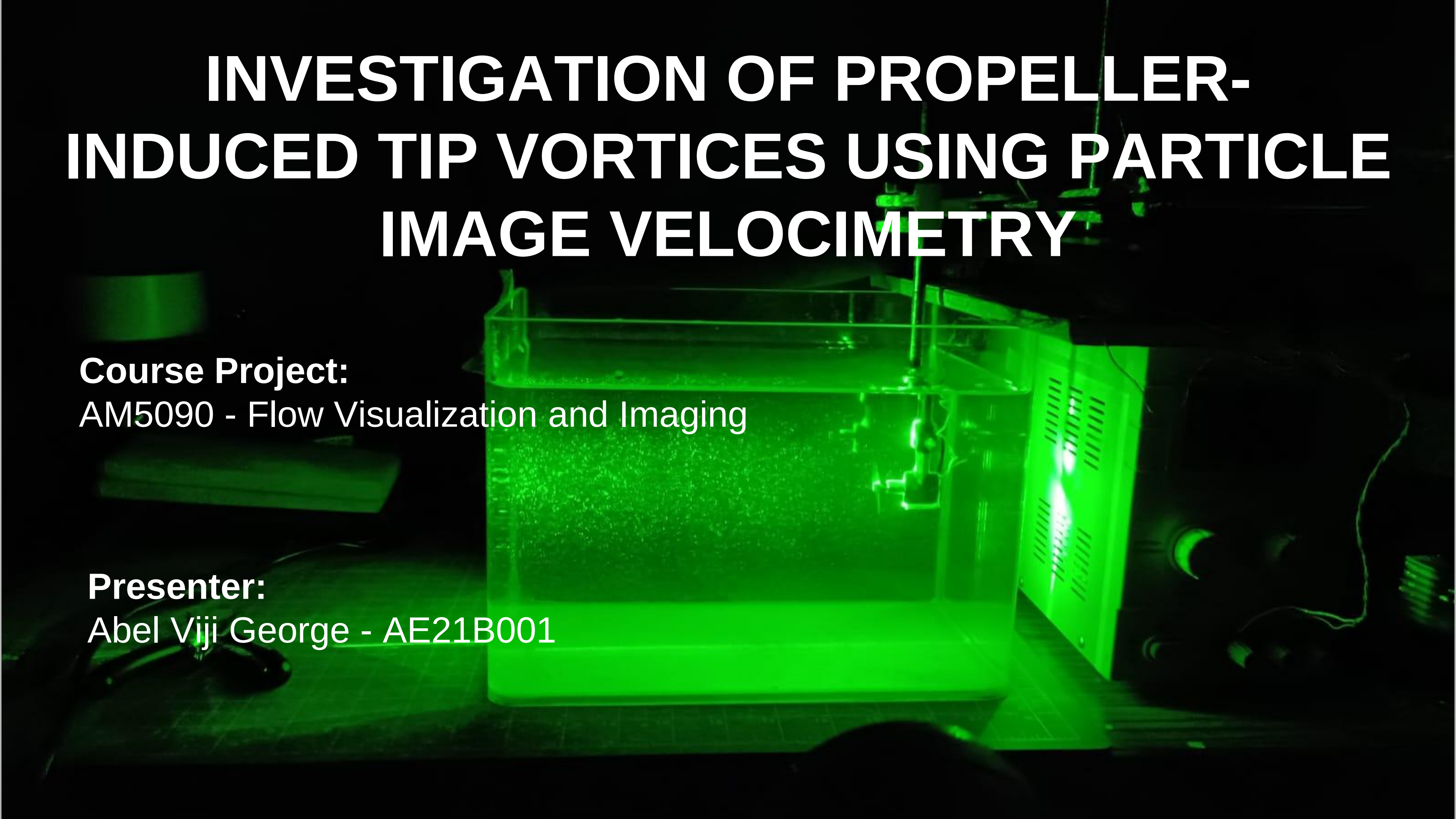


INVESTIGATION OF PROPELLER-INDUCED TIP VORTICES USING PARTICLE IMAGE VELOCIMETRY

Course Project:
AM5090 - Flow Visualization and Imaging

Presenter:
Abel Viji George - AE21B001

INTRODUCTION

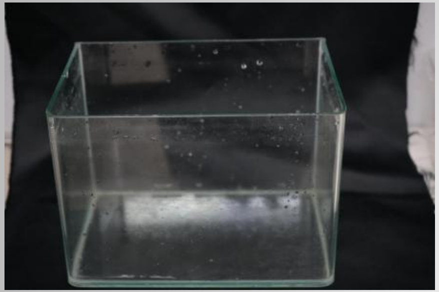
Objective:

- To set up a desktop PIV experiment to capture the flow induced due to rotating propellers.
- To study how vortices evolve in a quiescent flow purely due to the rotation of propellers.
- Compare the vortices generated due to a 2 bladed and a 3 bladed propeller.

Motivation:

- Three bladed propellers are known to be quieter than two bladed ones.
- Propeller noise can be attributed to the tip vortices [Miller et al. (1981) and Karimian et al.(2023)].
- Can we capture this trend?

APPARATUS



Glass Tank

2 bladed propeller

3 bladed propeller

Voltage Regulator

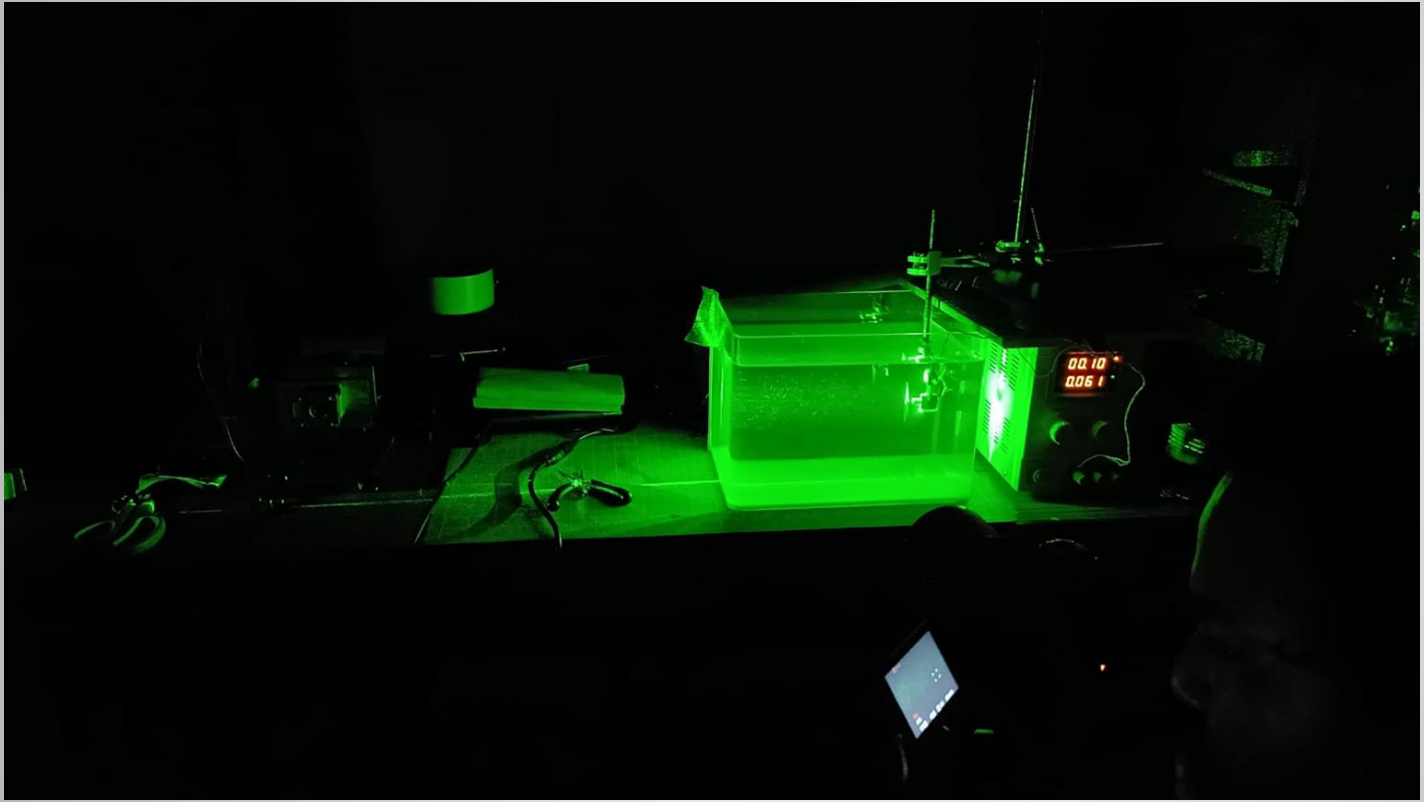
Laser-Lens-Assembly

Micro Coreless Motor

EXPERIMENTAL SETUP

Setup before the experiment

EXPERIMENTAL SETUP



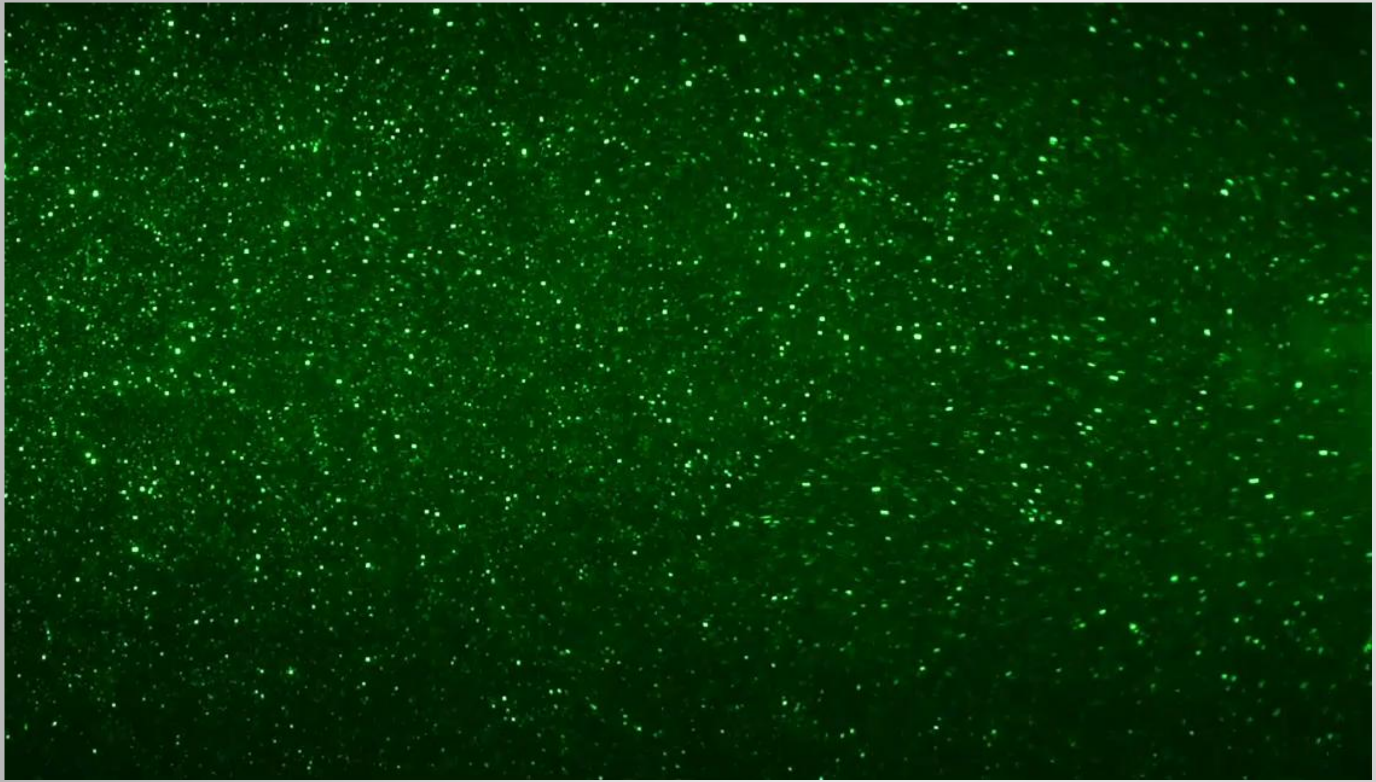
