

# **Twisted Savonius Turbine Based Marine Current Energy Conversion System**

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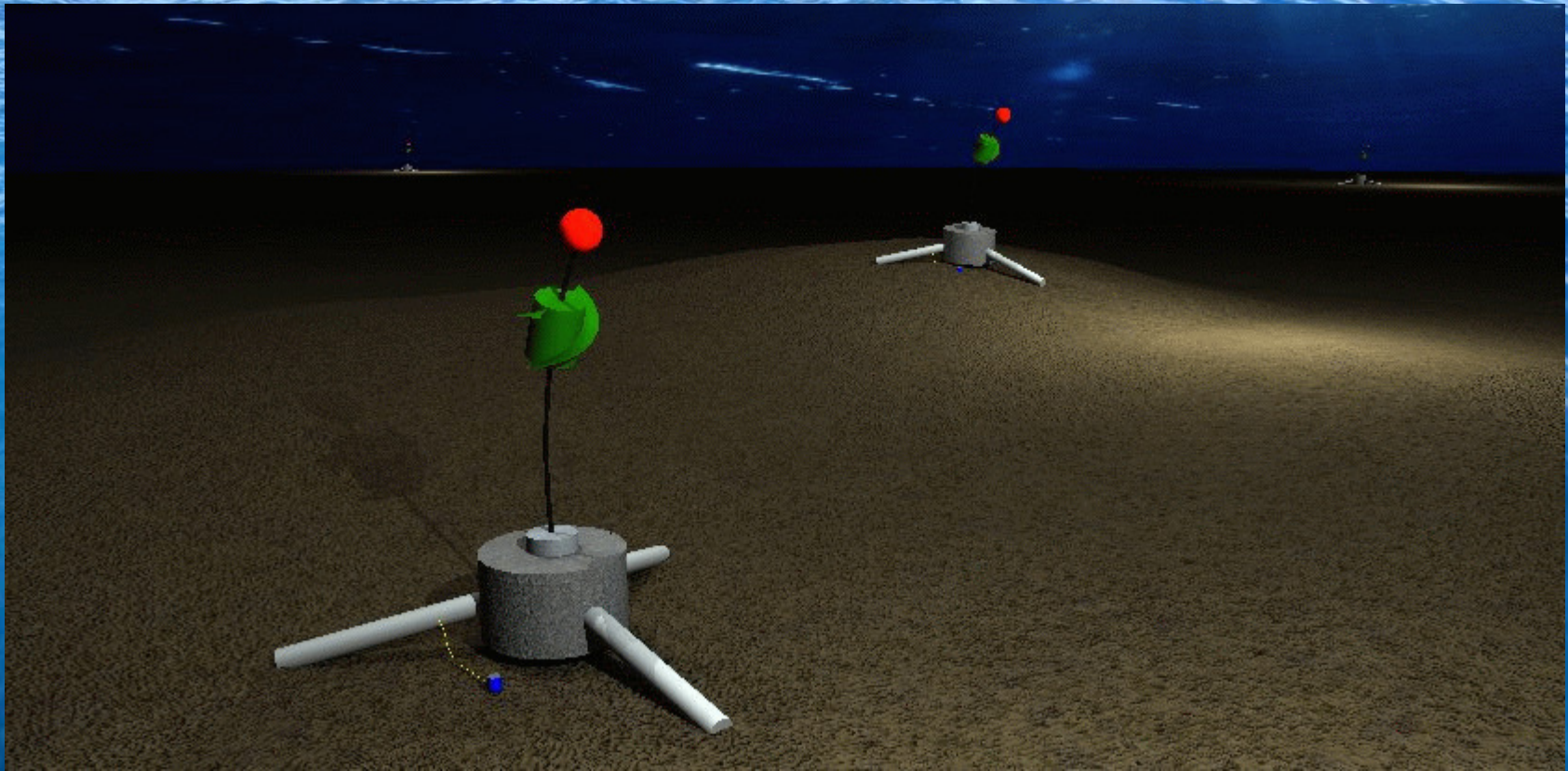
# Presentation Outline

- Introduction
- Background
- Experiments on the Turbine
- Simulations of the Turbine
- Control System
- Conclusion

# Thesis Objective

- Design and development of an efficient drag type turbine
- Implementation of an efficient converter along with control algorithm
- Proposal of an efficient marine current energy conversion device

# Introduction



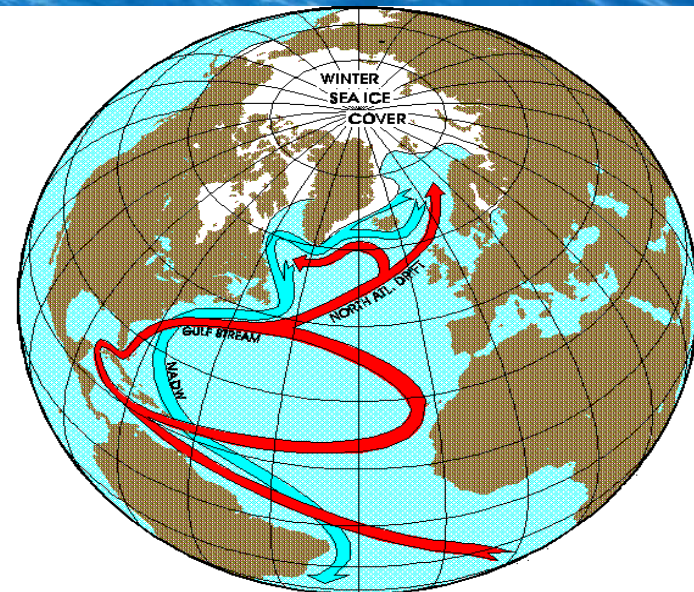
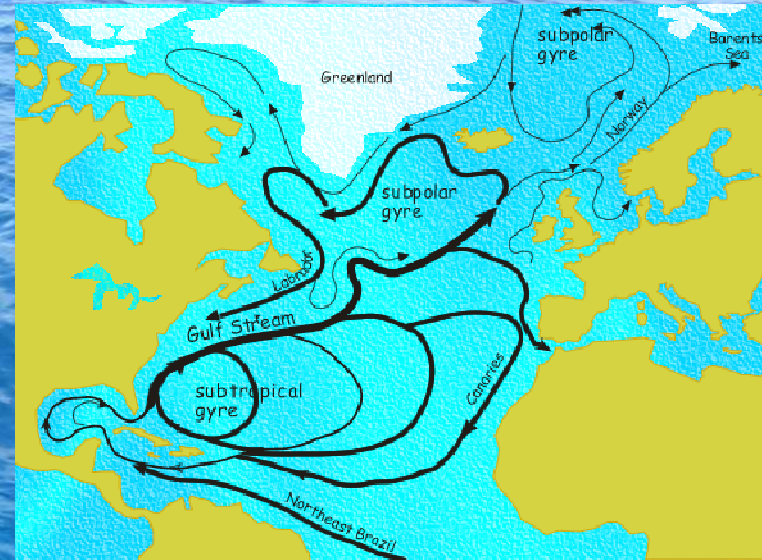
# Marine Currents

