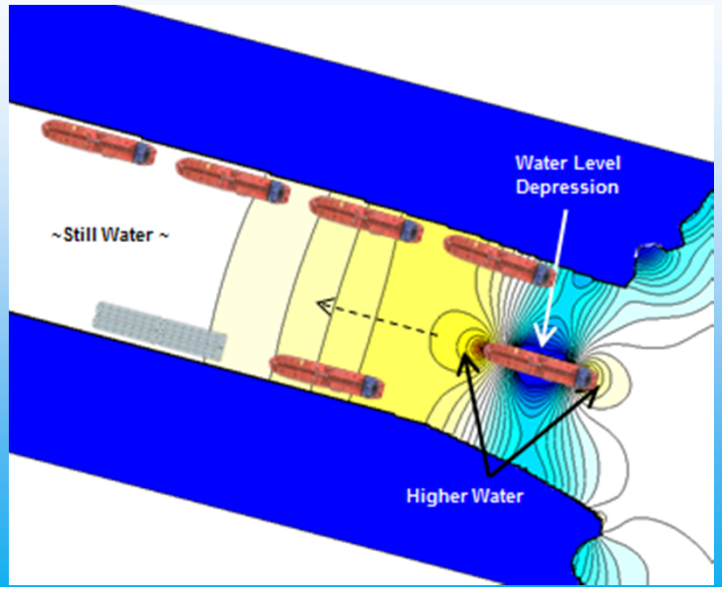
Simulating Complex Passing Ship Hydrodynamics

MOTT MACDONALD

Scott W. Fenical, PE, D.CE, D.PE
scott.fenical@mottmac.com

Presentation Outline

- Passing Ship Effects and Model Validations
- Broken Bore Formation and Propagation
- Harbor Sloshing/Bathtub Effects
- Ultra Large Container Vessels
- Conclusions



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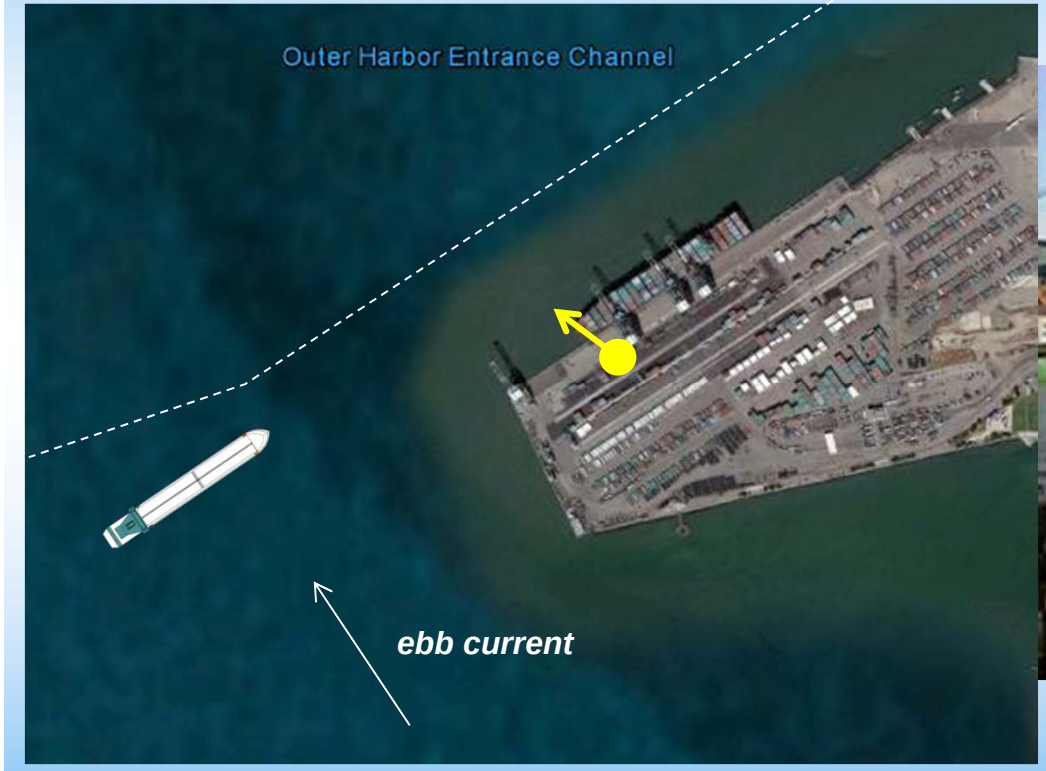
Passing Ship Effects



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Passing Ship Effects

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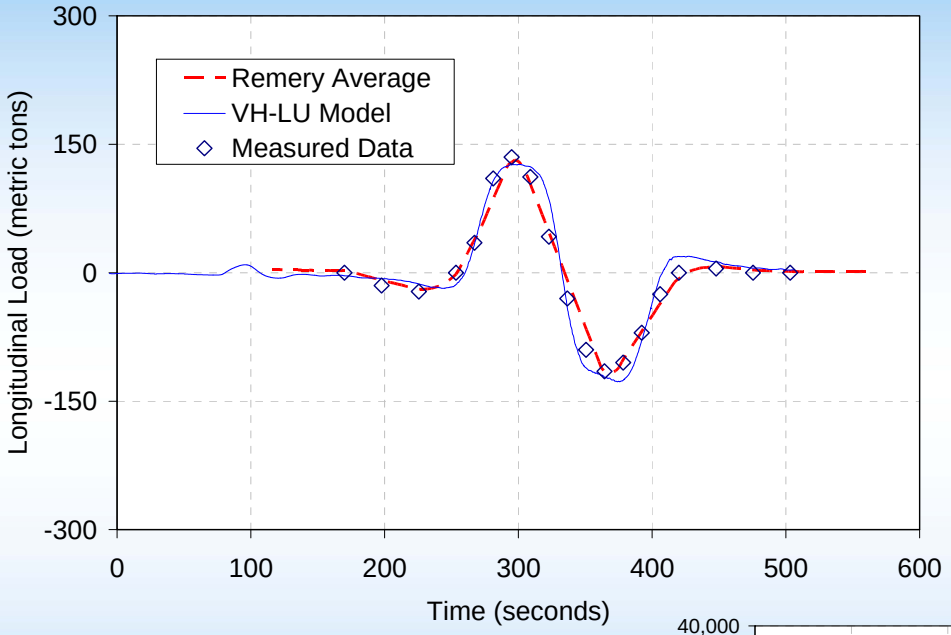
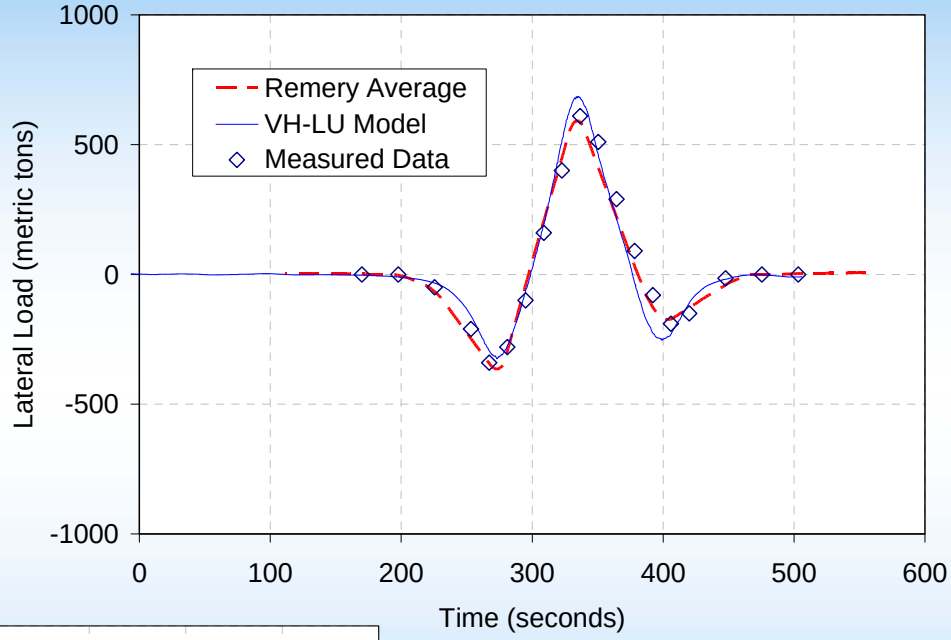
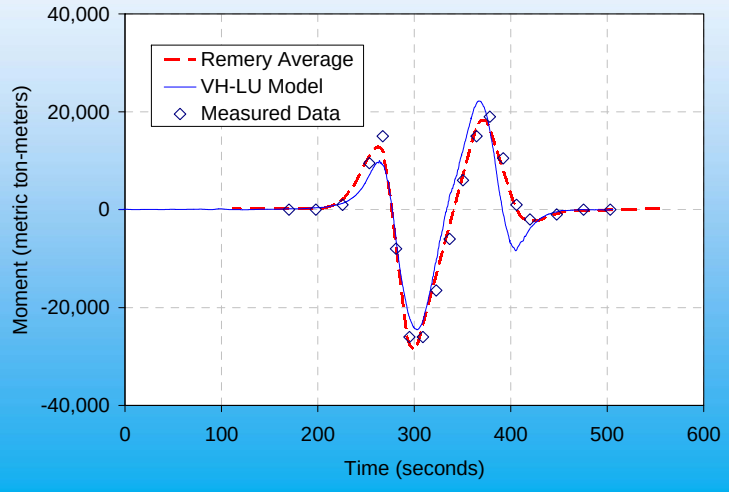
Validation - Laboratory Passing Vessel Forces REMERY (1974)







