Dynamic Positioning Committee

Marine Technology Society

NEW APPLICATIONS

A Tighter Watch Circle at High Speeds

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MARIN

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New Applications
A Tighter Watch Circle, At Higher Speeds
STLVAST and the Challenge of Close-In Precision Dynamic Positioning

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Presentation Outline

PHASE 1

Problem Definition and Concept Solution Based on Thruster Architecture

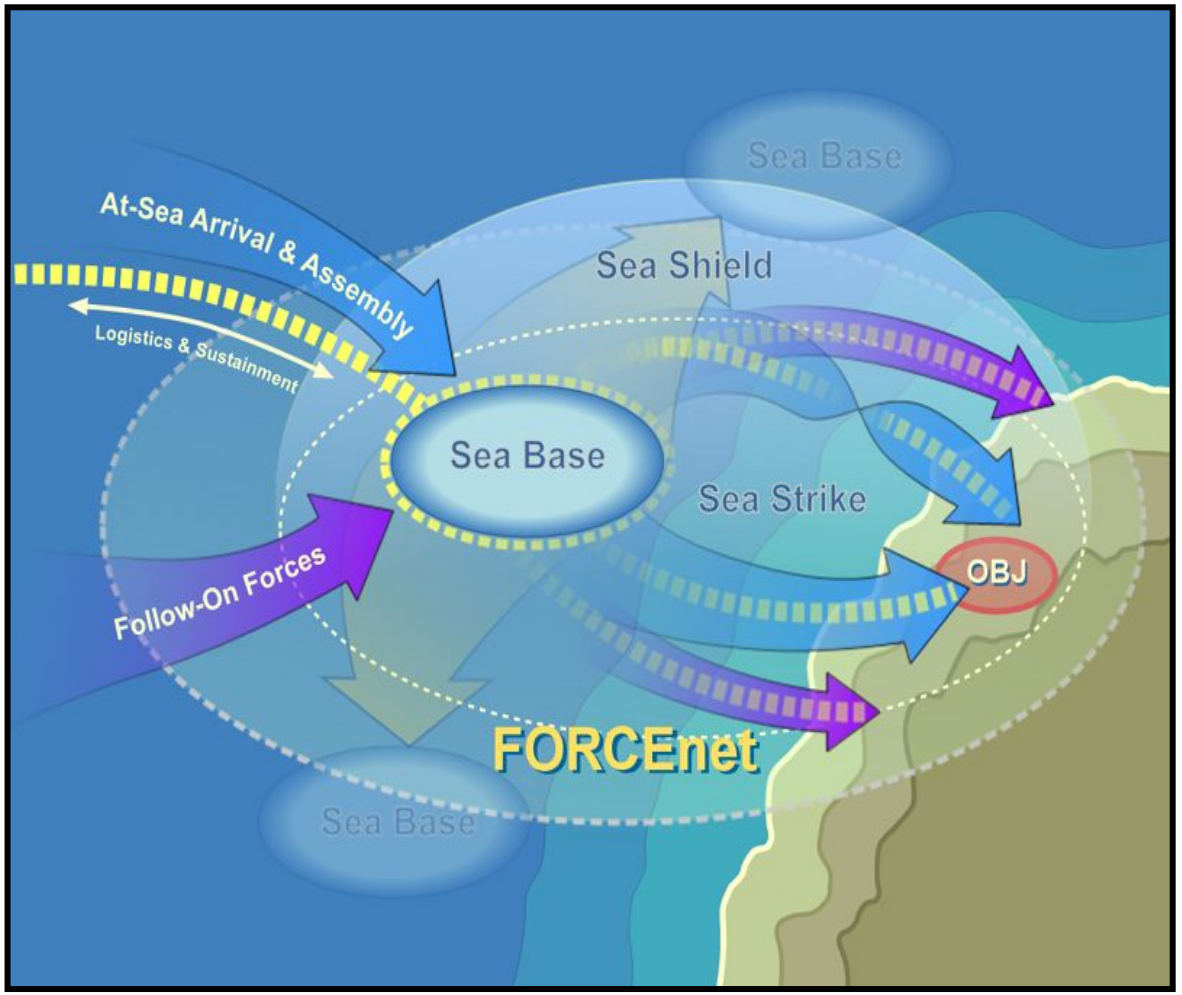
Who

An ONR Science & Technology Program led by Oceaneering as prime contractor, with a multi-national, multi-talented team:

- Research & Engineering analysis
- Test Facility, Data Analysis
- Use and Support of Scale VSP Units
- DP Control System Consulting
- System Certification Advice
- Two Ship Simulations Using LAMP

Why

To support the movement of supplies (by vehicle or crane) between vessels, at sea, in the Sea Base



What Does That Mean

Two large vessels, running side by side, for the movement of personnel, materiel and containers:

