Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Office of the Secretary Of Defense	Date: March 2023
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602890D8Z / *High Energy Laser Development*

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
Total Program Element	0.000	44.212	48.587	48.804	-	48.804	49.775	50.828	51.890	53.020	Continuing	Continuing
890: *High Energy Laser Development*	0.000	44.212	48.587	48.804	-	48.804	49.775	50.828	51.890	53.020	Continuing	Continuing

Note

New Start (Y/N): No

This Program will focus on Applied Research for Directed Energy (DE) technologies divided into the following areas: (1) DE Sources; (2) Beam Control; (3) Lethality and Vulnerability; and (4) Power and Thermal Management to reflect the OSD S&T priorities for Directed Energy.

Funding was realigned to this program from 0603924D8Z High Energy Laser Advanced Development starting in FY 24 for Directed Energy Applied Research that is focused on technology in support of a strategic mission capability for counter hypersonic missile defense. Lethality Applied Research focused on the counter hypersonic missile defense is increased in FY 24 to gain a better understanding on the vulnerabilities of threats of interest.

A. Mission Description and Budget Item Justification

This program supports the Department's initiatives to Defend the Homeland, Deter Aggression and Prevail in Conflict, and Build Sustainable and Long-Term Advantage.

This program funds Department of Defense Directed Energy applied research through the Joint Directed Energy Transition Office. This program is part of an overall Department of Defense Directed Energy Science and Technology program. DE weapons systems have many potential advantages, including speed-of-light time-to-target, high precision, low incremental cost per kill, and a magazine that is recharged through on-board, fuel-based power and thermal management systems that reduce logistics requirements in contrast to stocks of munitions or warheads. Directed Energy weapon systems have the potential to perform a wide variety of military missions, including high value asset and base protection, precision strike and platform self-protection versus a wide variety of missile, rocket, artillery, mortar and air platforms. Efforts under this program are generally chosen for their potential to have an impact on multiple Directed Energy weapon systems and multiple Service missions while complementing Service efforts that are directed for specific service needs. A broad range of technologies are addressed in key areas, such as laser sources, microwave sources, laser beam control, antennas, waveguides, modeling and simulation, and lethality mechanisms. This program provides the enabling technology necessary to demonstrate advanced concepts for high power microwave (HPM) sources, antennas and waveguides for mission areas not considered to date. The high power microwave lethality, hardware and software improvements and modeling and simulation advances provided by this program are essential to expand and build upon current architectures. Efforts in this program have been coordinated through the Department of Defense Science and Technology Executive Committee process to harmonize efforts and eliminate duplication.

This program is in Budget Activity 2, Applied Research, because this budget activity includes studies, investigations, component and subsystem design and development to further the knowledge base of Directed Energy technologies and enable future defense capabilities to be realized by the Services.

Exhibit R-2, RDT&E Budget Item Justification: PB 2024 Office of the Secretary Of Defense	Date: March 2023
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602890D8Z / *High Energy Laser Development*

B. Program Change Summary ($ in Millions)	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total
Previous President's Budget	45.852	48.587	49.663	-	49.663
Current President's Budget	44.212	48.587	48.804	-	48.804
Total Adjustments	-1.640	0.000	-0.859	-	-0.859
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Program Adjustments	-1.640	-	-0.859	-	-0.859

Change Summary Explanation

FY 2024 decrease to support higher DoD priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2024 Office of the Secretary Of Defense			Date: March 2023
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602890D8Z / *High Energy Laser Development*	Project (Number/Name) 890 / *High Energy Laser Development*	

COST ($ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
890: *High Energy Laser Development*	0.000	44.212	48.587	48.804	-	48.804	49.775	50.828	51.890	53.020	Continuing	Continuing

Note

This Program will focus on Applied Research for Directed Energy (DE) technologies divided into the following areas: (1) DE Sources; (2) Beam Control; (3) Lethality and Vulnerability; and (4) Power and Thermal Management to reflect the OSD S&T priorities for Directed Energy.

Funding was realigned to this program from 0603924D8Z High Energy Laser Advanced Development starting in FY2 4 for Directed Energy Applied Research that is focused on technology in support of a strategic mission capability for counter hypersonic missile defense. Lethality Applied Research focused on the counter cruise- and hypersonic-missile defense is increased in FY 24 to gain a better understanding on the vulnerabilities of threats of interest.

