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HYDRODYNAMICS OF A FISH-SHAPED RIGID BODY: VELOCITY-DRAG COUPLING

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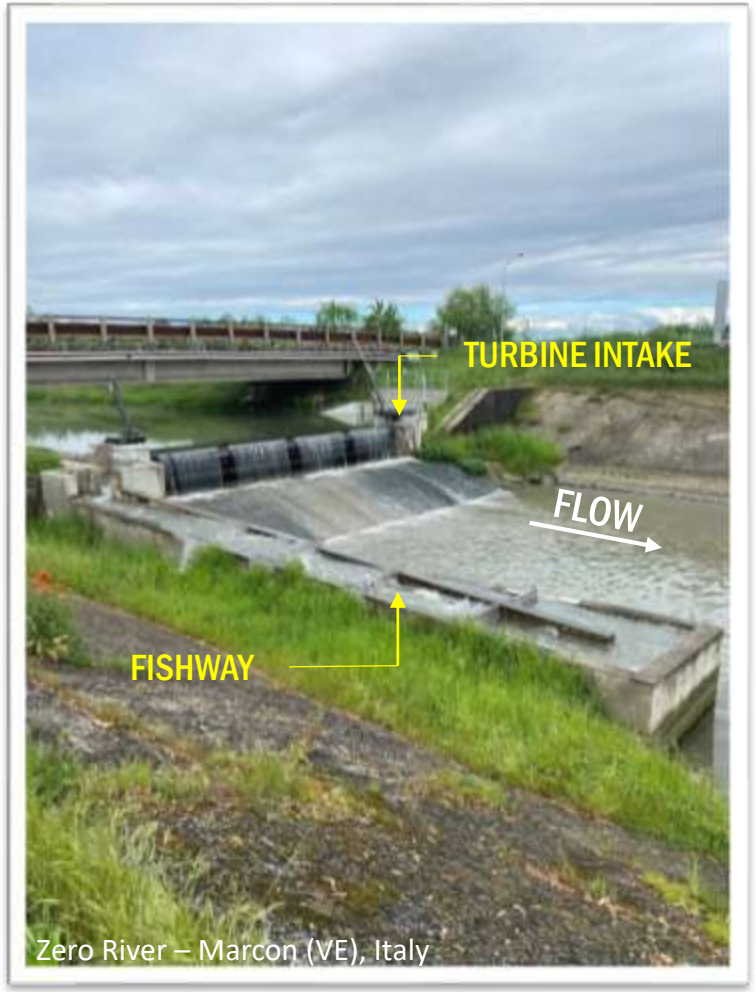
UNIVERSITY OF ABERDEEN

