



BETTER SHIPS, BLUE OCEANS



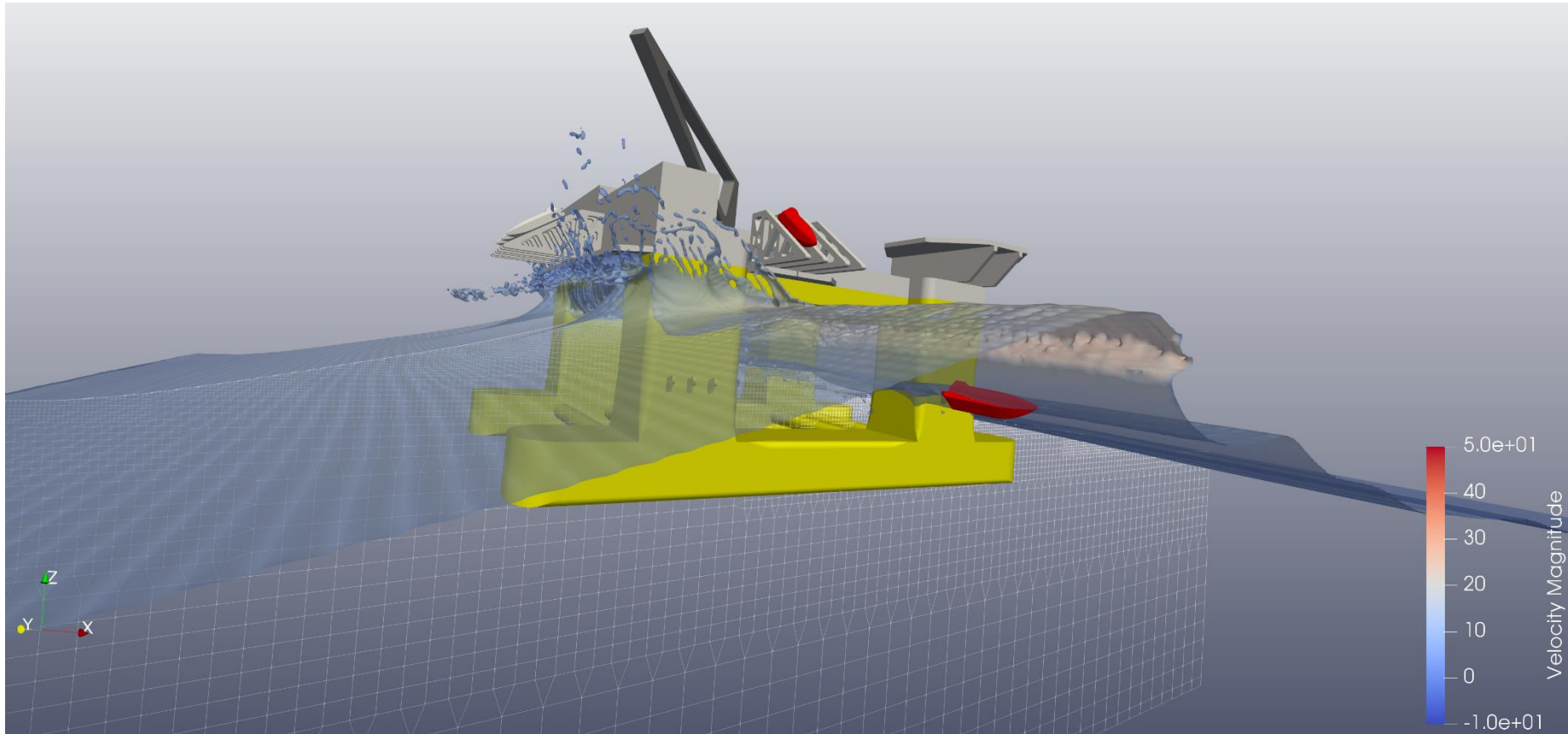
ComFLOW User Group

Joop Helder (j.helder@marin.nl)

What ComFLOW is *not* ...



What ComFLOW is...



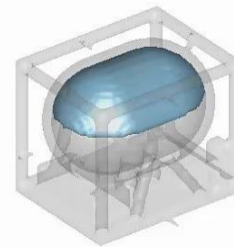
A tiny bit of background

Initially developed at RUG and NLR for sloshing in space (Prof. Veldman '98)

- Algorithms designed for very precise free surface modelling
- Efficient (low CPU times) and accurate

Picked up by Maritime industry

- Green water JIP (Bas Buchner)
- SafeFLOW, ComFLOW-2, ComFLOW-3 and ComMotion JIPs

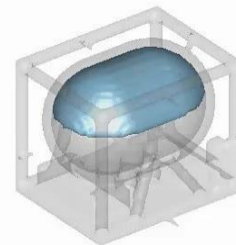


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rijksuniversiteit
 groningen

