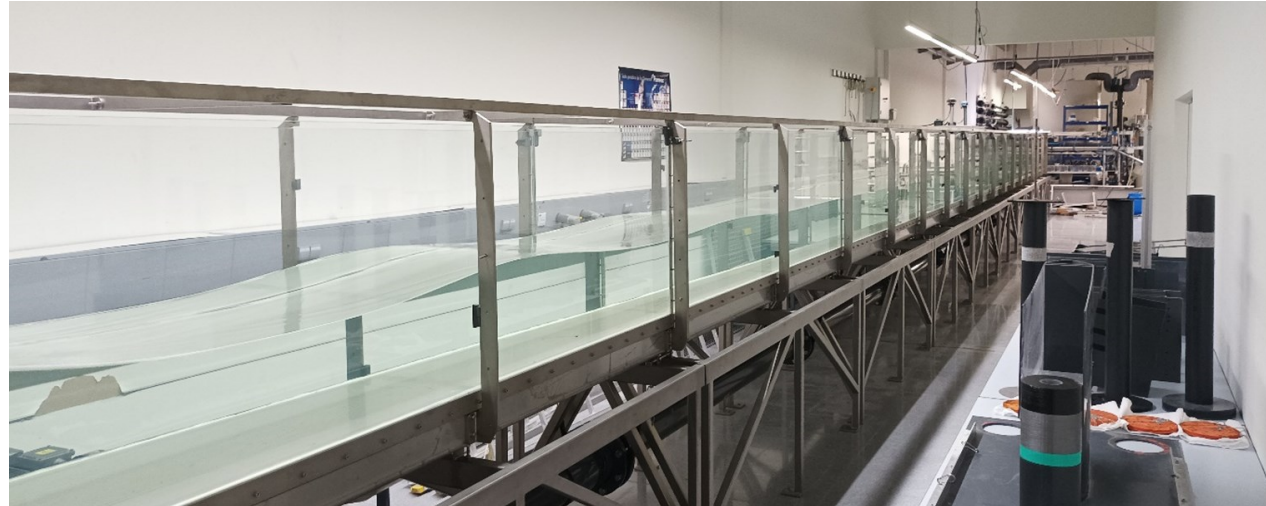


PhD:
***Hybridisation of renewable energies in the
marine environment***



Oier Peña Vega

Tutor:
Urko Izquierdo Ereño
Jesús María Blanco Ilzarbe

BACKGROUND

- Degree in Industrial Technology Engineering
- Master's degree in Industrial Engineering
- REM PLUS Master
- Sener internship
- PhD: *Hybridisation of renewable energies in the marine environment*

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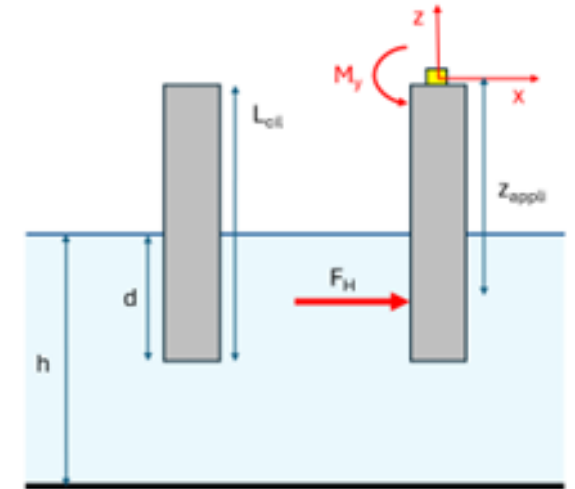
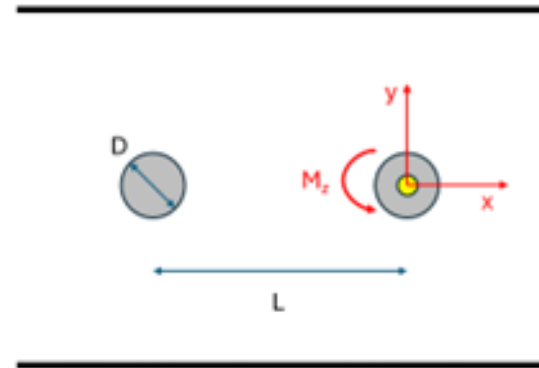
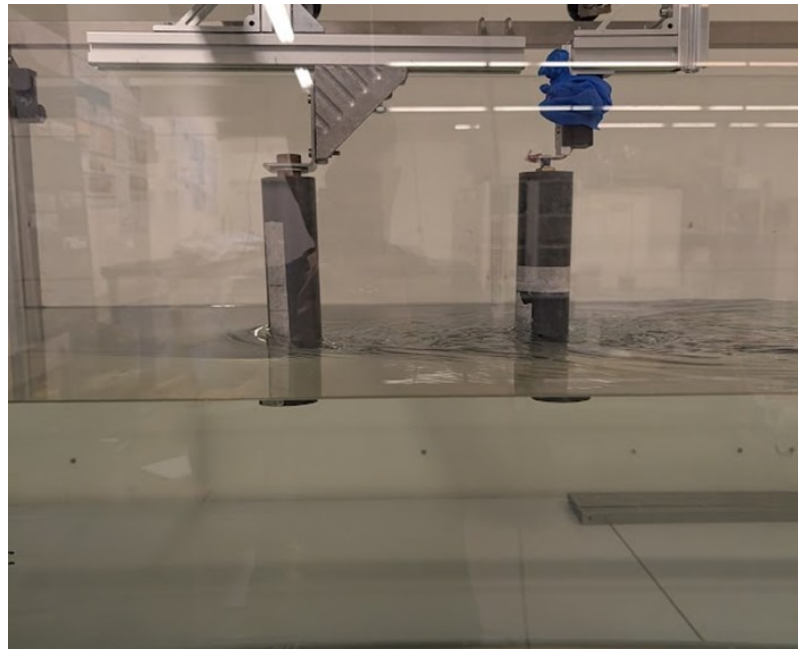
Universidad
del País Vasco