- At up to 8 Knots
- As close as 15-25 Ft
- Sea State 4

Challenges

System

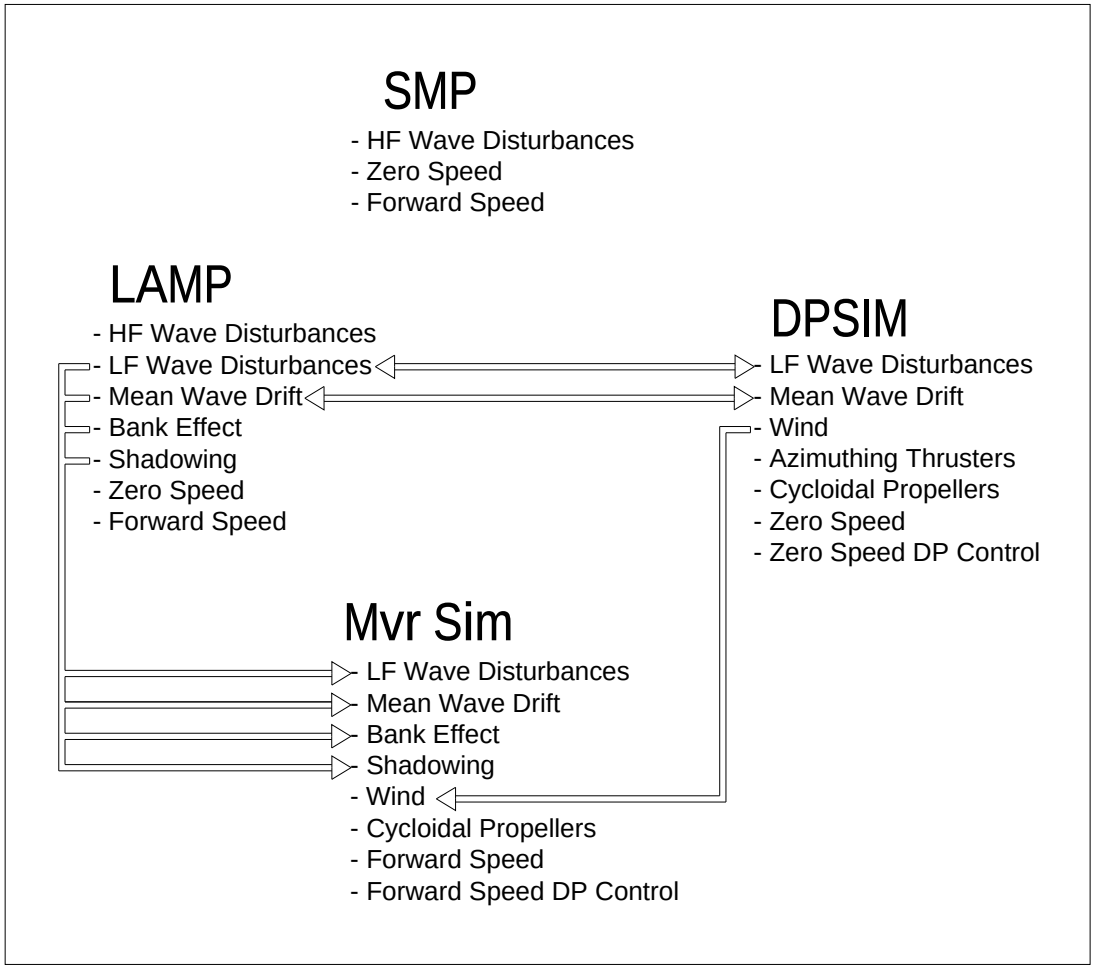
- Sensing relative position and orientation fast enough
- Rapid, powerful, thrust to hold position

Physics

- Second ship creates wave diffraction and ‘bank’ effect
- ahead speed increases sway/yaw coupling
- tighter positioning requirement
- thruster effectiveness drops away at 4+ knots

Theoretical Analysis

Theoretical analysis, supported by limited simulation established that a higher bandwidth thruster was required, and that it must remain effective at speeds above 4 knots



Voith Schneider Cycloidal Propellers

Cycloidal propellers have the ability to act as high bandwidth thrusters:

- They produce ample transverse thrust at high speeds
- They can completely reverse direction in 3 seconds, full scale
- The specified four VSP 36R6 EC/300-2 (3.8 MW) for the Mighty Servant 3, the testbed, at model scale, for Close-In Precision (CIP) DP

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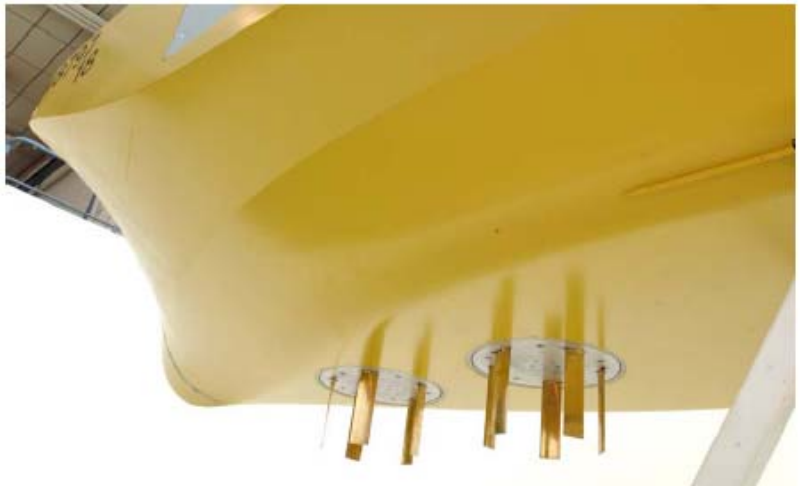


MARIN Tank Tests – April 08

In our first entry to MARIN we used four VSP's on the MS3 to provide DP, and slaved it to the free swimming LMSR alongside

