A Time-Domain Optimization Tool for Integrated Wave Energy Converter Design

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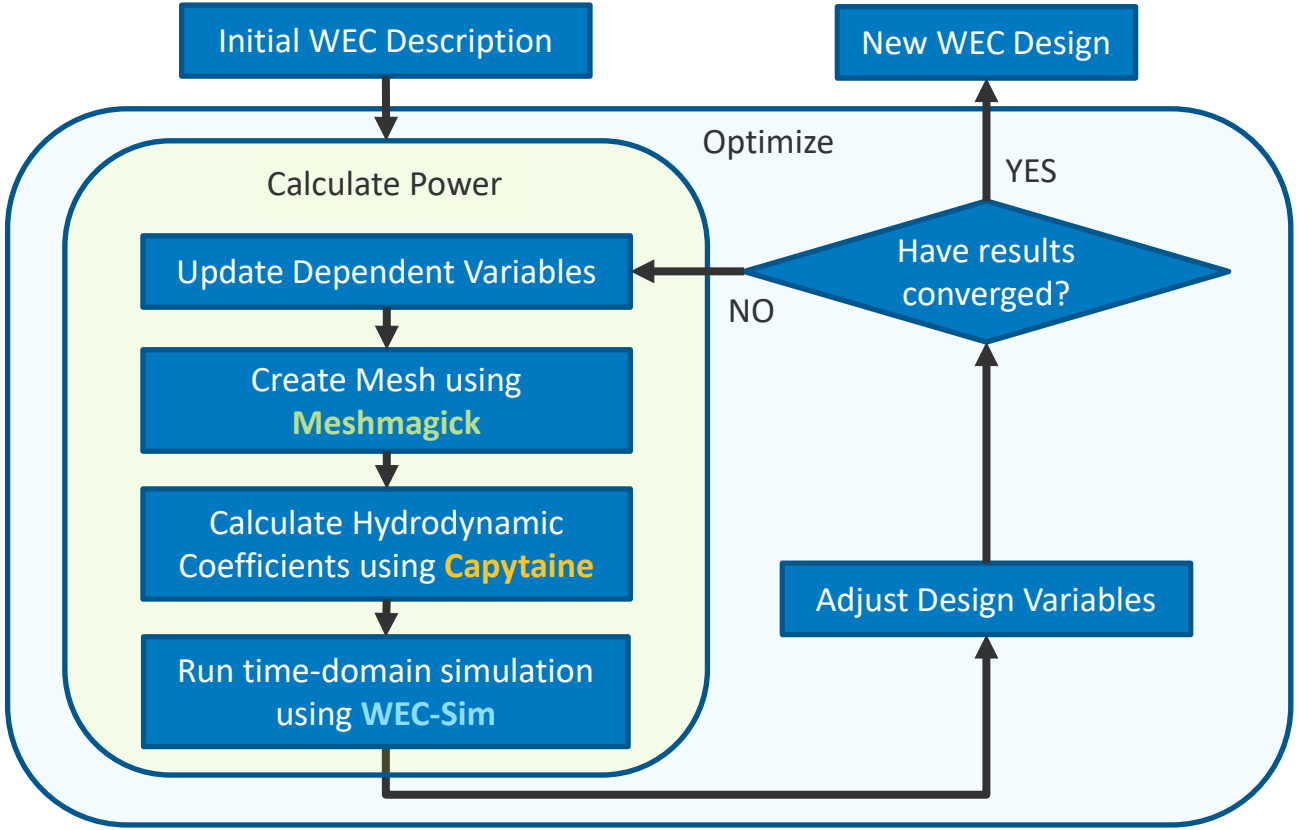
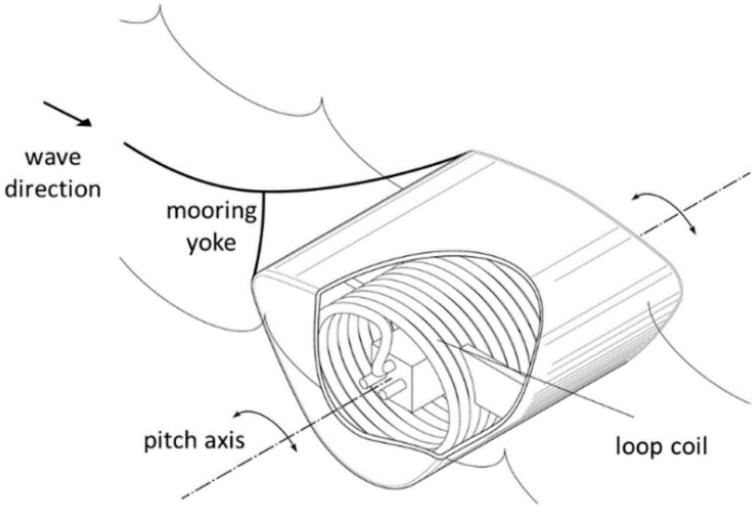
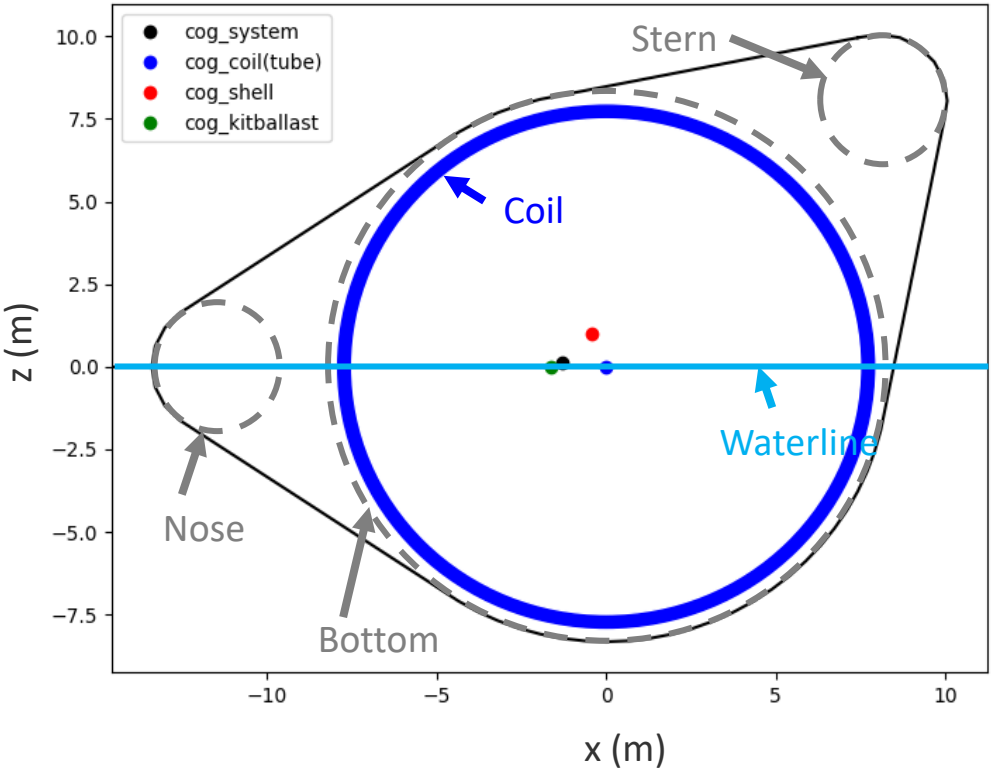
National Renewable Energy Laboratory – IProTech

