

Measurements of the resonance properties of fish swim bladders

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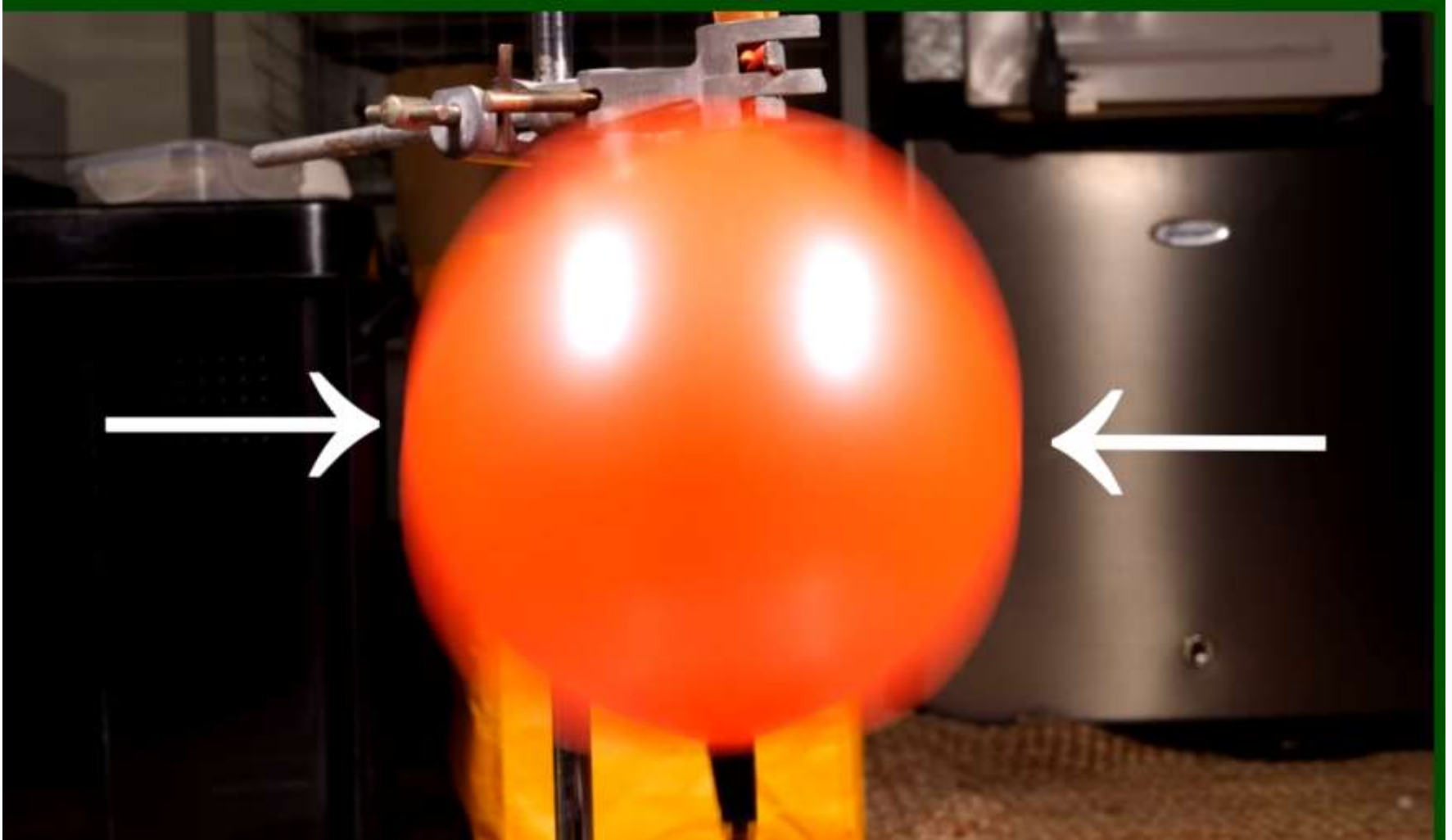
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Fish swim bladders

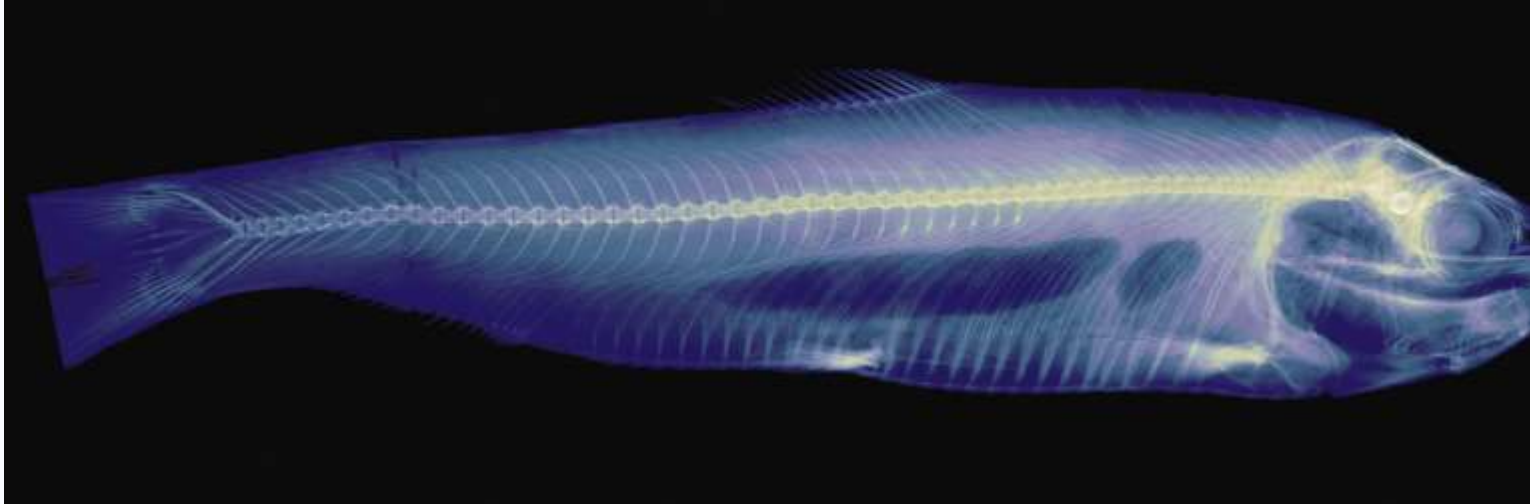
An important gas-filled organ in most bony fish

- It helps to control their **buoyancy** and **swimming stability**.
- It contributes to their **sensory of sound**.
- The acoustical properties are widely used in **marine science**.
- Potential applications in freshwater ecosystems: **acoustical deterrents, parasite load diagnosis**, etc.