Euskal Herriko
Unibertsitatea



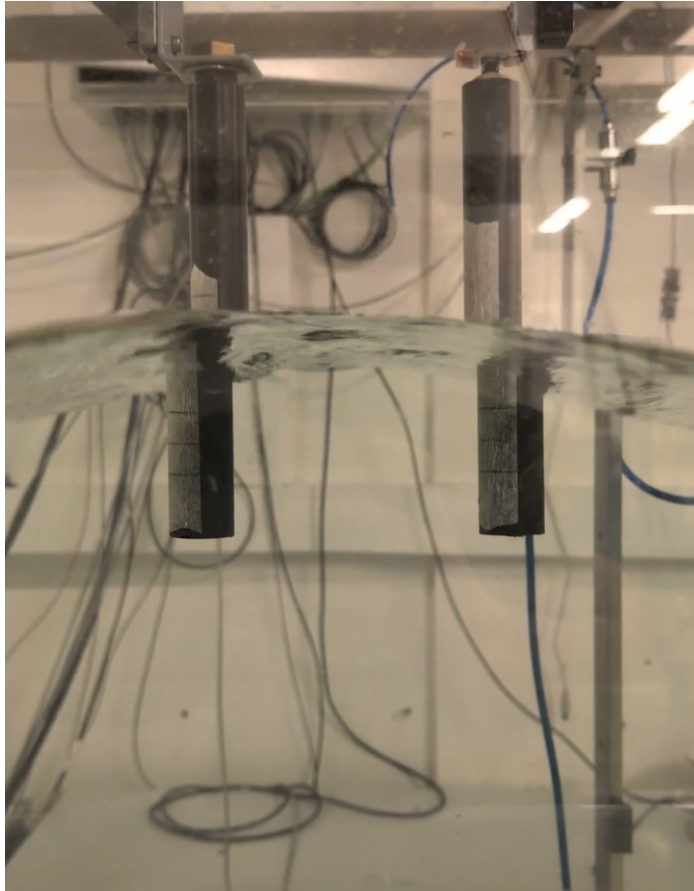
EKIOCEAN

- Design parameters
 - Diameters: from 30 mm to 50 mm
 - Draught
 - Distance between floaters