Setup after laser illumination

PROPELLER AND TANK CHARACTERISTICS

Property of Propeller	2 bladed Propeller	3 bladed propeller
Radius	22.5 mm	~ 22 mm
Mode of Manufacture	Purchased	Resin - 3D printed
Rotation speeds	0.07V, 0.1V, 0.2V, 0.3V, 0.5V	0.08V, 0.1V, 0.2V, 0.3V

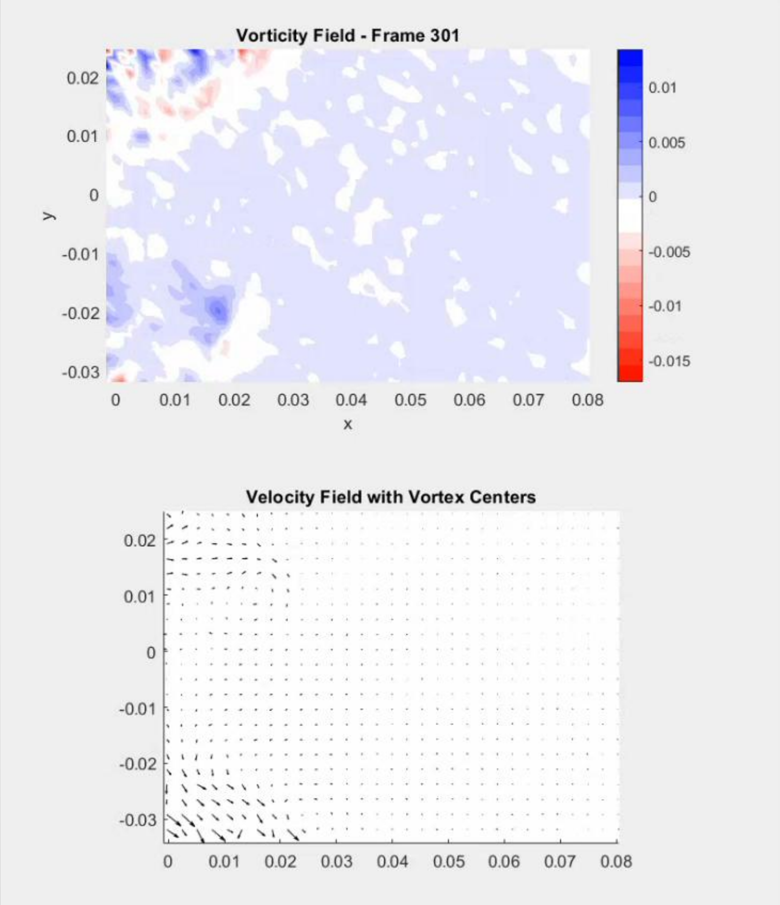
Property of Tank	Value
Length	26 cm
Width	17 cm
Depth	19 cm