The resonating balloon

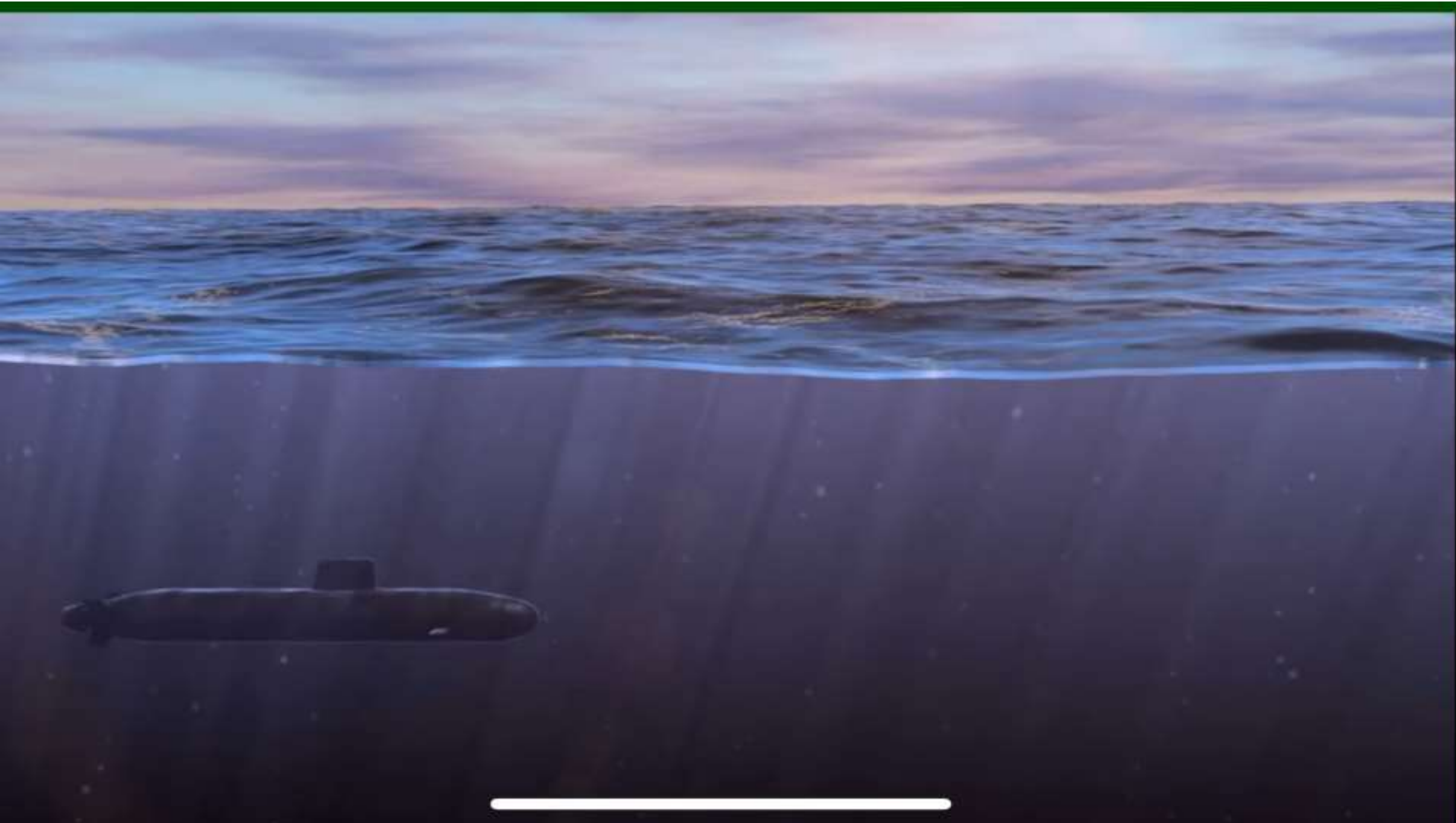


Swim bladder resonance

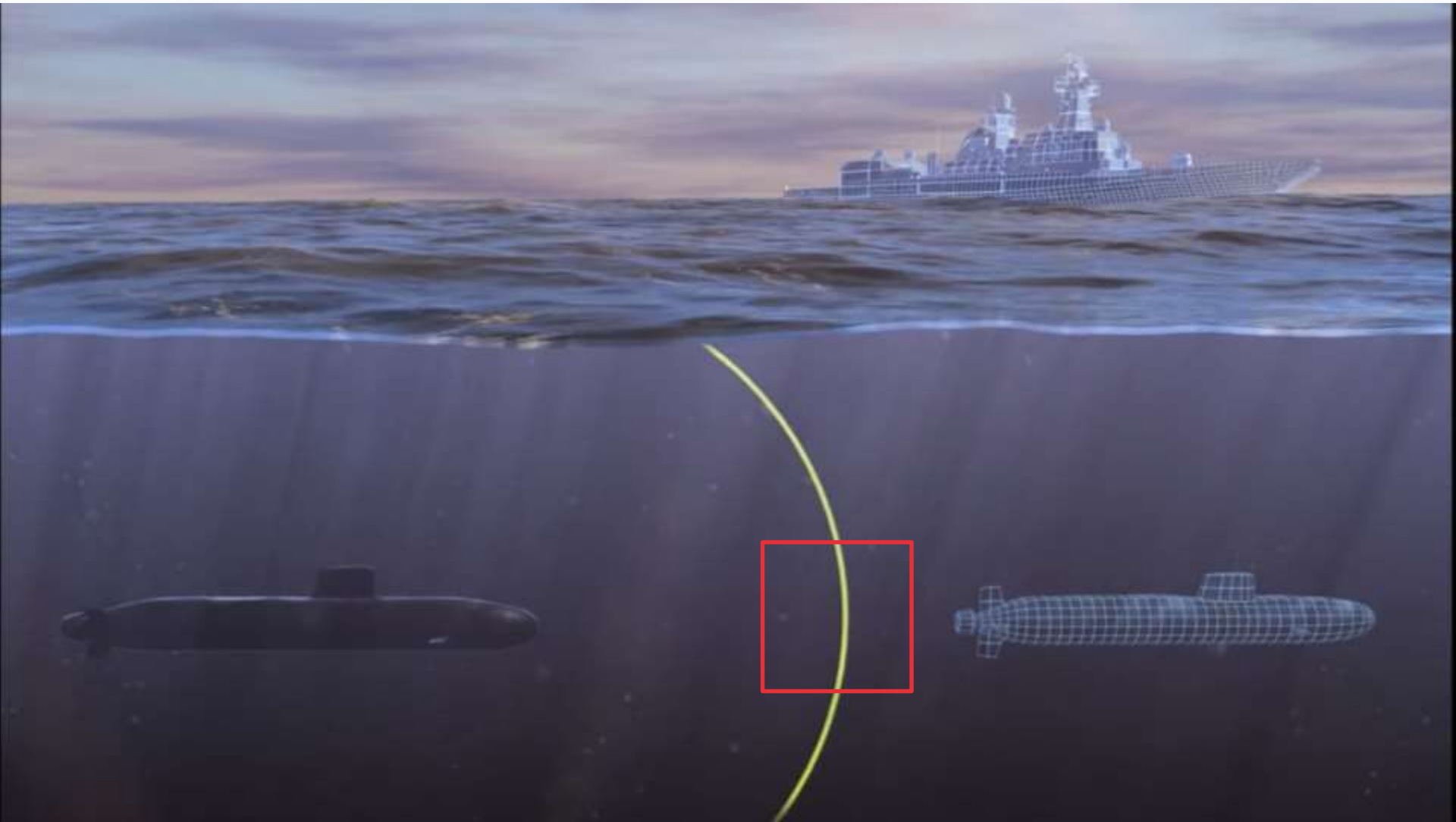


- Swim bladders will resonate at **right frequencies by sound**.
- The wall of the bubble will vibrate to **the greatest magnitude** when it is resonating.
- The **bigger** bubble gets a **lower** resonance frequency.

