

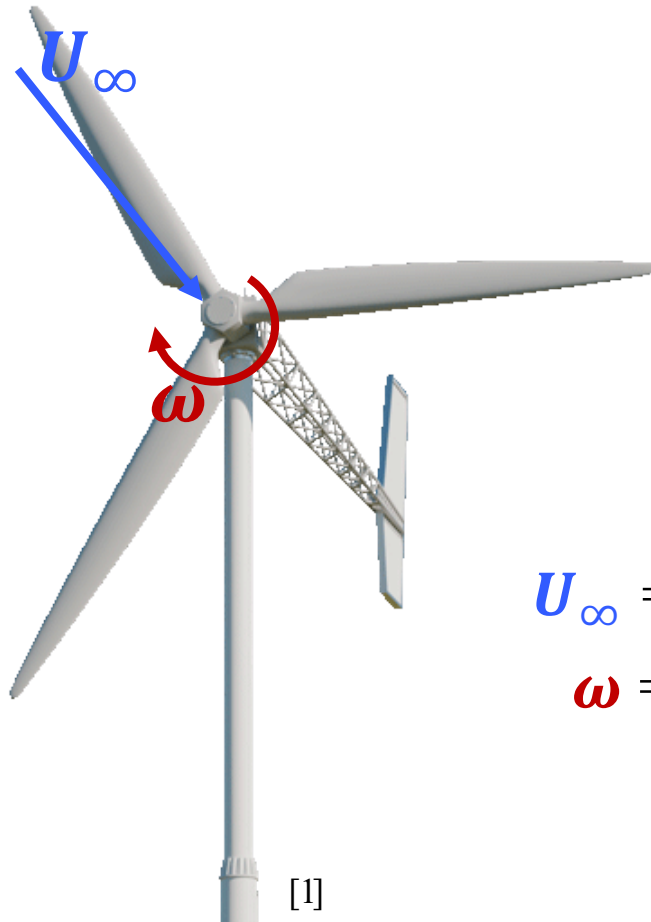
Effects of inclined flow on cross flow turbine performance -

Jayden Wood, Gemma Calandra, Aidan
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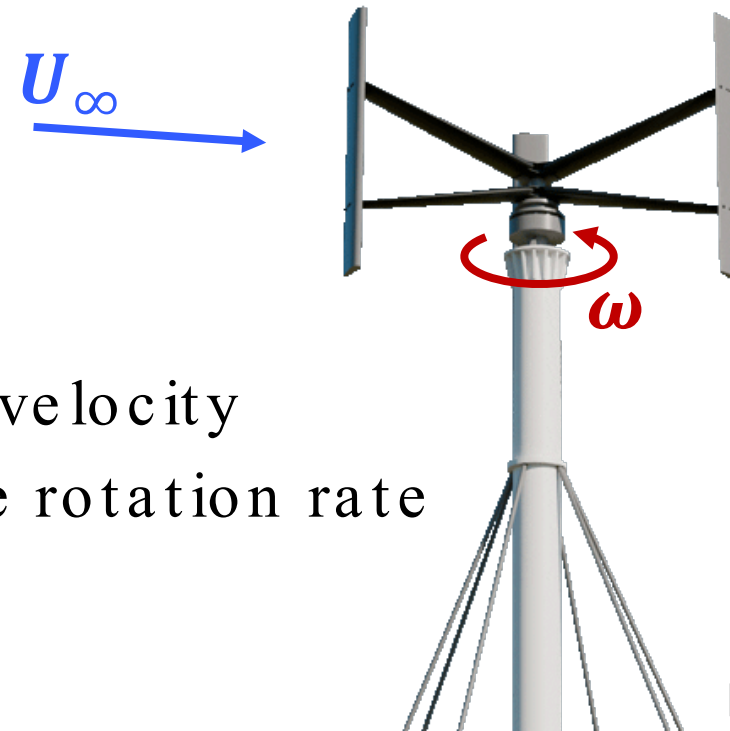
Motivation

Axial -Flow Turbine



[1]

Cross -Flow Turbine



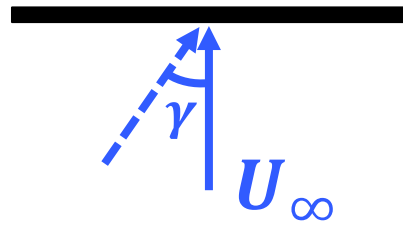
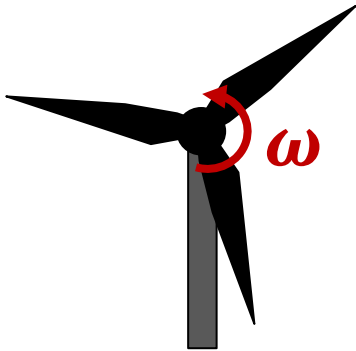
[1]