TOPWEC Process – The Numerical Design Tool



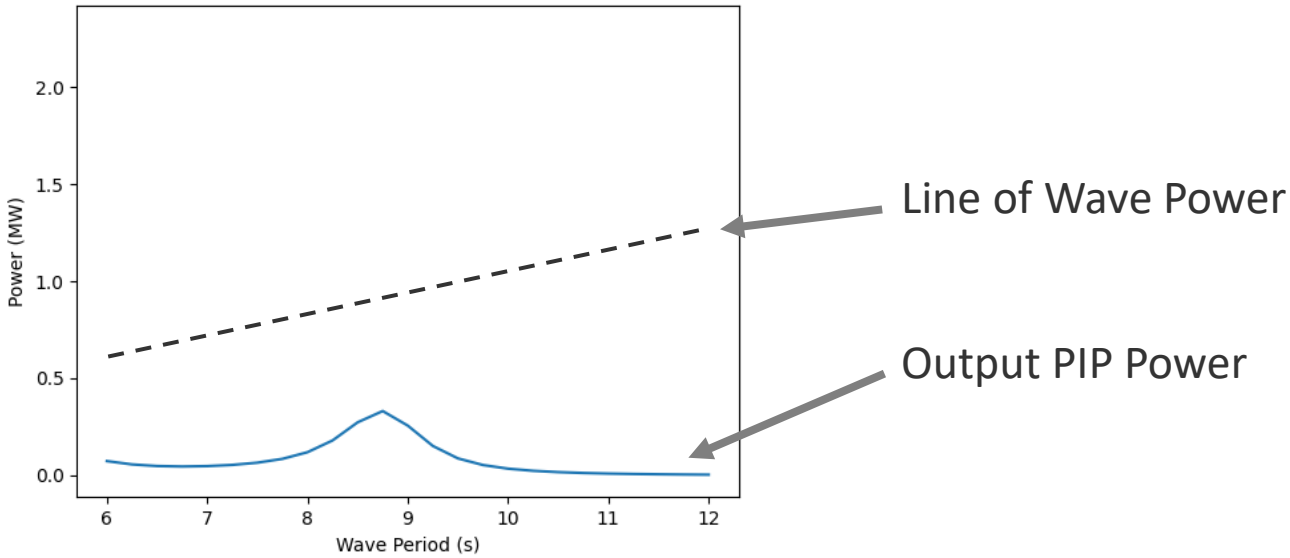
Pitching Inertial Pump – Case Study





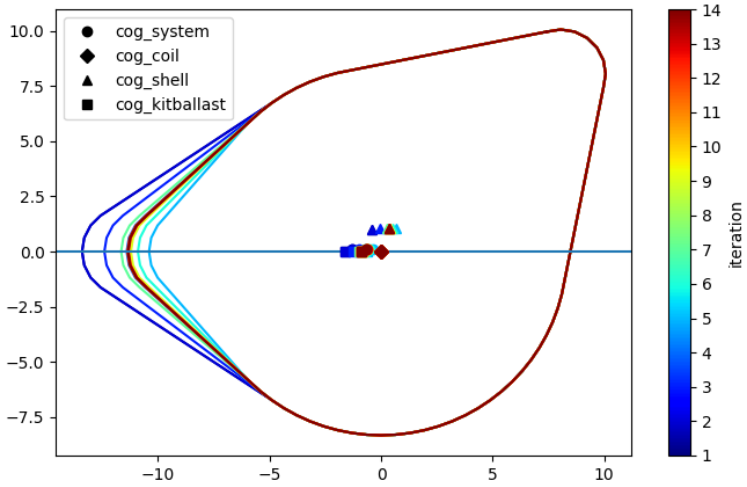
Optimizer Study and Wave Period Study

	COBYLA	Powell	SLSQP	Trust-constr	CG	Nelder-mead	TNC
Optimal noseX (m)	-14.99	-14.96	-14.68	-13.77	-13.40	-14.95	-14.52
Average Power (kW)	251.6	251.7	251.2	235.5	224.8	251.6	249.9
Number of Iterations	11	46	70+	44	32	42	39