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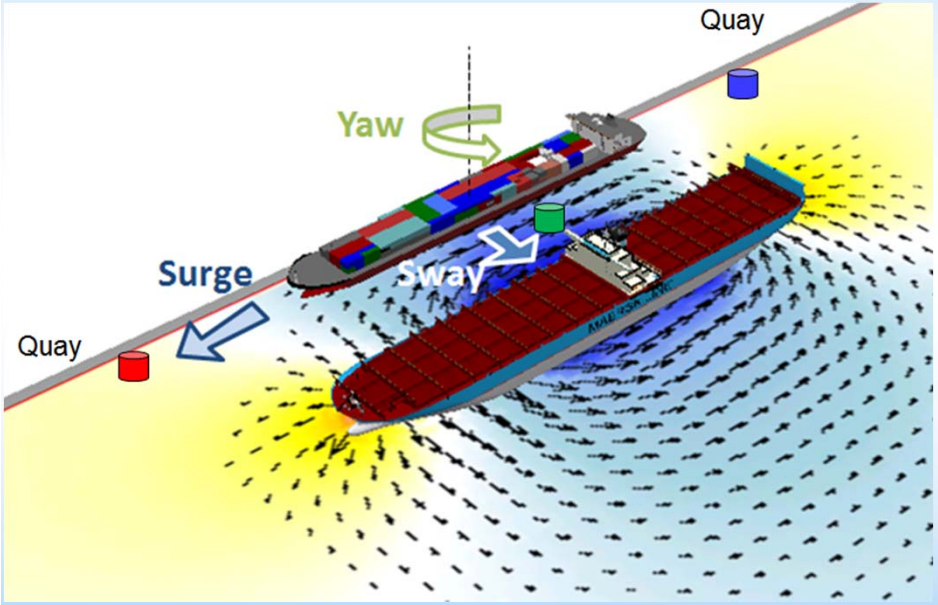
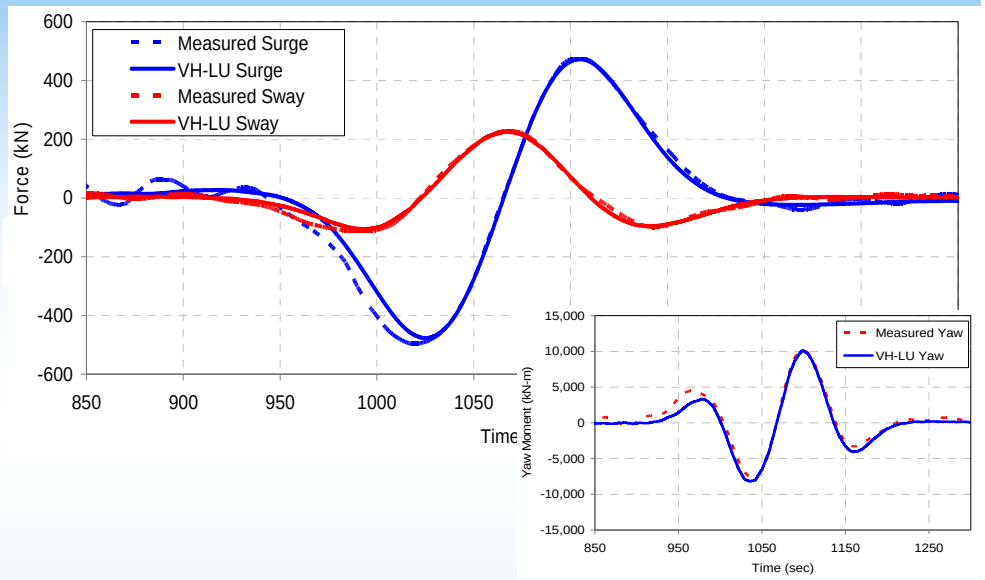
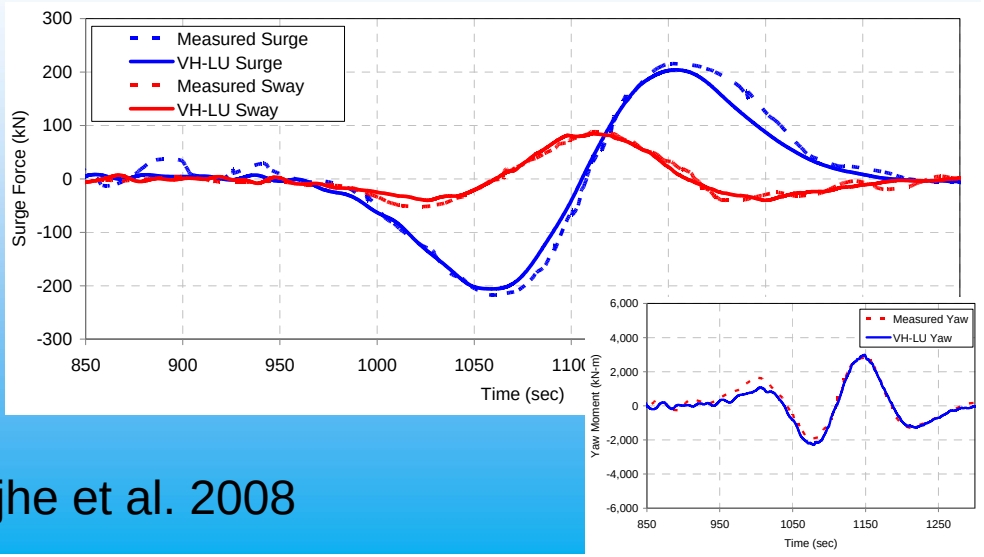
Validation - Laboratory Passing Vessel Forces MARIN (2008)







Passing Ship Speed: 5.5 knots
Passing Ship Distance: 75 m, 150 m

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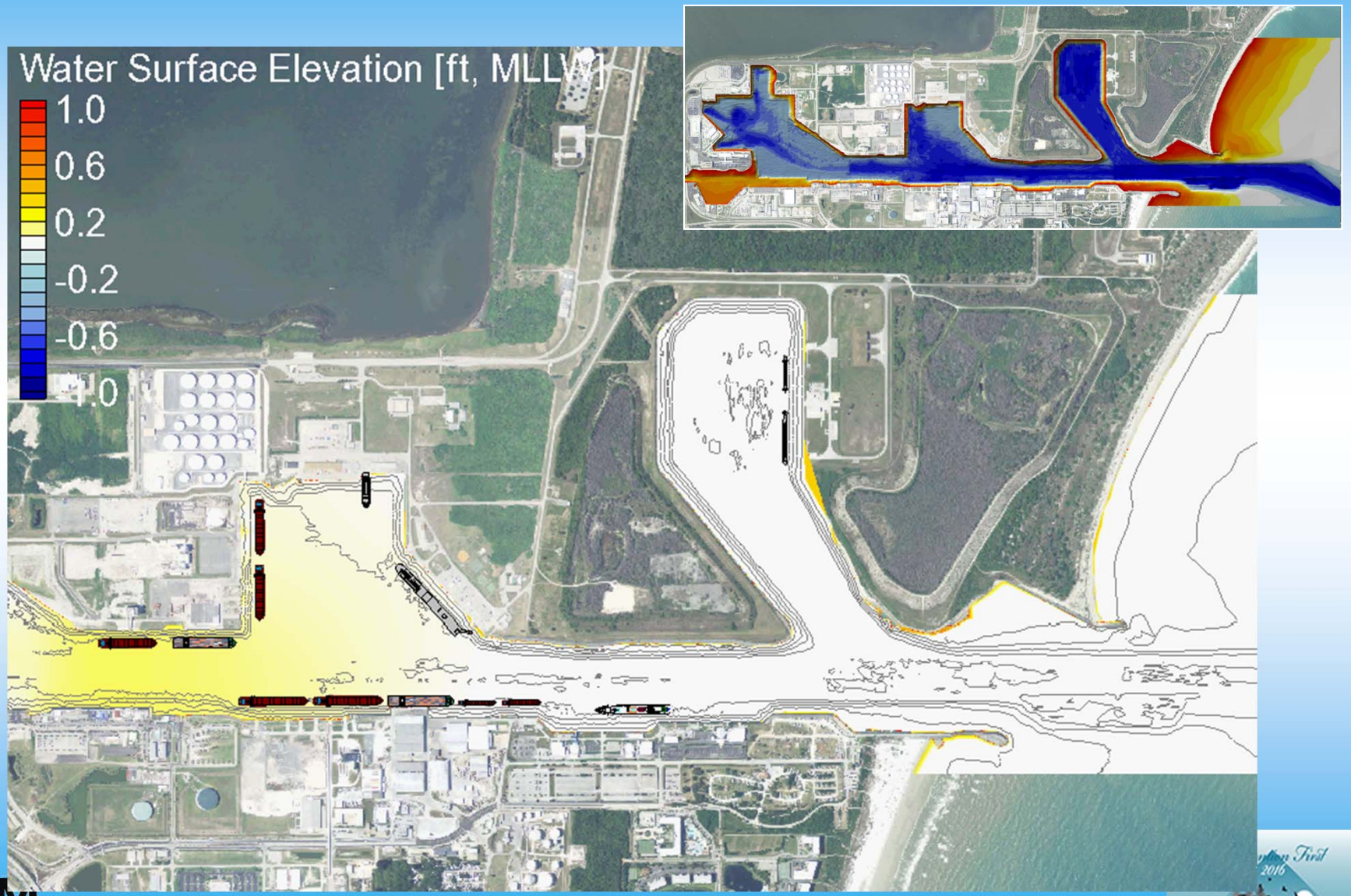
Data from van Wijhe et al. 2008

