IOT R&D Activities in Supporting the 25th ITTC Ice Committee Work

Michael Lau
Institute for Ocean Technology
Canada

Outline

- ITTC ice committee mandate

- Overview of IOT's R&D activities in supporting the committee mandate

Recommendation from 24th ITTC

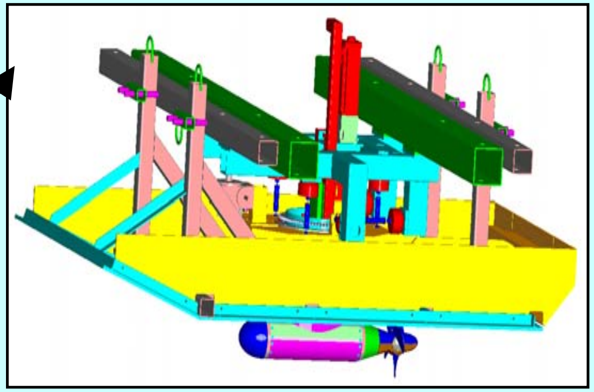
- (1) Develop a procedure for testing of podded propellers in ice
- (2) Develop a procedure for ship tank testing in brash ice.
- (3) Review existing testing procedures used to determine loads and responses of offshore structures in ice

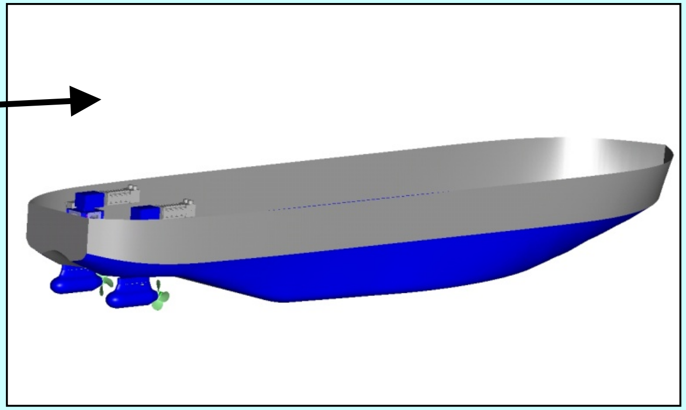
IOT's R&D Activities Related to Committee's Mandate No. 1

- Develop a procedure for testing podded propellers in ice tank

  – Phase 1: (a) development of pod model and measure of ice impact and milling load on podded propellers–Akinturk and Wang (2004-2007)

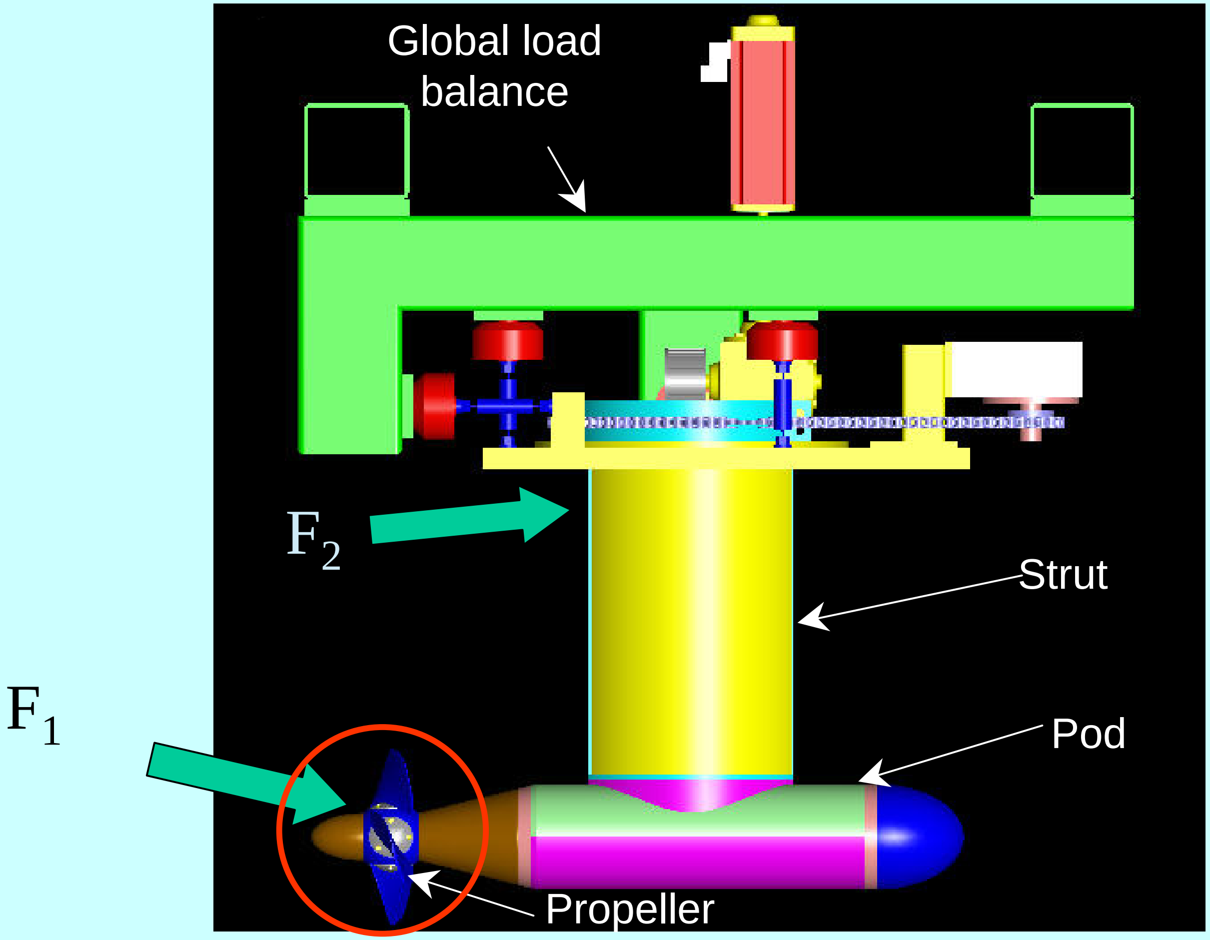
  – Phase 2: Simulating vessels driven by podded propulsors – Lau and Akinturk (2008)



