Twisted Savonius Turbine Based Marine Current Energy Conversion System

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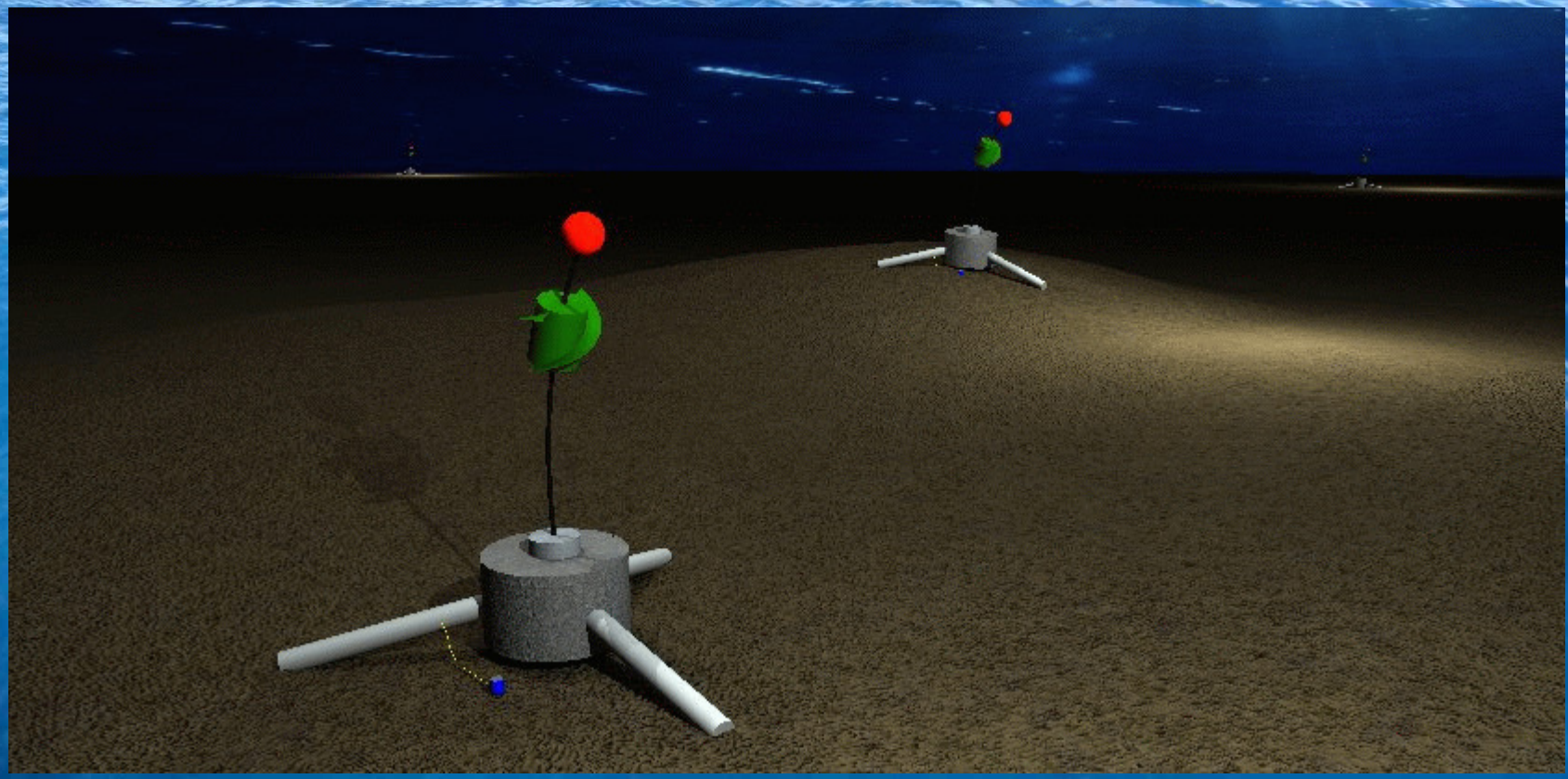
Presentation Outline

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

Thesis Objective

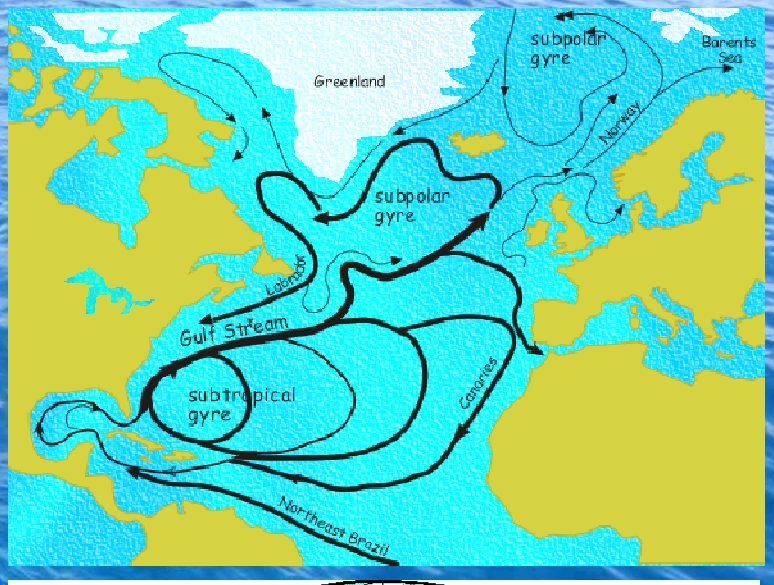
- Design and development of an efficient drag type turbine
- Implementation of an efficient converter along with control algorithm
- Proposal of an efficient marine current energy conversion device

Introduction

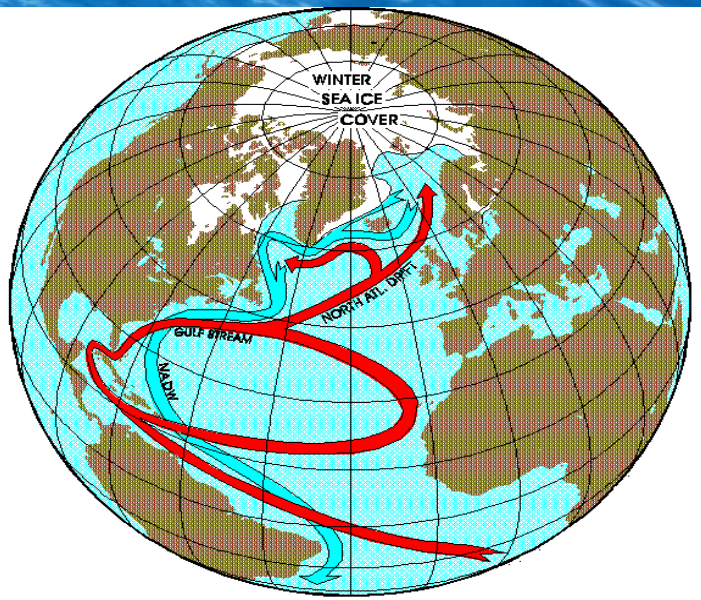


Marine Currents

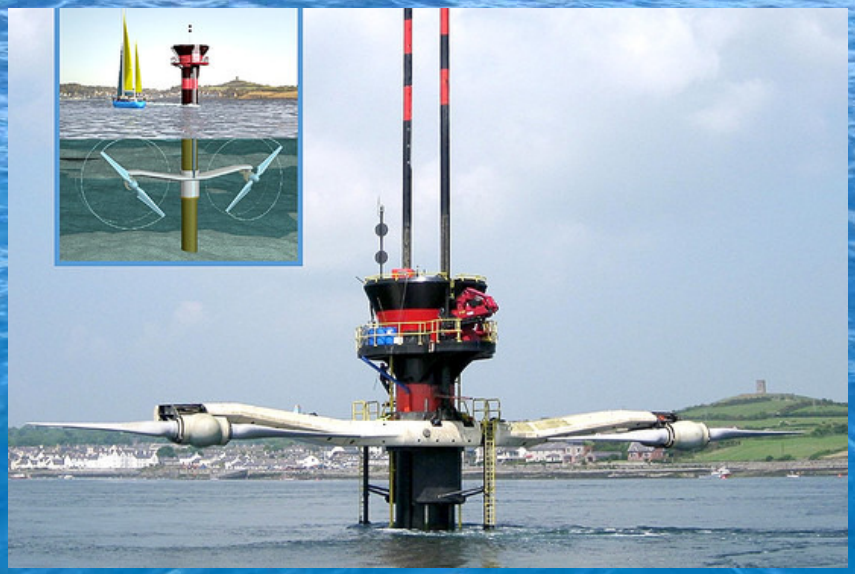
- Surface Currents
  - Wind
  - Coriolis Force



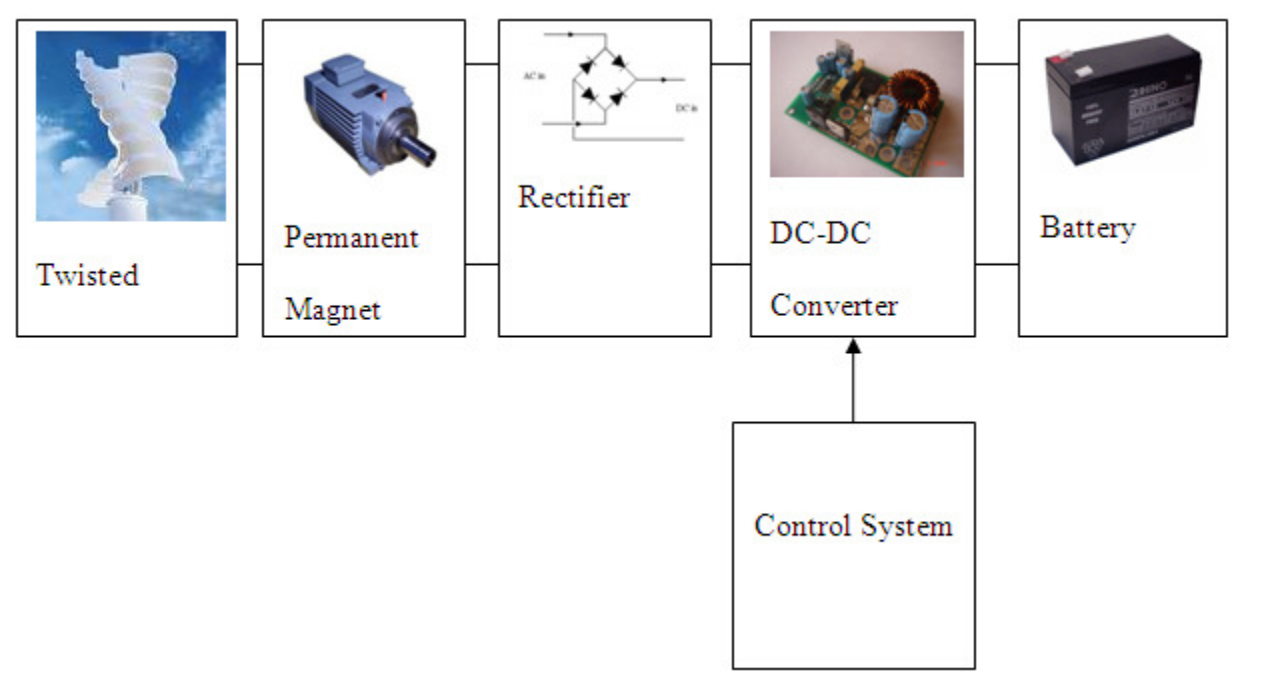
- Deep Water Currents
  - Temperature
  - Salinity