- Surface Currents

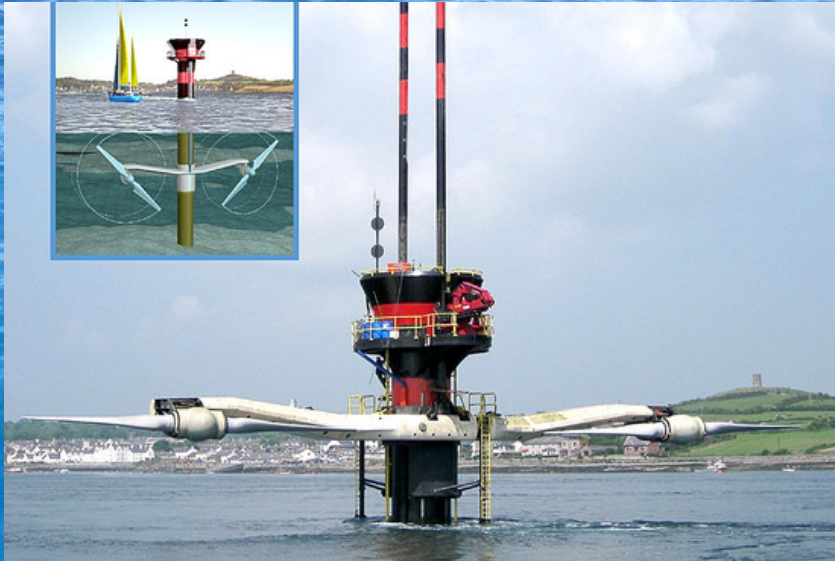
- Wind
- Coriolis Force

- Deep Water Currents

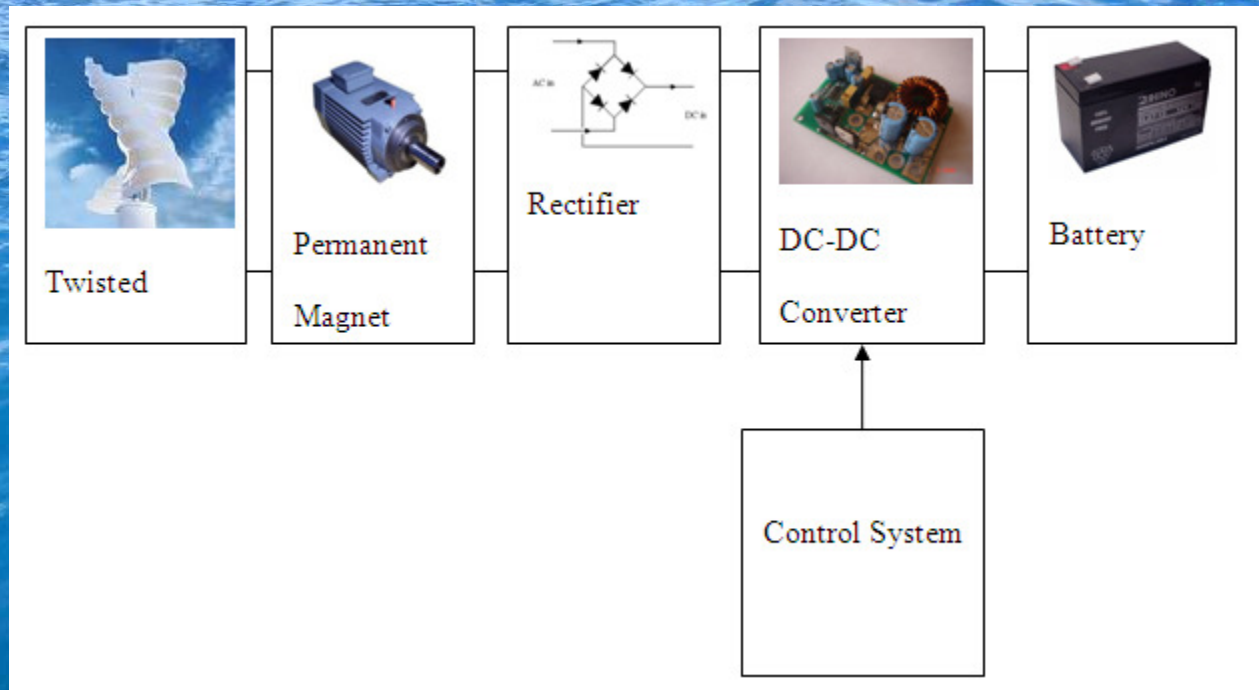
- Temperature
- Salinity



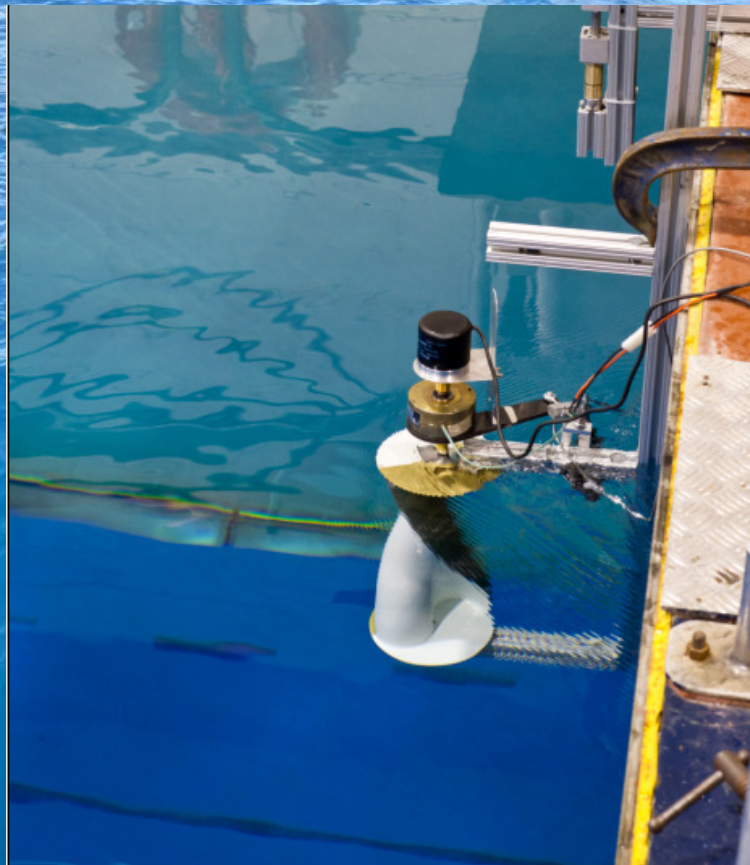
# Commercial Marine Current Turbines



# Proposed System



# Instrumentation of Twisted Savonius Turbine





# Twisted Savonius testing at Flume Tank



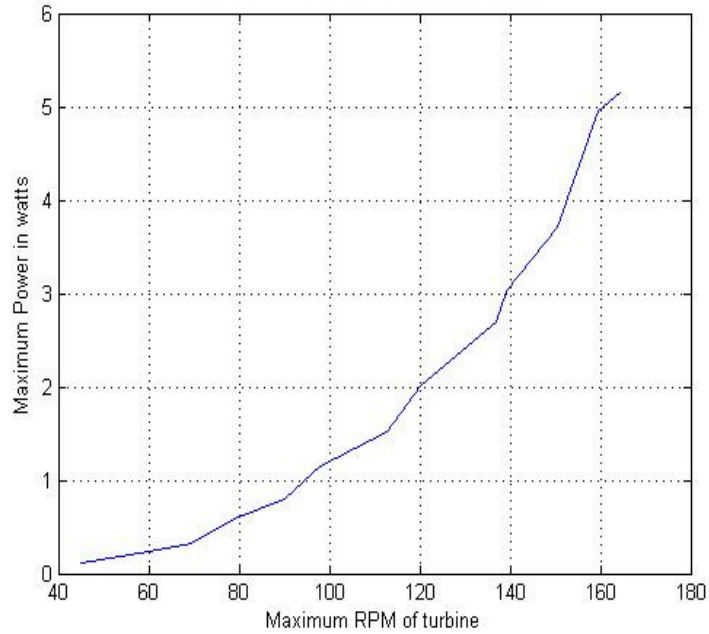
## SEAformatics Turbine Testing



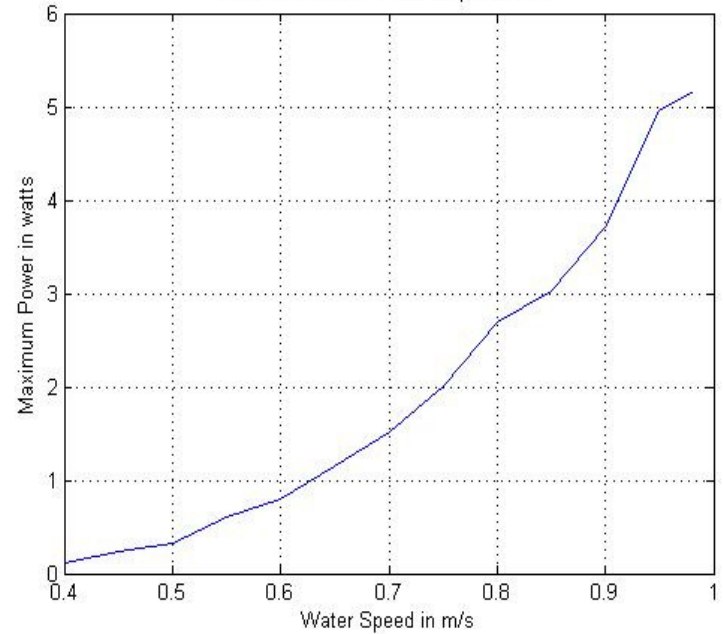
Centre for Sustainable Aquatic Resources  
Flume Tank Evaluations  
March 24, 2011