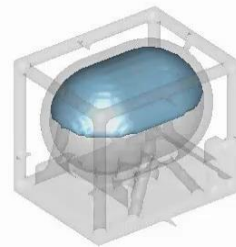


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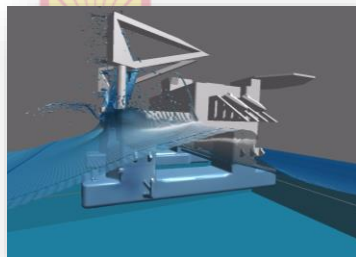


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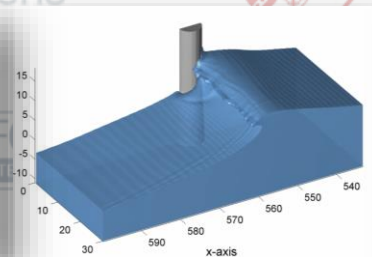
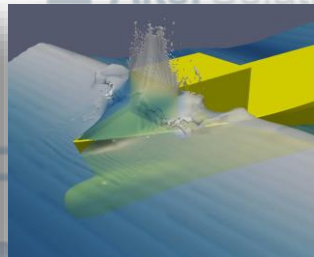
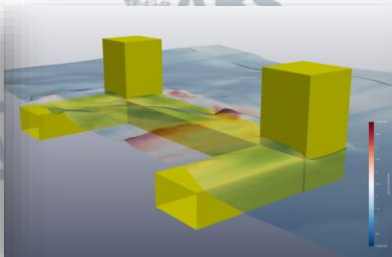
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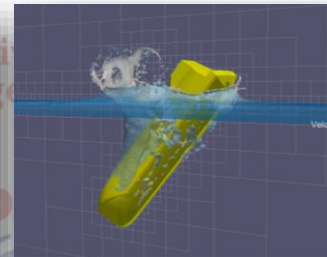
Extensively validated...



ConocoPhillips



an NOV company



an NOV company

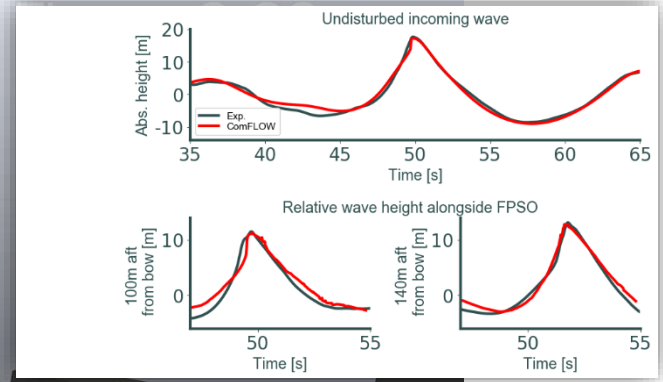
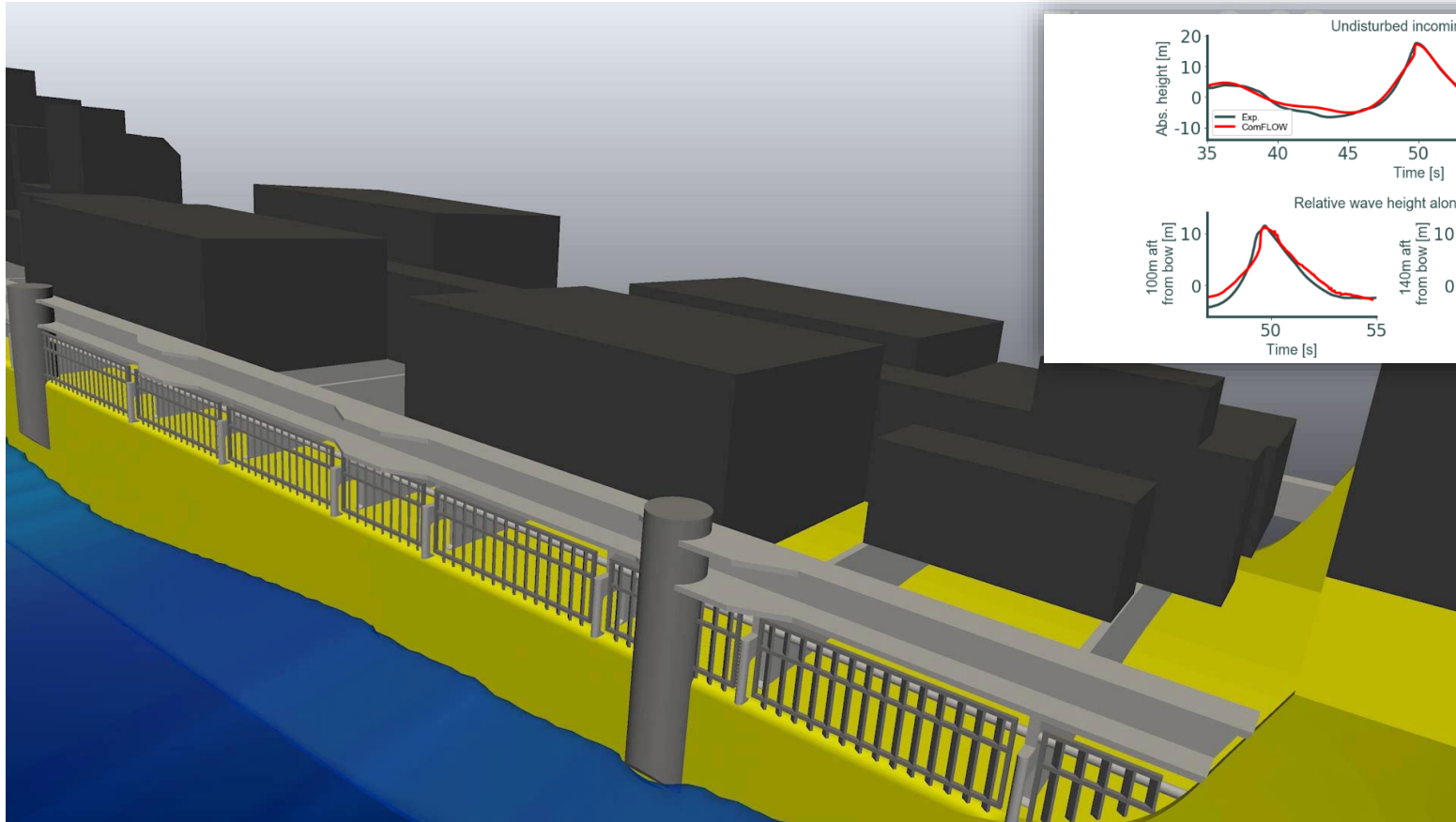
From