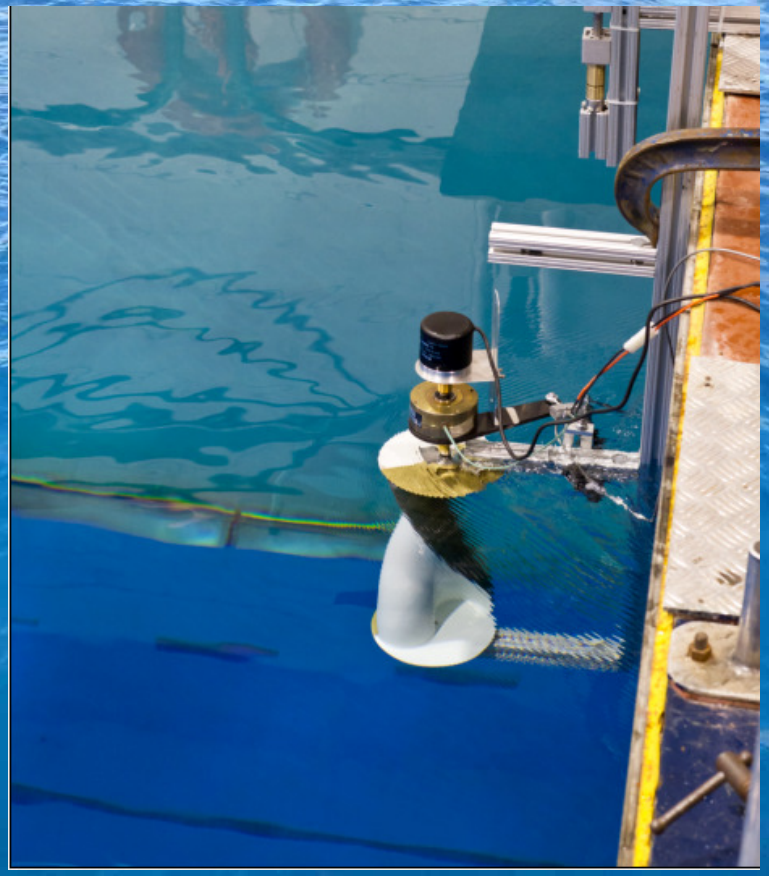
Commercial Marine Current Turbines



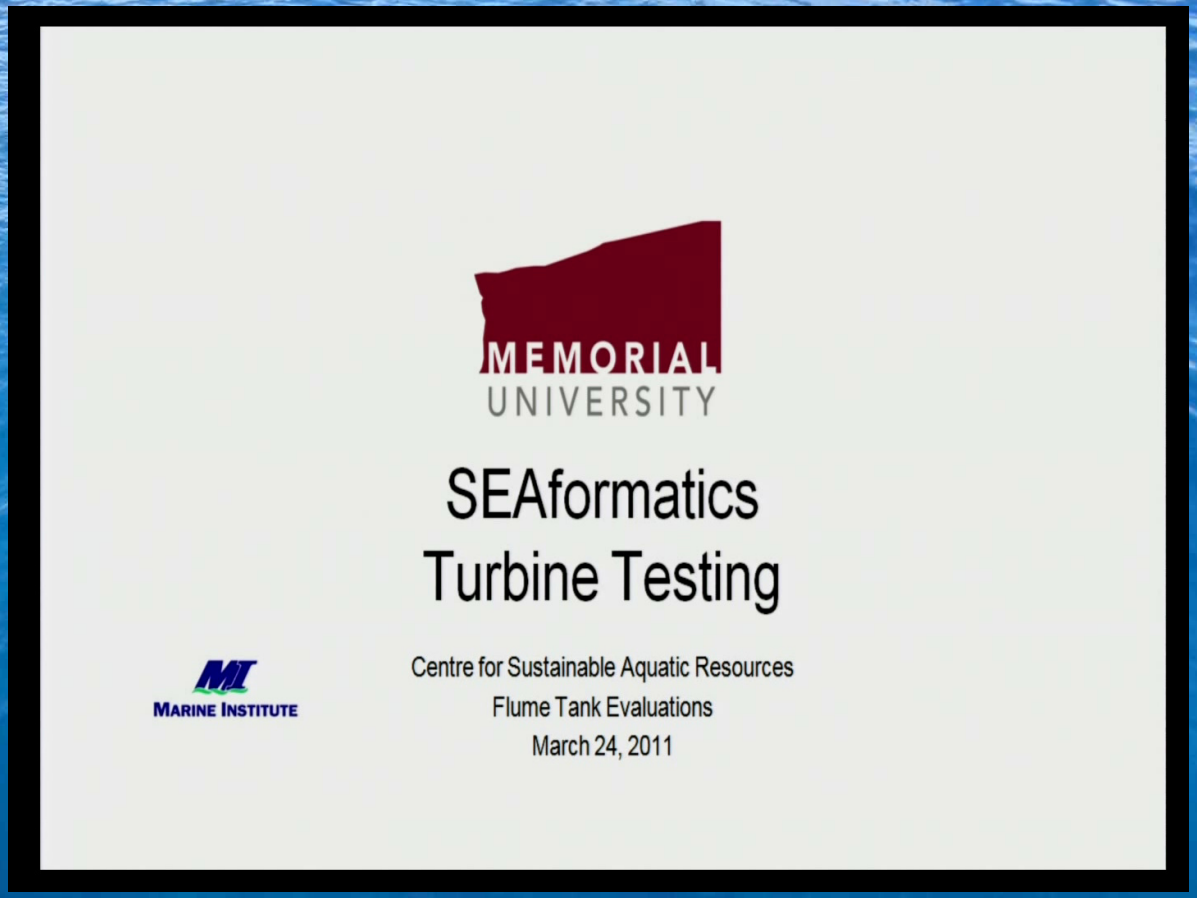
Proposed System



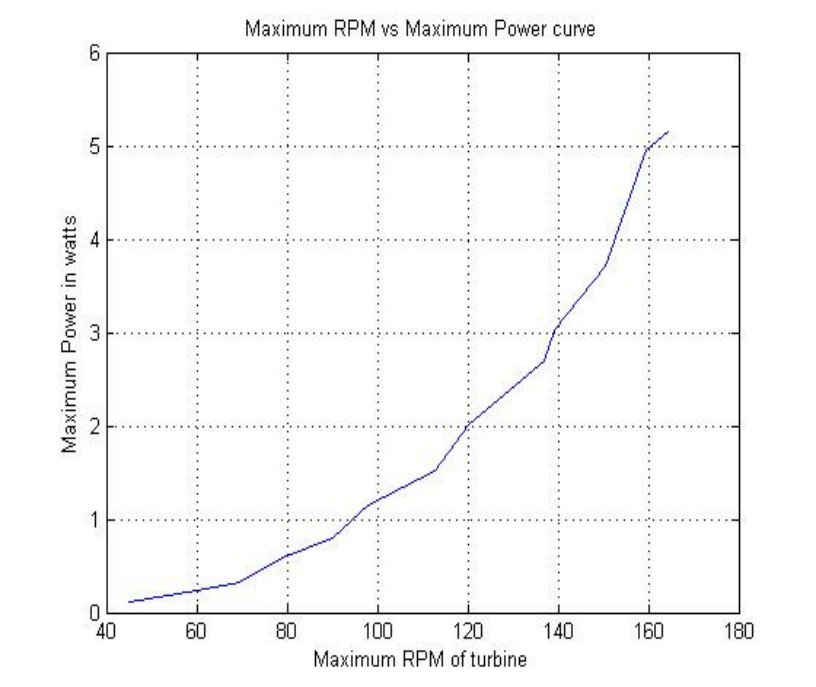
Instrumentation of Twisted Savonius Turbine

