

Jun 24th, 4:45 PM - 5:00 PM

Session B9: How Fish Use and Process Flow Information

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How Fish Use and Process Flow Information

Joachim Mogdans and Horst Bleckmann

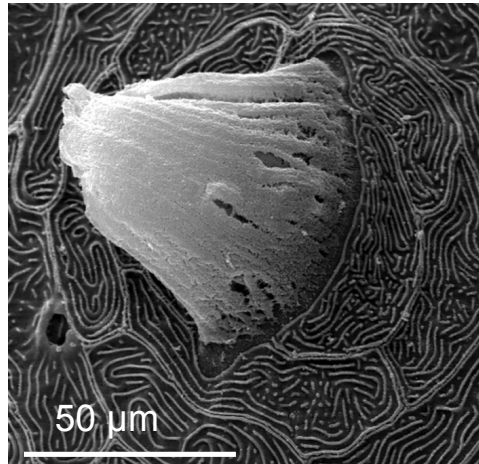


The Senses of Fish

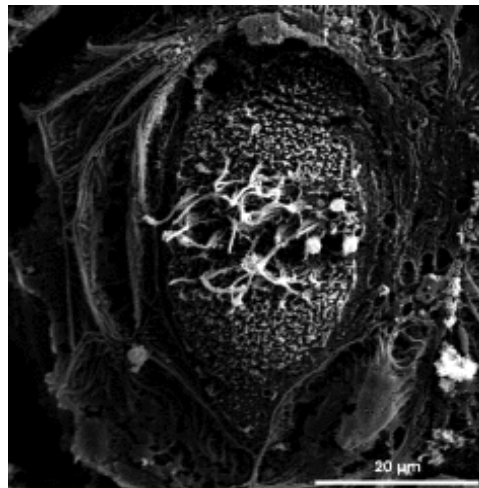
- Vision
- Hearing
- Vestibular Sense
- Chemosense
- Touch
- Nociception
- Electrosense
- Magnetic Sense
- Mechanosensory Lateral Line



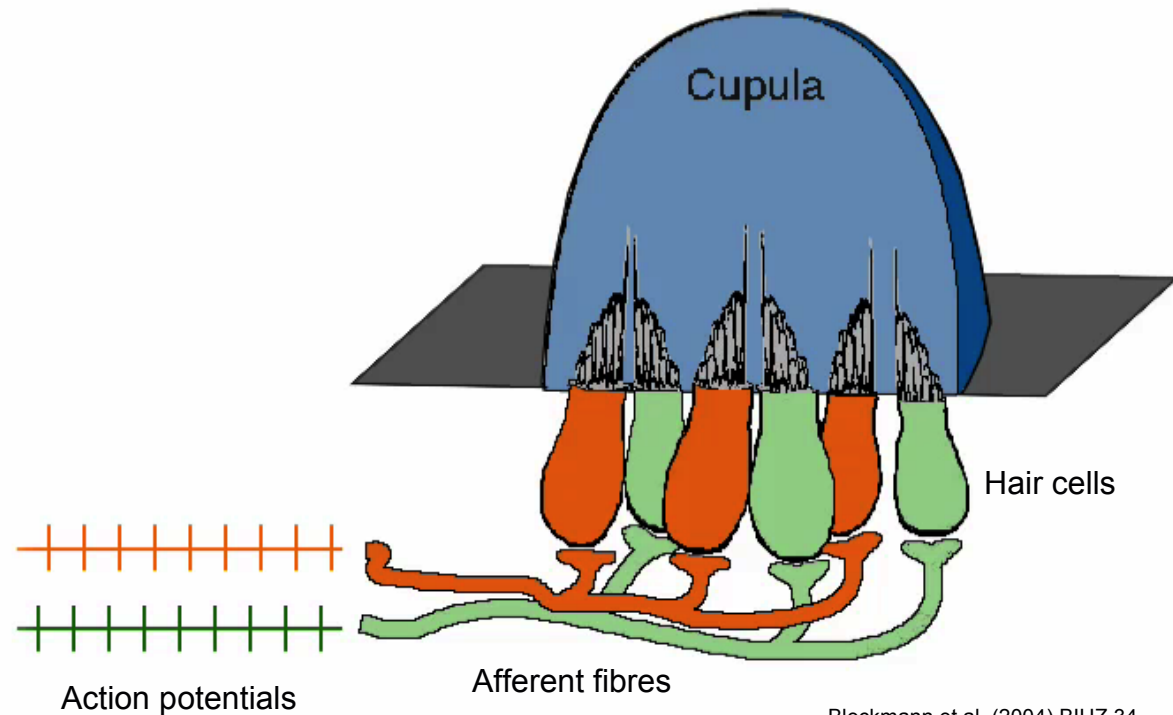
Neuromast structure and function



(picture J. Engelmann)



(picture J. Engelmann)