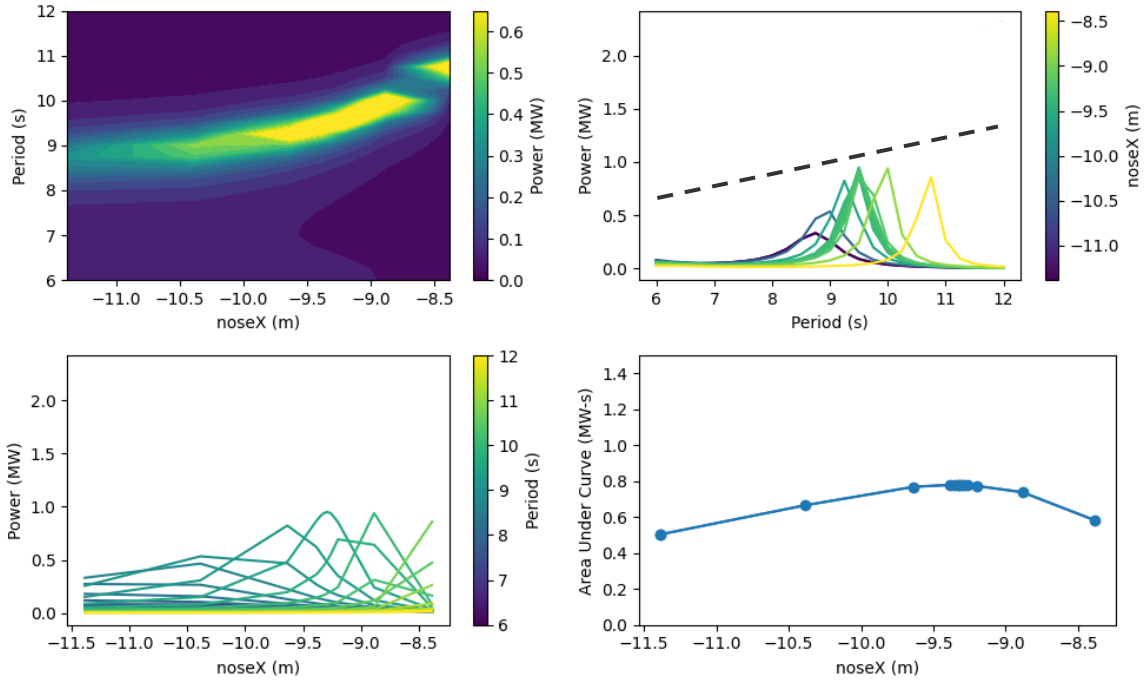


NoseX Optimization Results of the PIP

“NoseX” Optimization

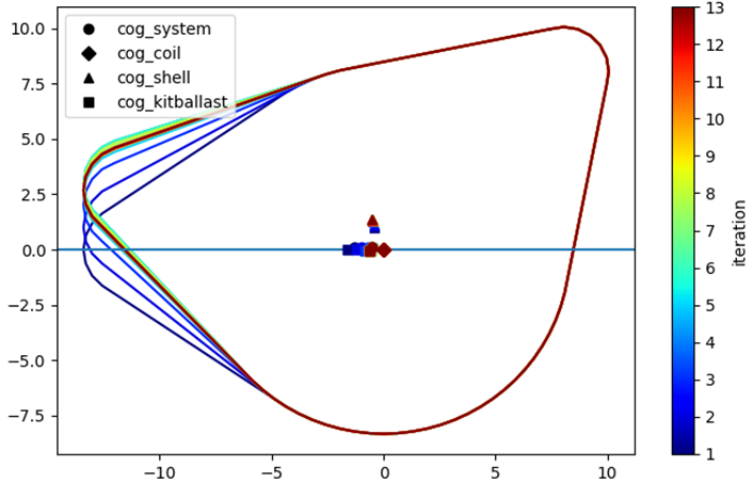


“NoseX” Optimization

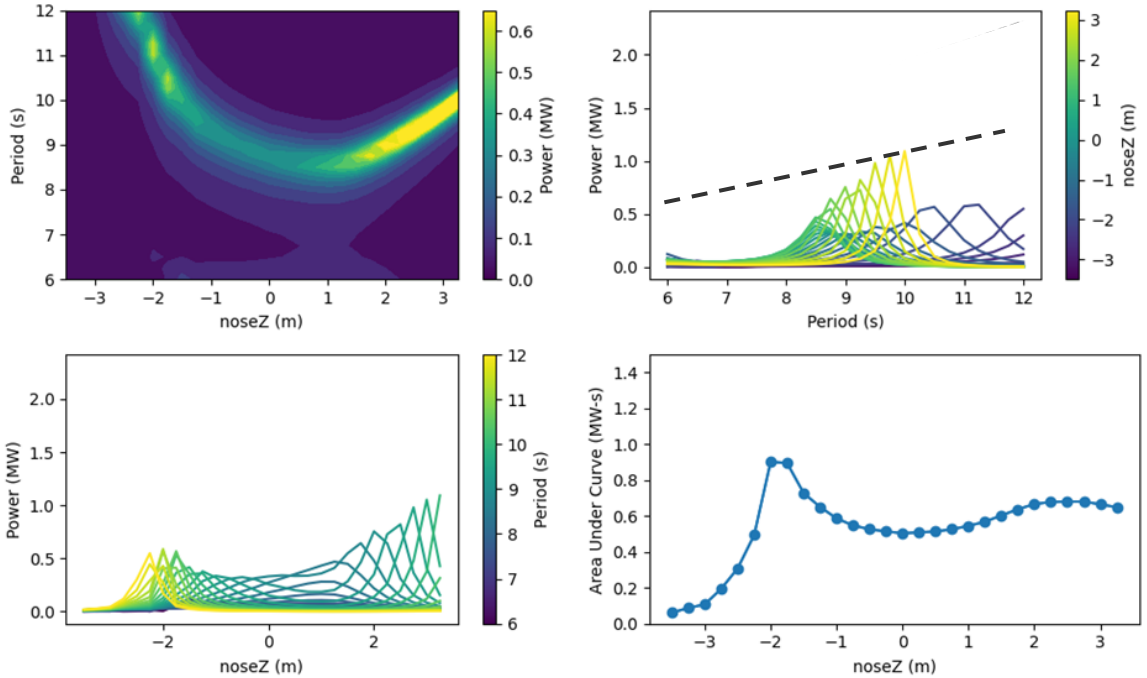


NoseZ Optimization Results of the PIP

“NoseZ” Optimization

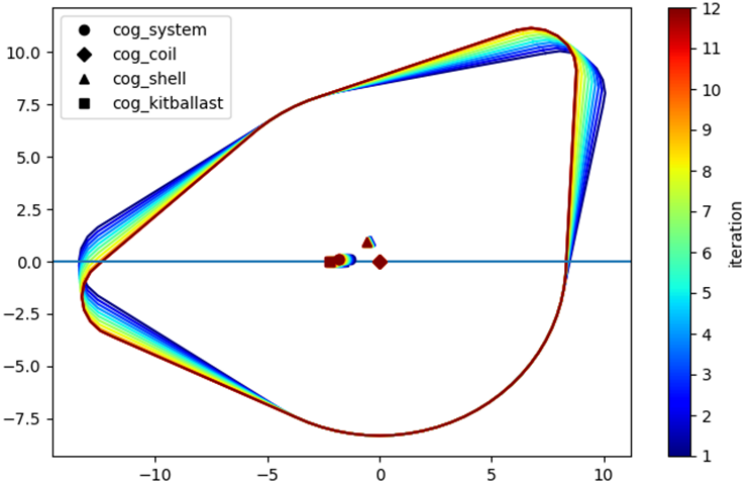


“NoseZ” Parameter Sweep

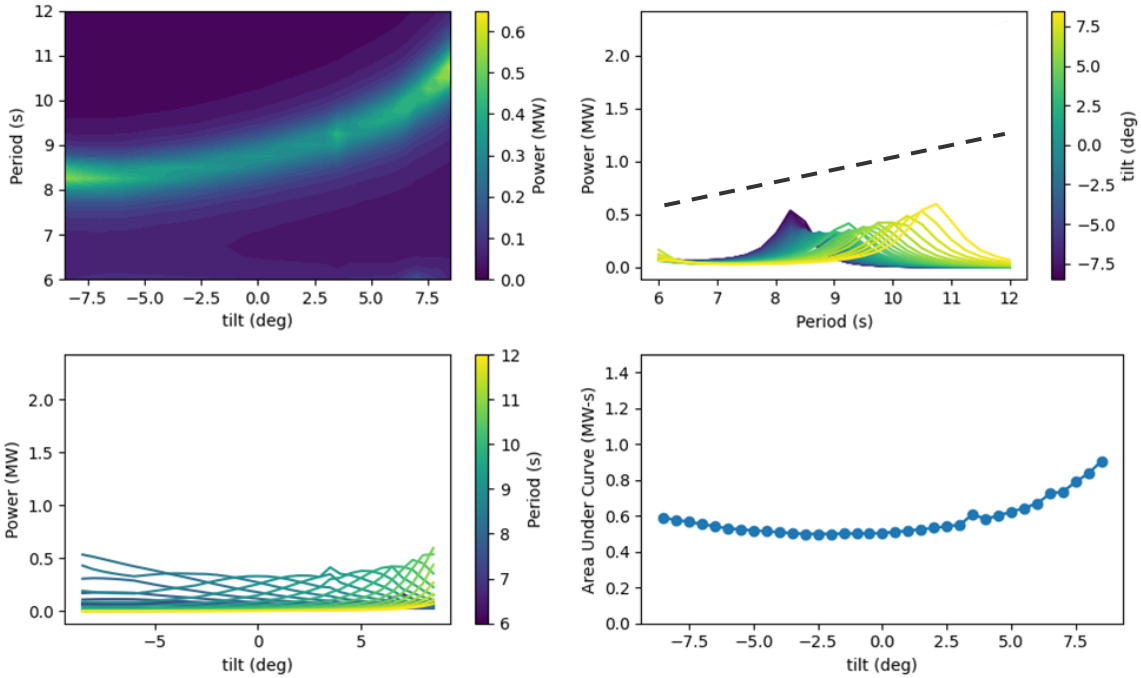


Tilt Optimization Results of the PIP

“Tilt” Optimization

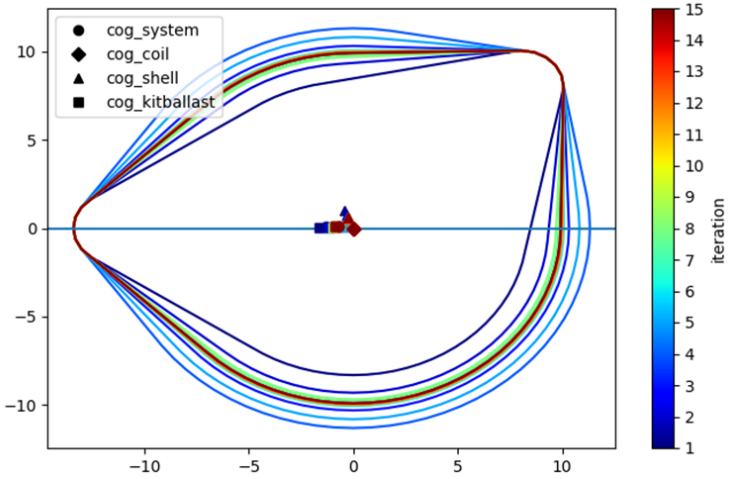


“Tilt” Parameter Sweep

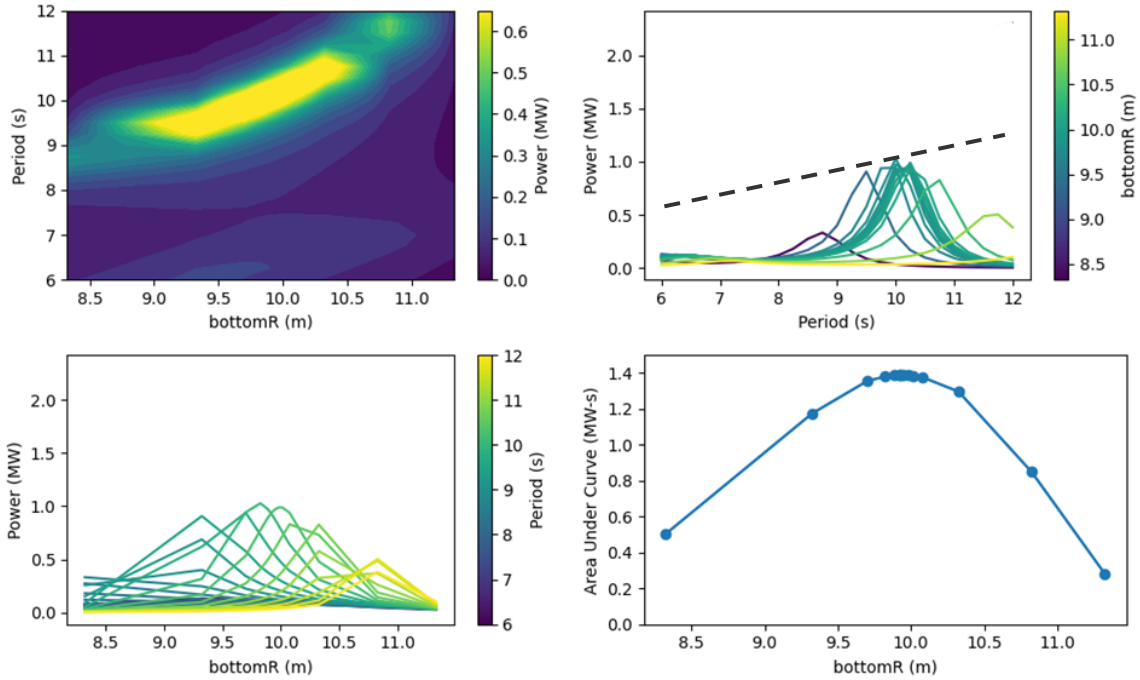


BottomR Optimization Results of the PIP

"BottomR" Optimization

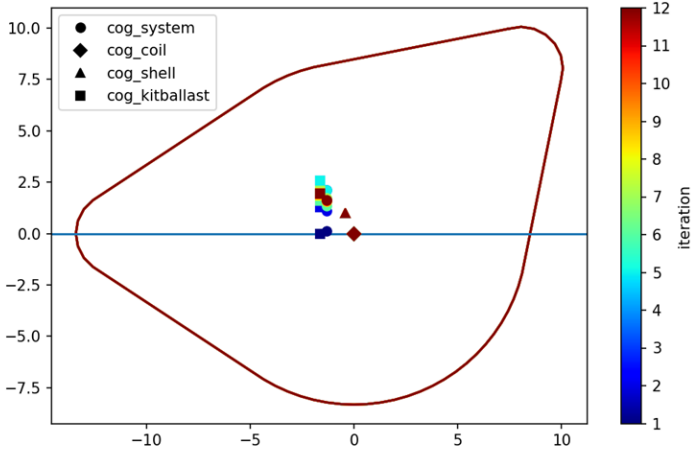


"BottomR" Optimization

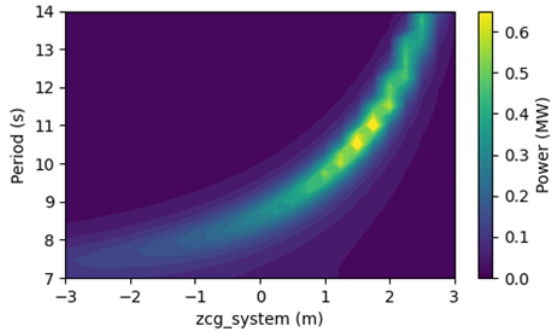