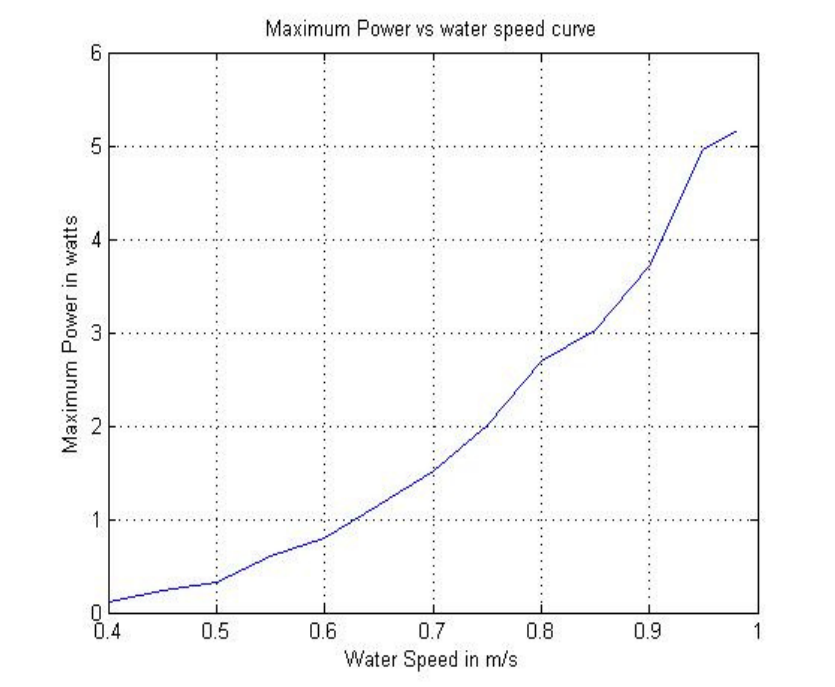


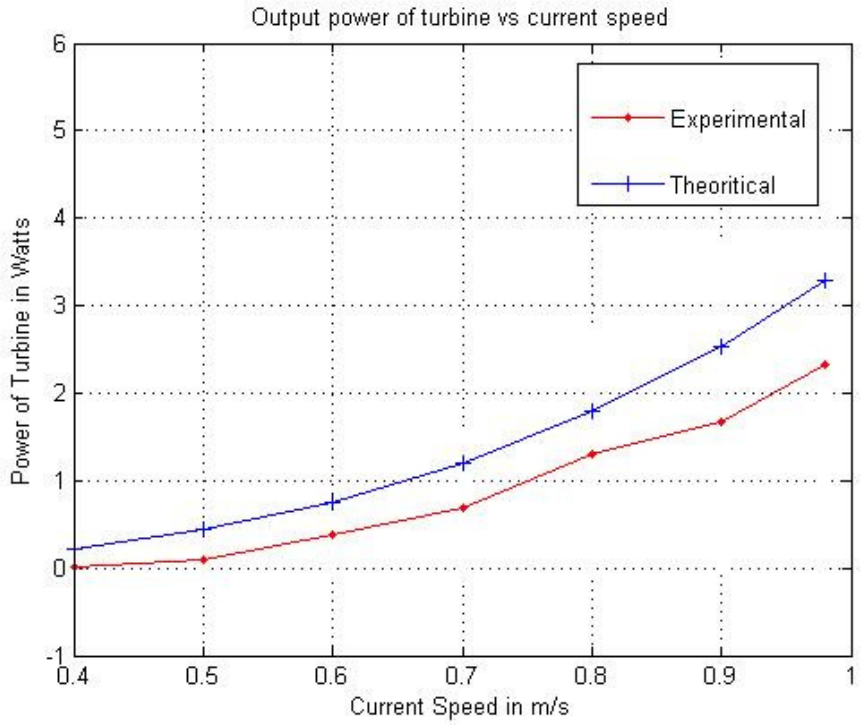
Twisted Savonius testing at Flume Tank

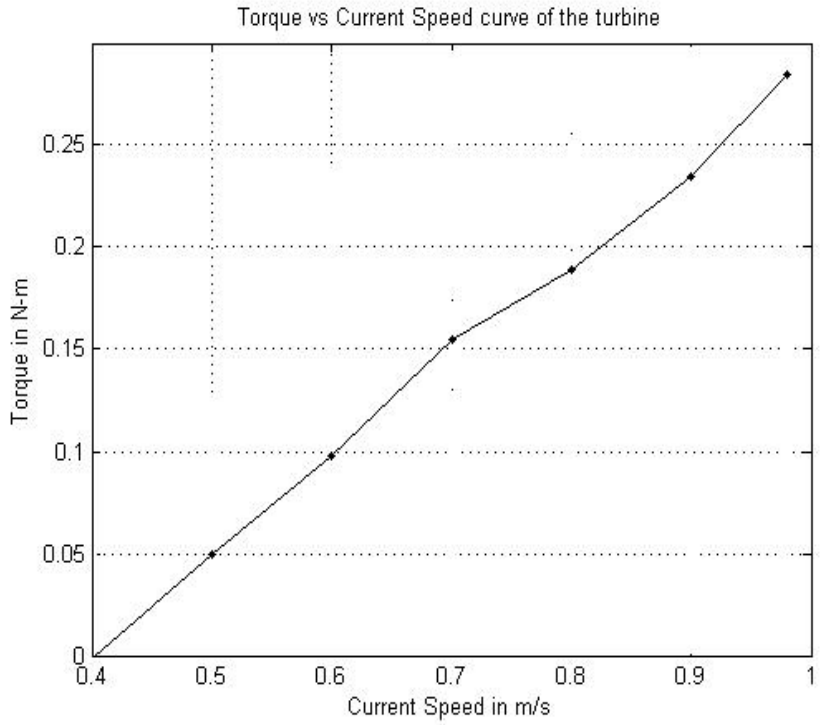


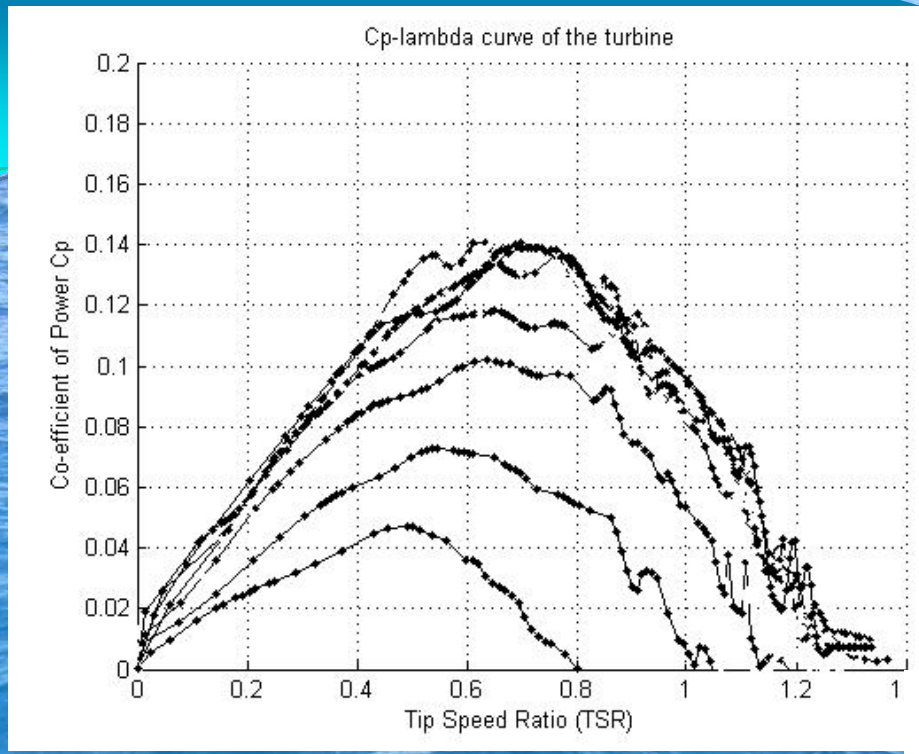
Test results a Flume Tank

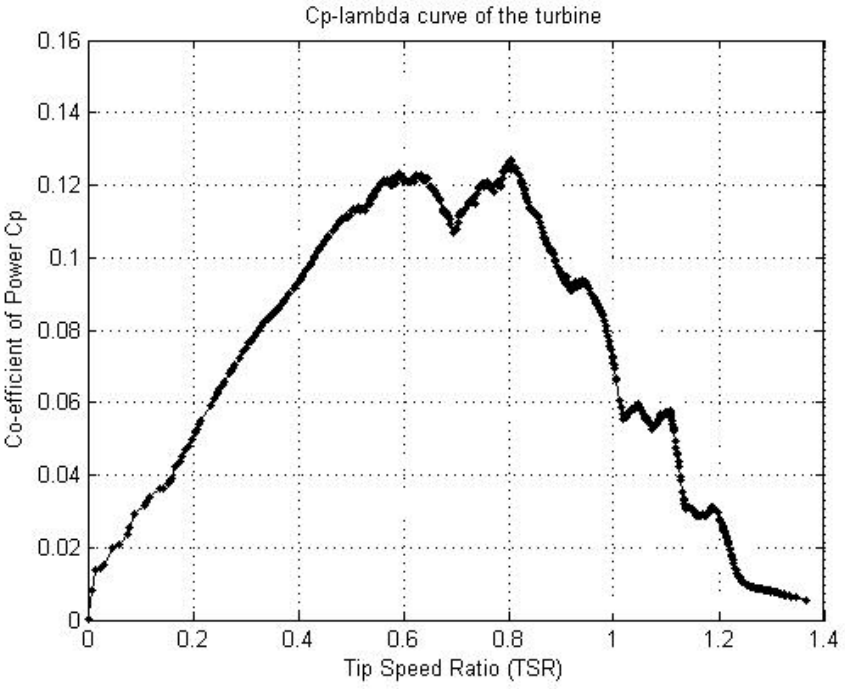





Output power of turbine vs current speed
Experimental
Theoritical
Power of Turbine in Watts
Current Speed in m/s
6
5
4
3
2
1
0
-1
0.4
0.5
0.6
0.7
0.8
0.9
1

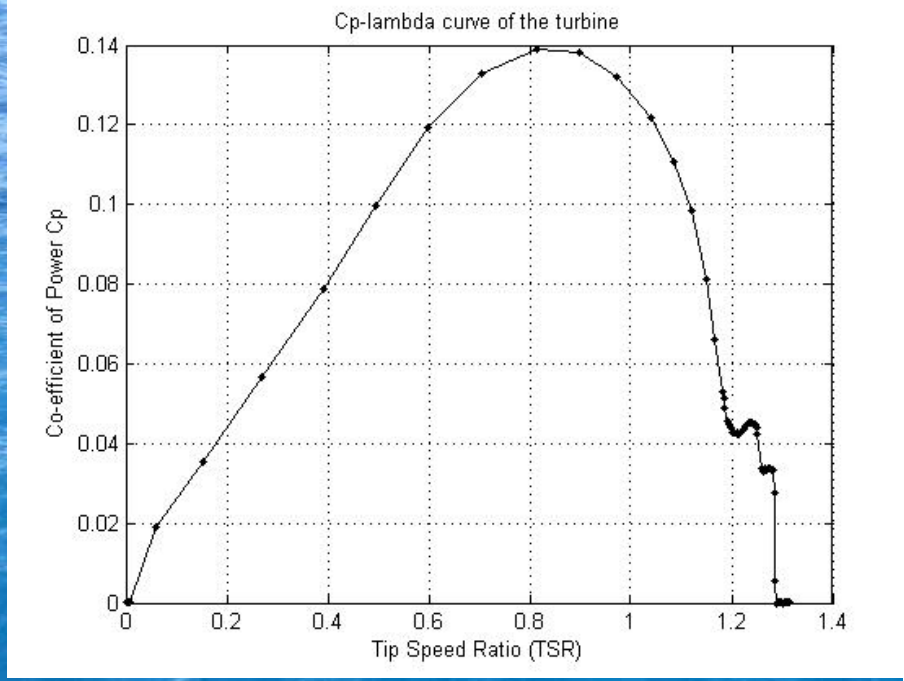

Torque vs Current Speed curve of the turbine
Torque in N-m
Current Speed in m/s
0.25
0.2
0.15
0.1
0.05
0
0.4
0.5
0.6
0.7
0.8
0.9
1


Cp-lambda curve of the turbine
Co-efficient of Power Cp
Tip Speed Ratio (TSR)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.2
0.4
0.6
0.8
1
1.2

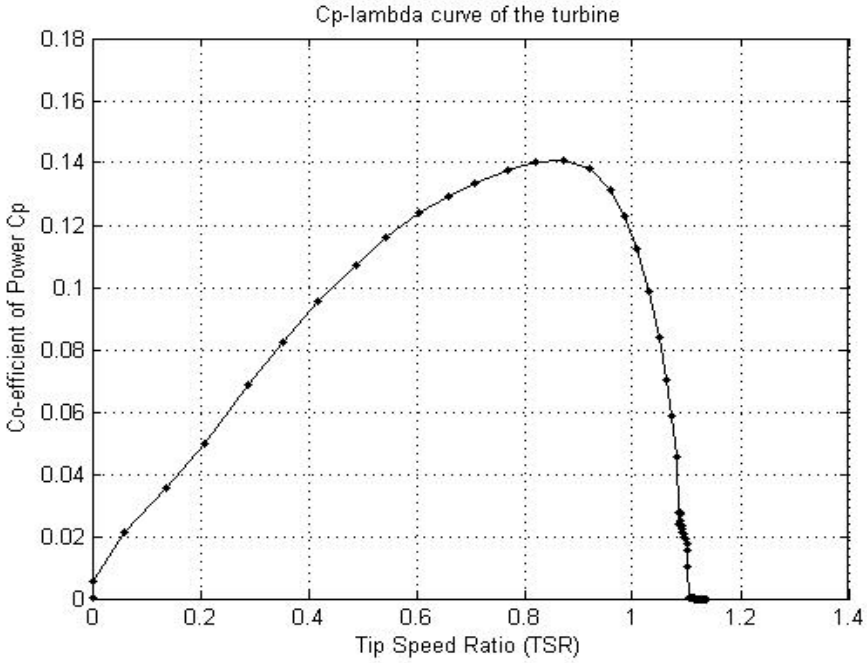

Cp-lambda curve of the turbine
Co-efficient of Power Cp
Tip Speed Ratio (TSR)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.2
0.4
0.6
0.8
1
1.2
1.4