RIBES

PROBLEM DESCRIPTION

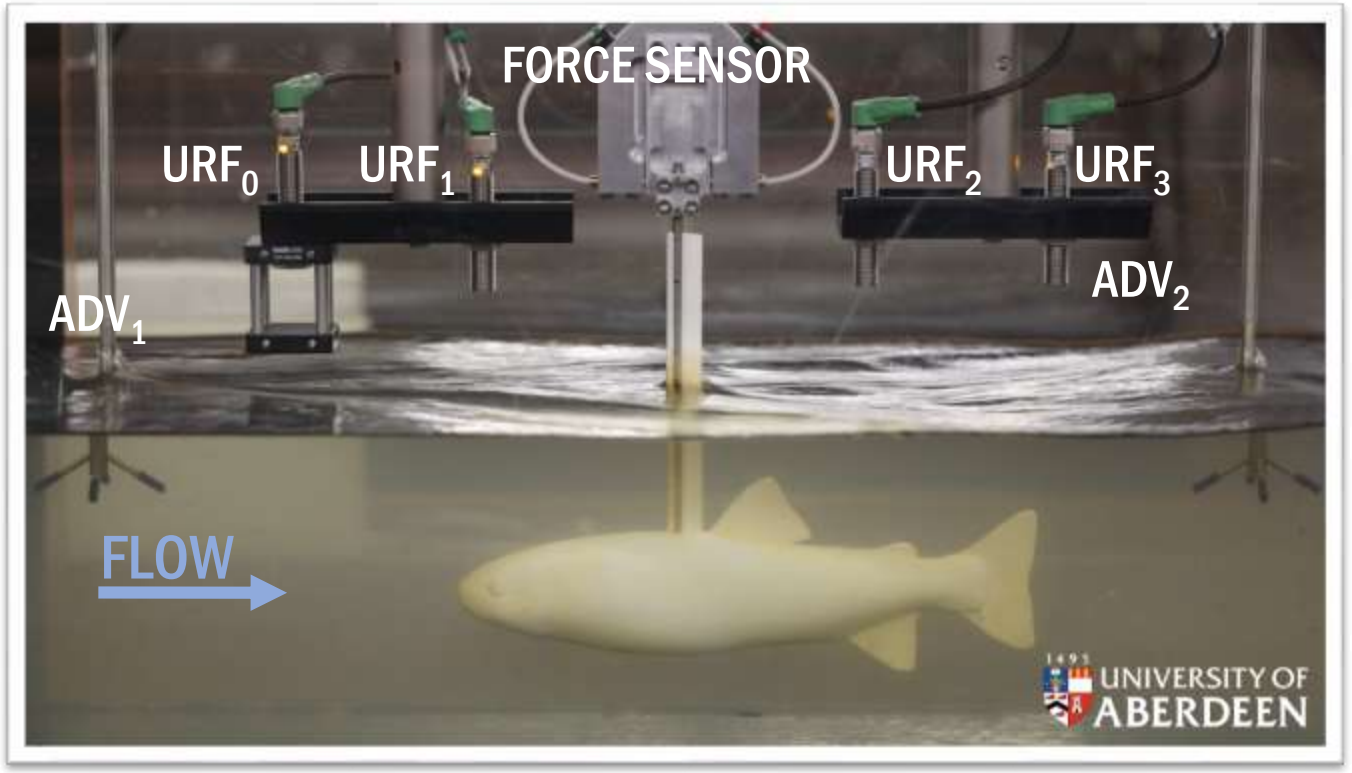
SMALL HYDROPOWER PLANT WITH FISHWAY



EXISTING FISHWAYS ARE SELDOM EFFECTIVE BECAUSE:

- Poor attraction efficiency
- Optimum flow conditions for target fish species within the fishway are not known
- Fish-flow interactions are not yet well understood

