

# AFRL

## ROTATING DETONATION ENGINES (RDE)

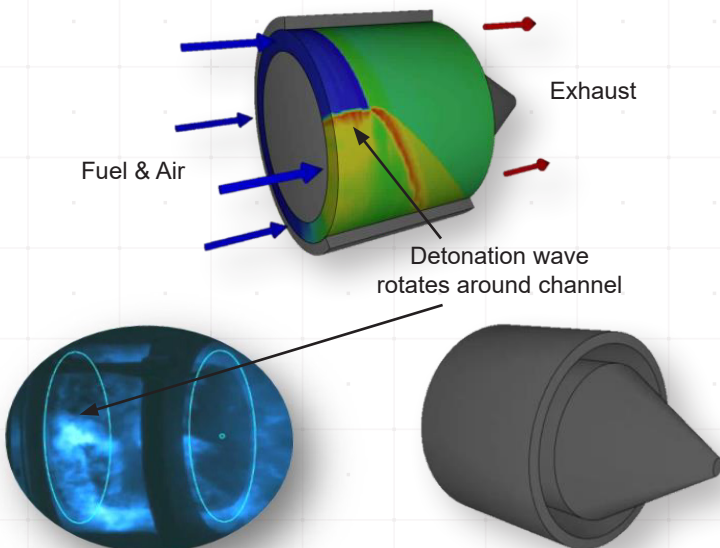
### DISRUPTIVE ENGINE TECH FOR AFFORDABLE, HIGH MACH, MASS EFFECT WEAPONS

#### WHAT IS A RDE?

A Rotating Detonation Engine (RDE) is essentially a more compact and efficient method of creating thrust for a wide variety of military relevant systems. These mechanically simple engines have no moving parts making them less complex than gas turbine engines and therefore potentially lower cost and simpler to manufacture.

RDEs rapidly burn fuel via a supersonically travelling detonation wave; this in turn delivers high performance in a small volume. This volume savings can be used to increase fuel and/or payload volume providing potential range, speed and affordability benefits compared to rockets, ramjets and gas-turbines.

This rapidly developing technology enables a wide range of military applications including air-to-ground, air-to-air and surface weapons. Building on sustained Air Force and Navy investment, current research is targeted at expeditiously transitioning truly disruptive effects to the warfighter.



How does a RDE work? Image Credit: AFRL/RQT

#### POTENTIAL OPERATIONAL BENEFITS

RDE munitions leverage high performance in a radically smaller/affordable package to deliver:

- Range, survivability, loadout and payload that enhances legacy platform utility in near peer fight
- Affordable, mass employable weapons with wide target set including high value and time sensitive
- Credible threat that holds vast majority of enemy systems at risk

#### HOW DOES A RDE WORK?

It is possible to leverage a detonation wave in systems from ground power to turbine engines, ram/scramjets and rockets. Each of these systems, benefits from a reduced volume/mass and an increased performance.

The illustration to left and described below is for the simplest of applications a rotating detonation ramjet:

- Composed of 2 coaxial cylinders with gap between
- Fuel & oxidizer continuously flow into annular gap
- Detonation travels around annulus & burns mixture
  - Delivering extremely compact heat release
  - Increasing pressure and cycle efficiency without mechanically complex rotating machinery
- Products leave nozzle axially creating thrust

Military relevance of RDE ramjets is enhanced by:

- Simple design potential enables production at rates necessary for mass weapon employment
- High-speed detonation wave delivers continuous thrust and minimizes integration challenges

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# THE AIR FORCE RESEARCH LABORATORY

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## WHY ARE RDE IMPORTANT TO WARFIGHTER?

As stated earlier, rotating detonation can be employed in a wide range of engine configurations including in ramjets, rockets and gas turbines. The discussion here will center on two applications of the RDE ramjet illustrated on page 1.

Both internally and externally carried munitions are constrained in overall dimension and launch mass by several factors including associated weapons platforms, ground handling equipment and logistical concerns. The small volume for the RDE combustor allows critical volume to be applied to fuel and payload.

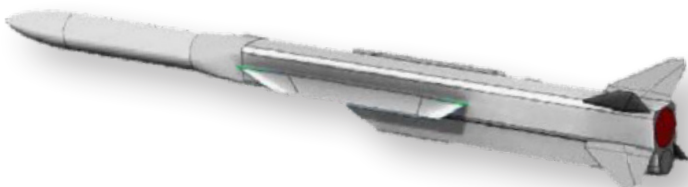


Notional Air-to-Ground Weapon. Image Credit: ARCTOS

## Air-to-ground weapons

RDE powered weapons have the potential to provide a clear advantage to our military:

- Range, survivability, loadout and payload that enhances legacy platform utility in near peer fight
- High-speed standoff with better loadout and versatility
- Compatible on a wide range of platforms
- Price point that delivers affordable destruction of high-value, time-sensitive targets and mass effects
- Addresses SECAF air dominance, moving target engagement and long-range strike Operational Imperatives (OI)



Notional Air-to-Air Weapon. Image Credit: ARCTOS

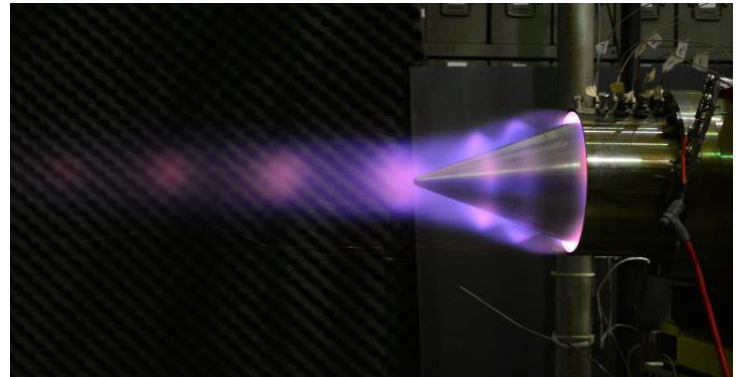
## Air-to-air missiles

Modern Integrated Air Defense Systems have made airspace increasingly contested. RDE powered long range air to air missiles have potential unique capabilities to restore freedom of maneuver:

- Range increase with same form factor and speed enabled by efficient, compact propulsion
- Compatible on a wide range of platforms
- Solid fuel RDE delivers long term storable round

## PARTNERSHIPS

Decades of sustained lab investment has laid a promising RDE technology set for others to build upon. Currently, AFRL is partnering across the DOD, DOE, industry and academia to accelerate the development and transition of RDE weapon systems to the warfighter.



Rotating Detonation Engine rig test. Photo Credit: AFRL/RQT

## ABOUT AFRL

The Air Force Research Laboratory (AFRL) is the primary scientific research and development center for the Department of the Air Force. AFRL plays an integral role in leading the discovery, development, and integration of affordable warfighting technologies for our air, space, and cyberspace force. With a workforce of more than 11,500 across nine technology areas and 40 other operations across the globe, AFRL provides a diverse portfolio of science and technology ranging from fundamental to advanced research and technology development. For more information, visit: [www.afresearchlab.com](http://www.afresearchlab.com).