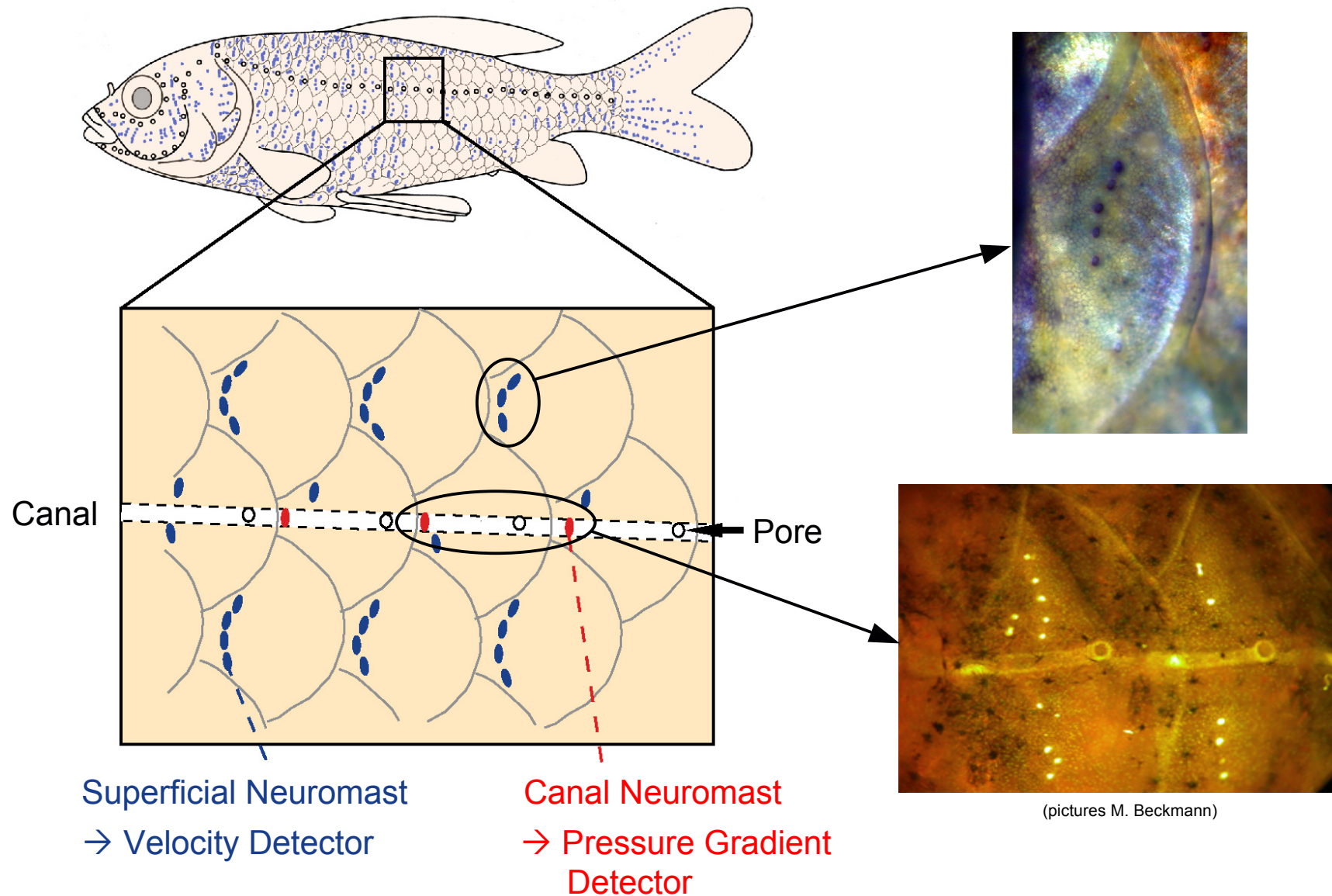
Bleckmann et al. (2004) BIUZ 34

Directionally sensitive flow sensor

Frequency range: DC - ca. 200Hz

Sensitivity: 0.01 μm p-p water displacement at the fish surface@100Hz

Distribution of Neuromasts



Lateral Line Array Variability

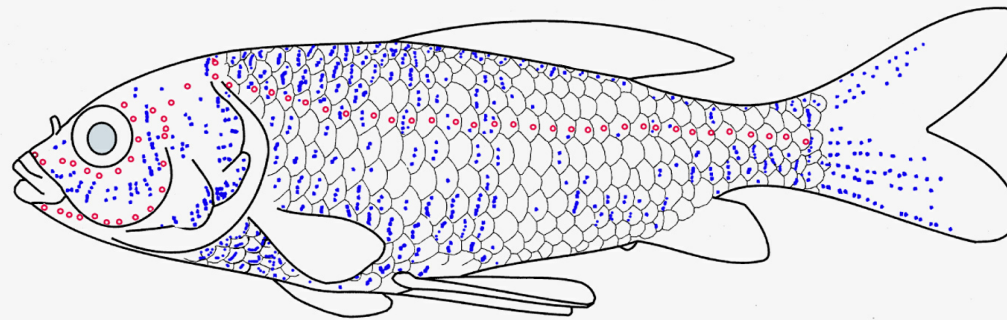
Superficial Neuromast System

Goldfish

Carassius auratus



ca. 2000 superficial neuromasts



10 mm

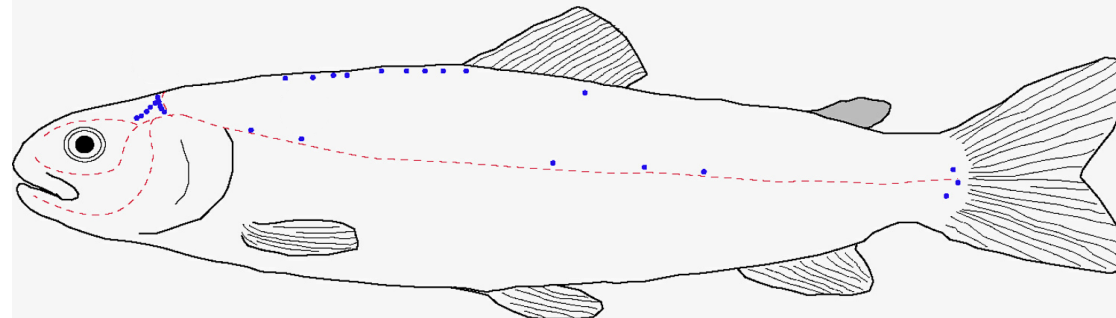
(data A. Grotefeld)

Trout

Oncorhynchus mykiss



36 superficial neuromasts



10 mm

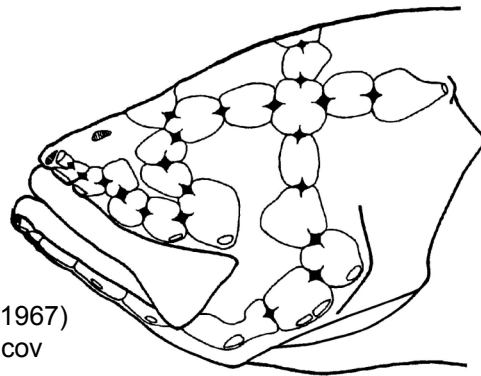
(data J. Engelmann)