U_{∞} = in flow velocity

ω = turbine rotation rate

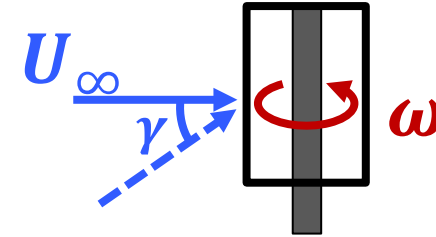
Inclined Flow

Axial -Flow Turbine



γ = incline angle

Cross -Flow Turbine



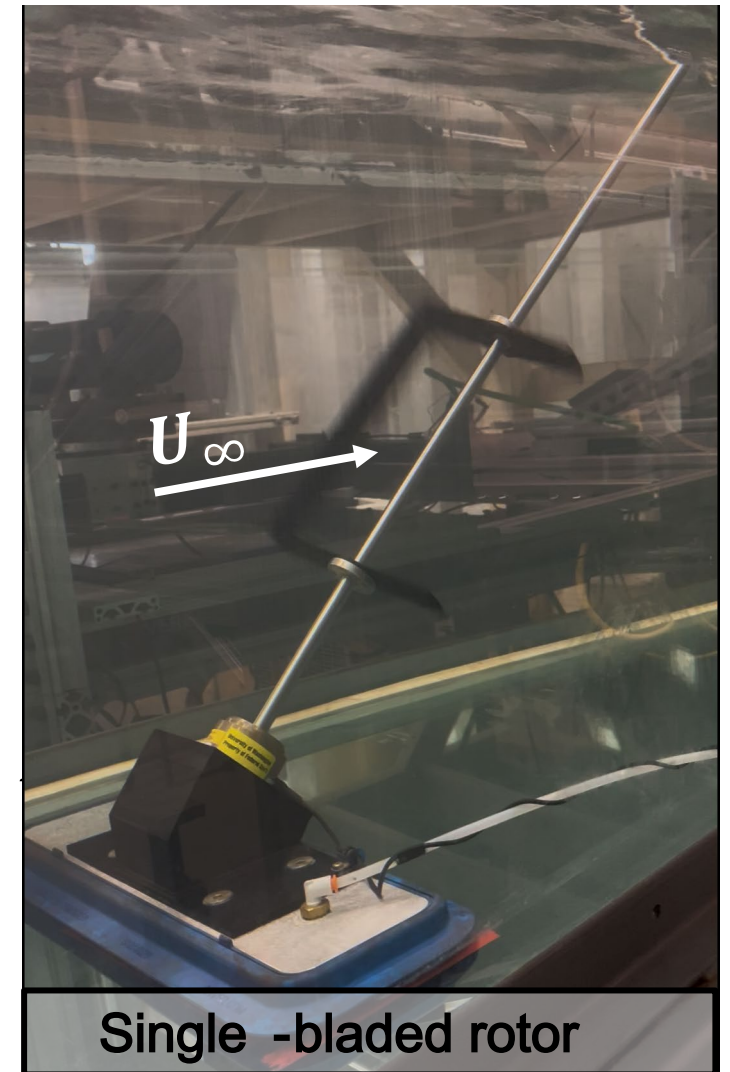
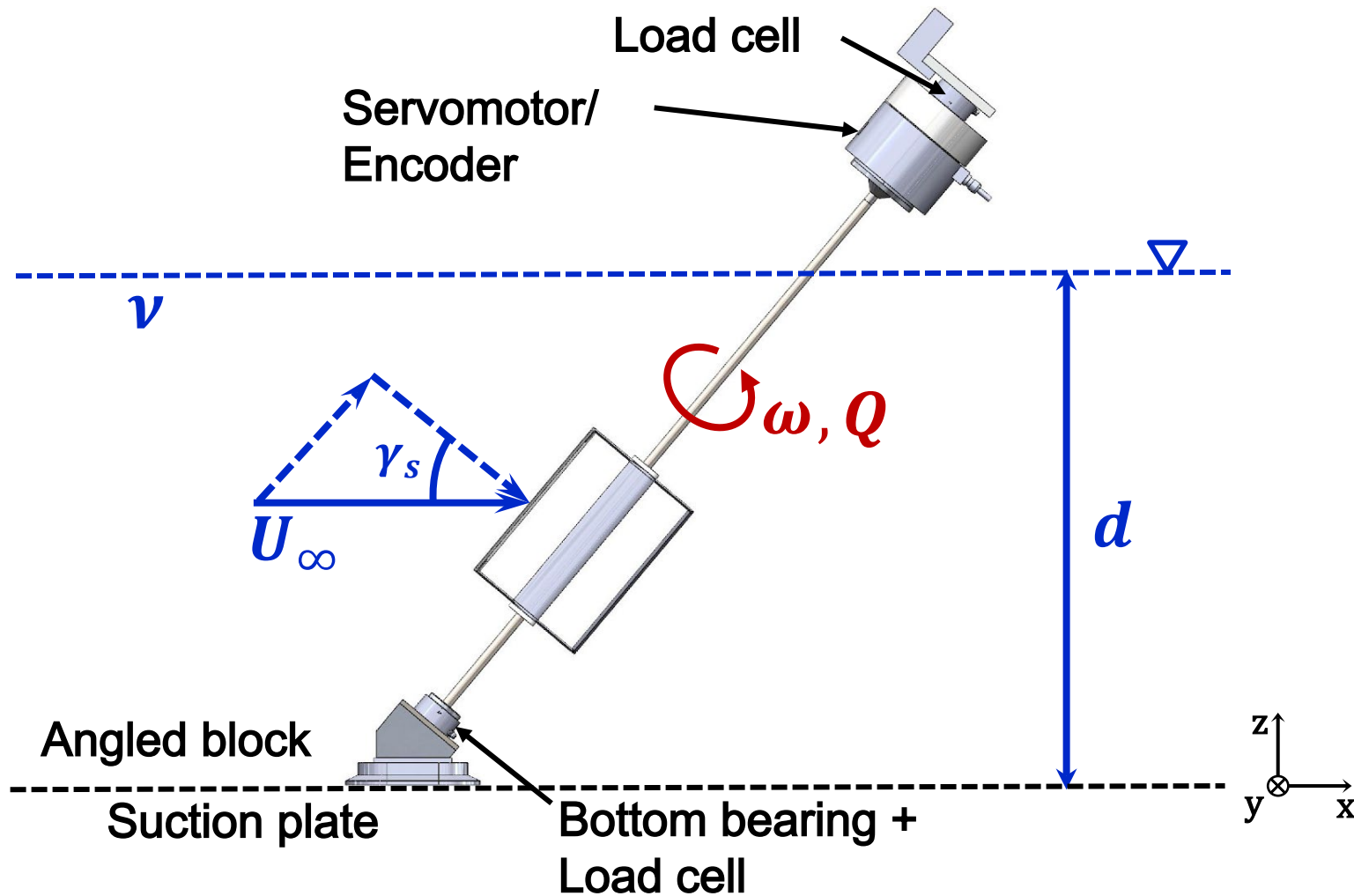
- Uneven seabed mounting
- Tilted mooring
- Local bathymetry

