

Numerical Investigation of Oblique Detonation Combustors

Master's Thesis

Contact: Benedikt Biller

Mail: benedikt.biller@tum.de

Start date: April 2026

Motivation

Oblique detonation combustors (ODCs) represent a novel concept for high-speed propulsion systems due to their potential for near-constant-pressure combustion and high thermodynamic efficiency. Figure 1 shows a typical propulsion system and its simplification for a numerical investigation.

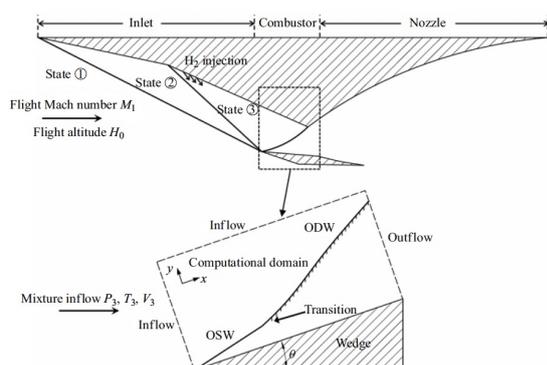


Figure 1: Typical ODC geometry [2].

Objectives

The purpose of this work is the numerical simulation and investigation of an ODC with increasing levels of complexity using the high-fidelity in-house code ALPACA guided by the following work packages:

1. Identification of a suitable geometry and simulation setup.
2. Simulation of premixed hydrogen air mixture.
3. Simulation of non-premixed hydrogen air mixture.
4. Simulation of liquid fuel atomization in an ODC geometry without combustion.

Starting points for work package 1 can be found in [1–3]. The employed CFD solver ALPACA is written in modern C++ and implements all required physical processes. However, for work packages 3 and 4 some minor boundary condition implementations might be necessary.

Requirements

- Ability to work independently
- Knowledge of gas dynamics and combustion theory
- Beneficial: Experience in C++ and python programming

Take aways

- Work with state-of-the-art CFD solver
- Experience with HPC clusters
- Scientific working and writing

References

- [1] Qin, J. and Zhu, D. "Criticality for Oblique Detonation Waves Induced by a Finite Wedge in a Hydrogen–Air Mixture". In: *Aerospace* 10.6 (2023). DOI: [10.3390/aerospace10060508](https://doi.org/10.3390/aerospace10060508).
- [2] Teng, H., Tian, C., Zhang, Y., Zhou, L., and Ng, H. D. "Morphology of oblique detonation waves in a stoichiometric hydrogen–air mixture". In: *Journal of Fluid Mechanics* 913 (2021). DOI: [10.1017/jfm.2020.1131](https://doi.org/10.1017/jfm.2020.1131).
- [3] Zhang, Z., Wen, C., Yuan, C., Liu, Y., Han, G., Wang, C., and Jiang, Z. "An experimental study of formation of stabilized oblique detonation waves in a combustor". In: *Combustion and Flame* 237 (2022), p. 111868. DOI: <https://doi.org/10.1016/j.combustflame.2021.111868>.