LABORATORY EXPERIMENTS



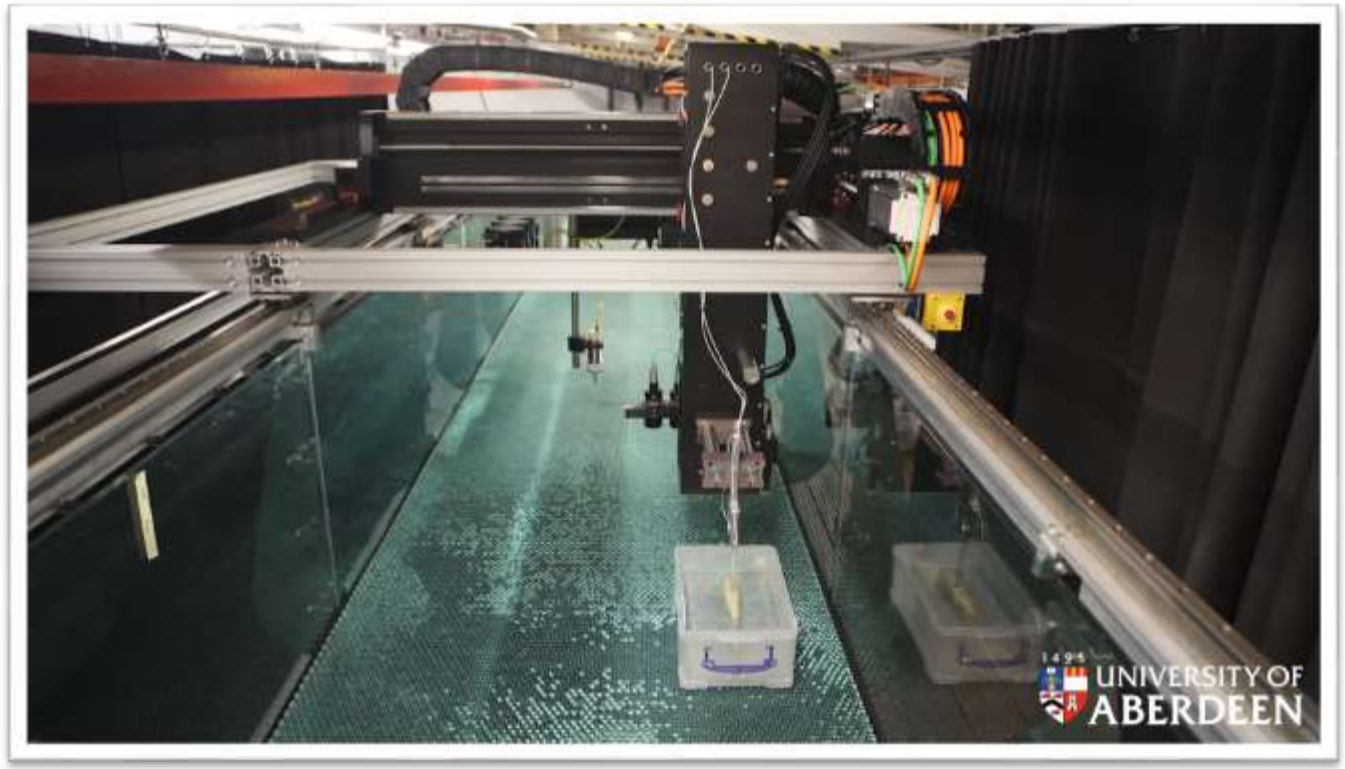
RUN	Q ($m^3 s^{-1}$)	U ($m s^{-1}$)	H (mm)	L (mm)
"U4-L5"	0.0358	0.660	180	270

- **Q** is flowrate
- **U** is cross-sectional average velocity
- **H** is water depth
- **L** is fish model body length