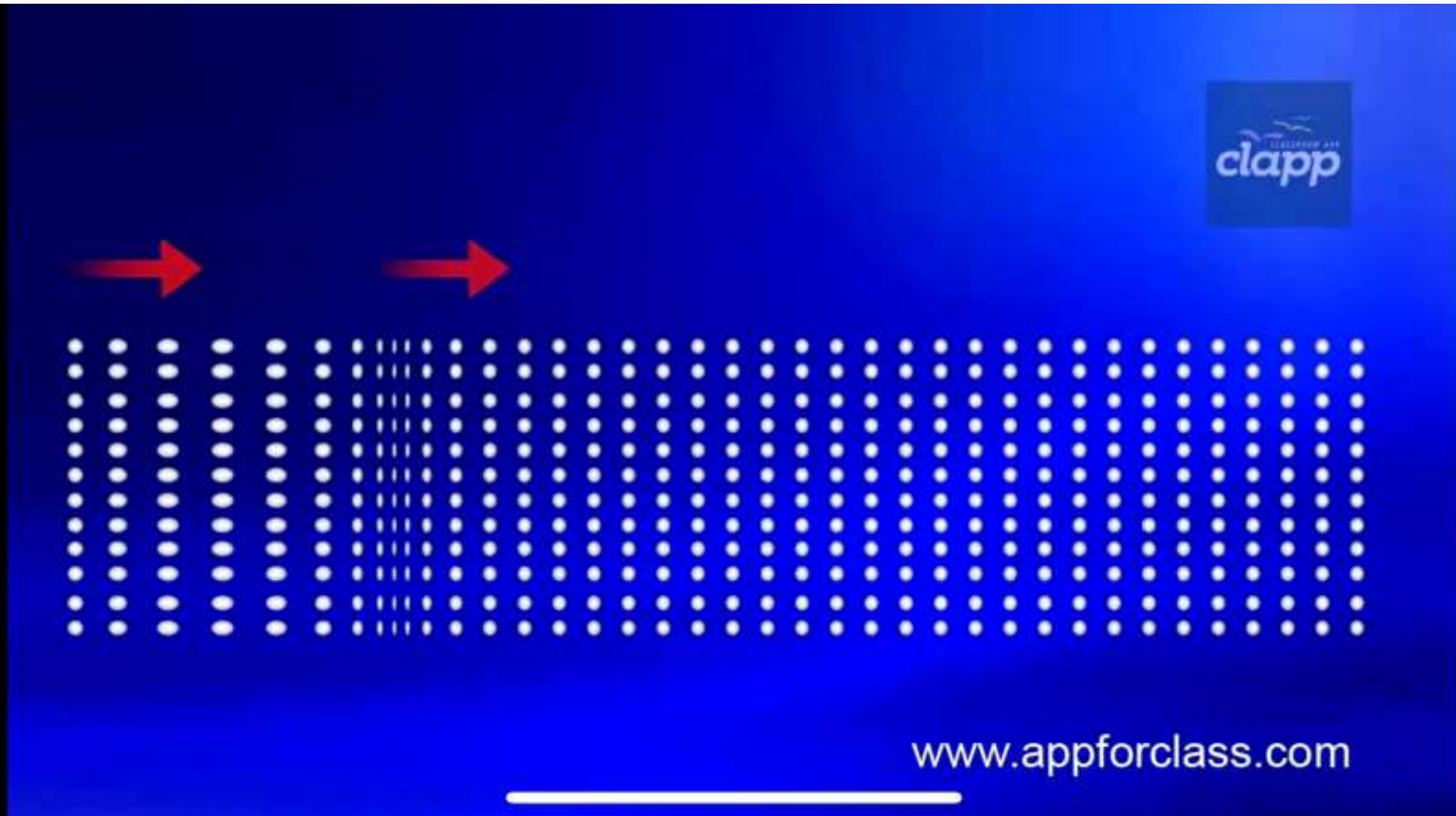
Underwater acoustics



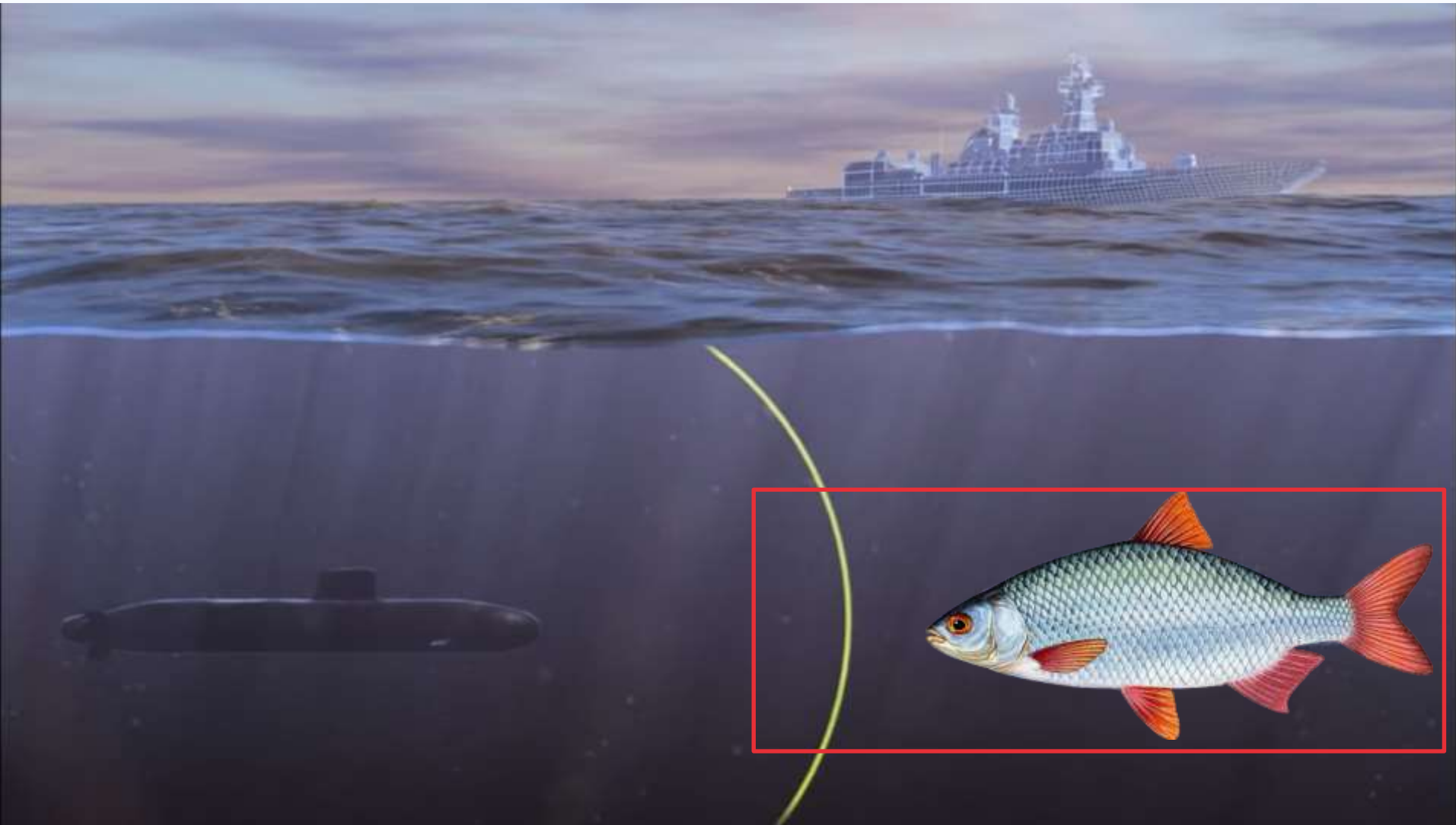
Underwater acoustics



The travelling of sound waves



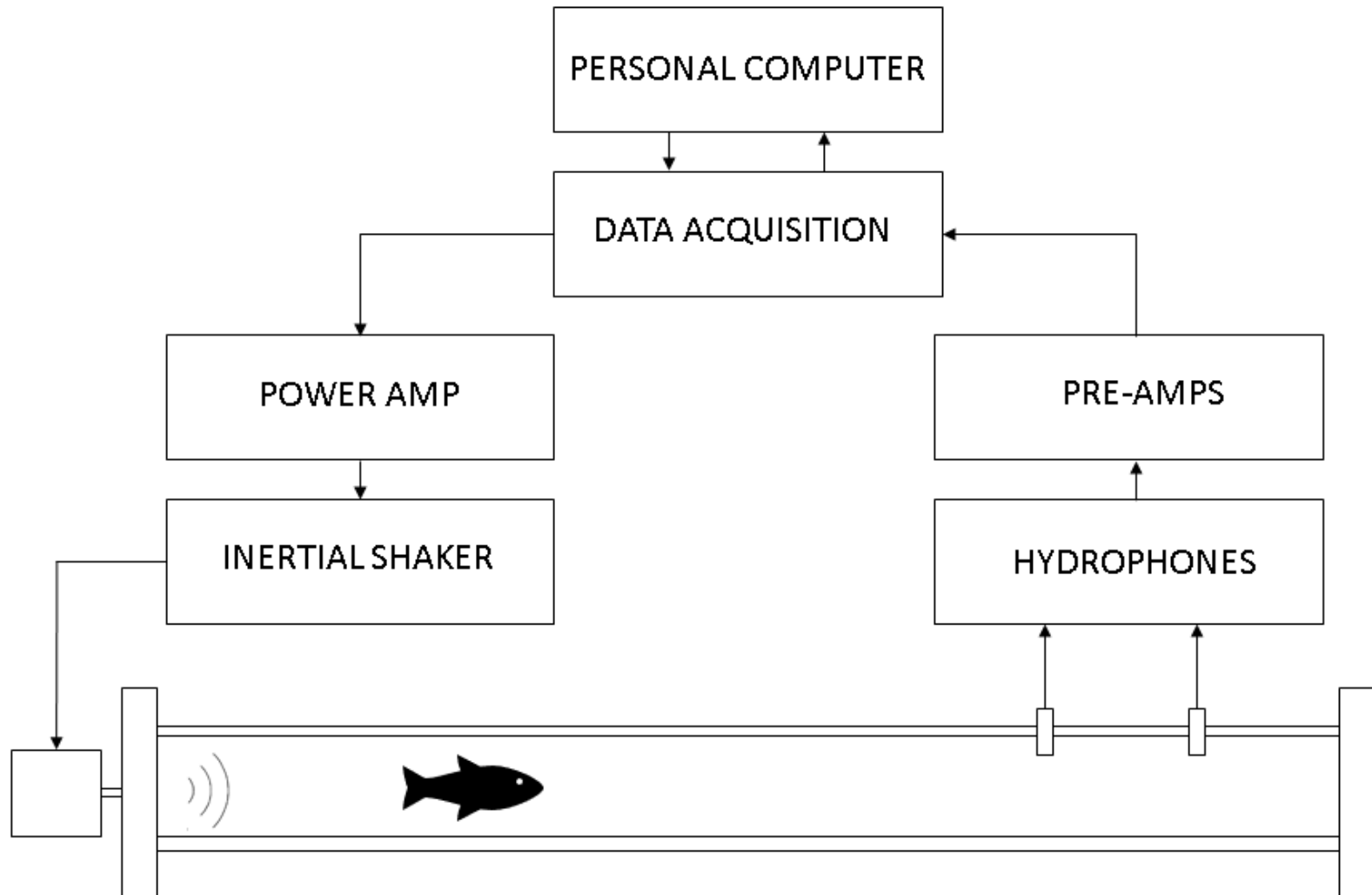
Methodology



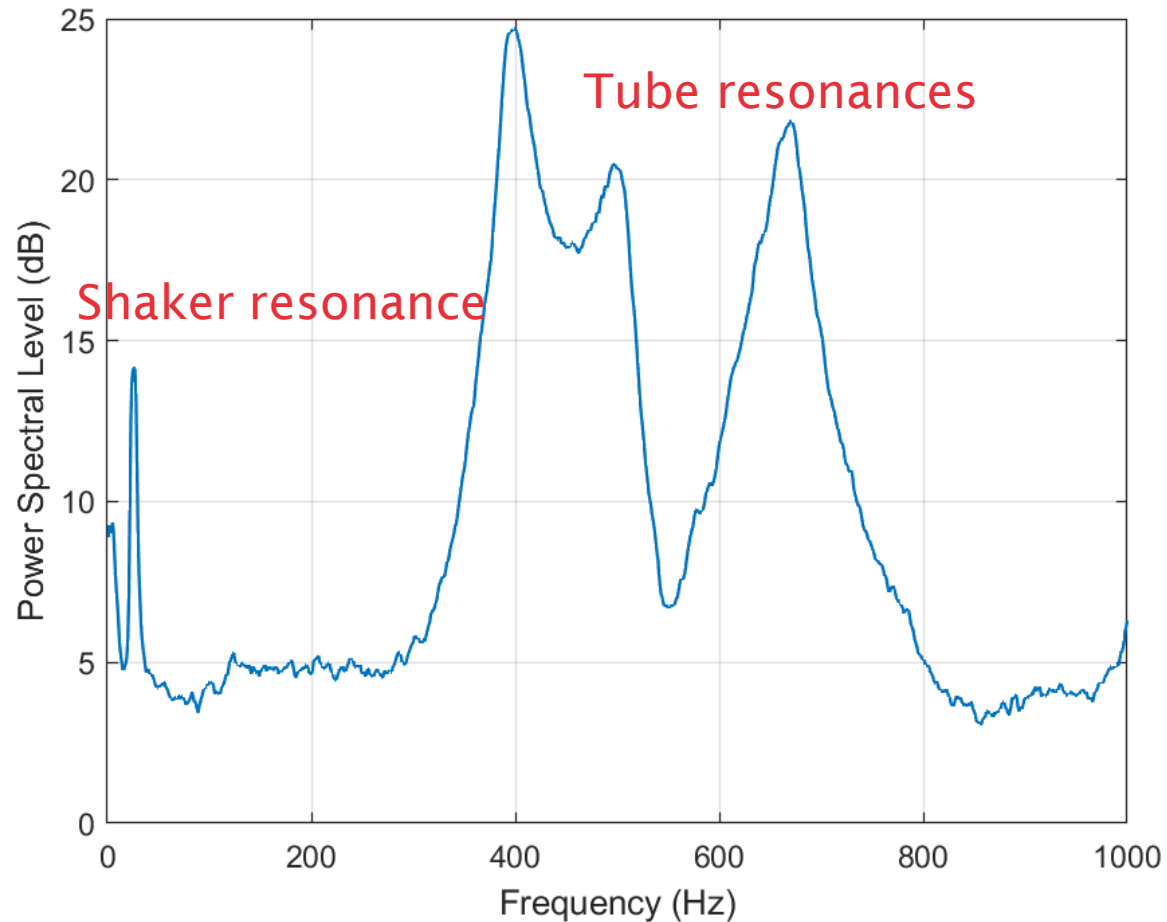