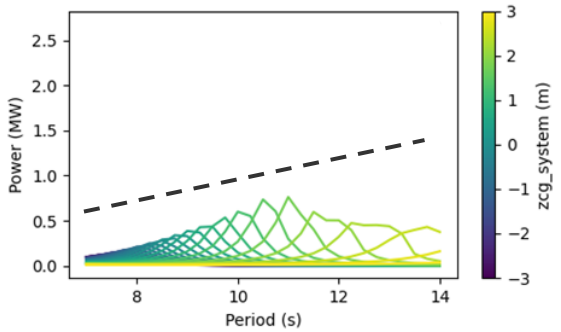
$z_{CG\,system}$ Optimization Results of the PIP

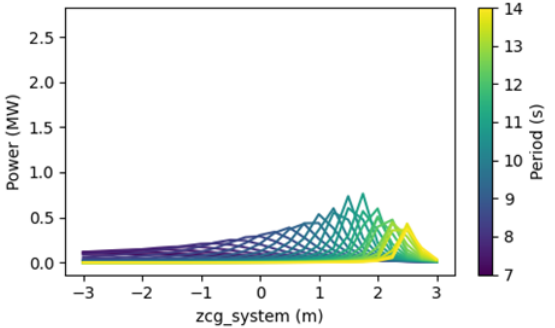
"$z_{CG\,system}$" Optimization

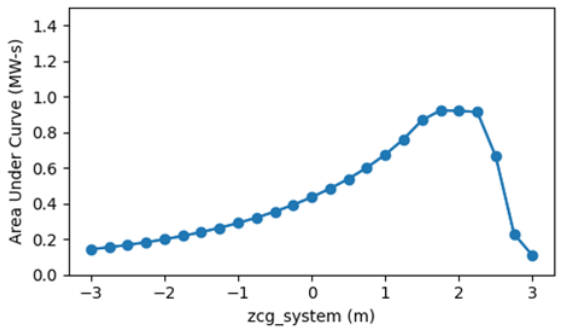


"$z_{CG\,system}$" Parameter Sweep









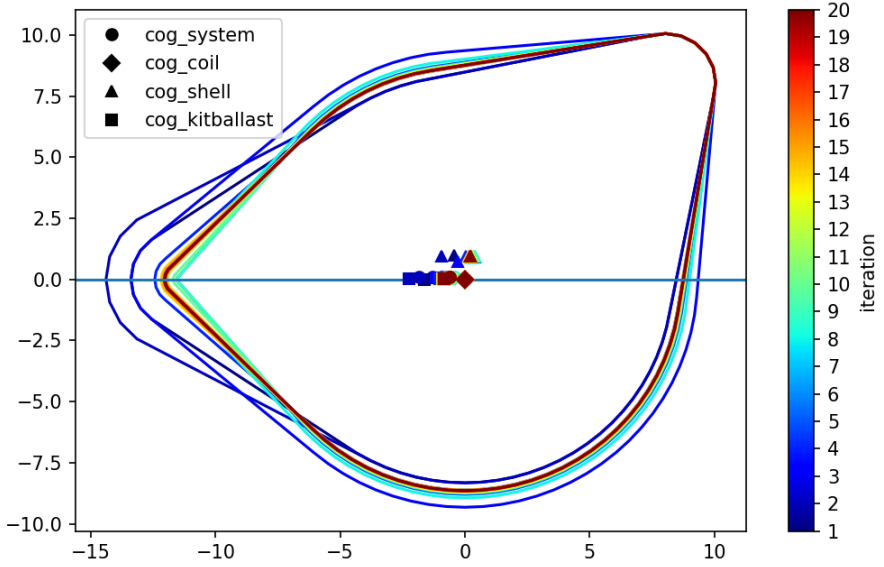
Concluding Thoughts

- Bottom circle radius, diameter of the coil: largest influence on power capture
- Multi-variable optimizations were performed, but not verified

- TOPWEC needs continued programming organization and optimization framework development
- Able to run WEC-Sim (time-domain) simulations inside an optimization loop -> rare functionality

- More studies needed on the full optimization of the PIP device (multi-variable, multi-objective, refined constraints, etc.)