At Wind Tunnel

Wind Tunnel Results

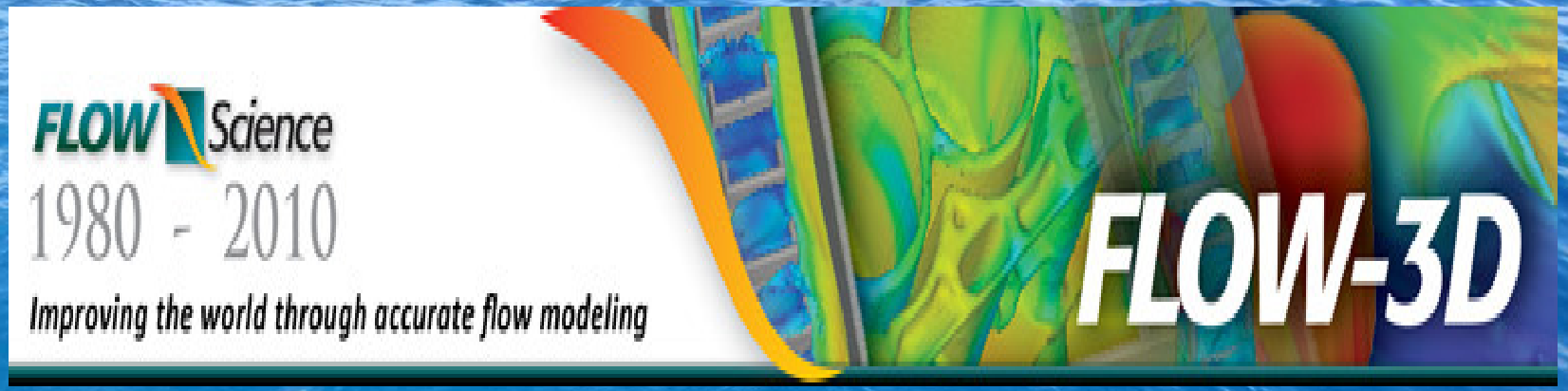


10 m/s wind speed

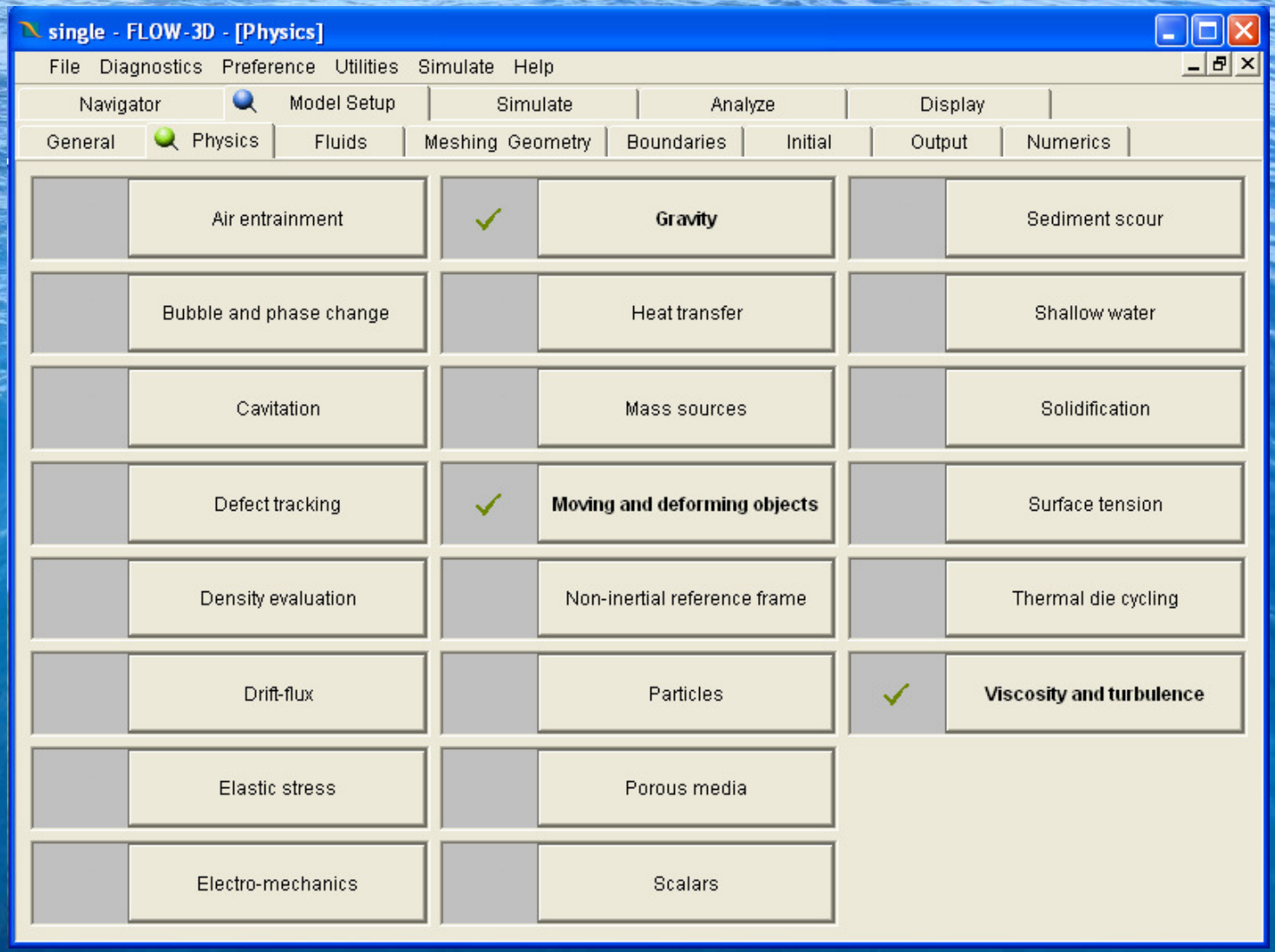


13 m/s wind speed

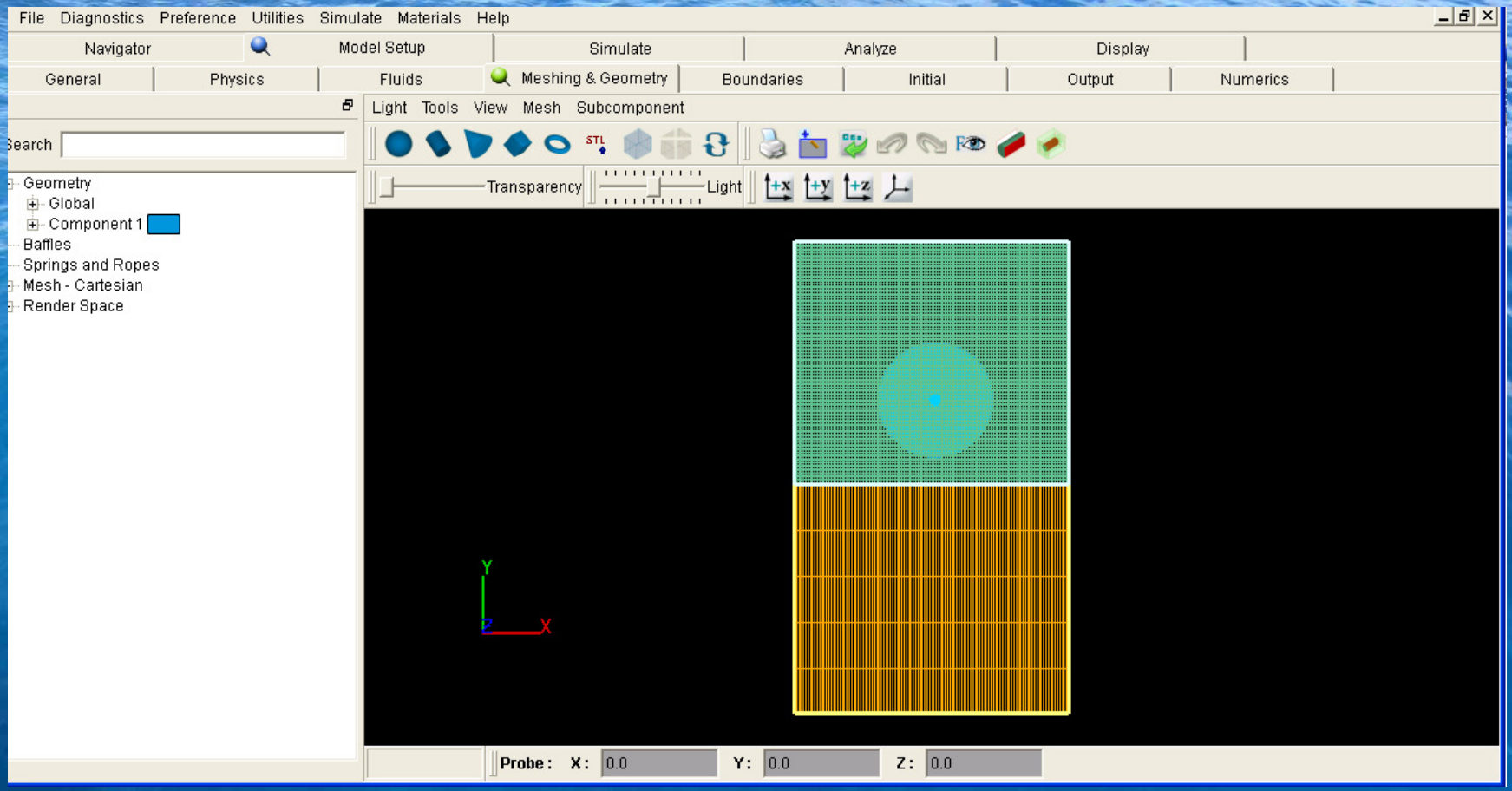
Computational Fluid Dynamics Flow-3D

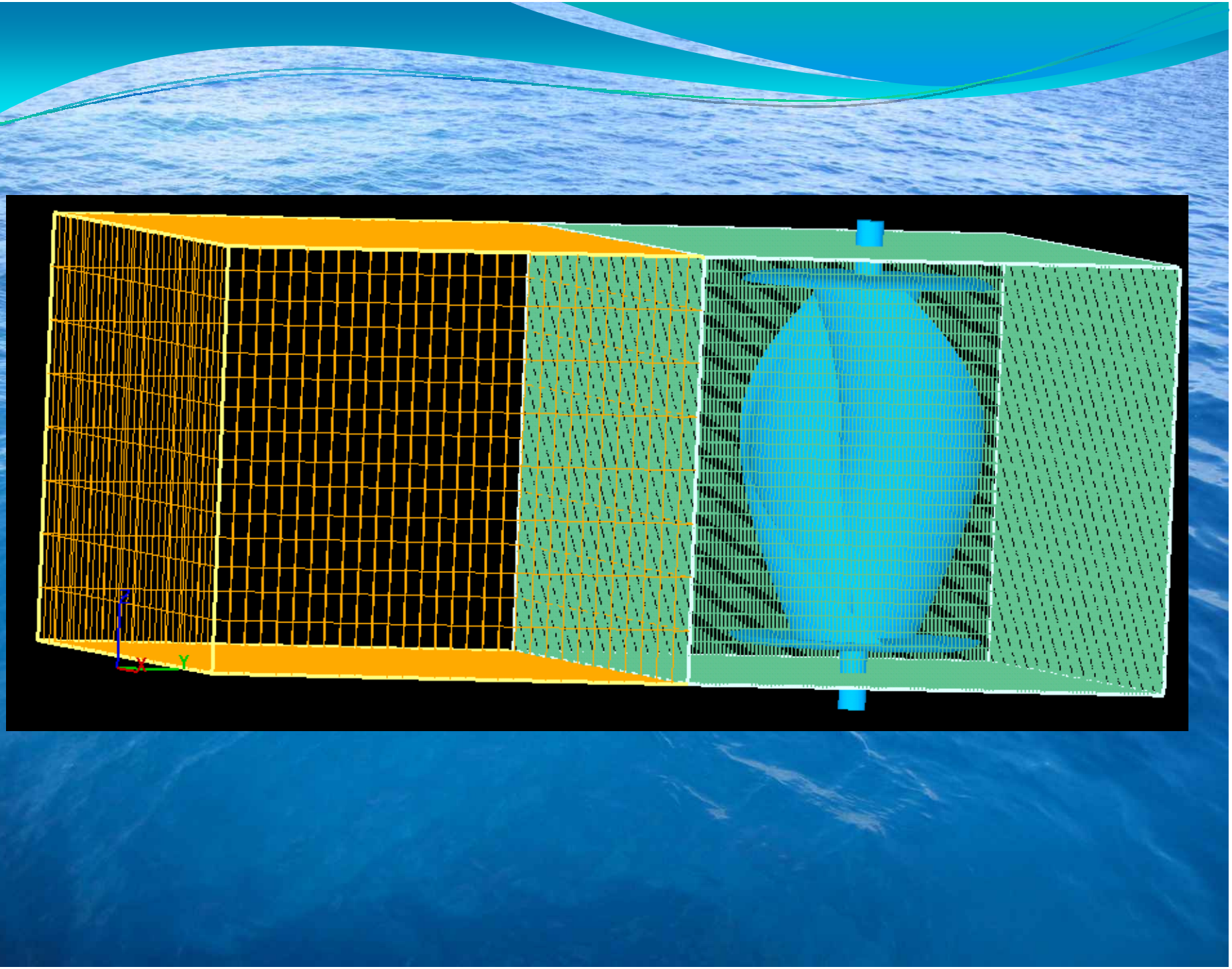


Model Setup

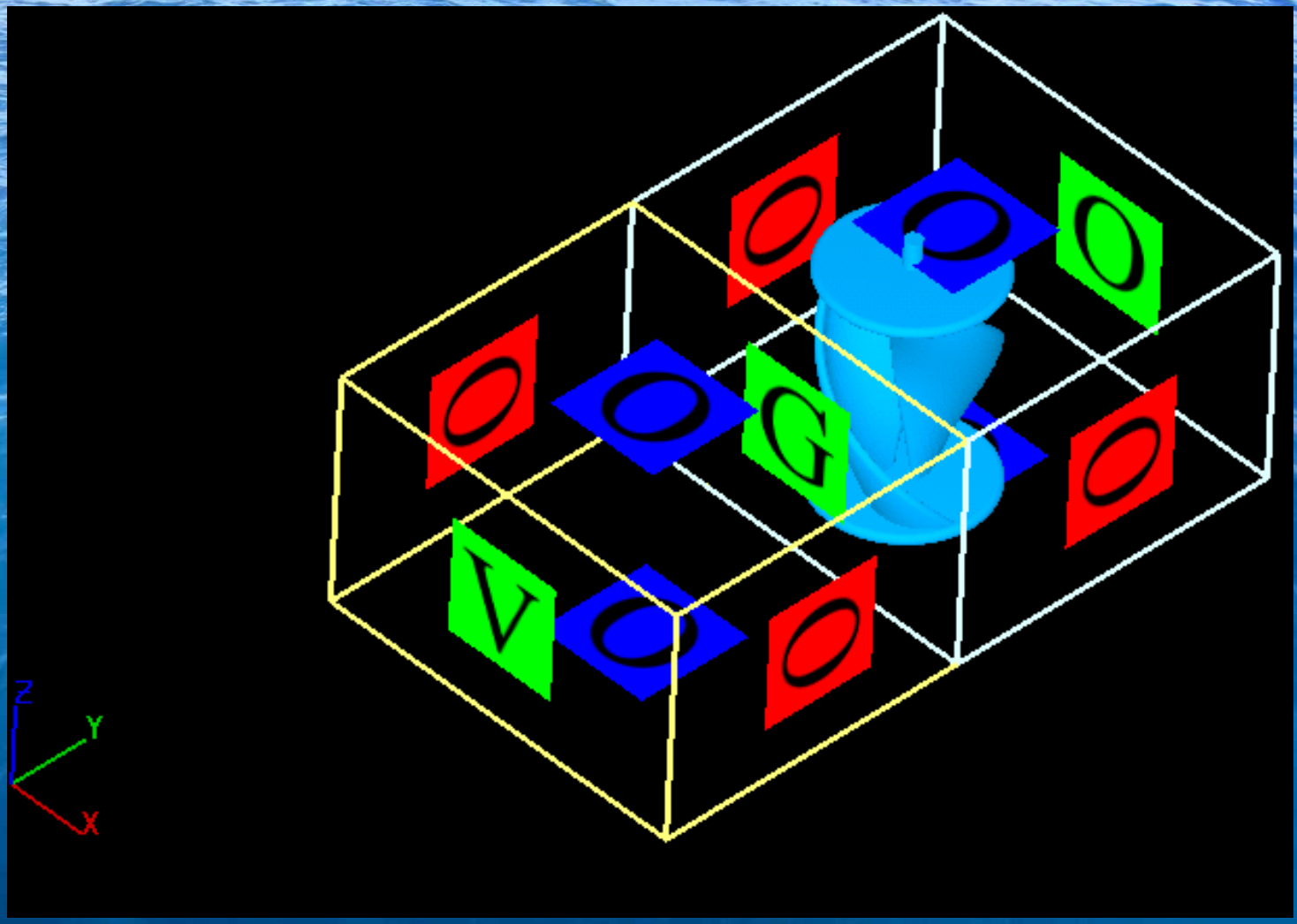

single - FLOW-3D - [Physics]
File Diagnostics Preference Utilities Simulate Help
Navigator
Model Setup
Simulate
Analyze
Display
General
Physics
Fluids
Meshing Geometry
Boundaries
Initial
Output
Numerics
Air entrainment
Gravity
Sediment scour
Bubble and phase change
Heat transfer
Shallow water
Cavitation
Mass sources
Solidification
Defect tracking
Moving and deforming objects
Surface tension
Density evaluation
Non-inertial reference frame
Thermal die cycling
Drift-flux
Particles
Viscosity and turbulence
Elastic stress
Porous media
Electro-mechanics
Scalars

