# MACH 8 HYPERSONIC WIND TUNNEL COMPUTATIONAL APPLICATION


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## ABSTRACT


- Hypersonic wind tunnels simulate extreme hypersonic flight conditions without costly full-scale tests.
- Preparing these tests involves complex calculations, often leading to errors and inefficiencies.
- The HADES Mach 8 Hypersonic Wind Tunnel application, developed in MATLAB, simplifies this process.
- Provides engineers control over key test parameters and integrates heater combustion and nozzle optimization code.
- Automated checks ensure operational safety, while a MATLAB GUI improves usability and efficiency.


## INTRODUCTION

- Hypersonic testing (>Mach 5) involves precise aerodynamic and thermal condition calculations.
- MATLAB-based tool developed to accurately define combustion parameters (heater: fuel-air ratio/$O_2$ percentage).
- Optimizes nozzle performance, ensuring realistic simulation conditions for accurate testing.

## ACKNOWLEDGEMENTS


I want give acknowledgement to Dr. Johnathan Reyes for his mentorship through this research project and the EXCEL program for this experience.


## METHODOLOGY

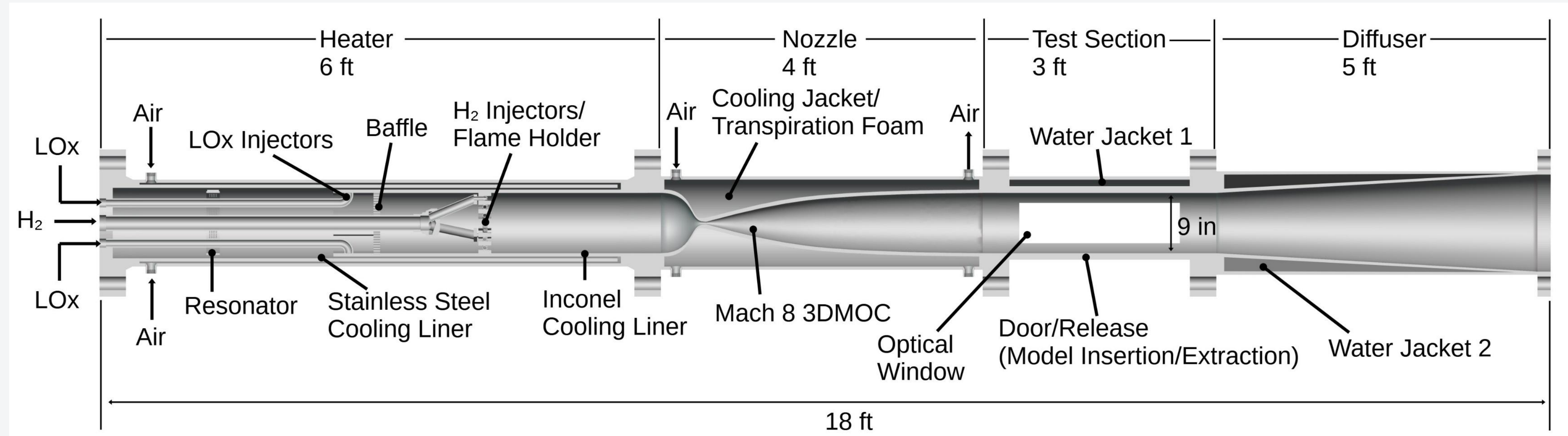
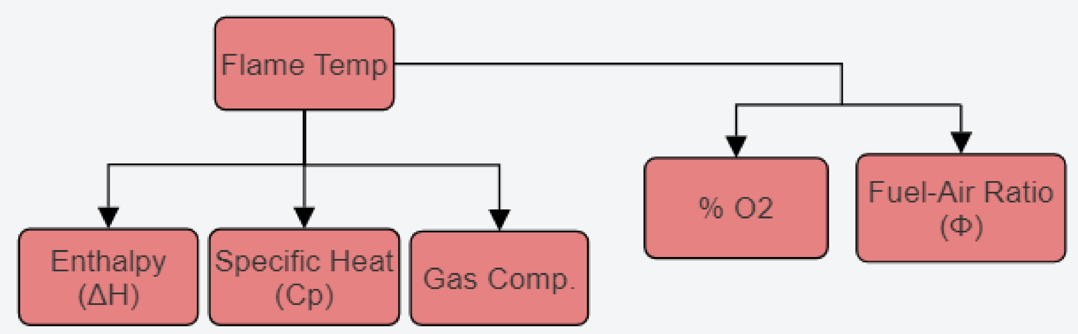
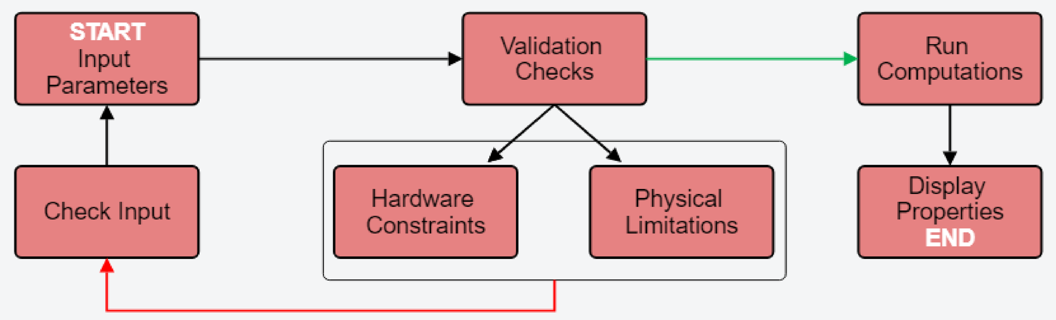



