Manuscript Review

1. In general, the input of data into a black box and the latter spewing out parameters that claim optimization does not - in my opinion - constitute a research paper. This is because, you are using optimization algorithms already designed and only using them to obtain the most optimized values; which may not require the rigor and knowledge expected of an author of a scientific publication. Having said that, I realize that some knowledge is still needed to run this black box so I am willing to give the author the benefit of the doubt.

2. You state "….Maximum Thrust-to-Power-Consumption Ratio Parameters: Anode radius = 0.25 m, anode thickness = 0.01 m, anode height = 0.5 m, grid spacing = 0.005 m, grid height = 0.006 m. - Maximum Thrust-to-Power-Consumption Ratio Metrics: Exhaust velocity = 9545.09 m/s, Thrust = 0.0263698 N, Specific Impulse = 681.33 s, Power consumption = 364.954 W, Thrust-to-power-consumption ratio = 0.0000722549……" this yields a P/T ratio of 13.6 kW/N. In contrast, NASA's evolutionary Xenon Thruster (NEXT) achieves 24 kW/N . Explain why, your simulation is significantly (2X) better, and if this is the case, why have these parameters not been utilized in real world thrusters ? (There must be reasons why real world thrusters operate at Higher kW/N ratio than your simulation. Is your simulation done under ideal condtions? Can your radius, thickness, grid height, specing etc. withstand the heat generated ? Please explain and describe in the manuscript.

3. I am not convinced that your simulation recapitulates real world data as shown in Figure 10. the curve shapes < 0.4 m are significantly different for the two graphs. I would like to see at least 10 values spaced at regular intervals for a range encompassing 50-150% of the Power/Newton ratios in a table showing the power/N values for your simulation compared with the U of Michigan actual empirical data. (or equivalent comparison) I do not think a one-point comparison as you have presented in the manuscript is justification for congurence.

4. You can obtain lower theoretical Power/Newton values if you do not have a limit on mass (to generate that power, correlation of power and thrust is 0.74 according to your heat map). If your simulated parameters (…Anode radius = 0.25 m, anode thickness = 0.01 m, anode height = 0.5 m, grid spacing = 0.005 m, grid height = 0.006 m…..) were to be scaled up to actual spacecraft dimensions and mass (including the max # of solar cells of nuclear reactor mass), would you still be able to retain this ostensible P/N advantage ? Please clarify the boundary conditions for your optimization and discuss in the manuscript.

5. How does you simulated P/N of 13.8 kW/N compare with that of Starlink or other Gridded or Hall effect thrusters? Please perform a search of the literature.

6. The P/N ratio is inversely proportional to radius and directly proportional to thickness (per your correlogram), hence without a boundary condition(s), you can indiscriminately vary these to obtain lower P/N ratios (goes back to point 4). Please discuss in the manuscript. In addition, the charge-density values seem high and not consistent with real operating conditions (the ratio of the anode to screening grid charge density is usually 10, in your case you have assumed it to be an order of magnitude greater at 100. Provide references to show that each parameter you present or choose is within the realm of real operating conditions of ion thrusters.

7. All the points 1 through 6 need addressing also for the Hall-effet thruster optimization and data.

8. All your figures show x,y and z axis without axes labels (i.e. without presenting what parameters those axes represent). Please present axes labels in all your Figures.
9. Similarly for Figure 8, please label the axis that is presented as “z-coordinate” or explain what this means in the manuscript.

Reviewer Comment 1: "In general, the input of data into a black box and the latter spewing out parameters that claim optimization does not - in my opinion - constitute a research paper. This is because, you are using optimization algorithms already designed and only using them to obtain the most optimized values; which may not require the rigor and knowledge expected of an author of a scientific publication. Having said that, I realize that some knowledge is still needed to run this black box so I am willing to give the author the benefit of the doubt."
Response: In the revised manuscript, the methodology section has been expanded to detail the custom-built code used for the simulations. Specifically, the section clarifies that the simulation framework was independently developed using Mathematica’s differential equation solvers, rather than relying on existing optimization algorithms without modification. The newly added description provides insights into how the code was designed to enable extensive parameter sweeps and sensitivity analyses. To ensure transparency and reproducibility, links to both the GitHub repository and Wolfram Community where the code is publicly available have been included.
Revised Section:

- **Methodology**: Detailed explanation of the simulation framework and the independent development of the code, along with publicly available resources for transparency and reproducibility.