NoseR and BottomR optimization



Questions? Contact Stein Housner
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Thank You

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Extra Slides

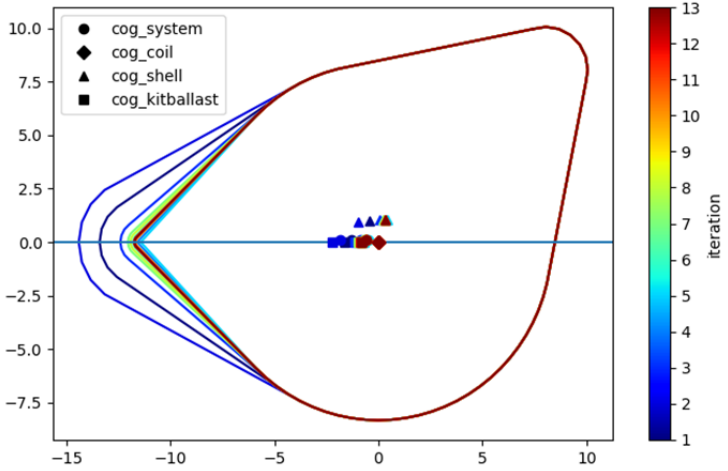
Single-Variable Optimization Results

	Initial DV Value	Optimized DV Value	Optimized Objective (MW-s) (Area Under Curve)
Default Design	-	-	0.504
noseX (m)	-11.385	-9.333	0.781
noseZ (m)	0.0	2.677	0.687
noseR (m)	2.01	0.328	0.708
bottomR (m)	8.325	9.924	1.388
sternX (m)	8.05	6.618	0.521
sternZ (m)	8.05	*20.02	*0.635
sternR (m)	2.01	1.290	0.513
tilt (°)	0.0	*8.508	*0.908
zcg_system (m)	0.108	1.634	0.900
Dtube (m)		Not Optimized	
kPTO (N/m)		Not Optimized	
cPTO (Ns/m)		Not Optimized	

