Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Air Force											Date: February 2019	
Appropriation/Budget Activity 3600: *Research, Development, Test & Evaluation, Air Force* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602890F / *High Energy Laser Research*							
COST ($ in Millions)	**Prior Years**	**FY 2018**	**FY 2019**	**FY 2020 Base**	**FY 2020 OCO**	**FY 2020 Total**	**FY 2021**	**FY 2022**	**FY 2023**	**FY 2024**	**Cost To Complete**	**Total Cost**
Total Program Element	-	40.156	43.192	44.221	0.000	44.221	45.103	46.019	46.948	47.887	Continuing	Continuing
625096: *High Energy Laser Research*	-	40.156	43.192	44.221	0.000	44.221	45.103	46.019	46.948	47.887	Continuing	Continuing

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. Directed Energy weapon systems have many potential advantages including speed of-light delivery, precision target engagement, significant magazine depth, low-cost per kill, and reduced logistics requirements. 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/Agency efforts that are directed at 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 supports the Senior Official as required. 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 element may include necessary civilian pay expenses required to manage, execute, and deliver science & technology capabilities. The use of program funds in this PE would be in addition to the civilian pay expenses budgeted in program elements 0601102F, 0602102F, 0602201F, 0602202F, 0602203F, 0602204F, 0602602F, 0602605F, 0602788F, 1206601F, and 0602298F.

As directed in the FY 2018 NDAA, Sec 825, amendment to PL 114-92 FY 2016 NDAA, Sec 828 Penalty for Cost Overruns, the FY 2018 Air Force penalty total is $14.373M. The calculated percentage reduction to each research, development, test and evaluation and procurement account will be allocated proportionally from all programs, projects, or activities under such account.

This program is in Budget Activity 2, Applied Research because this budget activity includes studies, investigations, and non-system specific technology efforts directed toward general military needs with a view toward developing and evaluating the feasibility and practicality of proposed solutions and determining their parameters.

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B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	43.049	43.359	44.221	0.000	44.221
Current President's Budget	40.156	43.192	44.221	0.000	44.221
Total Adjustments	-2.893	-0.167	0.000	0.000	0.000
• Congressional General Reductions	-0.104	-0.167			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	0.000	0.000			
• SBIR/STTR Transfer	-1.497	0.000			
• Other Adjustments	-1.292	0.000	0.000	0.000	0.000

Change Summary Explanation

Decrease in FY 2018 in Other Adjustments is due to realignment of funds to PE 0602212F to support Research and Development Projects,10 U.S.C. Section 2358.

C. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Title: Directed Energy Technologies	7.136	7.663	7.750	0.000	7.750
Description: Mature technologies that will provide system level performance commensurate with fieldable directed energy devices. In FY 2019, this effort was named Solid State Laser Technologies. Name changed to reflect the direction in the 2017 National Defense Authorization Act. ***FY 2019 Plans:*** Develop high reliability, lower cost, efficient and high temperature diode pump sources. Scale alternate laser wavelengths to additional militarily relevant uses and power levels. Investigate high power fiber technologies. Reduce technical risk in solid state lasers for inclusion in future laser weapon systems. Analyze trade space to understand performance, fielding, robustness and integration issues for military platforms. Investigate, analyze trade space, and reduce technical risk for high power microwave devices. ***FY 2020 Base Plans:*** Continue to develop high reliability, lower cost, efficient and high temperature diode pump sources. Continue to scale alternate laser wavelengths to additional militarily relevant uses and power levels. Investigate high power					

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
fiber technologies. Continue to reduce technical risk in solid state lasers for inclusion in future laser weapon systems. Continue trade space analysis to understand performance, fielding, robustness and integration issues for military platforms. Continue to investigate, analyze trade space, and reduce technical risk for high power microwave devices. ***FY 2020 OCO Plans:*** Not Applicable. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 decreased compared to FY 2019 by $0.087 million. Justification for the decrease is described in the plans above.					
Title: Advanced Directed Energy Technologies ***Description:*** Investigate new technologies that have revolutionary potential for high energy lasers and high power microwaves. In FY 2019, this effort was named Advanced Laser Technologies. Name changed to reflect the direction in the 2017 National Defense Authorization Act. ***FY 2019 Plans:*** Explore advanced concepts for directed energy technologies that will improve efficiency and decrease mass and volume for future weapon systems. Evaluate materials for directed energy applications. Improve understanding of short-pulse laser technologies to include material interaction and propagation. Scale electrically-pumped alkali vapor lasers to higher kilowatt class power levels. Characterize and understand the physics of high energy laser atmospheric propagation in adverse environmental conditions such as fog, rain, smoke and dust. Evaluate and test Avoidance and Air Space De-confliction systems on directed energy test ranges. Collaborate with the international directed energy community. Validate predictive models through analysis of atmospheric propagation data and measurements. ***FY 2020 Base Plans:*** Continue to explore advanced concepts for directed energy technologies that will improve efficiency and decrease mass and volume for future weapon systems. Continue to evaluate materials for directed energy applications. Continue to improve understanding of short-pulse laser technologies to include material interaction and propagation. Continue to scale electrically-pumped alkali vapor lasers to higher kilowatt class power levels. Continue to characterize and understand the physics of high energy laser atmospheric propagation in adverse	5.793	6.229	6.300	0.000	6.300