RESULT OF PIV



Note: Video, cannot be played in PDF format

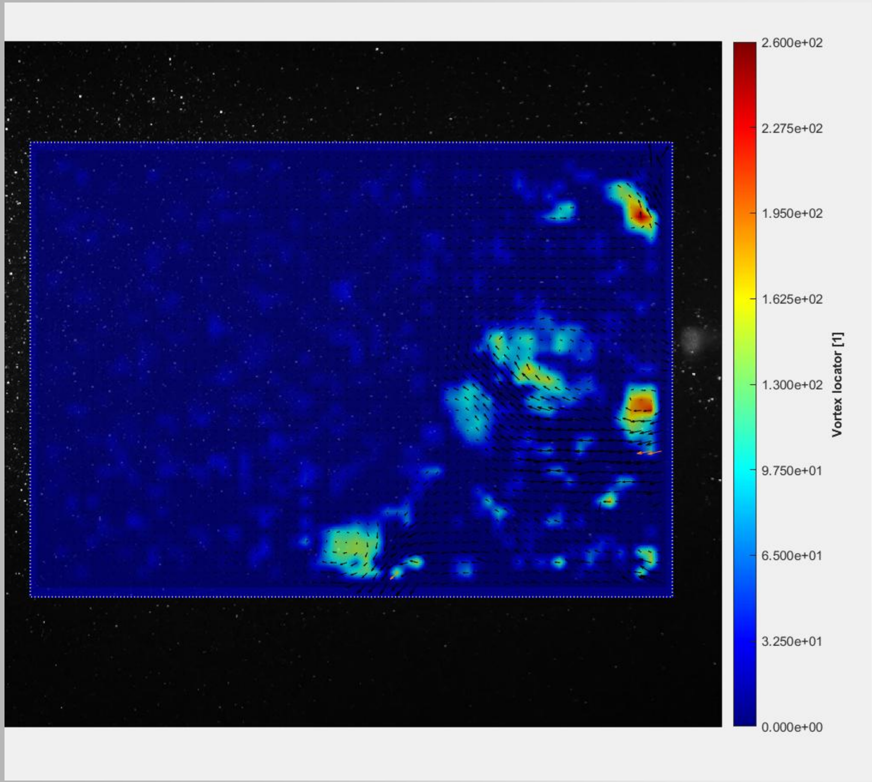
VORTEX PROPAGATION



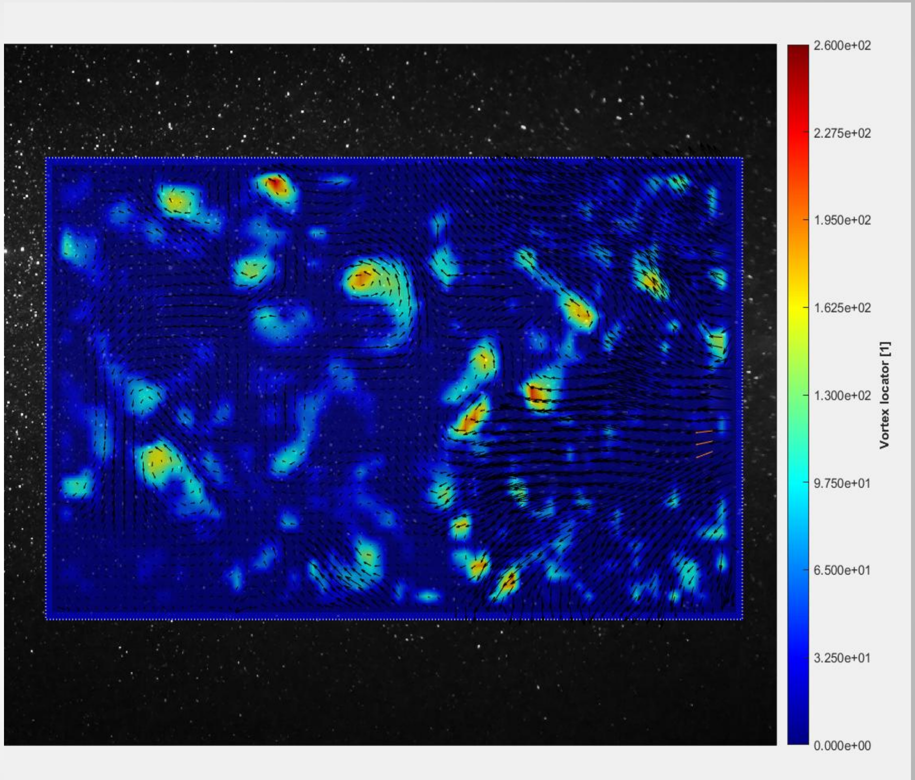
2 bladed, 1.56 rps

Note: Video, cannot be played in PDF format

VARIATION WITH RPM - TWO BLADE PROPELLER

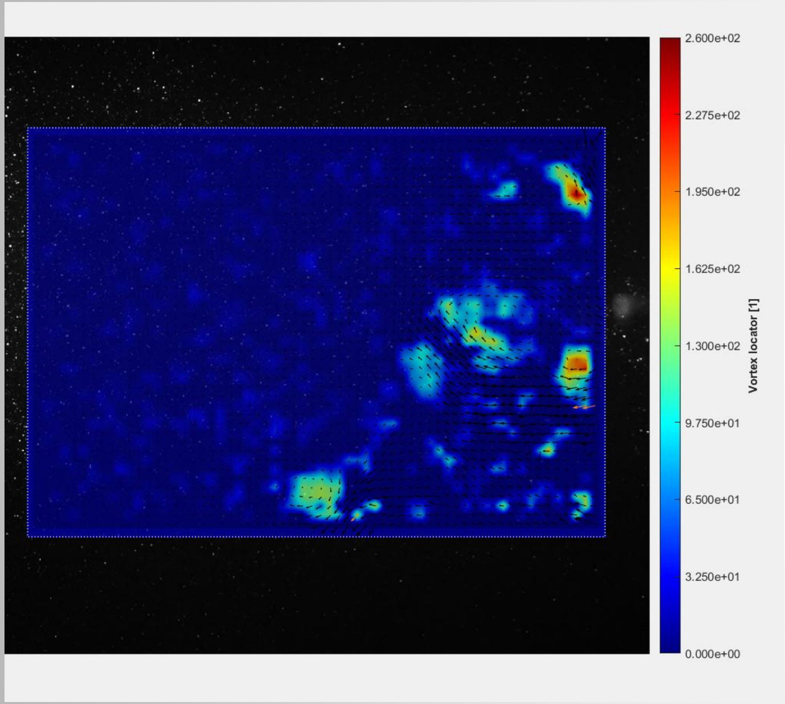


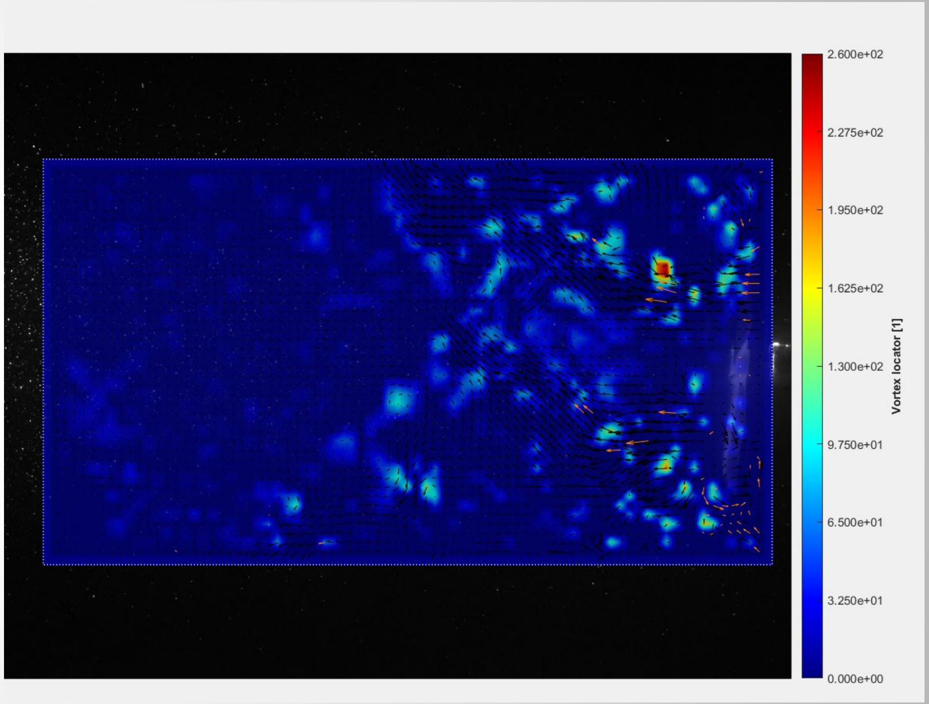
1.56 rps



3.91 rps

TWO BLADED VS THREE BLADED AT SAME RPM

