

Report

2011 Annual WAMIT Consortium Meeting

November 2-3, 2011

Woods Hole, Massachusetts

Agenda for 2011 Annual WAMIT Meeting
Room 310, Marine Resource Center, Swope Center, Woods Hole, MA

November 2, 2011:

9:00AM: Welcome

9:15 AM: "WAMIT Version 7.0"
J. N. Newman, WAMIT

10:00AM: "Status of V6.4S"
C.-H. Lee, WAMIT

10:20AM: "Automatic Free Surface Generation for ILOWHI=1, Version 6.4S"
X. Zhu, WAMIT

10:40AM Break

11:00PM: "What's New in MultiSurf. Techniques and enhancements
in MultiSurf for WAMIT 8.1 "
R. Page, AeroHydro Inc.

12:00PM: Lunch, Swope Center Dining Hall

1:30 PM: "Use of WAMIT to study`Cloaking' with domain decomposition
J. N. Newman, WAMIT

2:15PM: "Recent Wamit applications in Petrobras Research Center"
Marcos Ferreira, Petrobras SA

3:00 PM: Break

3:30 PM: "Technical discussion"

5:30PM: Mixer and Dinner, Swope Center Dining Hall

November 3, 2011

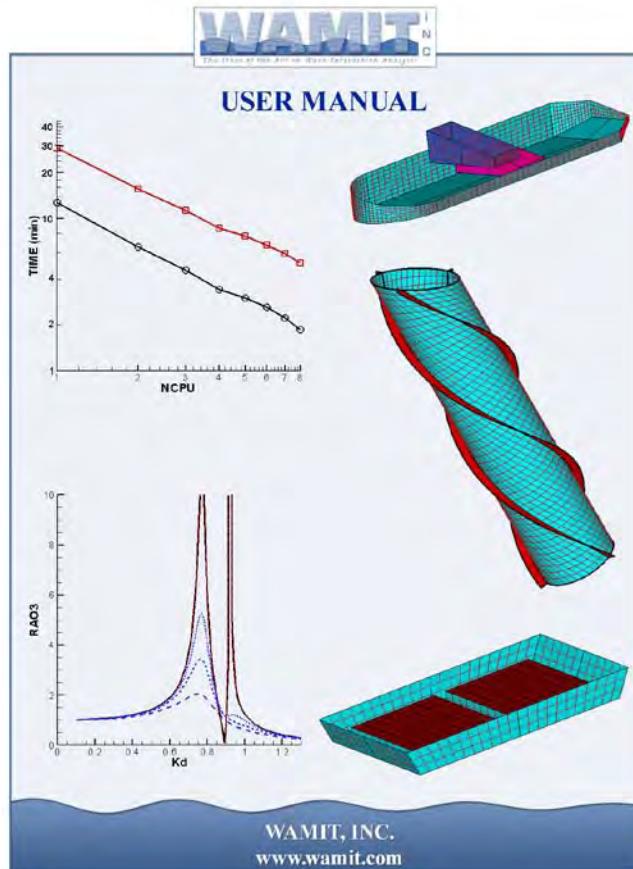
9:00AM: “Technical discussion”

10:30AM: Break

11:00AM: Business meeting

12:00AM: Lunch, Swope Center Dining Hall

WAMIT Version 7.0



List of extensions (from V6.4)

- Option to exploit geometric symmetry when NBODY>1 *
- Output patch data in `wamitlog.txt` file if NPER=0
- Improved error messages for bad input files
- Evaluate control surface drift forces without Option 9
- For option 9, list points with velocity > VMAXOPT9
- Modify tolerance for gaps on waterline
- Separate Froude-Krylov and scattering components of exciting force
- Use both `config.wam` and `runid.cfg` files for input *
- New algorithms for Rankine and Log singularities in the low-order method
- Use RAMGBMAX to avoid scratch disk I/O *
- Parallel processing (NCPU>1) *
- IFORCE=2: evaluate FORCE outputs in POTEN period loop *
- Pressure surface elements on body boundary *
- Compiled with Intel Fortran 12.1
- IPERIN and IPEROUT replace IPERIO

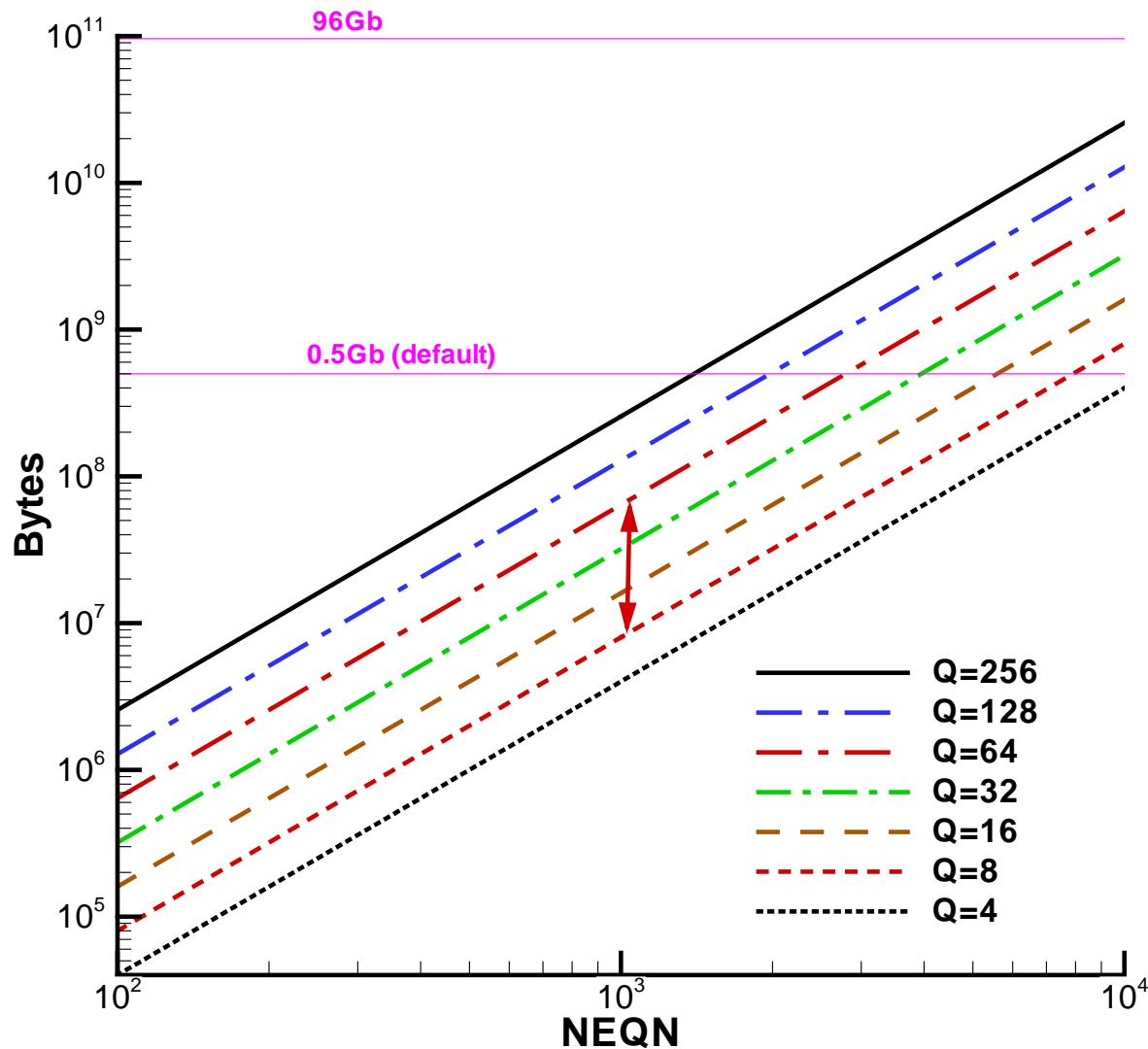
Principal extensions: further details

- Option to exploit geometric symmetry when NBODY>1:
If all bodies have a common plane of symmetry this is used by the program, saving considerable time
- Use both **config.wam** and **runid.cfg** files for input:
Use **config.wam** for system-dependent data (NCPU, RAMGBMAX, USERID_PATH)
- IFORCE=2: evaluate FORCE outputs in POTEN period loop: Enables viewing completed outputs during run
- Pressure surface elements on body boundary: BC for pressure instead of normal velocity. Useful for OWC, ACV, vessels with flooded compartments, possibly also for damping of free-surface resonances