EKIOCEAN

- Waves



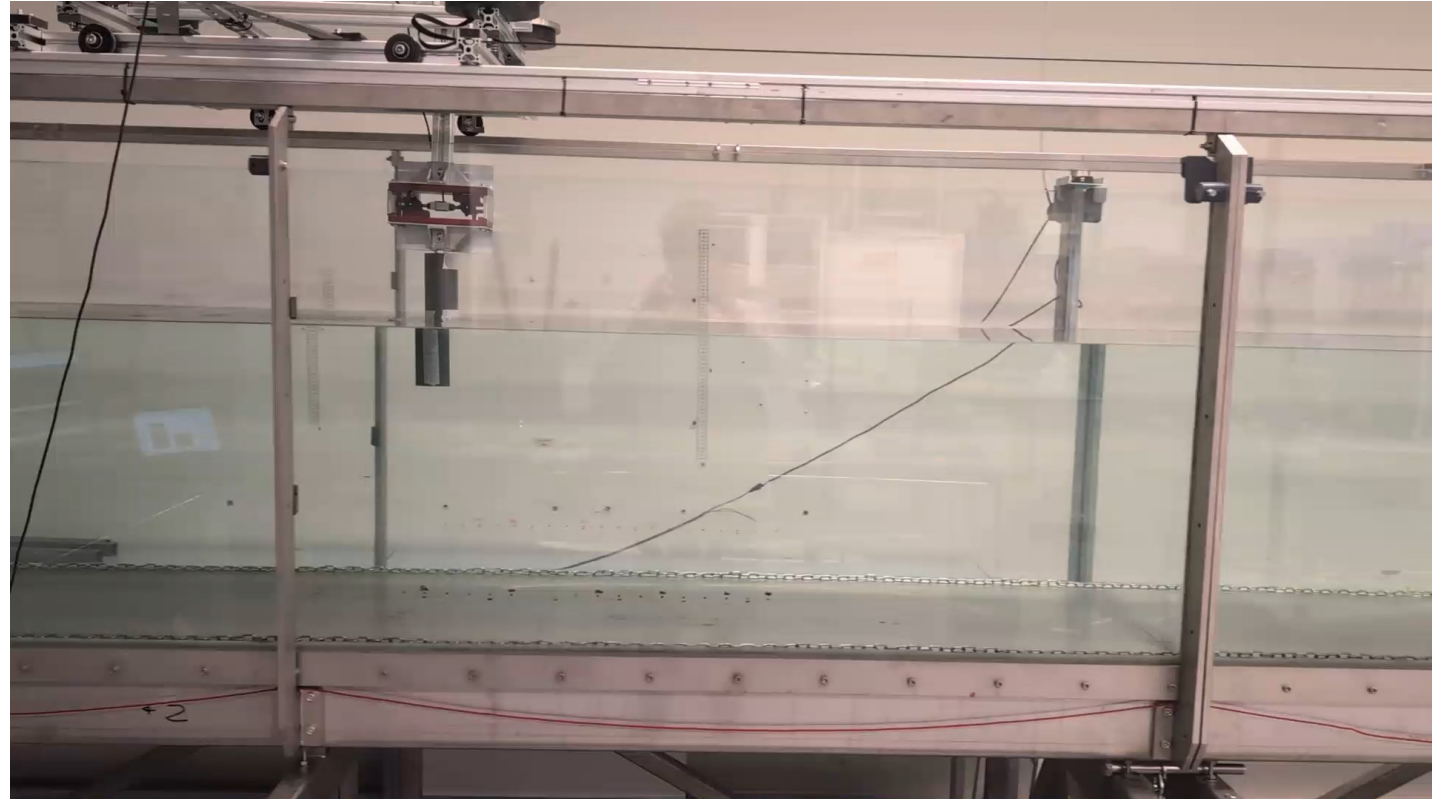
H (m)	T (s)	Case	Scale	D (m)
0.025	0.632	H1T4	1:40	0.05
0.05	0.894	H1T4	1:20	0.05
0.025	0.949	H1T6	1:40	0.05
0.05	1.342	H1T6	1:20	0.05
0.04	0.707	H2T5	1:50	0.04
0.08	1.000	H2T5	1:25	0.04
0.03	1.102	H2T9	1:66.7	0.03
0.06	1.559	H2T9	1:33.3	0.03
0.08	0.919	H4T6.5	1:50	0.04
0.16	1.300	H4T6.5	1:25	0.04
0.06	0.796	H4T6.5	1:66.7	0.03
0.12	1.126	H4T6.5	1:33.3	0.03
0.06	1.225	H4T10	1:66.7	0.03
0.12	1.732	H4T10	1:33.3	0.03

EKIOCEAN



- Currents:

U real (m/s)	D real (m)	D exp (m)	Scale	U exp (m/s)
0.5	1	0.05	1:20	0.112
0.5	2	0.05	1:40	0.079
1	1	0.05	1:20	0.224
1	2	0.05	1:40	0.158
1.5	1	0.05	1:20	0.335
1.5	2	0.05	1:40	0.237
2	1	0.05	1:20	0.447
2	2	0.05	1:40	0.316