Project Goal

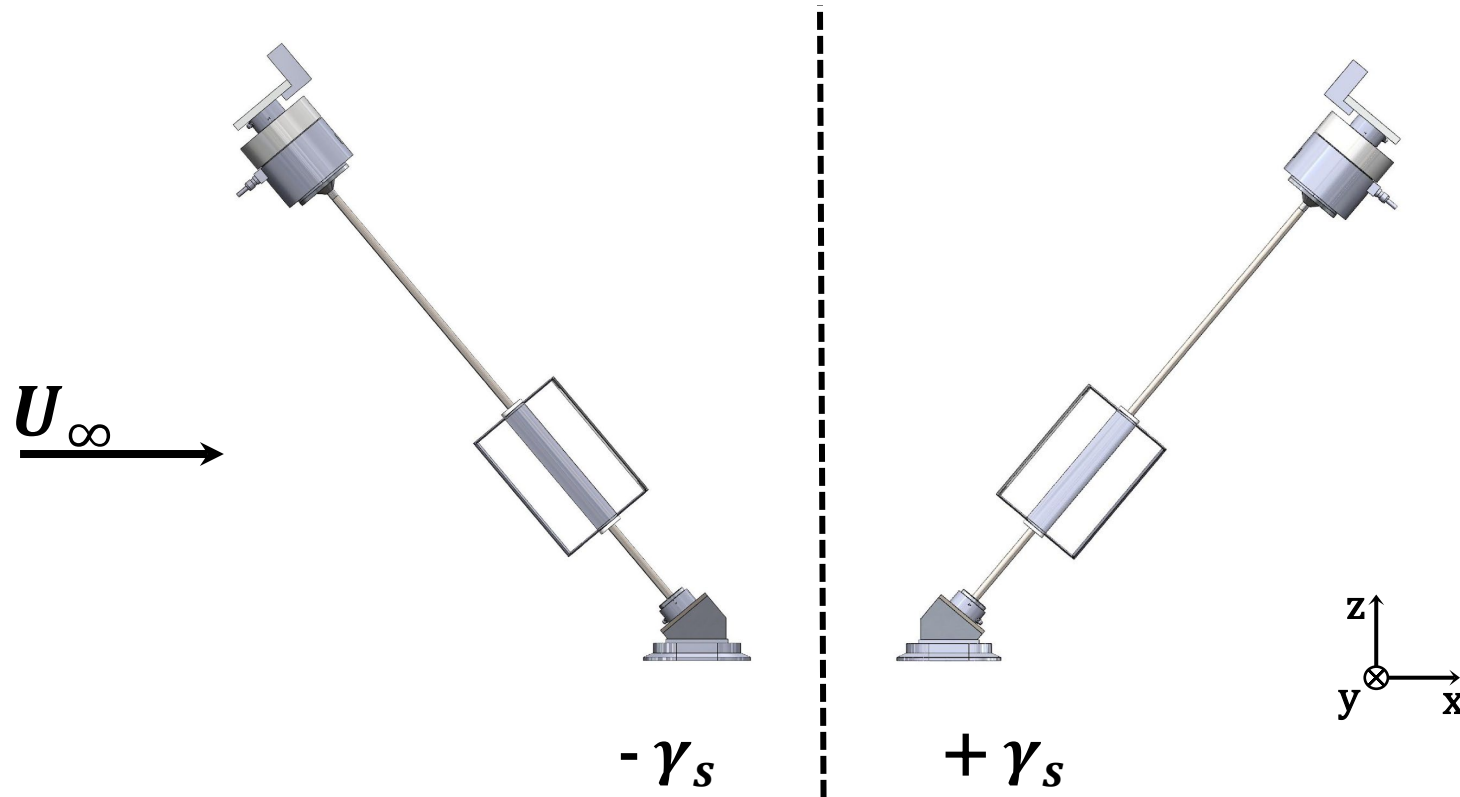
- Develop a holistic understanding of performance effects from turbine inclination through the experimental characterization of a lab-scale CFT
- Limited range of:
 - Incline angles, γ
 - Operating conditions (i.e., tip-speed ratio)
- Variations in rotor geometries

