Phase-Averaged Static Pressure Fields Inside a Rotating Detonation Combustor

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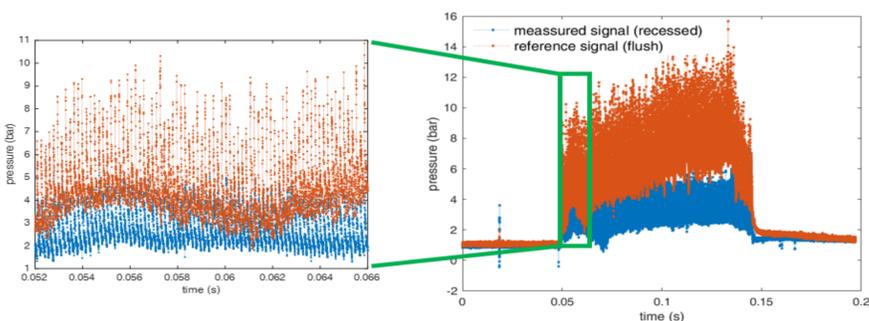Technische Universität Berlin, Chair of Fluid Dynamics, 10623 Berlin, Germany

Motivation

- RDCs have received considerable attention, however experimental measurements of the static pressure field in the combustor are difficult
- It is necessary to develop a measurement technique to preserve the sensor while providing a temporally-resolved pressure field
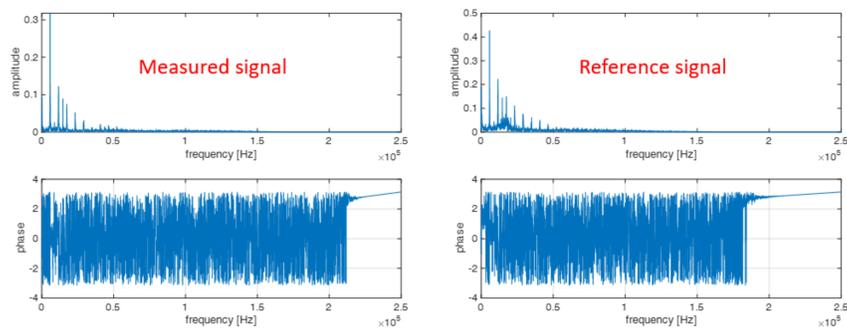
'True' pressure reconstruction

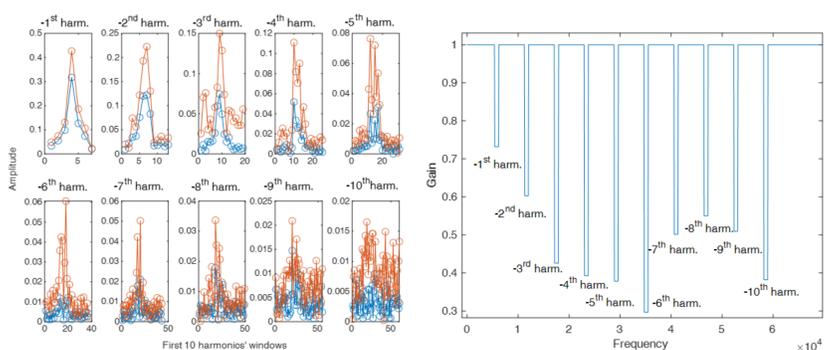### Transfer function between flush and recessed mounted Kulite

- Two Kulites in flush and recessed setup are installed in neighboring azimuthal positions but at the same axial position of the combustor
- Run time is limited below 150 ms
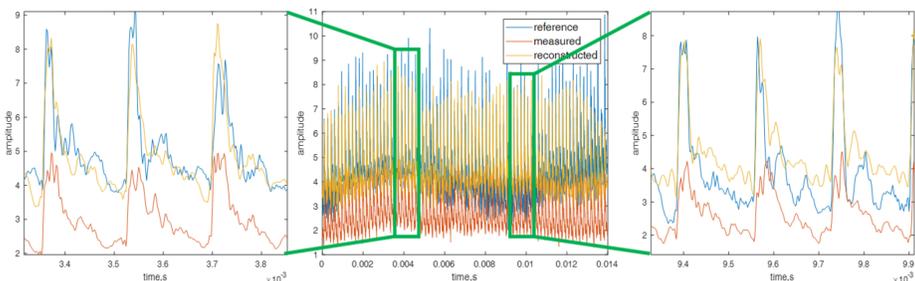