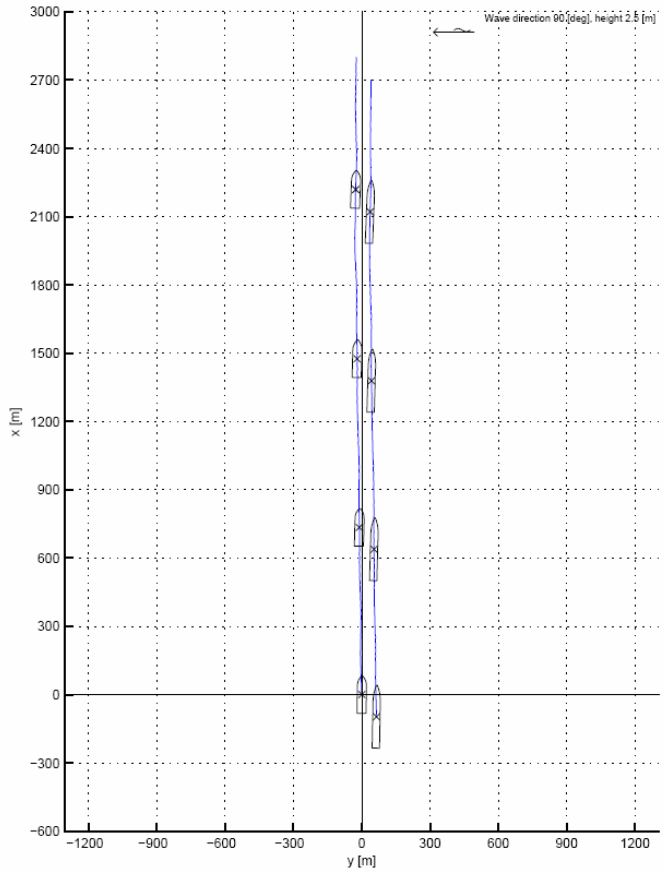
Test setup and tuning took 4 days, in the two test days we conducted 62 two ship runs

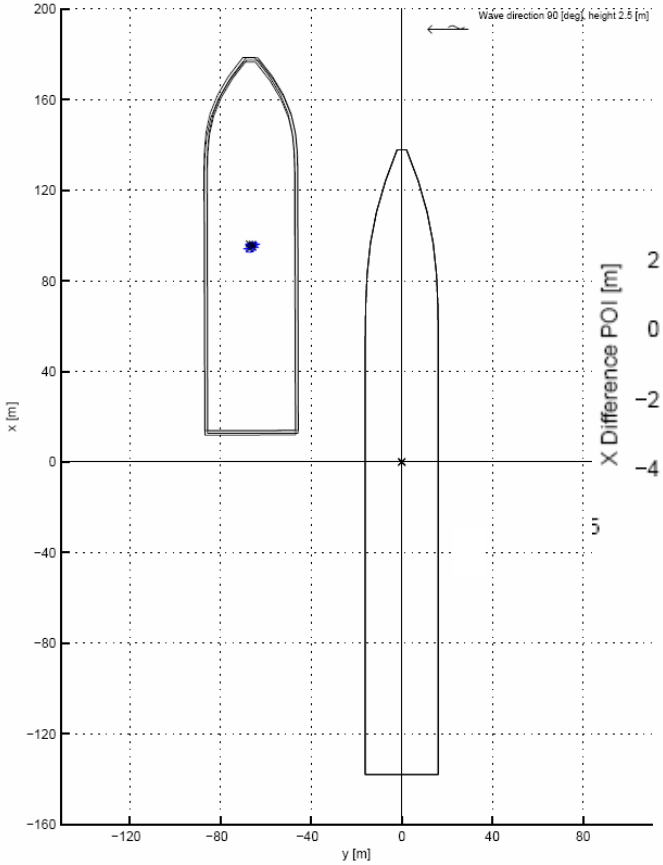
Early on we decided to cut out the Kalman filter, as this introduced a significant phase lag, and hence instability in the DP controller

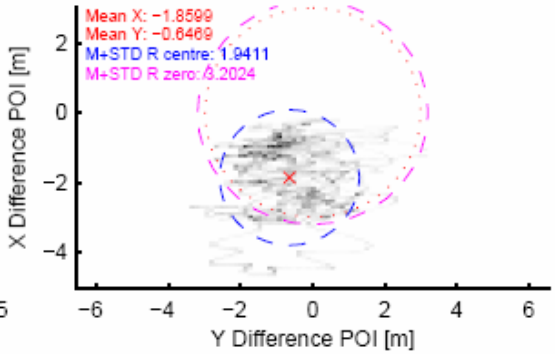
Sample of Tank Run Results

Run 24 [8 knots, 90’ apart, SS4 beam sea, COTS VSP]

Run 24 is one of more exciting “fast and far” regime tests, and illustrates the affect of beam seas. The roll period of the MS3 matches the beam seas almost exactly. R=5m (16.5’) Run 24 MS3-LMSR VSP.wmv



