Ushichka and its (interdisciplinary) challenges

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The Ushichka dataset consists of multi-sensor, multi-night recordings of echolocating bats in a cave. This document highlights the opportunity the dataset provides to drive scientific and methodological development across different fields.

3D Video tracking of multiple bats

- 3D video tracking: the three cameras in the dataset are calibrated (DLT coefficients can be estimated). Bats fly in and out of the field-of-view.
- 2D tracking of the bats is perhaps achievable, but correspondence matching of the 2D tracks needs to be done.
- Building 3D tracks from the matched 2D tracks

Acoustic tracking in dense audio scenes

- Acoustic tracking with dense and possibly overlapping sounds is technical *terra nova*.
- Sounds must be detected, and correspondence matched across channels. With Ushichka, we could actually use the positions of the bats from 3D video tracking to inform the detection and correspondence matching problems.

Call parameter inference with beam-shape modelling

Bats can alter many aspects of their calls, how loud, whether it is narrow/broad, or even where they point the call. Experiments have used densely packed mic arrays to track call parameters. This only works when the bat calls directly onto the array.

To date only one beam-shape model has been used (piston in an infinite baffle) - and produces useful predictions only in *front* of the bat. Using realistic beam-shape models allows efficient inference of call parameters with fewer microphones and better call parameter estimation.

This requires:

- Fast implementations of sound radiation models (see Beranek & Mellow 2012) using computer algebra systems (piston in a sphere, piston in a closed baffle, rectangular cap in a sphere)
- Running parameter estimation on the optimised beam-shape models.

References:

- Chapters 12-13, Beranek, L. L., & Mellow, T. (2012). Acoustics: sound fields and transducers. Academic Press.