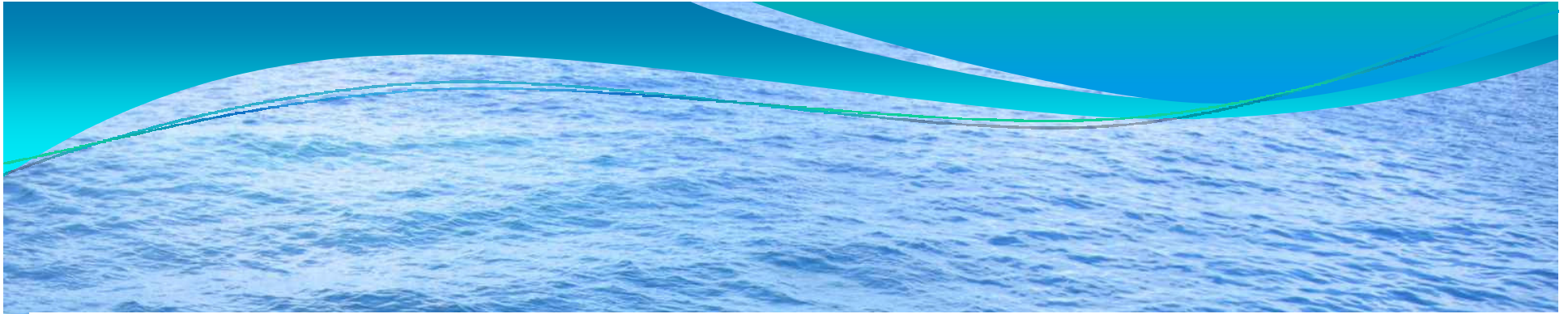
# Test results a Flume Tank

Maximum RPM vs Maximum Power curve

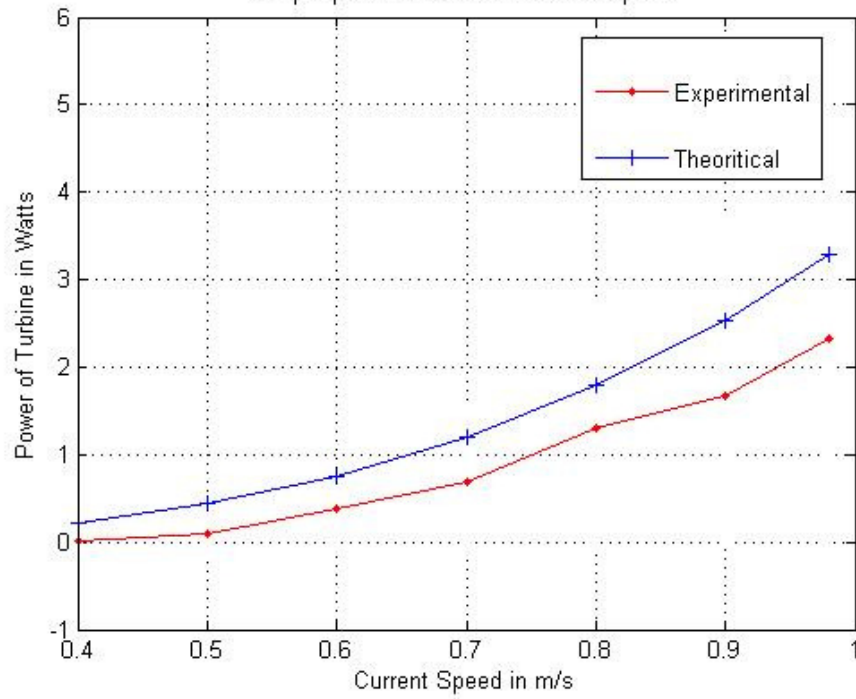


Maximum Power vs water speed curve

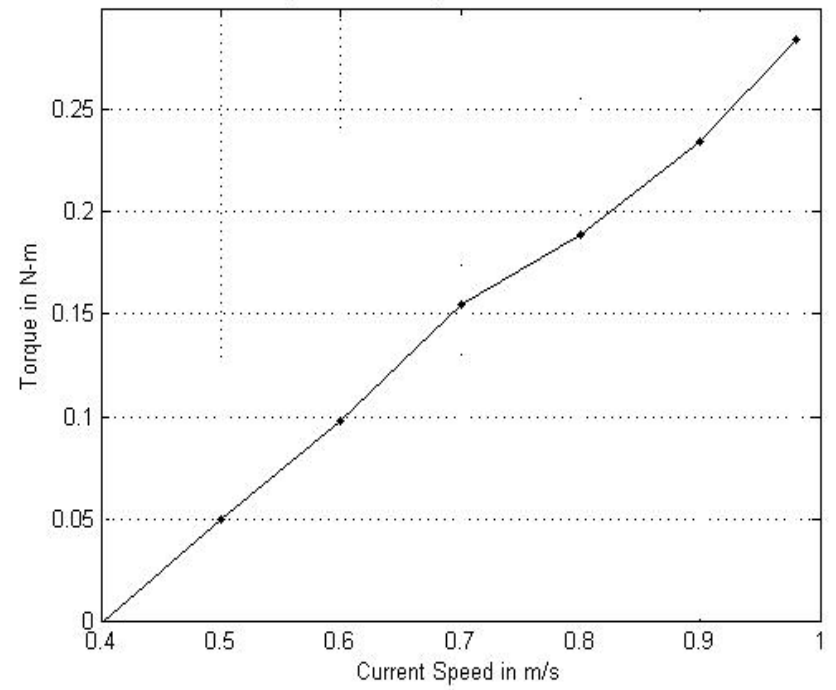


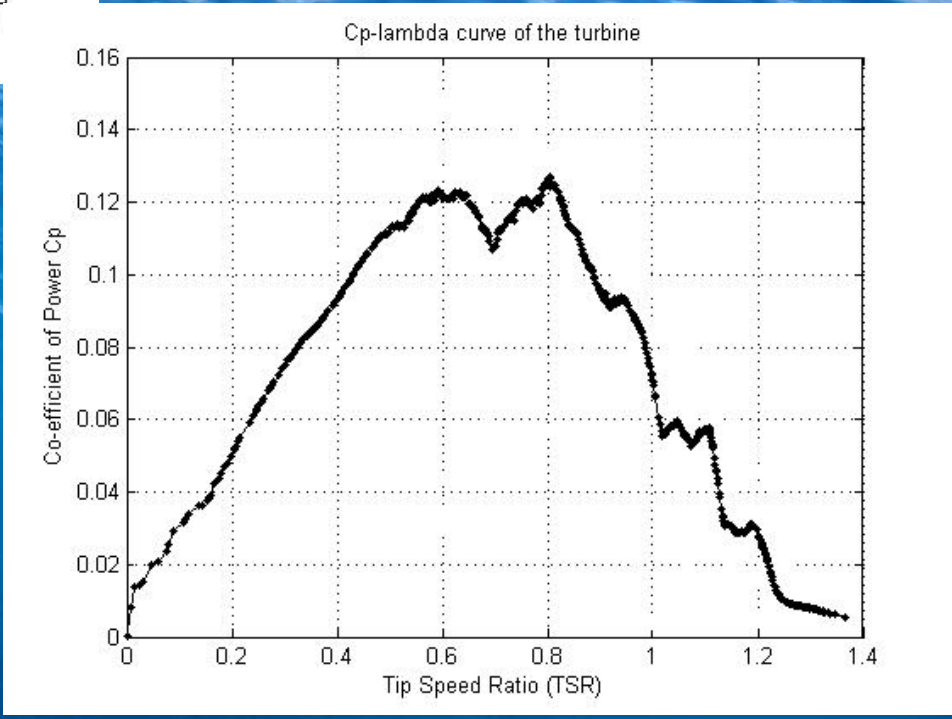
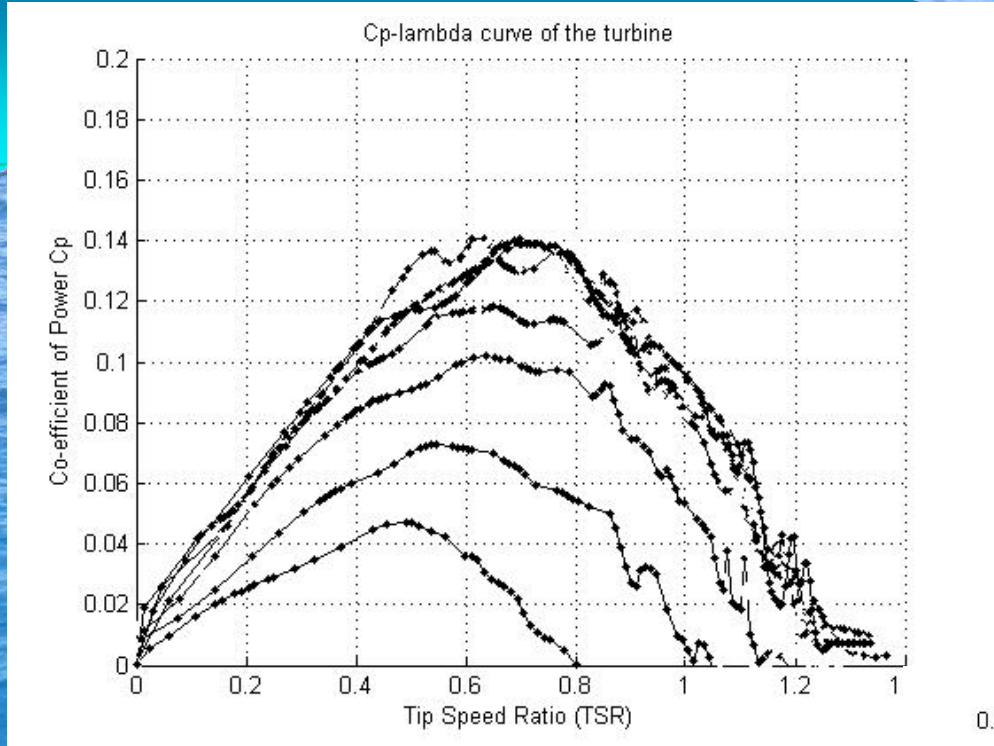