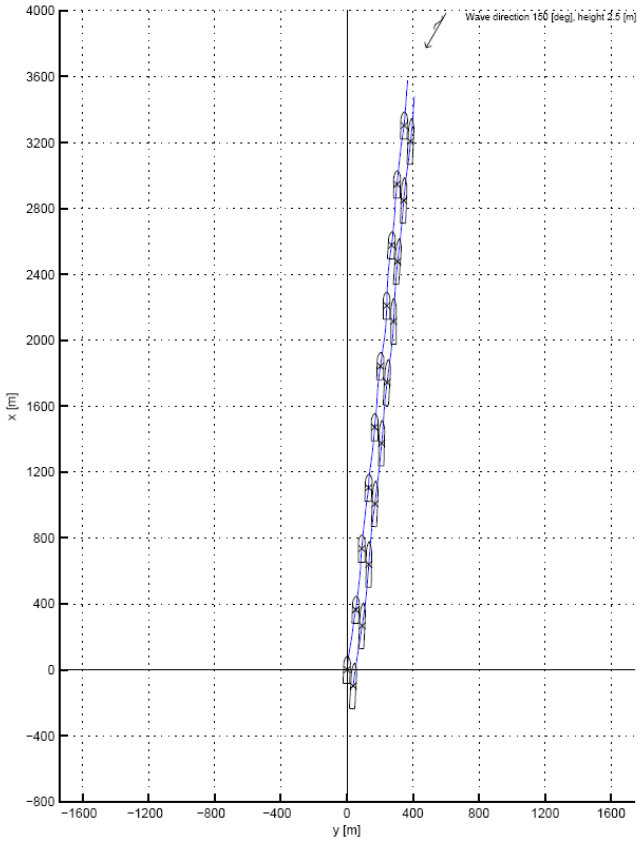


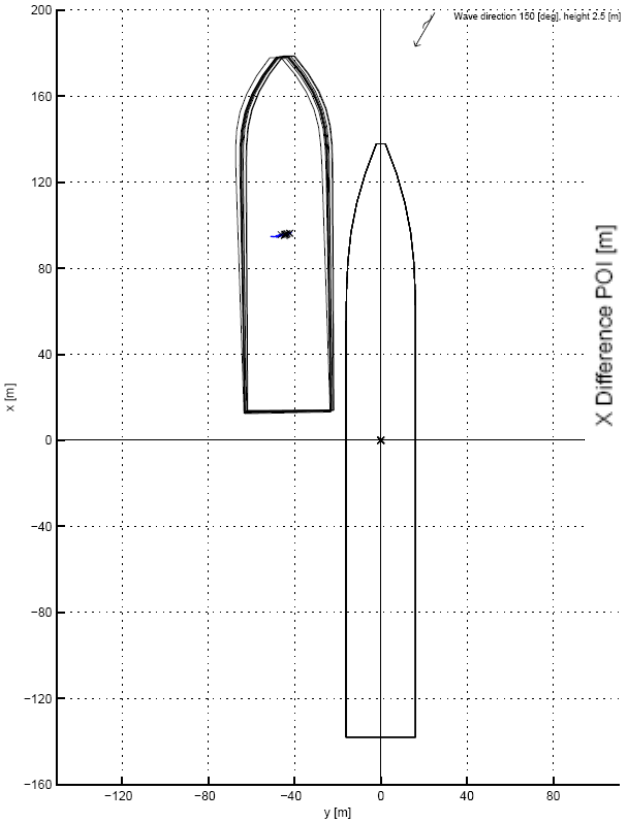


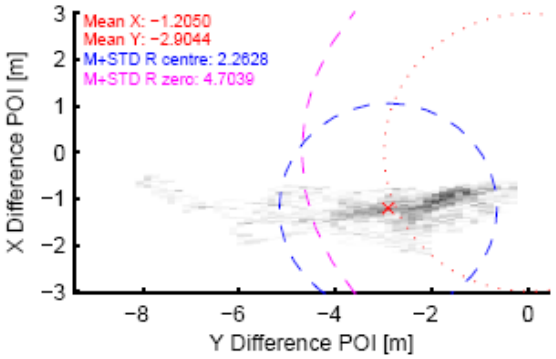
Sample of Tank Run Results

Run 13 [4 knots, 15' apart, SS4 bow quartering sea, COTS VSP]

This is our "close and slow" regime and illustrates some pretty large excursions (watch circle radius R=8m (26') at one point). But the DP, using the COTS VSP's always brings the MS3 back to position, and no collision occurs Run 13 MS3-LMSR VSP.wmv