Methodology



Methodology



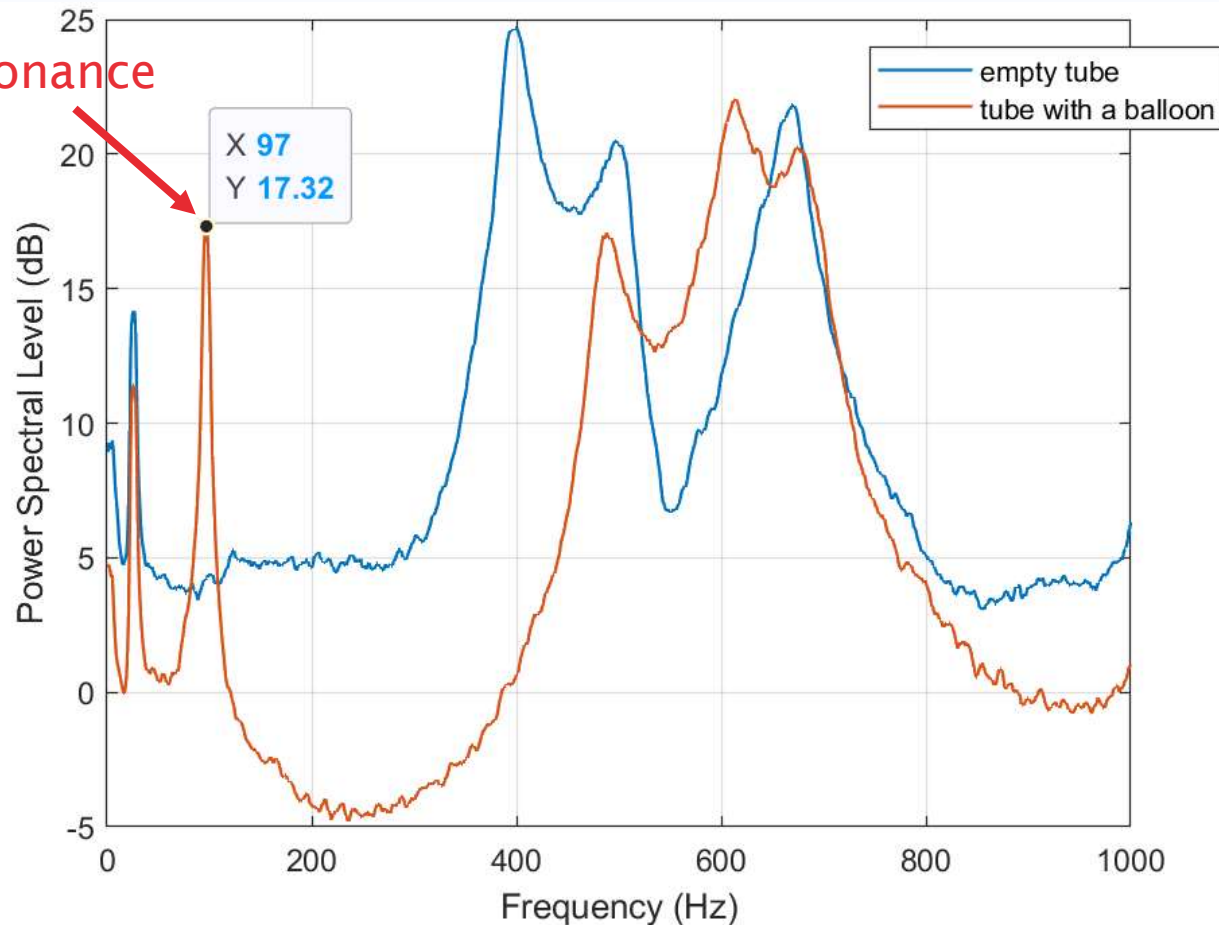
Empty tube frequency response



Three tube resonances appear at 400, 500 and 660 Hz.

Frequency response of tube with a balloon

Balloon resonance



A very sharp peak appeared at 97 Hz while original tube modes shifted due to the air-water mixture dispersion.

Recently euthanised brown trout



Total number $N = 18$;

Body length (standard length) $S.D. L = 22.1 \text{ cm} \pm 2.0$.