Output power of turbine vs current speed



Torque vs Current Speed curve of the turbine

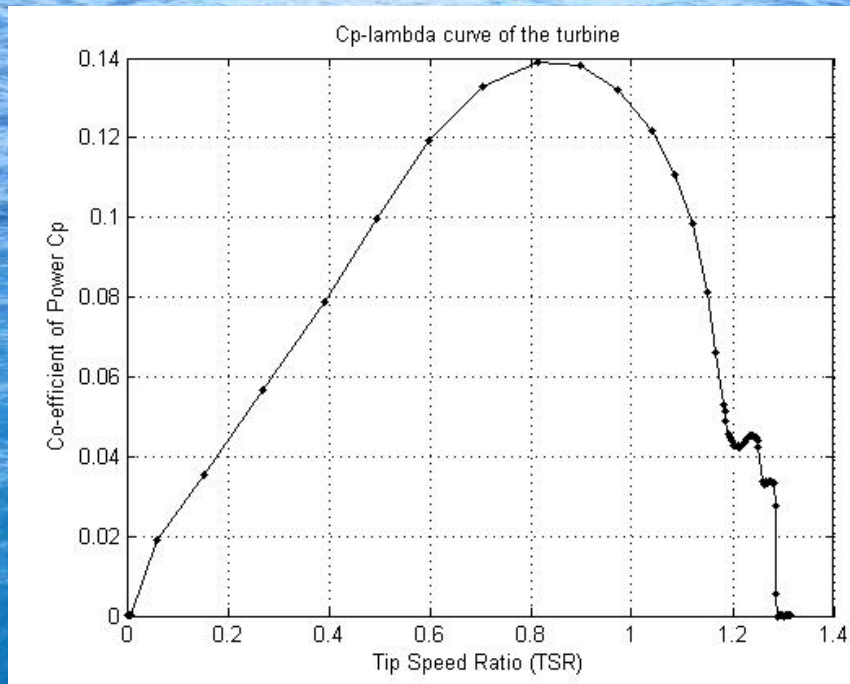




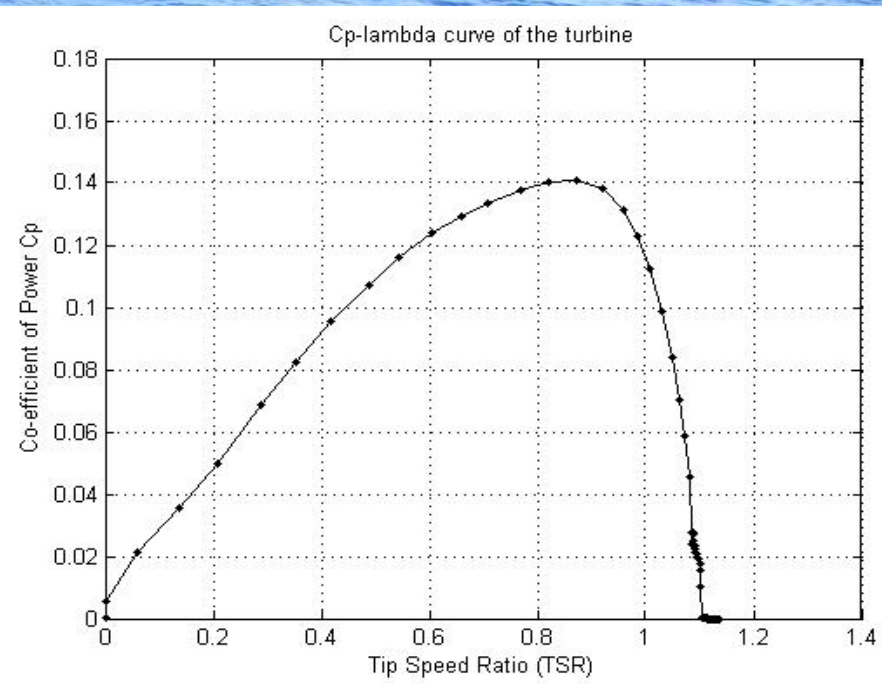
# At Wind Tunnel



# Wind Tunnel Results



10 m/s wind speed



13 m/s wind speed

# Computational Fluid Dynamics Flow-3D

**FLOW** Science

1980 - 2010

*Improving the world through accurate flow modeling*



**FLOW-3D**

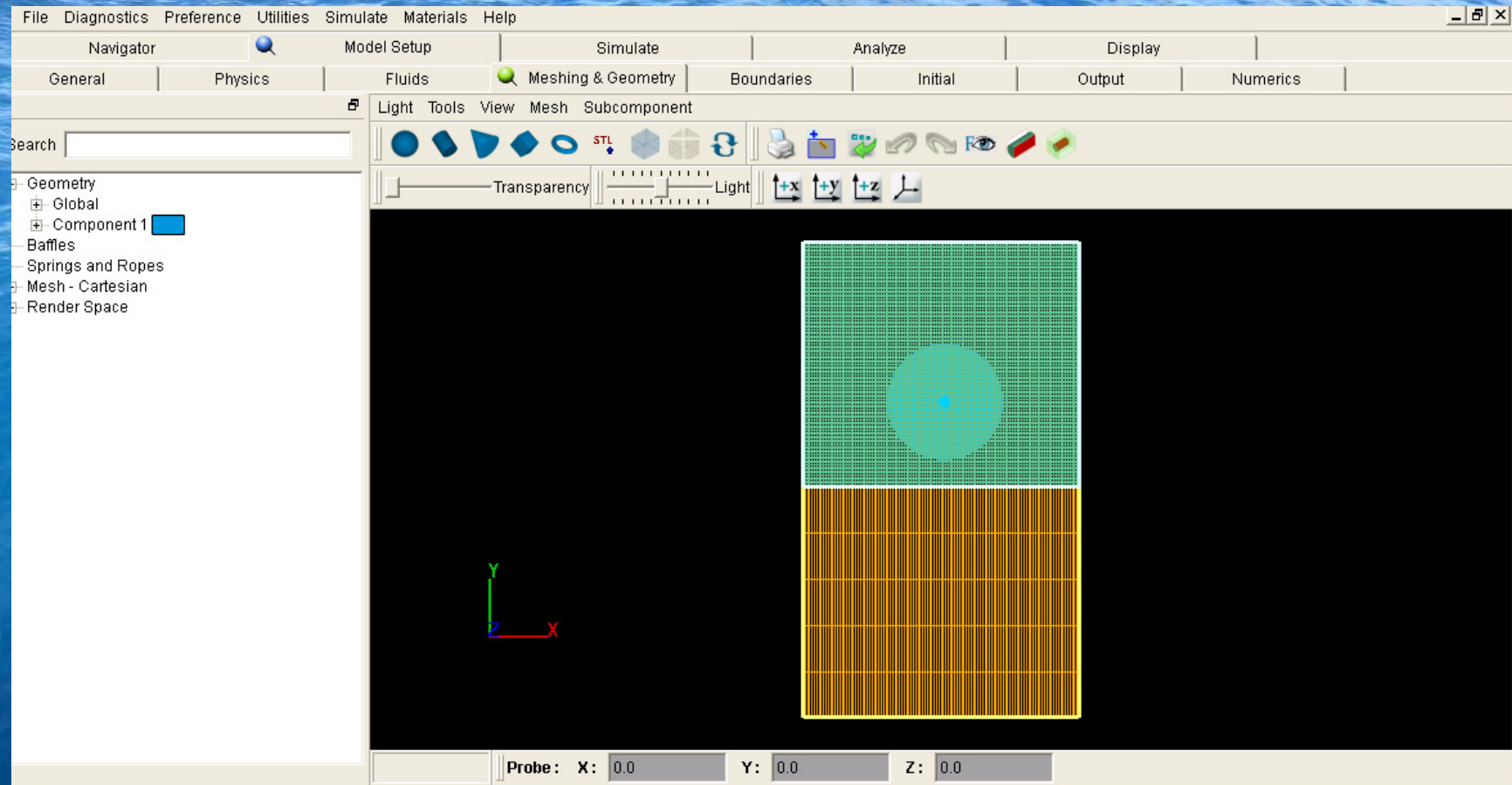
# Model Setup

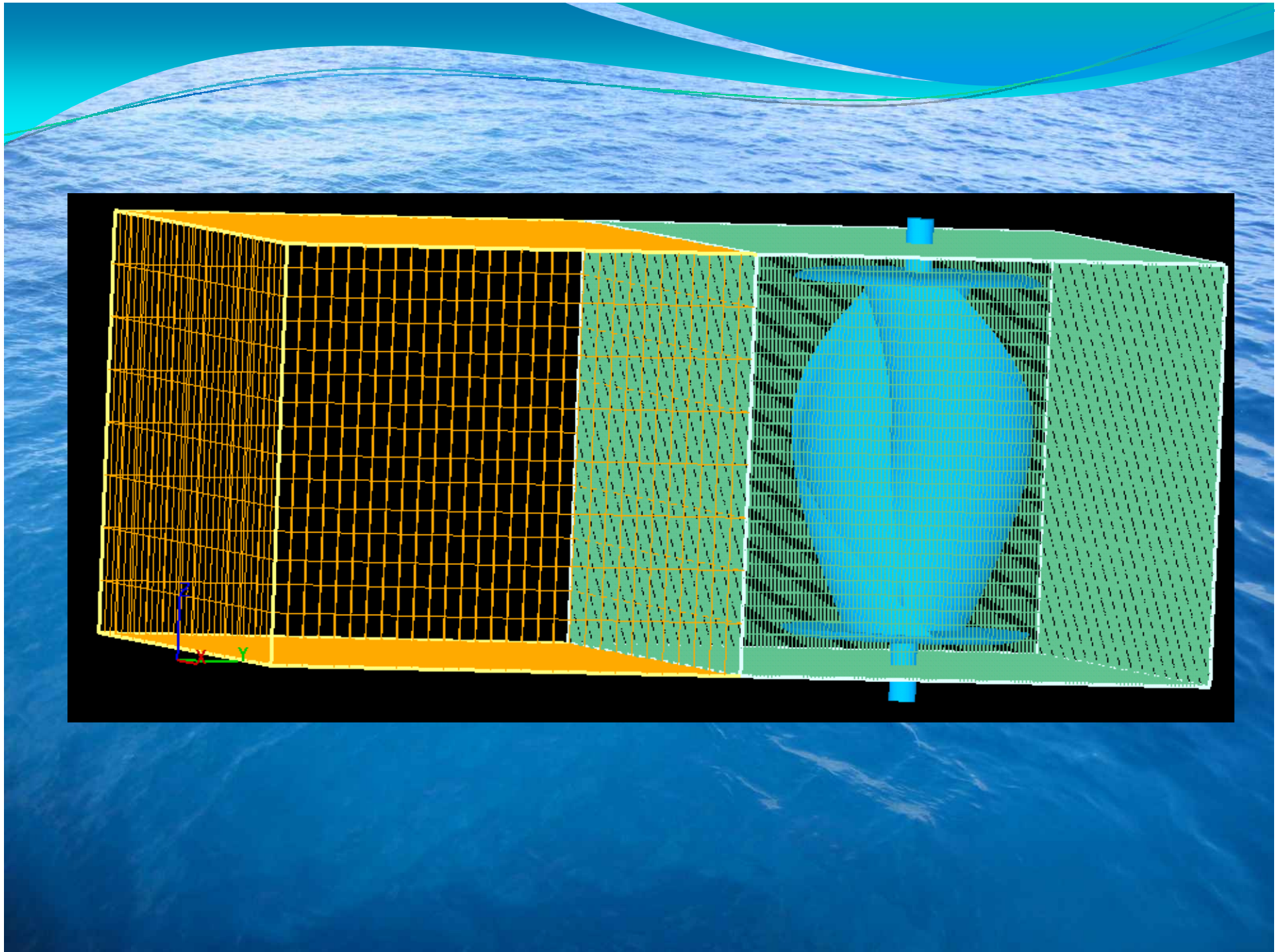
The screenshot shows the 'Model Setup' window in FLOW-3D. The window title is 'single - FLOW-3D - [Physics]'. The menu bar includes 'File', 'Diagnostics', 'Preference', 'Utilities', 'Simulate', and 'Help'. The 'Navigator' pane shows 'Model Setup' selected. The 'Physics' tab is active, displaying a grid of physics models. Each model has a checkbox and a green checkmark indicating it is selected. The selected models are: Air entrainment, Gravity, Moving and deforming objects, and Viscosity and turbulence. Other models include Bubble and phase change, Heat transfer, Sediment scour, Cavitation, Mass sources, Shallow water, Defect tracking, Non-inertial reference frame, Solidification, Surface tension, Density evaluation, Thermal die cycling, Drift-flux, Particles, Elastic stress, Porous media, Electro-mechanics, and Scalars.

Model Name	Selected
Air entrainment	Yes
Bubble and phase change	No
Cavitation	No
Defect tracking	Yes
Density evaluation	No
Drift-flux	No
Elastic stress	No
Electro-mechanics	No
Gravity	Yes
Heat transfer	No
Mass sources	No
Moving and deforming objects	Yes
Non-inertial reference frame	No
Particles	No
Porous media	No
Scalars	No
Sediment scour	No
Shallow water	No
Solidification	No
Surface tension	No
Thermal die cycling	No
Viscosity and turbulence	Yes

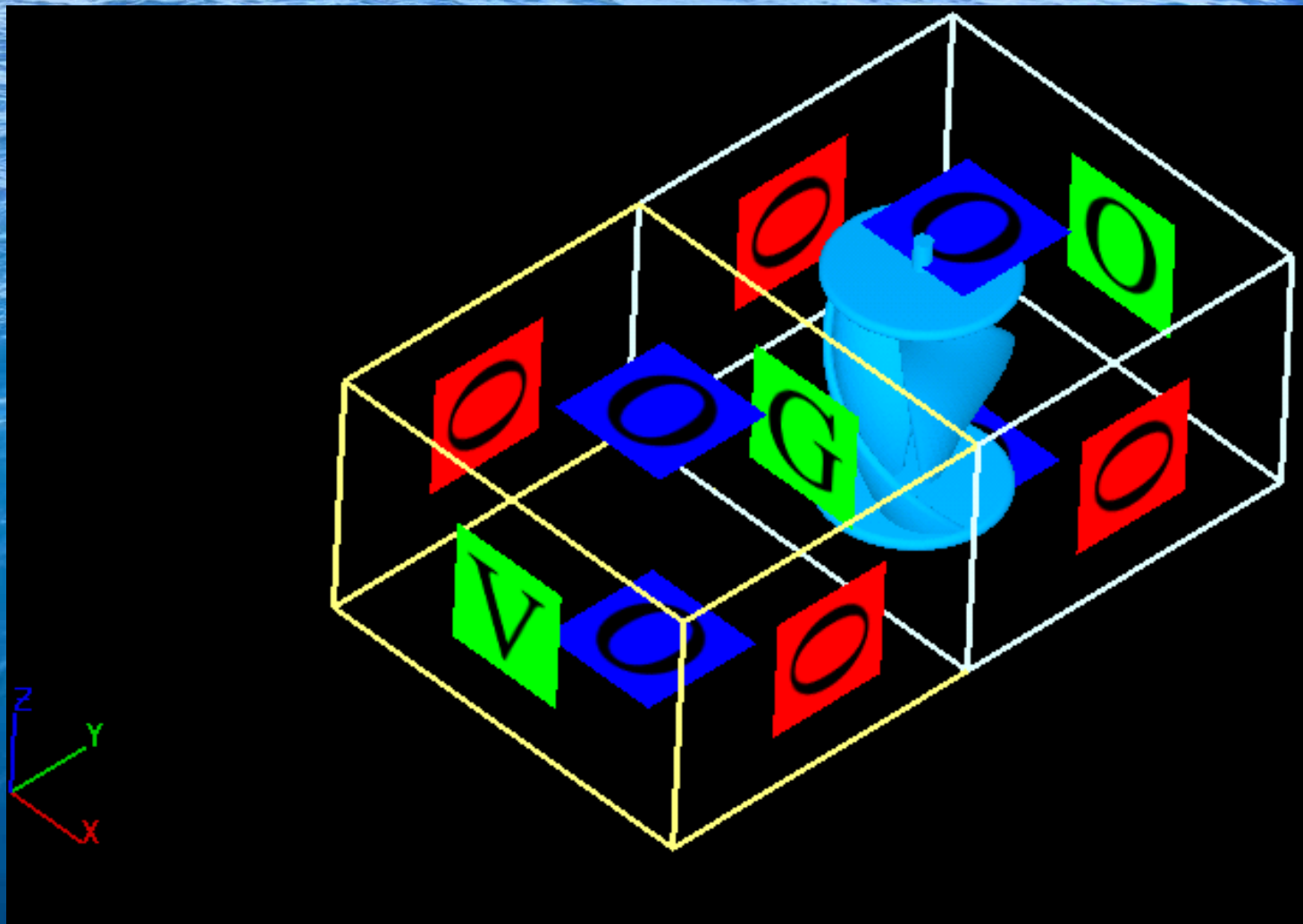


# Meshing and Geometry

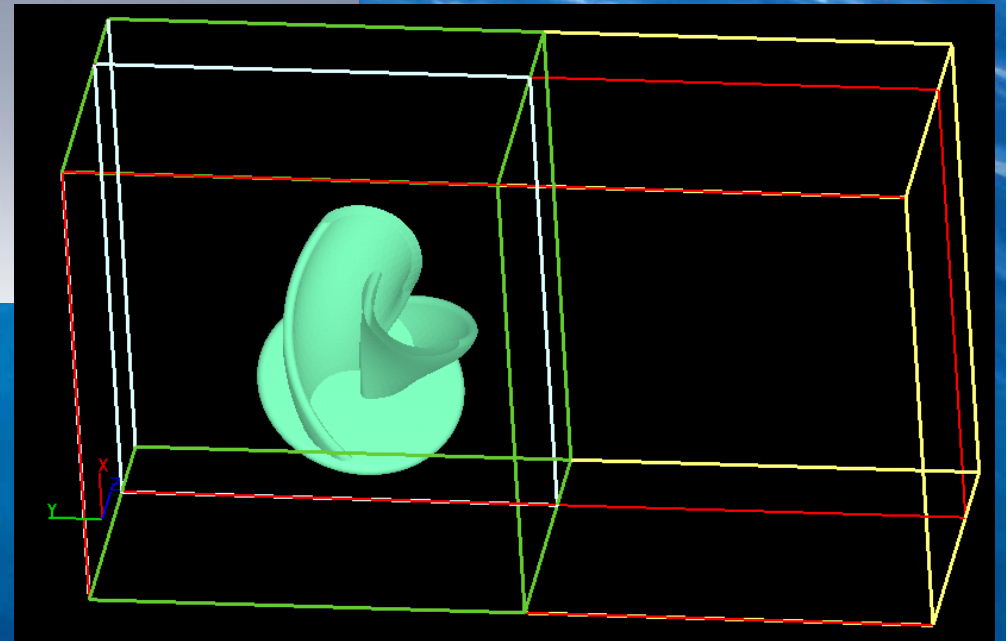
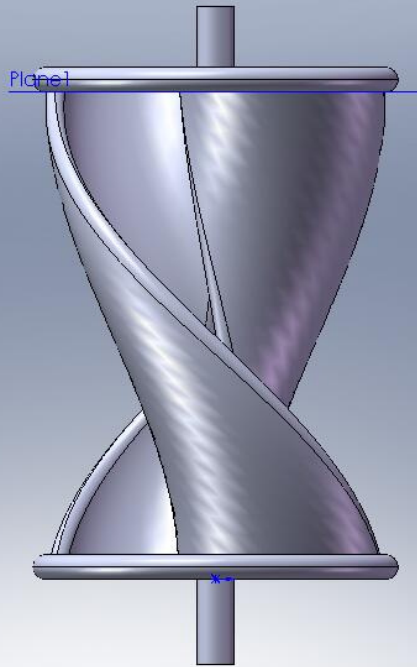