Principal extensions: continued

- Use RAMGBMAX to avoid scratch disk I/O: Saves considerable computing time, required for NCPU>1 (default RAMGBMAX=0.5)
- Parallel processing (NCPU>1): Main loops in POTEN and FORCE are parallelized. For long runs time is nearly $\sim 1/\text{NCPU}$ (default NCPU=1)

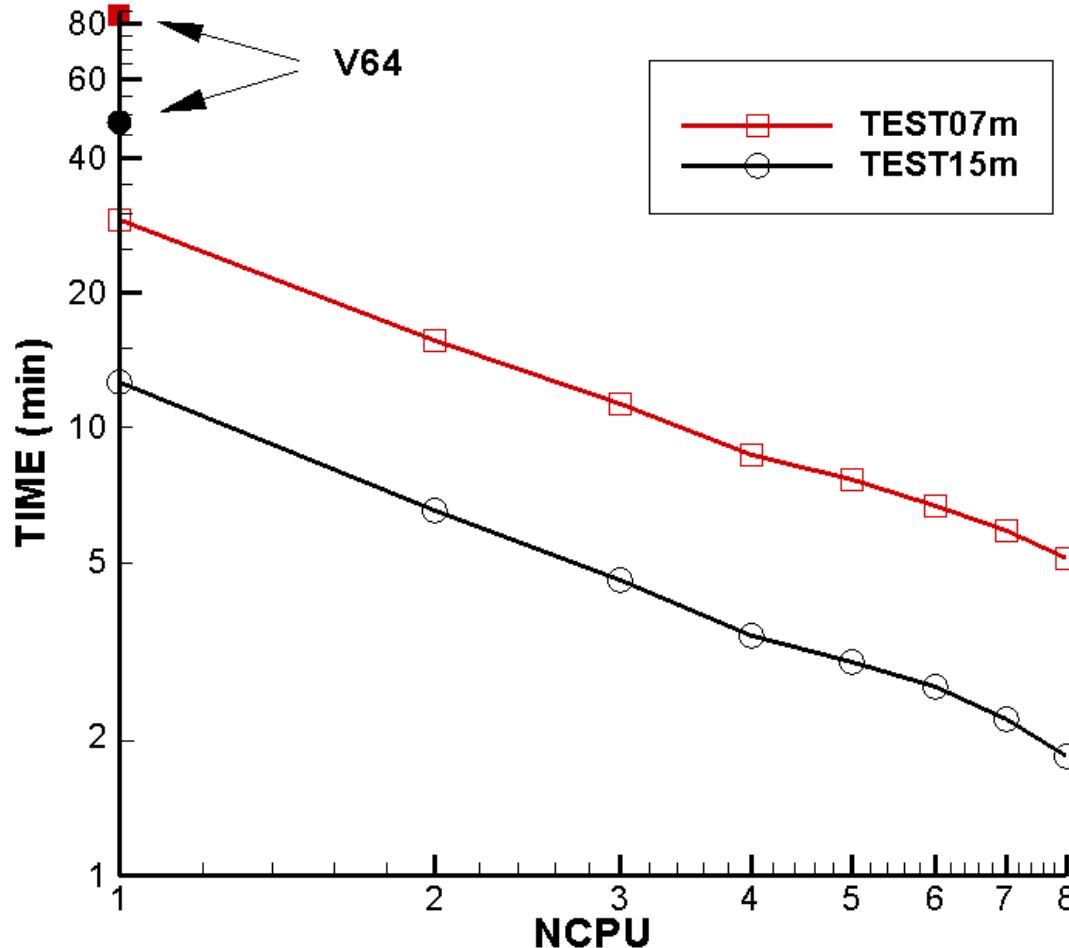
RAM required: Q=8-64 is typical for NCPU=1
(see User Manual Section 14.4 for details)



Runtimes for low-order and higher-order tests:

TEST07m: ISSC TLP, NEQN=4048, NPER=32

TEST15m: Semi-sub, NPER=32, OPTN(7)=1



Changes in input files

- Old Alternative 1 POT file not supported
- New POT file uses Alternative 2 format except NEWMDS and IRR moved to CFG
- IQUAD, IDIAG removed for low-order
- Old Option 7 combined with Option 6 (like Option 5)
- Option 7 used for control surface drift forces (replaces old Option 9c)
- Dipole panels or patches assigned in CFG only (not in GDF)
- ISX,ISY < 0 replaced by IWALLX0, IWALLY0
- IALTPOT, ICTRSURF, IDIAG, IQUAD, MAXSCR, IPERIO removed from CFG

`v6v7inp.exe` can be used to convert old files
(see Appendix B)

Status of WAMIT V6.4S

The new features and updates in V6.4S

(*Red Italic* is progress made since the last meeting)

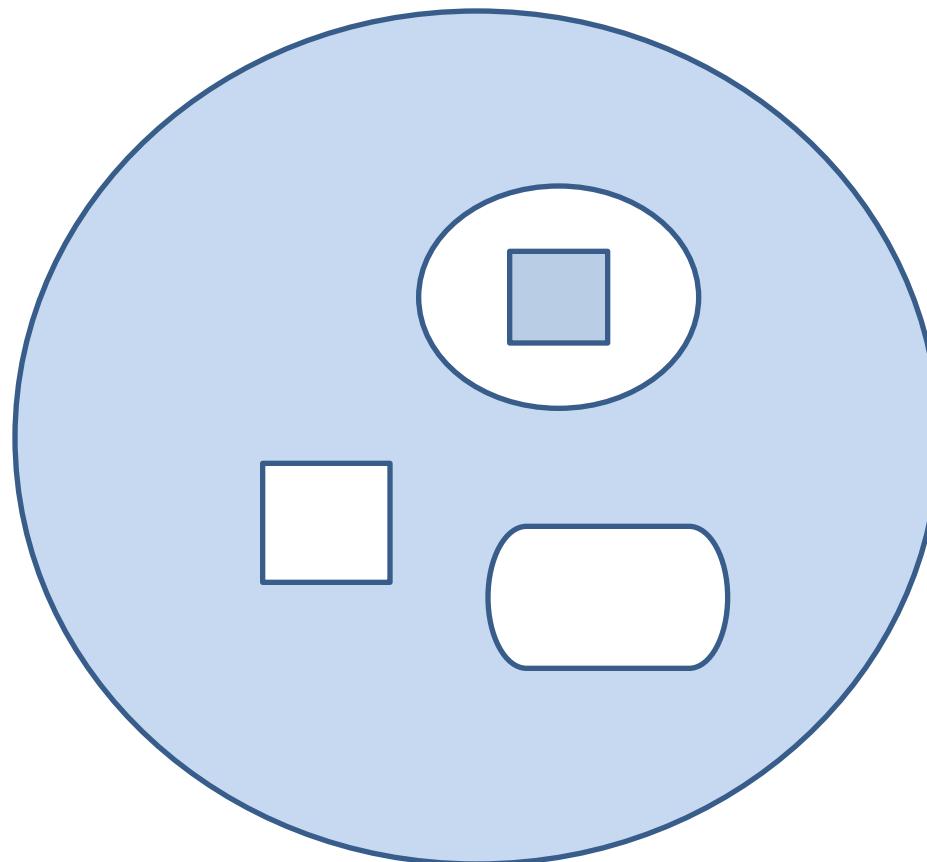
- Option to evaluate quadratic forces using control surfaces.
- Complete second-order forces on vessels with internal tanks.
(ILOWHI=0 and *ILOWHI=1*)
- As in V61S, the quadratic forcing on RHS is considered in a piecewise manner for ILOWHI=1. But exact body surface is considered instead of an approximation using flat panels.
- Option for automatic descretization on the external free surface
(ILOWHI=0 and *ILOWHI=1*) and *tank free surface*

