Pressure signal processing

JMO Massey[†], F Cabrera-Booman, T Jaroslawski, J Klewicki, BJ McKeon

Center for Turbulence Research
Stanford University

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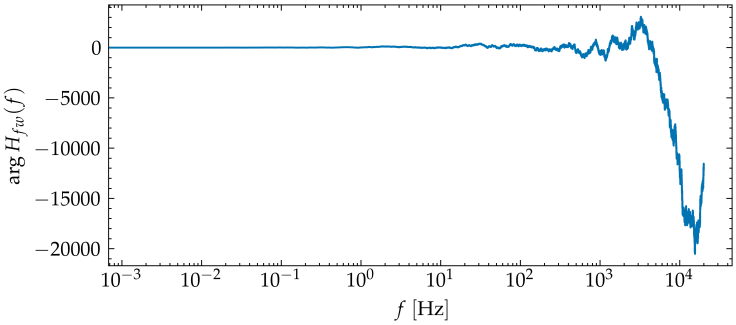
 [†]masseyj@stanford.edu

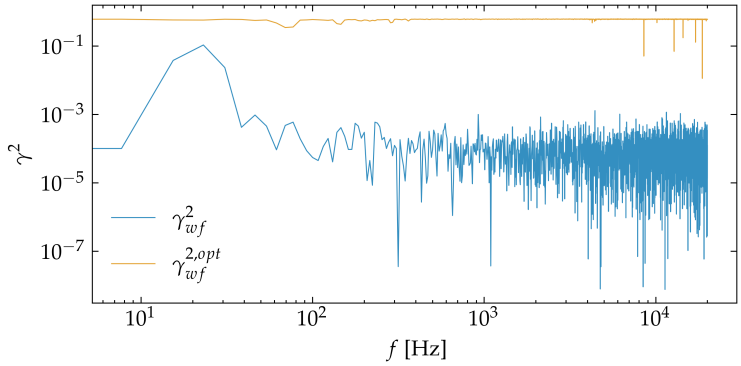
Match mics by finding the complex transfer function



- The microphones aren't phase matched
- Here, we match the phase response of the fs and wall measurements to approximate the complex transfer function
- $arg H_{fw}(f)$ *should* be found in an anechoic chamber with a known input signal

†masseyj@stanford.edu

Phase matching dramatically increases the coherence



- Without the complex transfer function, the coherence is very low
- The magnitude of the transfer function between fs and wall measurements needs to be determined
  - We *assume* it is unity for the purposes of this analysis

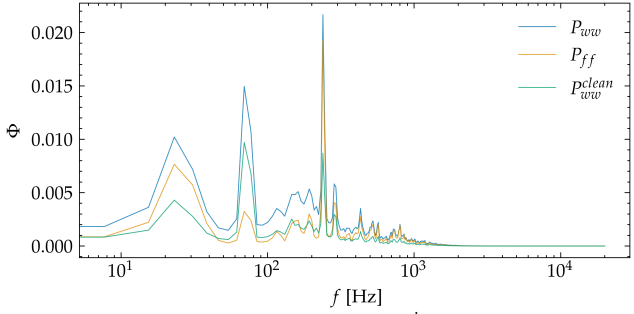
†masseyj@stanford.edu

Wiener filter

The Wiener filter is used to reject free-stream noise from the wall-pressure measurements. It has equation

$$H_{\text{Wiener}}(f) = \frac{P_{fw}(f)}{P_{ww}(f)} \tag{1}$$

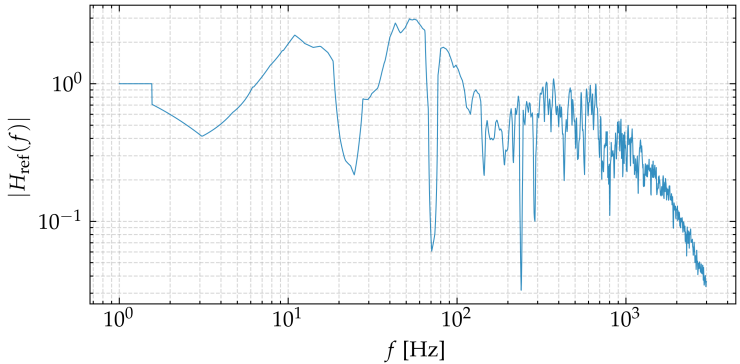
where $P_{fw}(f)$ is the cross spectral density between the reference and wall pressure signals, and $P_{ww}(f)$ is the power spectral density of the wall pressure signal.



- Duct modes *should* be removed by the Wiener filter
- Need $|H_{wf}(f)|$ for this

†masseyj@stanford.edu

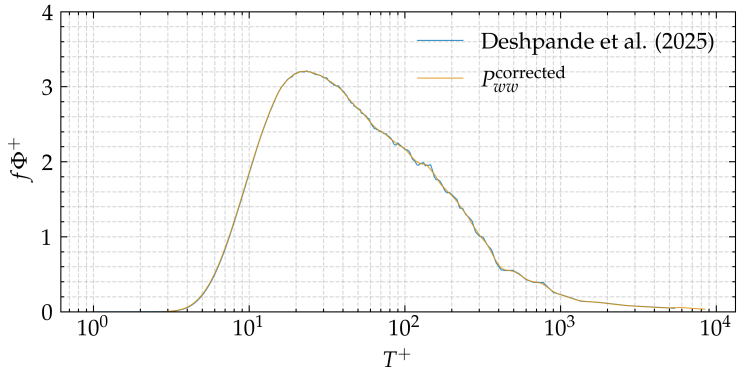
Transfer function between reference spectra and measurements



- Transfer function between reference spectrum (Deshpande *et al.*, 2025) and current measurements
  - Duct modes show up through the troughs of the transfer function

†masseyj@stanford.edu

Corrected signals



- Corrected wall pressure signal spectrum will always match the reference spectrum
  - We need the actual transfer function to do this
- Pressurising the facility will likely change the transfer function

†masseyj@stanford.edu

References

Deshpande, Rahul, Vinuesa, Ricardo, Klewicki, Joseph & Marusic, Ivan 2025 Active and inactive contributions to the wall pressure and wall-shear stress in turbulent boundary layers. *J. Fluid Mech.* **1003**, A24.