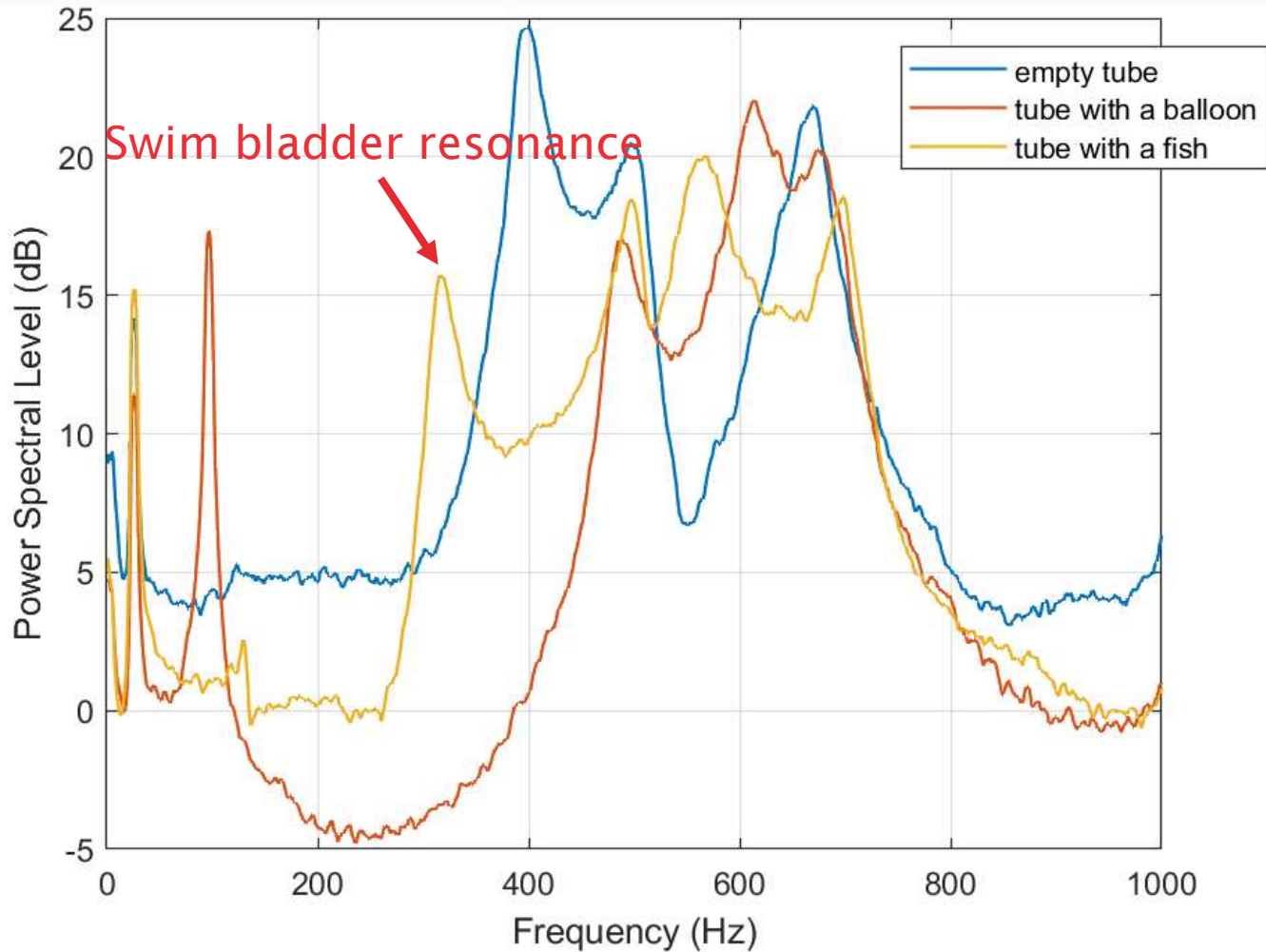
Swim bladder of the brown trout



Swim bladder volume $V = 8.6 \text{ mL}$;

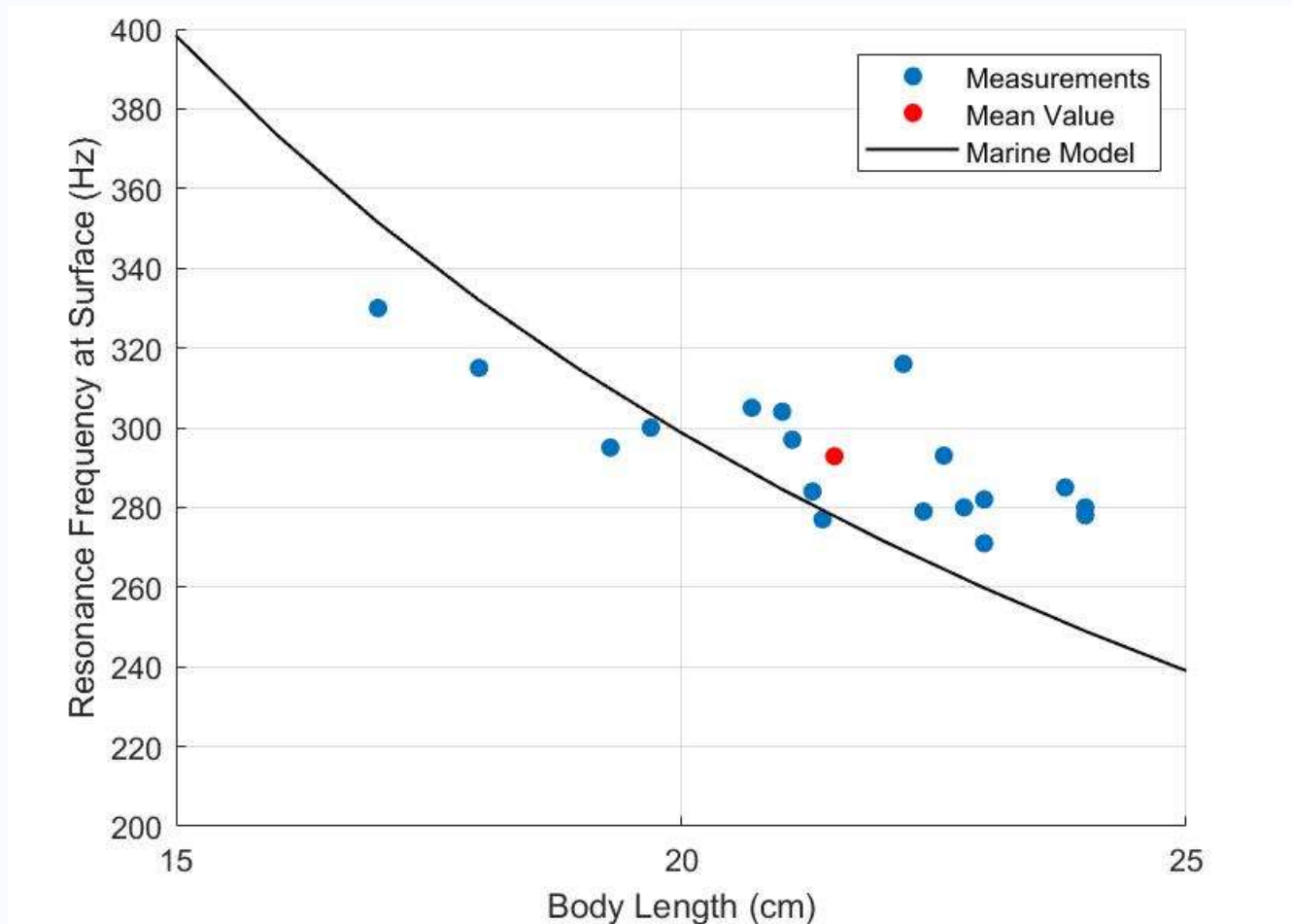
Equivalent spherical bubble radius $a = 1.26 \text{ cm}$.