Lateral Line Array Variability

Canal System

Perch

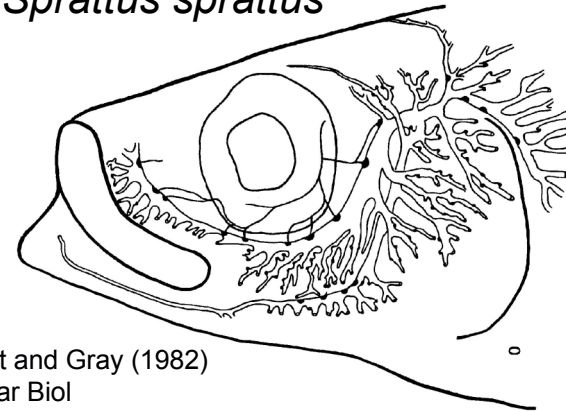
Percarina demidoffi



Jakubowski (1967)
Acta Biol Cracov

Sprat

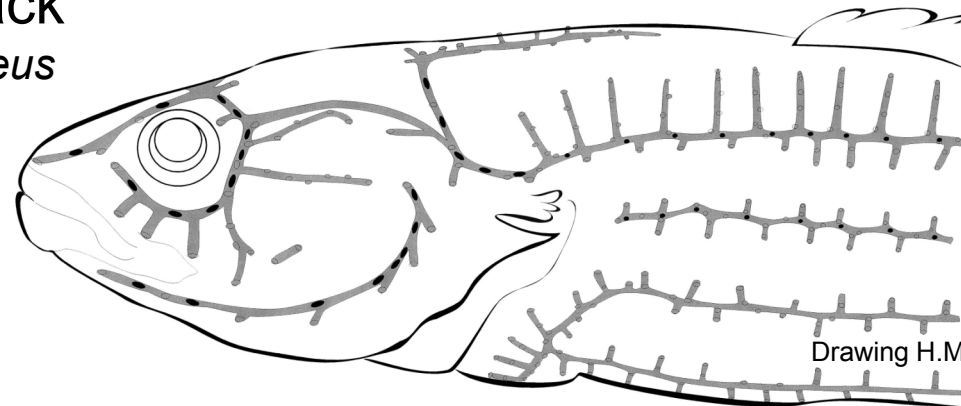
Sprattus sprattus



Best and Gray (1982)
J Mar Biol

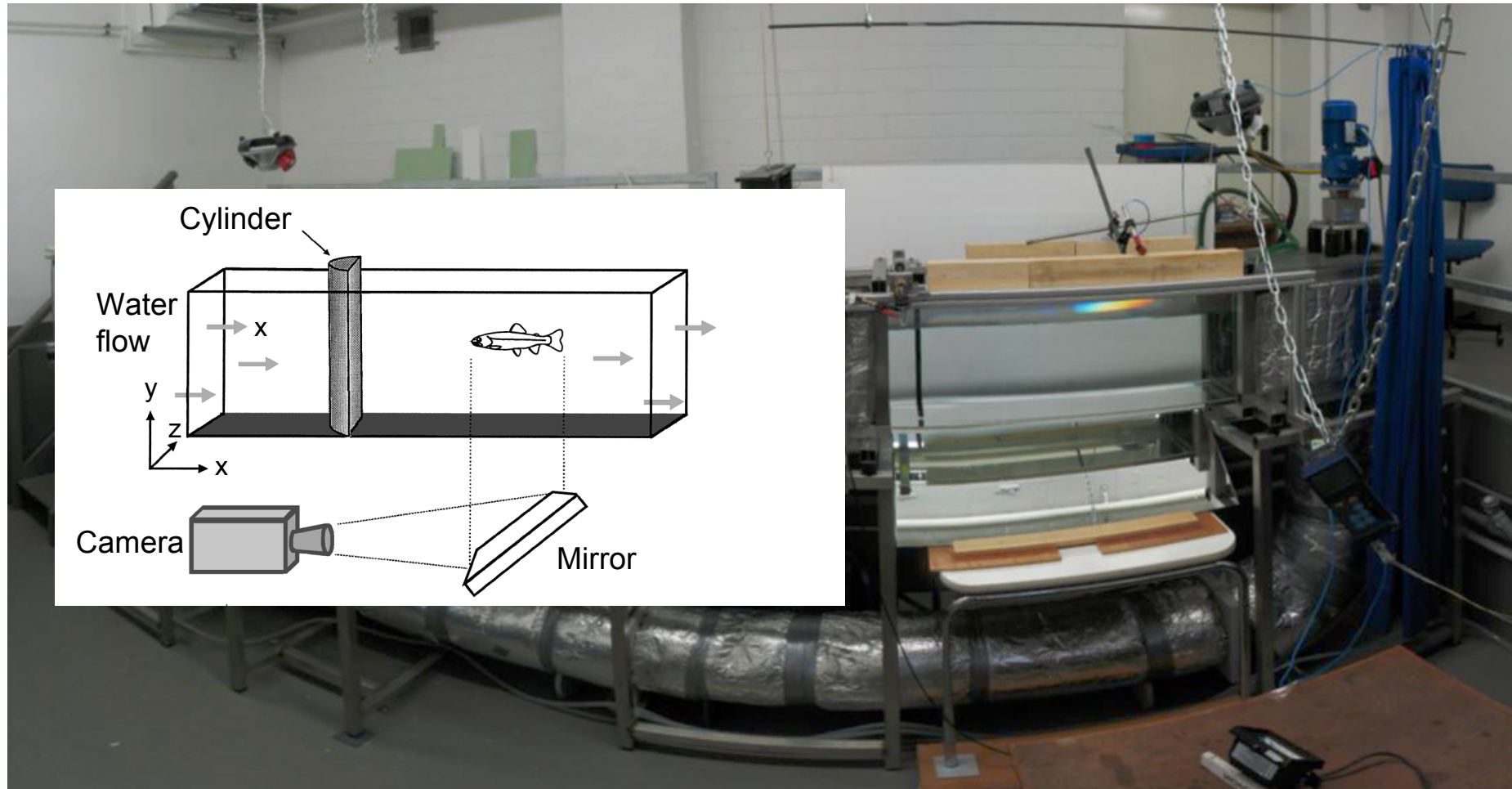
Black prickleback

Xiphister atropurpureus



Drawing H.Münz

Fish Behavior in Flow