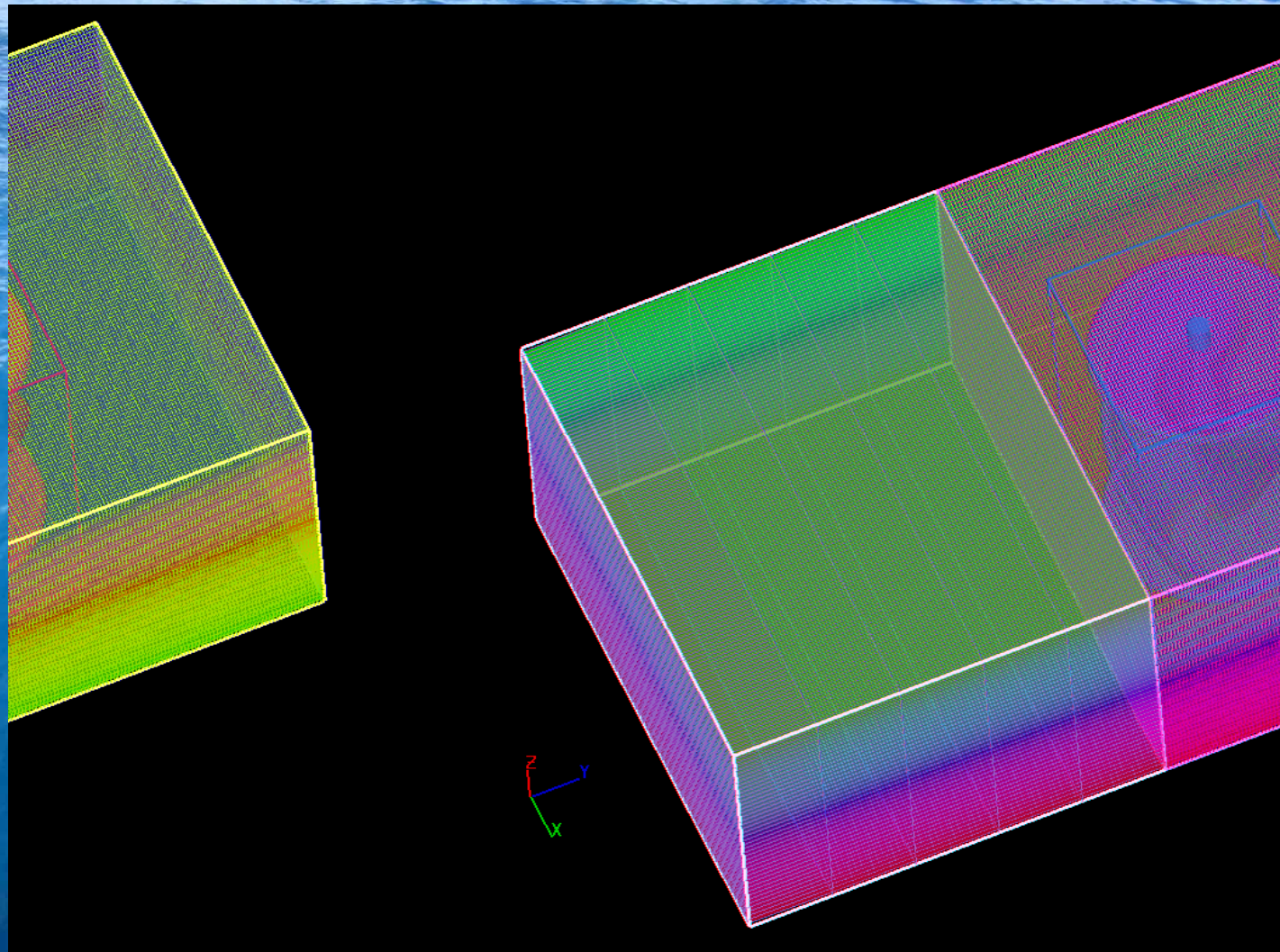
# Boundary Conditions



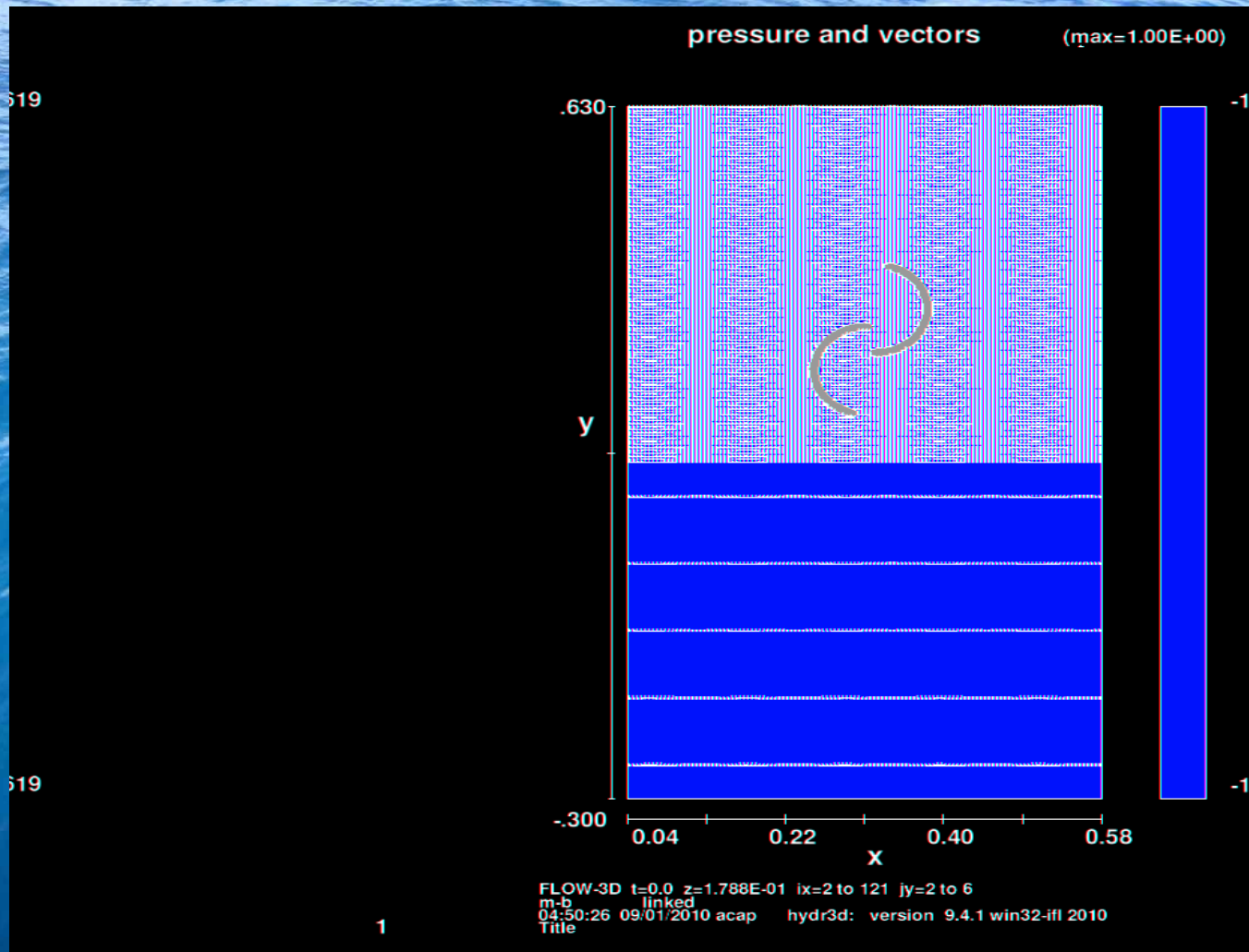
# Twisted Savonius Rotor with Overlap Ratio