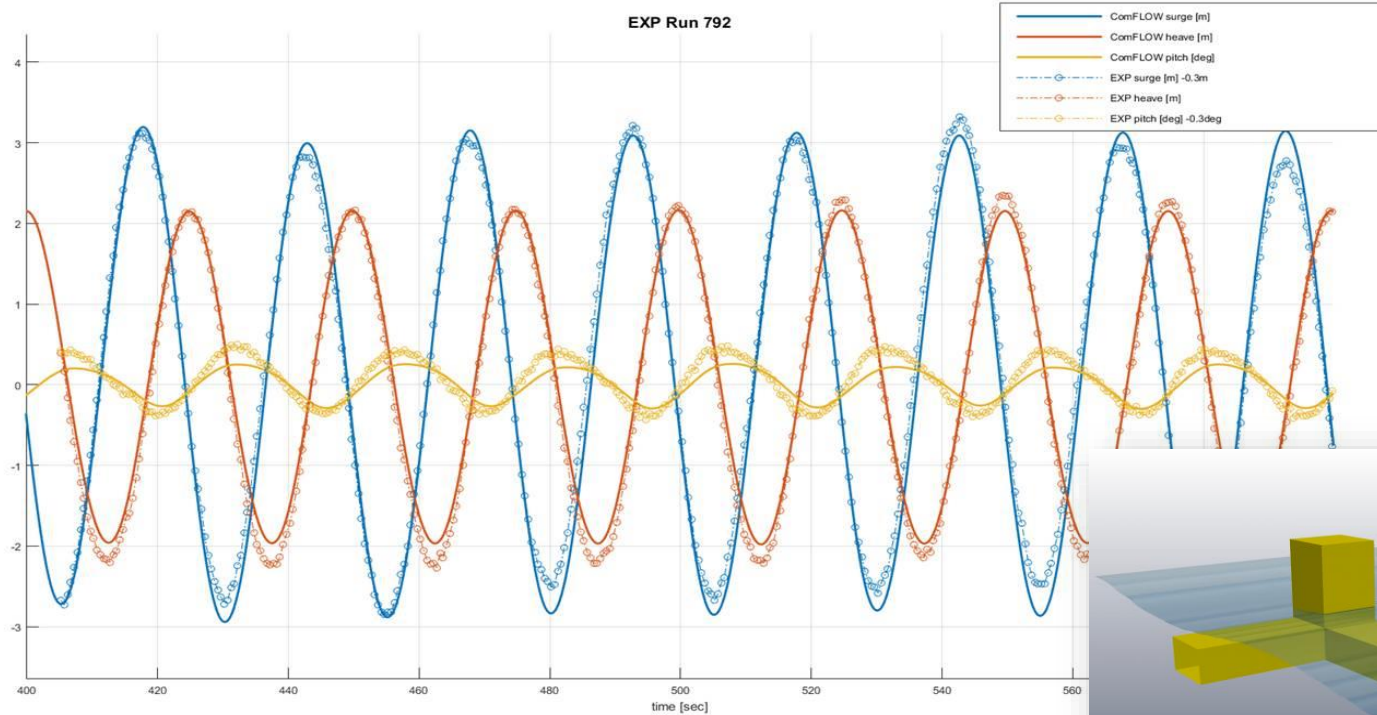
to.....