Trout Swimming in Flow Channel

Free stream



Vortex street



Kármán Gait

Trout Swimming in Flow Channel

Bow wake swimming

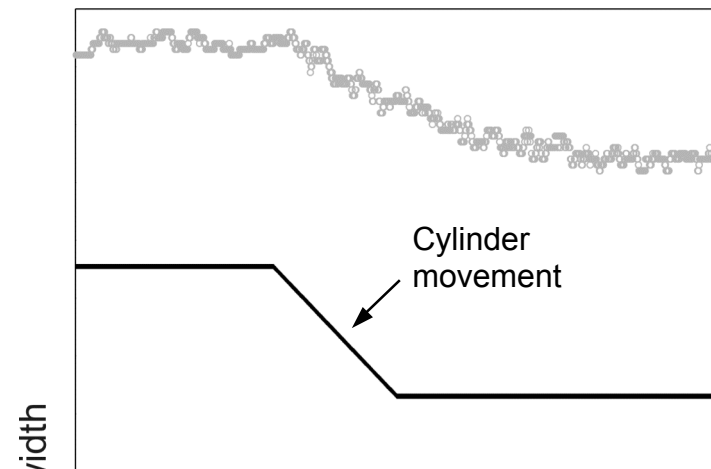


Entraining

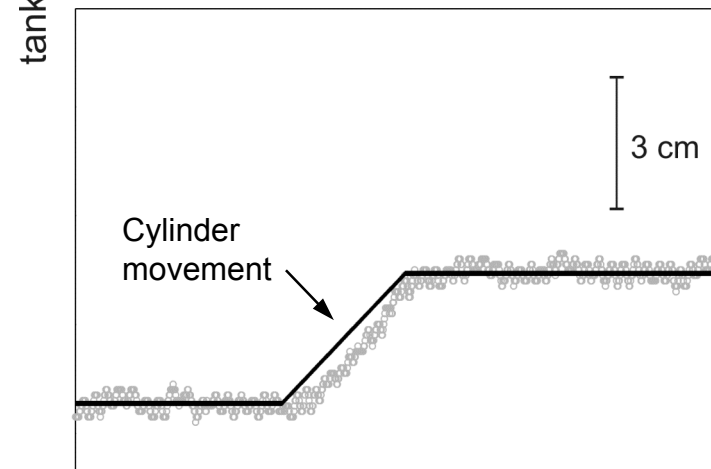


Trout Swimming in Unstable Flow

Entraining



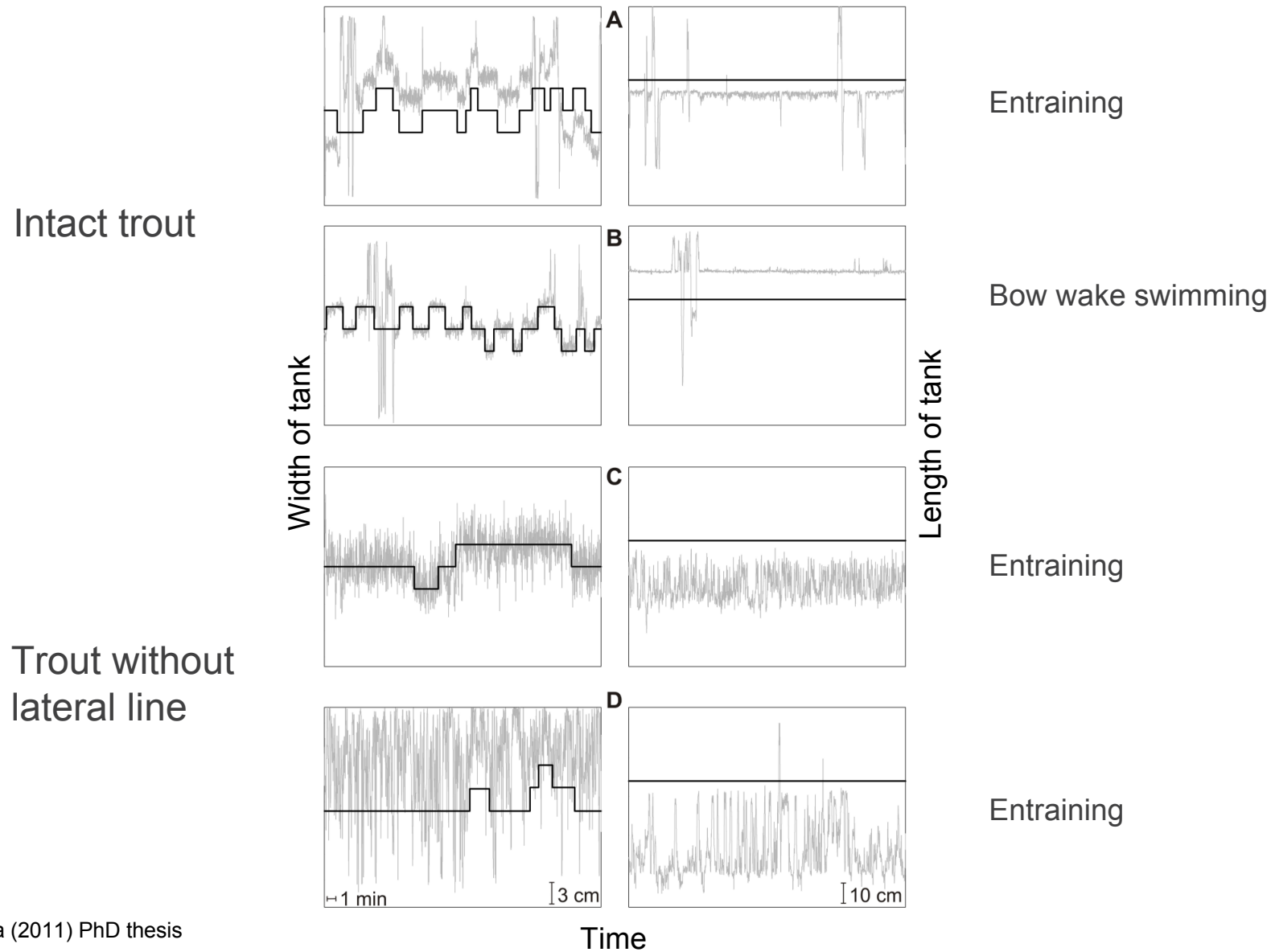
Bow Wake Swimming



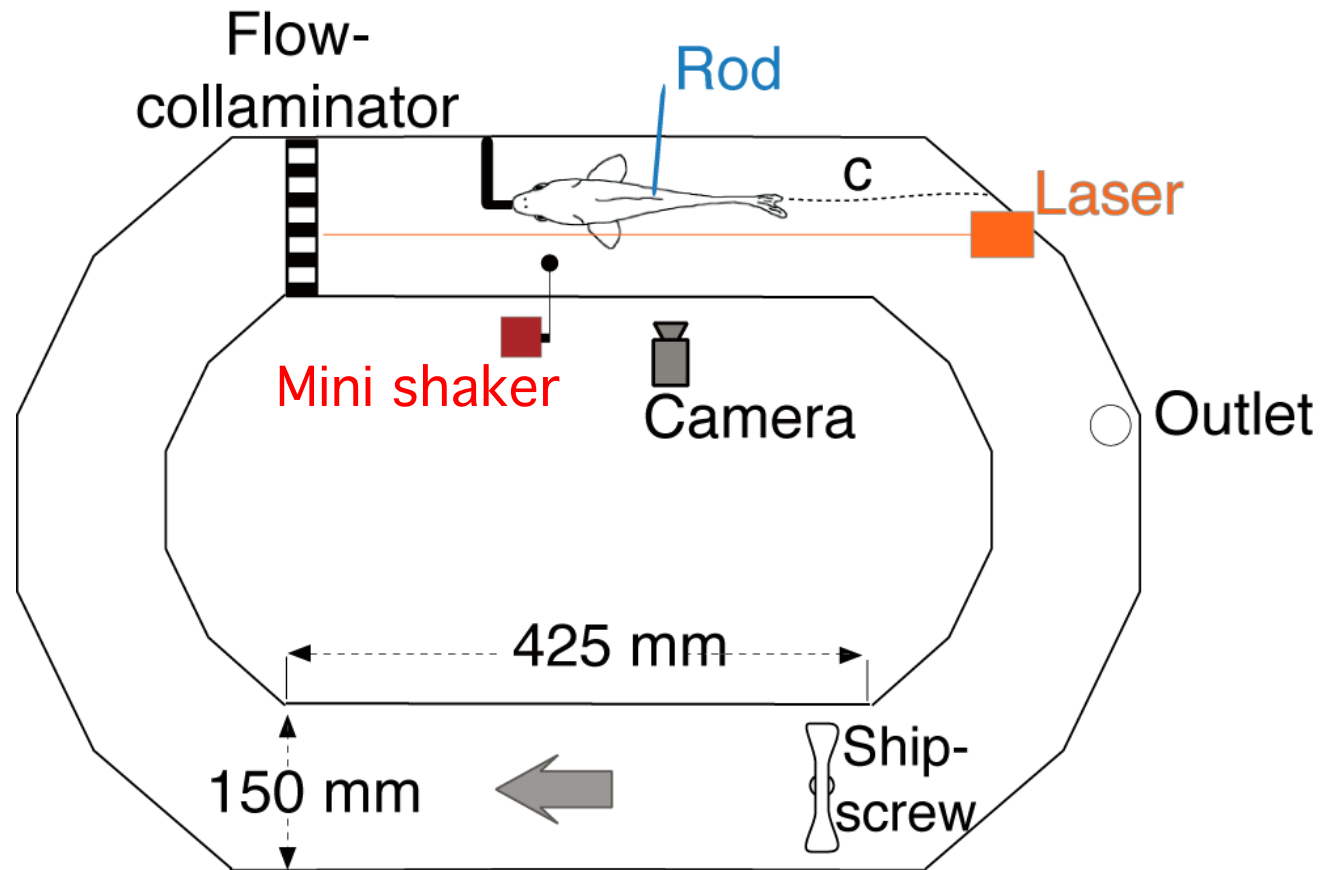
A [5] B [3] C [3] D [5]

time [s]