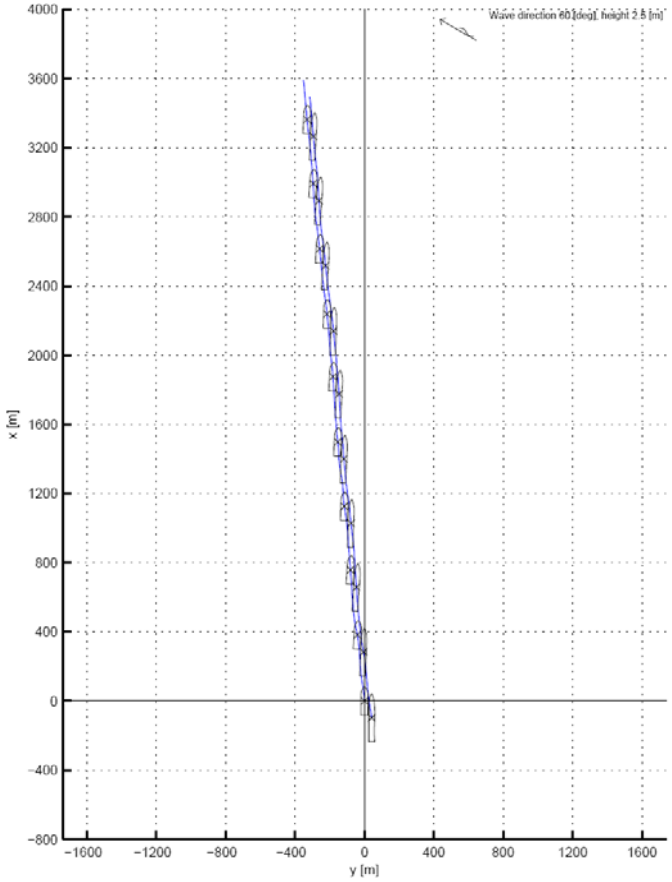


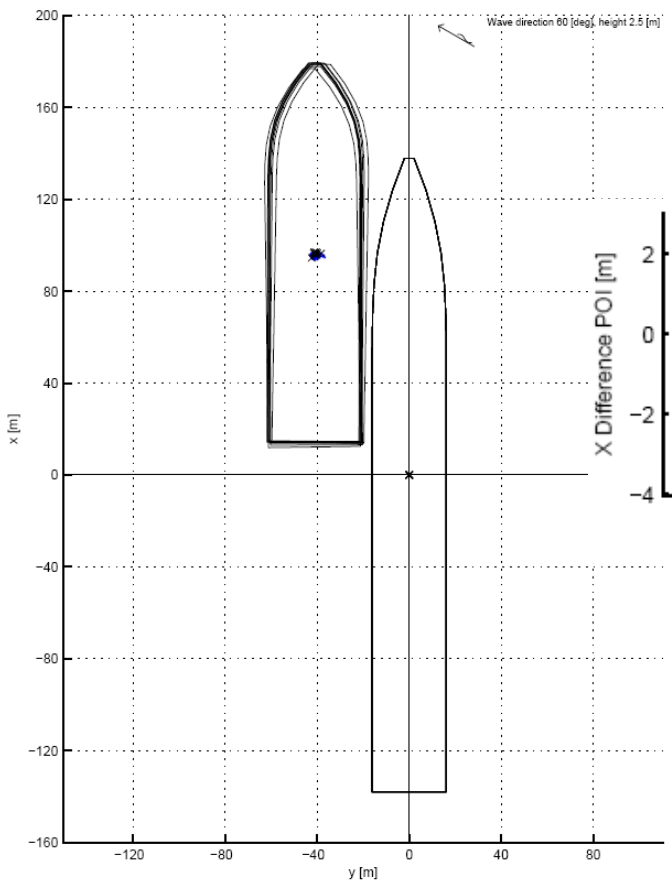


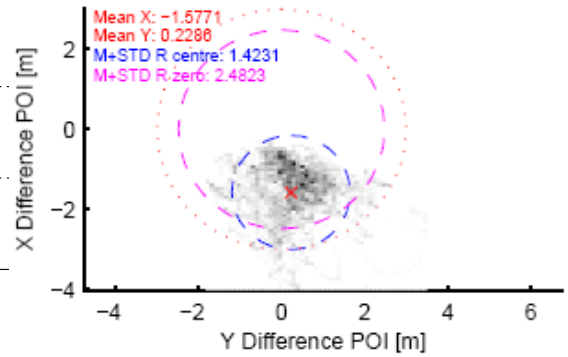
Sample of Tank Run Results

Run 19 [4 knots, 15’ apart, SS4 30 deg aft of beam, COTS VSP]

This run is one of only two in which collision occurred. Again the closest approach at highest regime speed, but this time the stern quartering sea forces the gap closed. Watch circle was tighter (R=4.9m (16’)) but limited by steel at one extreme! Run 19 MS3-LMSR VSP.wmv