Empty tube, tube with balloon/fish



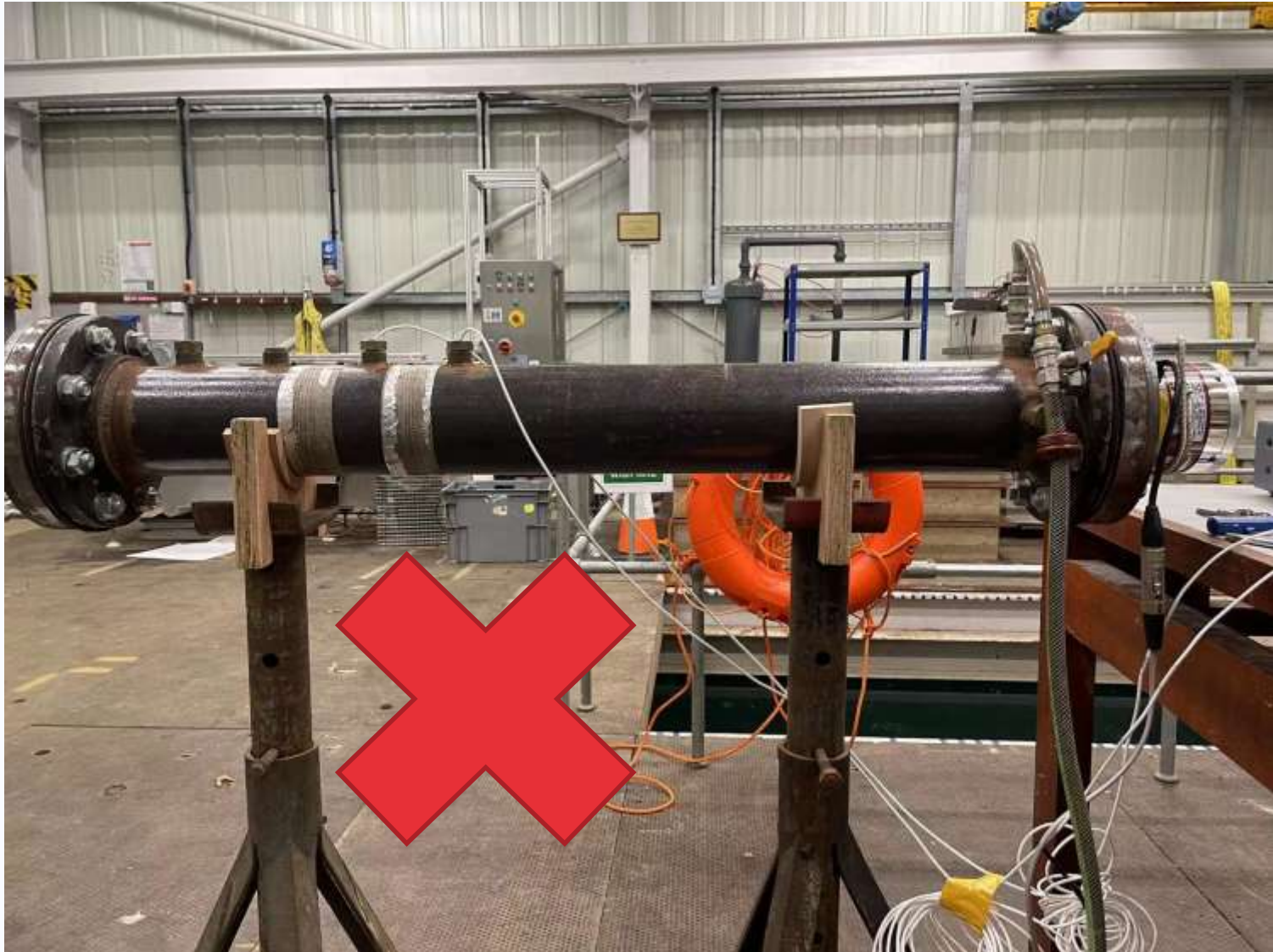
A damped resonance peak shows at 316 Hz.

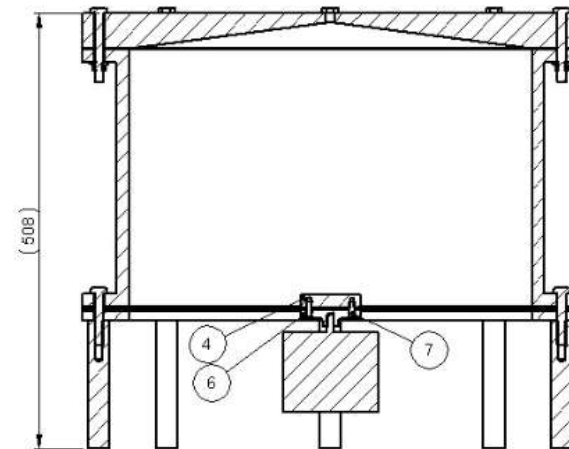
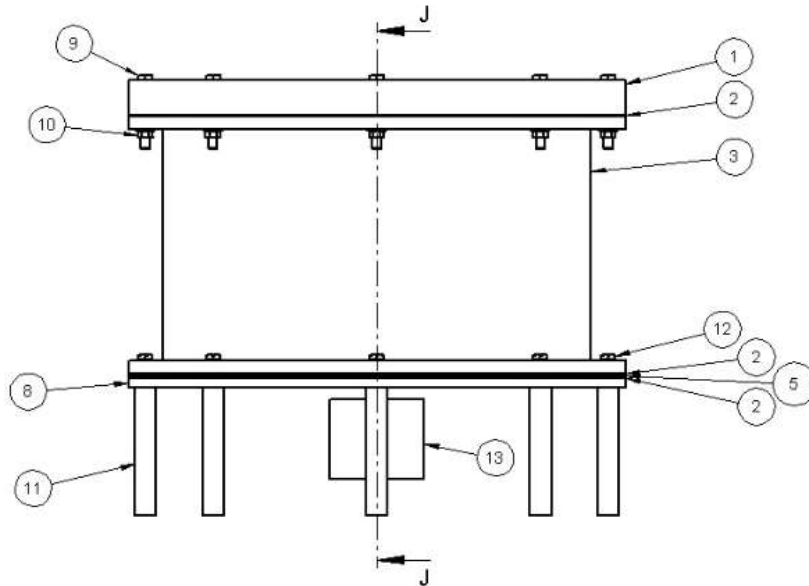
Results