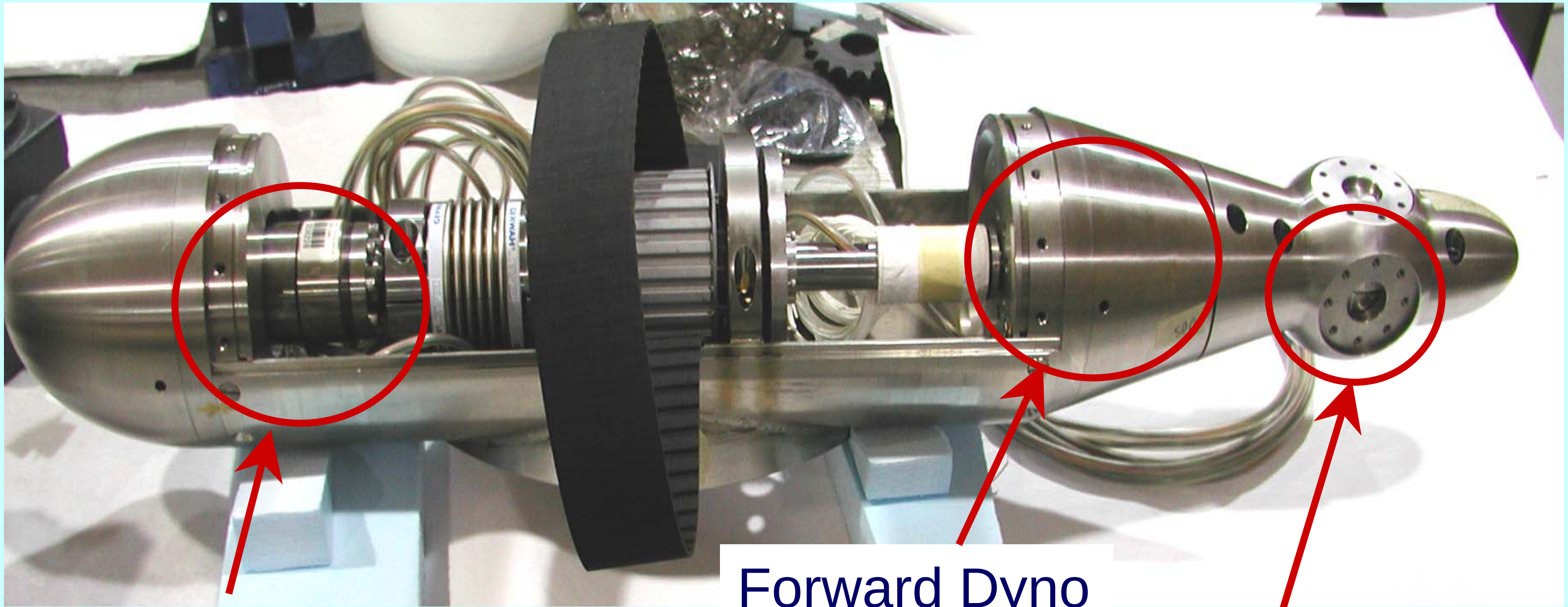


Phase 1: Ice Loads on Pods

Partially assembled model showing the measuring system



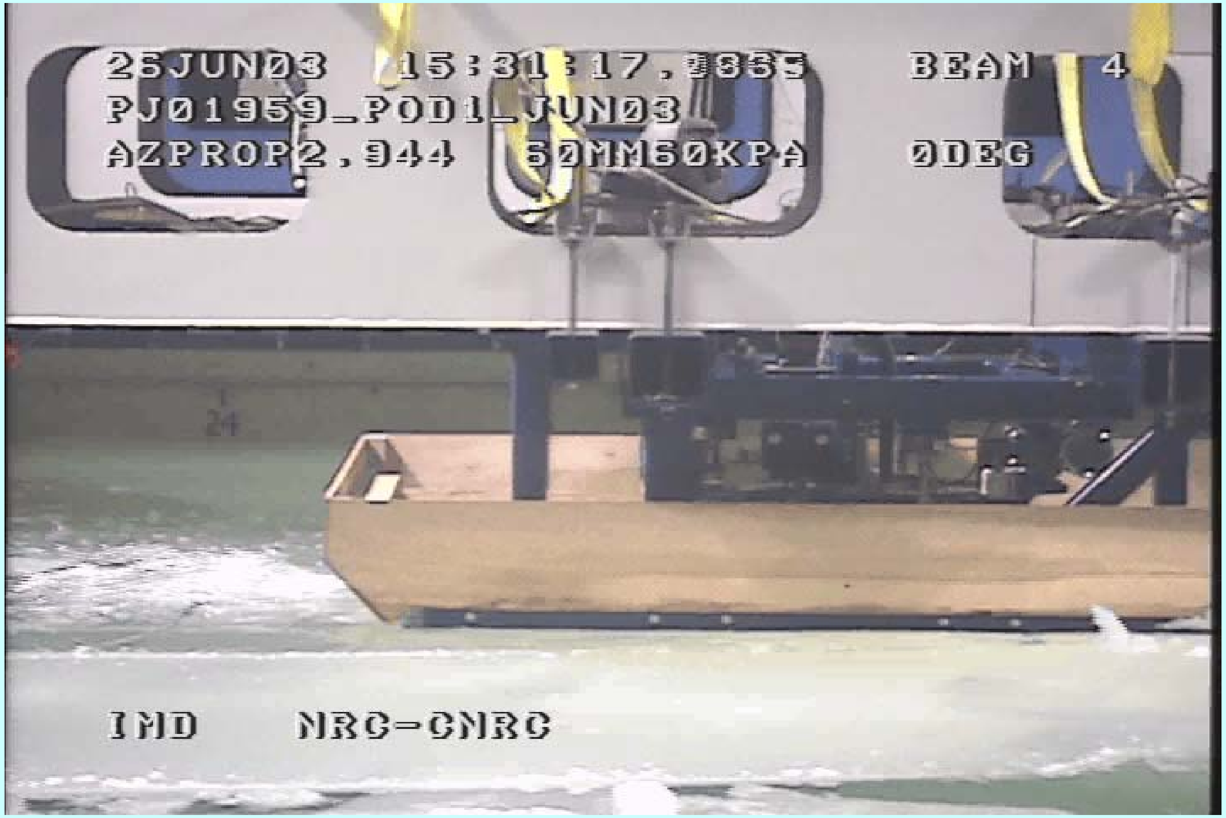
Pod Assembly



Ice-Pod Interaction Experiment

Fully assembled model

Example Run – ice impact load (pre-broken ice)