Harbor Sloshing/Bathtub Effects



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Harbor Sloshing/Bathtub Effects

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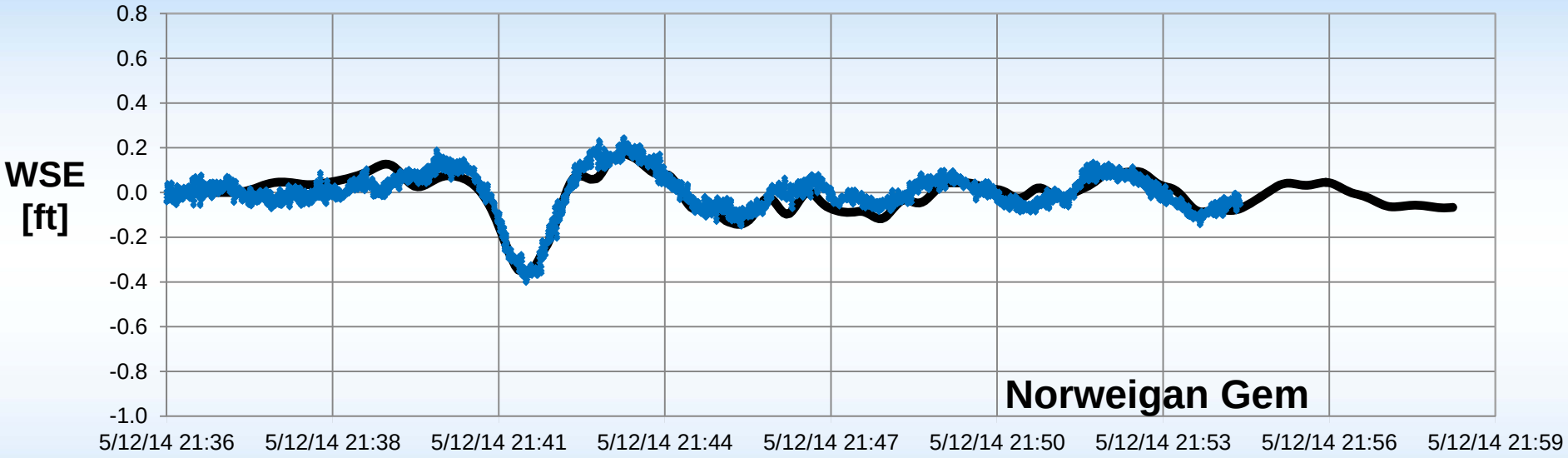
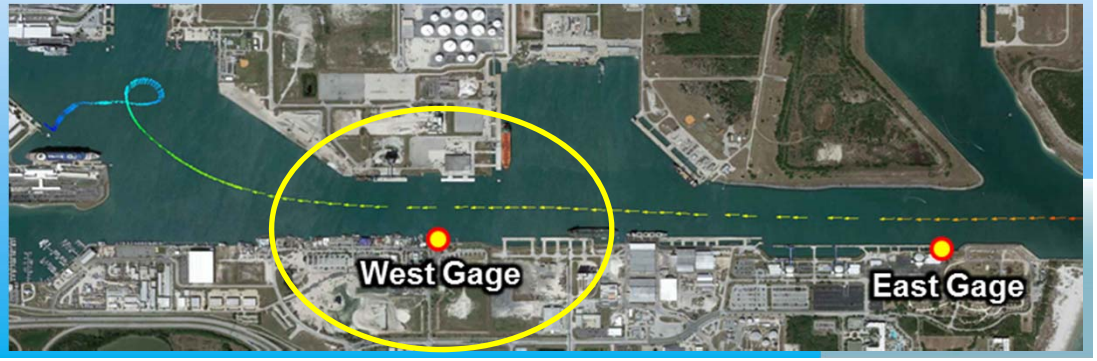
Harbor Sloshing/Bathtub Effects

Summer 2014 Field Campaign





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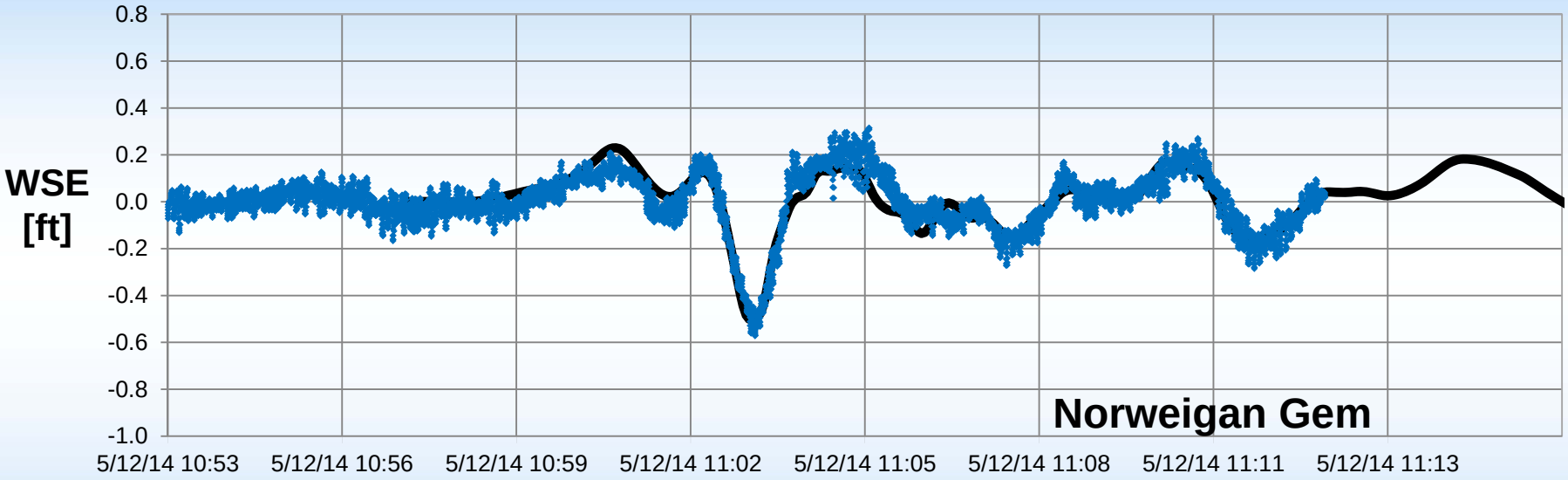

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Harbor Sloshing/Bathtub Effects