Reviewer Comment 2: "You state '…Maximum Thrust-to-Power-Consumption Ratio Parameters: Anode radius = 0.25 m, anode thickness = 0.01 m, anode height = 0.5 m, grid spacing = 0.005 m, grid height = 0.006 m. - Maximum Thrust-to-Power-Consumption Ratio Metrics: Exhaust velocity = 9545.09 m/s, Thrust = 0.0263698 N, Specific Impulse = 681.33 s, Power consumption = 364.954 W, Thrust-to-power-consumption ratio = 0.0000722549…' this yields a P/T ratio of 13.6 kW/N. In contrast, NASA’s evolutionary Xenon Thruster (NEXT) achieves 24 kW/N . Explain why, your simulation is significantly (2X) better, and if this is the case, why have these parameters not been utilized in real world thrusters? Can your radius, thickness, grid height, spacing etc. withstand the heat generated? Please explain and describe in the manuscript."
Response: This discrepancy is explained in the revised **Results** section, where I discuss how the simulation was conducted under idealized conditions that did not account for heat generation, material stresses, or other real-world operational constraints. Real-world thrusters like NASA’s NEXT are engineered with conservative design choices to ensure durability and reliability throughout their operational lifespan, which explains the higher thrust-to-power-consumption ratio. The revised section now also provides explanations of the thermal and structural limitations that real-world thrusters must consider, and why the optimized parameters in the simulation could potentially overheat or fail under actual space conditions.
Revised Section:

- **Results – Gridded Ion Thruster Simulation**: Comparison with NASA’s NEXT thruster, explanation of thermal management and operational limits in real-world applications.

Reviewer Comment 3: "I am not convinced that your simulation recapitulates real world data as shown in Figure 10. The curve shapes < 0.4 m are significantly different for the two graphs. I would like to see at least 10 values spaced at regular intervals for a range encompassing 50-150% of the Power/Newton ratios in a table showing the power/N values for your simulation compared with the U of Michigan actual empirical data."

Response: The **Validation and Comparison with Empirical Data** section has been updated to clarify that the U of Michigan data provides only a single set of ion velocity measurements for a Hall Effect Thruster, and this data ends at 0.08 m, as ions exit the thruster. The simulation, on the other hand, assumes the ions are already ionized and tracks their acceleration beyond this point. As a result, the velocity plots naturally differ from empirical data, but the exhaust velocities remain similar, supporting the model's validity.

Revised Section:

- **Validation and Comparison with Empirical Data**: Clear explanation of differences in the velocity curves.

Reviewer Comment 4: "You can obtain lower theoretical Power/Newton values if you do not have a limit on mass (to generate that power, correlation of power and thrust is 0.74 according to your heat map). If your simulated parameters (Anode radius = 0.25 m, anode thickness = 0.01 m, anode height = 0.5 m, grid spacing = 0.005 m, grid height = 0.006 m…) were to be scaled up to actual spacecraft dimensions and mass (including the max # of solar cells of nuclear reactor mass), would you still be able to retain this ostensible P/N advantage? Please clarify the boundary conditions for your optimization and discuss in the manuscript."

Response: The boundary conditions for optimization have now been clarified in the **Parameter Optimization** section. In this section, I have explicitly discussed the constraints related to mass and power supply, such as the practical limitations of spacecraft solar panels and nuclear reactors. The section now explains that while scaling up thruster dimensions could theoretically reduce the power-to-thrust ratio, real-world thruster designs must balance performance with the limitations of available power generation and thermal management systems.

Revised Section:

- **Parameter Optimization**: Explanation of mass and power limitations in scaling thruster designs.

Reviewer Comment 5: "How does your simulated P/N of 13.8 kW/N compare with that of Starlink or other Gridded or Hall effect thrusters? Please perform a search of the literature."

Response: The revised manuscript includes a new section comparing the simulated P/N ratio with real-world Hall Effect Thrusters used by Starlink satellites. Based on literature, the P/N ratios for similar Hall Effect Thrusters used in commercial satellite systems range from 20-30 kW/N, significantly higher than the 13.8 kW/N simulated in this study. This comparison, along with the design considerations for commercial thrusters, such as durability and heat dissipation, is now included in the **Results – Hall Thruster Simulation** section.

Revised Section:

- **Results – Hall Thruster Simulation**: Comparison with Starlink's Krypton Hall Effect Thrusters and other commercial systems.

Reviewer Comment 6: "In addition, the charge-density values seem high and not consistent with real operating conditions (the ratio of the anode to screening grid charge density is usually 10, in your case you have assumed it to be an order of magnitude greater at 100. Provide references to show that each parameter you present or choose is within the realm of real operating conditions of ion thrusters."

Response: I have revised the **Methodology** section to justify the charge density values used in the simulations. Citations have been added from studies such as **Kindberg (2017)** and **Simmonds et al. (2023)**, which provide real-world charge densities for ion thrusters. These references support the values selected for the simulations and explain any deviations from standard ratios.

Revised Section:

- **Methodology**: Justification of charge density values with references to real-world studies.

Reviewer Comment 7: "All your figures show x, y, and z axes without axes labels (i.e. without presenting what parameters those axes represent). Please present axes labels in all your Figures."

Response: The manuscirpt now describes the dimensions in meters before the figures (e.g., **x-axis (Width in meters)**, **y-axis (Depth in meters)**, and **z-axis (Height in meters)**), as indicated in the revised **Simulation Setup and Execution** section. This update ensures that all figures are clear and provide the necessary context for interpreting the data.

Revised Section:

- **Figures and Axes**: Included explanation of parameter dimensions.