Automatic Free Surface Generation for ILOWHI=1

WAMIT V6.4S

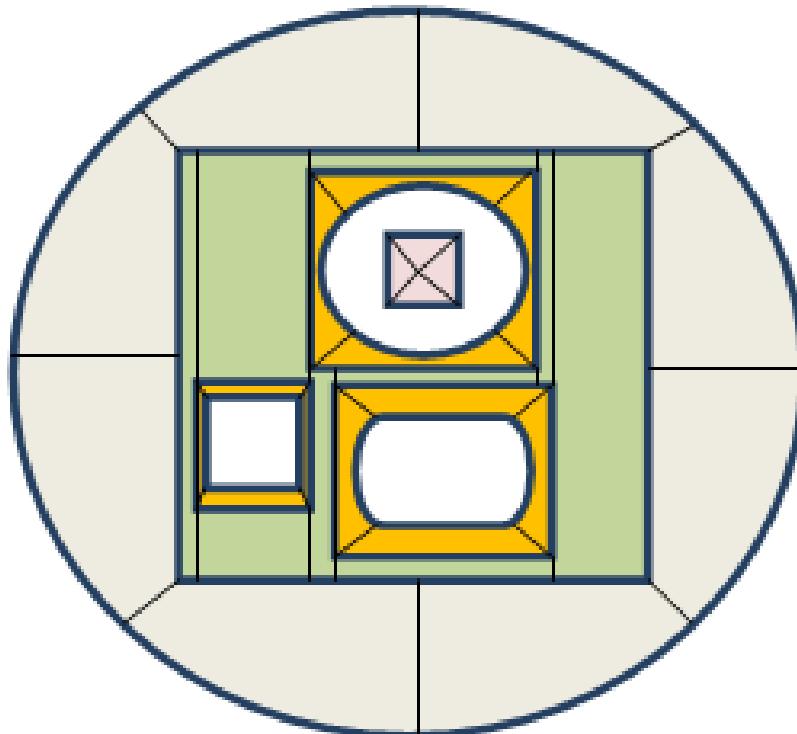
Main Idea

- To generate patches automatically on free surface
 - Inside partition circle (blue area) represented by a number of patches
 - White color areas: waterplane areas
 - Small blue rectangle : tank free surface area

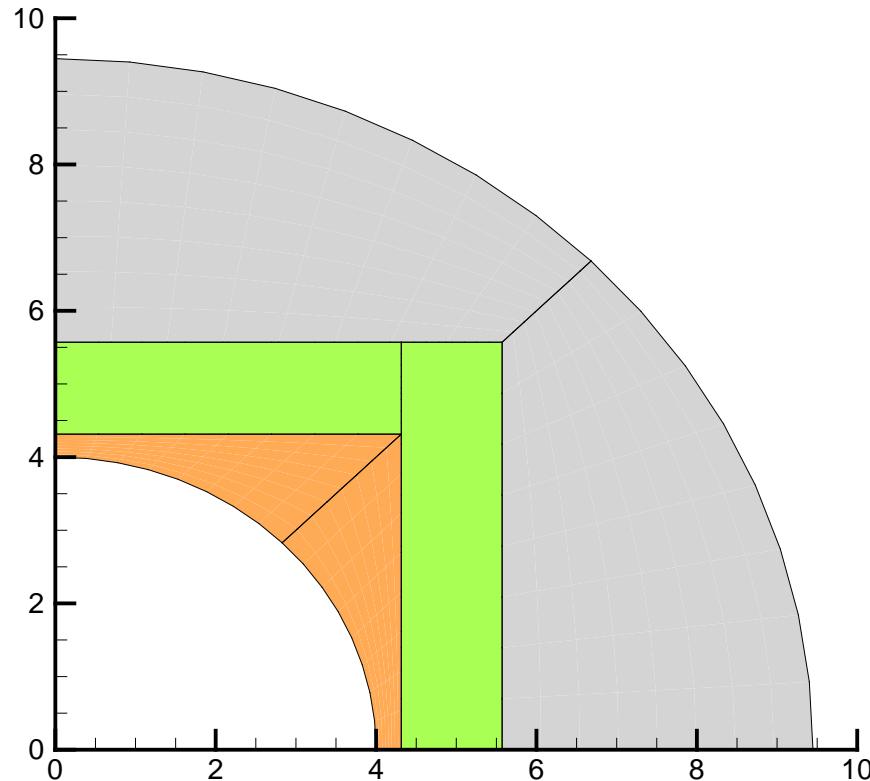


Free Surface Patches Prototype

- Type 1 (yellow): patches surrounding each individual waterline
- Type 2 (green): patches within large square and small rectangles
- Type 3 (grey): patches within partition circle and large square
- Type 4 (pink): patches tank free surface
- Black lines: vertices of patches

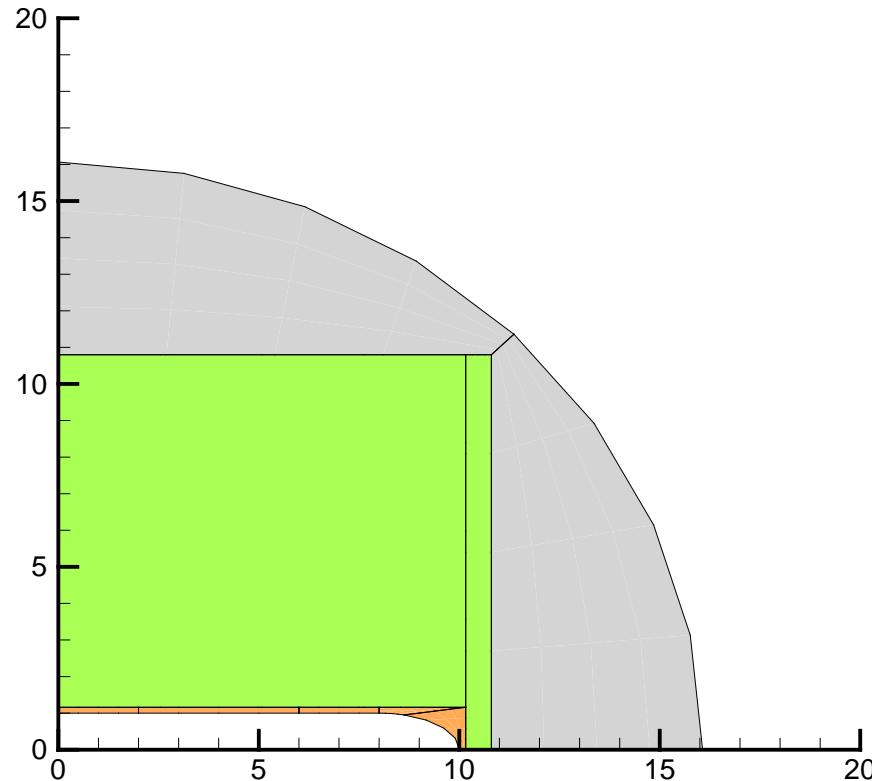


Free Surface of a Cylinder



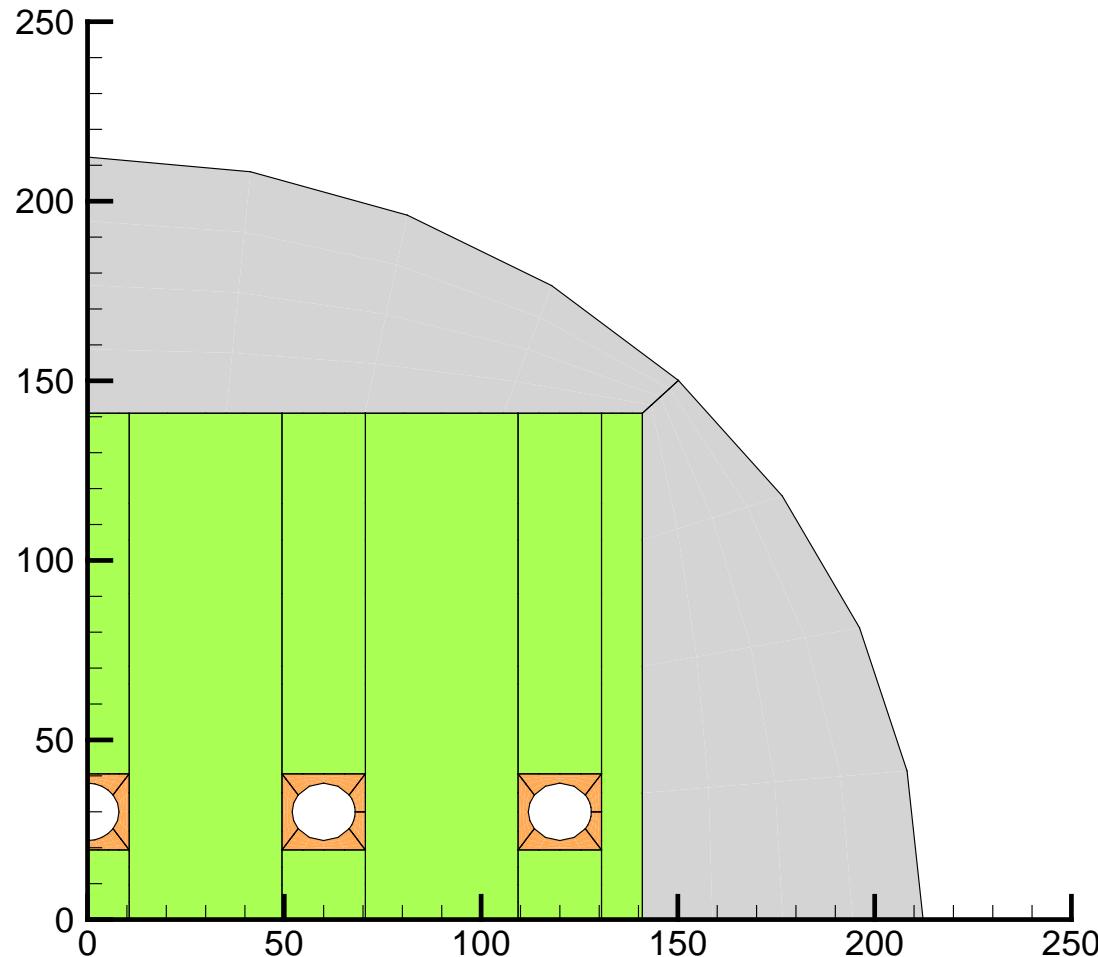
6 free surface patches are generated on free surface
All patches parameters are determined inside the code