What is ComFLOW ...

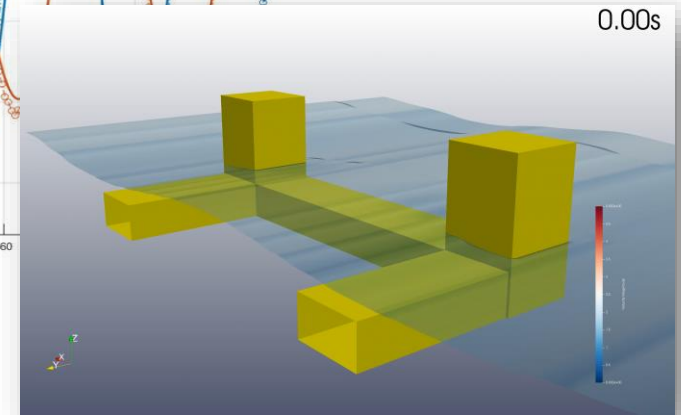


1-body example: results...

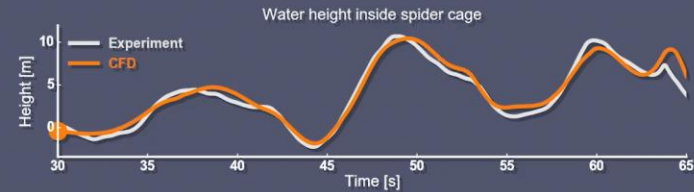
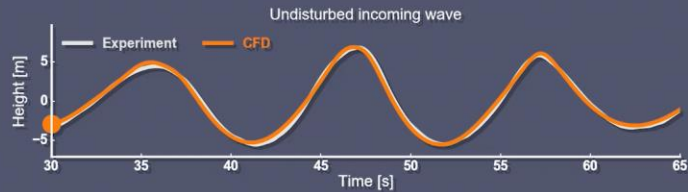
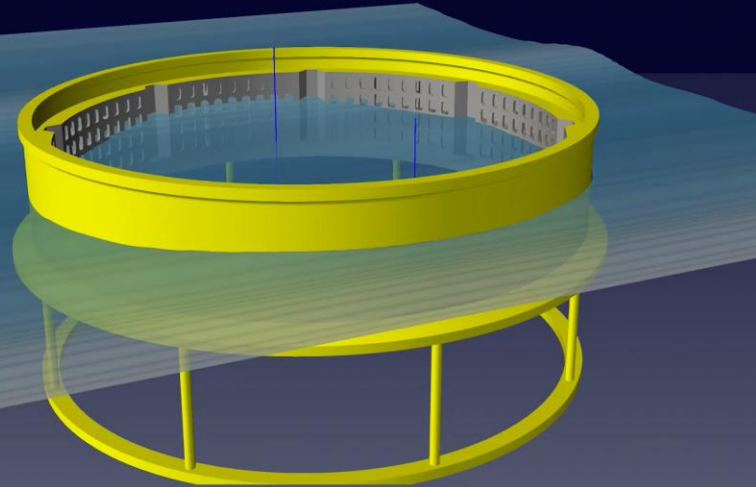


On 1 node (24 cores) / coarse mesh:

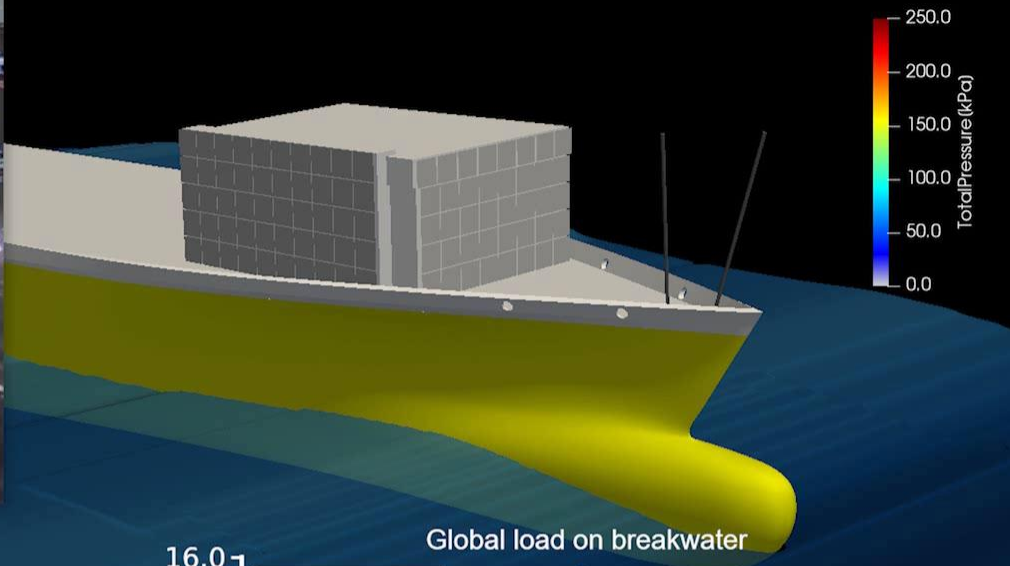
✓ 1800sec in 2h04m: only factor 4 of real time!