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
environmental conditions such as fog, rain, smoke and dust. Continue to evaluate and test Avoidance and Air Space De-confliction systems on directed energy test ranges. Continue to collaborate with the international directed energy community. Continue to validate predictive models through analysis of atmospheric propagation data and measurements. ***FY 2020 OCO Plans:*** Not Applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $0.071 million. Justification for increase is described in the plans above.					
Title: Directed Energy Propagation Technologies ***Description:*** Develop technology to support high performance beam control systems and integrated demonstrations. In FY 2019, this effort was named Laser Beam Control Technologies. Name changed to reflect the direction in the 2017 National Defense Authorization Act. ***FY 2019 Plans:*** Develop beam control technologies for directed energy weapon use on multiple platforms (aircraft, ground vehicles and shipboard systems) in stressing environments. Continue development of a predictive avoidance fire control system for use on multiple platforms. Develop kill assessment technologies. Develop hardware and technologies to improve throughput efficiency through the beam director or antenna, decrease component weight, and improve tracking and compensation through the atmosphere. Select and develop additional concepts for Service-specific applications. ***FY 2020 Base Plans:*** Continue to develop beam control technologies for directed energy weapon use on multiple platforms (aircraft, ground vehicles and shipboard systems) in stressing environments. Continue to development of a predictive avoidance fire control system for use on multiple platforms. Continue develop kill assessment technologies. Continue to develop hardware and technologies to improve throughput efficiency through the beam director	19.660	21.158	21.936	0.000	21.936

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
or antenna, decrease component weight, and improve tracking and compensation through the atmosphere. Continue select and develop additional concepts for Service-specific applications. ***FY 2020 OCO Plans:*** Not Applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $0.778 million. Justification for increase is described in the plans above.					
Title: Directed Energy Lethality Research ***Description:*** Conduct directed energy vulnerability experiments on materials, components, and targets. Develop a lethality database, and integrate into a systems-level architecture plan and lethality models. In FY 2019, this effort was named High Energy Laser Lethality Research. Name changed to reflect the direction in the 2017 National Defense Authorization Act. ***FY 2019 Plans:*** Integrate lethality data into campaign-level directed energy system models. Conduct directed energy vulnerability experiments on materials, components, and targets. Develop a suite of directed energy weapon tools to be used in a database from which the warfighter can assess target vulnerabilities and mission utility for given directed energy weapon platform and engagement. Develop warfighter tools employing service and agencies metrics and criteria such as the Joint Munitions Effectiveness Standards. ***FY 2020 Base Plans:*** Continue to integrate lethality data into campaign-level directed energy system models. Continue to conduct directed energy vulnerability experiments on materials, components, and targets. Continue to develop a suite of directed energy weapon tools to be used in a database from which the warfighter can assess target vulnerabilities and mission utility for given directed energy weapon platform and engagement. Continue to develop warfighter tools employing service and agencies metrics and criteria such as the Joint Munitions Effectiveness Standards. ***FY 2020 OCO Plans:*** Not Applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:***	3.820	4.123	4.170	0.000	4.170

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C. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
FY 2020 decreased compared to FY 2019 by $0.047 million. Justification for decrease is described in the plans above.					
Title: Directed Energy Modeling ***Description:*** Maintain and evaluate high-fidelity engineering models for high energy laser and high power microwave system scenario evaluation and incorporation into the directed energy toolkit. Provide atmospheric propagation and directed energy system modeling for mission-level war-gaming activities. In FY 2019, this effort was named High Energy Laser Modeling. Name changed to reflect the direction in the 2017 National Defense Authorization Act. ***FY 2019 Plans:*** Provide maintenance, verification, validation, and accreditation for updated system level atmospheric propagation and directed energy 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. Conduct verification and validation planning to support advanced beam control objectives, diagnostics and warfighter tools. ***FY 2020 Base Plans:*** Continue to provide maintenance, verification, validation, and accreditation for updated system level atmospheric propagation and directed energy system models. Continue to collaborate with Service-sponsored field-test planning to correlate model predictions with measured data for surface, maritime and aerospace environments. Continue to incorporate atmospheric data into theater models to support performance characterization tables. Continue to conduct verification and validation planning to support advanced beam control objectives, diagnostics and warfighter tools. ***FY 2020 OCO Plans:*** Not Applicable ***FY 2019 to FY 2020 Increase/Decrease Statement:*** FY 2020 increased compared to FY 2019 by $0.046 million. Justification for the increase is described in the plans above	3.747	4.019	4.065	0.000	4.065
Accomplishments/Planned Programs Subtotals	40.156	43.192	44.221	0.000	44.221

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D. Other Program Funding Summary ($ in Millions)

N/A

Remarks

E. Acquisition Strategy

N/A

F. Performance Metrics

Please refer to the Performance Base Budget Overview Book for information on how Air Force resources are applied and how those resources are contributing to Air Force performance goals and most importantly, how they contribute to our mission.