Free Surface of a Barge



Type 1 patches : 5
Waterline segments: 4

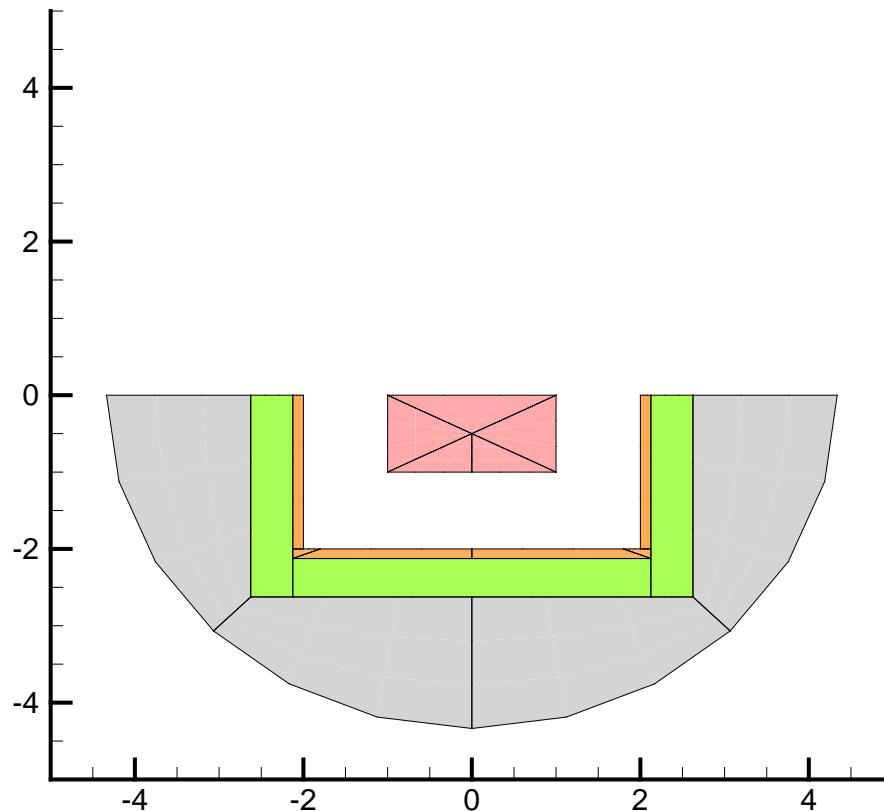
Semi Sub Example



Each waterline contour segment: 1

Type 1 patches surrounding each waterline contour: 3 or 5

Barge with tank Example



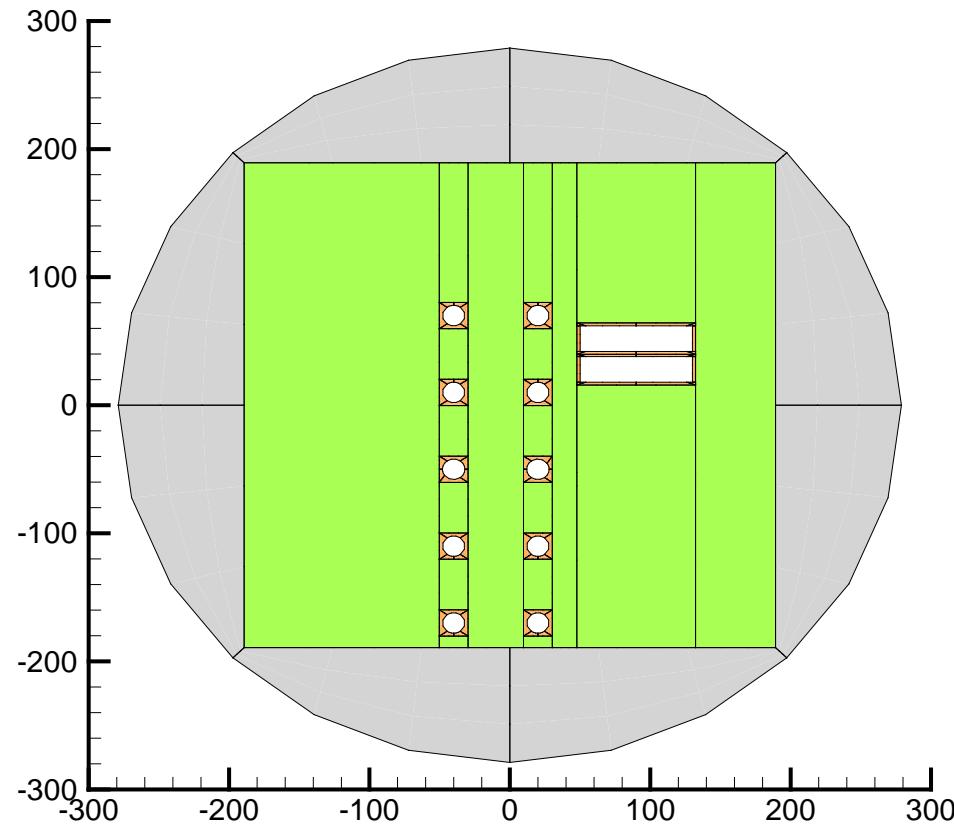
Type 1 patches: 6

Type 2 patches: 3

Type 3 patches: 4

Type 4 patches: 5

Multiple Body (semi-sub and catamaran barge)



Note: Plots to show features, not for real problems
total of 98 free surface patches

Summary

- NPATCHFD<0 in *.fdf input file
- Free surface is discretized automatically
- Tank free surface is discretized automatically
- The number of patches is determined inside WAMIT
- Both a single body and multiple bodies can be used
- Checking the free surface discretization from output data file for Tecplot is strongly recommended