Meshing and Geometry

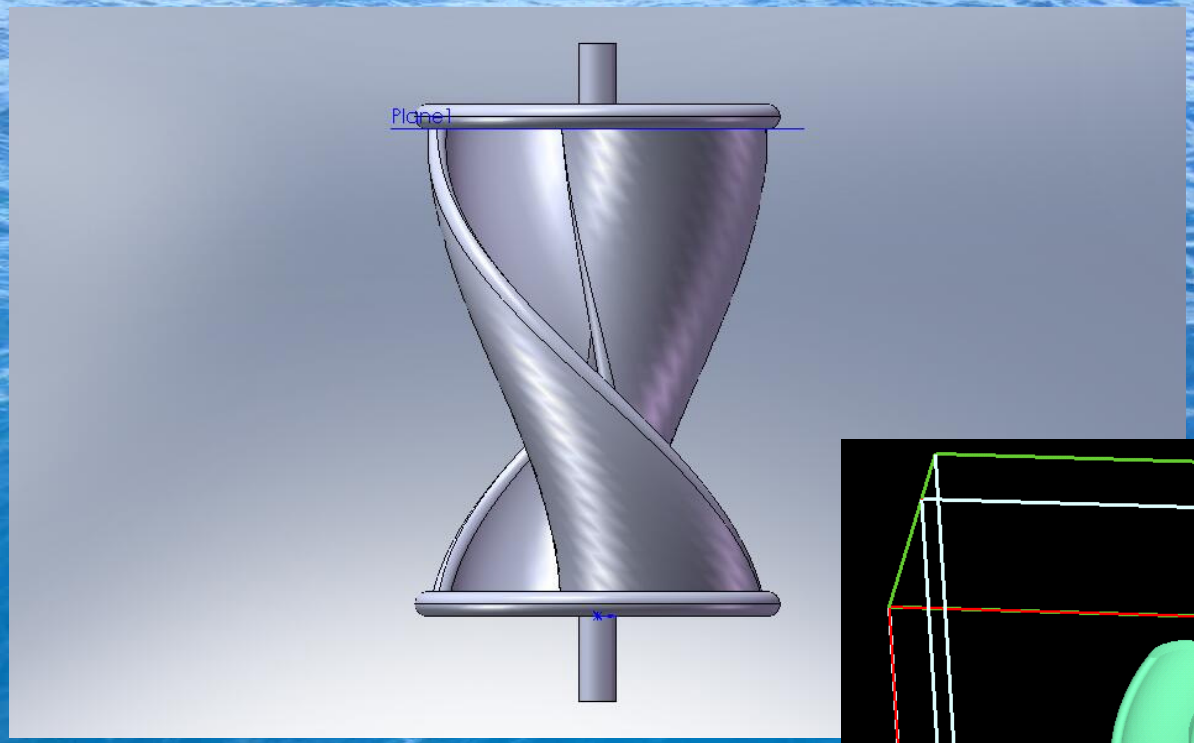


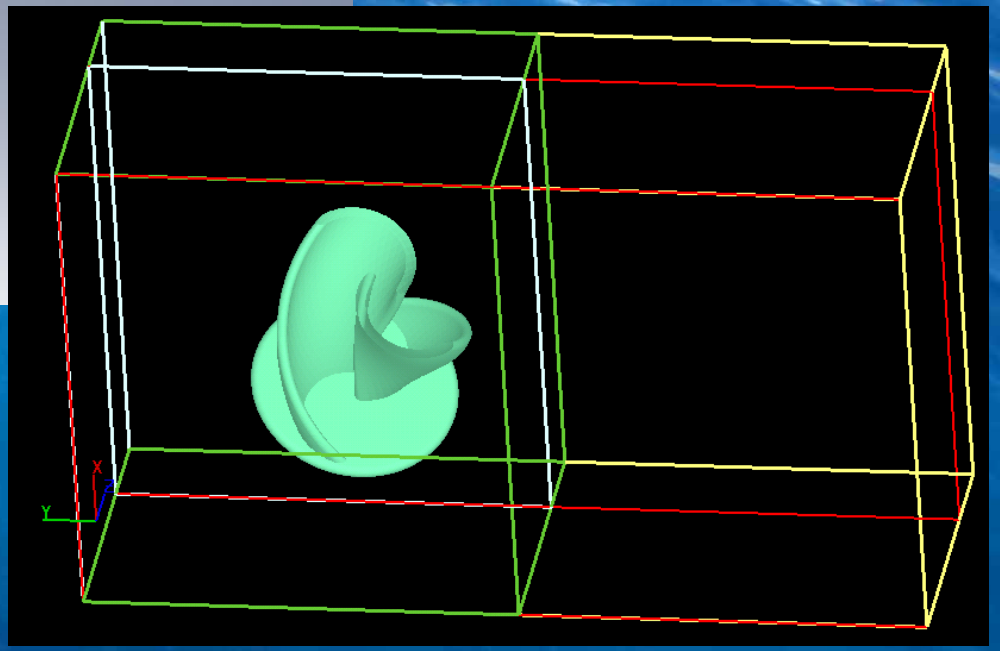

Z
Y

Boundary Conditions

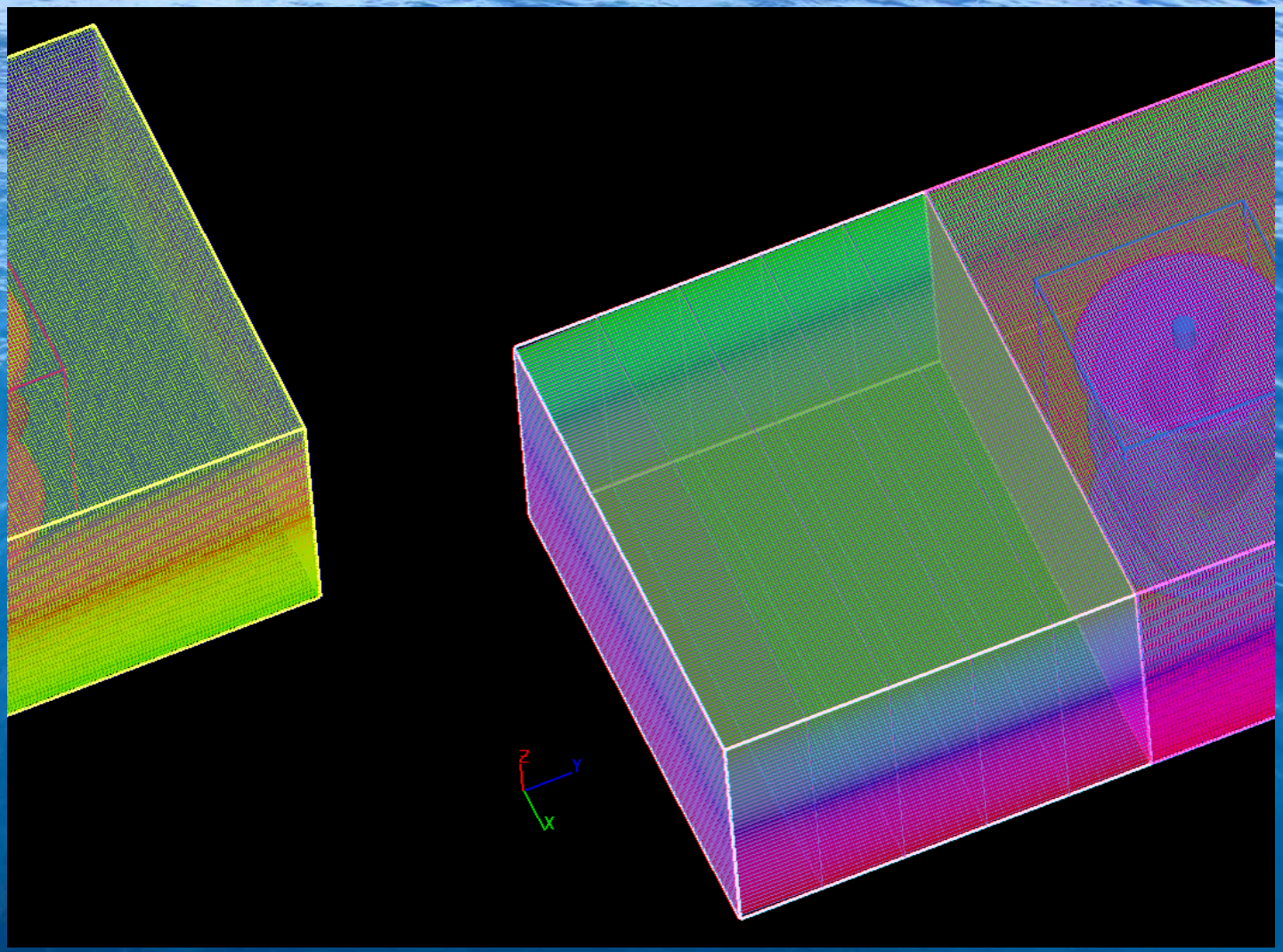


Twisted Savonius Rotor with Overlap Ratio

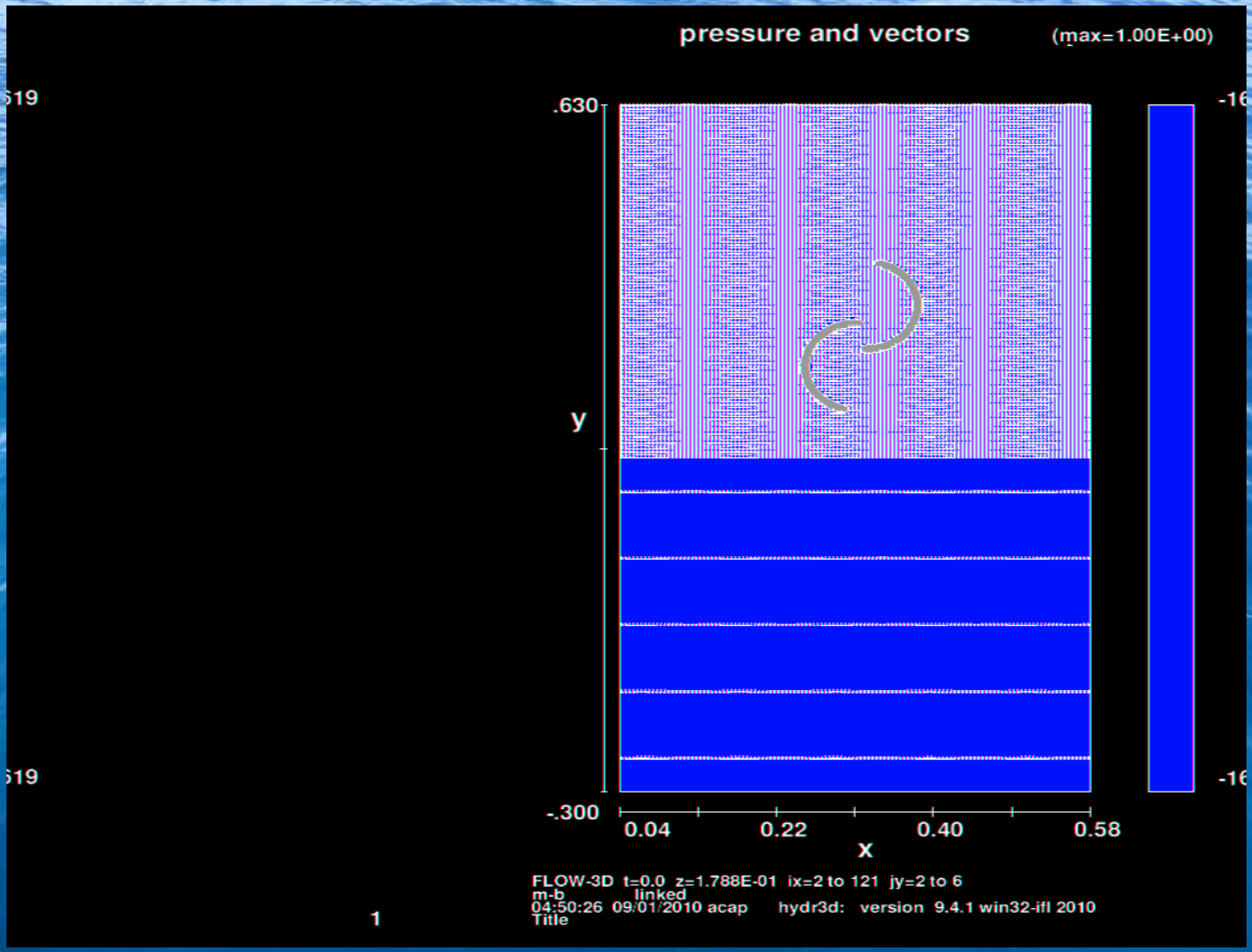