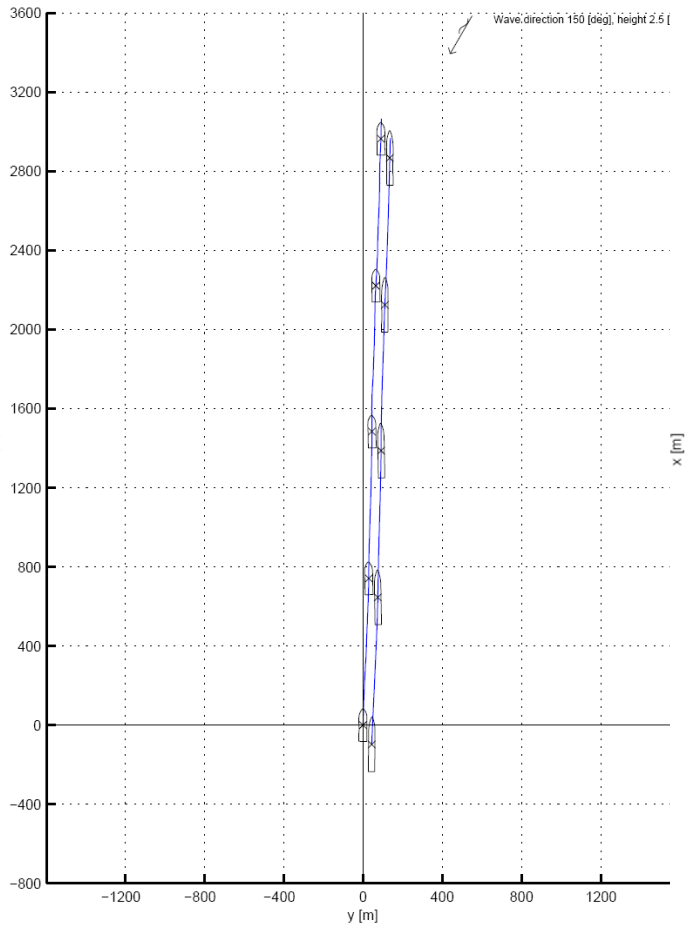


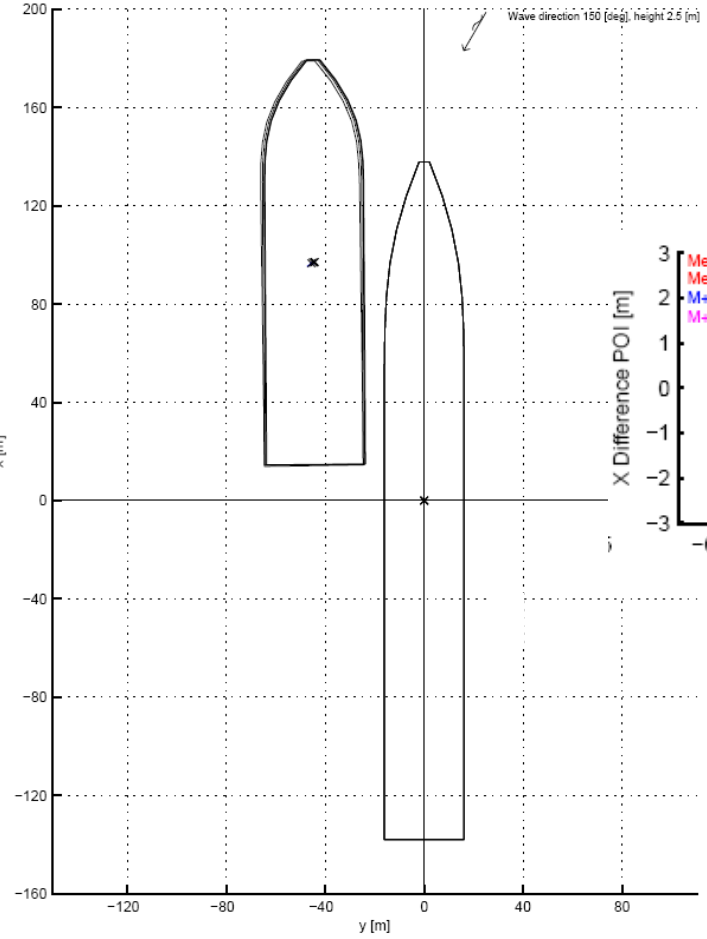


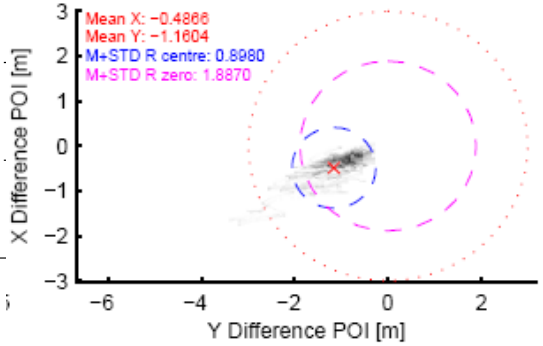
Sample of Tank Run Results

Run 45 [8 knots, 25’ apart, SS4 bow quartering sea, SUPER VSP]

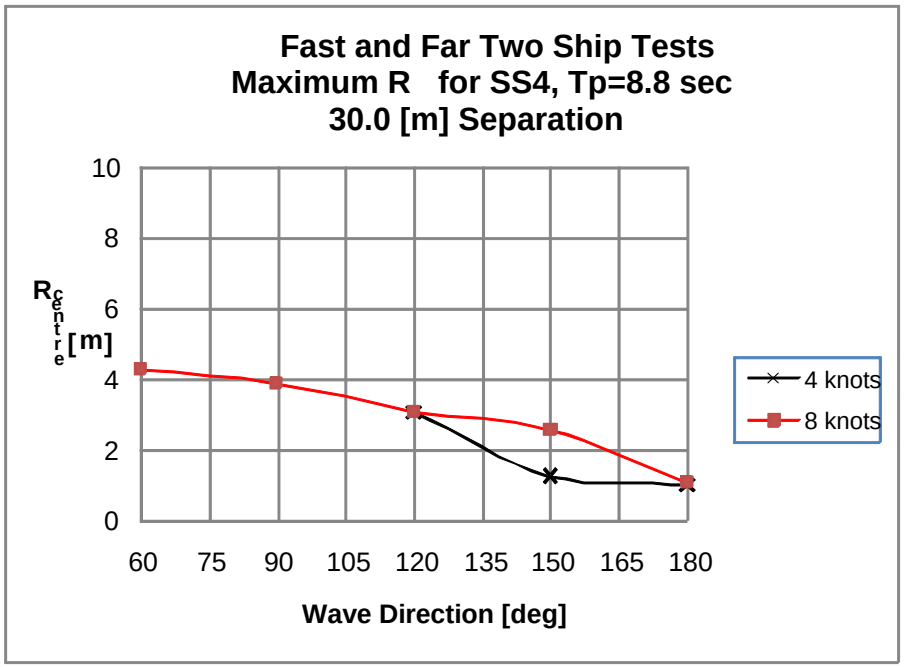
Our final run and we decided to try the ultimate regime, “close and fast”. This time we needed the Super Voiths, which performed admirably R=3.8m (12.5’) Run 45 MS3-LMSR VSP.wmv