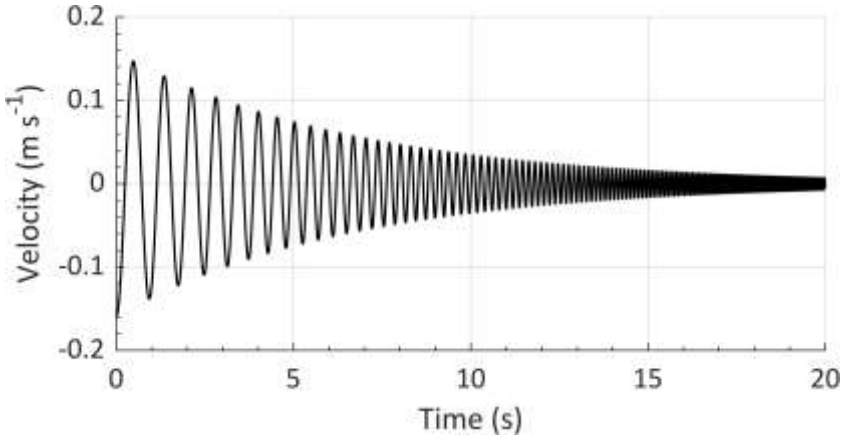
ADV = Acoustic Doppler Velocimeter

URF = Ultrasonic Range Finder

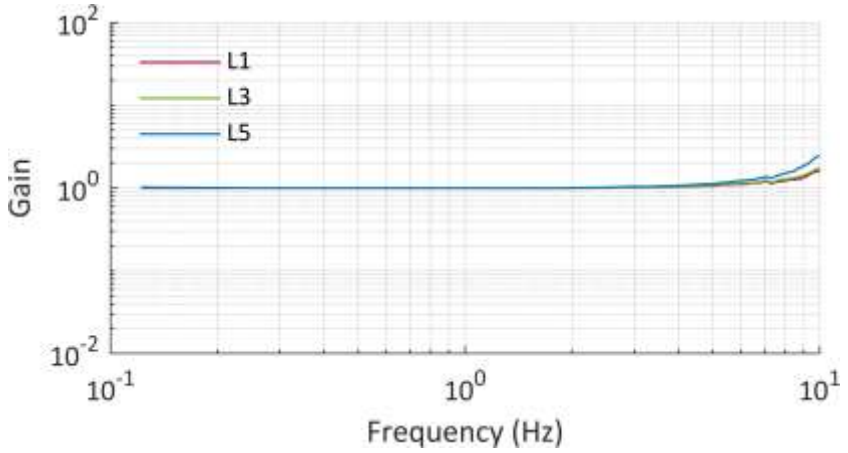