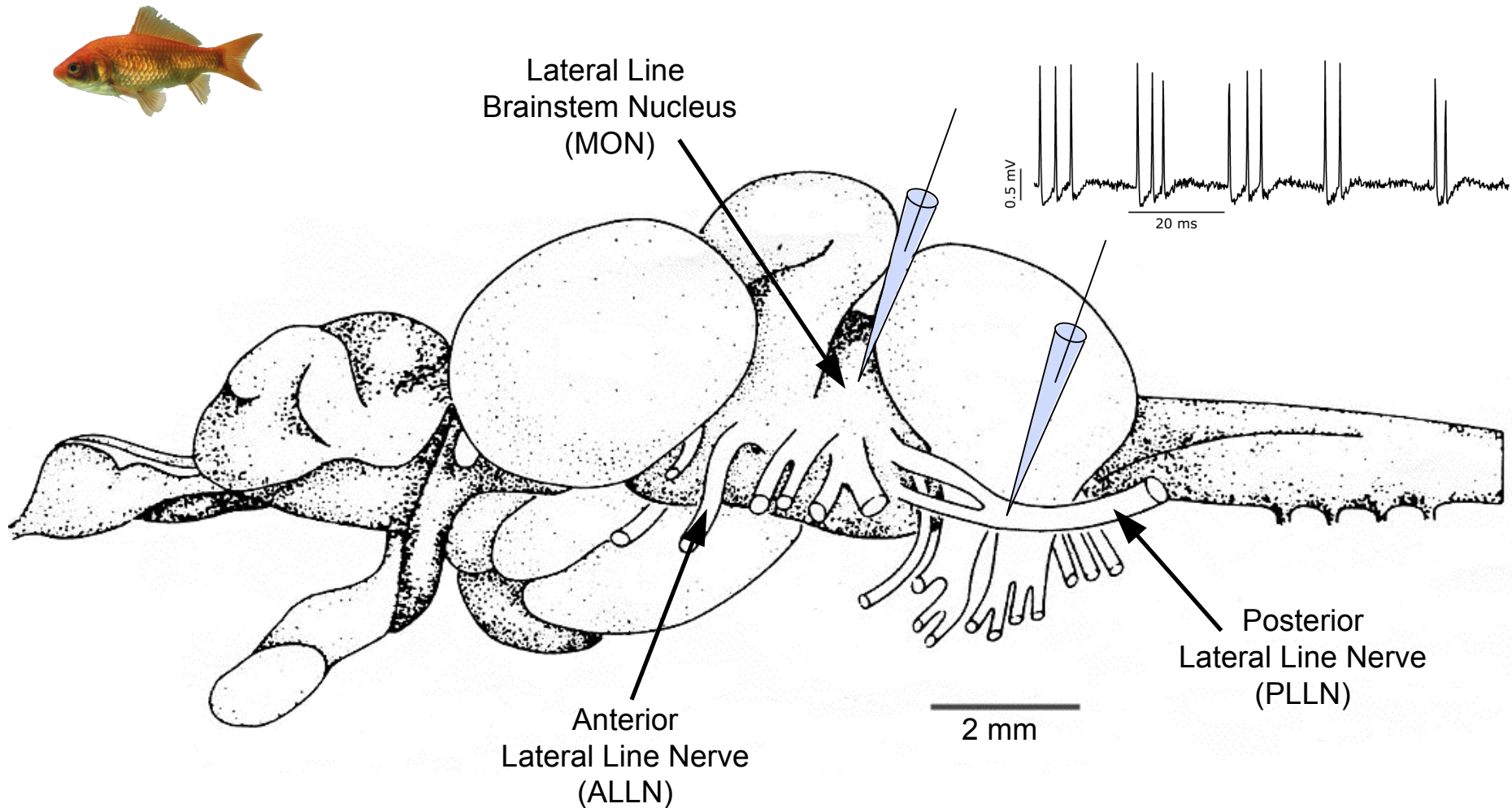
Trout Swimming in Unstable Flow



Flow Tank for Physiological Studies



The Fish Brain and the Lateral Line Pathway



After Wullimann & Northcutt (1988) Brain Behav Evol

Neuronal Representation of Flow

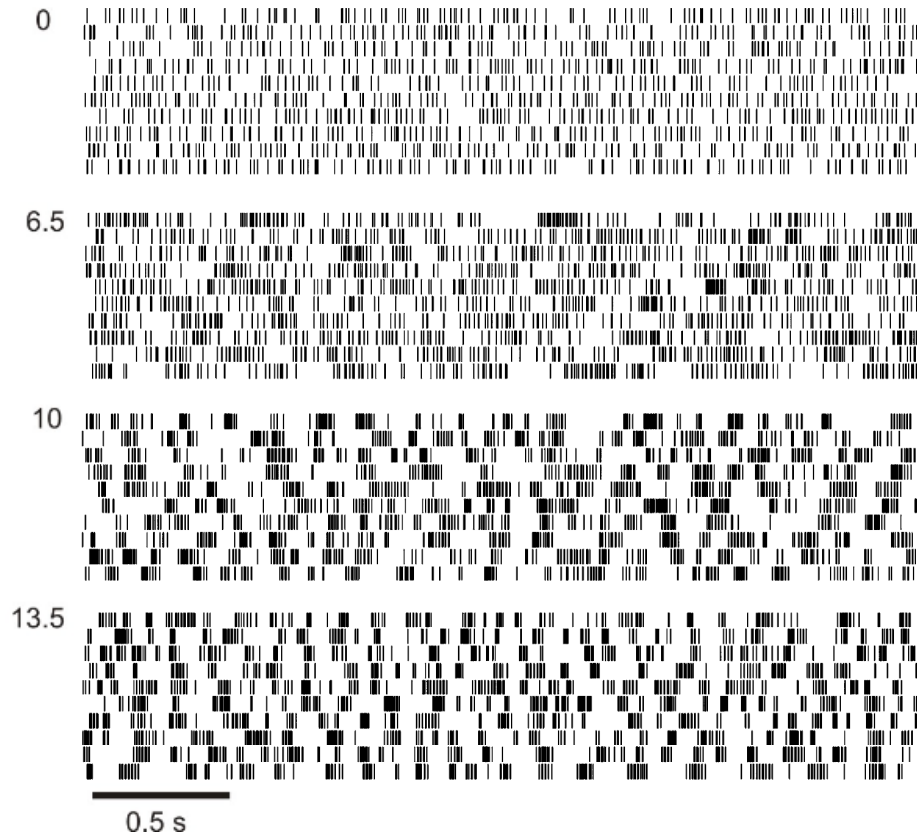
Primary Afferent Nerve Fibers



Flow
[cm*s⁻¹]