Figure 1: Detailed layout of the HADES wind tunnel

### Heater Section




### Nozzle Section




### Results

- Code in MATLAB hypersonic conditions using relevant equations on a function basis
- Develop an algorithm to detect system within physical and hardware limitations ensuring safety
- Construct GUI using MATLAB's App Designer that is user friendly
- Stoichiometric Calculator to balance combustion at desired phi or $O_2$
- Heater code delivers essential combustion properties

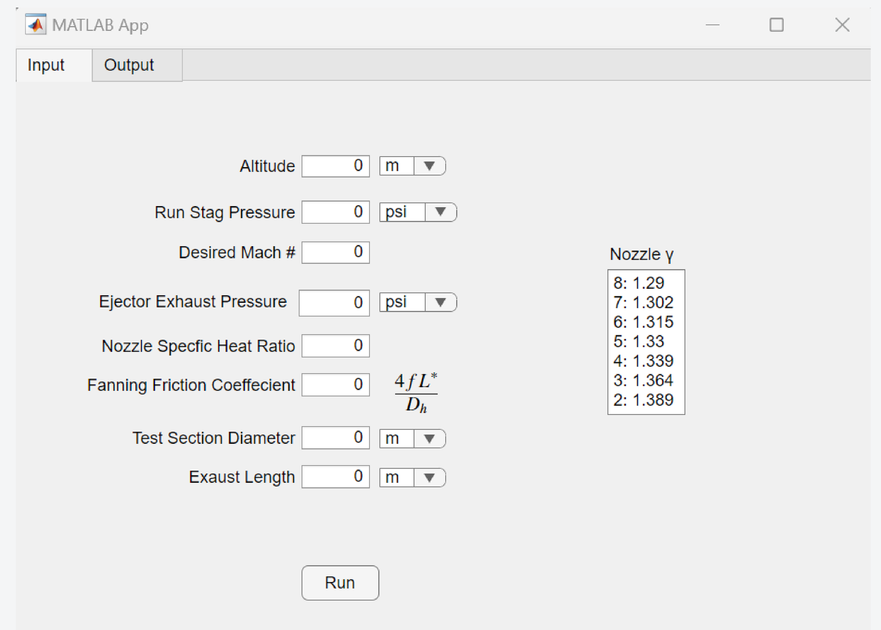



Figure 2: Required input conditions user must enter into MATLAB GUI

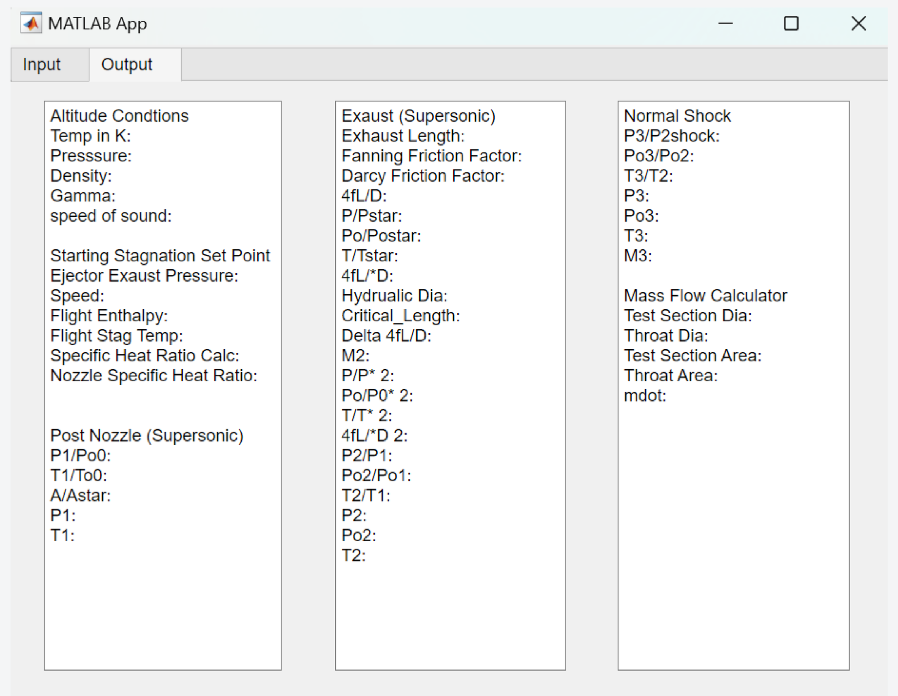



Figure 3: Output of hypersonic properties in MATLAB GUI

## CONCLUSION

The HADES Mach 8 Hypersonic Wind Tunnel application lays the groundwork for hypersonic testing at UCF. This tool automates the calculations for the nozzle and heater sections allows engineers every detail about their system to make informed decisions. A reduced setup time with reliable calculations minimizes the likelihood of mistakes.

## FUTURE WORK

- Packaging the MATLAB code into a standalone executable file for easier sharing with those who do not use MATLAB
- Incorporating wireless capabilities so that researchers can adjust wind tunnel settings directly from the tool.
- Further refine the tool using data collected from experimental calibration [1]

## REFERENCES


**[1]** Lynn, K. C., Commo, S. A., and Parker, P. A., 2005, "Hypersonic Wind Tunnel Calibration Using the Modern Design of Experiments," *NASA Technical Reports Server*. [Online]. Available: https://ntrs.nasa.gov/api/citations/20050192473/downloads/20050192473.pdf.

**[2]** Anderson, J. D., 2010, *Fundamentals of Aerodynamics*, 5th ed., McGraw-Hill Education, New York. [Online]. Available: http://students.aiu.edu/submissions/profiles/resources/onlineBook/P9L5e4_Fundamentals%20of%20Aerodynamics.pdf.

**[3]** MathWorks, 2024, *MATLAB Documentation*, The MathWorks, Inc., Natick, MA. [Online]. Available: https://www.mathworks.com/help/matlab/.