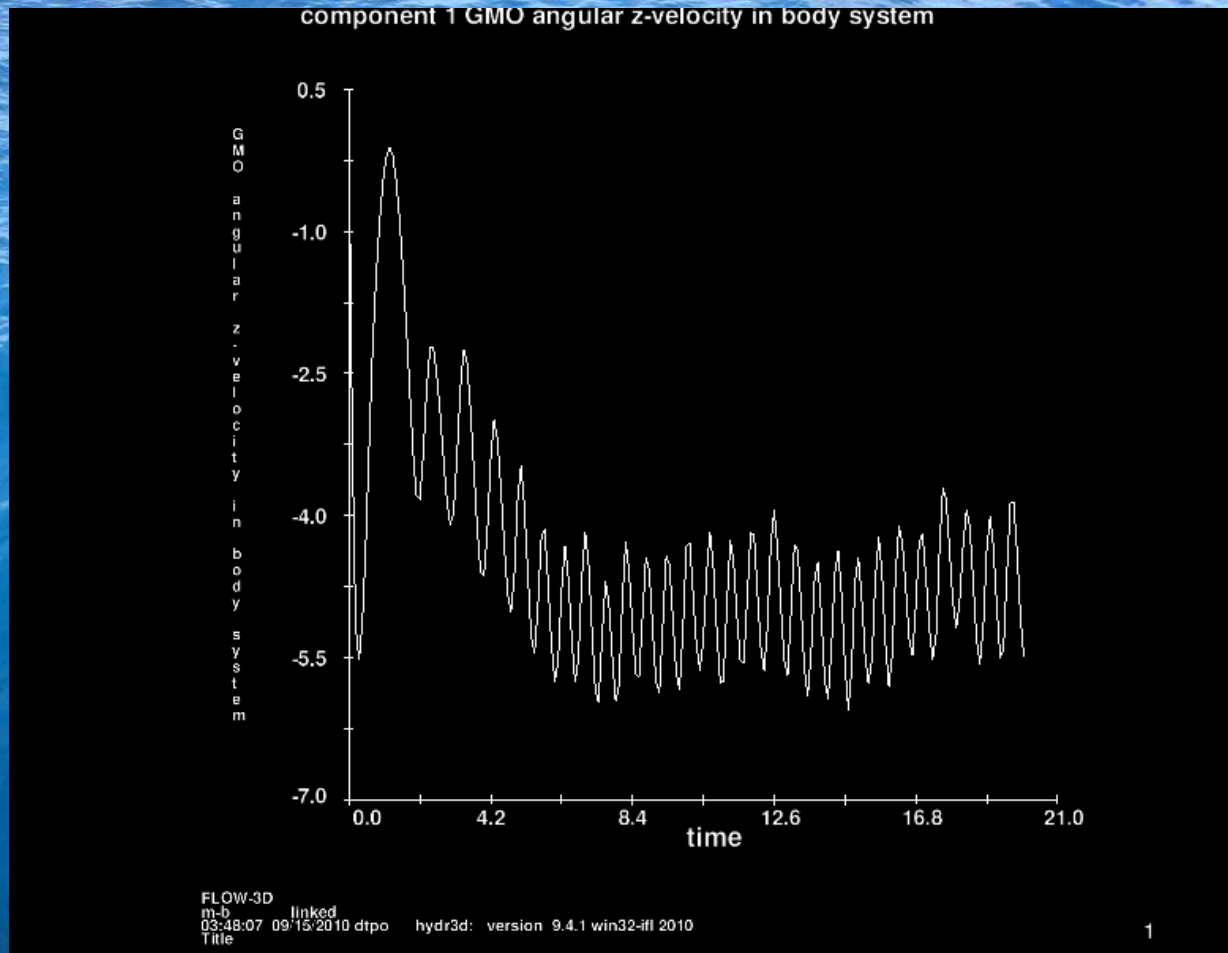
# 3D Animation



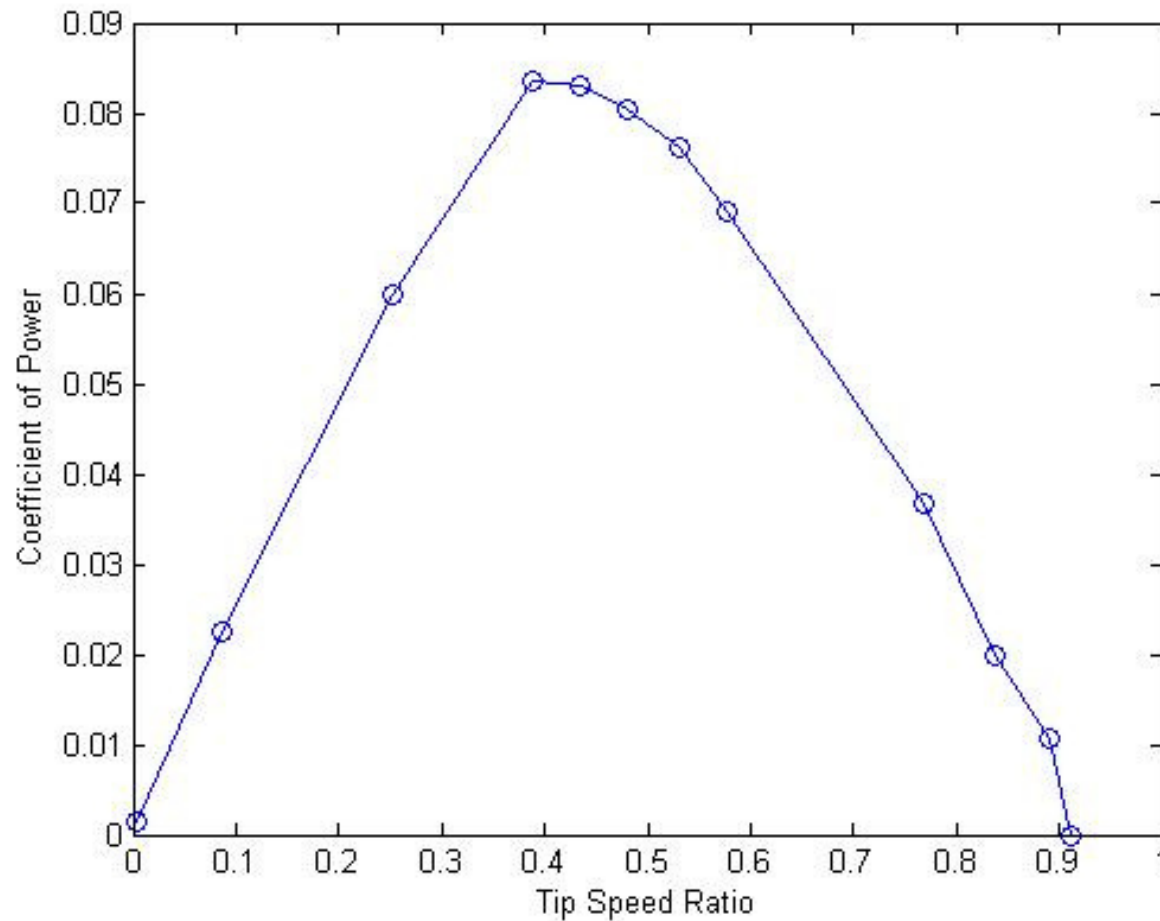
# 2D Animation



# Angular Speed

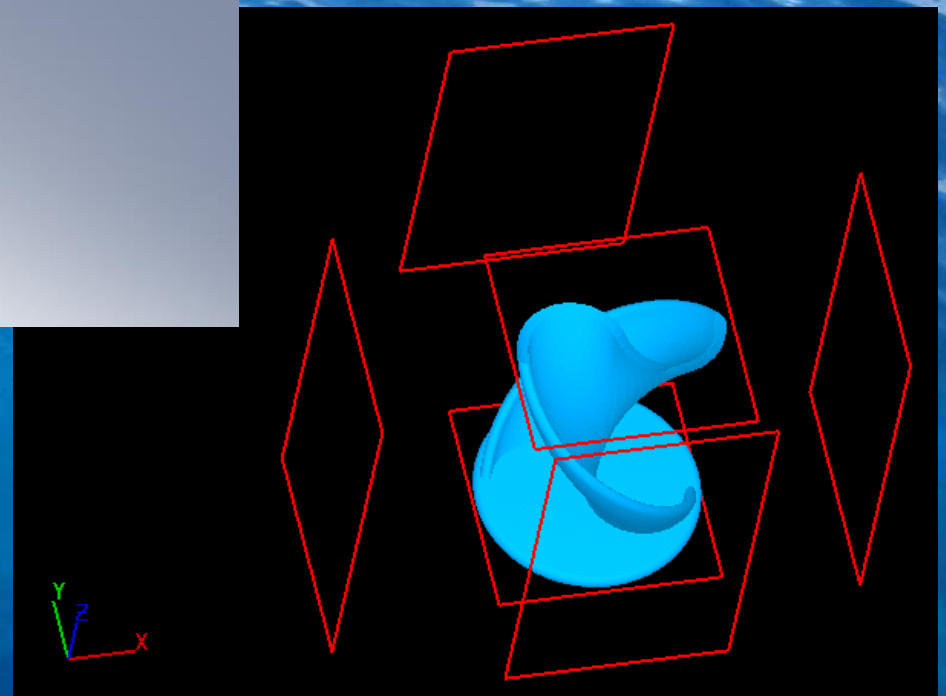
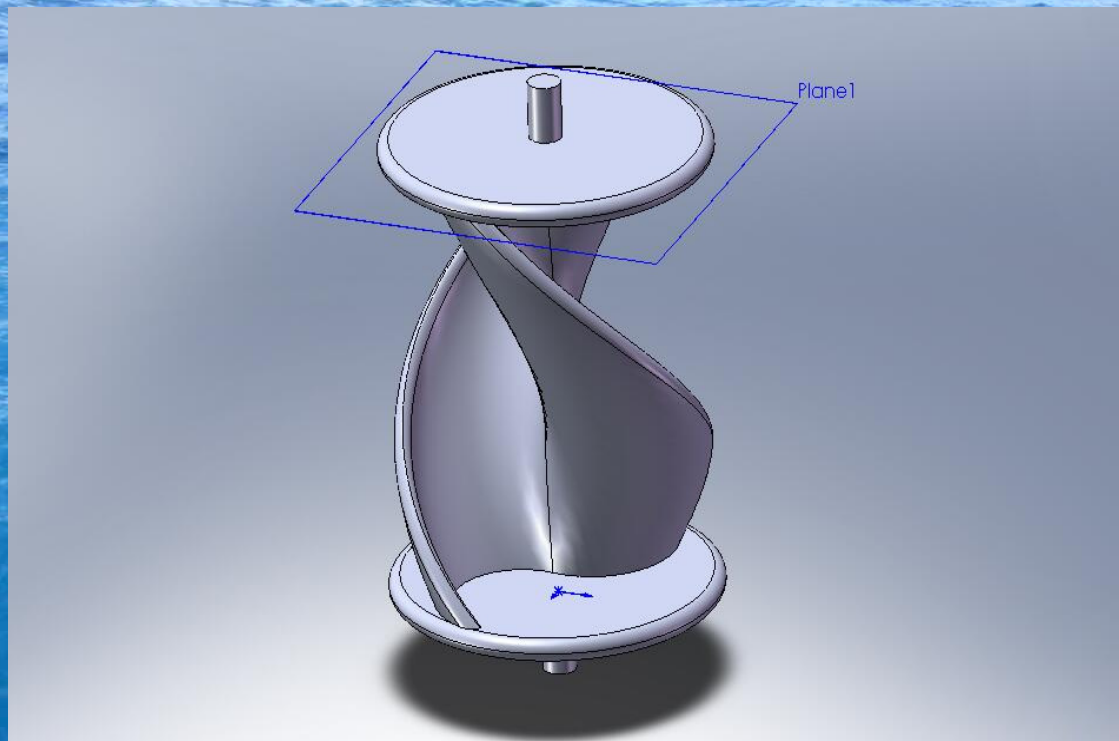


# For Twisted Savonius with Overlap Ratio

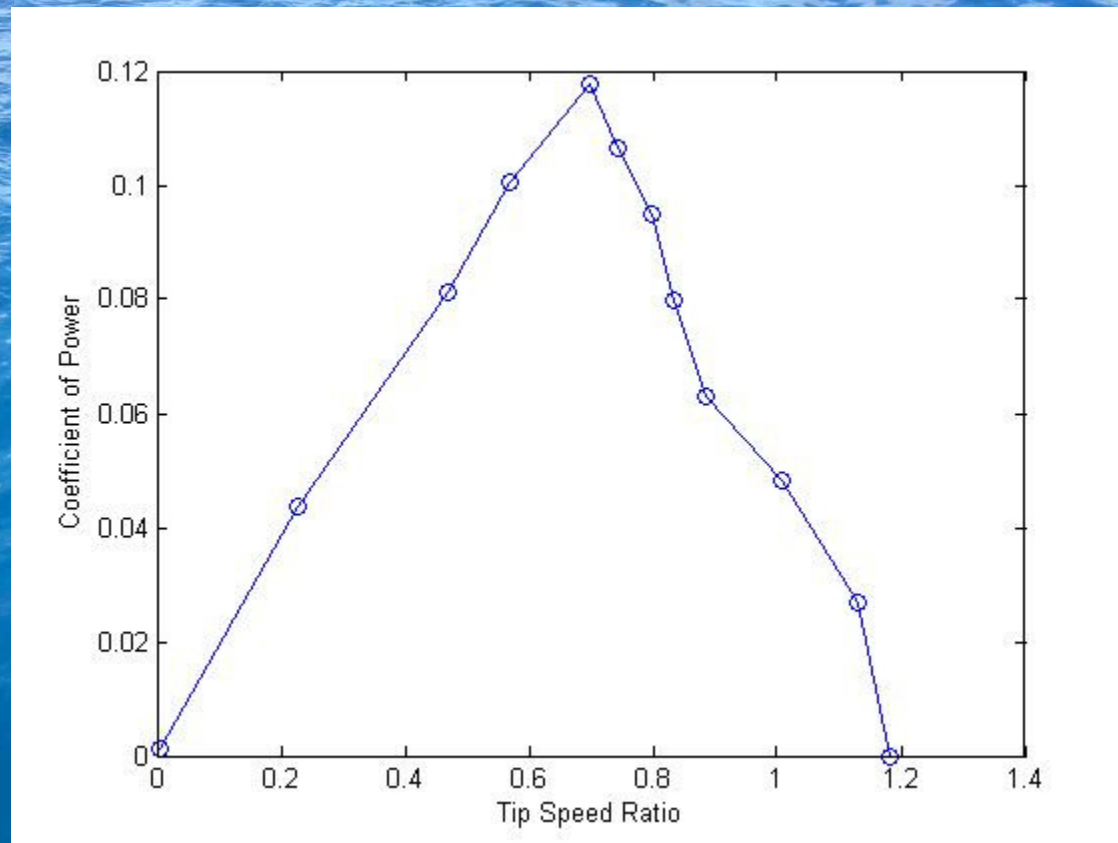




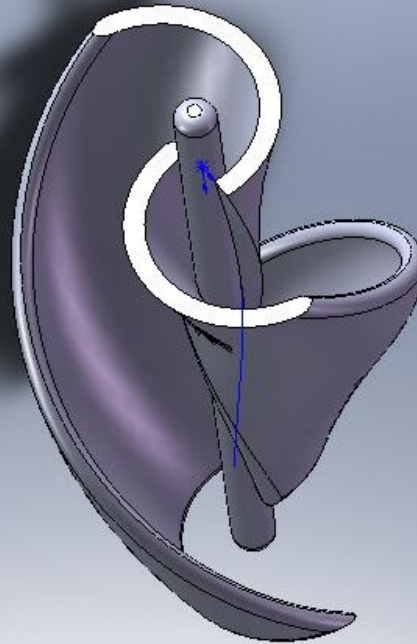
# Twisted Savonius with Zero Overlap Ratio