**This presentation:
Initial results on power production**

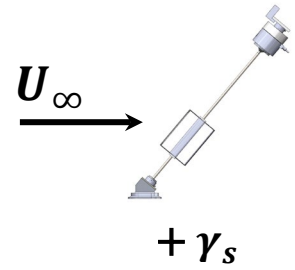
Experimental Setup



Experimental Setup



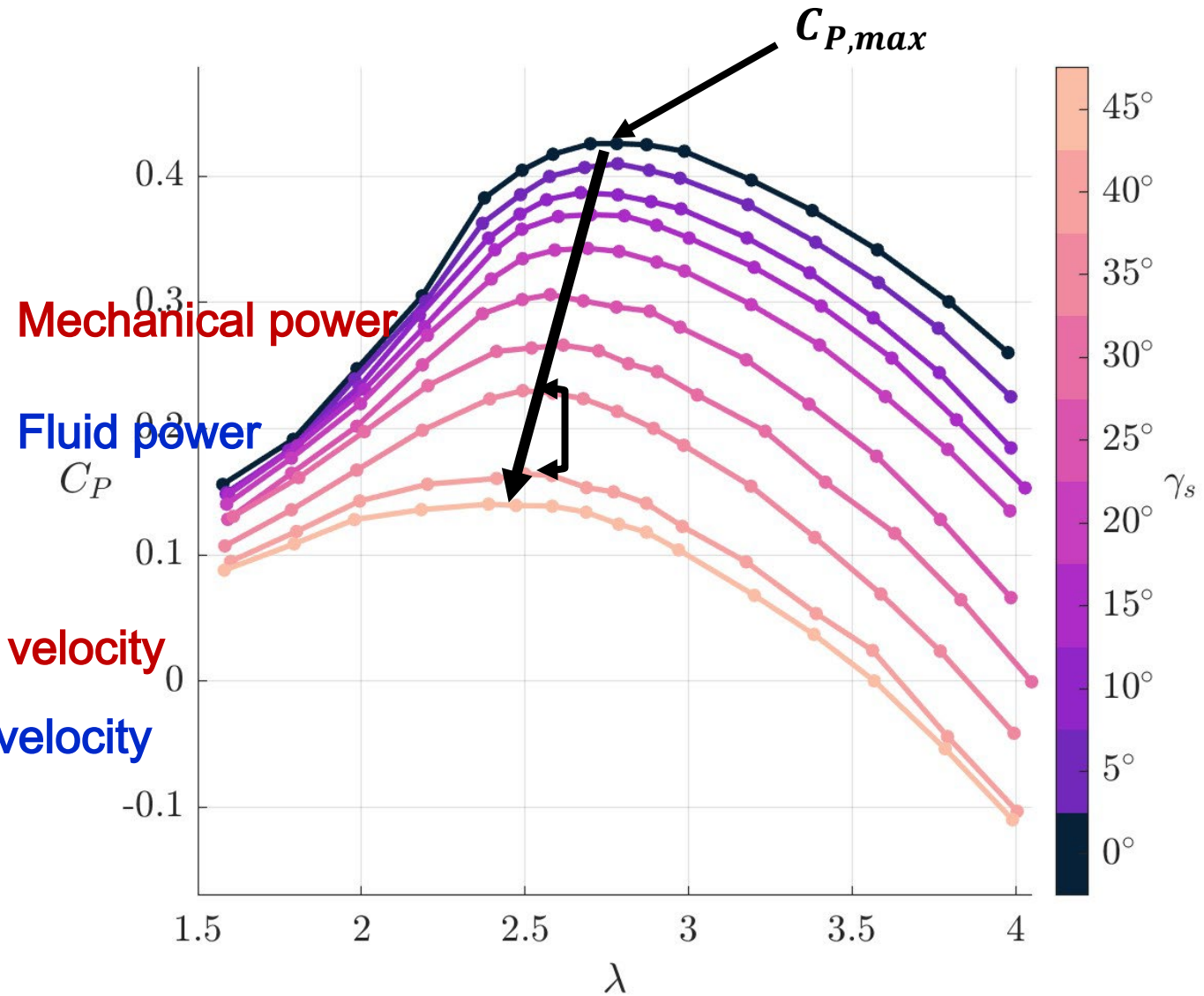
Assessing Performance



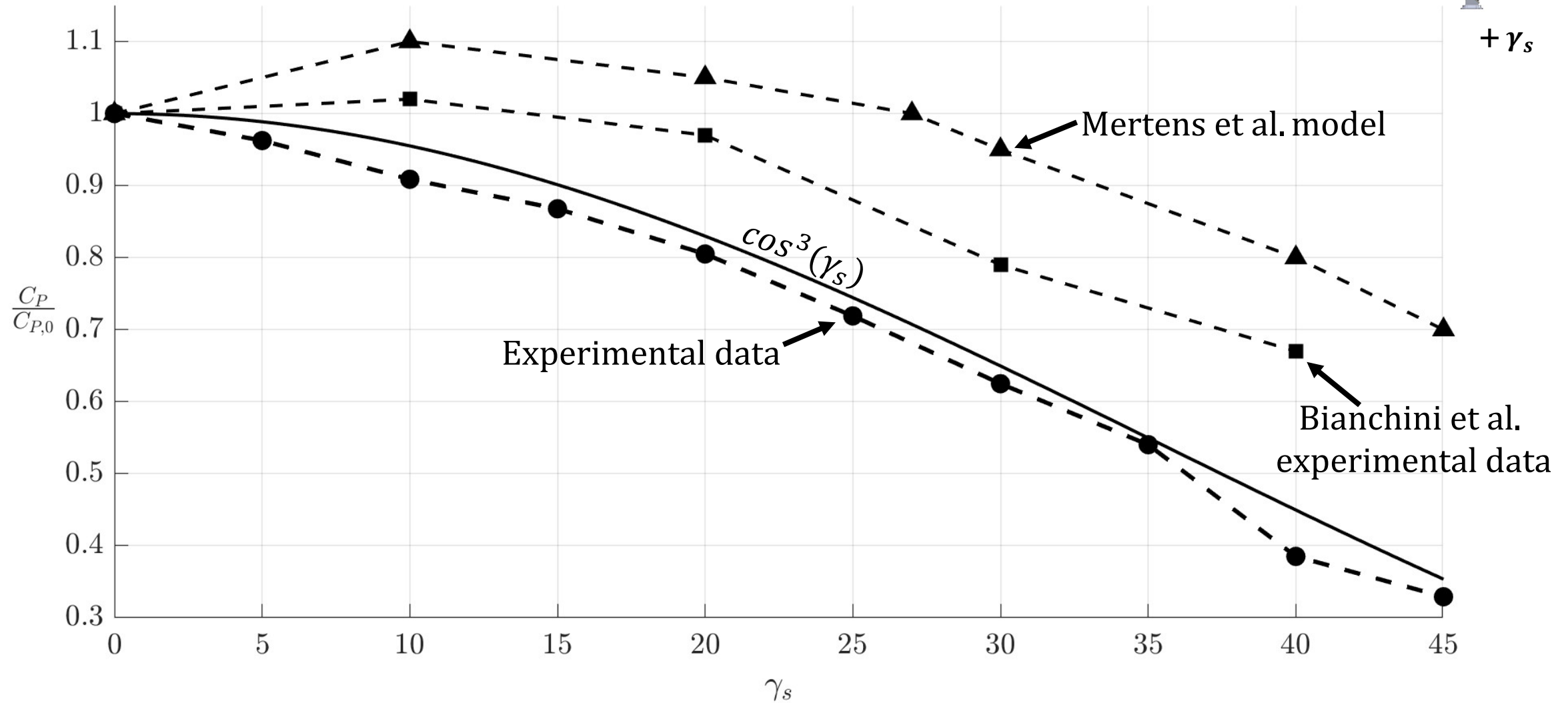
$$C_P = \frac{Q\omega}{\frac{1}{2}\rho AU_\infty^3}$$