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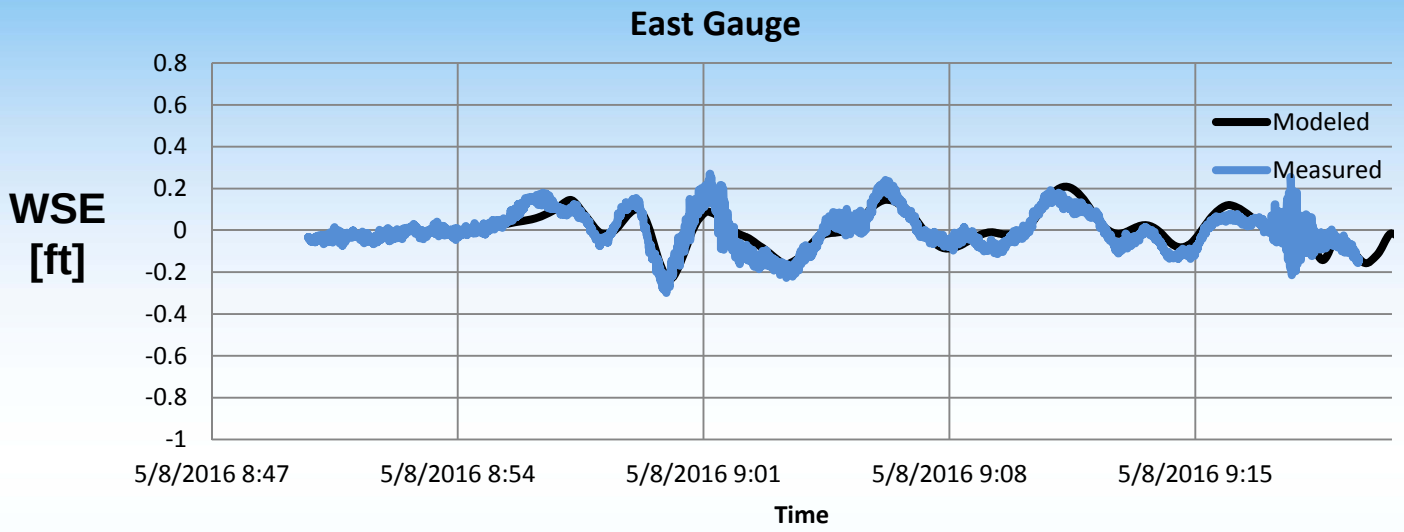
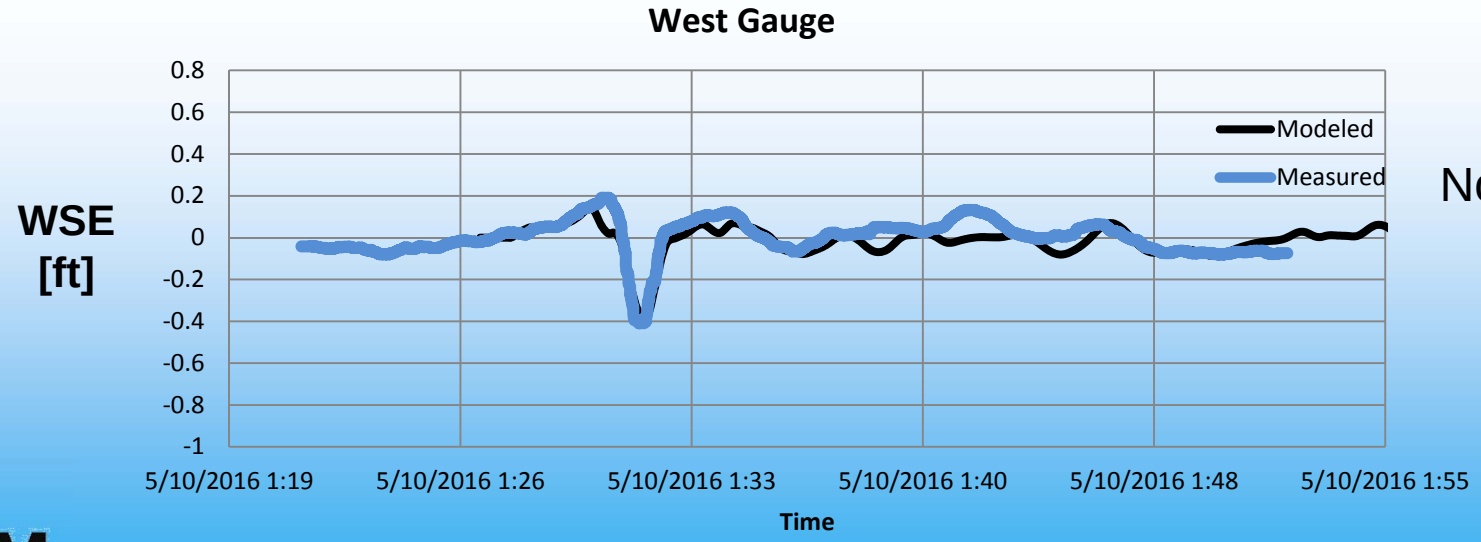


Disney Magic



Norwegian Gem

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Harbor Sloshing/Bathtub Effects

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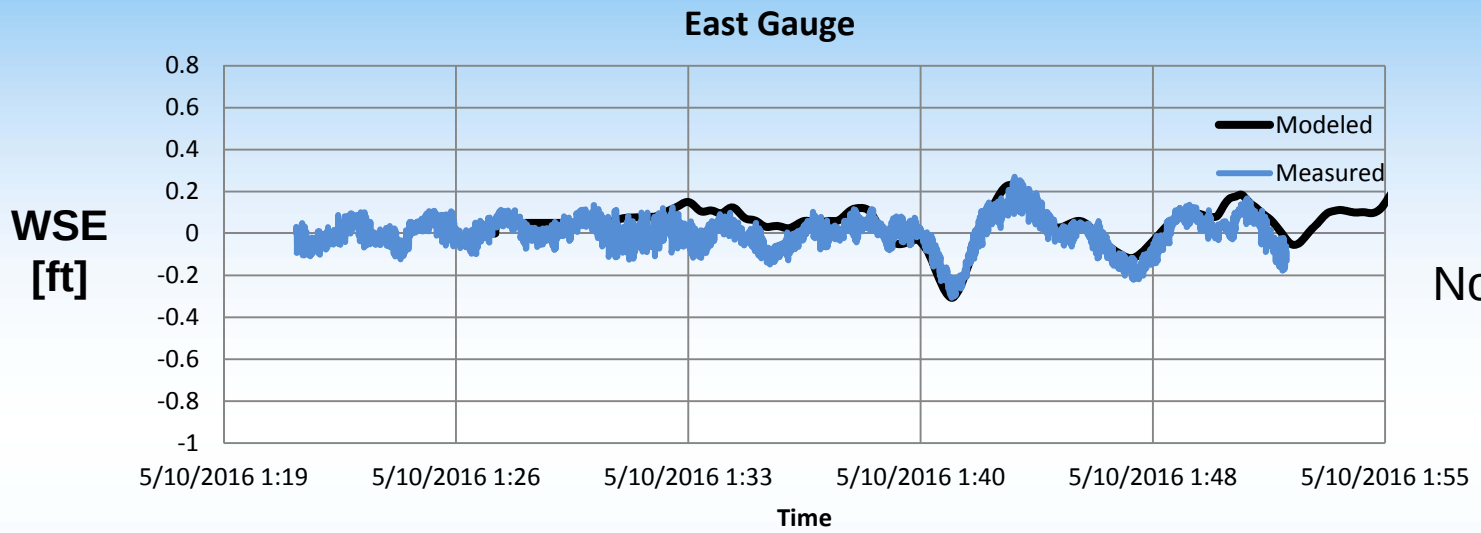

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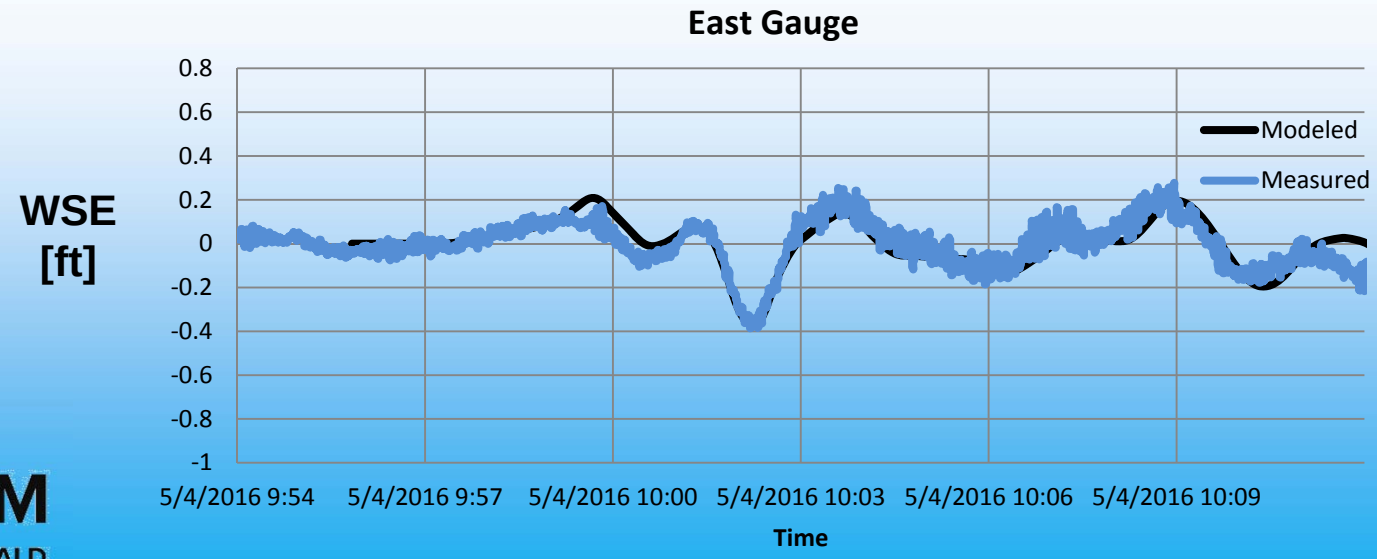