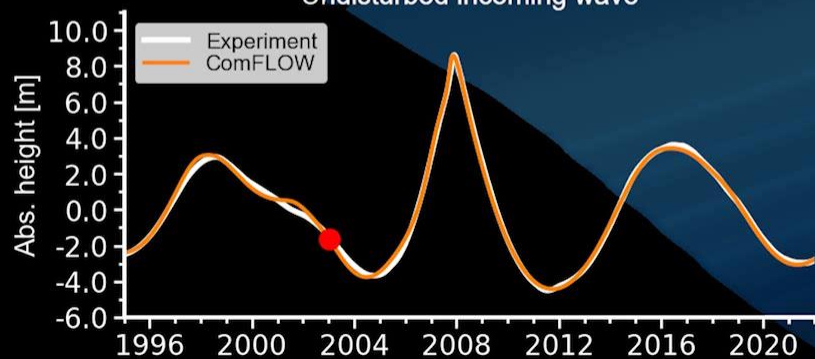
Time (Exp.): 7m11s
Time (CFD): 30.00s



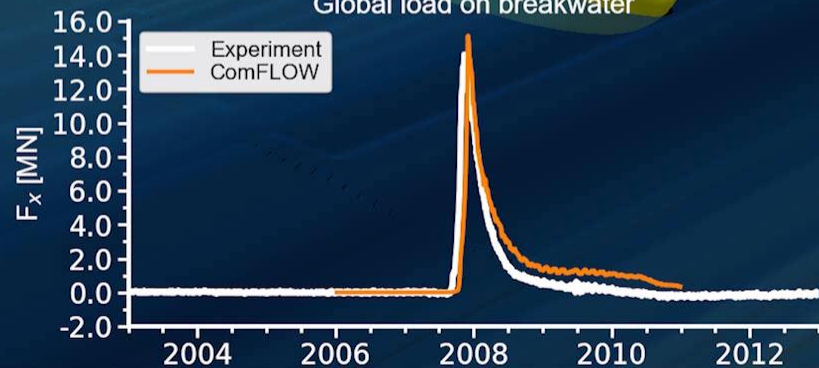
Time: 2003.00s

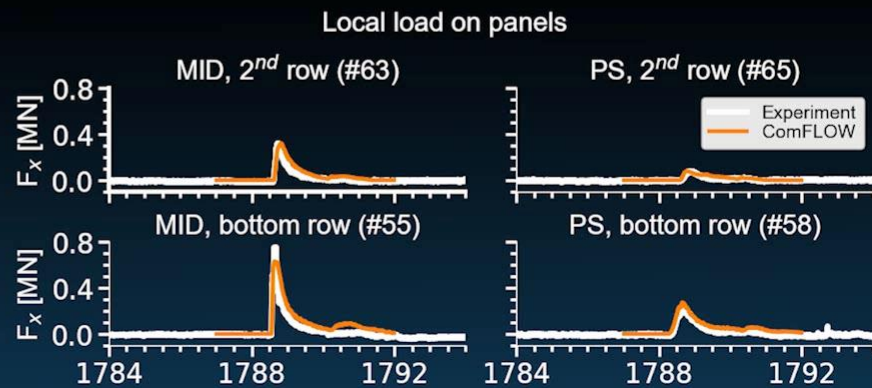
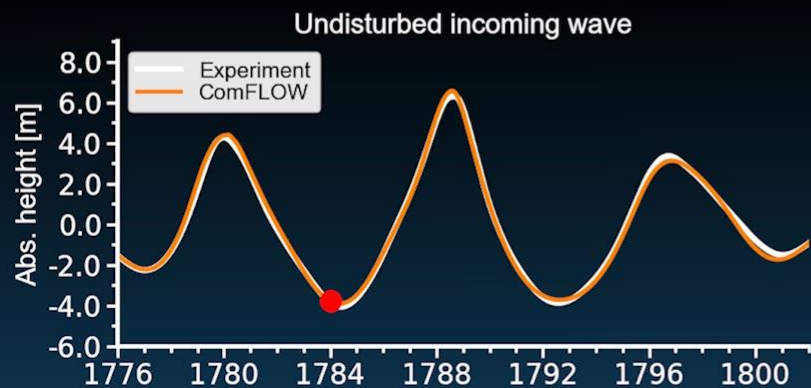
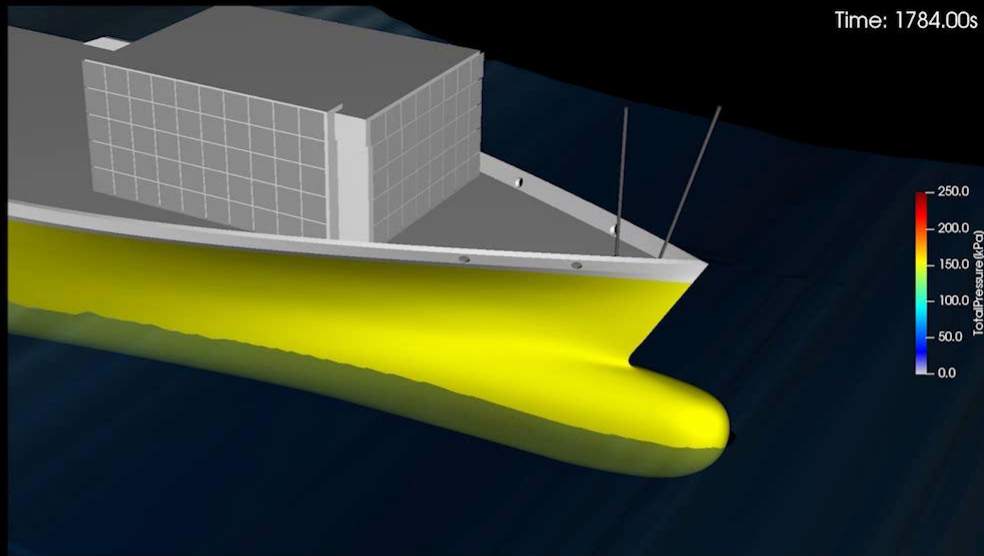