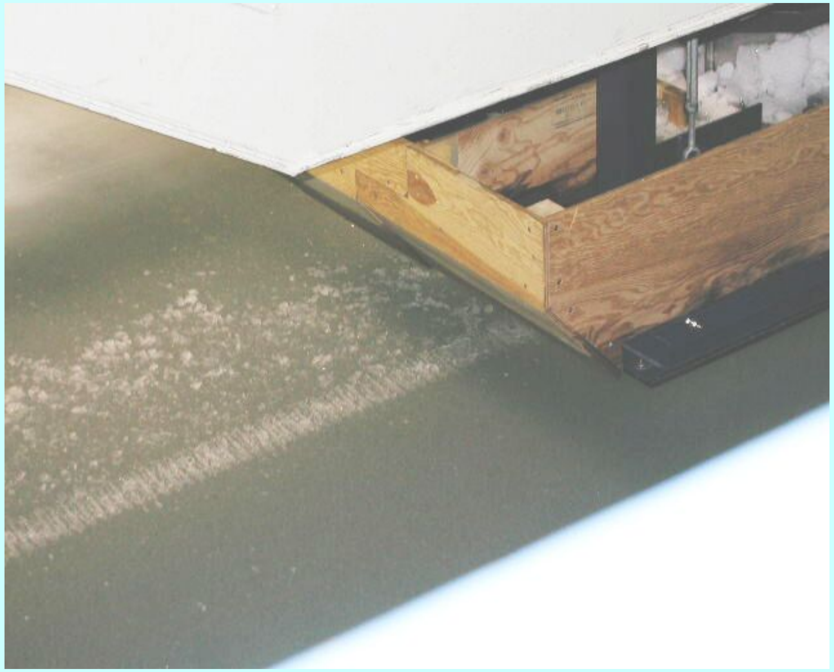


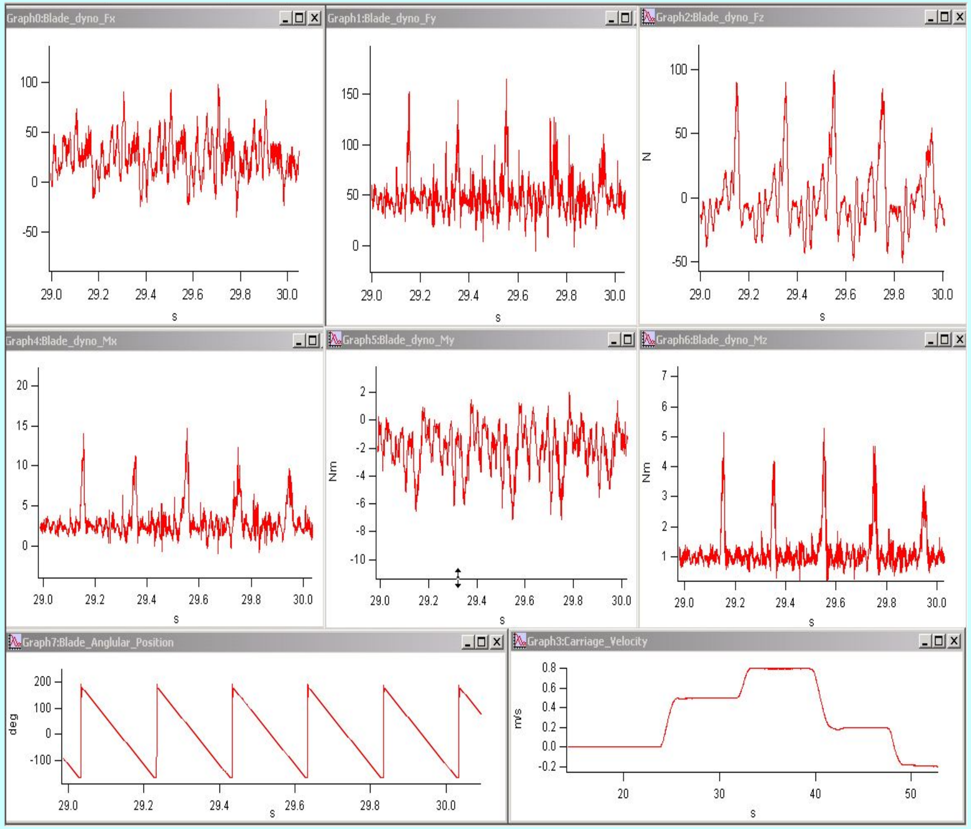
1 & 2 View from side showing false stern

3 View from below showing propeller breaking ice

4 Propeller hits the ice

Ice Milling Load Experiment

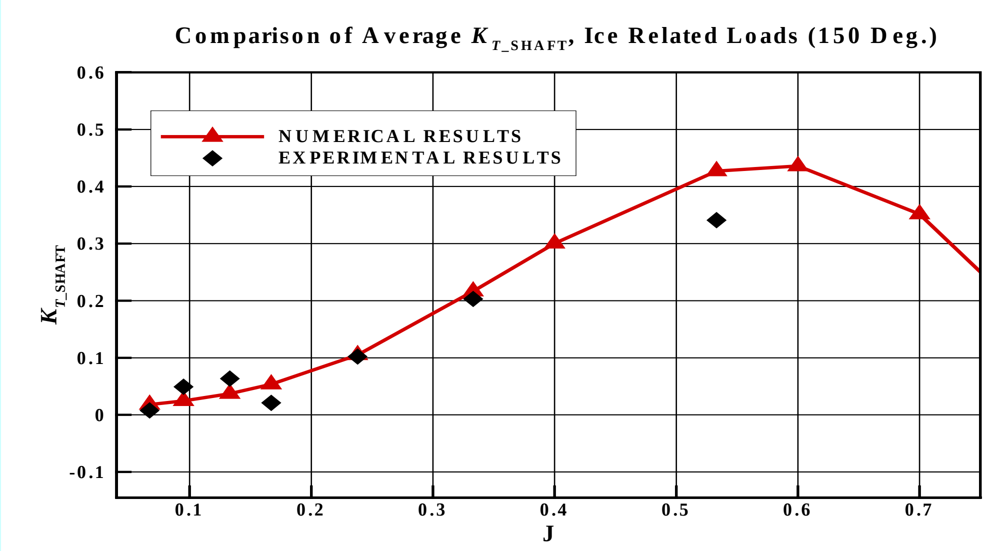


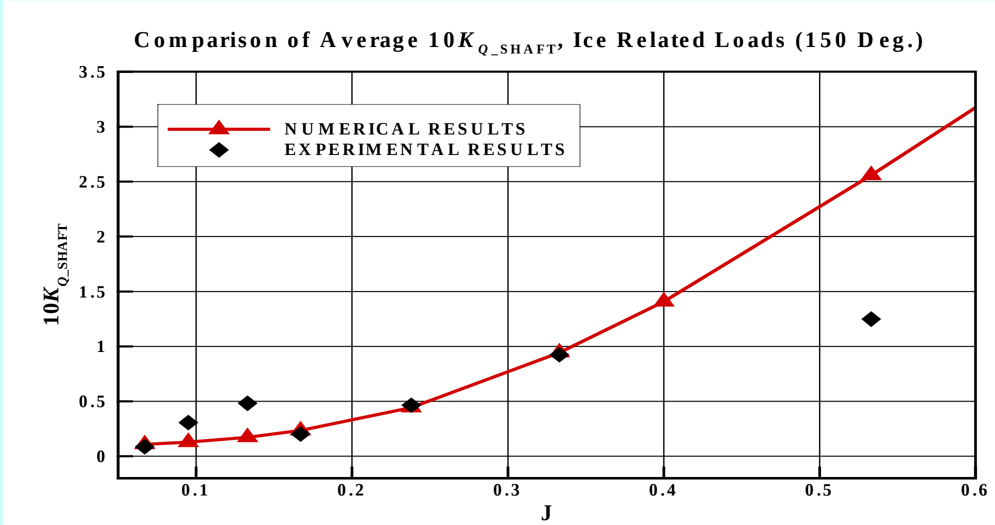


Sample time series data

Numerical Results

- Numerical prediction for the propeller ice milling load was performed (Wang et al, 2006)
- Ice related loads were calculated with the azimuthing angle between 180 and 90 for the tractor mode
- The numerical predictions have a good agreement with experimental results at low advance coefficients (less than 0.4)





Comparisons (Shaft, Ice Related Loads, 150 Deg.)