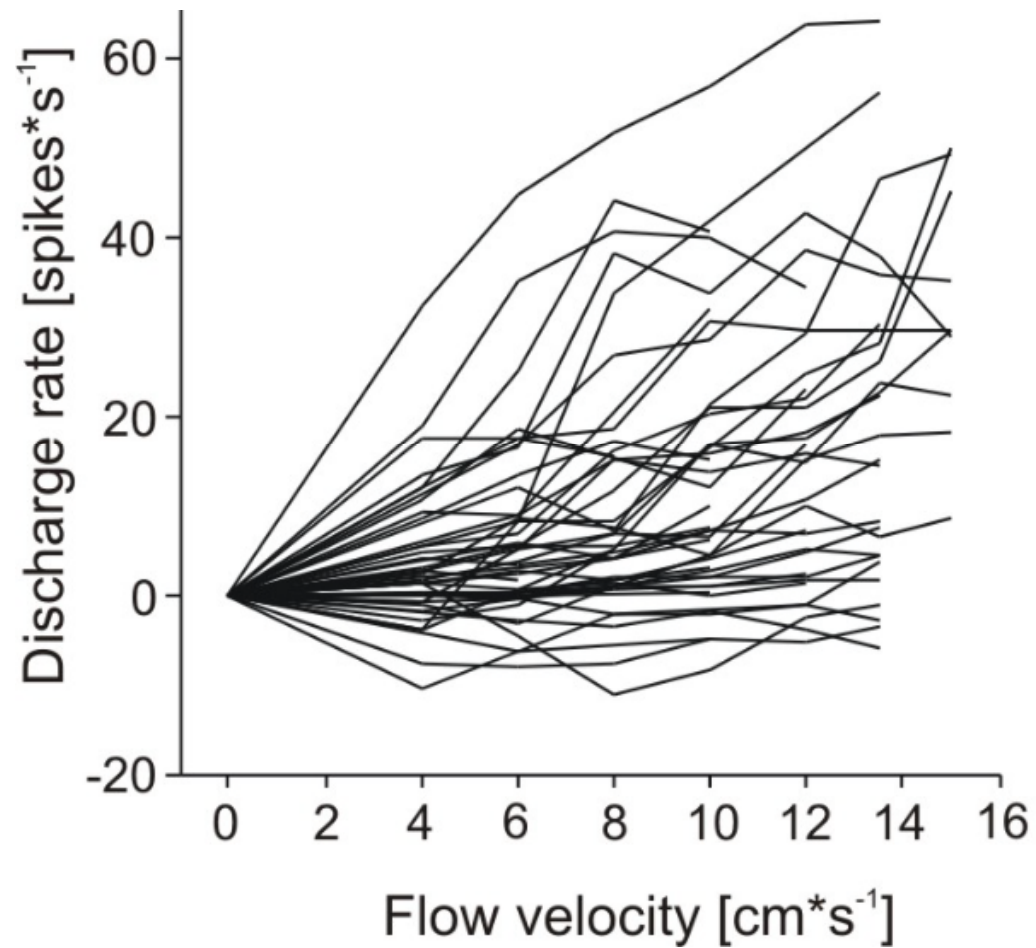
Flow-sensitive

Flow-insensitive



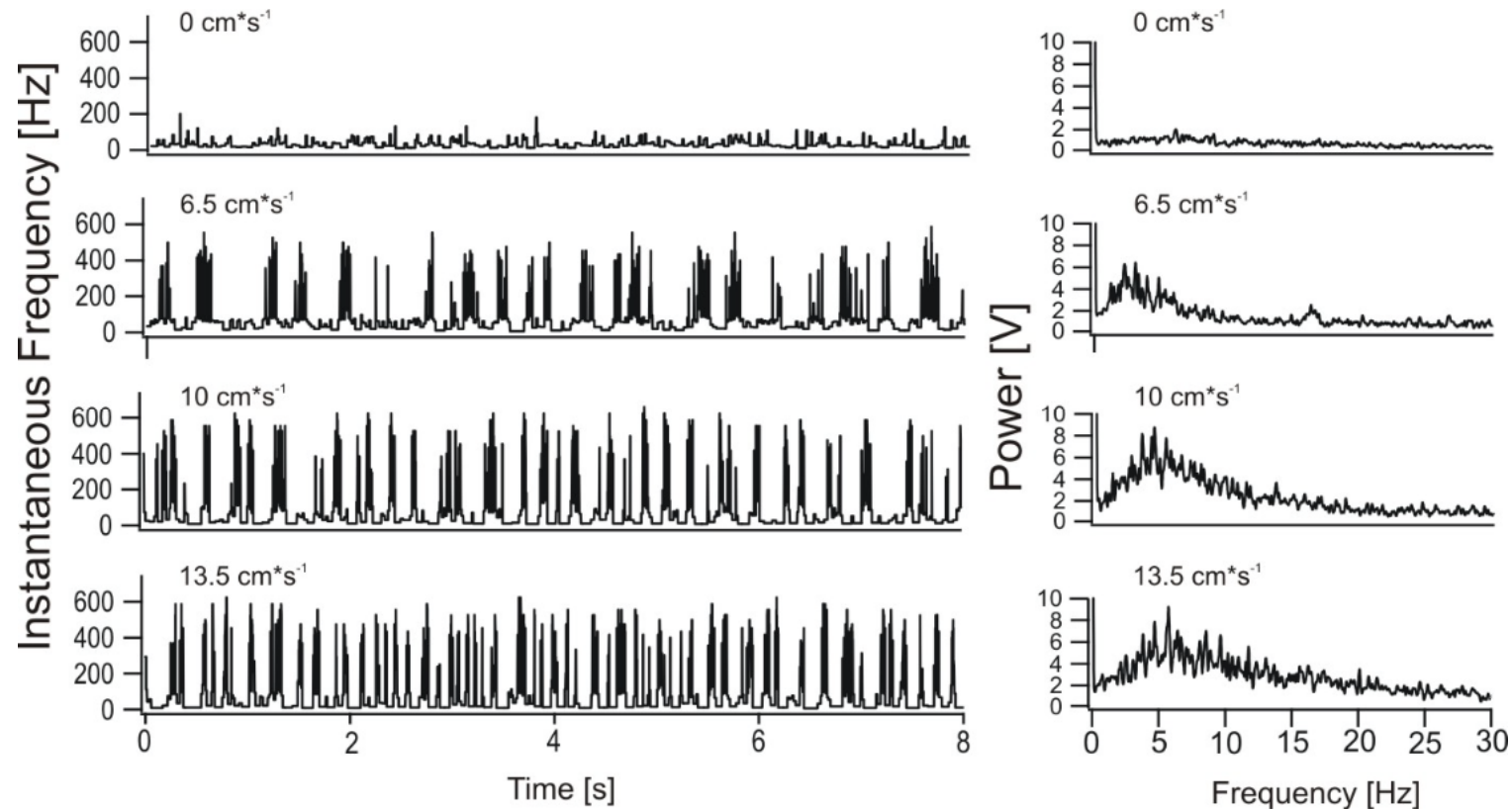
Neuronal Representation of Flow

Primary Afferent Nerve Fibers



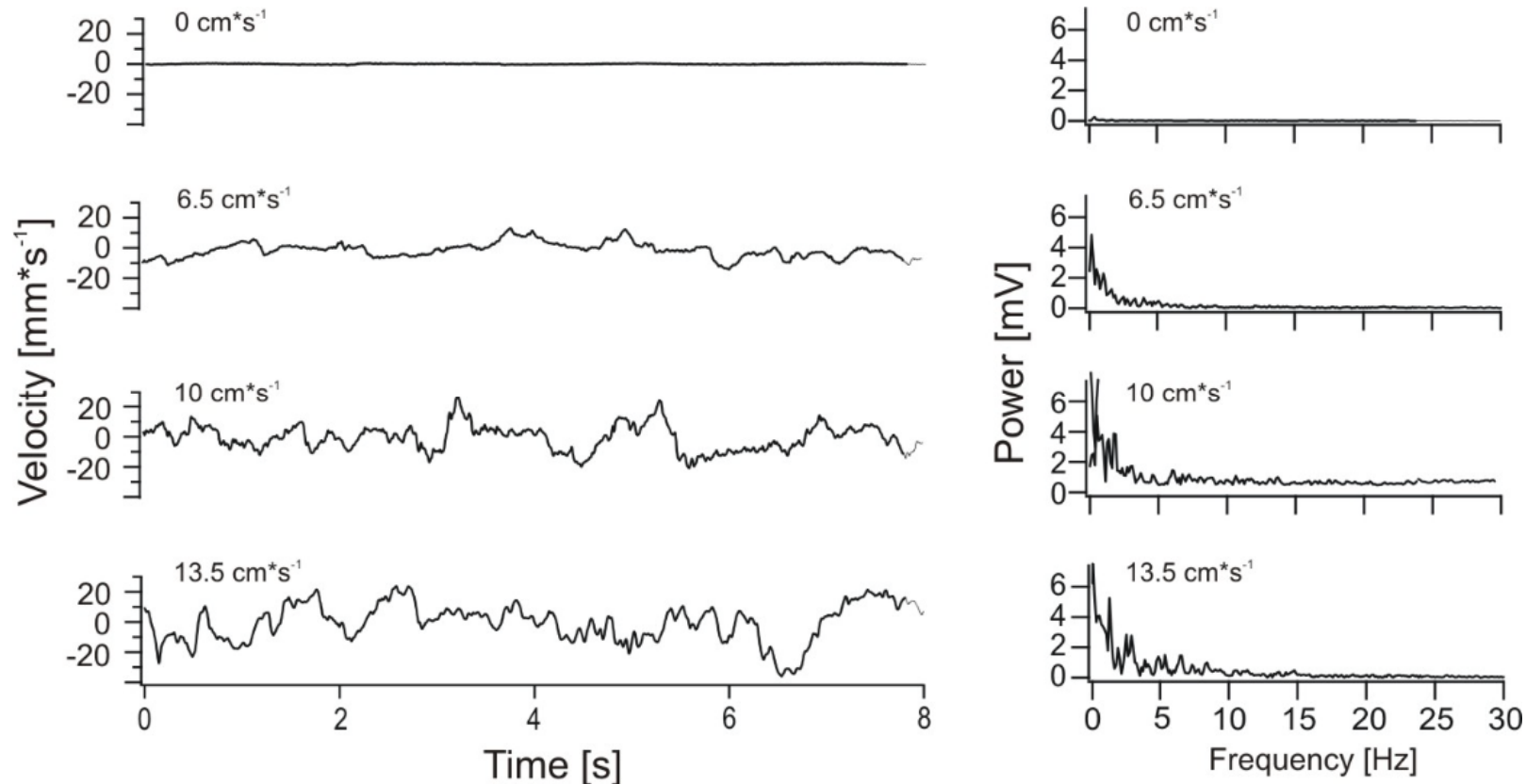
Neuronal Representation of Flow

Bursting Activity of Primary Afferent Nerve Fibers

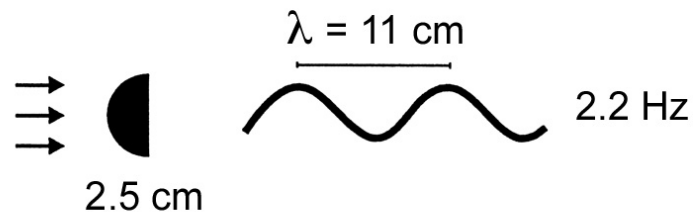
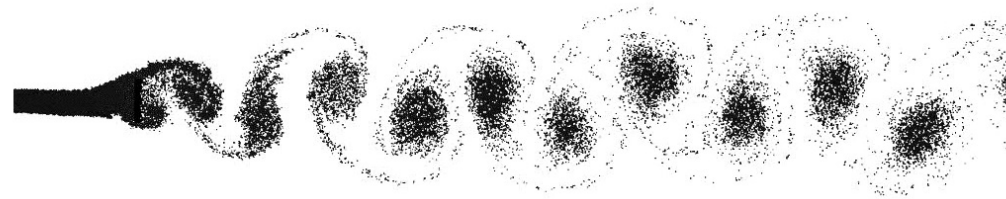


Quantification of Water Flow

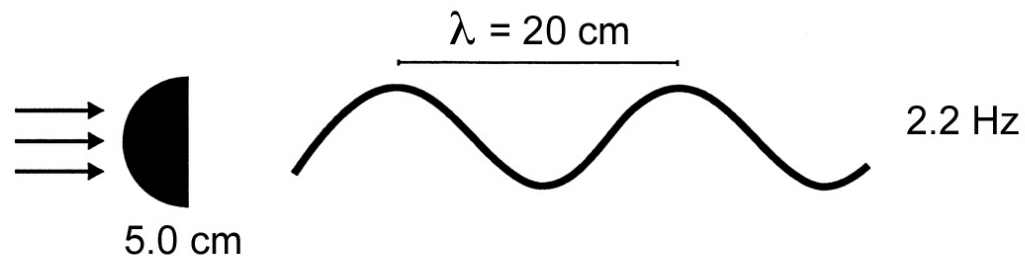
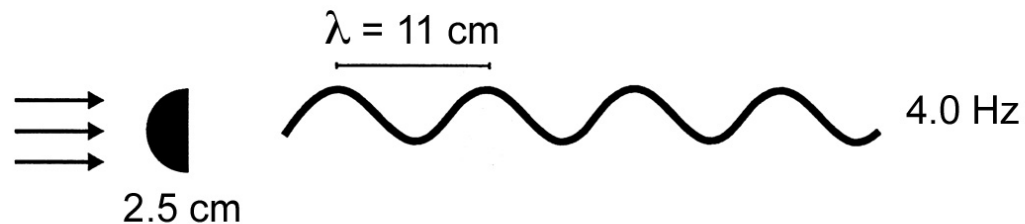
Velocity Fluctuations within Bulk Water Flow