DRAG DEVICE FREQUENCY RESPONSE



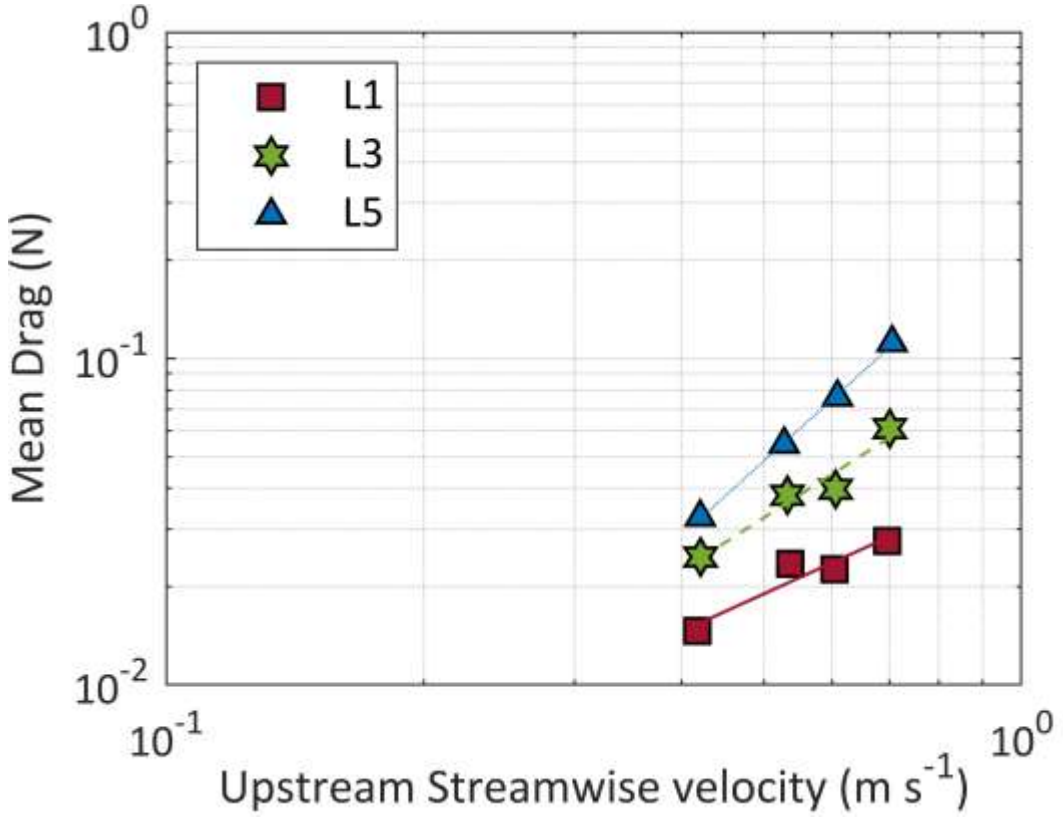
SINE SWEEP FUNCTION

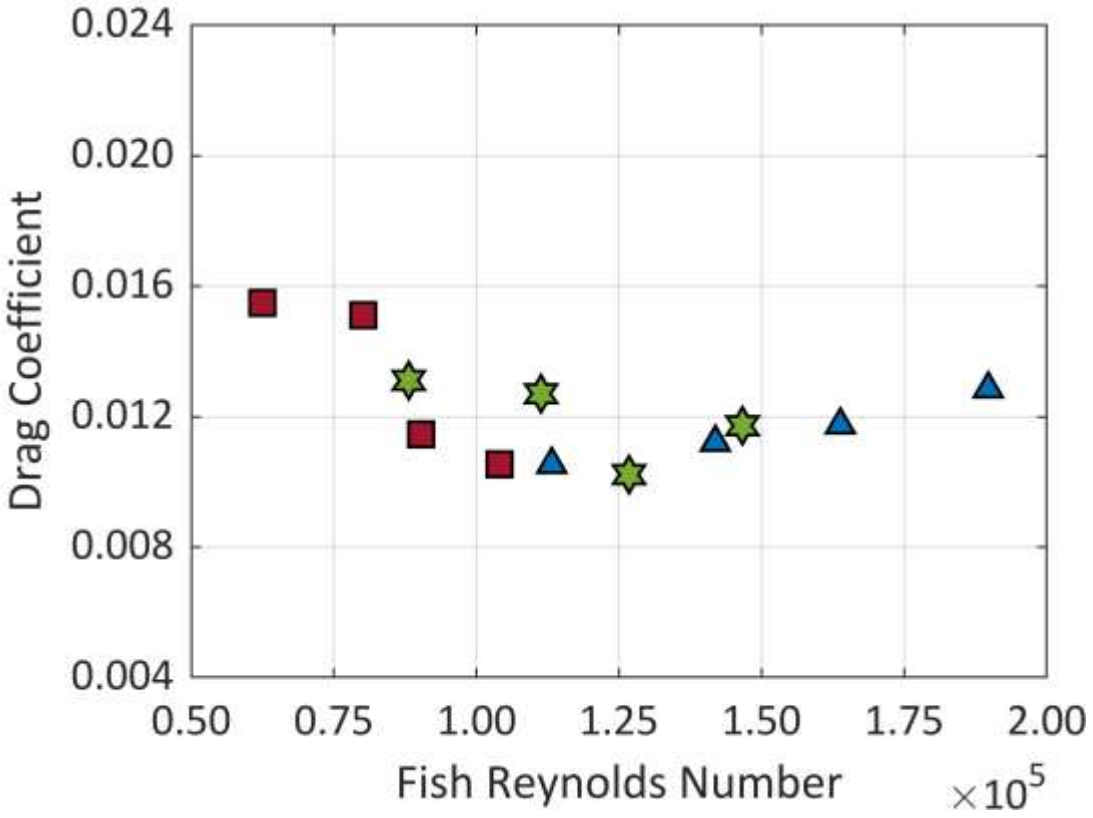


MAGNITUDE OF THE FREQUENCY RESPONSE FUNCTION