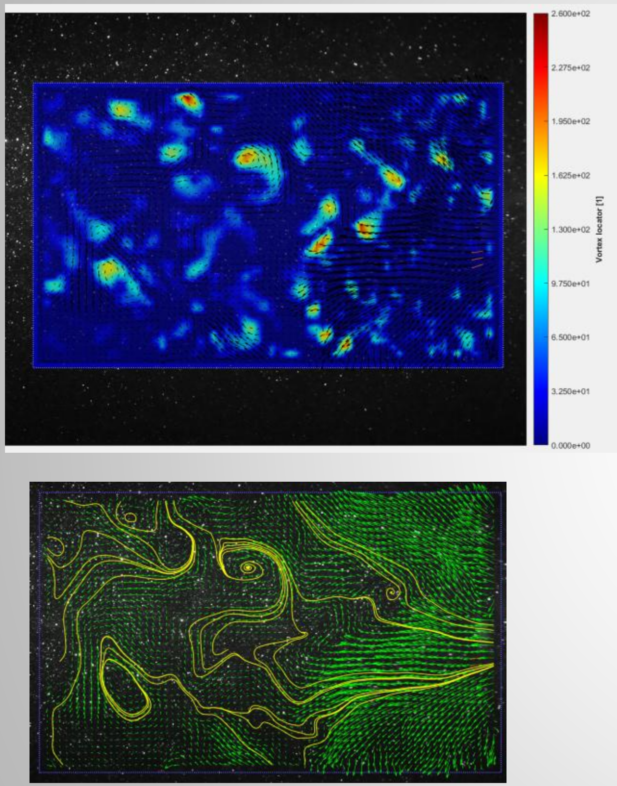




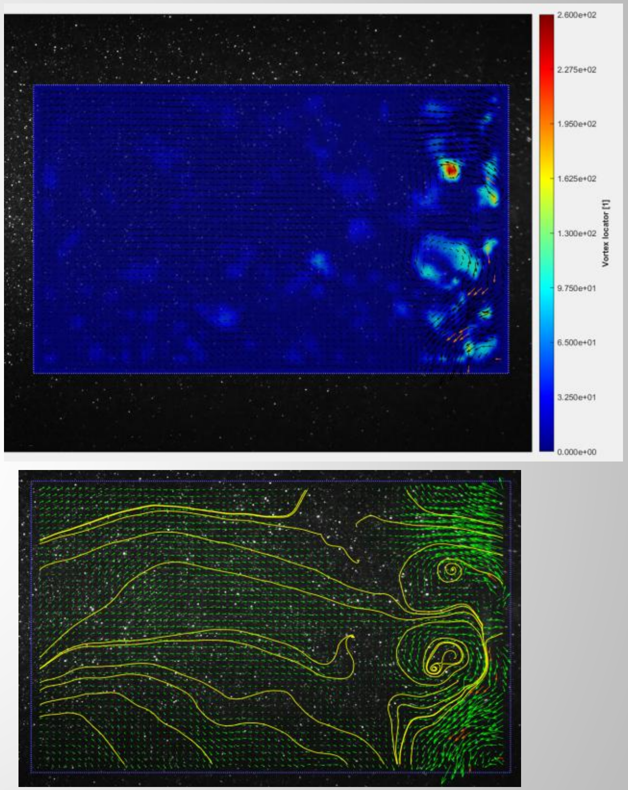
Two bladed propeller vortices ~ 1.5 rps

Three bladed Propeller vortices ~ 1.5 rps

EFFECTS OF FINITENESS OF DOMAIN



Before reverse flow



Suppressed vortices

CONCLUSIONS AND FURTHER ANALYSIS

Observations

- Higher RPMs generate more and longer-lasting tip vortices.
- 2-blade propellers produce more distinct, long-lived vortices.
- 3-blade vortices are closer, interact more, and dissipate faster.
- Reverse flow from domain boundaries dampens vortices unless captured early.

What next?

- Track the number of vortices per frame and plot versus time supporting observations on vortex transport, decay, and backflow effects.
- Compare the vorticity contours due to the two balded and three bladed propellers.

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THANK YOU!