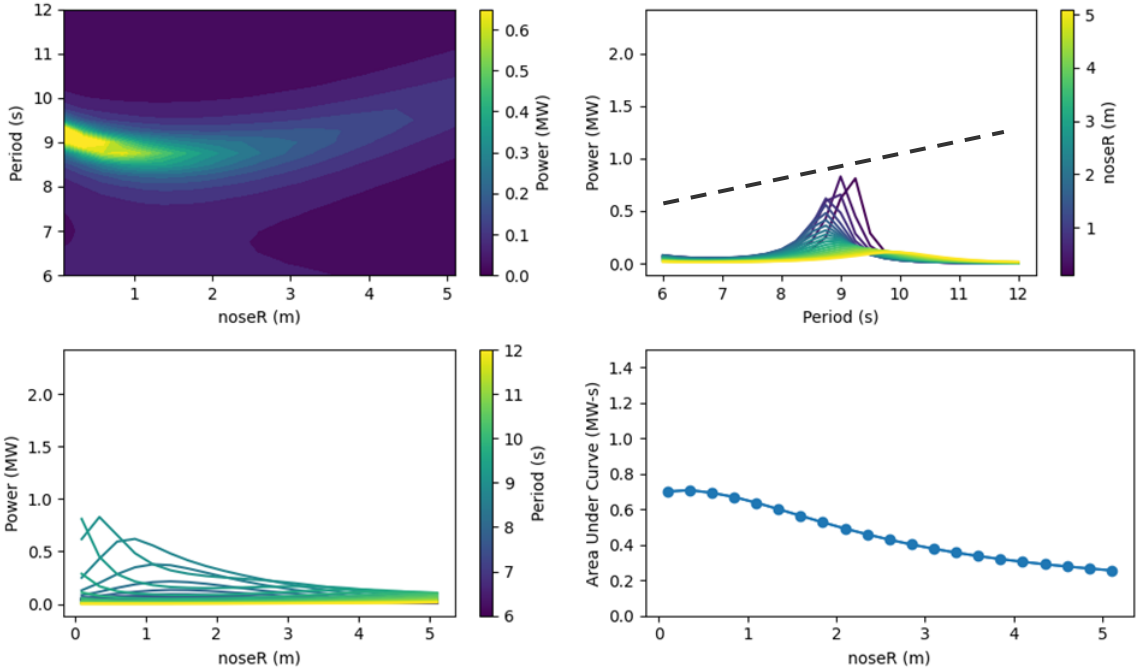
***Optimized design increases indefinitely past the bounds**

