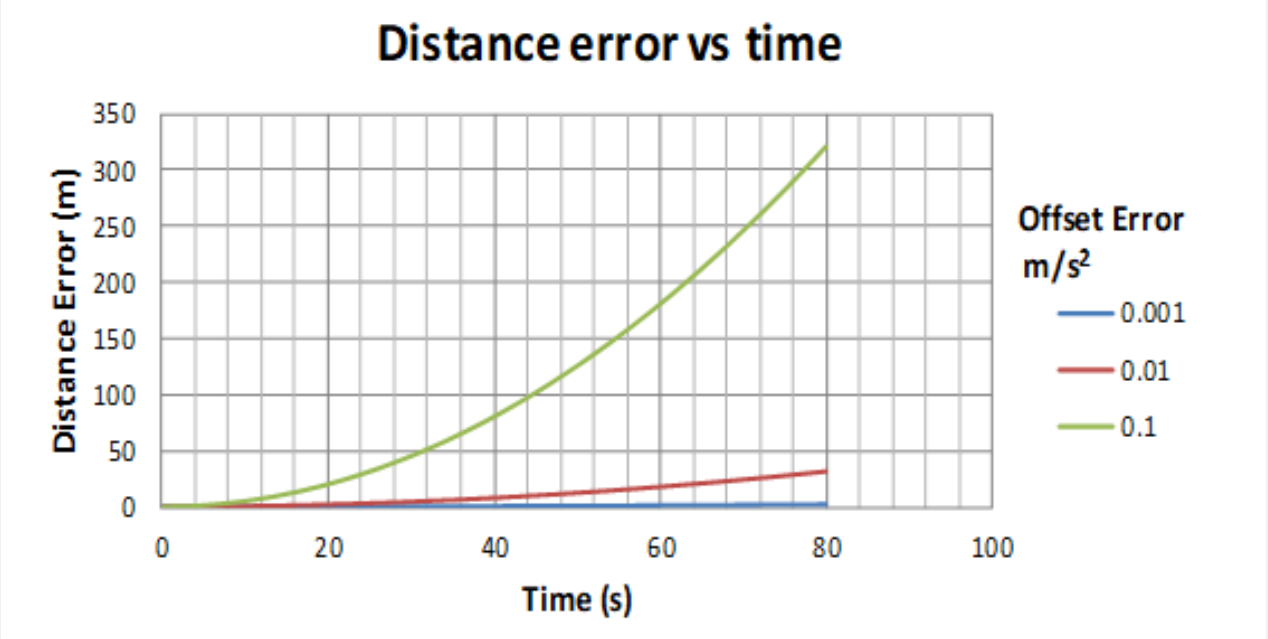
Additional commercial applications for deep space vehicles.

Challenge 4: Low Drift Inertial Sensors

Challenge 4: Low Drift Inertial Sensors

Problem Statement

Longer duration trajectories require lower drift to prevent positional error accumulation from exceeding the accuracy tolerance



Challenge 4: Low Drift Inertial Sensors

Existing Methods and Limitations

Existing methods are Micro Electronic Mechanical Systems (MEMS) based or larger electromagnetic devices.

Generally, a trade-off between dynamic range and drift.

MEMS accelerometers and gyroscopes are largely limited by noise (largest contributor to drift).

Electromagnetic accelerometers are complex and expensive to design and manufacture.

Challenge 4: Low Drift Inertial Sensors

Project Vision: Key Attributes

Sensors for strap-down inertial navigation with:

Low noise

Low bias instability

Low random walk

High Dynamic range

Form and fit suitable for space domain

Challenge 4: Low Drift Inertial Sensors

Potential Defence Applications

Long range/mission-duration vehicles operating without receipt of external position updates

We are not seeking:

- Solutions that may become subject to the Regulations and Agreements around the Movement of Strategic Controlled Goods ie ITAR, Wassenaar, MTCR, etc
- Solutions that require MODREC approval.
- Solutions that are stagnated at lower Technology Readiness Levels with no clear route to further exploitation.
  - Bids into Challenge 1, 2 or 4 are expected to start at a minimum of TRL 3 and reach TRL 5 by the end of the project.
  - Bids into Challenge 3 are expected to start at a minimum of TRL 2 and reach TRL 4 by the end of the project
- Solutions that offer no increase in current levels of resilience, reliability, capability etc.

Further details in the **Competition Document section 5.7**.