Kármán Vortex Street Caused by Cylinder

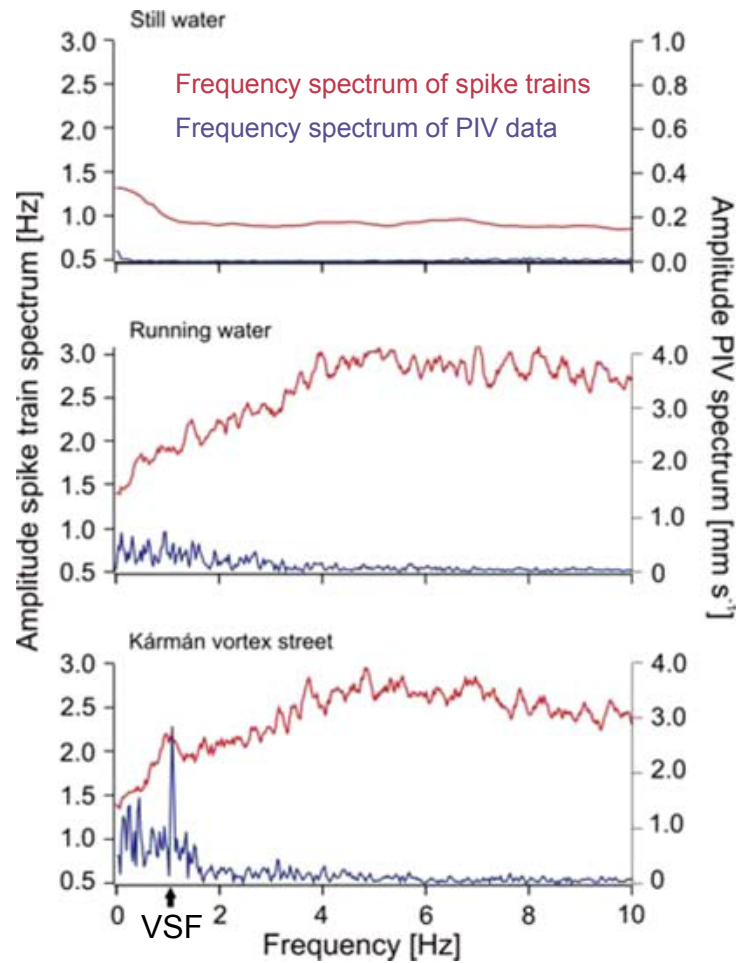


Vortex Shedding Frequency (VSF) depends on cylinder size and flow velocity

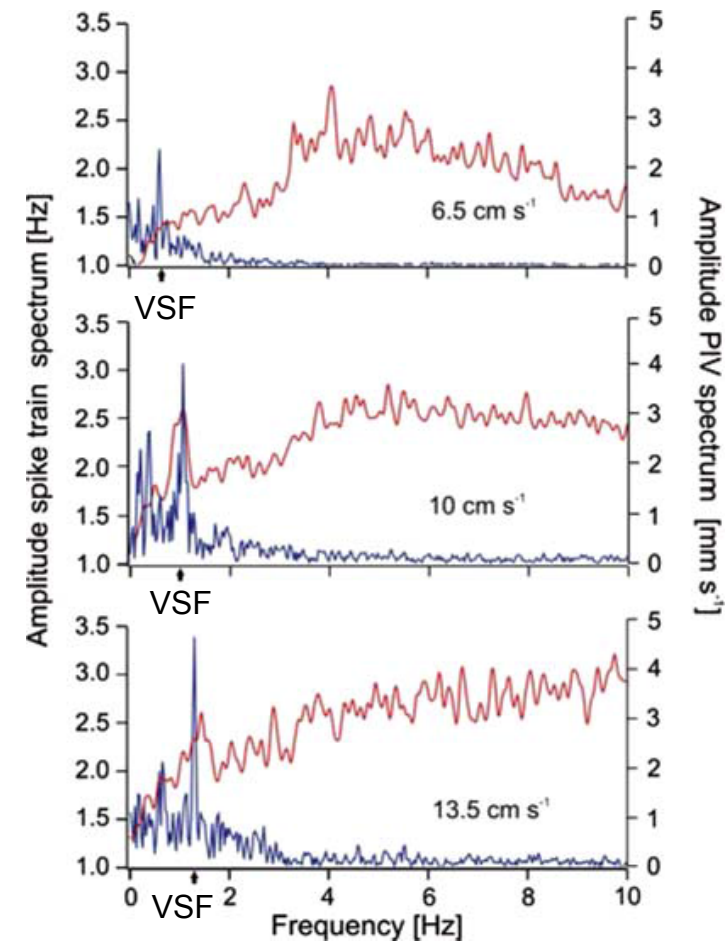


Representation of Kármán Vortex Street

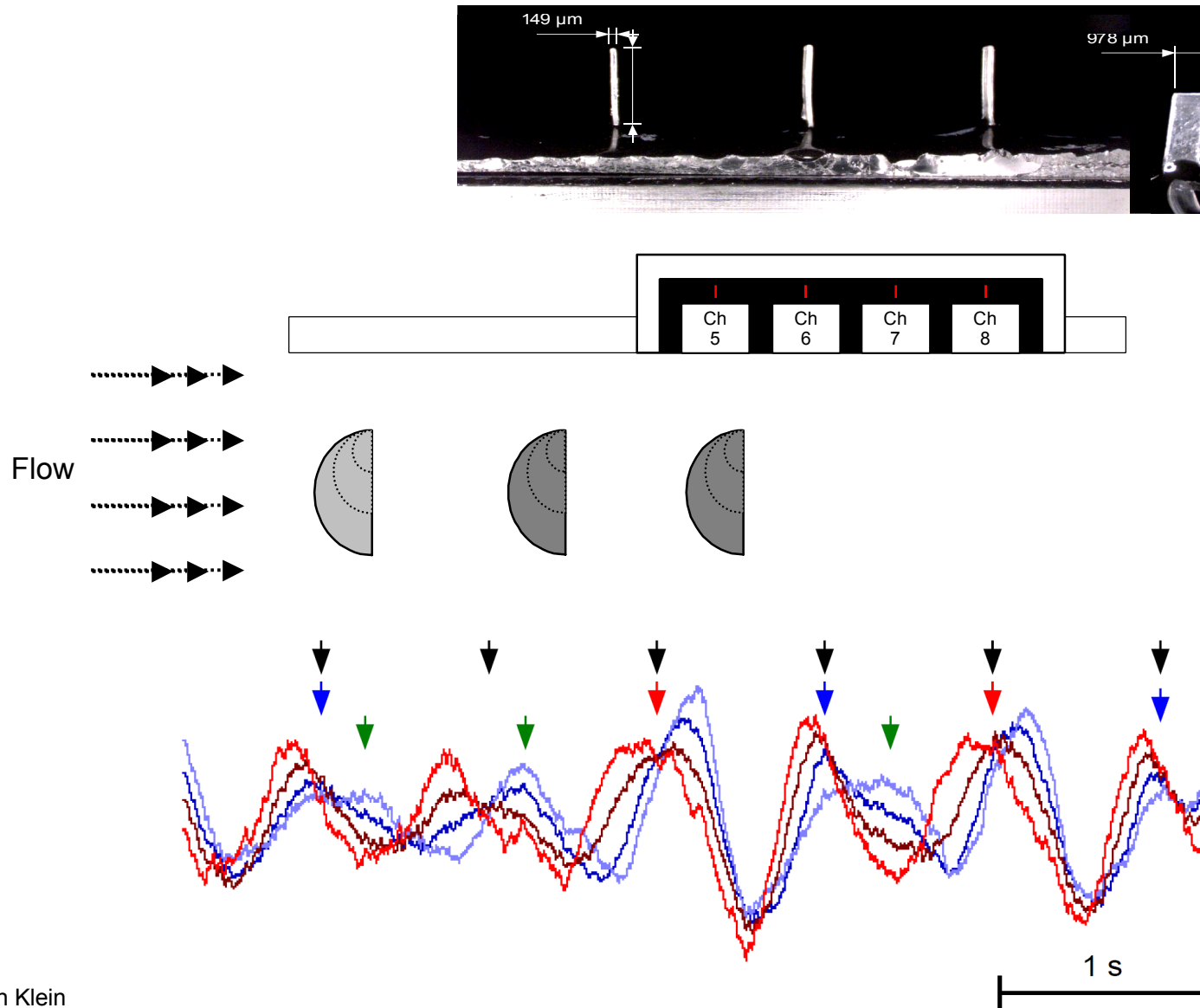
Still water vs. running water



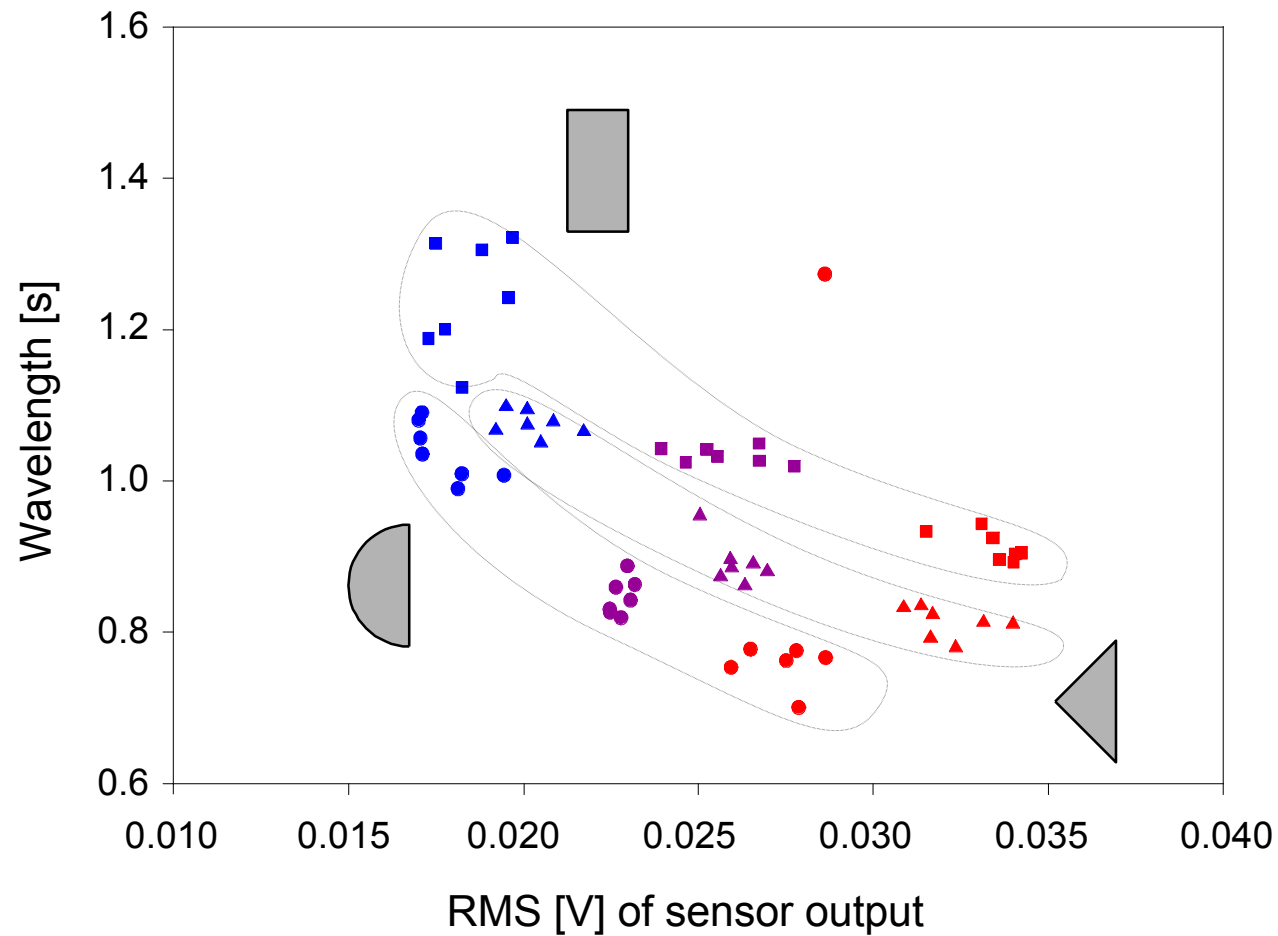