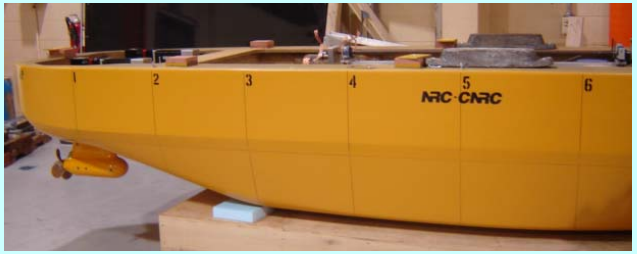
Phase 2: Ice loads on Podded Propeller During Ship Maneuvering - Overview

- This study investigates the performance of ship model with podded propulsors (APP) in various (realistic) operating conditions: open water and different level ice and pack ice conditions, straight run and various manoeuvres using PMM
- The model used in this phase was the icebreaker Mackinaw equipped with twin podded propulsors
- Measurement include steering moment generated by the propulsors, thrust and torque of the propellers, and the force and moments on the hull body
- Preliminary results on the APP were presented by Akinturk and Lau (2008).

Experimental Set-Up

USCG Mackinaw Model

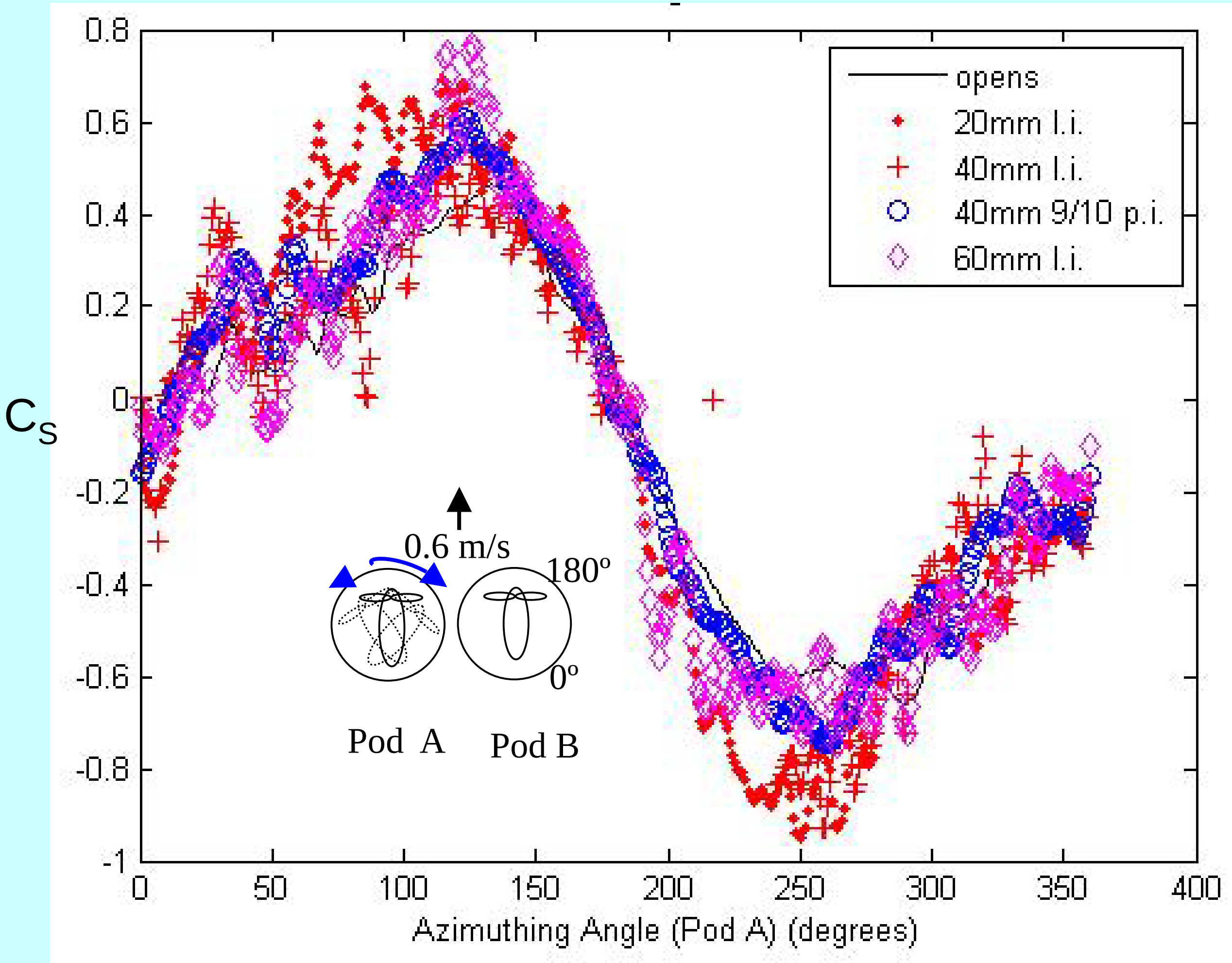
Planar Motion Mechanism



Example Run

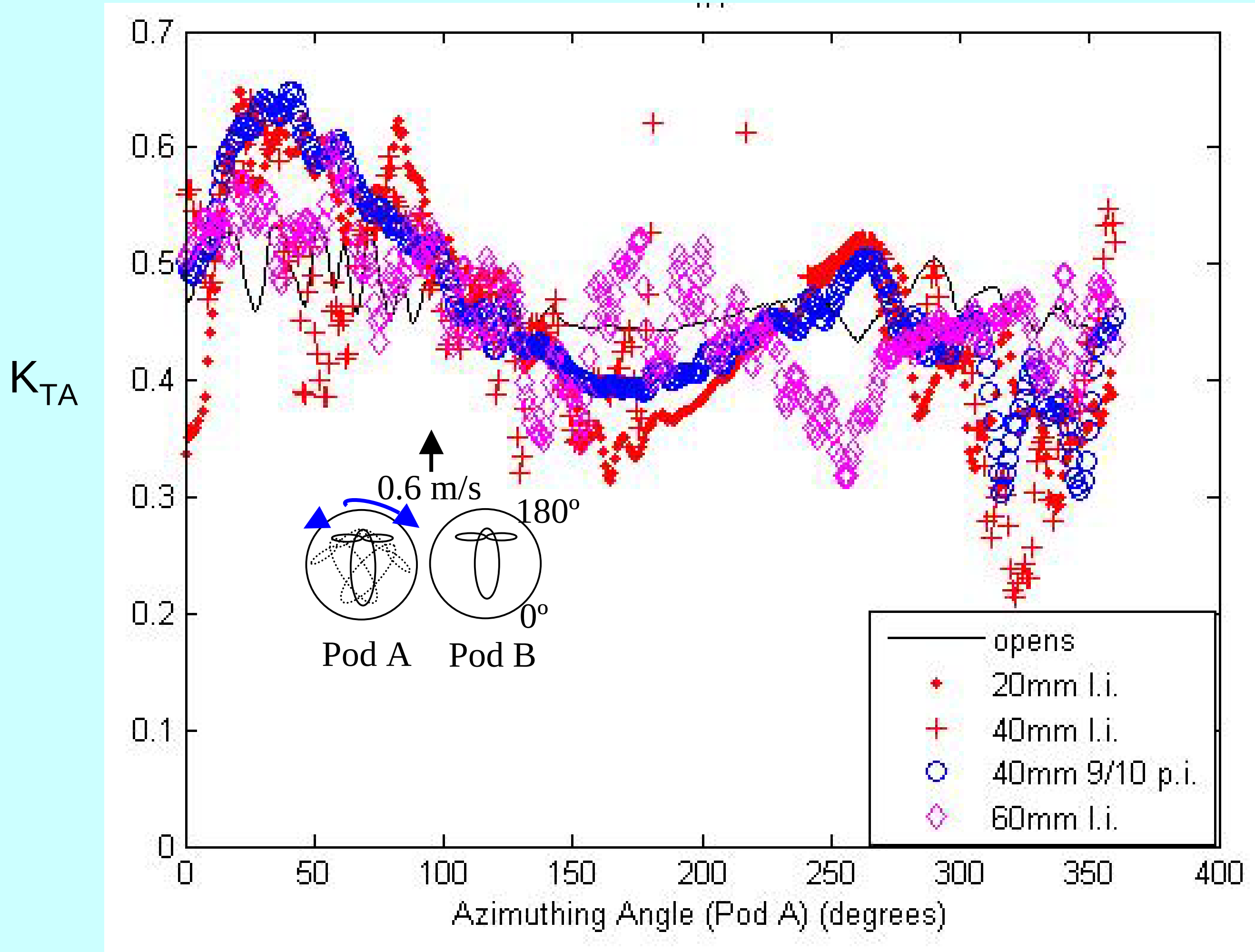