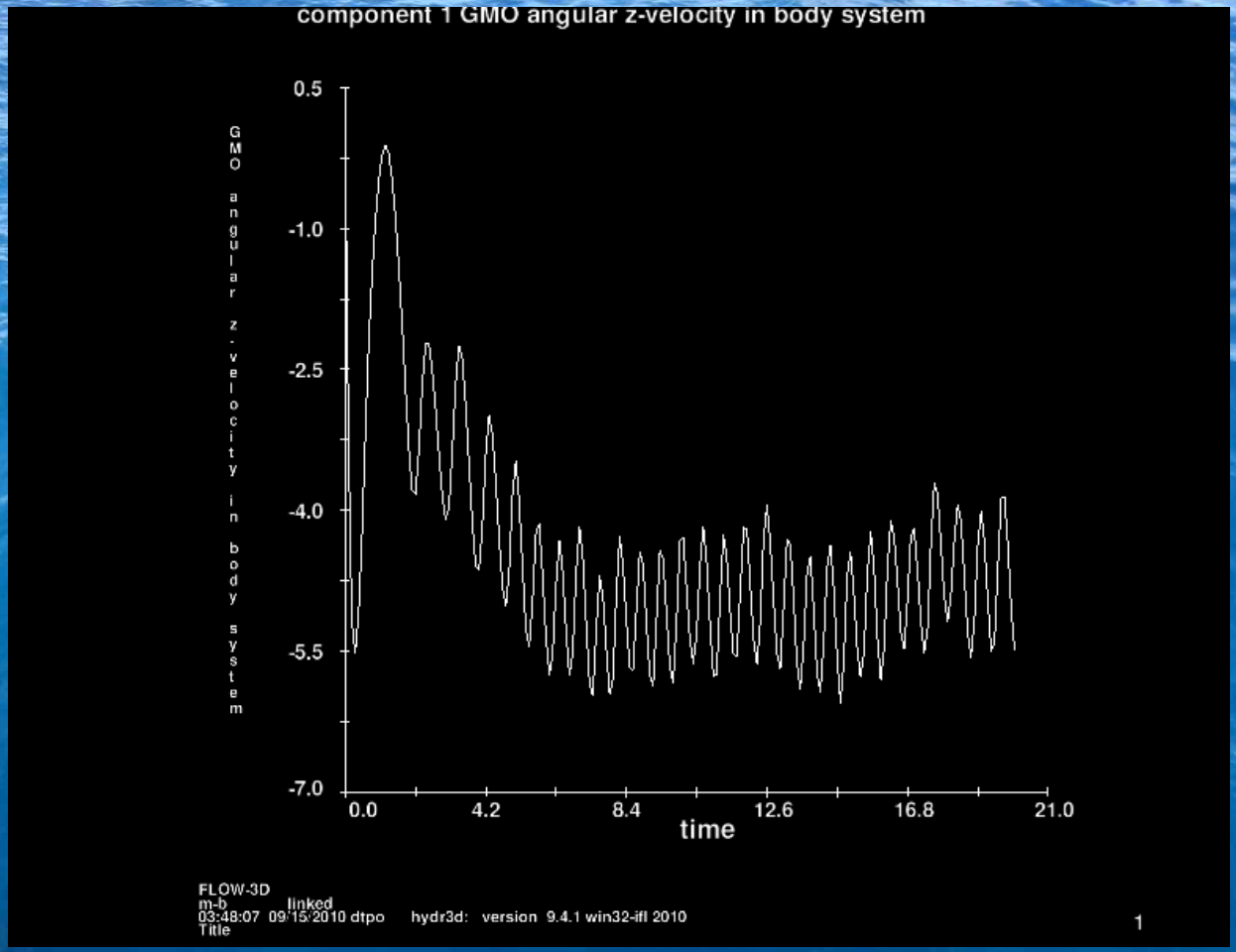
3D Animation



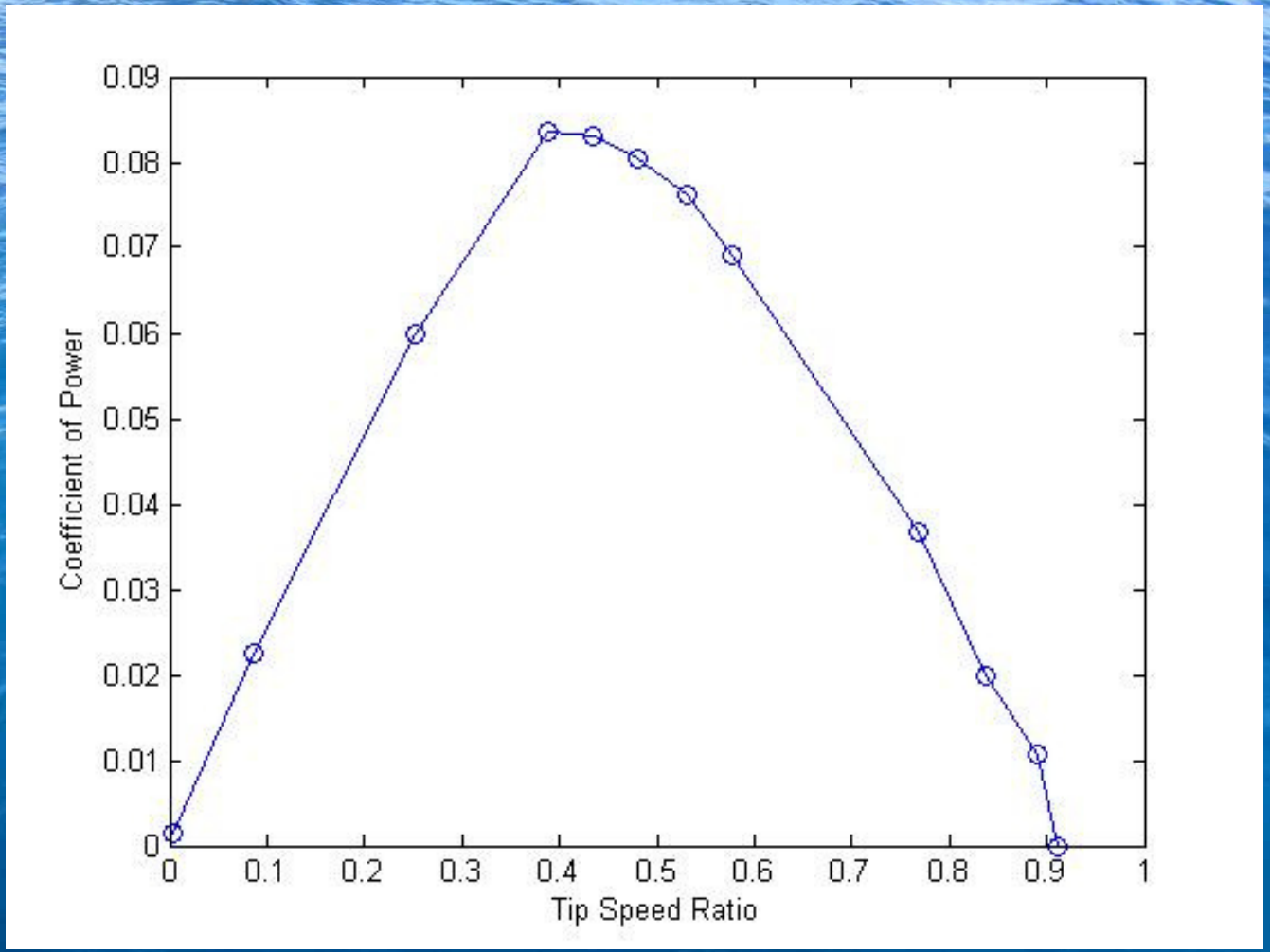
2D Animation



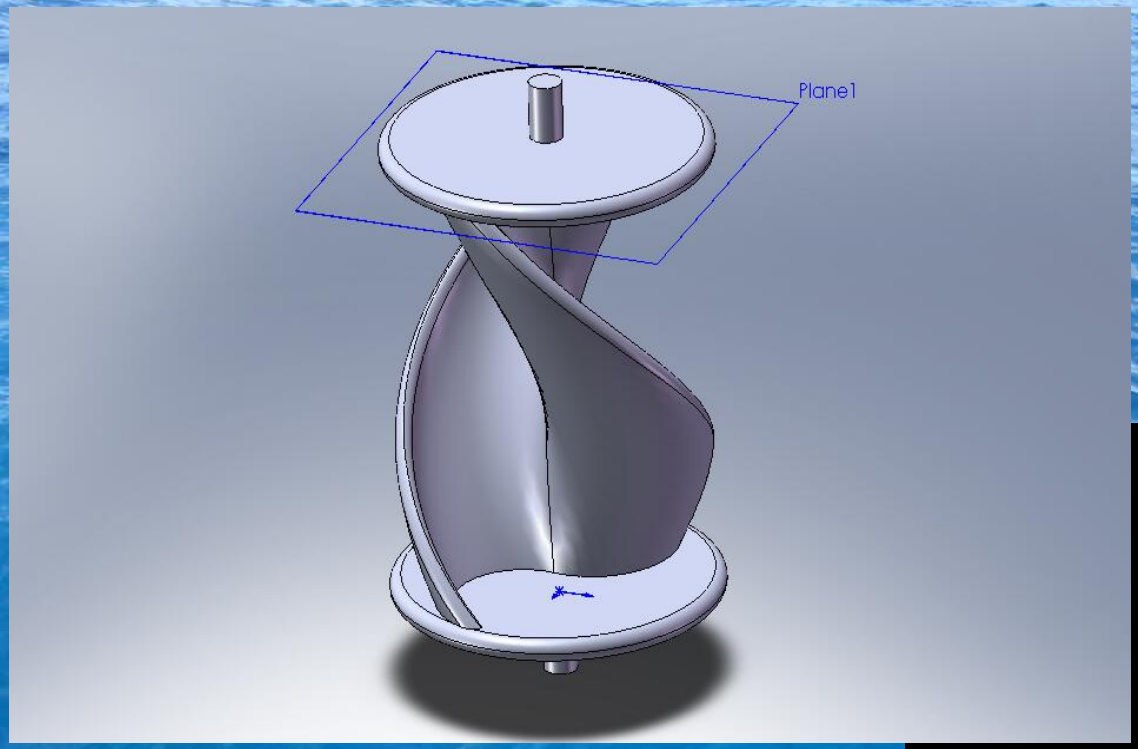
Angular Speed

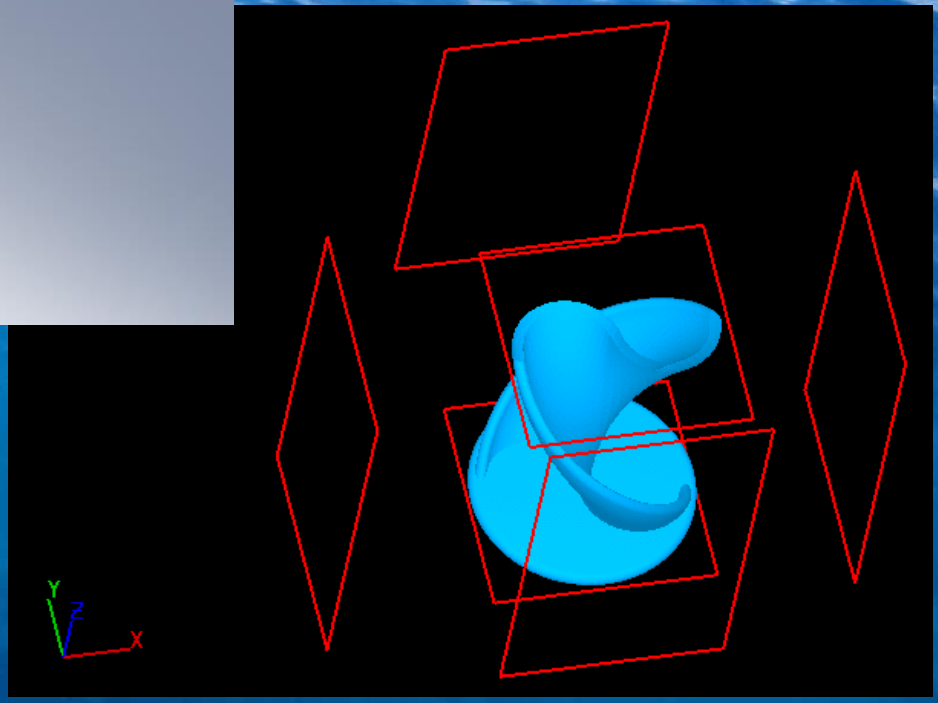