$$\lambda = \frac{R\omega}{U_\infty}$$

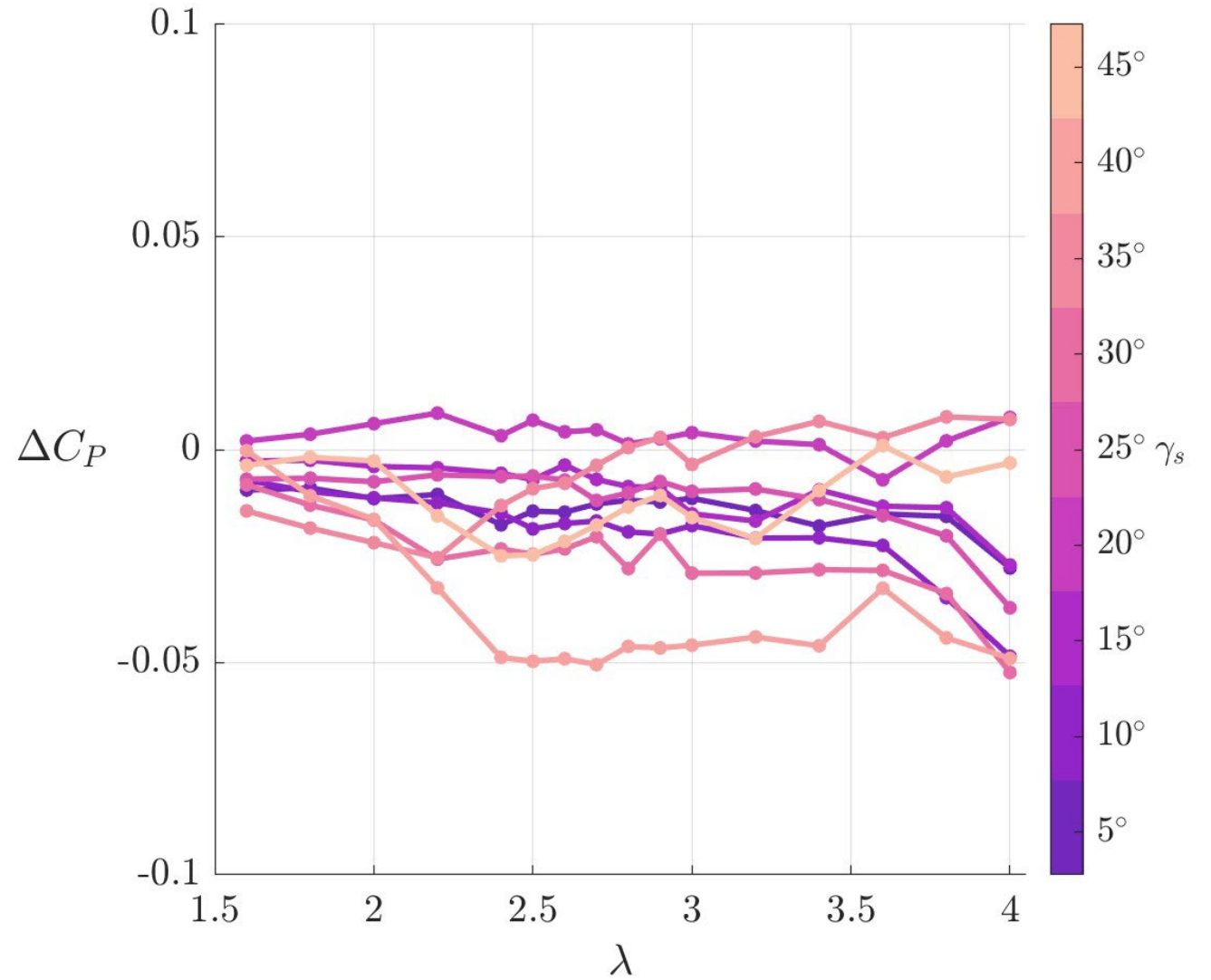
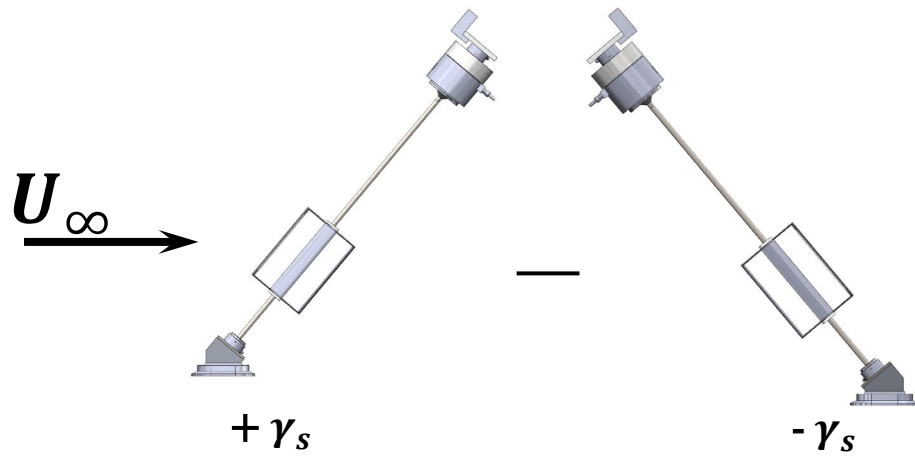
Rotor velocity
Fluid velocity