Disney Fantasy

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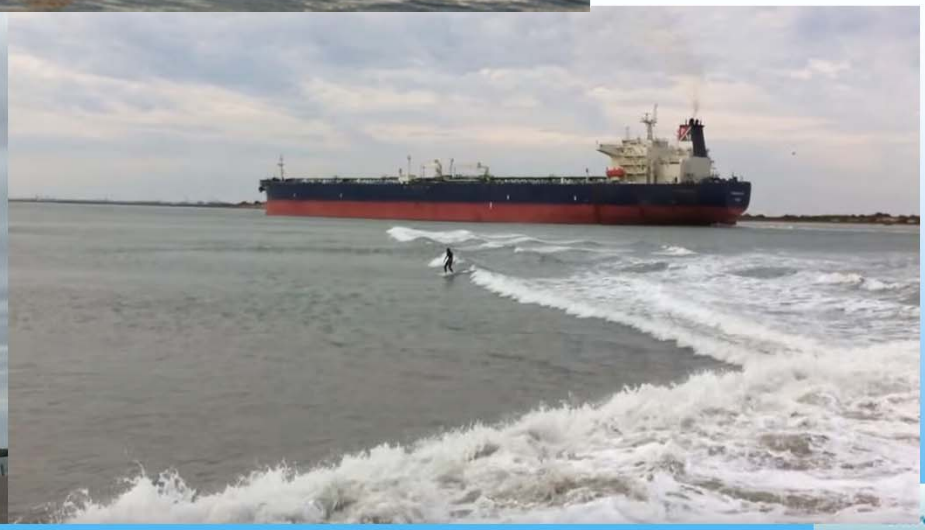
Broken Bore Formation and Propagation



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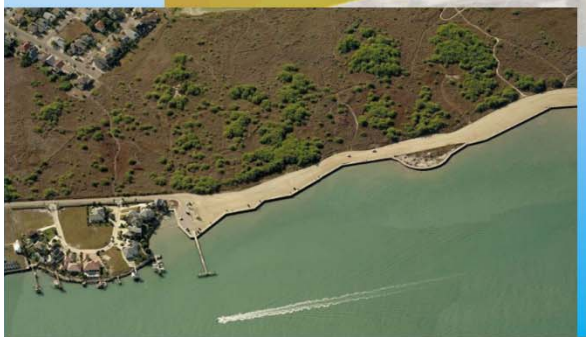
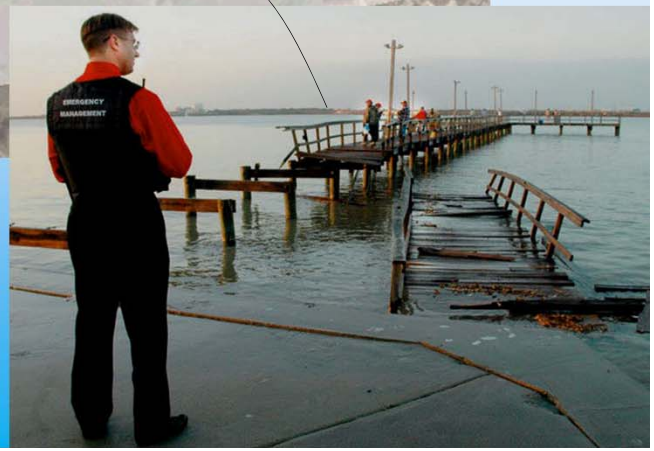
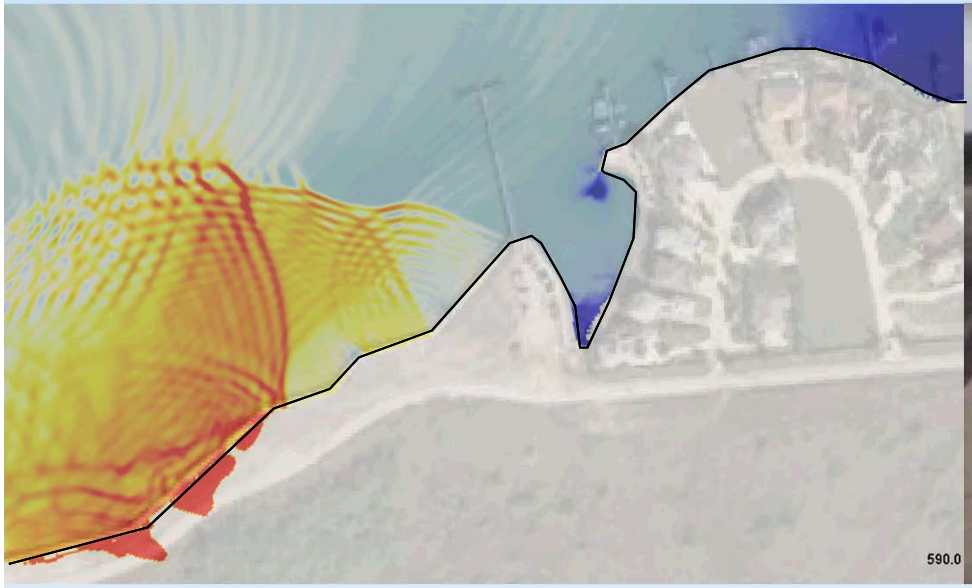




Broken Bore Formation and Propagation



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Ultra Large Container Vessels

Particular	CMA CGM Ben Franklin
Length Overall	1309.0 ft
Length Between Perpendiculars	1251.4 ft
Breadth	177.2 ft
Moulded Depth	99.1 ft
Draft	52.5 ft

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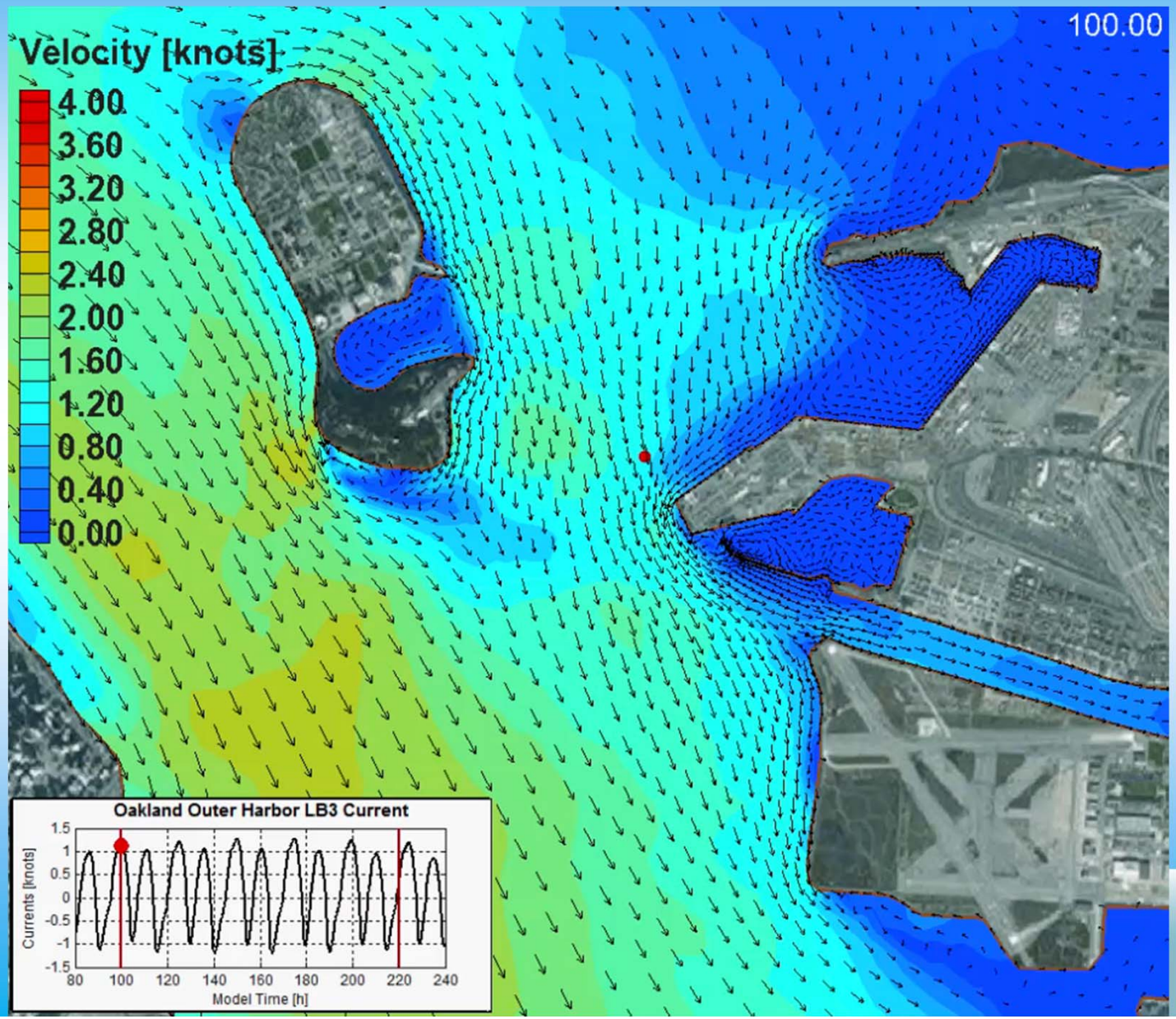
Ultra Large Container Vessels