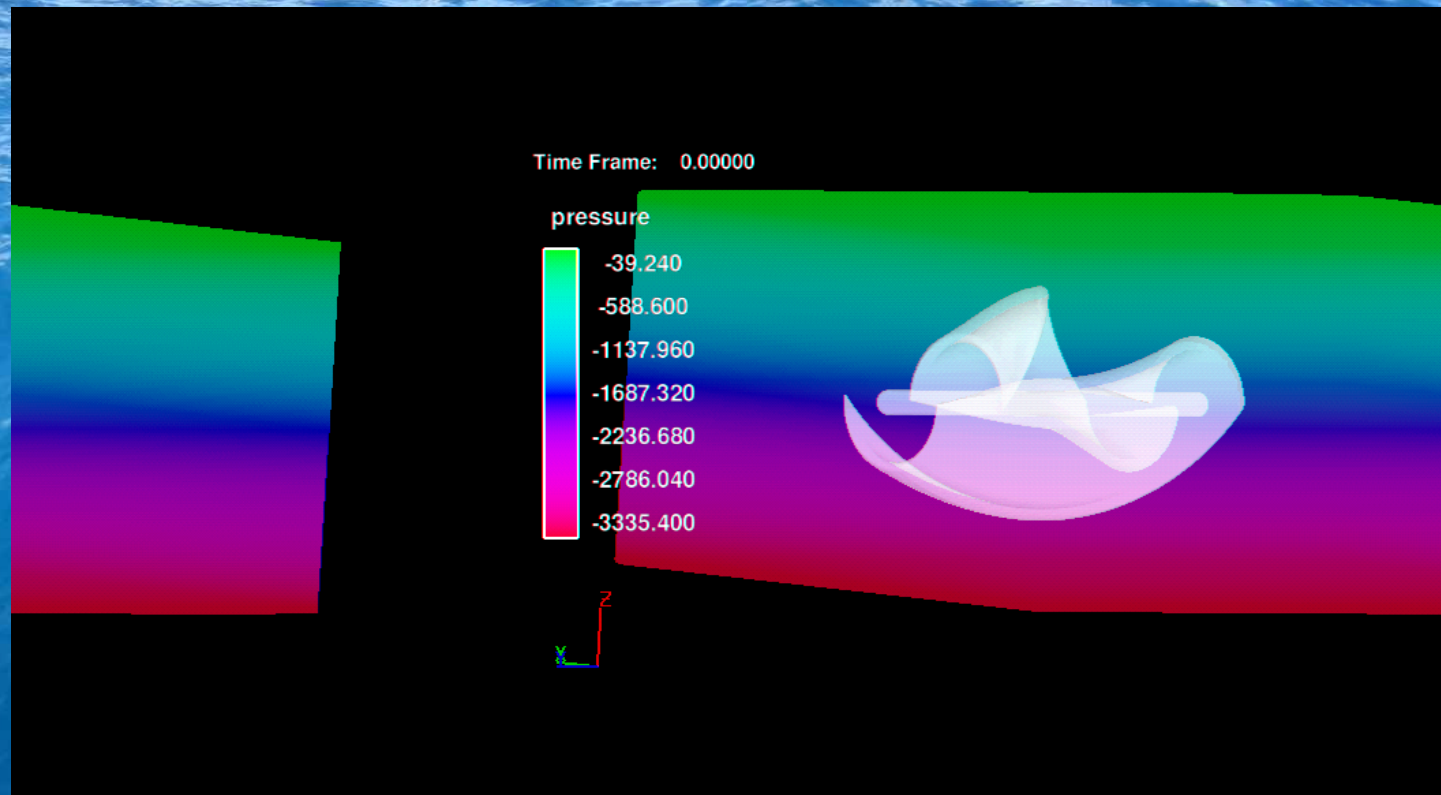
# For twisted Savonius with Zero Overlap Ratio