Results

Steering Moment Coefficient



Results

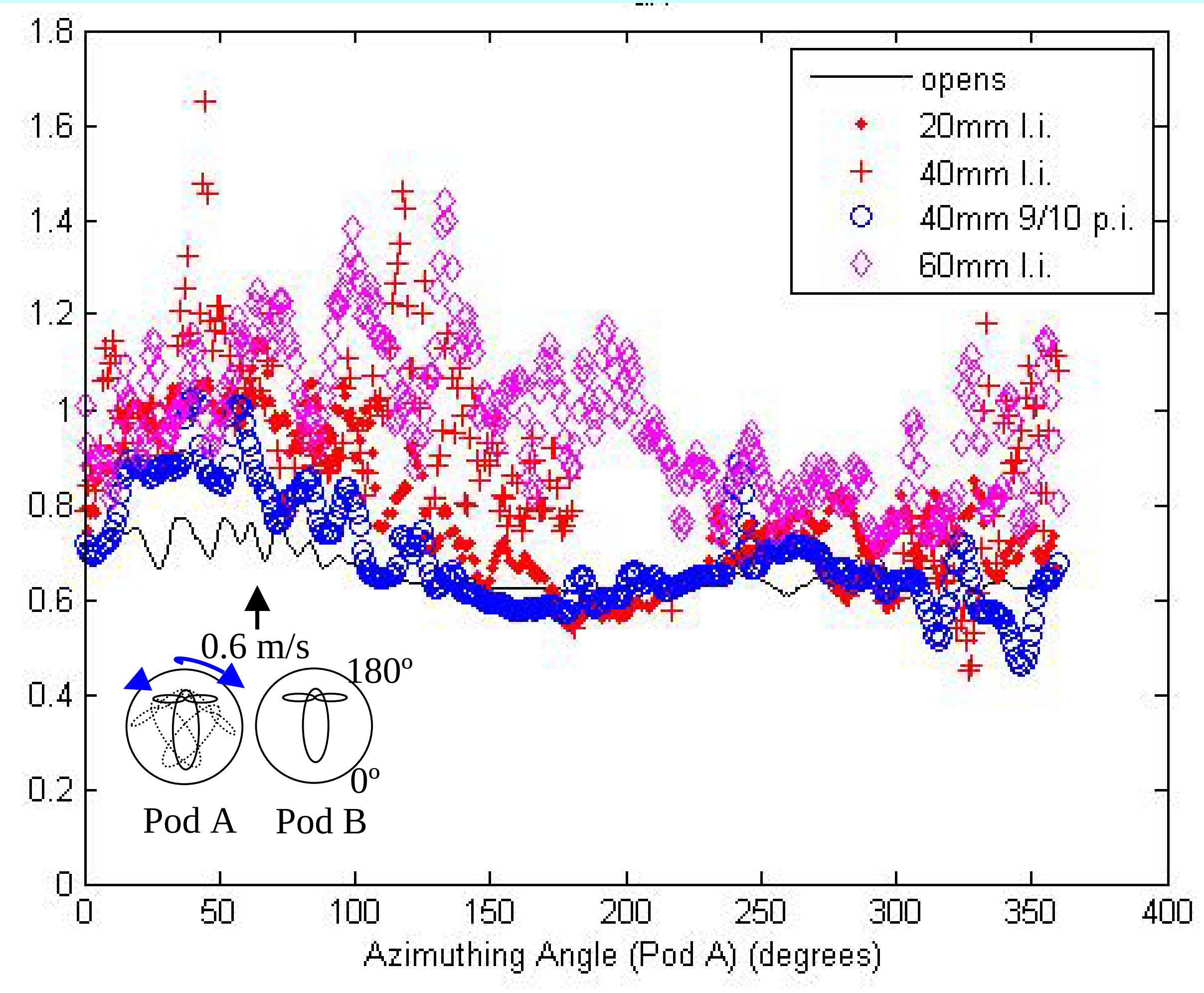
Pod A - Thrust Coefficient



Results

Pod A - Torque Coefficient

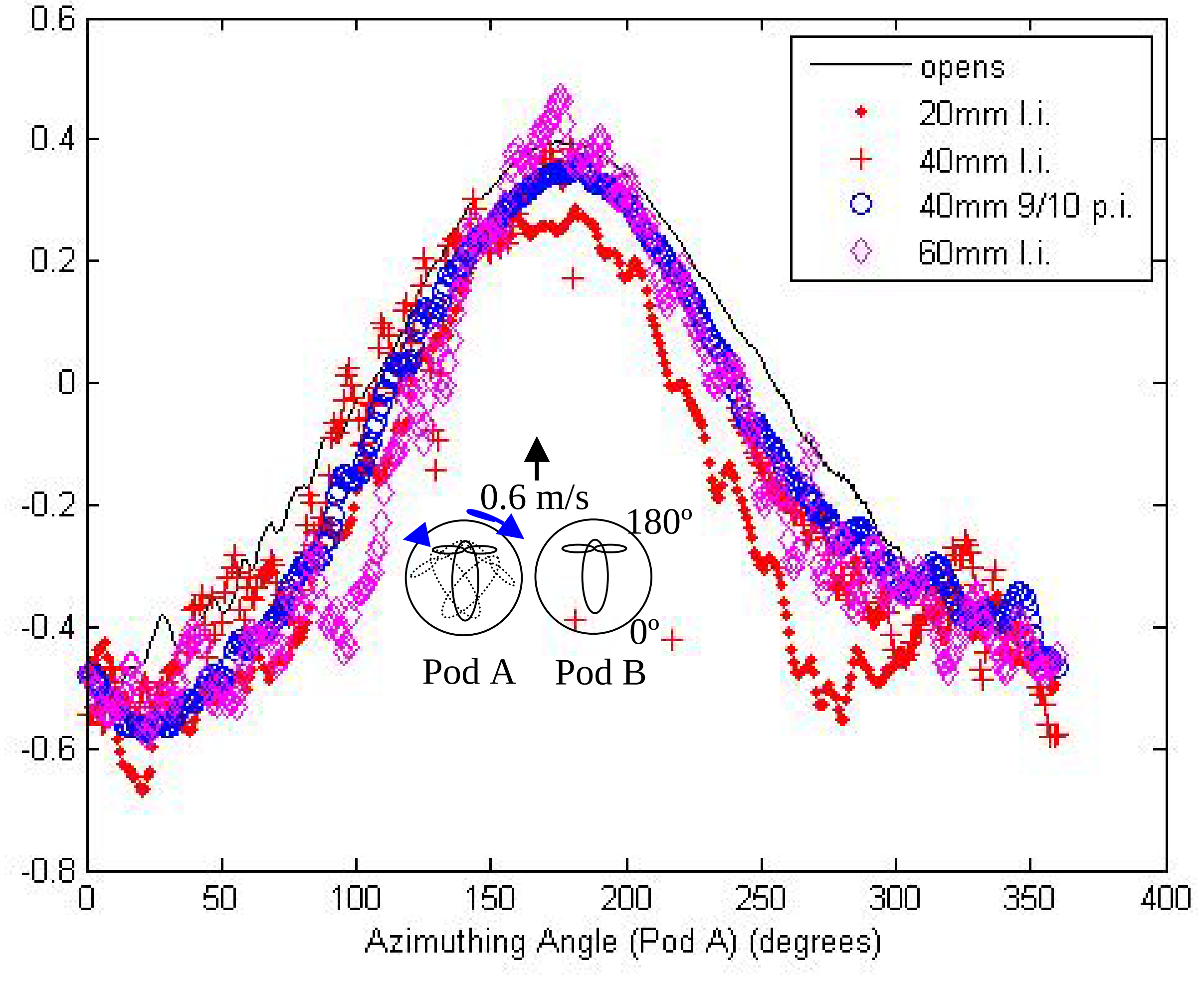
10K$_{QA}$



Results

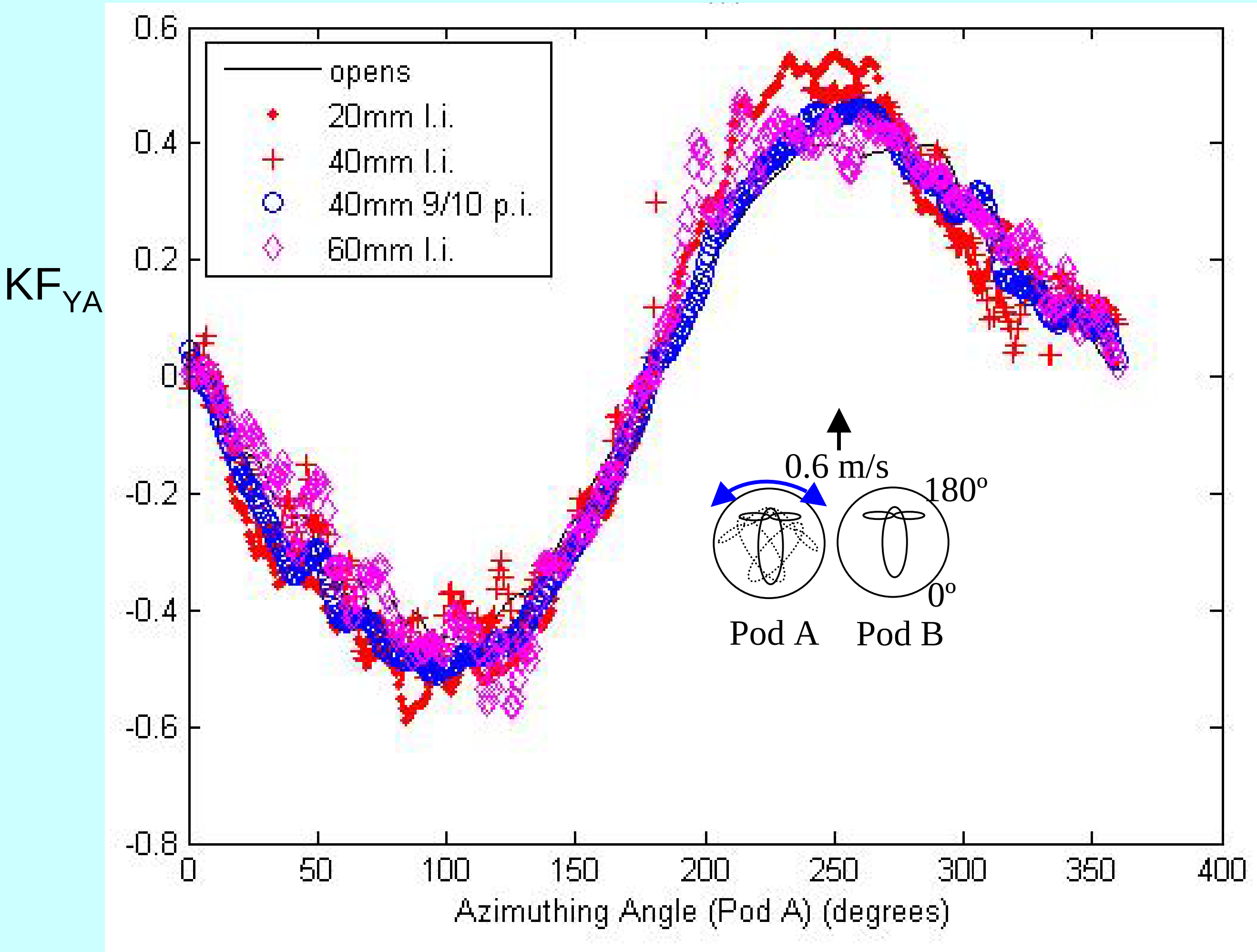
Pod A - Unit Thrust Coefficient

KF_{XA}



Results

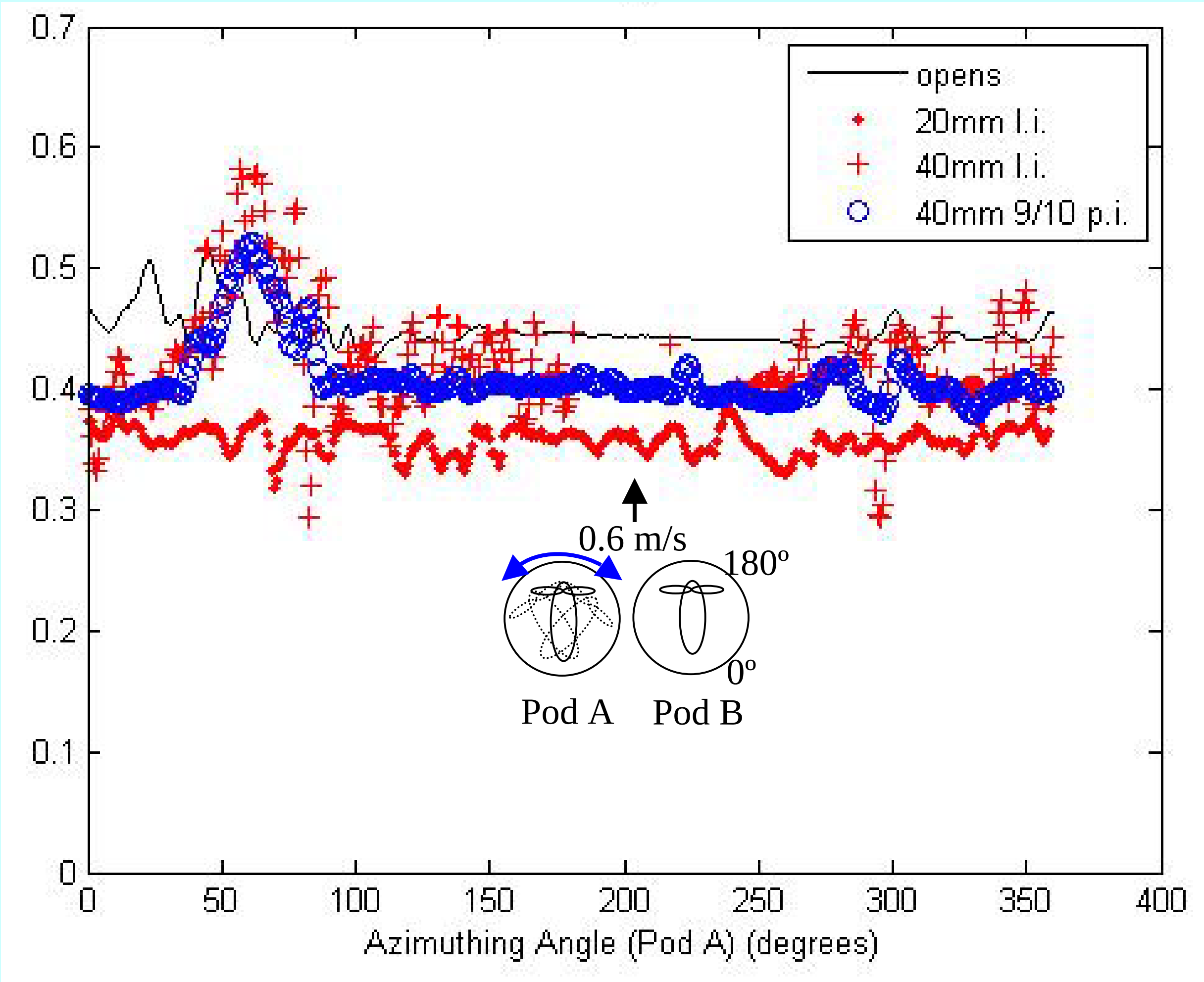
Pod A - Side Force Coefficient



Results

Pod B - Thrust Coefficient

K_{TB}



Ice loads on Podded Propeller – Further Work

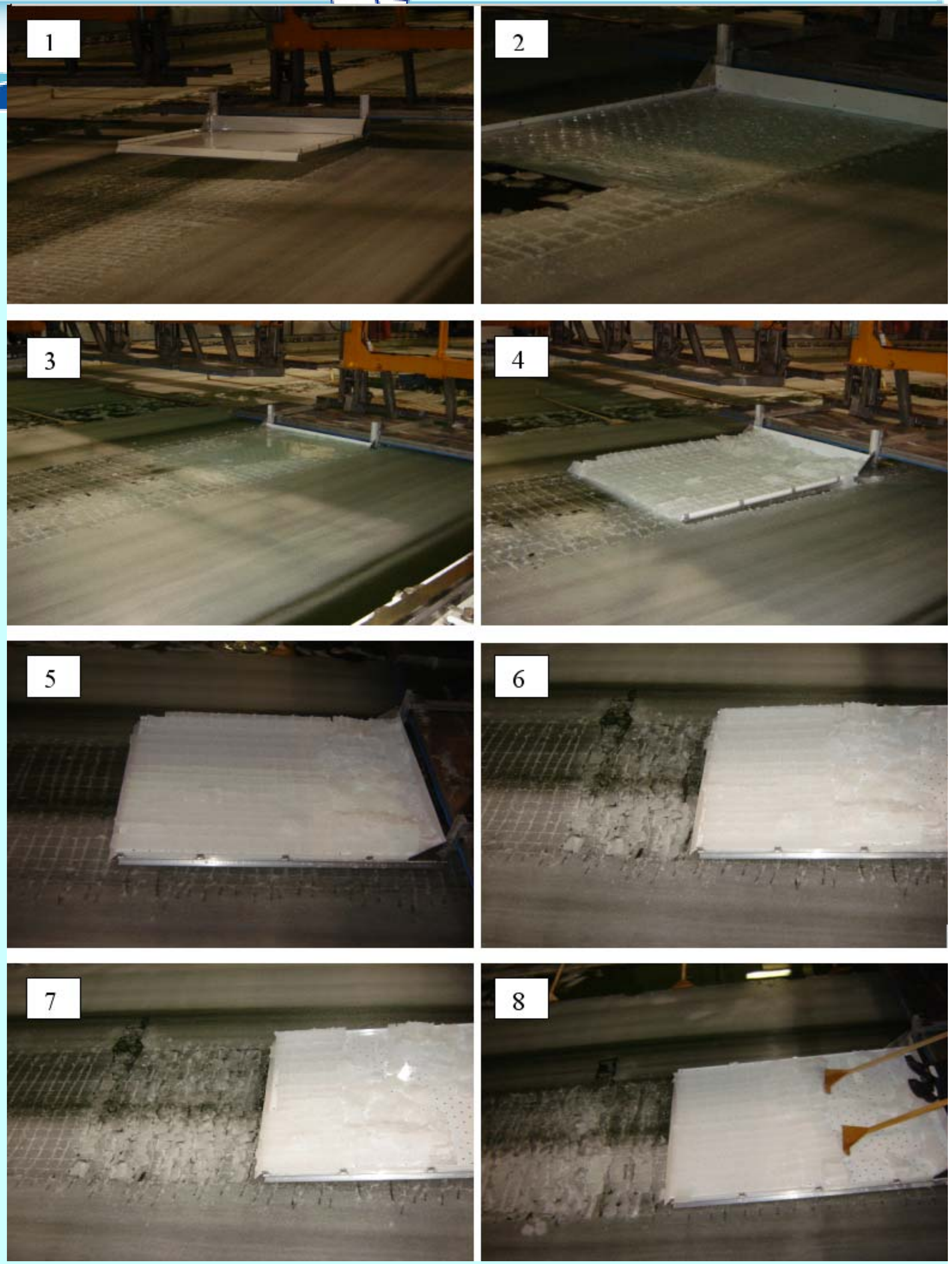
- Complete data analysis with different hull velocity and maneuvers, including the loading on the hull
- Conduct additional tests with a second icebreaker (MOERI`s new icebreaker Arion) – also measure pressure distribution on hull
- Develop tools for performance prediction and simulator application
