# Spatial Properties of the DEMAND Noise Recordings

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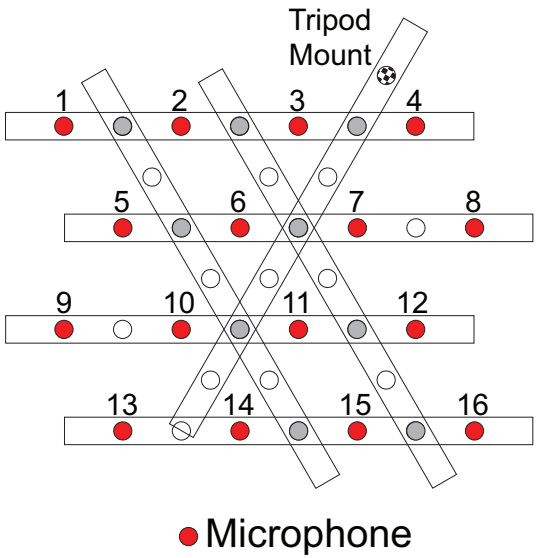
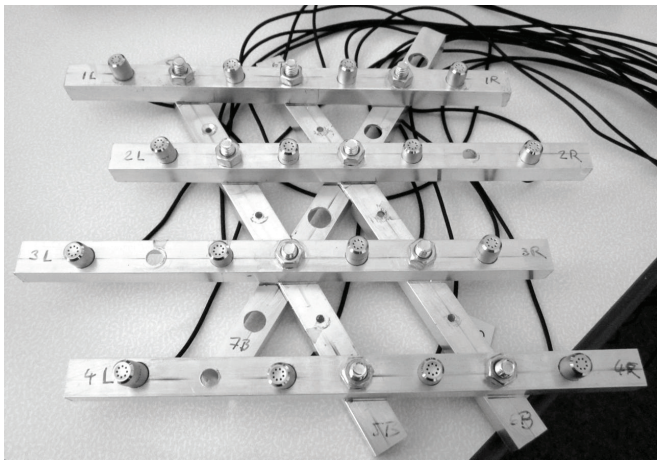
# Content

# The DEMAND Noise Database

- DEMAND is a set of 18 recordings of noise in a diverse set of indoor and outdoor environments.
- Recorded using a 16-channel planar microphone array in a configuration consisting of 4 staggered rows.
- CC-licensed, available at 48 kHz and 16 kHz sampling rates.



# The DEMAND Noise Database

- Purpose of DEMAND is to let researchers test algorithms on real-world data.
- What are the spatial properties of the data?

# Theory of the diffuse acoustic field

- Diffuse noise field properties known since the 50's [Cook, 1955].
- Coherence of 2 microphone signals depends only on the frequency and the distance between them:

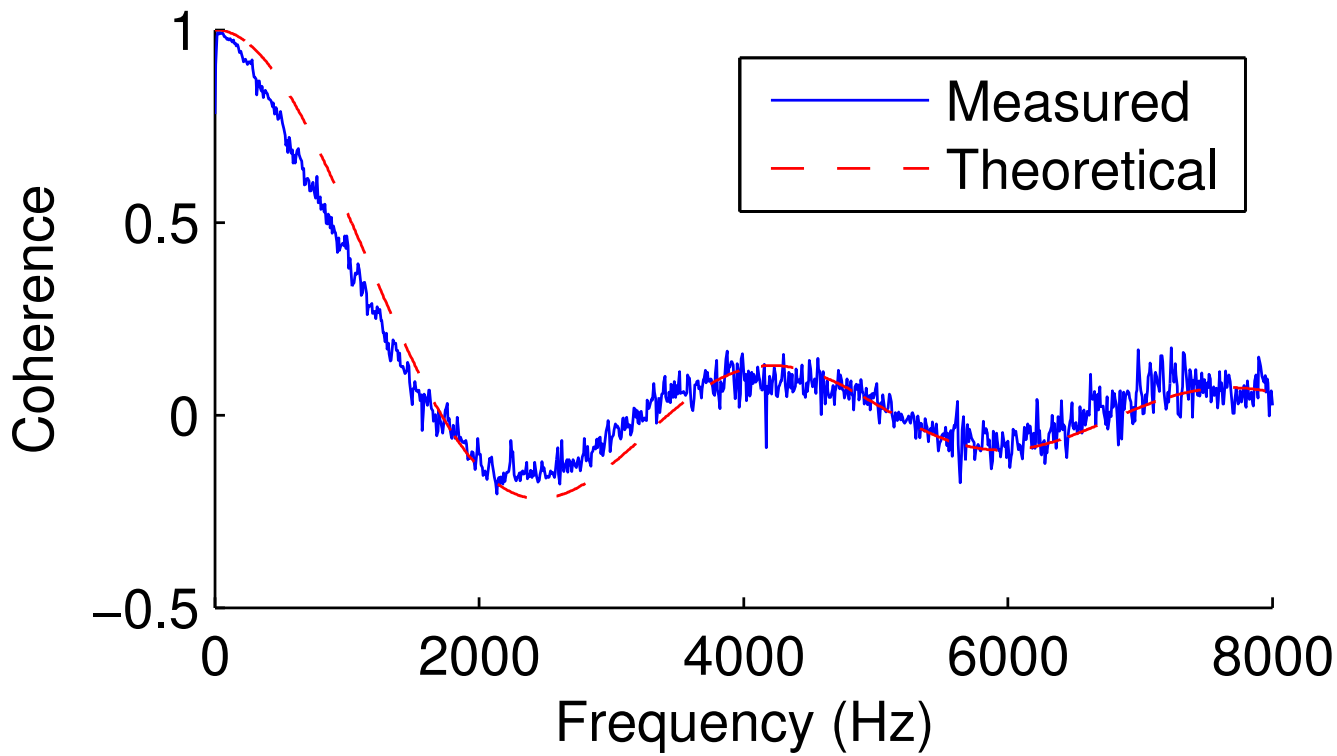
$$\Gamma_{ij}(f) = \frac{\phi_{ij}(f)}{\sqrt{\phi_{ii}(f)\phi_{jj}(f)}}, \tag{1}$$

$$\Gamma_{ij}^{\text{diffuse}}(f) = \text{sinc}\left(\frac{2\pi f d_{ij}}{c}\right). \tag{2}$$

where $\phi_{ij}(f) = x_i(f)x_j^{\star}(f)$.

# Matching the data: PSTATION

- Recording in the Metro Station “Republique” resulted in best match to theoretical data




Microphones 1 and 10 (10 cm distance)