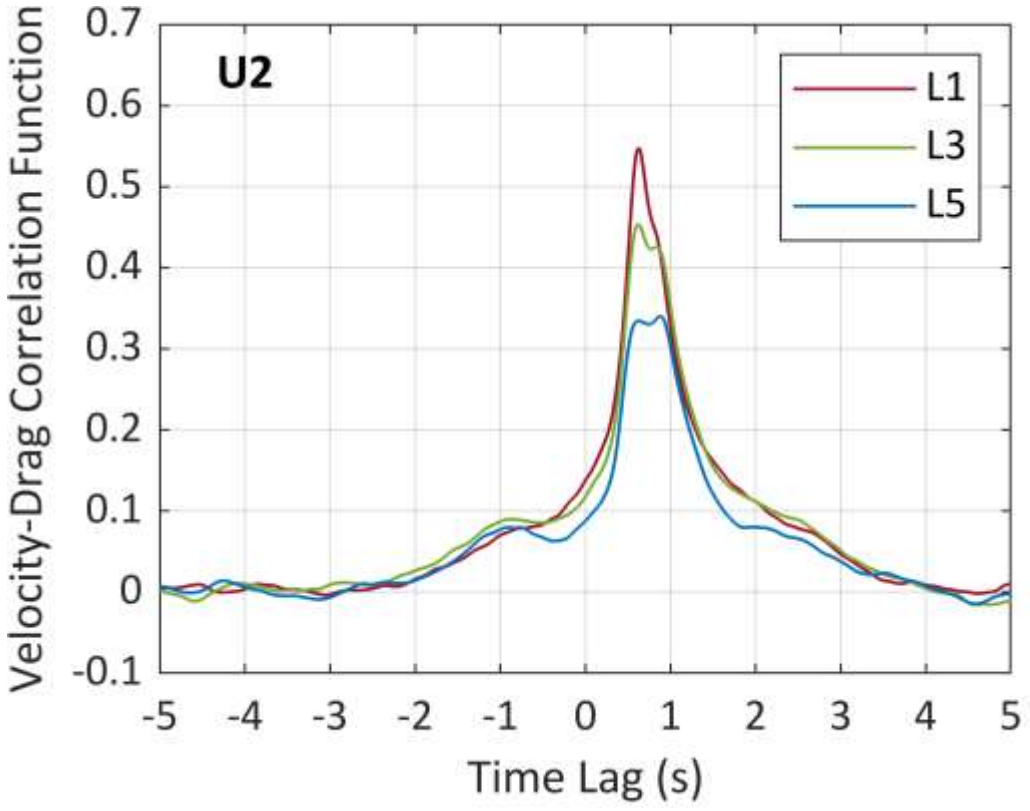


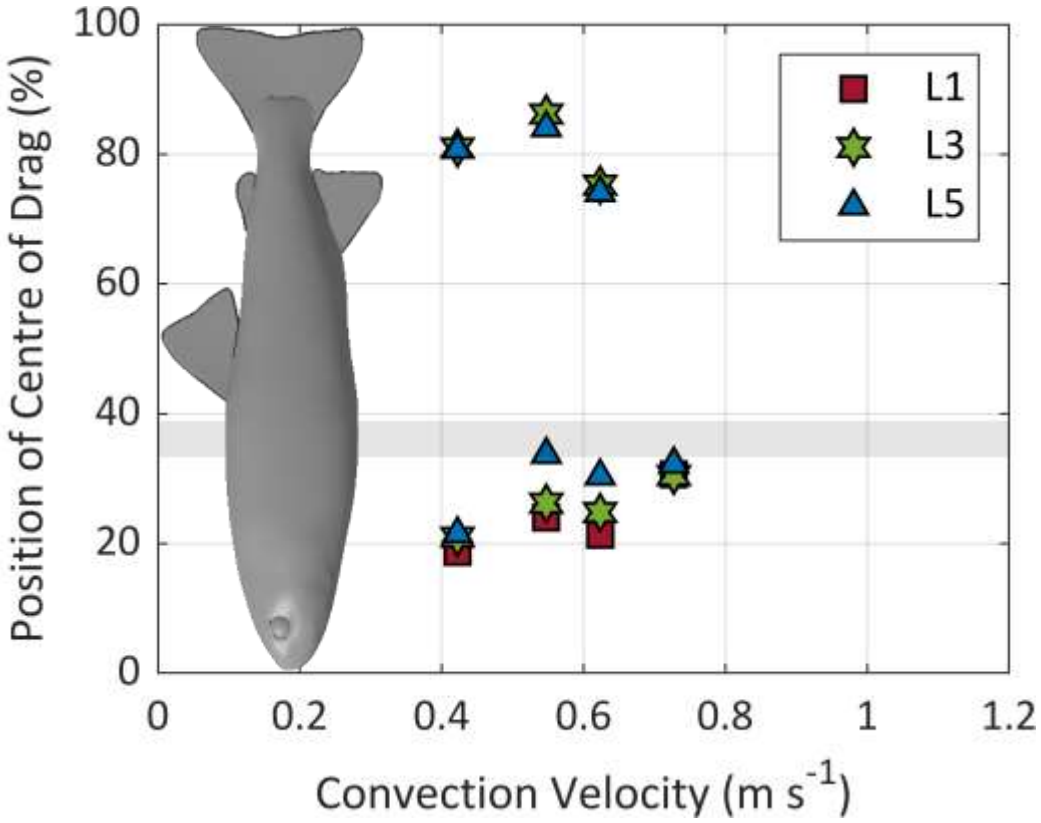
MEAN DRAG


L1
L3
L5
Mean Drag (N)
Upstream Streamwise velocity (m s-1)