Assessing Performance



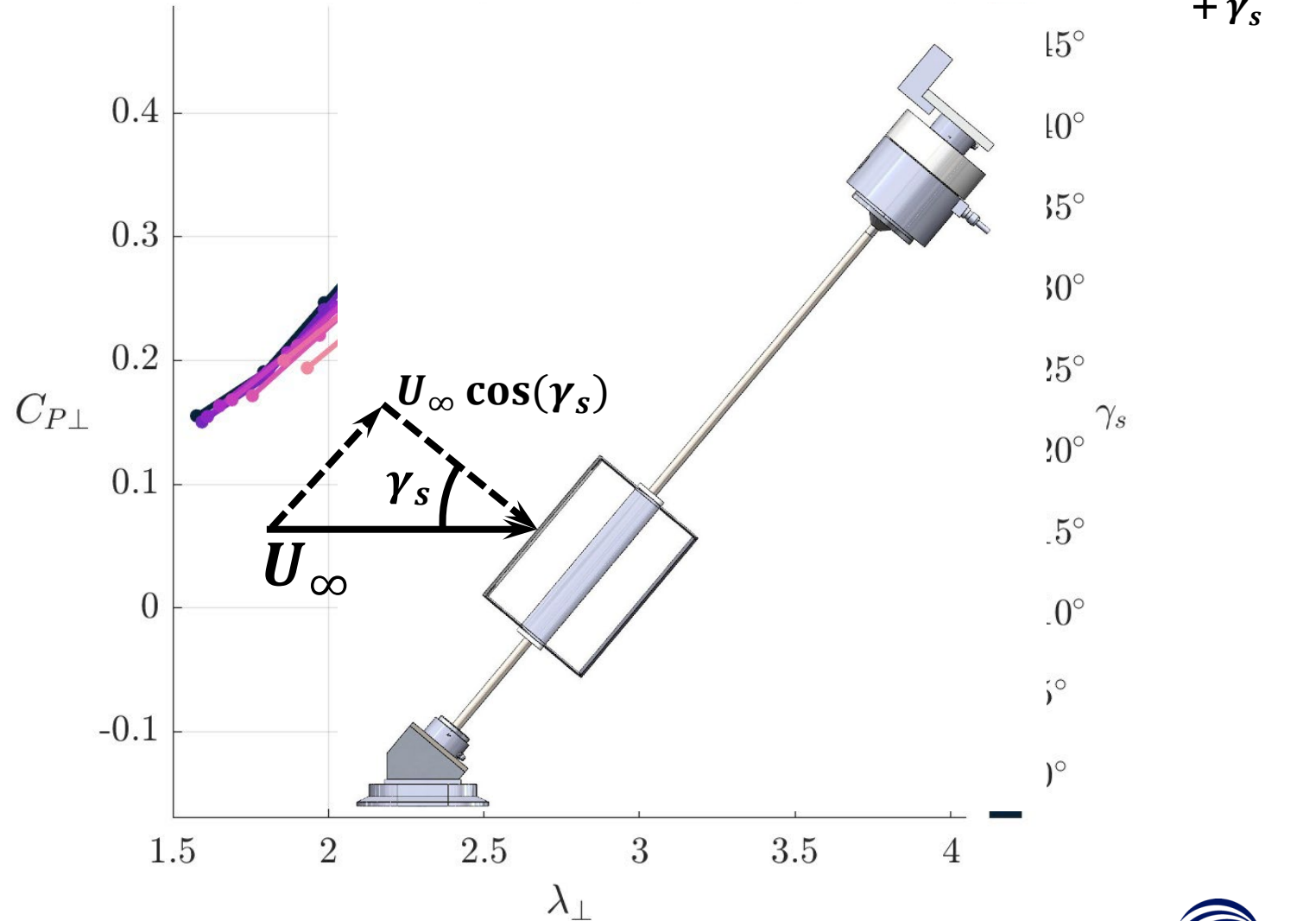
Assessing Performance



Assessing Performance

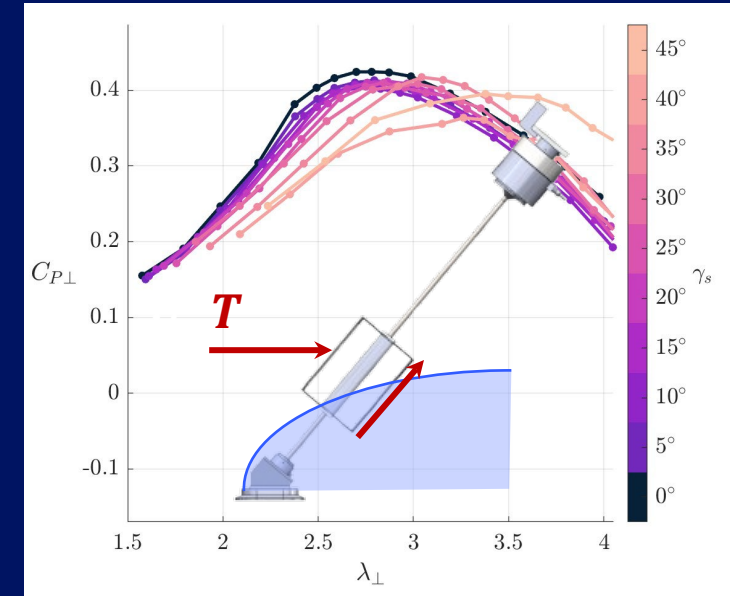
$$C_{P\perp} = \frac{Q\omega}{\frac{1}{2}\rho A (U_\infty \cos(\gamma_s))^3}$$

$$\lambda_\perp = \frac{R\omega}{U_\infty \cos(\gamma_s)}$$



Conclusions

- Performance decreases with γ
- At large incline angles
 - Experimental artifact
 - Increase distance b/w block & turbine
- Characterization of structural forces (e.g., thrust force)



References

- [1] “Maximize Efficiency with Small Wind Energy Solutions.” *Freen*, 23 Apr. 2025, freen.com/.
- [2] Mertens, Sander, Gijs Kuik, et al. “Performance of a High Tip Speed Ratio H-Darrieus in the Skewed Flow on a Roof.” *41st Aerospace Sciences Meeting and Exhibit*, American Institute of Aeronautics and Astronautics, 2003, <https://doi.org/10.2514/6.2003-523>.