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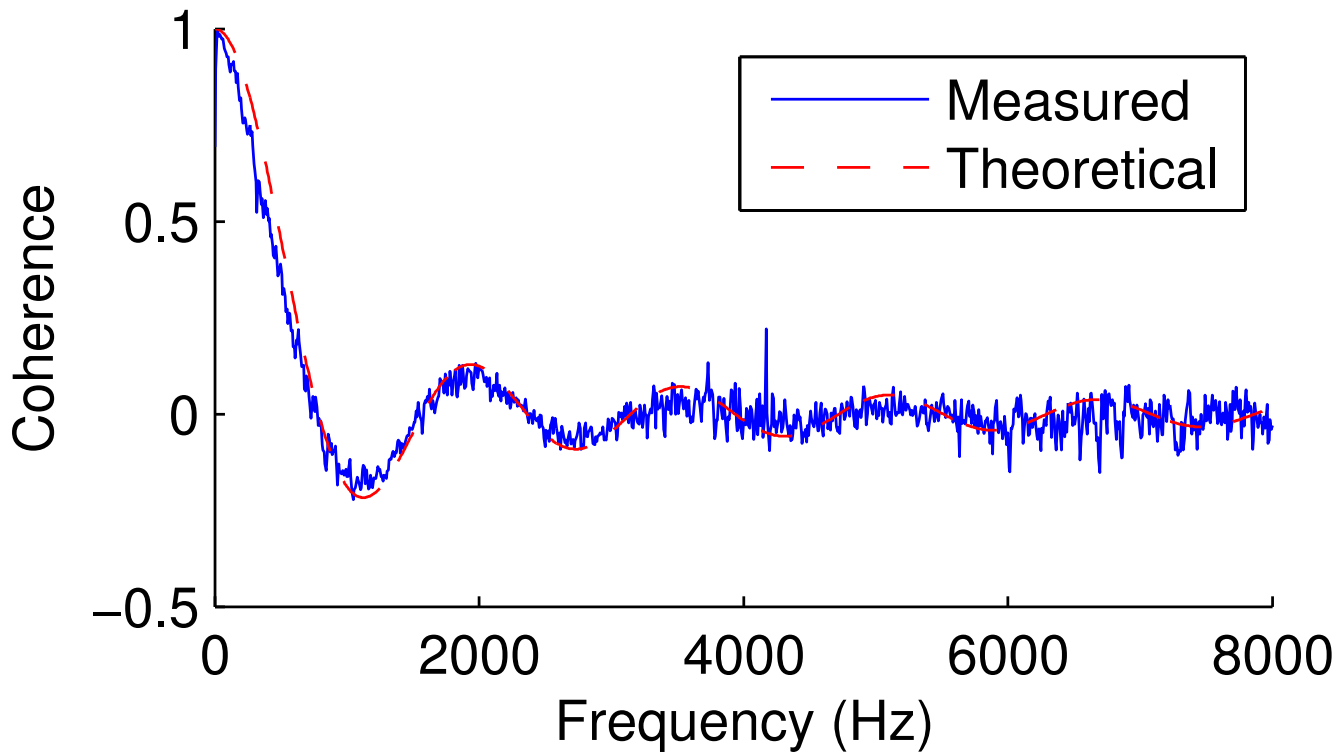
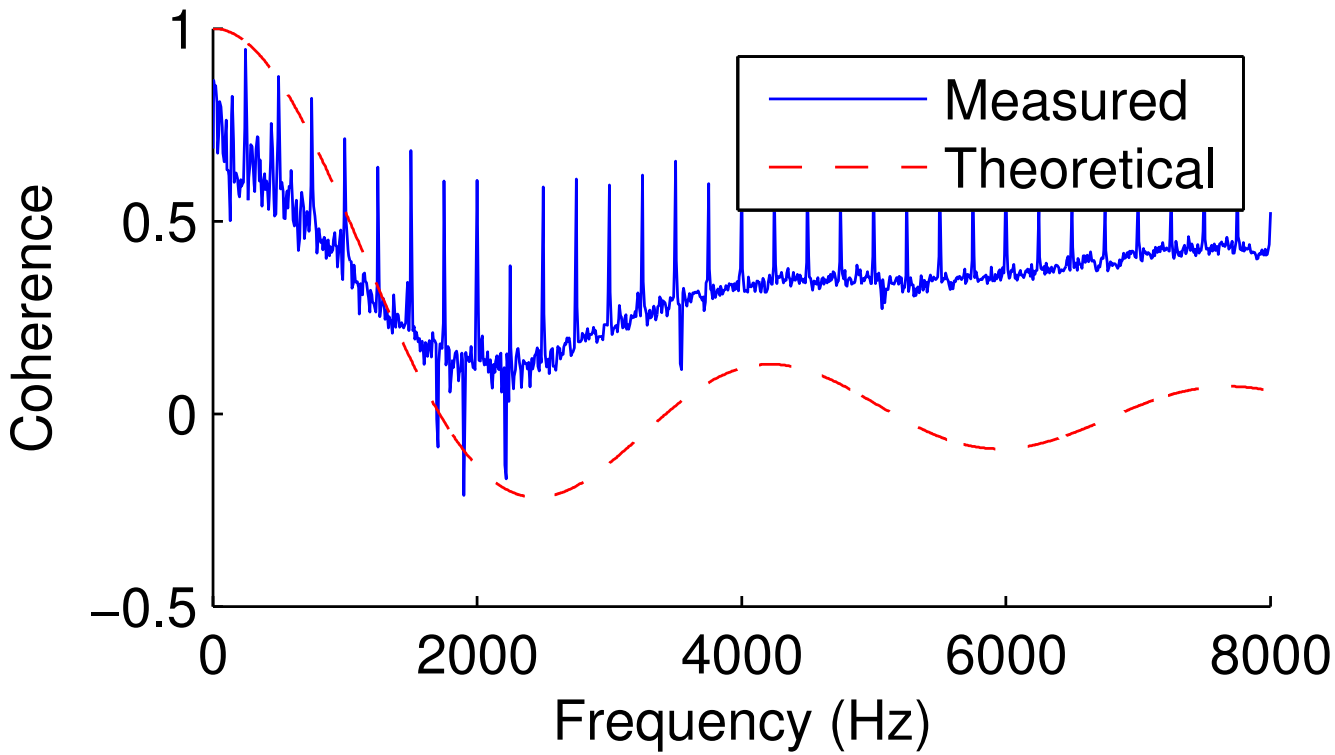



Microphones 1 and 16 (21.8 cm distance)