AWE NUCLEAR SECURITY TECHNOLOGIES

Questions?

www.awe.co.uk

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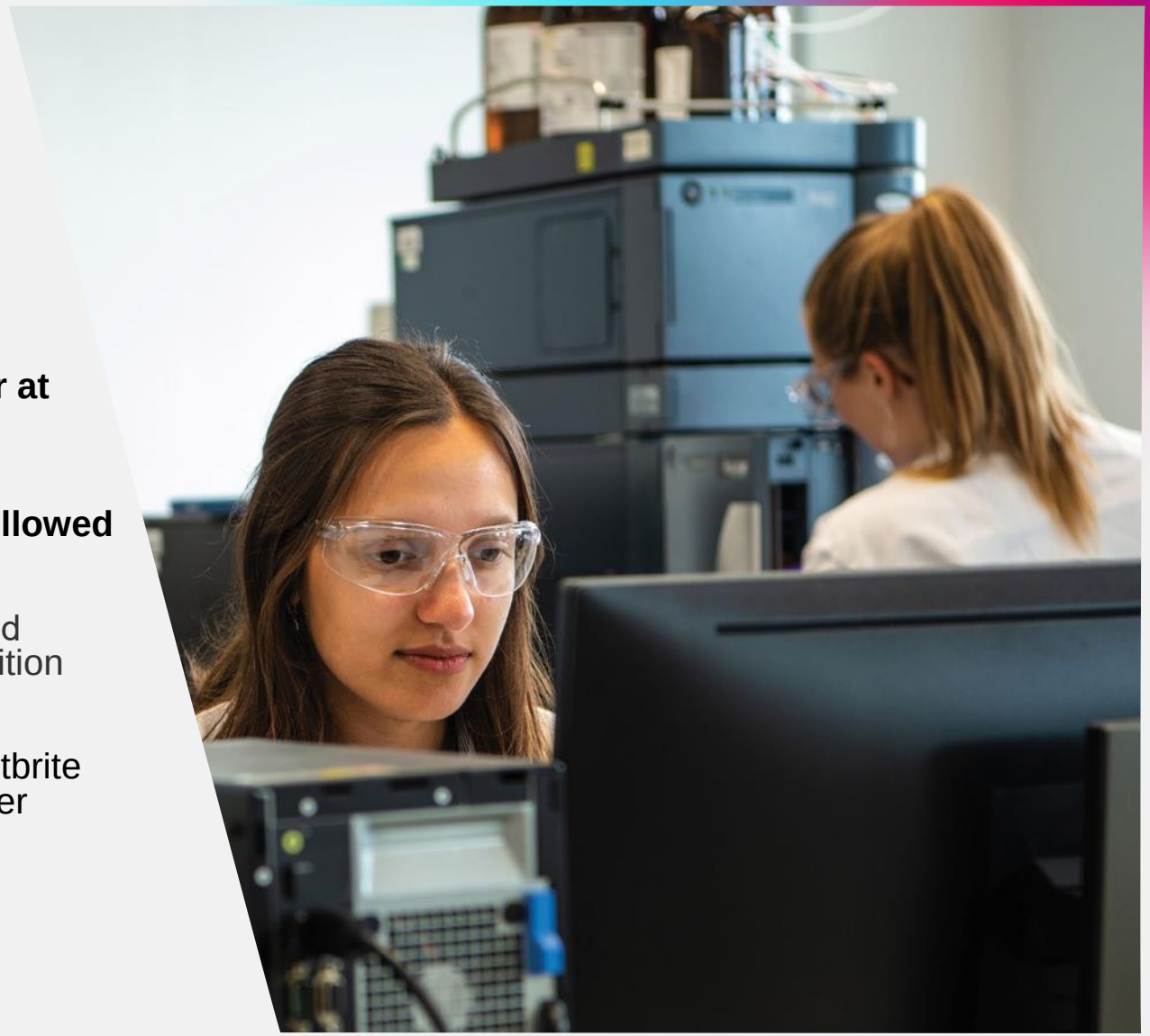
AWE plc Aldermaston, Reading, Berkshire, RG7 4PR

Closing remarks

- Thank you for attending this Webinar and Q&A event
- **Deadline for submitting a proposal is 10th December at Midday.**
- Proposals will be subject to mandatory criteria – **the competition document is your guide and must be followed when submitting your proposal.**
- The slides from today's event along with the anonymised questions and answers with be uploaded to the competition page on the gov.uk website in the coming days.
- We also invite you to book a 1-2-1 session via the Eventbrite links on the competition document if you have any further questions you would like to ask.
- Slots are available on:
  - 1-2-1 Session **Monday 28th October 2024**
  - 1-2-1 Session **Tuesday 29th October 2024**



Thank you for attending!

We look forward to receiving your submissions by Midday (GMT) on Tuesday 10th December 2024.

accelerator@dstl.gov.uk