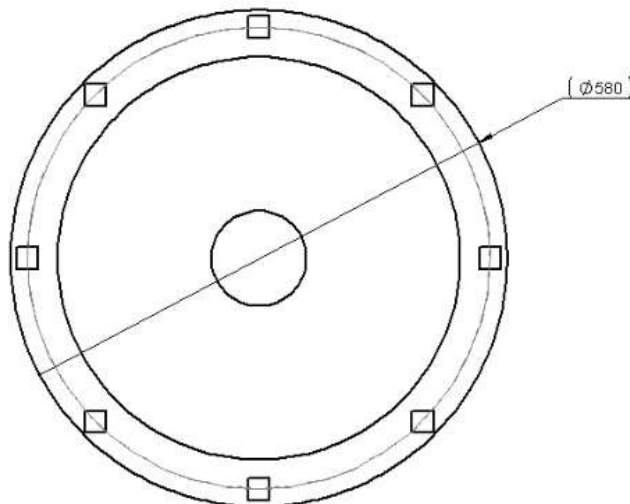
- Bigger fish gets a lower resonance frequency.
- Resonance frequency *S.D.* $f_R = 292 \text{ Hz} \pm 12.6$.

The call for a new tank






SECTION J-J



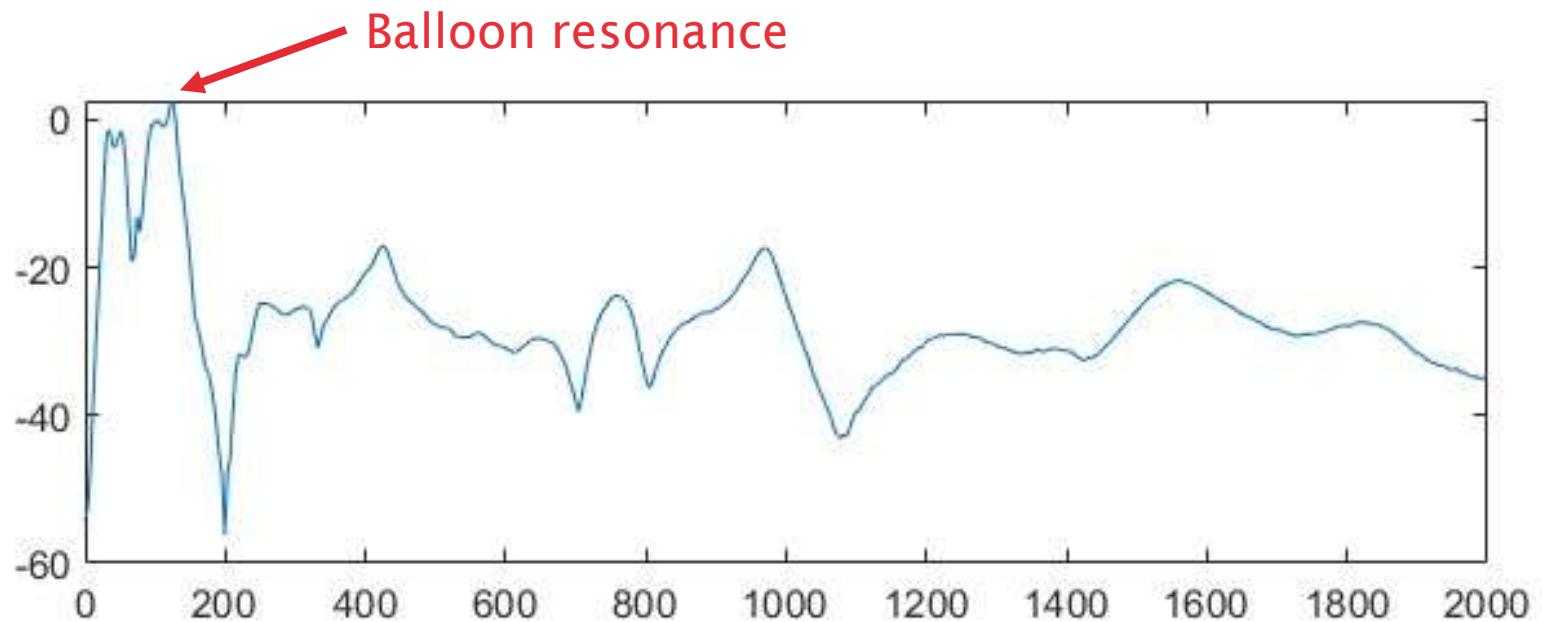
ITEM	PART NO.	DESCRIPTION	QTY
1	-	ACRYLIC LID	1
2	-	RUBBER SEAL	3
3	-	ACRYLIC TUBE	1
4	1	PLATE TOP	1
5	2	PLATE MID	1
6	3	PLATE BOTTOM	1
7	-	M6 x 20 - HEX SOCKET HEAD COUNTERSUNK	4
8	4	FRAME	1
9	-	M10 x 80 - HEX BOLT	8
10	-	M10 HEX NUT WITH FLANGE	8
11	5	FOOT	8
12	-	M10 x 60 - HEX BOLT	8
13	-	SHAKER	1

DO NOT SCALE		DRAWN BY LUOCHENG WU	TO BE RANG ED IF A LEAD O TR DESIGNER STATED		UNIVERSITY OF Southampton Faculty of Engineering and the Environment
A3		DESIGNED BY LUOCHENG WU	DATE 10/11/22	SCALE 1:5	
ENGINEER	DEPARTMENT F ENG EVR	DATE 10/11/22	SCALE 1:5	DETAILS (DRAWN BY) HANDOWN REVISIONS (DRAWN BY) DATE (DRAWN BY)	FILE
PROJECT FISH TANK	SUPERVISOR PAUL WHITE	MATERIAL	FEATURE CLEAN	SUPPLY ACCT. IN DIS ✓ OIL OKEY (MESH) ✓ OTHERWISE (SIZES)	FISH TANK ASSEMBLY
REMOVE ALL DRAP ED ID IF IN 30 SET PLEASE ASK	THIS INFORMATION CONTAINED IN THIS DOCUMENT IS THE PROPERTY OF THE UNIVERSITY OF SOUTHAMPTON DO NOT CO PY WITH OUT WRITTEN PERMISSION.		SHEET 1 of 1	FIG. NO. 1	ASSEMBLY NUMBER 1
			DRAWING NUMBER	REVISION A	



The new acrylic test tank has been built for resonance measurements and behavioural response studies.

Transfer function (dummy swim bladder)



The resonance peak of the dummy swim bladder (48 mm diameter) appears at 125 Hz in the TF of the new tank.

THANK YOU

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