# Matching the data: OHALLWAY

- One of the worst matches: An office hallway

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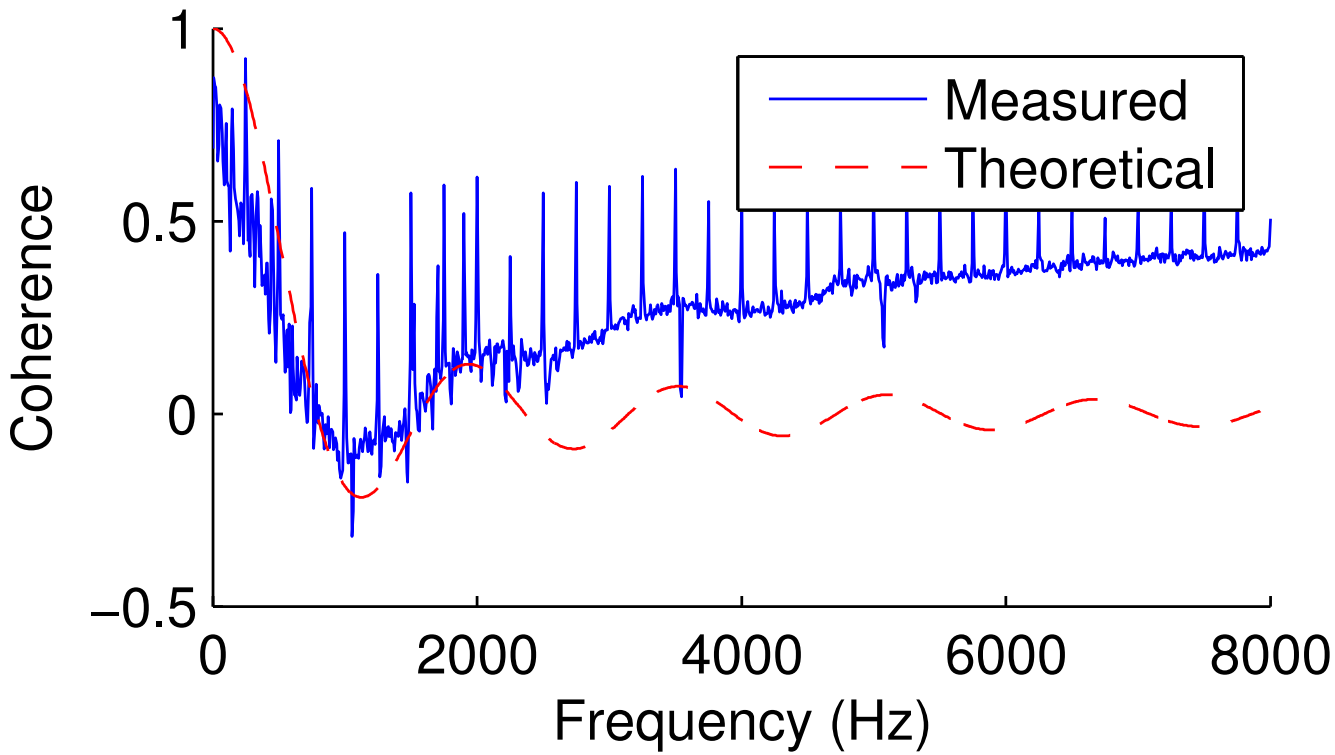


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# Observations

- All indoor public areas show close fit to theoretical values
  - PCAFETER, PRESTO, PSTATION, TBUS, TMETRO
  - RMS error $< 0.09$
- DLIVING, NFIELD, OHALLWAY show large error
  - RMS error $> 0.31$
  - all these are relatively quiet with few stationary sources

# Array calibration test

We use the “best” recordings in an attempt to calibrate the array:

- for a better match of simulated setups to the recordings
- using Levenberg-Marquard algorithm to find best $d_{ij}$ matching the measured data
- estimates using TMETRO give maximum error of 5.9 mm
- on average the estimates were 4.06 % higher than the design

# Observations

- better measurements of the array are needed
- there are inherent limits to calibration based on the signals:
  - natural variations in the speed of sound (temperature, wind shear, etc.)
  - microphone and amplifier self-noise

# Conclusion

- DEMAND recordings consist of recordings that have both very diffuse noise and noise mixed with localizeable sources.
- Although the microphone positions are not known to a high degree of precision, the database can be used to evaluate calibration algorithms on real data.
- In the future we plan to measure the positions to a higher degree.
- You can download the DEMAND data at `http://parole.loria.fr/DEMAND/`.

# FIN

Thank you for your attention.