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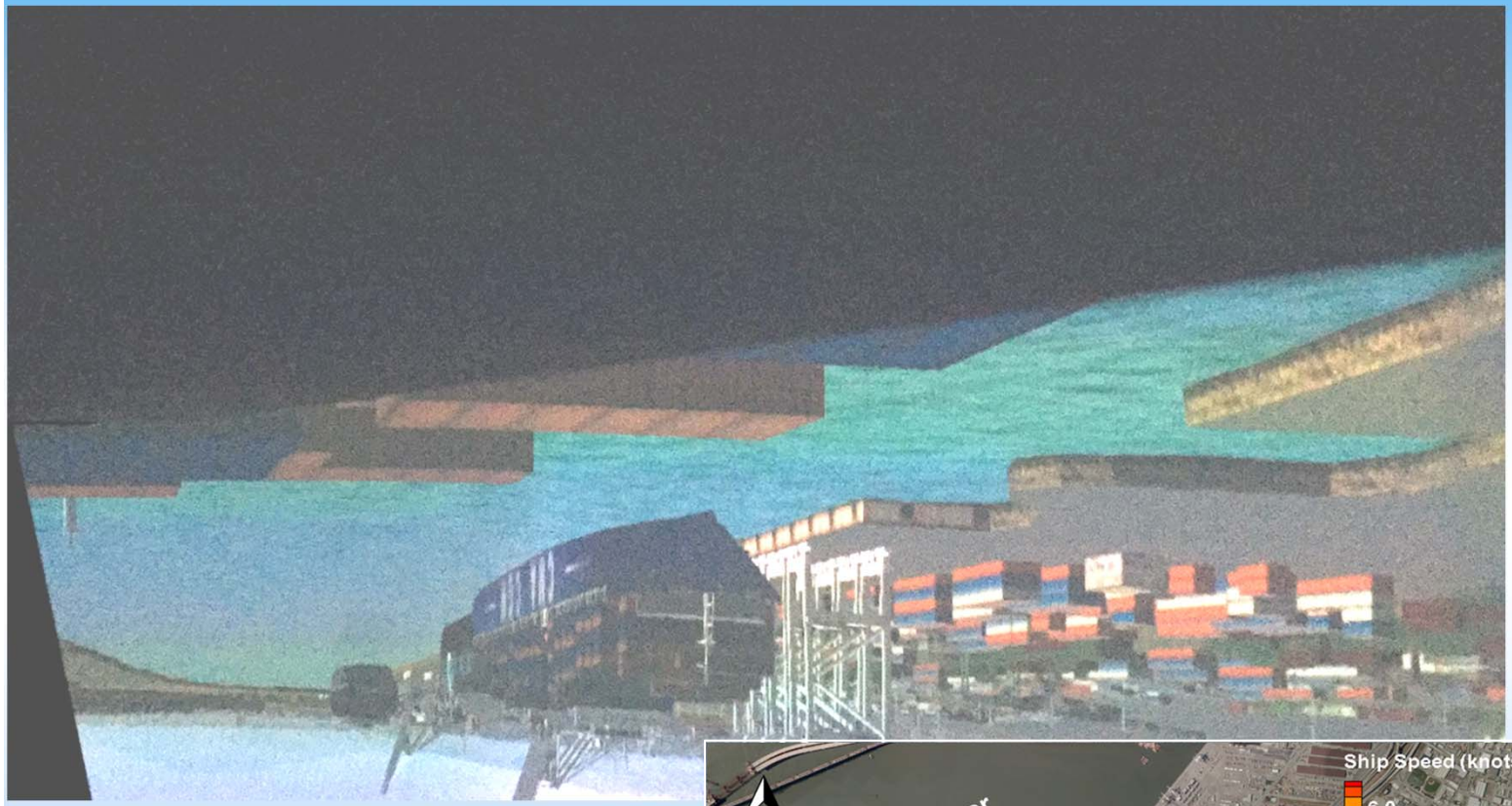

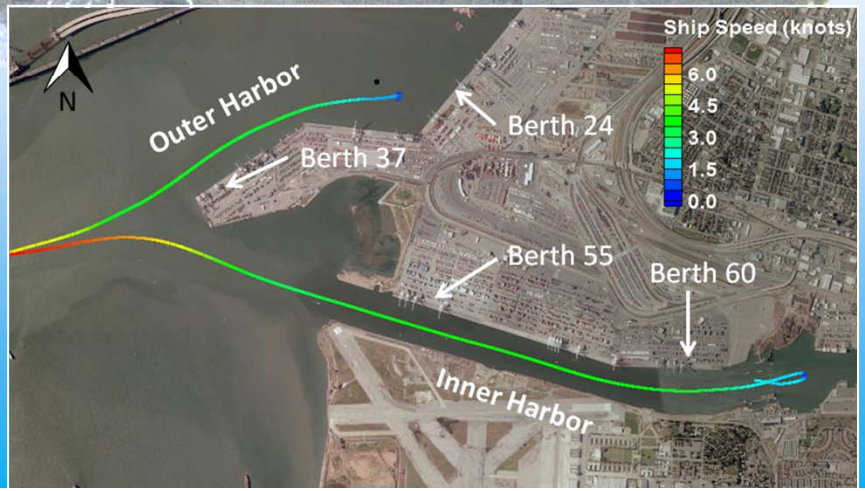

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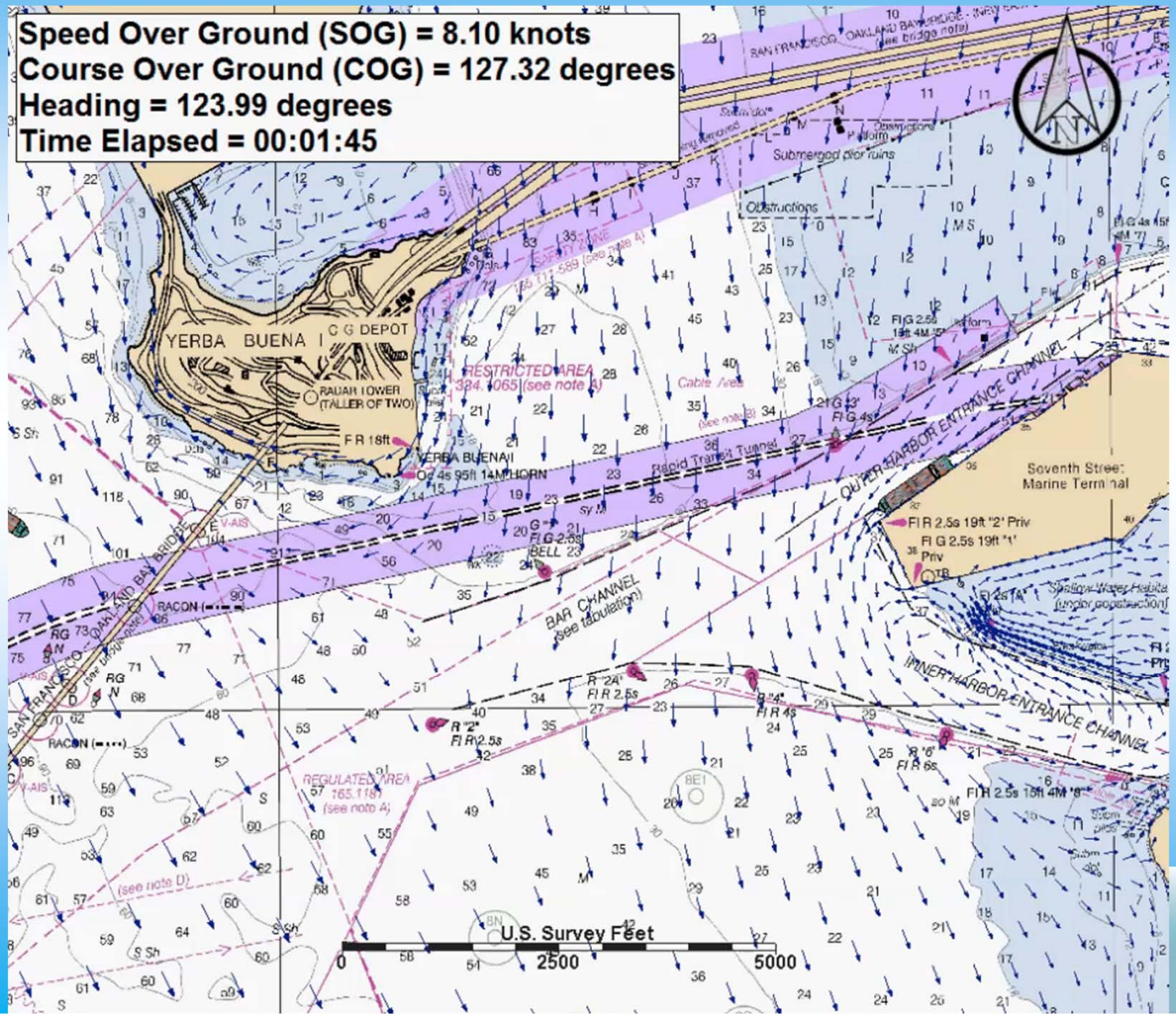