NoseR Optimization Results of the PIP

“NoseR” Optimization

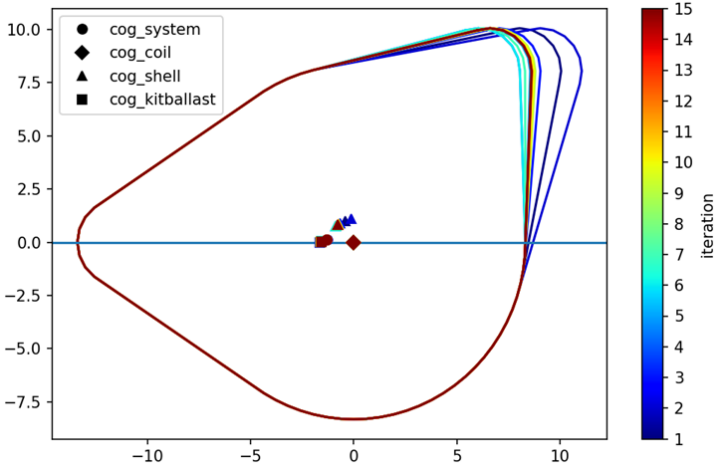


“NoseR” Parameter Sweep

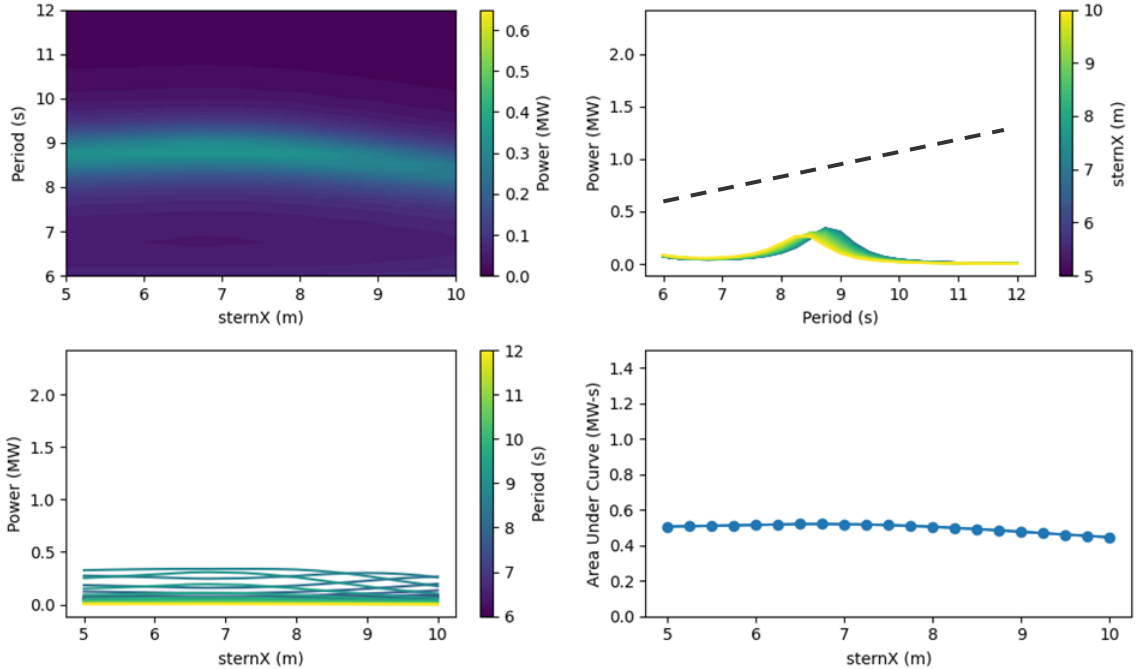


SternX Optimization Results of the PIP

“SternX” Optimization

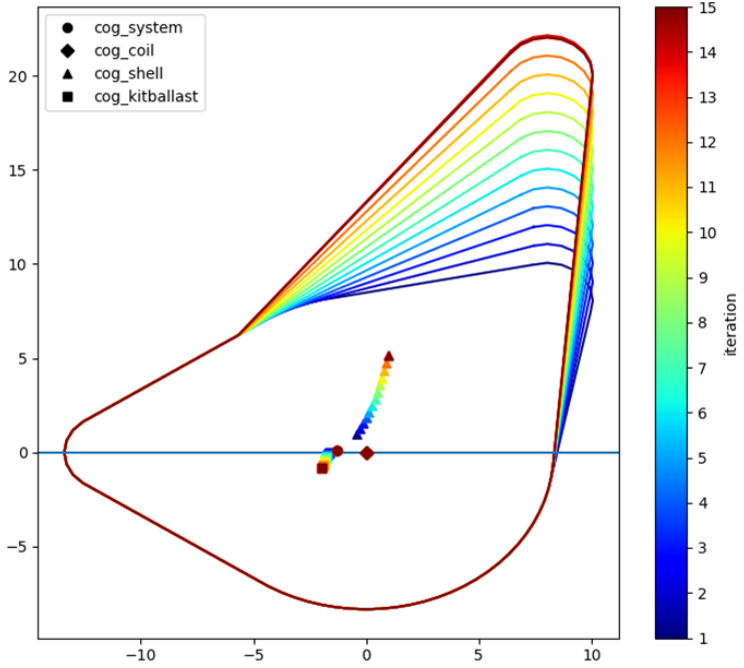


“SternX” Parameter Sweep



SternZ Optimization Results of the PIP

“SternZ” Optimization



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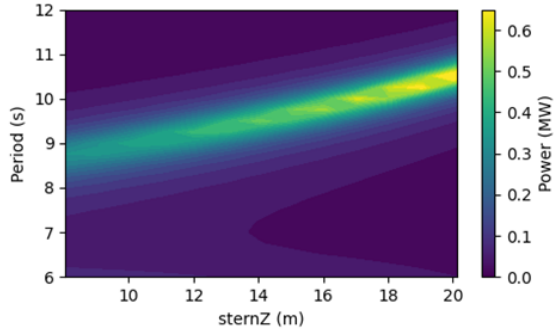
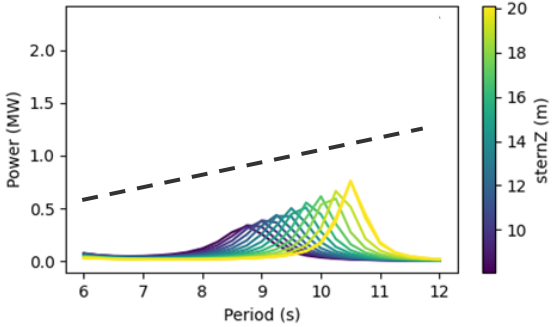
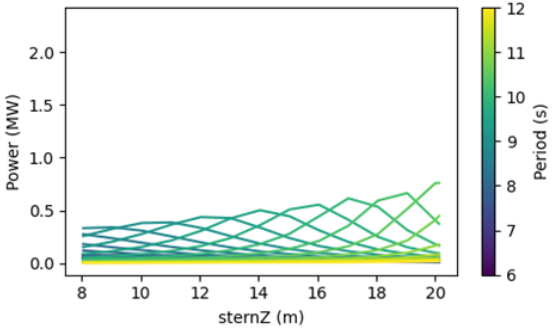
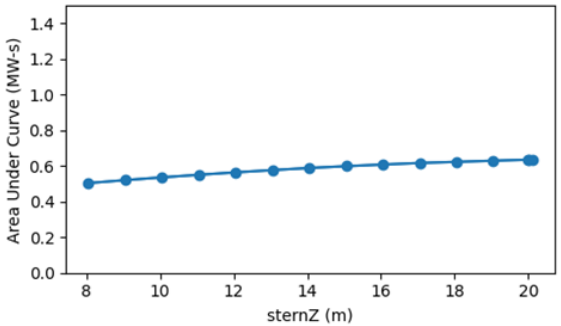