Increasing flow velocity



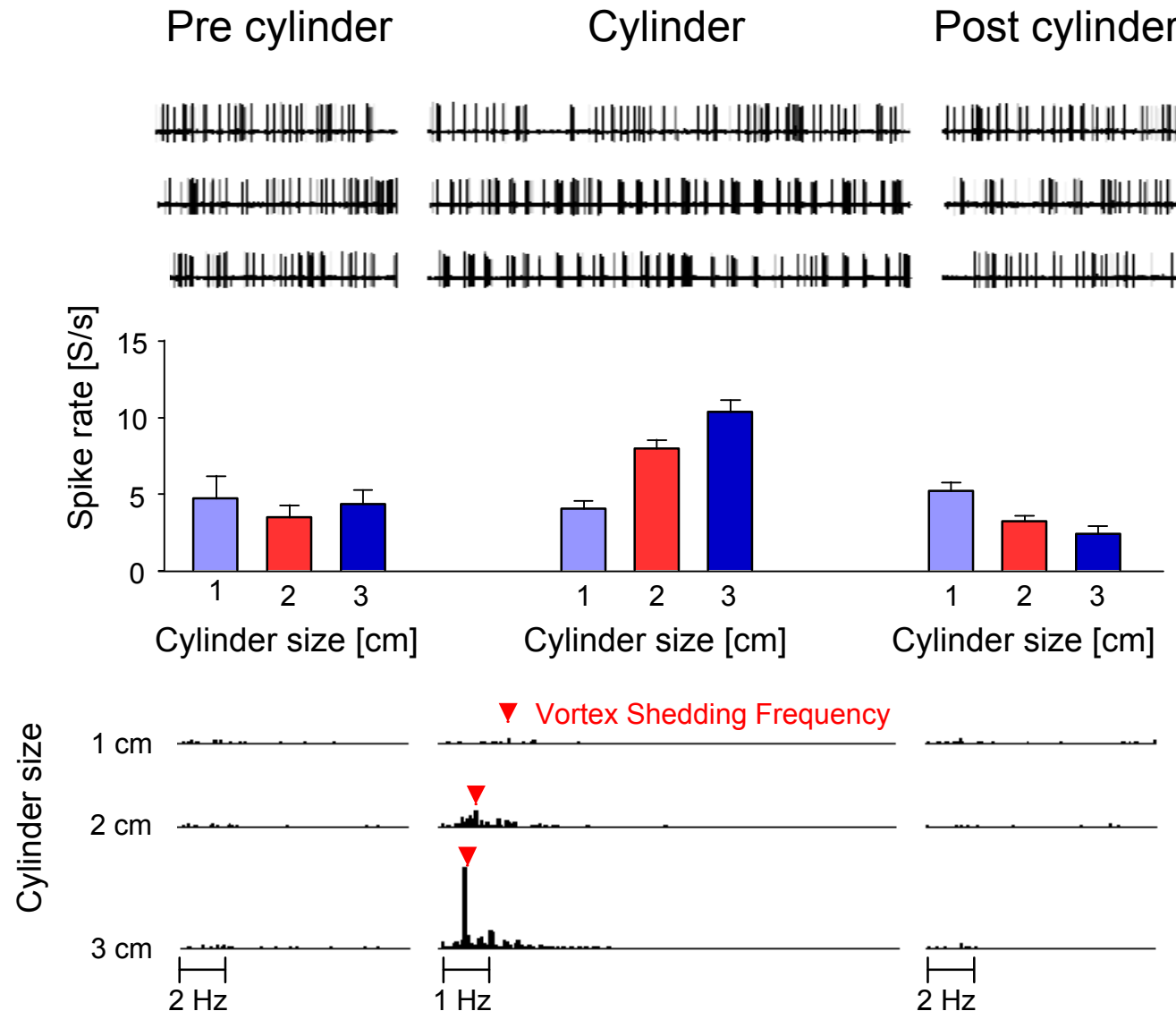
Object Discrimination by Artificial Flow Sensors



Sensor Readout for Different Objects at Different Bulk Flow Velocities



Object Representation by the Lateral Line



Thanks to



Christoph Brücker
Boris Chagnaud
Wolf Hanke
Adrian Klein
Anja Przybilla
Anke Schmitz
Jan Winklankemper