Fast Fourier transform

- Amplitudes and phases are obtained for each signal and the gain is determined as the ratio of the fundamental and harmonic components
- First 10 harmonics are considered for reconstruction

- Window width for each harmonic increases due to spectral leakage
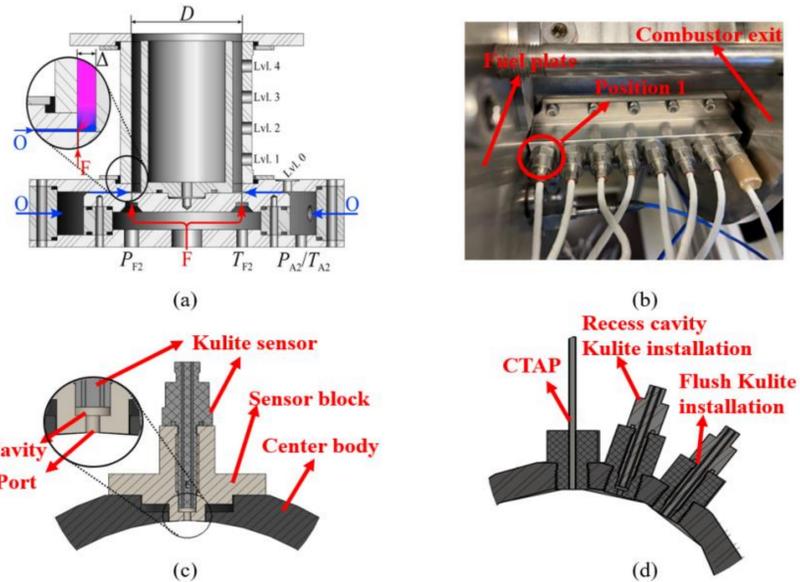
Reconstruction

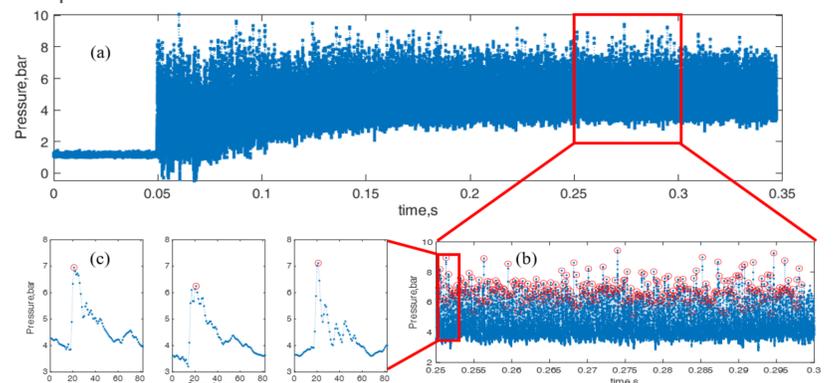- IFFT(Inverse fast Fourier transform)

Experimental setup

(a) TU Berlin's RDC, (b) recessed sensor block on the RDC, (c) cross section of a recessed mounted Kulite sensor, and (d) Kulite sensors in flush, recessed and CTAP configuration.

Average pressure

- An arithmetic mean is a conventional method to average pressure data in the RDC but will lead to the loss of sharp features such as the steep-fronted detonation wave. One key part of the current work is to explore a different averaging technique in order to preserve these sharp features using Dynamic Time Warping (DTW)

Representative pressure histories

- Choose a empirically "stable" penultimate 50 ms pressure trace
- Divide the full pressure trace into individual time windows, each catching one lap of the detonation wave

Average methods comparison

- The arithmetic mean method causes a distortion of the average pressure curve in the blue square
- DBA (DTW Barycenter Averaging) method is better than the arithmetic mean method but shows the obvious noise
- Soft-DTW method provides a smoothing parameter gamma to reduce noise. A balance needs to be found to preserve the features of pressure traces without developing artifacts as in the DBA

Ongoing work

- The performance of the transfer function at other frequencies/ amplitudes needs to be further quantified. The final version of this work will incorporate the corrected static pressure signal and averaging procedures to measure the pressure field through the combustion chamber and investigate the variation in this pressure field through the variation of key combustor parameters such as outlet restriction, mass flow rate, and equivalence ratio, among other values.

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