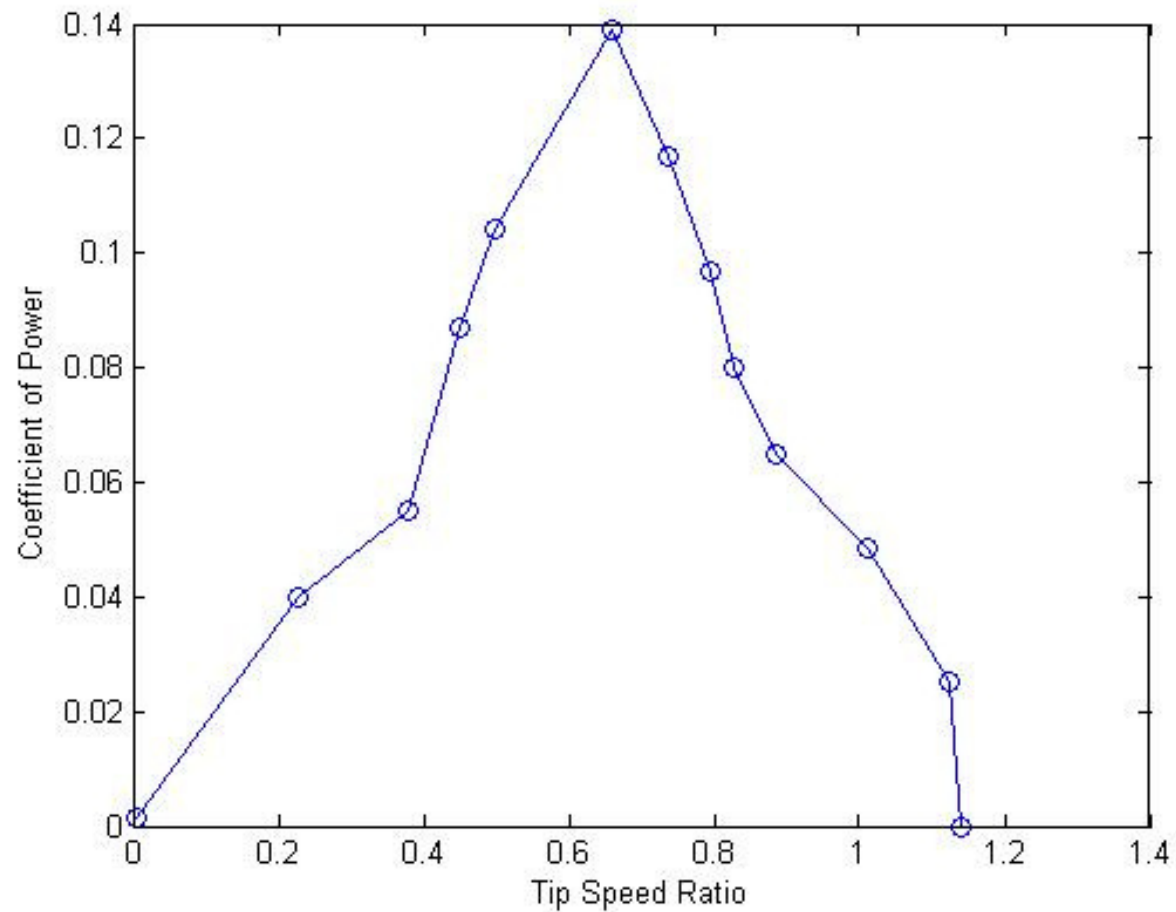
# Twisted Savonius with no endplates



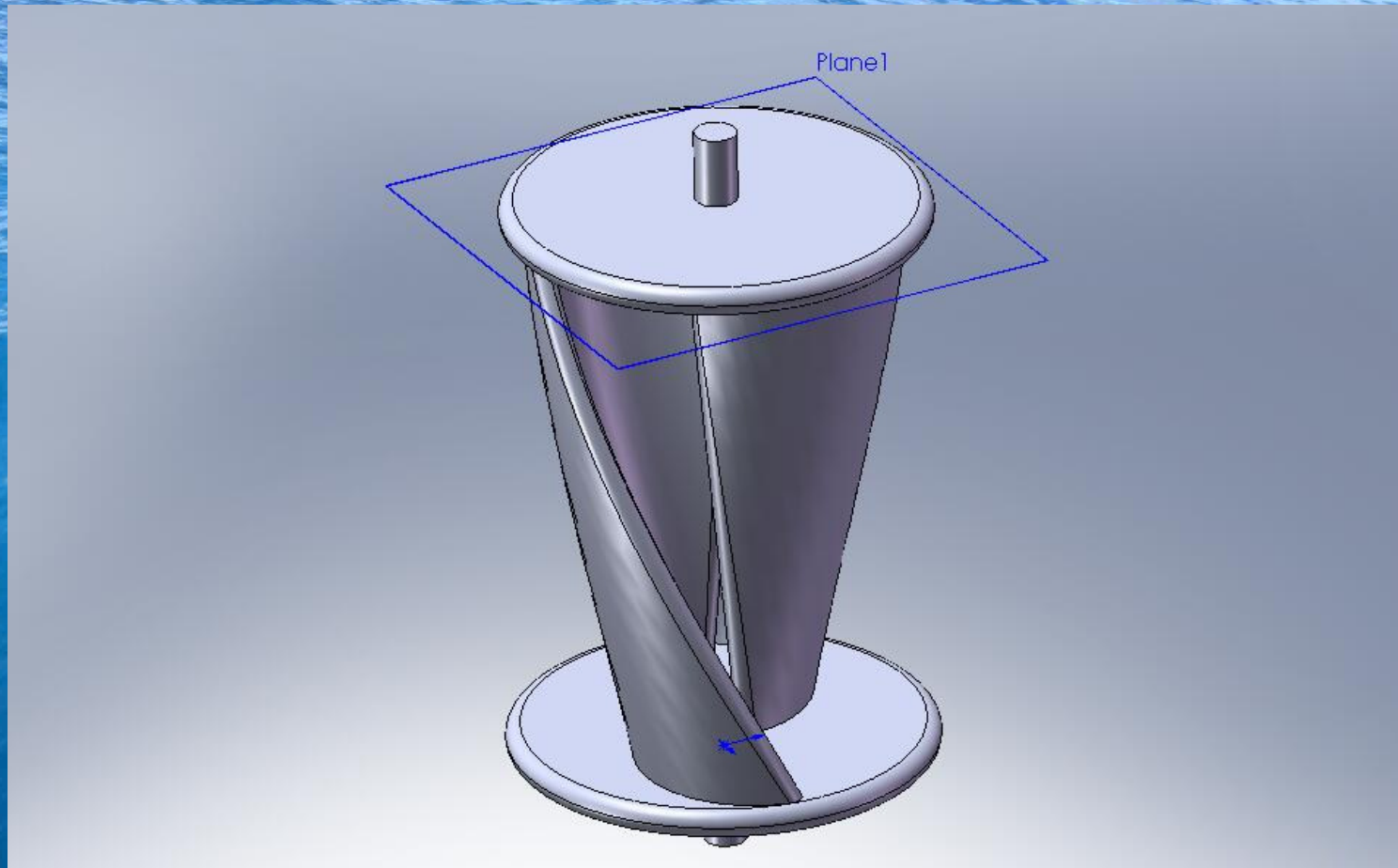
# Horizontally Mounted Position 2



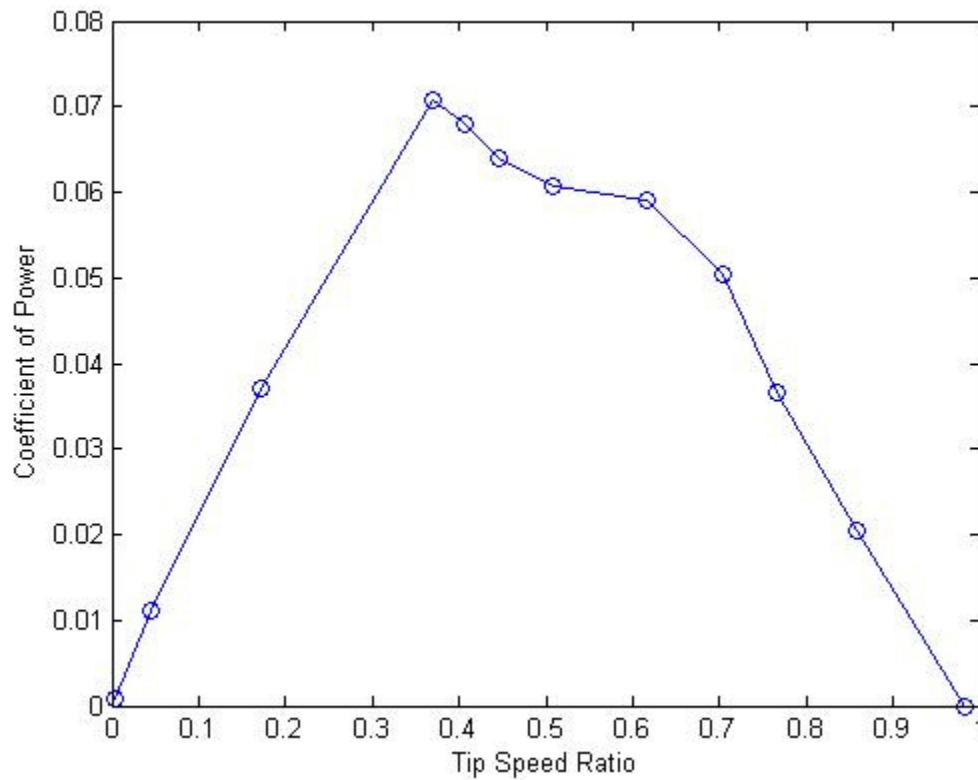
## For Horizontally Mounted Position 2



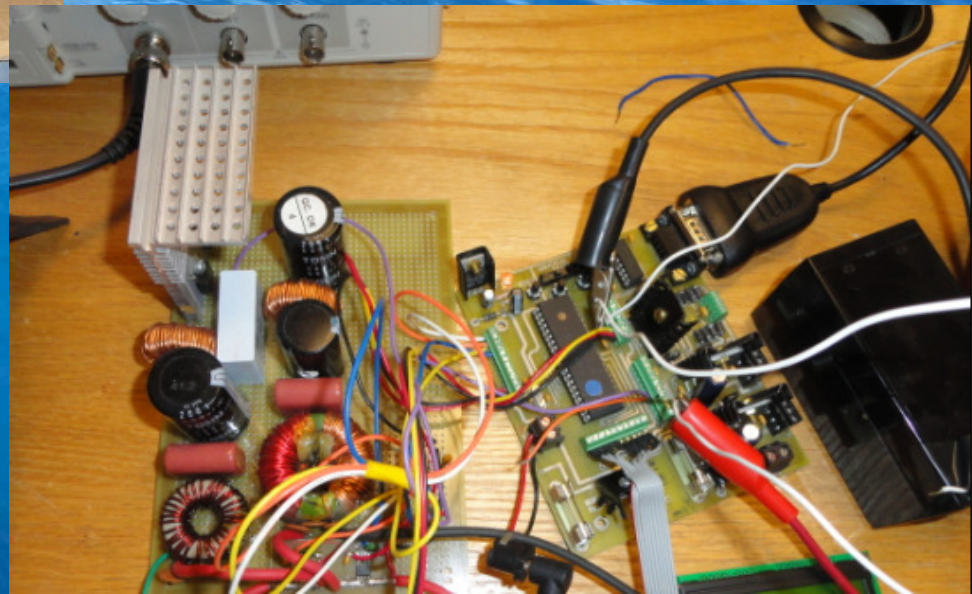
# Quarter Pitched Twist



# For Quarter Pitch Twisted Savonius Rotor

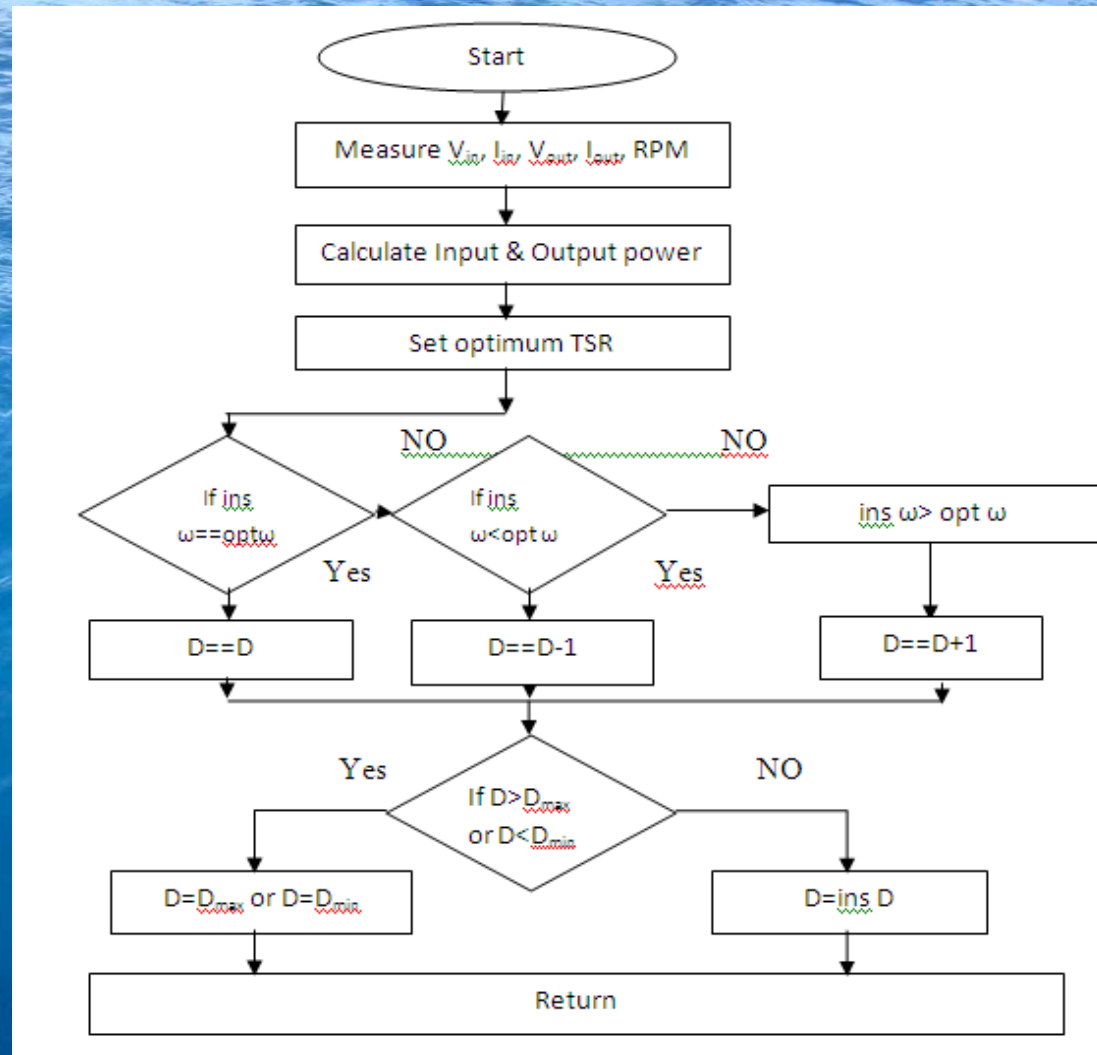


# Twisted Savonius Turbine Emulator and Lab Set up

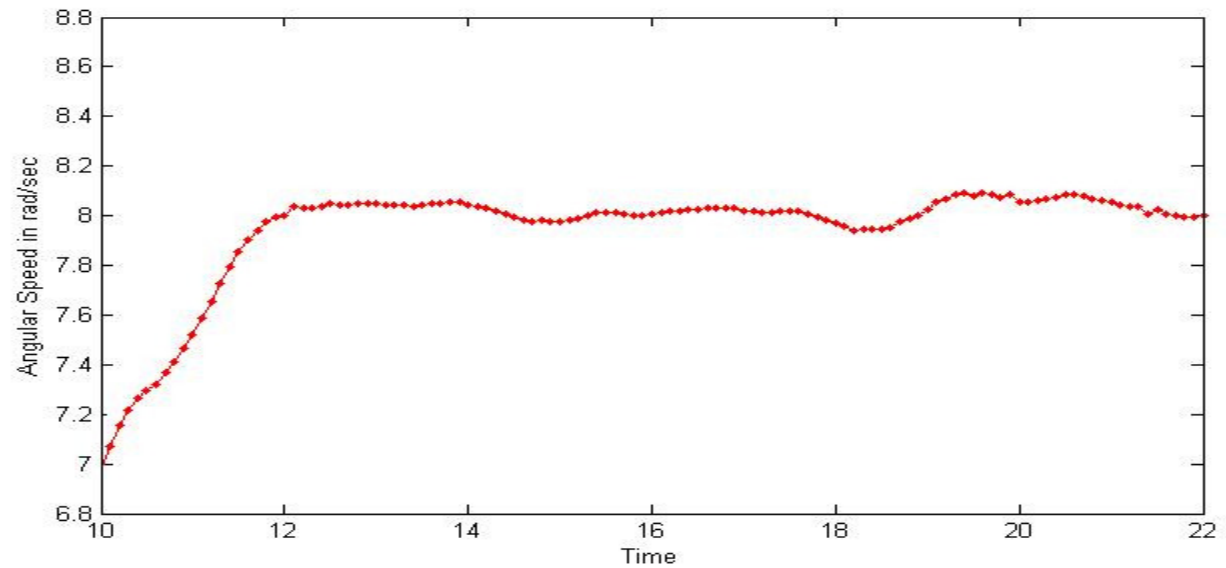
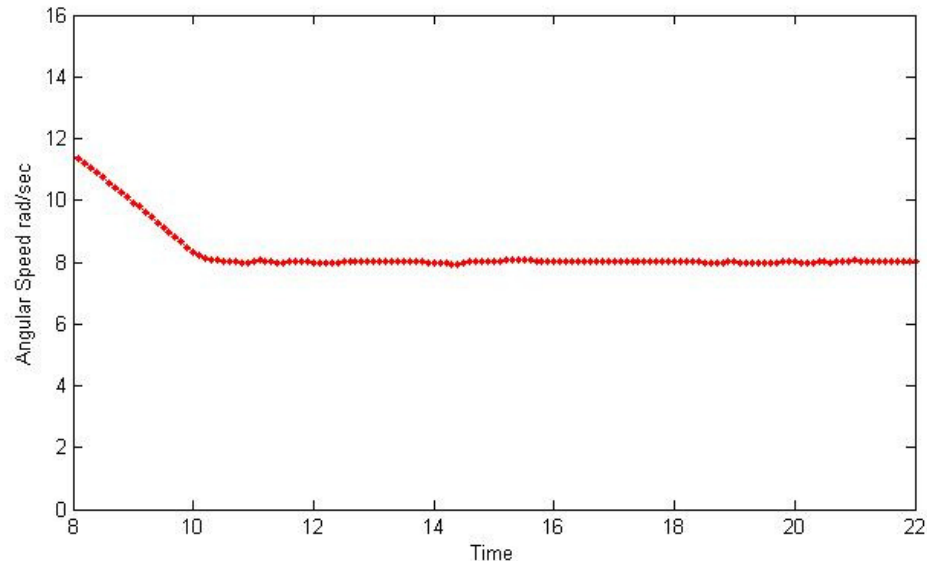




# MPPT Algorithm



# Angular Speed Stabilization



# Conclusion

- A better turbine has been designed
- Twisted Savonius is better than Conventional one
- MPPT Algorithm optimizing angular speed

# Acknowledgements

Supervisors

Dr. Tariq Iqbal

Dr. Michael Hinchey

Seaformatics Group: Dr. Vlastimil Masek, Andrew Cook  
Brian Pretty, Nahidul Khan

SeaCraft International: Wallace Robert

My Family and Friends

# Publications

- "Performance comparison of different Savonius Rotors based on CFD analysis" submitted in 11<sup>th</sup> Annual FLOW-3D European Users Conference, Monza, Italy
- "CFD Analysis of a Twisted Savonius Turbine", The 18<sup>th</sup> Annual Newfoundland Electrical and Computer Engineering Conference, IEEE Newfoundland and Labrador Section
- "Performance of a Quarter Pitch Twisted Savonius Turbine" (accepted) International Conference of Utility Exhibition on Power and Energy System (ICUE), Co sponsored by IEEE September 28-30, 2011, Pattaya city, Thailand

The image features a vibrant blue ocean with gentle ripples. At the top, there is a decorative border consisting of several overlapping, wavy bands in shades of teal and light blue. Centered in the middle of the ocean is the word "Thanks" in a clean, black, sans-serif font.

Thanks