- Develop in-house standards and procedures governing ship testing (propulsion and maneuvering) with APP

IOT’s R&D Activities Related to Committee’s Mandate No. 2 - Brash Ice Test

- Develop a procedure for ship tank testing in brash ice
  - Most test were performed by Arctic and HSVA to provide commercial testing of Baltic ice-going ships
  - First test in IOT
- Collaboration with MOERI to co-develop testing procedure and techniques to test ships in brash ice
- It involved ice tests of the CCGS Terry-Fox transiting in a brash ice channel conducted and analyzed as per IOT's standard for model propulsion in ice.
- The Finnish-Swedish Ice Class Rules (FSICR) class 1A was targeted
- New brash ice production techniques were introduced and the results of ship resistance and propulsion performance were summarized in Lee and Lau et al (2008).

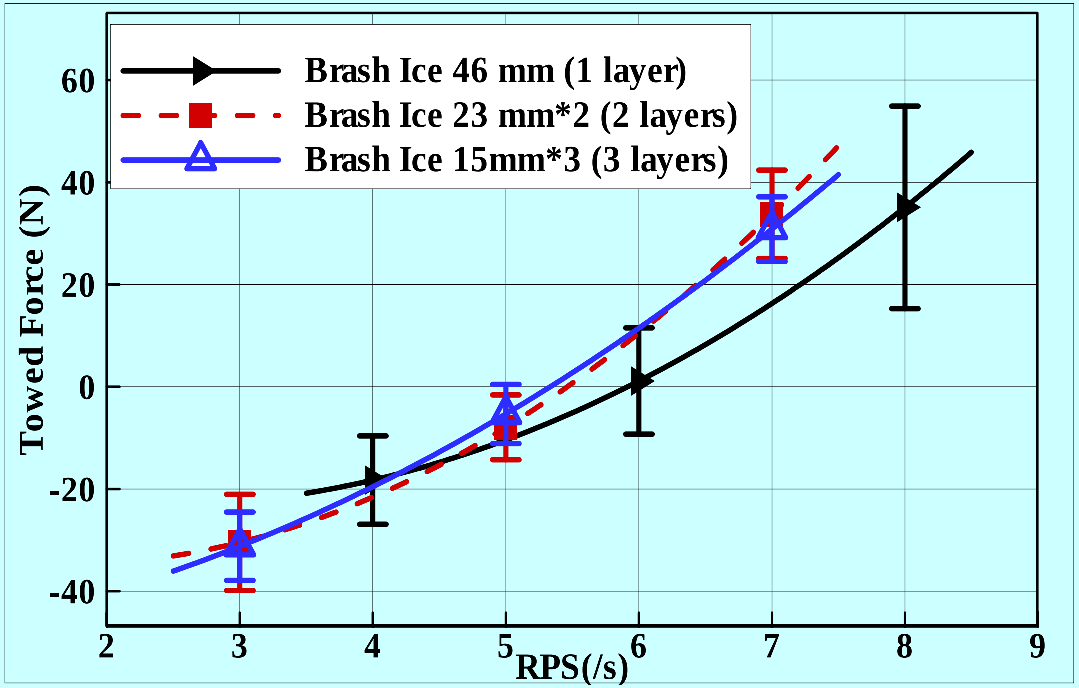
Brash Ice Test – Brash Ice Production

- For the present model tests, the influence of ice piece thickness or number of layers that makes up the brash ice channel was considered.
- Three parent ice sheets with thickness of 46mm, 23mm and 15mm, were used to make brash ice of one, two and three layers, respectively.



Brash Ice Test – Typical Test

- The data shows a good agreement of the towed force between the two- and three- layers constructions (self-propulsion point of 5.4 and 5.3 rps)
- For one layer brash ice, the self-propulsion point was at 5.9 rps possibly due to increased resistance.
- Structure of the brash ice layer is important



Propulsion test - towed forces as a function of propeller speed for one, two and three layers brash ice with the nominal thickness of 46mm

Brash Ice Test – Summary

- We just start modeling brash ice in our tank
- Challenge is still existed in control and characterize the brash ice
- The procedure developed looks reasonable
- Benchmark test methodology and standard development are yet to be done
- The data suggested the importance of using multi-layers to properly model the ship resistance/propulsion in brash ice.

General Summary

- IOT has performed R&D work to develop procedure to test APP and ships in brash ice in an ice tank facility
- Demand for performance revaluation of ships with APP and/or in brash ice increases greatly
- A few other facilities has procedure to perform tests with APP and brash ice; ITTC standards and guidelines are yet to be developed
- Recommendation to follow up work in these areas