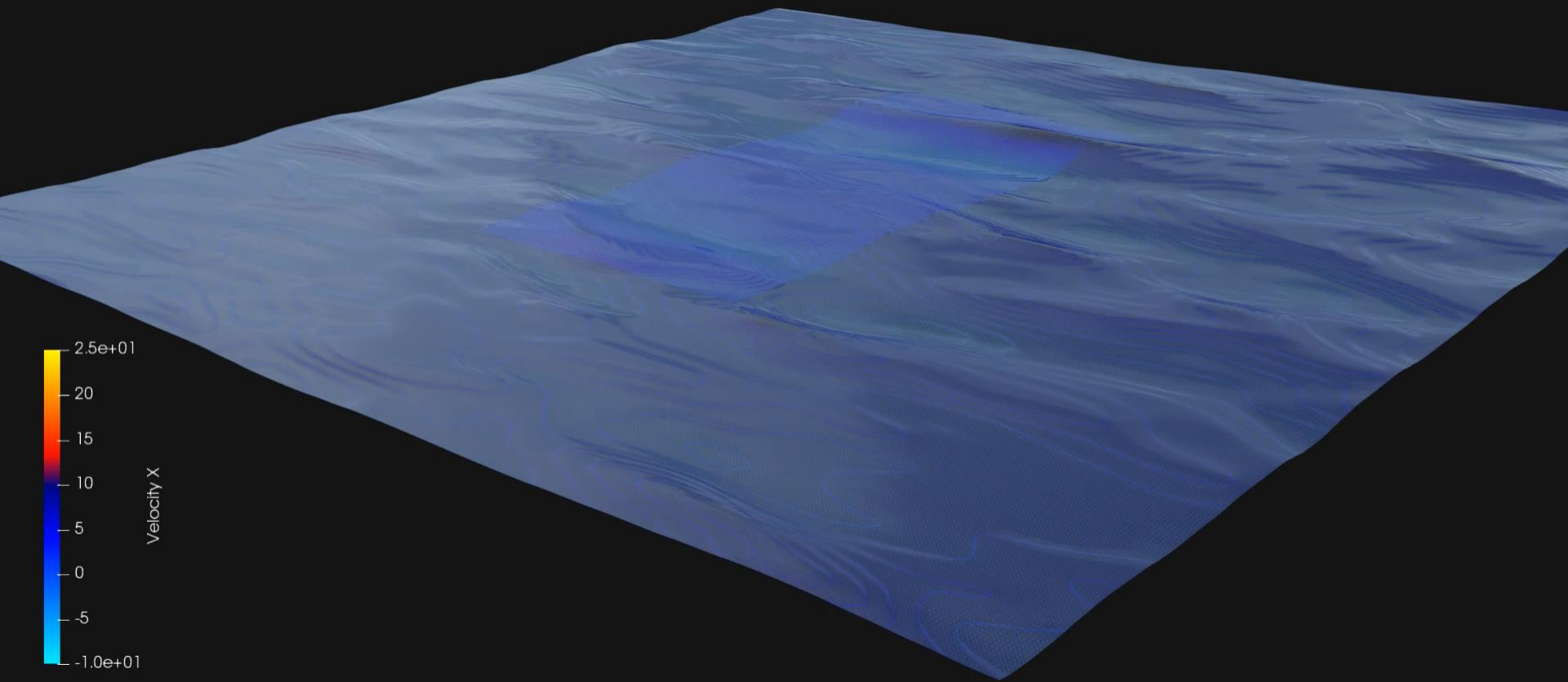
Undisturbed incoming wave

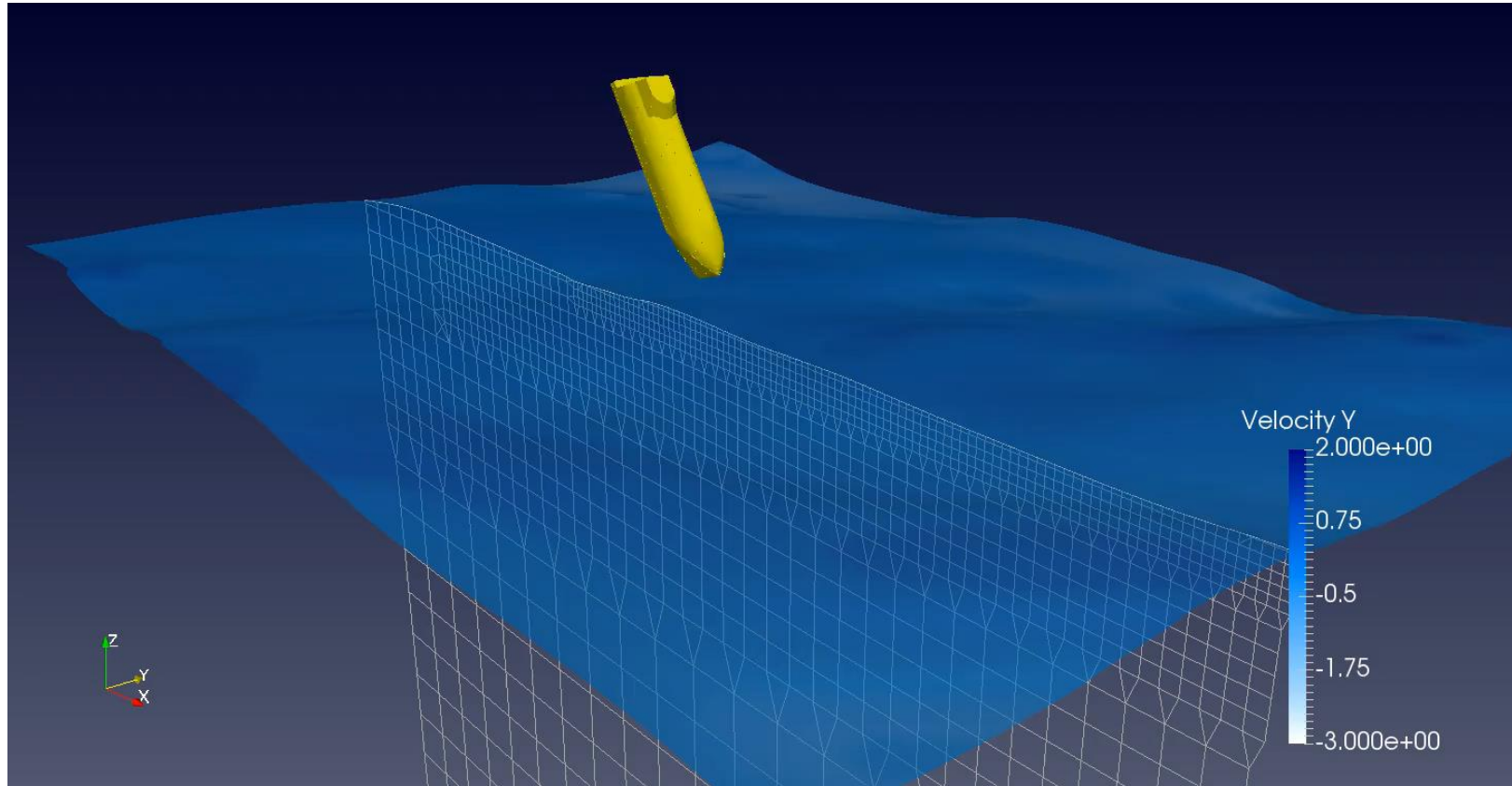


Global load on breakwater







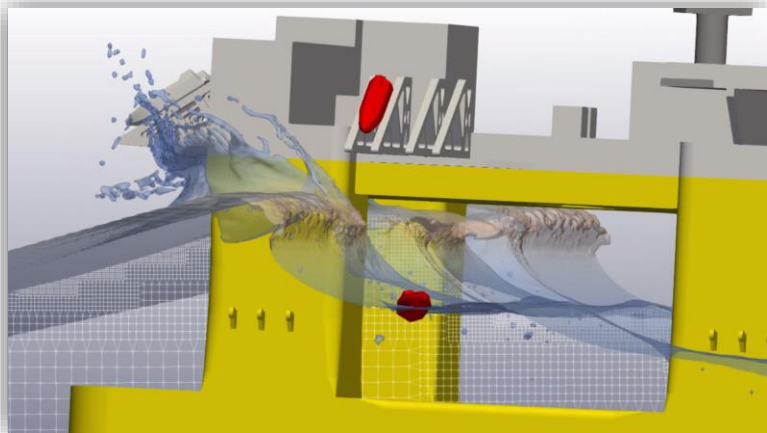


Physics:

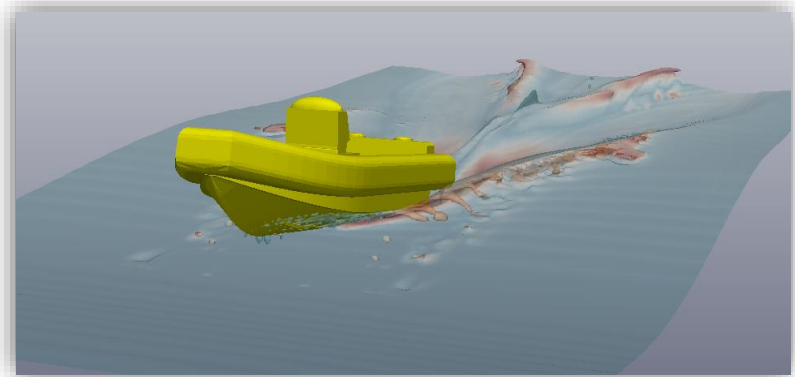
- ✓ (in)compressible Navier-Stokes
- ✓ 1-phase and 2-phase
- ✓ Absorbing b.c. at in- and outflow
- ✓ Multiple moving objects
- ✓ Dynamic mooring
- ✓ Extreme (multidirectional) waves

Numerics:

- ✓ staggered Cartesian base grid
- ✓ Adaptive mesh refinement
 - ✓ Free surface
 - ✓ (parts of) geometries
 - ✓ Flow characteristics
- ✓ cut-cell method for geometry
- ✓ Sharp interface (PLIC VOF)
- ✓ Conservation of underlying physics
- ✓ Mass-preserving VOF method
- ✓ Energy-preserving discretization
- ✓ dedicated poisson solver