For Twisted Savonius with Overlap Ratio

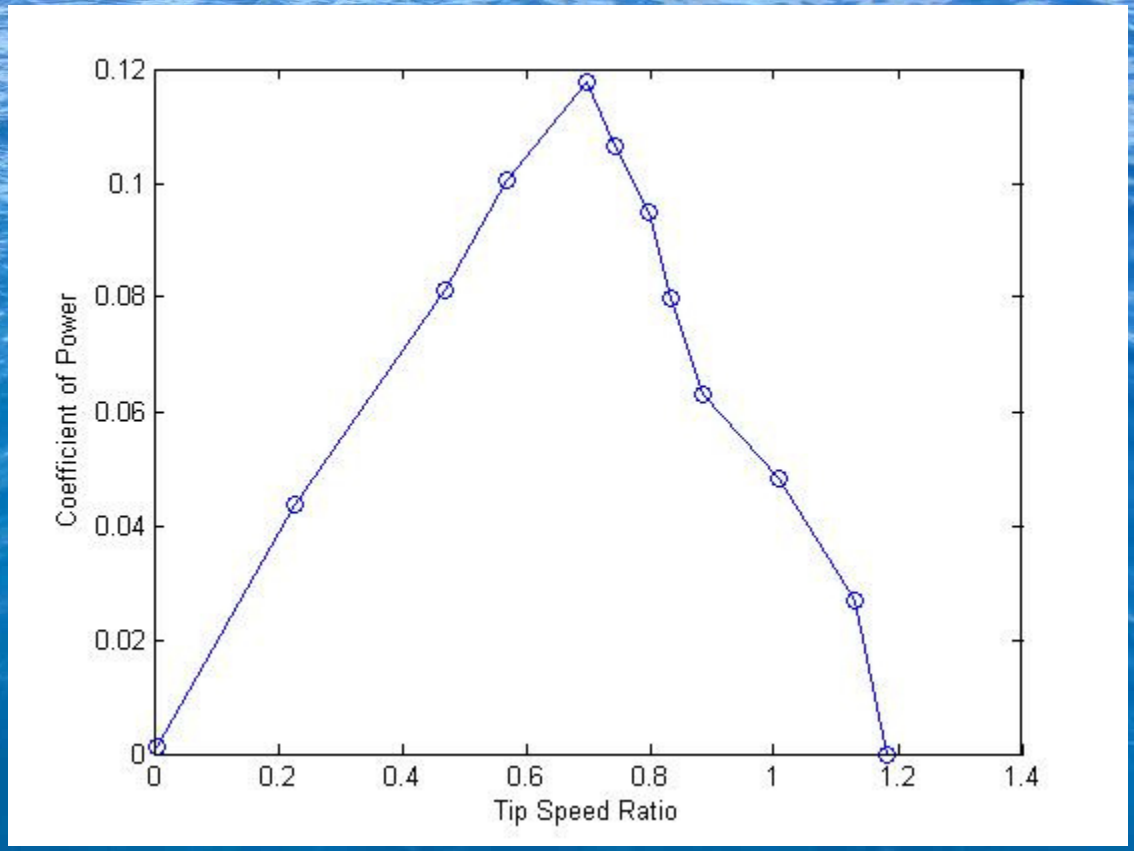


Twisted Savonius with Zero Overlap Ratio

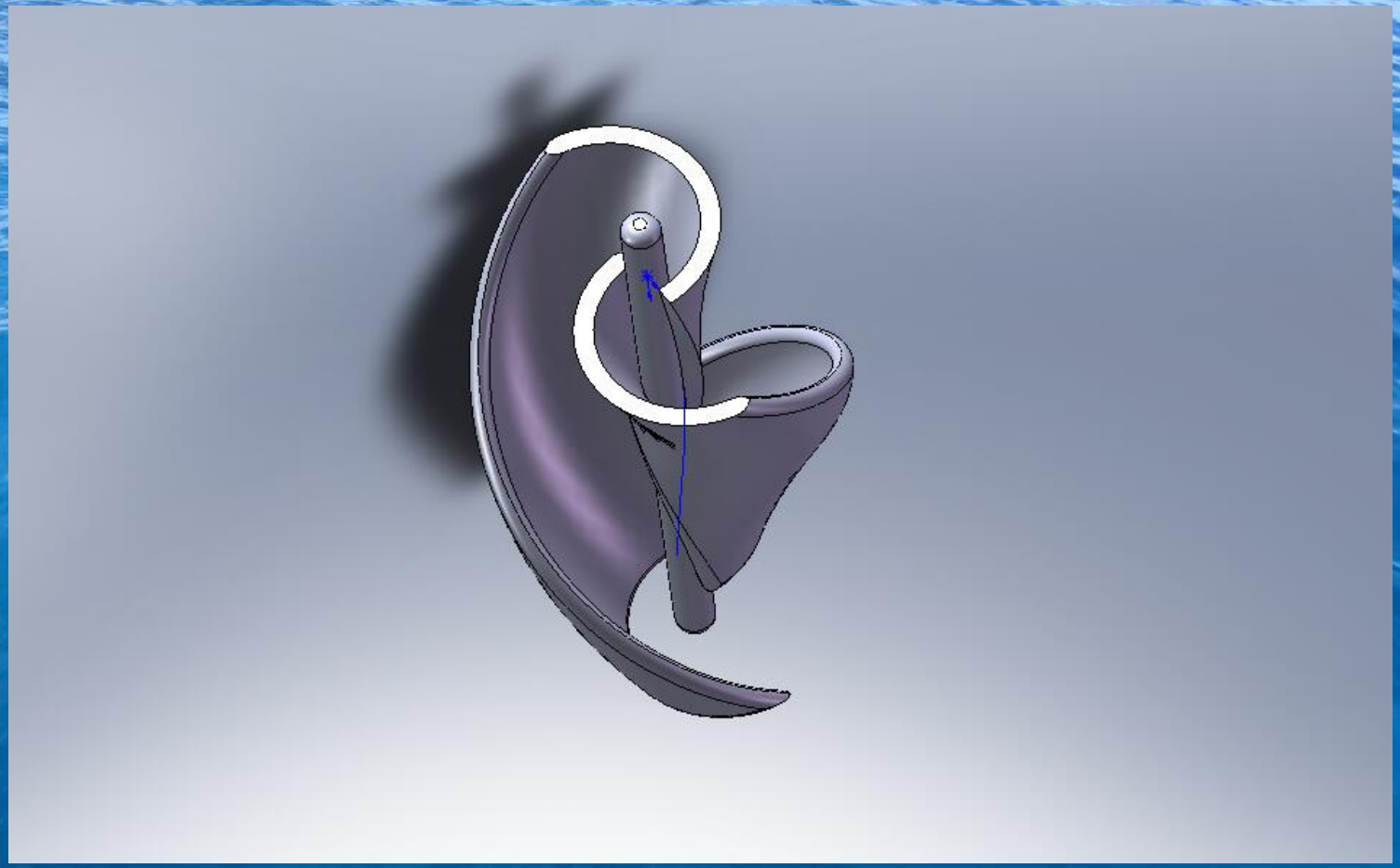




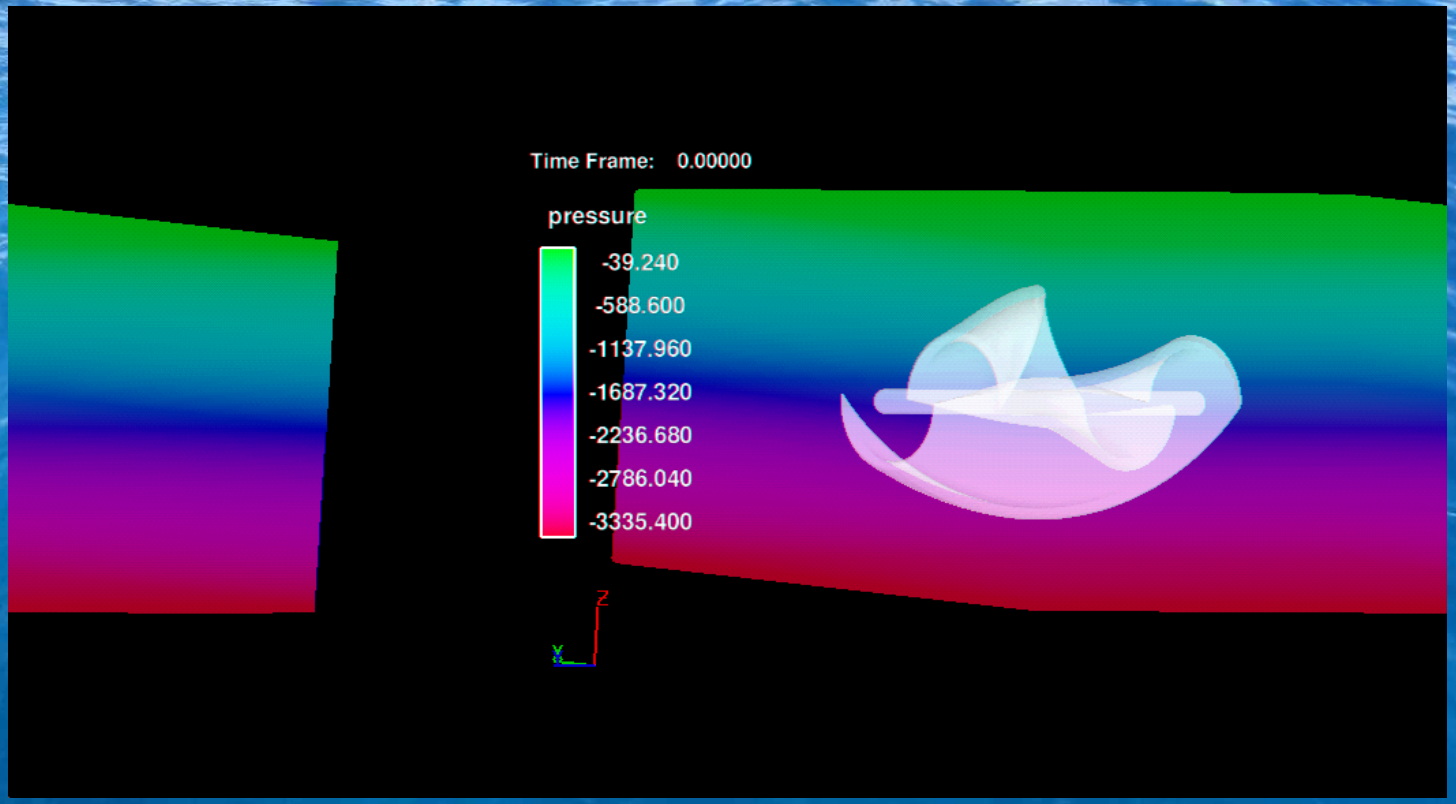
For twisted Savonius with Zero Overlap Ratio