A. Mission Description and Budget Item Justification

This program funds Department of Defense Directed Energy applied research through the Joint Directed Energy Transition Office. This program is part of an overall Department of Defense Directed Energy Science and Technology program. DE weapons systems have many potential advantages, including speed-of-light time-to-target, high precision, low incremental cost per kill, and a magazine that is recharged through on-board, fuel-based power and thermal management systems that reduce logistics requirements in contrast to stocks of munitions or warheads. Directed Energy weapon systems have the potential to perform a wide variety of military missions, including high value asset and base protection, precision strike and platform self-protection versus a wide variety of missile, rocket, artillery, mortar and air platforms. Efforts under this program are generally chosen for their potential to have an impact on multiple Directed Energy weapon systems and multiple Service missions while complementing Service efforts that are directed for specific service needs. A broad range of technologies are addressed in key areas, such as laser sources, microwave sources, laser beam control, antennas, waveguides, modeling and simulation, and lethality mechanisms. This program provides the enabling technology necessary to demonstrate advanced concepts for high power microwave (HPM) sources, antennas and waveguides for mission areas not considered to date. The high power microwave lethality, hardware and software improvements and modeling and simulation advances provided by this program are essential to expand and build upon current architectures. Efforts in this program have been coordinated through the Department of Defense Science and Technology Executive Committee process to harmonize efforts and eliminate duplication.