- ✓ User group open for all interested parties
- ✓ Annual 'license & support' fee
- ✓ Unlimited (# nodes / # users) use of executables
- ✓ Open source modules for participants of user group
- ✓ Further code development within user group



What you get:

- ✓ ComFLOW executables (Linux and windows)
- ✓ Unlimited use of executables (amount of nodes / users / simulations)
- ✓ Maintenance and support
- ✓ Code updates, optimization, support and bug fixes (man hours limited to the available budget from the user fees)
- ✓ Development of additional functionality / case studies when agreed upon by all users
- ✓ Possibility of own code development through open modules
- ✓ Half-year meetings to share knowledge and experiences

Fees:

- ✓ 7.5 kEuro/year
- ✓ Additional entry costs (due to license and IP contributions):
 - 7.5kEuro/year for first 2 years for new participants
 - 7.5kEuro/year for first 1 year for previous ComFLOW JIP participants

List of ComMotion JIP participants:

DAMEN Shipyards
DELTARES
DNV-GL
FORCE Technology
GustoMSC
Hyundai Heavy Industries
MARIN
Delft University of Technology

List of former ComFLOW JIP participants:

ABS
Aker Solutions
Astano/Navantia
Ausenco Sandwell
Bluewater
BP/Amoco
Bureau Veritas
Chevron/Texaco
Conoco/Philips
Daewoo Shipbuilding & Marine Engineering
FMC Sofec
Hess Corporation
Health and Safety Executive (UK)
IHC
Kawasaki Heavy Industries
Norwegian Petroleum Directorate
Petrobras
Samsung Heavy Industries
Shell
Single Buoy Mooring
Statoil/Norsk Hydro (now Equinor)
WS Atkins

THANK YOU.. QUESTIONS?