- [3] A. Bianchini, G. Ferrara, L. Ferrari, and S. Magnani, “An improved model for the performance estimation of an h-darrieus wind turbine in skewed flow,” *Wind Engineering*, vol. 36, pp. 667–686, 2012, <https://doi.org/10.1260/0309-524X.36.6.667>.

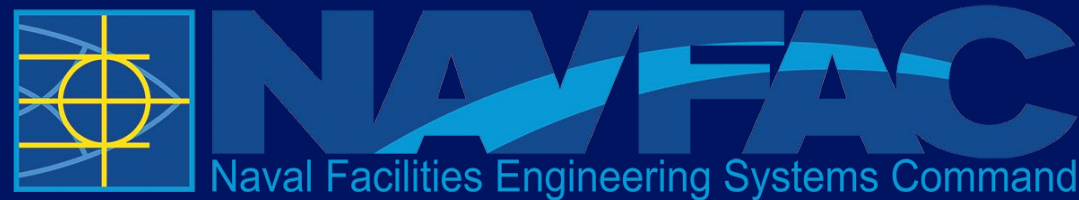
Acknowledgements

Advisor: Dr. Brian Polagye

Collaborators

MREL colleagues

Funding:



An underwater scene with a deep blue background. In the upper left, a fish is visible near the surface where light rays and bubbles are present. The rest of the frame is filled with numerous small, bright blue bubbles rising towards the top right.

Questions

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