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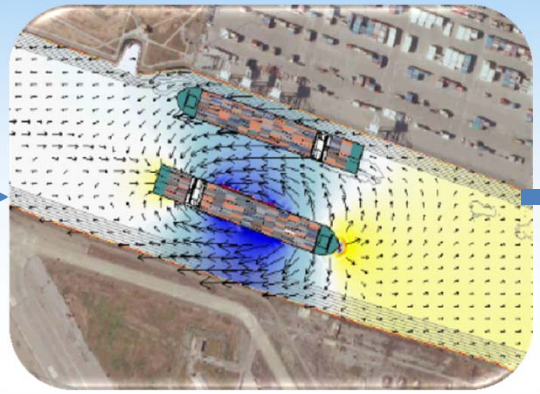
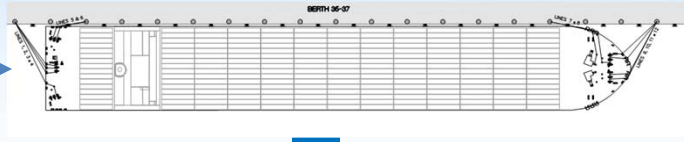
Ultra Large Container Vessels

Full Bridge Simulations

Ship Hydrodynamic Modeling



Dynamic Mooring Analysis



- Berthed vessel size or location
- Berthed vessel draft
- Berth depth
- Mooring arrangement modifications
- Berth infrastructure improvements

Loads and Motions within Limits?

NO

YES

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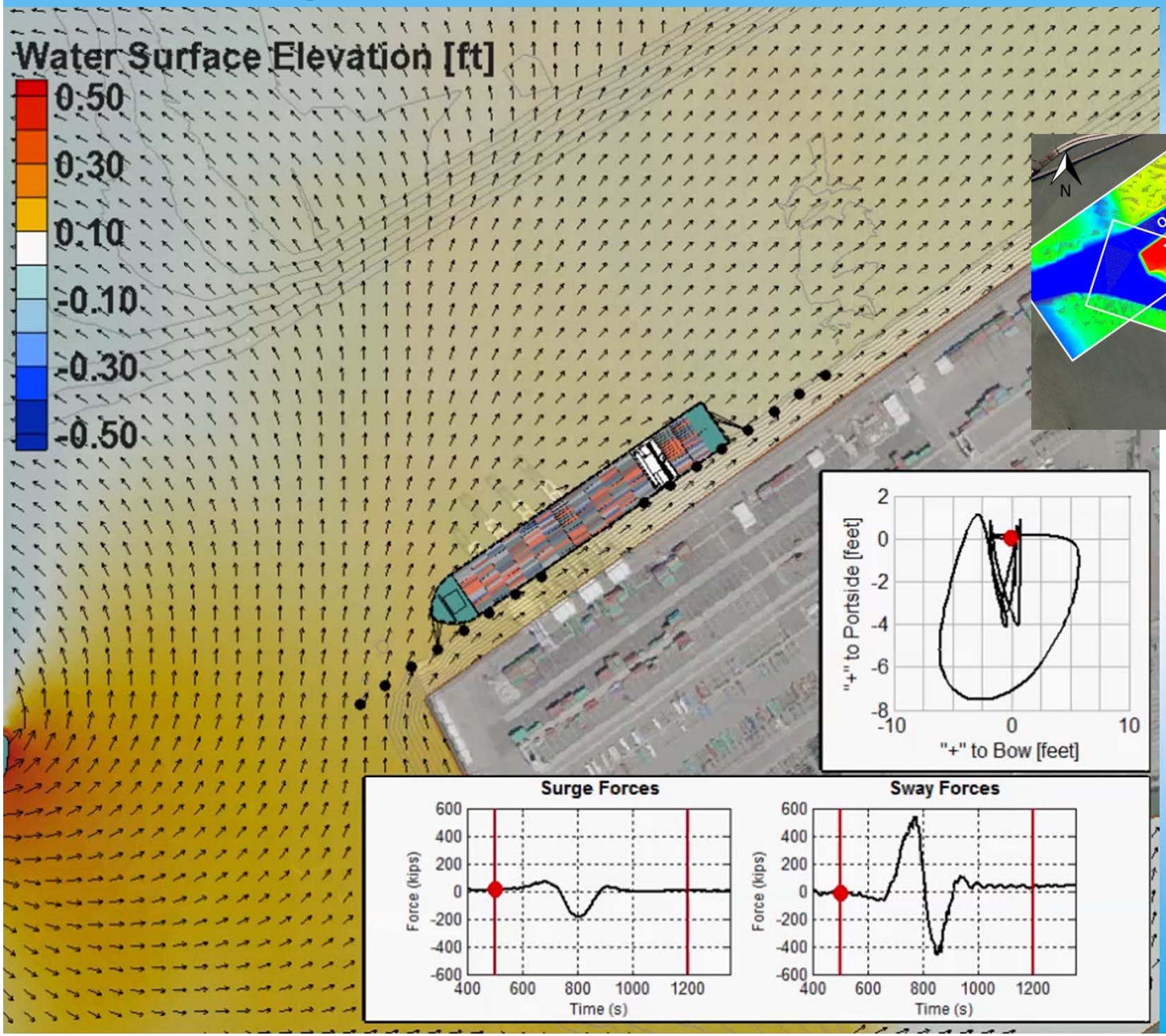
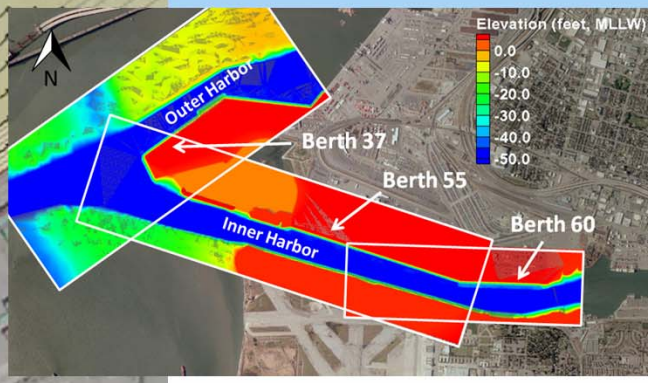
Ultra Large Container Vessels





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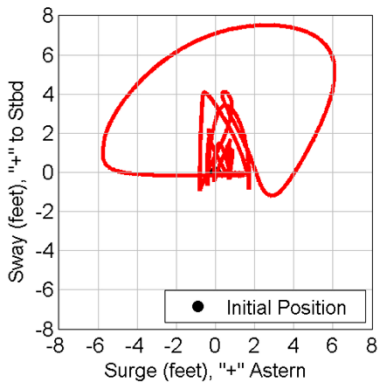