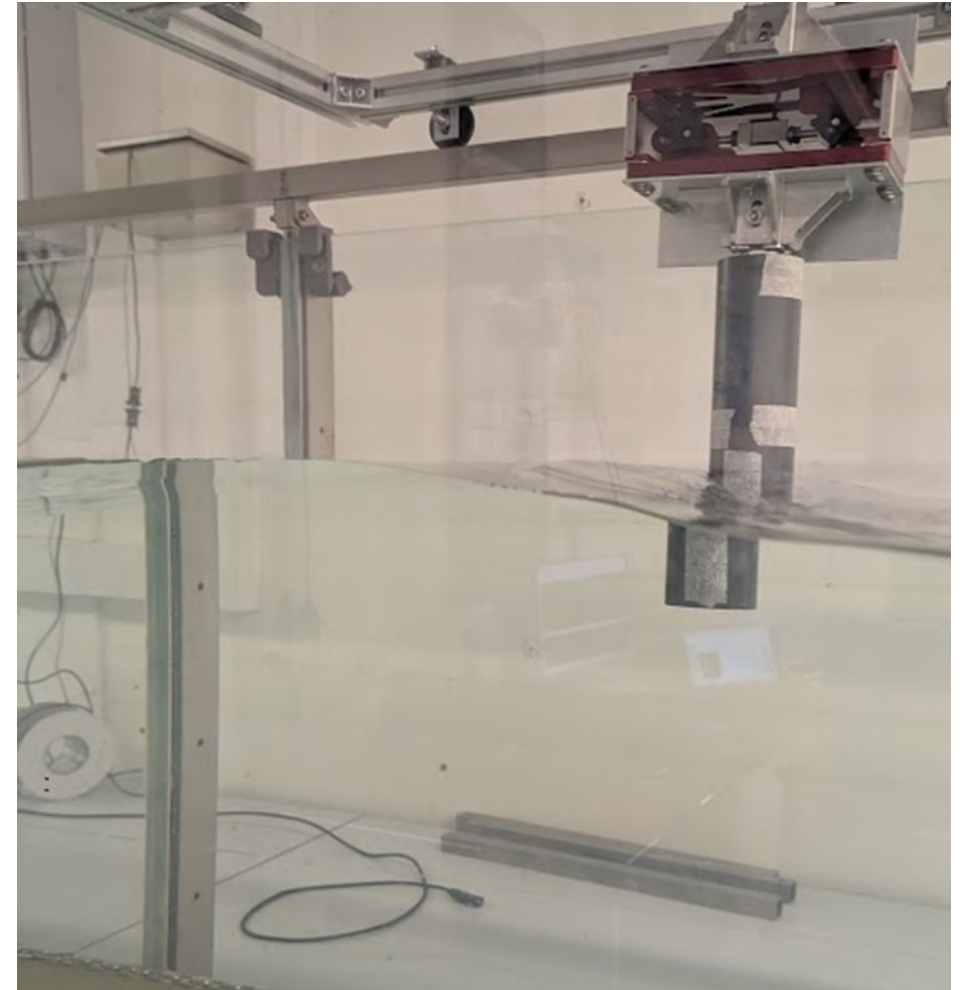
EKIOCEAN



- Values of horizontal forces
- Hydrodynamic coefficients calculation
 - Drag coefficient
 - Inertia coefficients