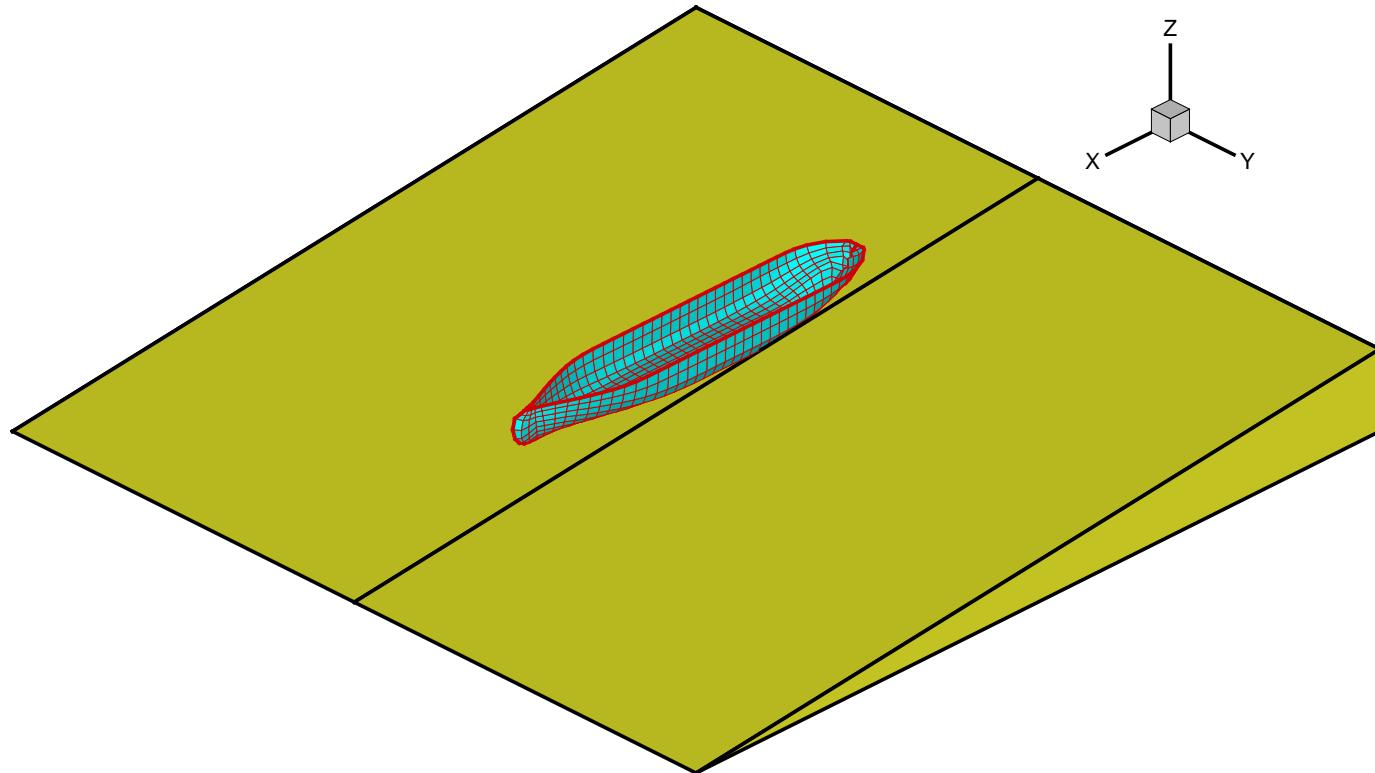
Use of WAMIT to study ‘Cloaking’ with domain decomposition

(Scattering by a bottom-mounted cylinder with variable bathymetry)

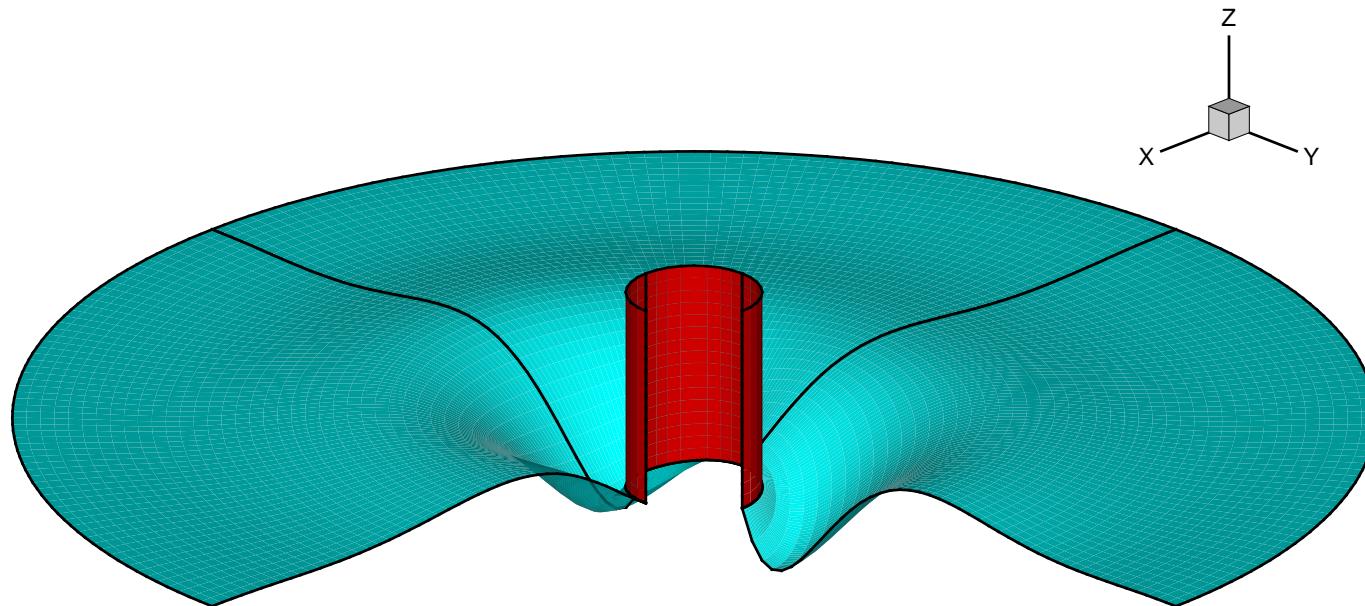
by J. N. Newman
WAMIT Consortium Meeting
November 2011

Variable depth bottom can be represented as an extension of the body surface, with additional panels or patches, provided the depth everywhere is less than or equal to h (constant depth in far field)

e.g. Newman & Ferreira, IWWWFB 2009



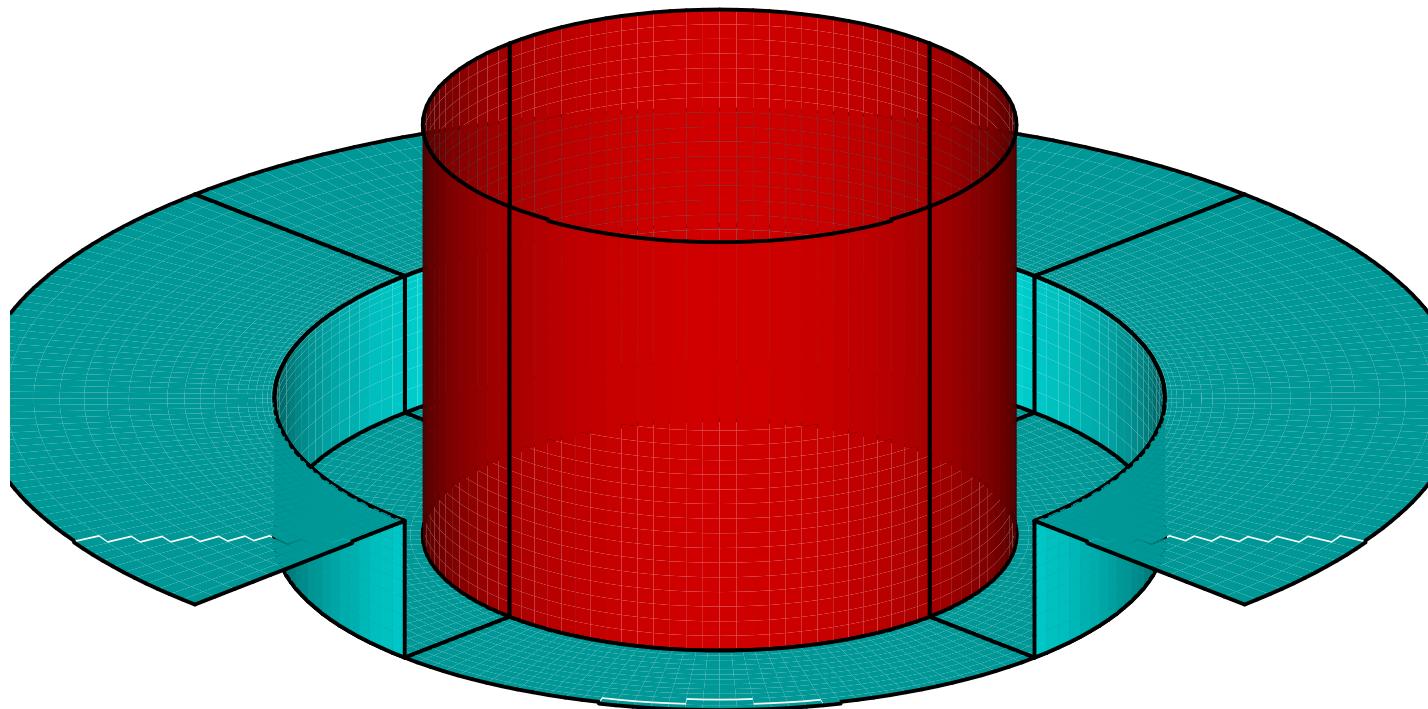
Motivation for this work came from `Cloaking of a cylinder in waves' by R. Porter, IWWWFB 2011:



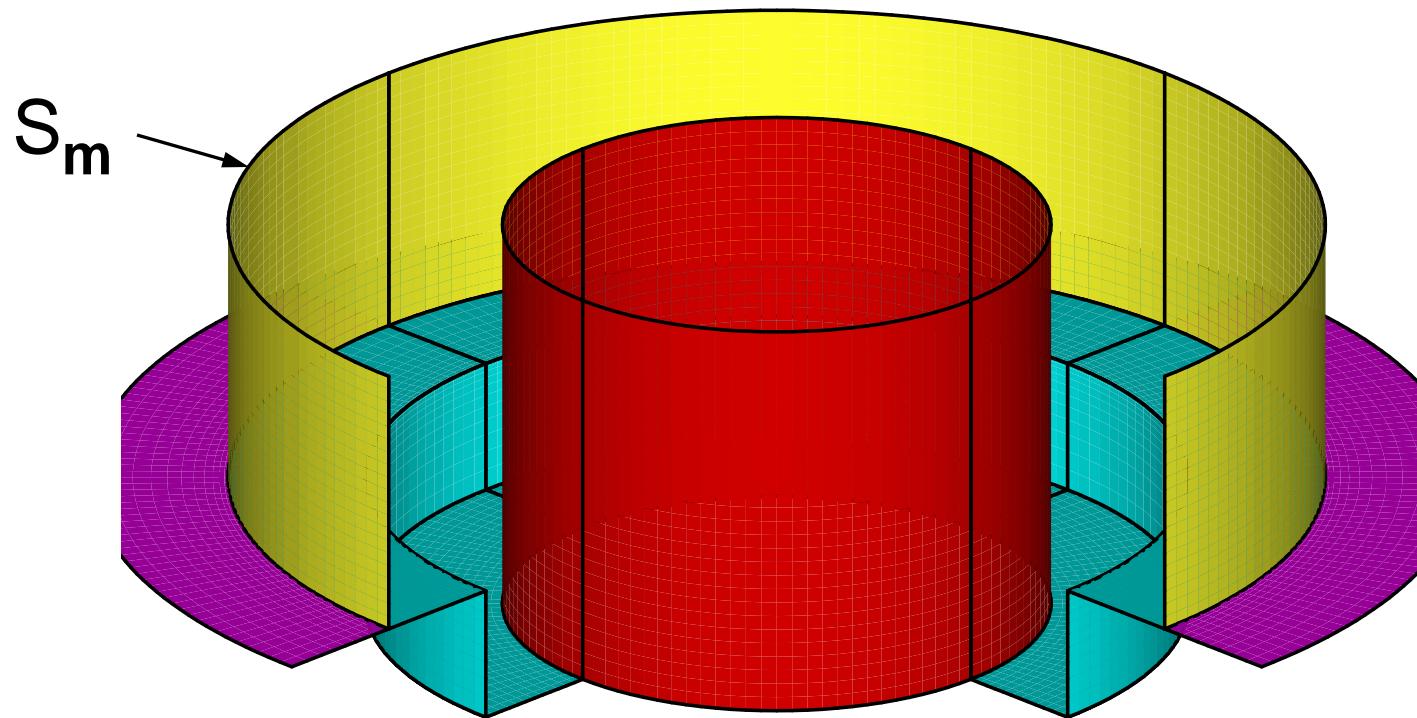
Bathymetry of 'bed' represented by Chebyshev/Fourier expansion in radial/azimuthal directions, 2*4 coefficients optimized to minimize scattering energy at $kh=1$
using NAG routine with **Mild-Slope Approximation**
Scattered Energy Ratio = 0.000000016

A simpler problem with the same fundamental issue for WAMIT:

Bottom-mounted cylinder in a pit



How to get around this issue with WAMIT: Domain decomposition with a matching boundary



Interior domain (1): use infinite-depth Green function
Exterior domain (2): use finite-depth Green function
match potentials and normal velocities on S_m

Integral equations based on Green's Theorem

S_m =matching boundary, S_b =body + bed inside S_m

$$2\pi\phi^{(1)} + \iint_{S_b} \phi^{(1)} G_n^{(1)} d\xi + \iint_{S_m} \phi^{(2)} G_n^{(1)} d\xi - \iint_{S_m} G^{(1)} \phi_n^{(2)} d\xi = 0 \quad (\mathbf{x} \text{ on } S_b)$$

$$2\pi\phi^{(2)} + \iint_{S_b} \phi^{(1)} G_n^{(1)} d\xi + \iint_{S_m} \phi^{(2)} G_n^{(1)} d\xi - \iint_{S_m} G^{(1)} \phi_n^{(2)} d\xi = 0 \quad (\mathbf{x} \text{ on } S_m)$$

$$-2\pi\phi^{(2)} + \iint_{S_m} \phi^{(2)} G_n^{(2)} d\xi - \iint_{S_m} G^{(2)} \phi_n^{(2)} d\xi = -4\pi\phi_I^{(2)} \quad (\mathbf{x} \text{ on } S_m)$$

Unknowns: potential on S_b
potential on S_m ,
normal velocity on S_m

Validation of modified code

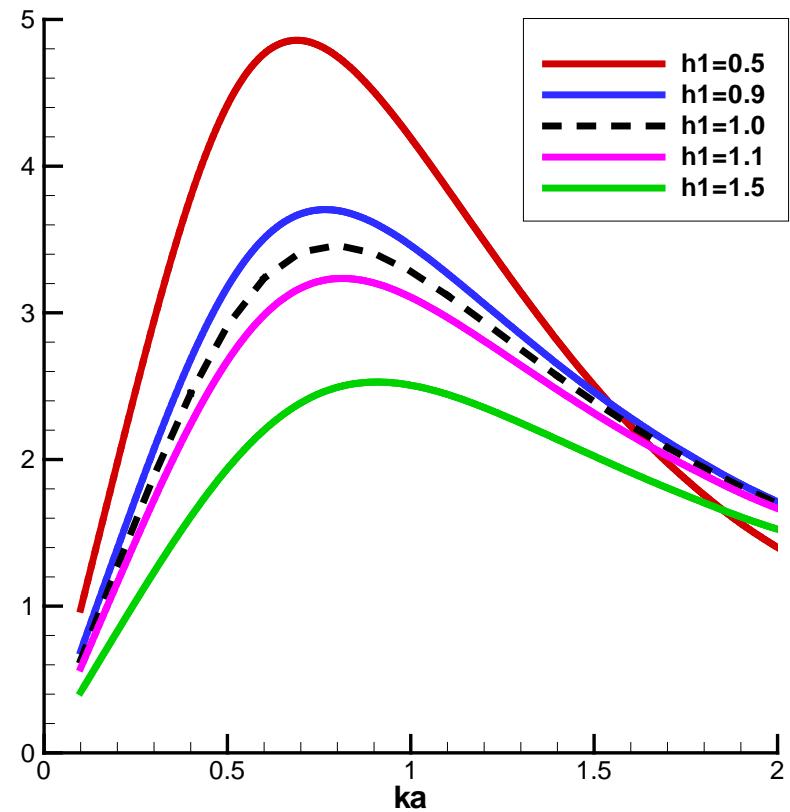
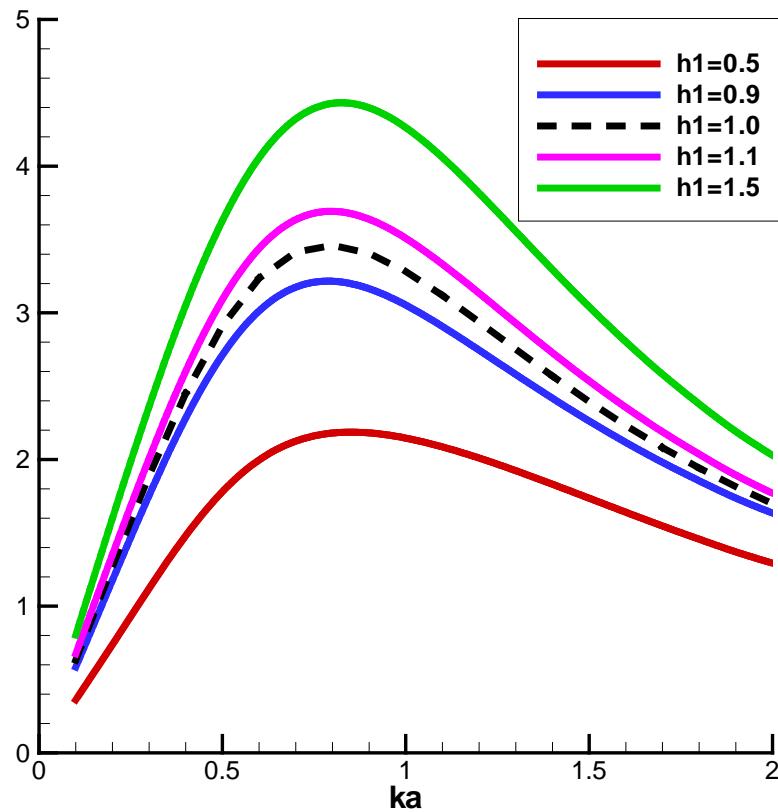
Bottom-mounted circular cylinder: $R=1$, $h=1$
Surge and diffraction forces, drift forces
 $ka=0.1(0.1)2.0$