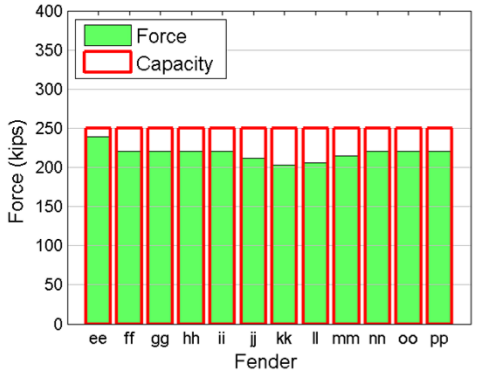

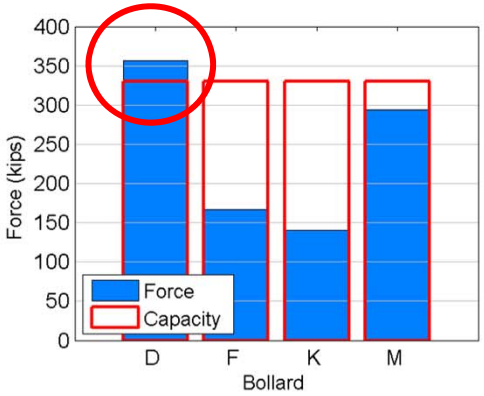

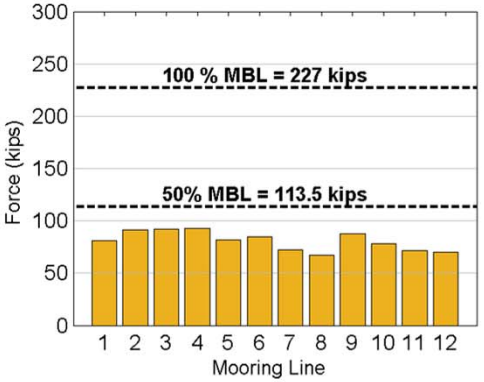

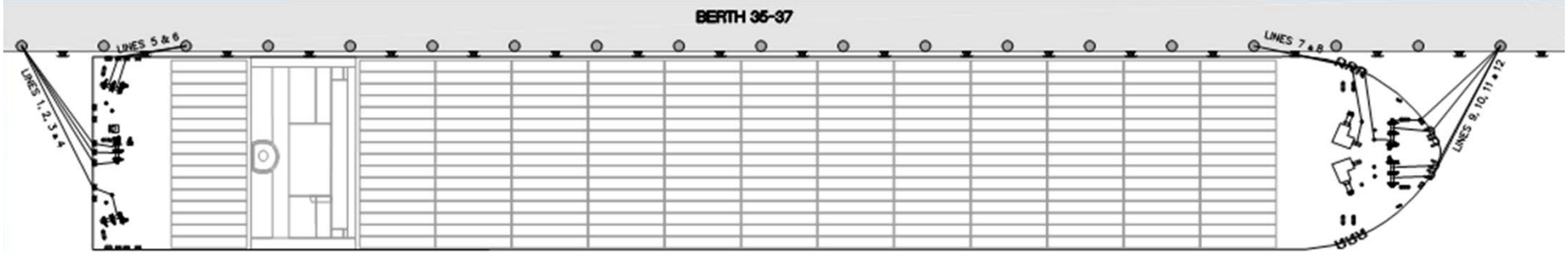

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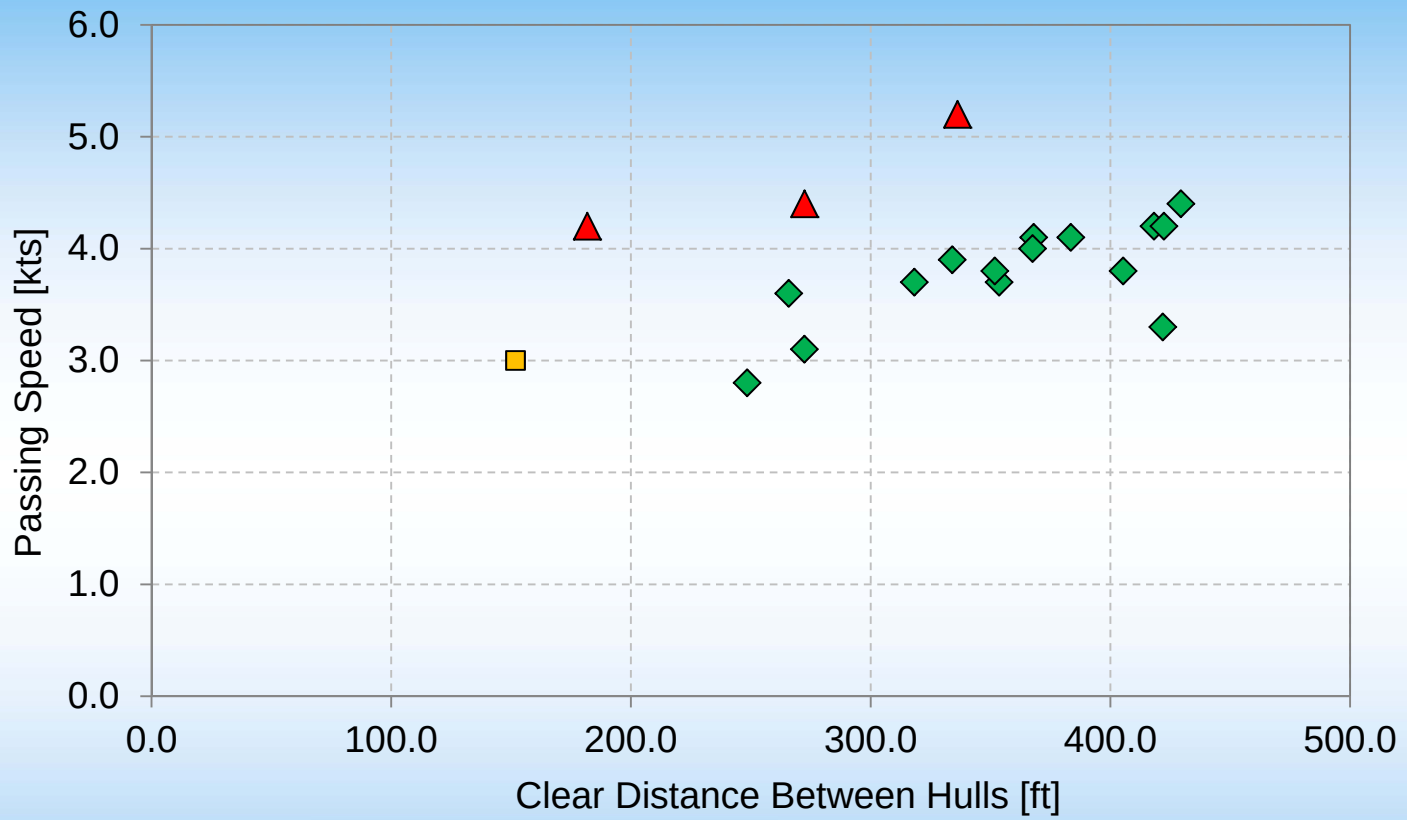

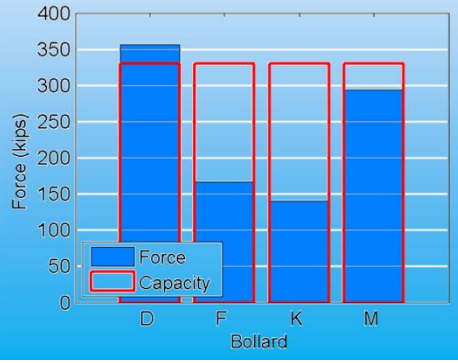

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Ultra Large Container Vessels

- Thorough analysis performed to determine feasibility of accommodating 18k TEU vessels
- Real-time full bridge simulations determined to be essential for pilot comfort and testing maneuvering-based risk mitigation measures
- Efficient system developed:
  - Simulator data taken directly into ship hydrodynamic model to produce loads and moments on berthed vessel(s)
  - Hydrodynamic model data taken directly into dynamic mooring analysis to determine potential mooring impacts
  - Mooring analysis results used to develop guidance for pilots, risk assessment for berth infrastructure, recommended improvements

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Ultra Large Container Vessels

- Results indicate that ULCVs are so large that:
  - Maneuvering safety sensitive to environmental forces
  - Difficult to control speeds given large swept path with drift angle
  - Loads on berthed vessels are highly sensitive to speed and passing distance
- Maneuvering improvements crucial to reduce passing speeds
- In some instances, ULCVs *passing* a particular berth pose the largest new risk to existing berth infrastructure (vs. ULCVs mooring at a berth).

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Conclusions

- ULCVs require particular attention be paid to passing ship effects.
- Berth infrastructure risk during accommodation of ULCVs should also consider smaller ships passed at berth.
- Validations successfully expanded to include complex (realistic) maneuvering and hydrodynamic processes such as bow solitary waves, broken bore effects, and sloshing/bathtub effects.
- Real maneuvering is often complex, accurate loads on berthed vessels require simulations and/or AIS information.
- Numerical modeling proven critical in the development and testing of measures to mitigate the harmful impacts of these hydrodynamic phenomena.

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