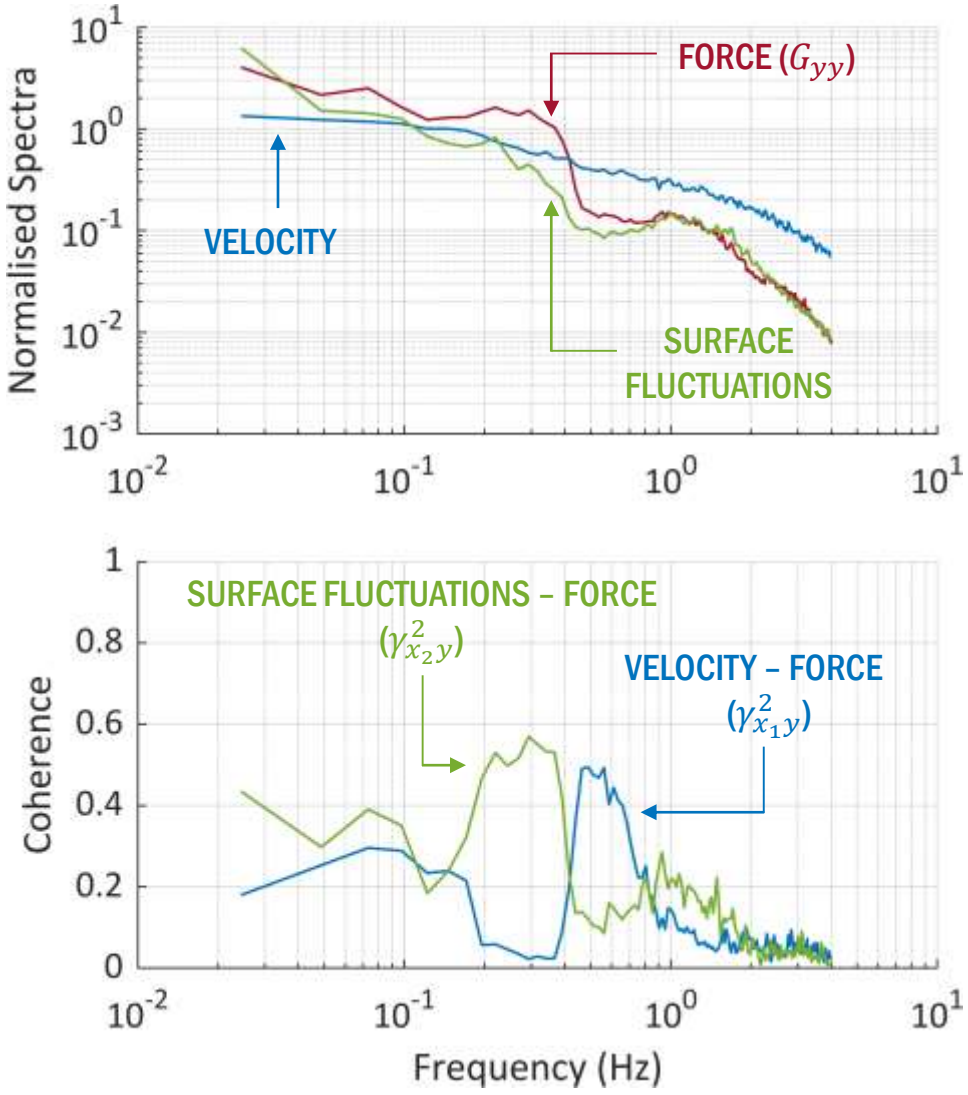

Drag Coefficient
Fish Reynolds Number
×10^5

VELOCITY-DRAG INTERRELATIONSHIP





DRAG FORCE GENERATION MECHANISMS



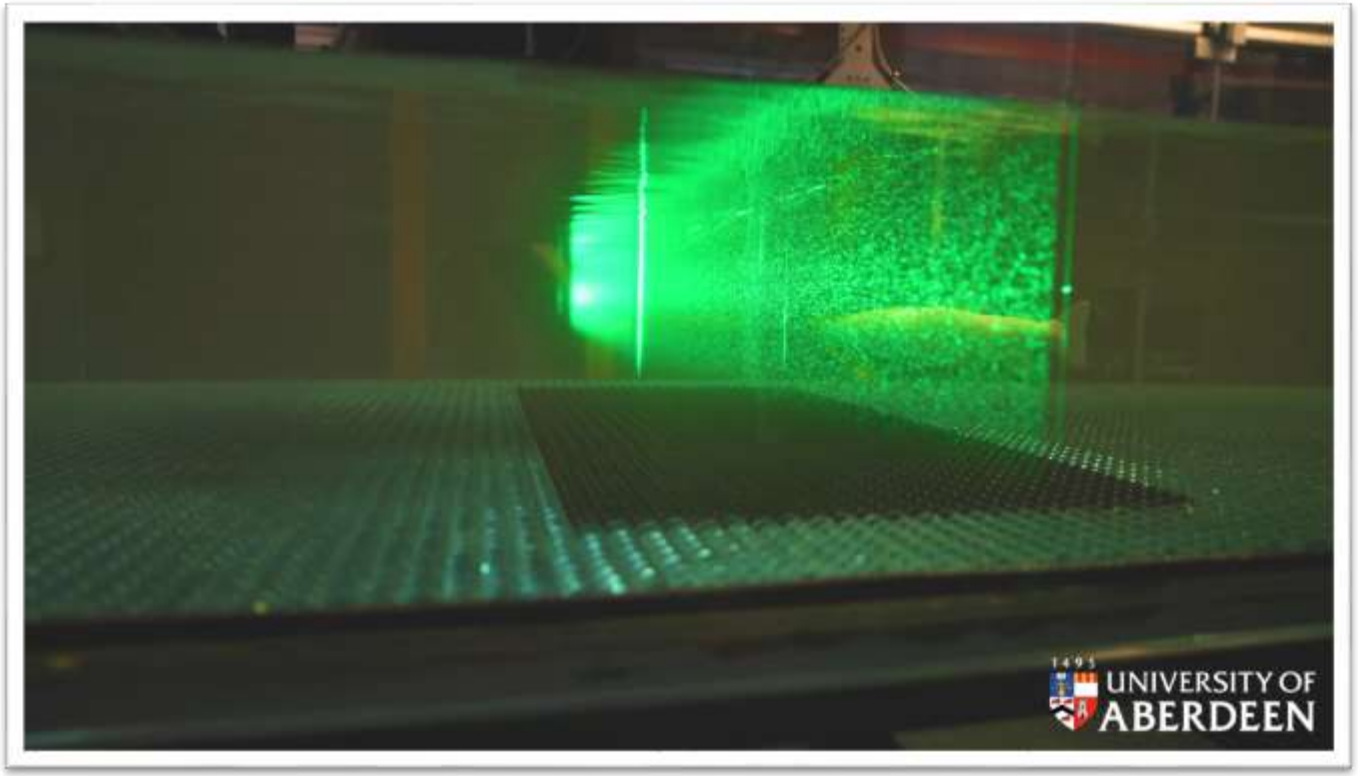
TWO-INPUT LINEAR MODEL:

$$\text{Force variance} = \underbrace{\int_0^{5\ Hz} \gamma^2_{x_1y} G_{yy}\ df}_{15\%} + \underbrace{\int_0^{5\ Hz} \gamma^2_{x_2y} G_{yy}\ df}_{35\%} + \underbrace{\text{Residual}}_{50\%}$$

NEXT STEPS

Particle Image Velocimetry **“PIV” experiments** to clarify:

- Origin of the two peaks in the correlation function
- Three dimensional wake structure
- Optimum configuration for the momentum integral method



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...Any questions?