- 1) Using standard V70 code
- 2) Using modified code with 2 domains,
matching on $R=2$

All outputs agree to 4 or 5 decimals

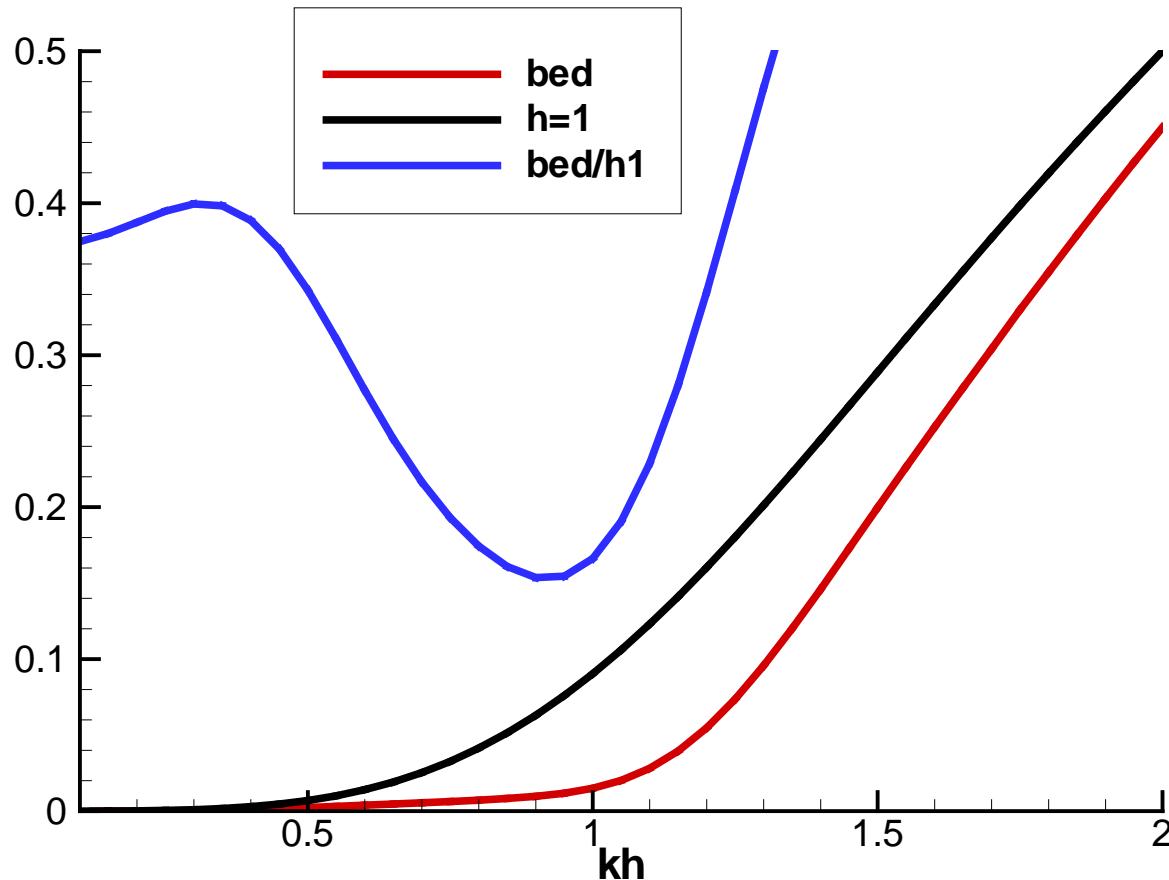
Surge exciting force on: cylinder (left), cylinder + bottom (right)

$a=r_1=1.0$, $h_2=1.0$, $r_2=1.5$, h_1 =depth in $r_1 < r < r_2$



WAMIT results for constant depth and Porter bed scattering energies and ratio

cylinder radius=0.5h, matching radius=2h



New results using WAMIT (modified!)

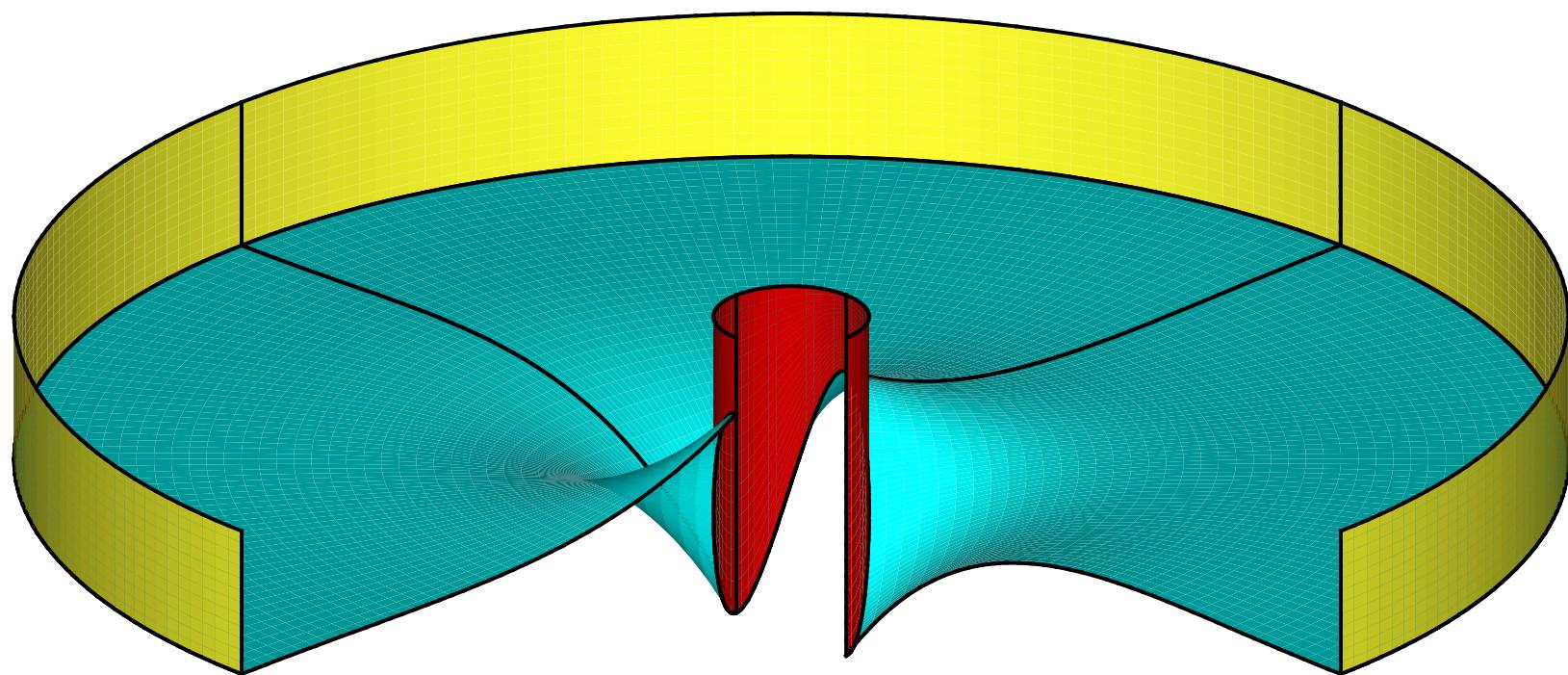
- Cylinder radius = $0.5h$
- Matching radius = $2 h$
- Same bottom expansion as Porter
(Chebyshev/Fourier)
- Optimized to minimize scattering at $kh = 1.0$
- PRAXIS optimizer (http://people.sc.fsu.edu/~jburkardt/f_src/praxis/praxis.html)
- PRAXIS calls WAMIT as a FUNCTION!