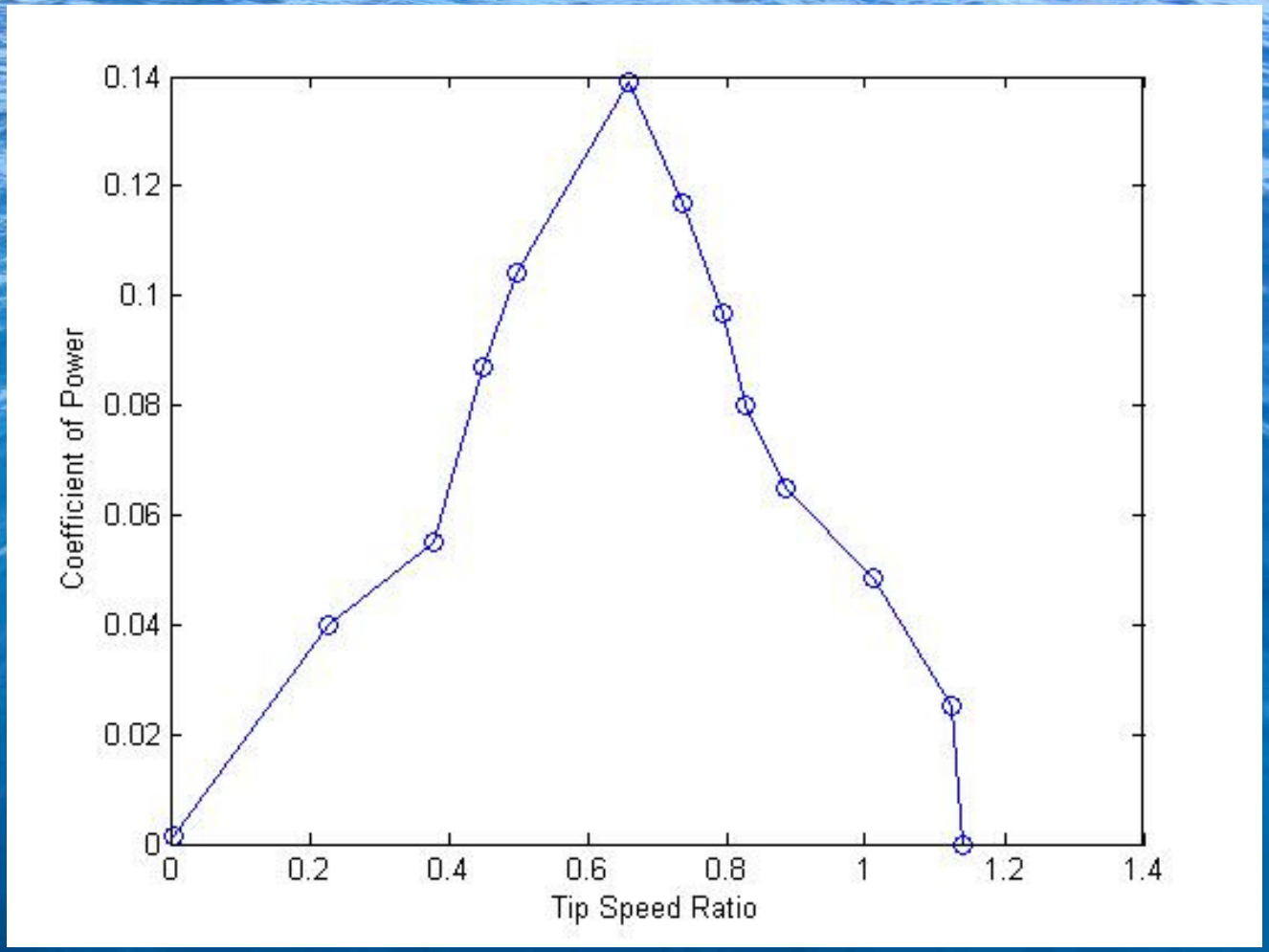
Twisted Savonius with no endplates



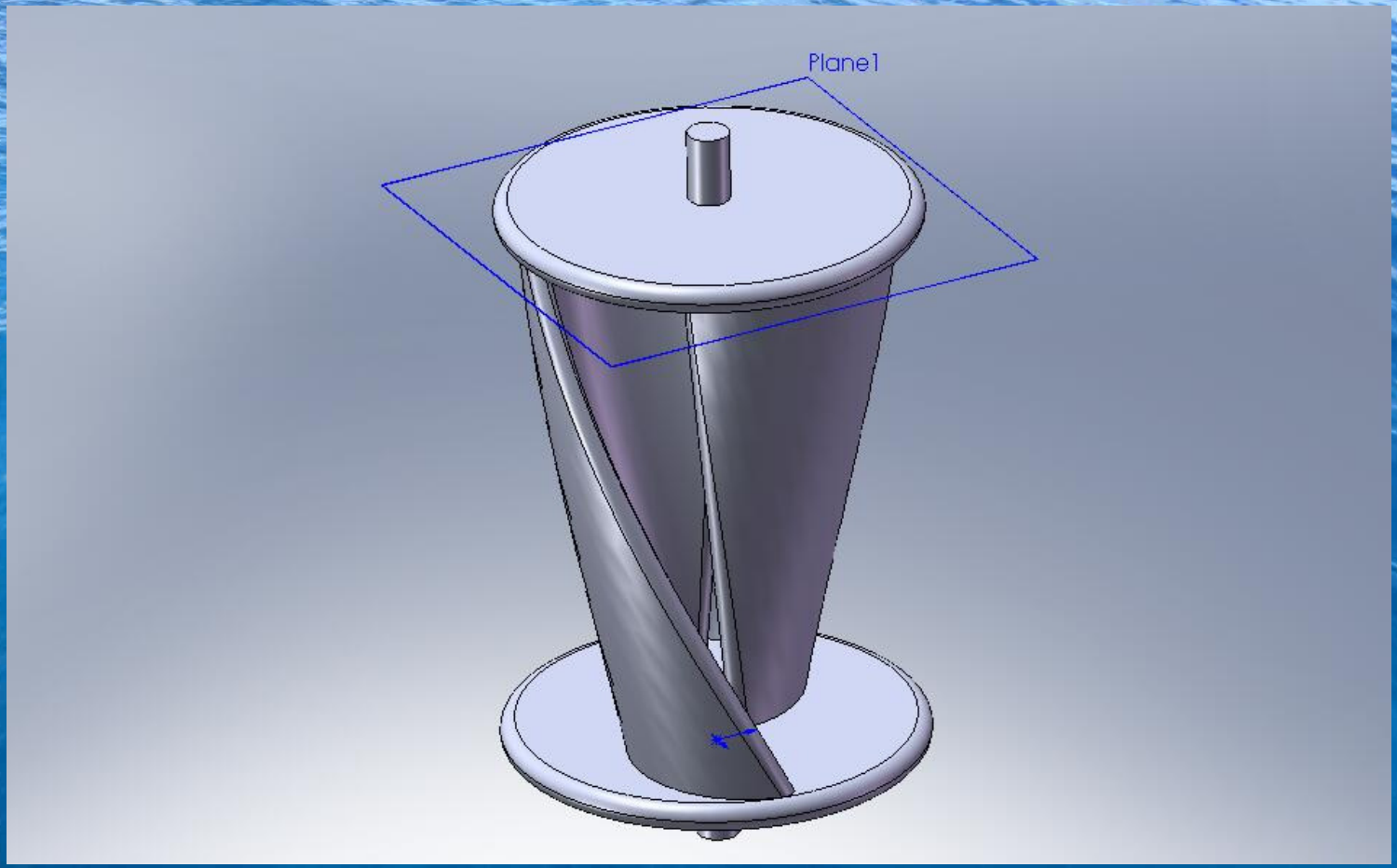
Horizontally Mounted Position 2



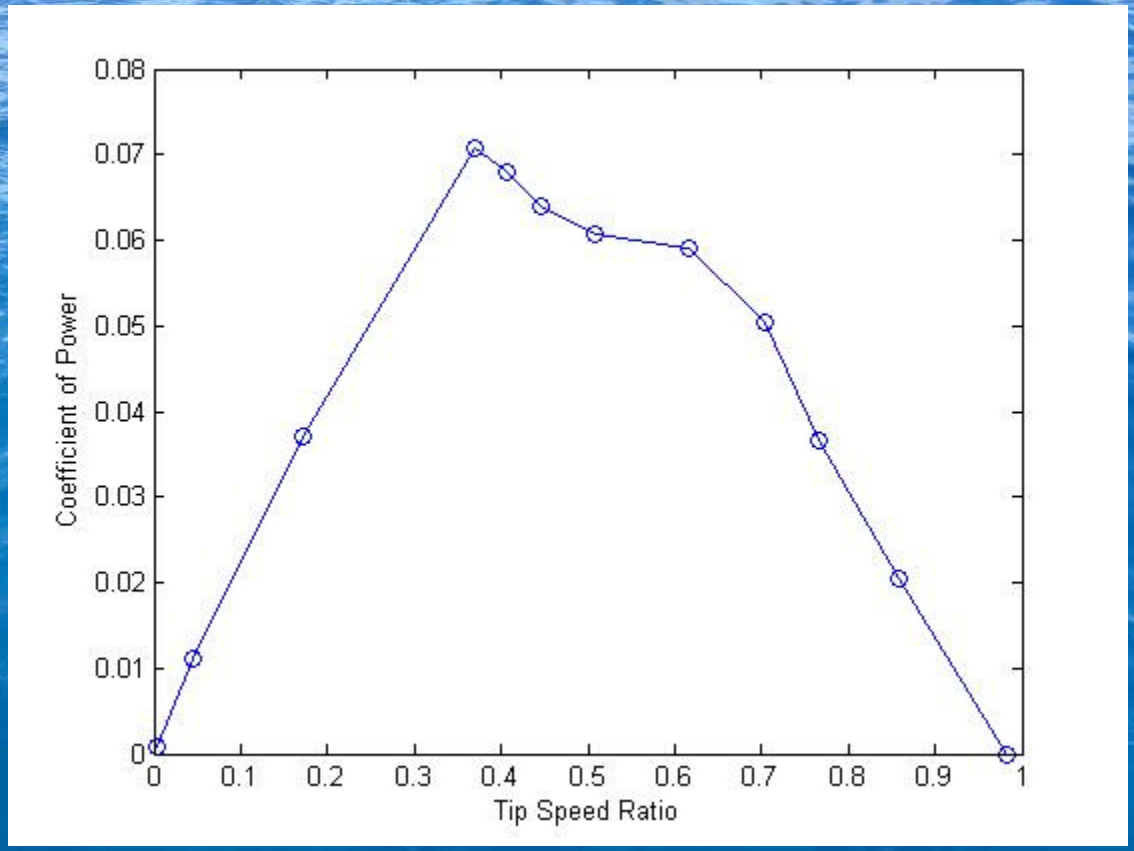
For Horizontally Mounted Position 2



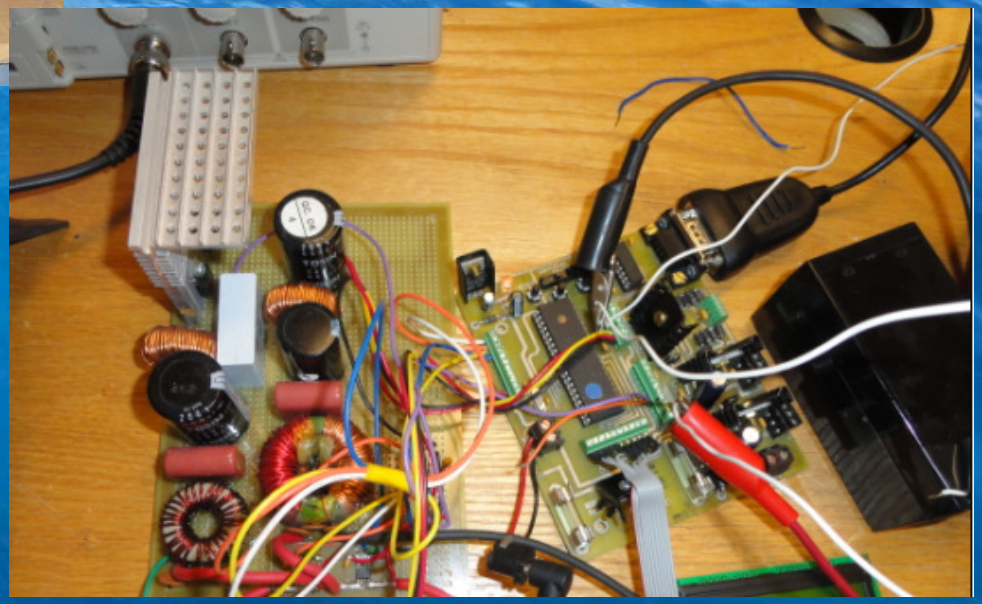
Quarter Pitched Twist



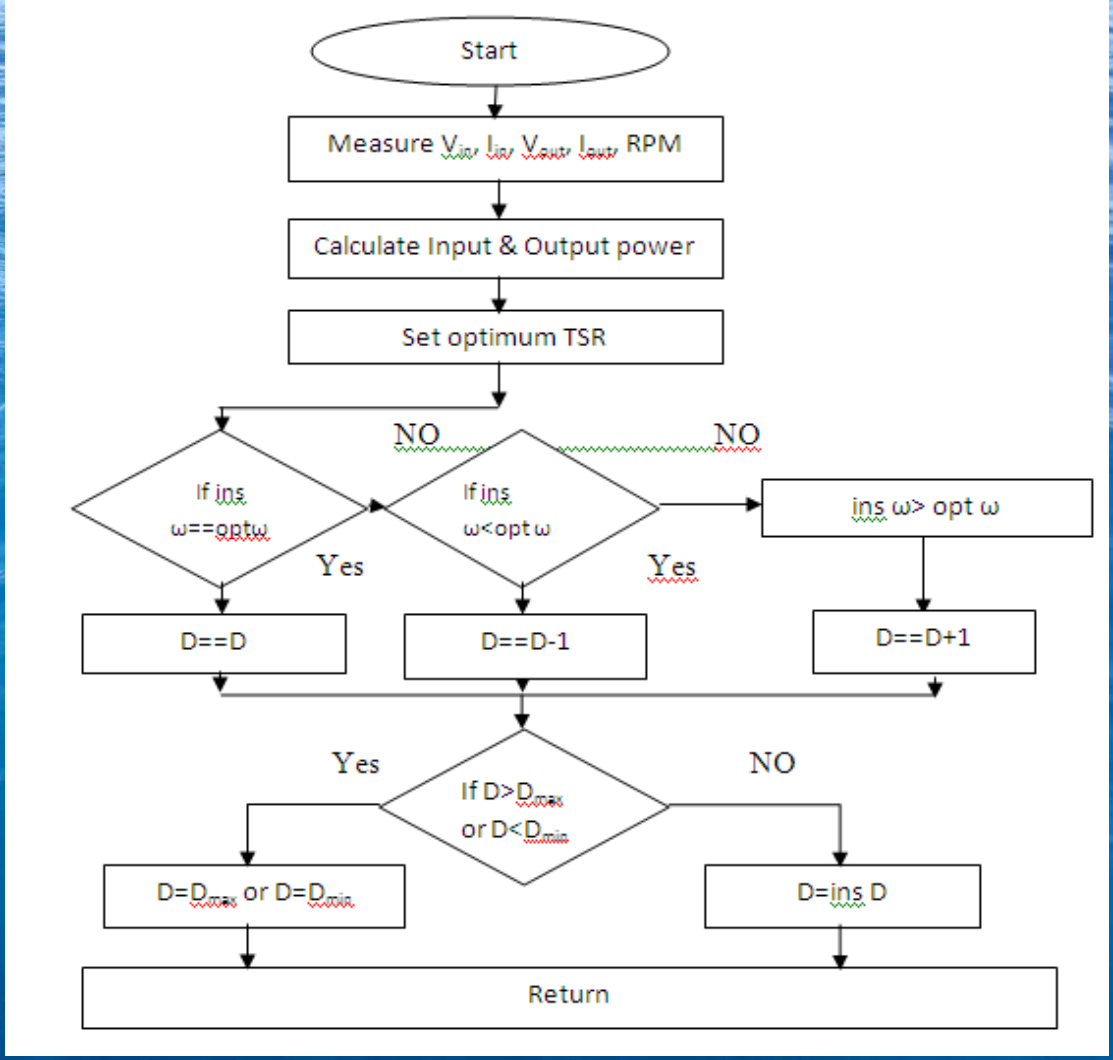
For Quarter Pitch Twisted Savonius Rotor



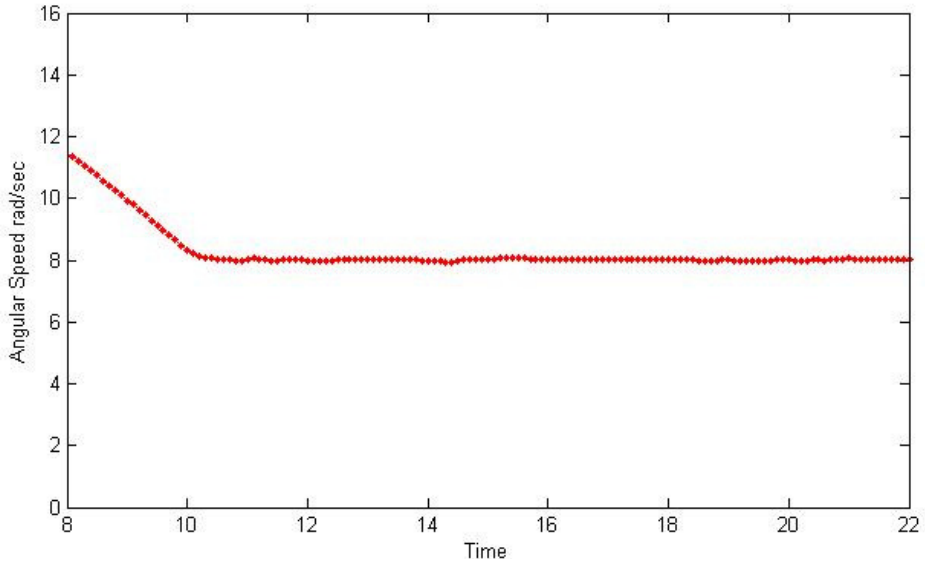
Twisted Savonius Turbine Emulator and Lab Set up

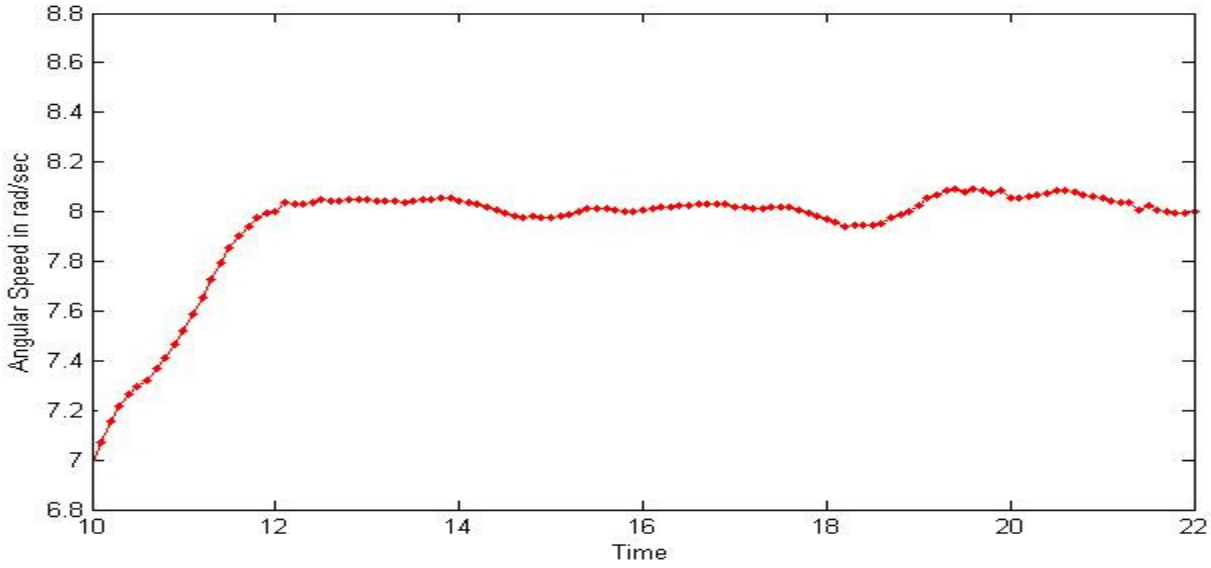


MPPT Algorithm



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

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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 11th Annual FLOW-3D European Users Conference, Monza, Italy
- “CFD Analysis of a Twisted Savonius Turbine”, The 18th 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


Thanks