This program is in Budget Activity 2, Applied Research, because this budget activity includes studies, investigations, and component and subsystem design and development to further the knowledge base of Directed Energy technologies and enable future defense capabilities to be realized by the Services.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
Title: Directed Energy Applied Research	44.212	48.587	48.804
Description: Mature technologies that will provide system level performance commensurate with fieldable directed energy devices. Develop technologies that support improving beam control and beam propagation for DE weapon systems. Conduct			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Office of the Secretary Of Defense		Date: March 2023
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602890D8Z / *High Energy Laser Development*	**Project (Number/Name)** 890 / *High Energy Laser Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
directed energy vulnerability experiments on materials, components, and targets. Develop a lethality database, and integrate into a systems-level architecture plan and lethality models. ***FY 2023 Plans:*** Develop high-reliability, lower-cost, efficient diode pump sources. Scale alternate laser wavelengths to additional militarily relevant uses and power levels. Investigate next generation high power fiber technologies. Collaborate with the national and international directed energy community on progress in the development and application of high energy laser technologies for military missions. Reduce technical risk in solid state lasers for inclusion in future laser weapon systems. Conduct trade space analyses to understand performance, fielding, robustness and integration issues of the various architecture types for military platforms. Advance investments in illuminator laser sources and laser gain media and explore nontraditional fiber designs and materials for revolutionary increases in fiber performance. - Investigate, analyze trade space, and reduce technical risk for high power microwave devices. Conduct analyses and trades studies to determine the most effective microwave source parameters. Collaborate with the national and international directed energy community on progress in the development and application of high power microwave technologies for military missions. - Develop beam control technologies for high energy laser weapon use across all domains of the Department. Develop technologies to improve the beam director throughput efficiency, optimize size and weight, and improve/automate tracking and compensation through the atmosphere. Invest in atmospheric sensor innovation, field test evaluations, and next-generation models. - Characterize and understand the physics of high energy laser atmospheric propagation in adverse environmental conditions such as fog, rain, smoke and dust. Improve cameras and track illuminators to enable target engagement at longer ranges and enable improvements to shorten engagement timelines. Develop AI based tracking systems that show promise for automation of target recognition, aimpoint selection and maintenance as well as tracking in clutter. Explore Digital Holography to enable wavefront compensation with improved deformable mirrors for HEL propagation through severe turbulence and reducing SWaP - Provide maintenance, verification, validation, and accreditation for updated system level atmospheric propagation and high energy laser system models. Collaborate with Service-sponsored field-test planning to correlate model predictions with measured data for surface, maritime and aerospace environments. Incorporate atmospheric data into theater models to support performance characterization tables. Continue the development of a predictive avoidance fire control system for use on multiple platforms.			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Office of the Secretary Of Defense		Date: March 2023
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602890D8Z / *High Energy Laser Development*	**Project (Number/Name)** 890 / *High Energy Laser Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
- Develop theoretical physical models describing the propagation of a high power microwave (HPM) pulse through the atmosphere to understand the reflection characteristics of the HPM propagation. Study and understand the dynamic behavior of the propagation of high-power microwave pulses and the effects on the intensity, frequency, and width of the pulse and the physical processes occurring during the interaction of the pulse with the air. Develop hardware and technologies to improve throughput efficiency of the antenna, decrease component weight, and improve tracking and compensation through the atmosphere. - Integrate lethality and target imagery data into campaign-level high energy laser system models. Conduct high energy laser vulnerability experiments on materials, components, and targets. Conduct laser lethality effects testing and modeling specifically focused on subsonic / supersonic threats, assessment of threat aim-points, development of sophisticated techniques to rapidly determine threat vulnerability and techniques to accurately predict time-to-kill. Develop a suite of high energy laser weapon tools to be used in a database from which the warfighter can assess target vulnerabilities and mission utility for given high energy laser weapon platform and engagement. Develop warfighter tools employing Service and Agencies metrics and criteria such as the Joint Munitions Effectiveness Standards. - Develop new predictive modeling software tools to assess the effectiveness of high power microwave (HPM) weapons on electronic systems of interest for blue-on-red or red-on-blue engagements. - Collaborate with Service and Agency sponsored High Power microwave survivability / lethality community's interest in, and use of, high power microwave (HPM) engagement models. ***FY 2024 Plans:*** Conduct analyses and trades studies to determine the most effective microwave source parameters. Collaborate with the national and international directed energy community on progress in the development and application of high power microwave technologies for military missions. - Explore advanced concepts for technologies that will improve efficiency and decrease size and weight for future Directed Energy (DE) weapon sources. Evaluate materials for high energy laser and high power microwave weapons applications. Improve understanding of laser technologies to include material interaction and propagation. Scale electrically driven lasers to higher kilowatt-class power levels. - Develop beam control technologies for high energy laser weapon use across all domains of the Department. Develop technologies to improve the beam director throughput efficiency, optimize size and weight, and improve/automate tracking and compensation through the atmosphere. Invest in atmospheric sensor innovation, field test evaluations, and next-generation models.			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Office of the Secretary Of Defense		Date: March 2023
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602890D8Z / *High Energy Laser Development*	**Project (Number/Name)** 890 / *High Energy Laser Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
- Characterize and understand the physics of high energy laser atmospheric propagation in adverse environmental conditions such as fog, rain, smoke and dust. Improve cameras and track illuminators to enable target engagement at longer ranges and enable improvements to shorten engagement timelines. Evaluate effectiveness of Digital Holography for wavefront compensation with improved deformable mirrors for HEL propagation through severe turbulence and reducing SWaP - Collaborate with the national and international directed energy community on progress in the development and application of high energy laser technologies for military missions. Validate predictive models through analysis of atmospheric propagation data and measurements. - Provide maintenance, verification, validation, and accreditation for updated system level atmospheric propagation and high energy laser system models. Collaborate with Service-sponsored field-test planning to correlate model predictions with measured data for surface, maritime and aerospace environments. Incorporate atmospheric data into theater models to support performance characterization tables. Continue the development of a predictive avoidance fire control system for use on multiple platforms. - Develop theoretical physical models describing the propagation of a high power microwave (HPM) pulse through the atmosphere to understand the reflection characteristics of the HPM propagation. Study and understand the dynamic behavior of the propagation of high-power microwave pulses and the effects on the intensity, frequency, and width of the pulse and the physical processes occurring during the interaction of the pulse with the air. Develop hardware and technologies to improve throughput efficiency of the antenna, decrease component weight, and improve tracking and compensation through the atmosphere. - Characterize and understand the physics of high power microwave propagation in adverse environmental conditions. Collaborate with the national and international directed energy community on progress in the development and application of high power directed energy weapon (DEW) technologies for military missions. - Integrate lethality and target imagery data into campaign-level high energy laser system models. Conduct FY 2022 Accomplishments: Achieved fiber laser pump power necessary for 6 kW fiber amplifiers supporting higher power fiber combined HEL concepts. Completed SWIR camera focal plane array testing and validation for active fine track and wavefront compensation. ***FY 2023 to FY 2024 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2024 Office of the Secretary Of Defense		Date: March 2023
Appropriation/Budget Activity 0400 / 2	**R-1 Program Element (Number/Name)** PE 0602890D8Z / *High Energy Laser Deve lopment*	**Project (Number/Name)** 890 / *High Energy Laser Development*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2022	FY 2023	FY 2024
FY 24 increase funding of $0.217 million is for programmatic adjustments and budget fluctuations.			
Accomplishments/Planned Programs Subtotals	44.212	48.587	48.804

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

N/A

D. Acquisition Strategy

N/A