1st optimized bed with 2*2 coefficients

Scat E = 0.035, ratio = 0.40

opti1

SCAT=.035

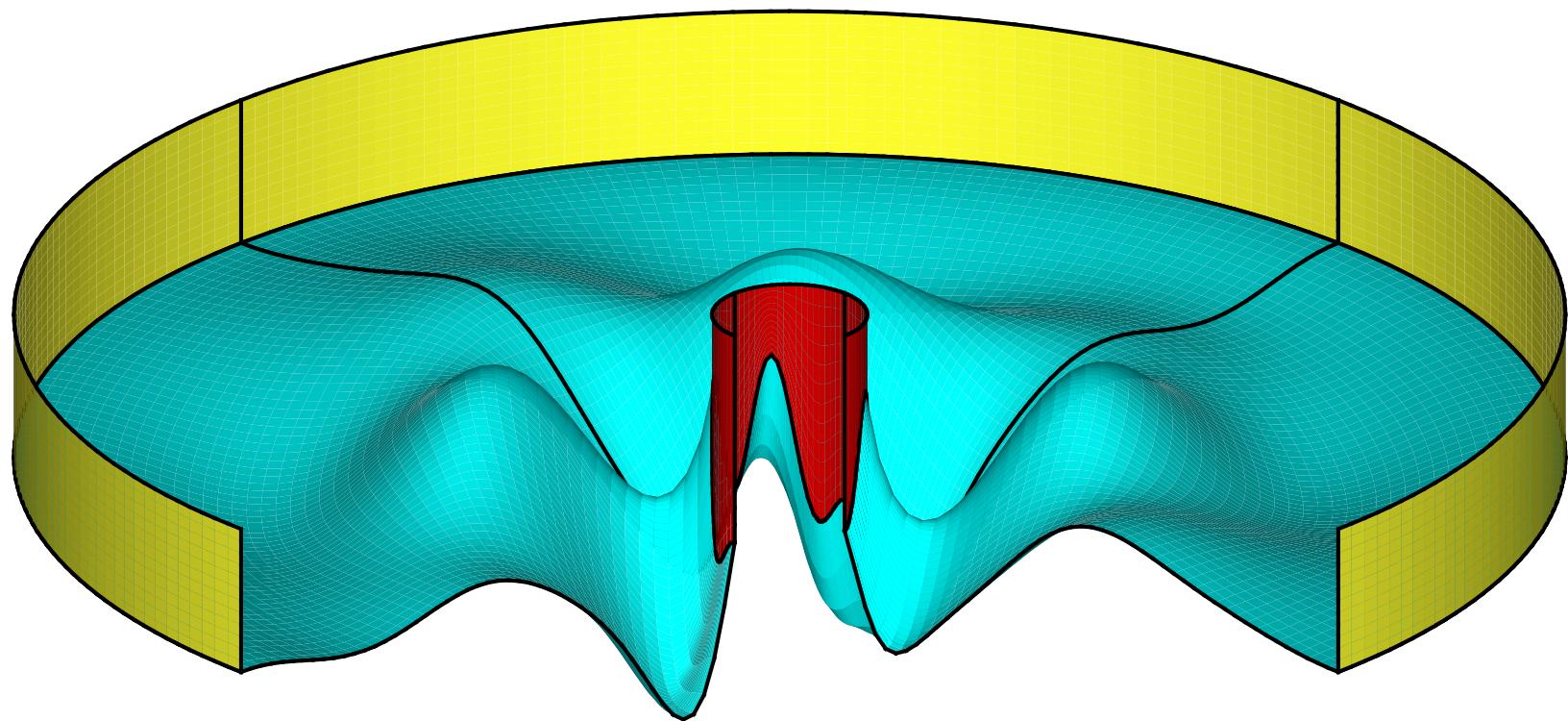


7th optimized bed with 4*8 coefficients

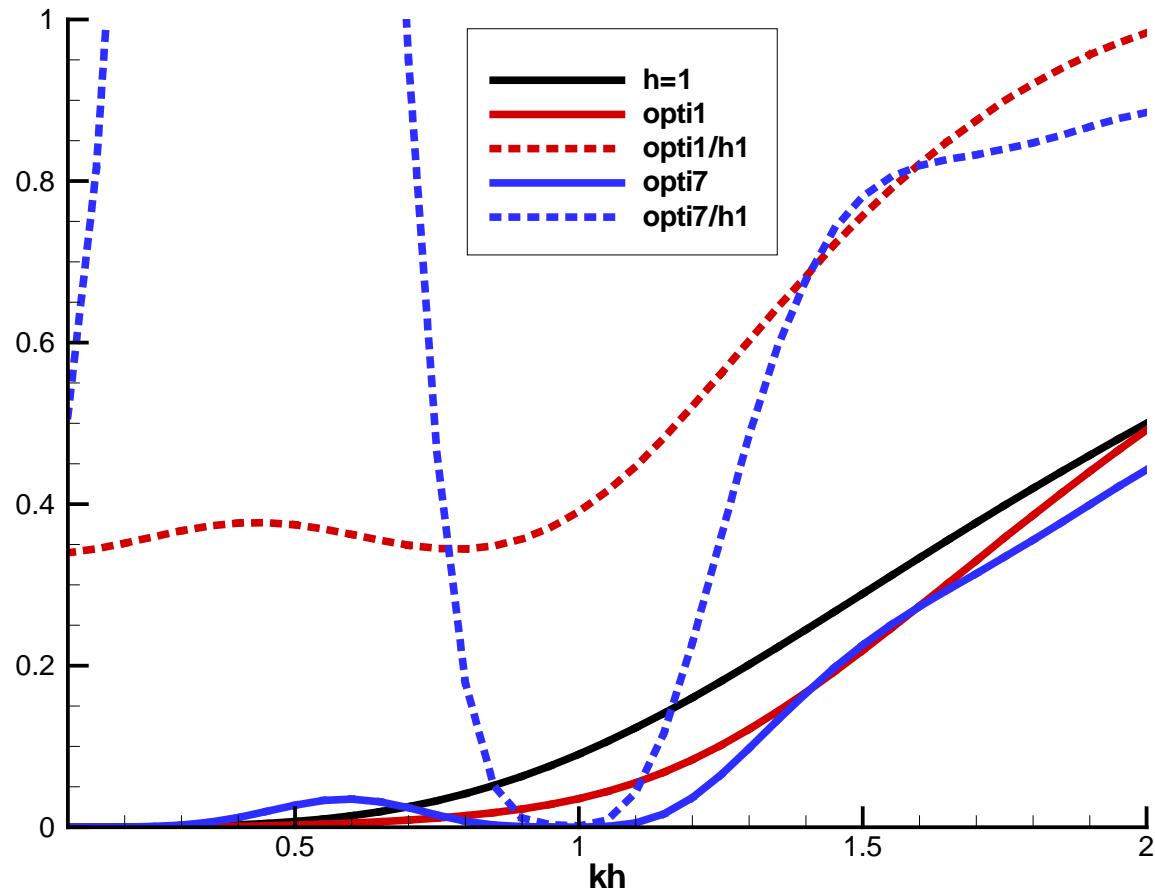
Scat E = 0.00013, ratio = 0.0015

opti7

SCAT=.000127



Scattering energy and ratio for optimized beds



Conclusions

- Results suggest (but don't prove) that complete 'cloaking' is possible for water-wave diffraction
- Probably not directly useful
- Domain decomposition may be useful for special applications (not available in V7.0)
- Other applications of optimization using WAMIT?

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