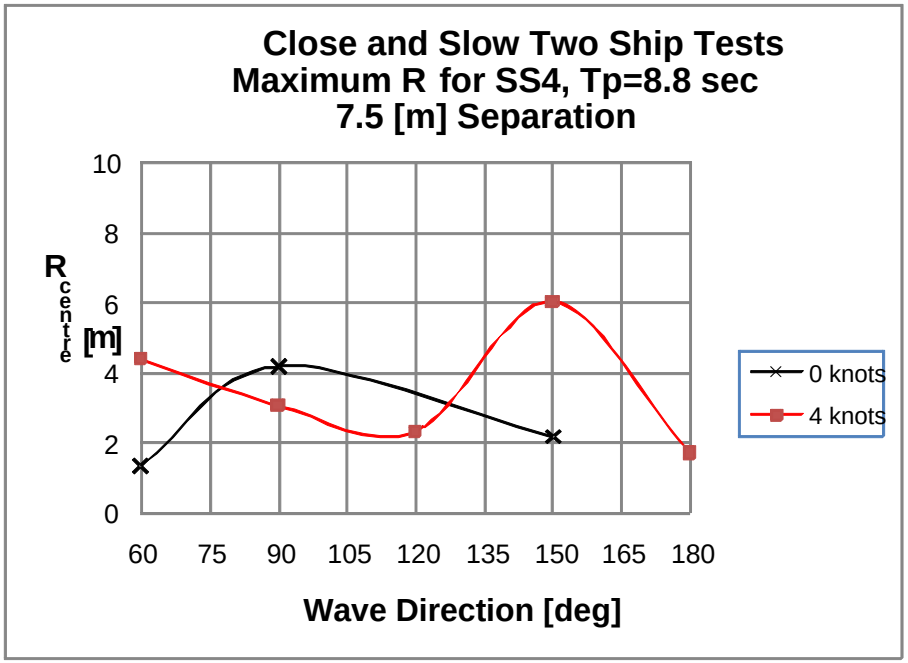






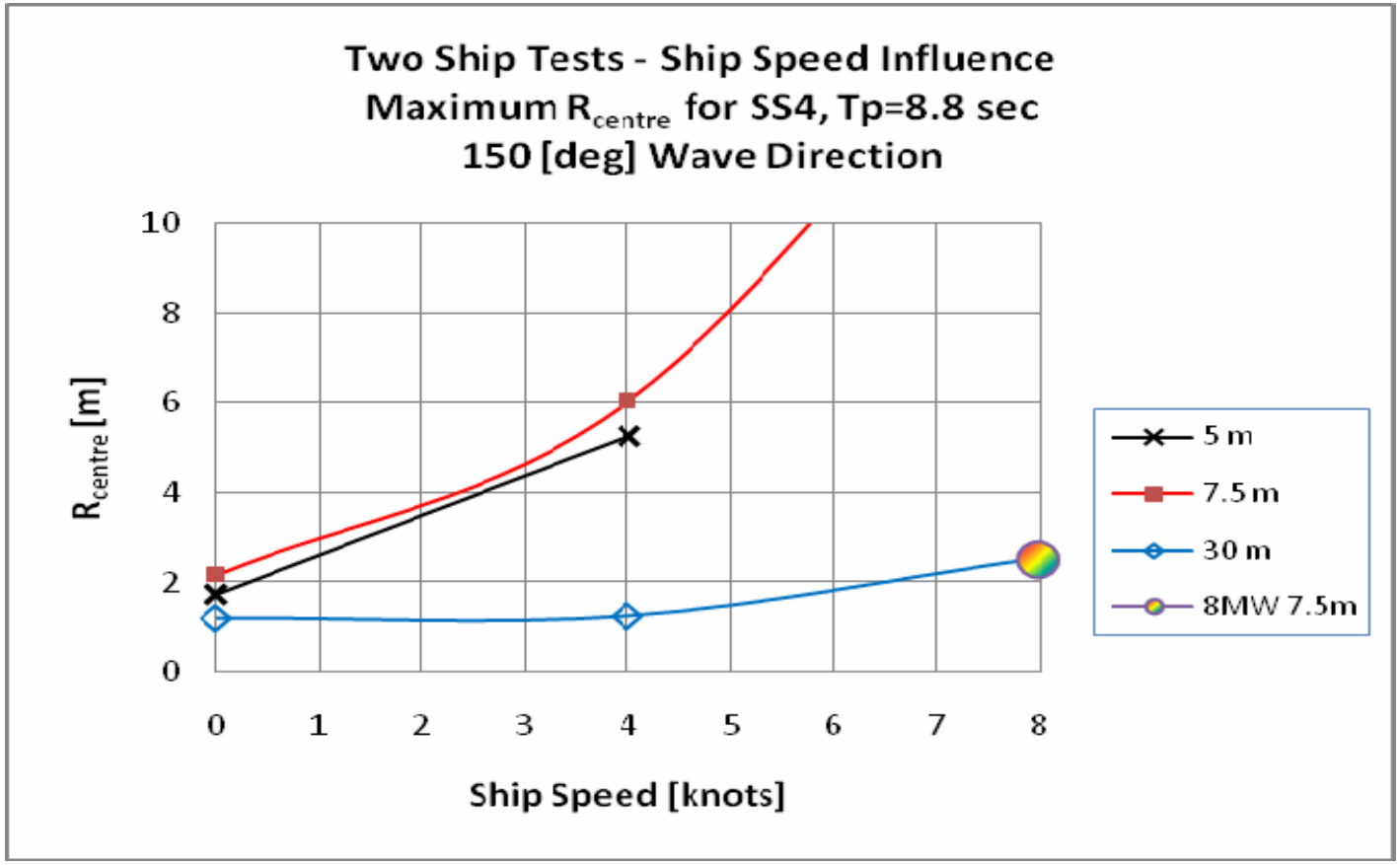
Summary of Results





R_{centre} (Watch Circle Radius) plotted against incoming wave direction, at varying ahead speeds (0,4 & 8 Knots)