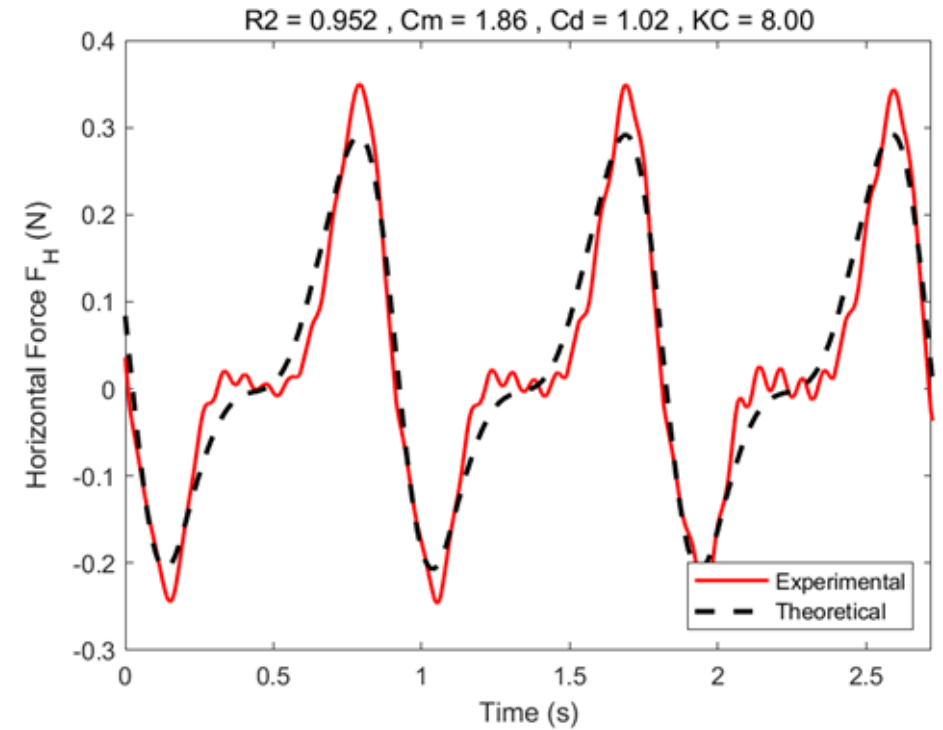
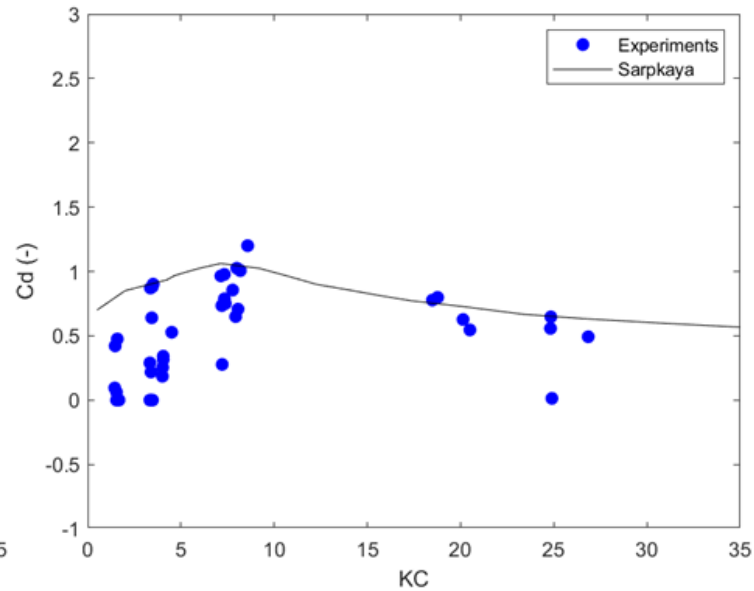
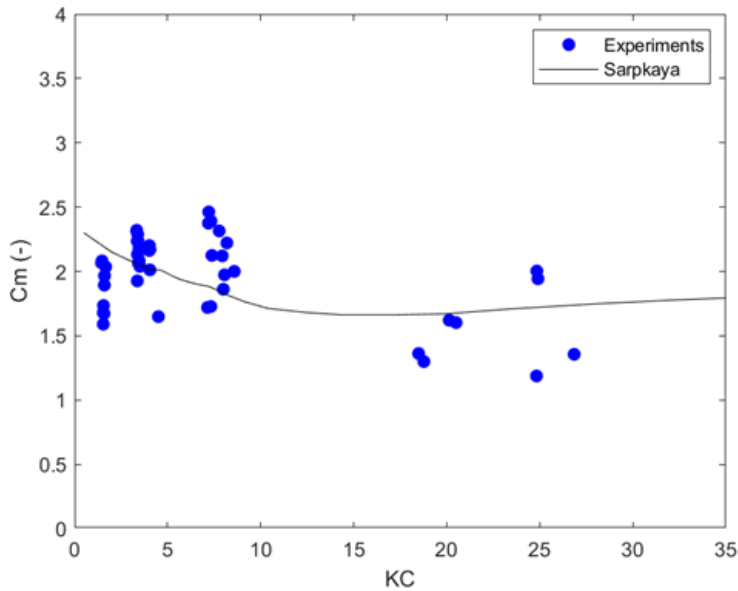
$$F_H = F_{inertia} + F_{drag}$$
$$F_H = C_M \cdot \rho \cdot \frac{\pi D^2}{4} \cdot \dot{u} + C_D \cdot \rho \cdot \frac{D}{2} \cdot u \cdot |u|$$