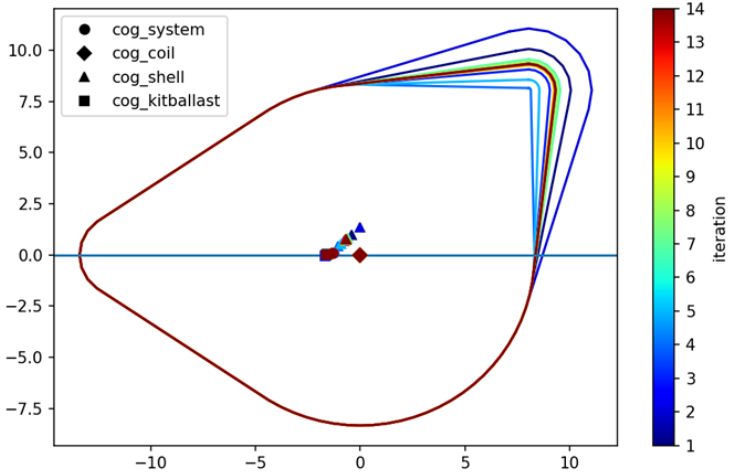




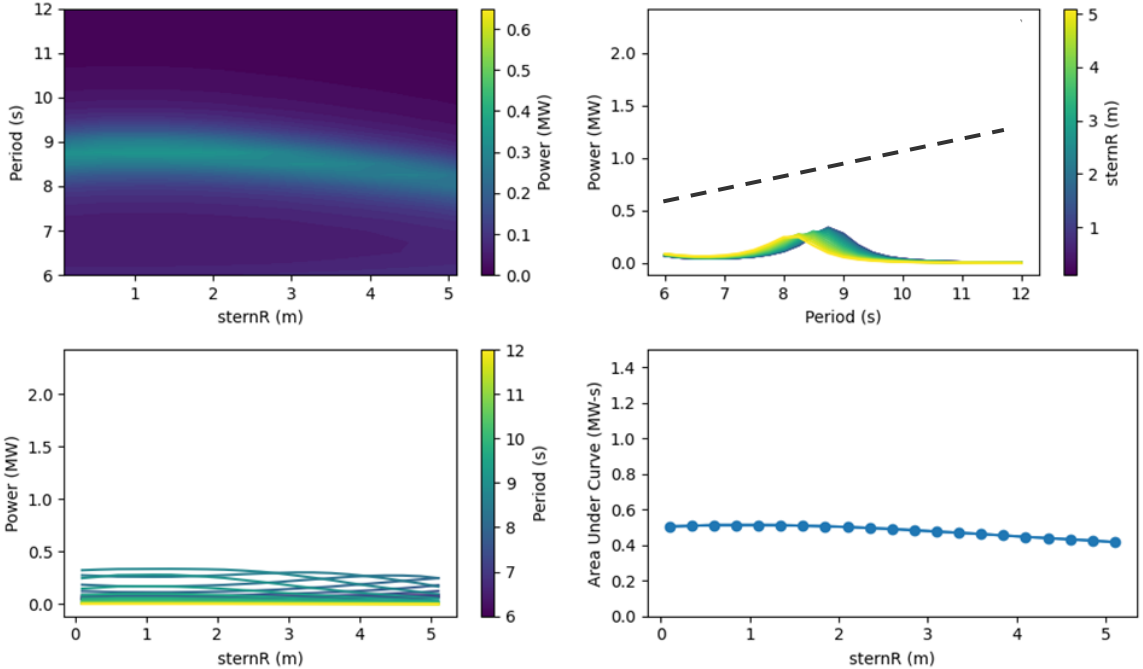


SternR Optimization Results of the PIP

“SternR” Optimization

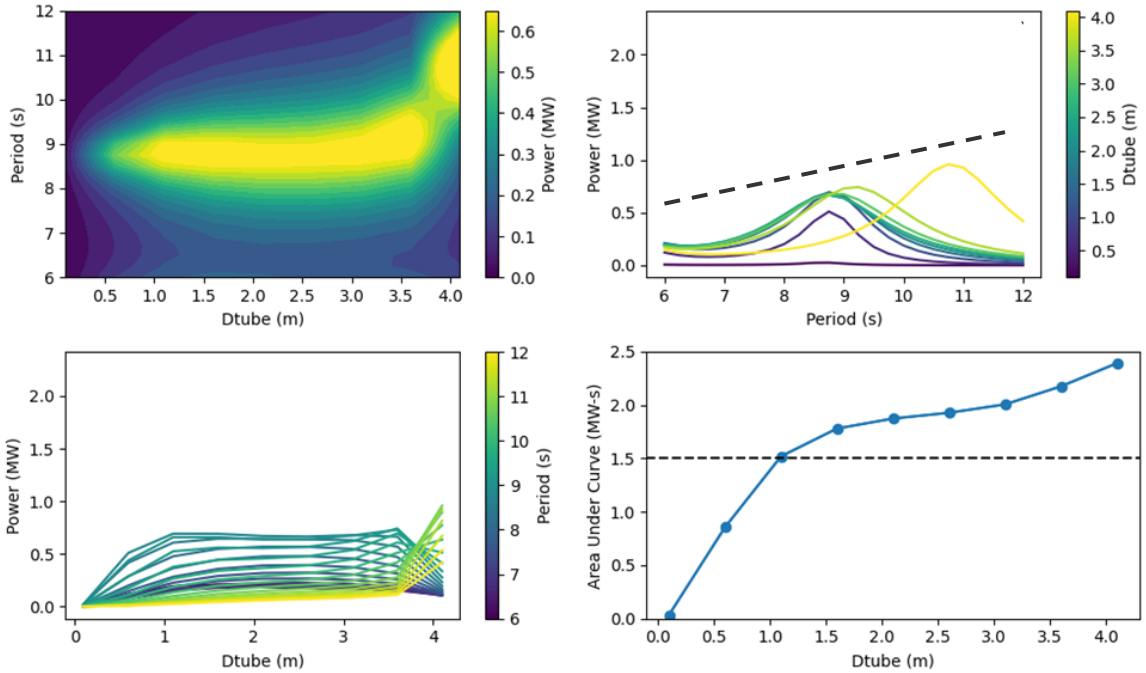


“SternR” Parameter Sweep



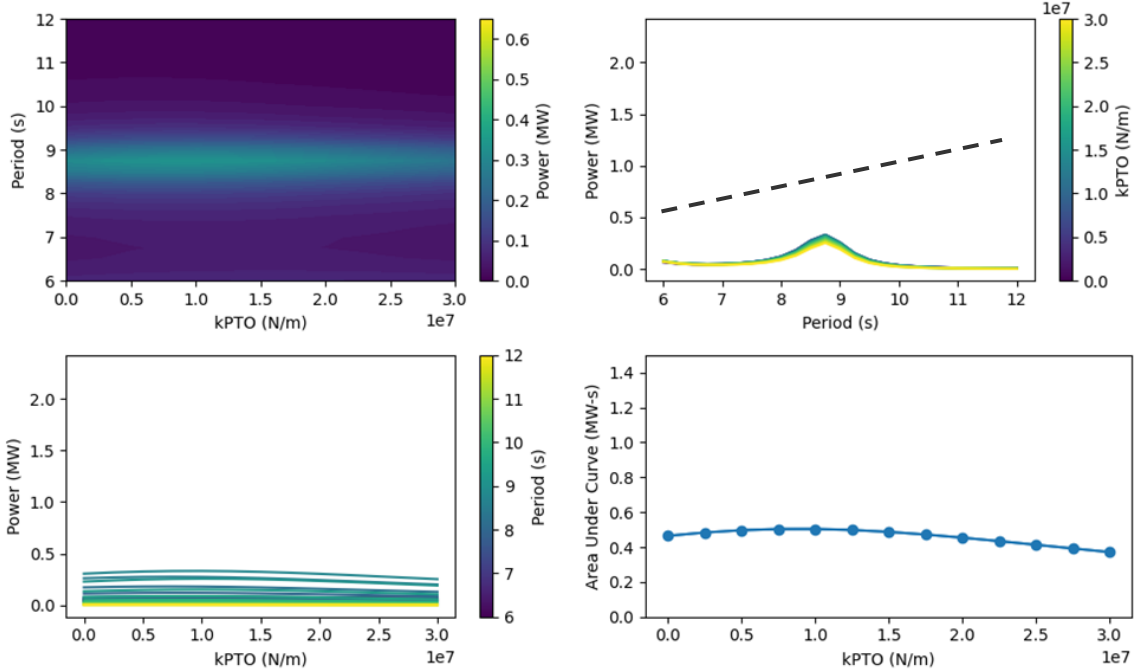
Dtube Optimization Results of the PIP

"Dtube" Parameter Sweep



kPTO Optimization Results of the PIP

“kPTO” Parameter Sweep



cPTO Optimization Results of the PIP

“cPTO” Parameter Sweep