Summary of Results



Rcentre (Watch Circle Radius) plotted against ship speed, at three separations between vessels

Conclusions re VSP's

A higher bandwidth thruster, capable of producing control thrust effectively at higher forward speeds, appears to be effective in meeting the position keeping capability of large vessels in the range of STLVAST speeds and sea conditions

Presentation Outline

PHASE 2

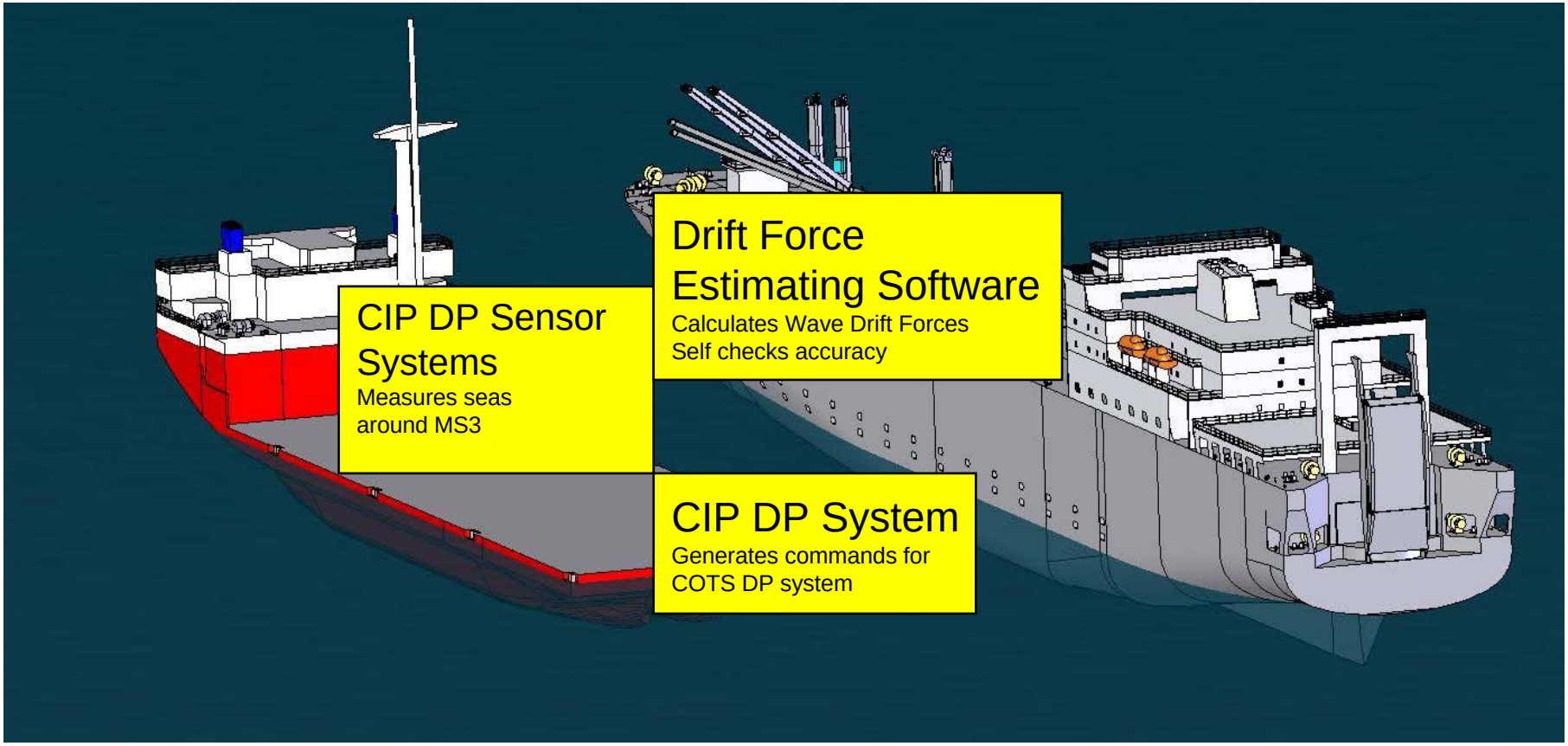
Developing a Solution Based on Controls and Sensors

Wave Feed Forward

Consider the implementation of wave feed forward to a COTS DP system. Wave feed forward should improve position keeping accuracy by allowing the slower azimuthing thrusters to react sooner to “wave drift” and other forces

- Wave feed forward has been studied before, theoretically and experimentally
- It hasn’t been applied to our two vessel challenge, or ahead speeds

CIP DP - WFF Products



The yellow boxes above show function, not necessarily position. The ultimate goal will be locate any required sensors and systems directly on the MS3

WFF Status

Initial drift force measurement & estimation testing just completed at MARIN (3rd Sept 08)

We'll add DP and attempt WFF performance improvement testing in Nov 08