Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Avoiding High-frequency Thermoacoustic Instabilities in Liquid Propellant Rocket Engines Using Bayesian Deep Learning USHNISH SENGUPTA, University of Cambridge, GUENTHER WAXENEGGER-WILFING, JAN MARTIN, JUSTIN HARDI, German Aerospace Center (DLR) Lampoldshausen, MATTHEW JUNIPER, University of Cambridge — Destructive high-frequency thermoacoustic instabilities have afflicted liquid propellant rocket engine development for decades. The 90 MW cryogenic liquid oxygen/hydrogen multi-injector research combustor BKD operated by DLR Lampoldshausen is a platform that allows their study under realistic conditions. In this study, we use data from BKD experimental campaigns where the static chamber pressure and fuel-oxidizer ratio were varied such that the first tangential mode of the combustor is excited under some conditions. We train a Bayesian neural network to predict the occurence probability of thermoacoustic instabilities 500 ms in the future, given the power spectra of the most recent 300 ms sample of the dynamic pressure data and mass flowrate control signals as input. The Bayesian nature of our algorithms allow us to work in this "small data" setting where the size of our dataset is restricted by the effort and expense associated with each experimental run, without making overconfident extrapolations. We find that the network is able to accurately forecast the occurence probability of instabilities on unseen experimental runs. We envision that these algorithms will eventually be used online by rocket engine controllers to avoid regions of thermoacoustic instabilities.

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Date submitted: 02 Aug 2020 Electronic form version 1.4