- Wave dissipation or wake effect



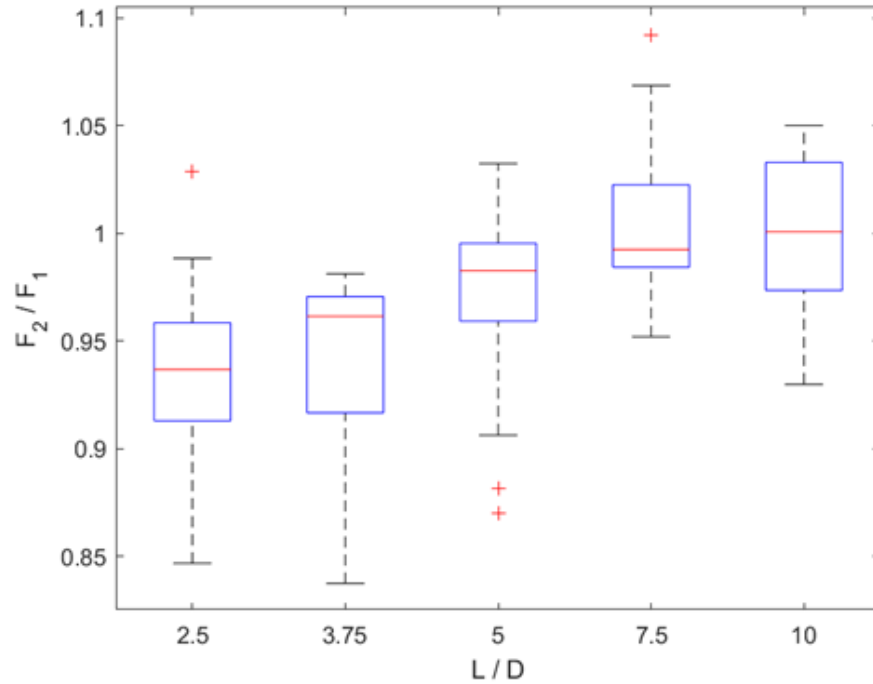
RESULTS

- Forces match with theoretical values
- Hydrodynamic coefficients:
 - $C_M \approx 2.0$
 - $C_D \approx 0.7$

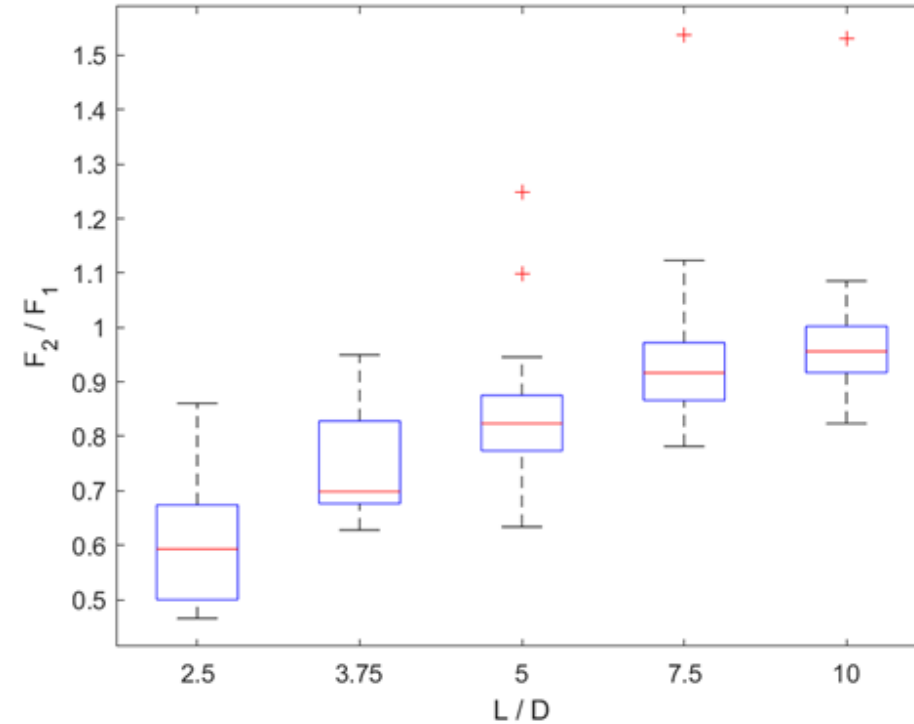


RESULTS

- Wave dissipation (waves)



- Wake effect (currents)



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FUTURE WORKS

- EKIOCEAN: unit cell validation
- Other floating solar solutions
- Wave Energy Converters: floating breakwaters
- Hibridisation of both systems

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