



Variable resolution in DualSPHysics: developments and applications

Francesco Ricci

SUMMARY

REFERENCES

SCIENTIFIC ARTICLES

- Ricci, Francesco, Renato Vacondio, and Angelantonio Tafuni. "Multiscale smoothed particle hydrodynamics based on a domain-decomposition strategy." *Computer Methods in Applied Mechanics and Engineering* (2024).
- Ricci, Francesco, Renato Vacondio, and Angelantonio Tafuni. "Three-dimensional variable resolution for multi-scale modeling in Smoothed Particle Hydrodynamics." *Computer Physics Communications* (2025).

DOCUMENTATION

- **Guide:** in doc/guides/XML_GUIDE_VRESOLUTION.pdf
- **Examples:** examples/vresolution

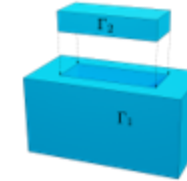
SUPPORT

- <https://github.com/DualSPHydics/DualSPHydics/issues>

THEORY

VARIABLE RESOLUTION ALGORITHM

1. Computational domain is partitioned in sub-domains, each with its own resolution.

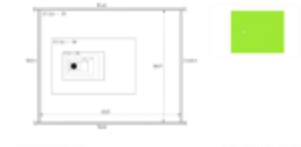


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Downloaded from <https://www.cambridge.org/core>

APPLICATIONS

FLOW PAST A CYLINDER



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WAVES



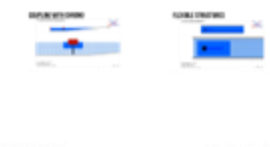
Downloaded from <https://www.cambridge.org/core>

MOVING OBJECTS



Downloaded from <https://www.cambridge.org/core>

COUPLING WITH OTHER METHODS



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FUTURE OUTLOOK



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SCIENTIFIC ARTICLES

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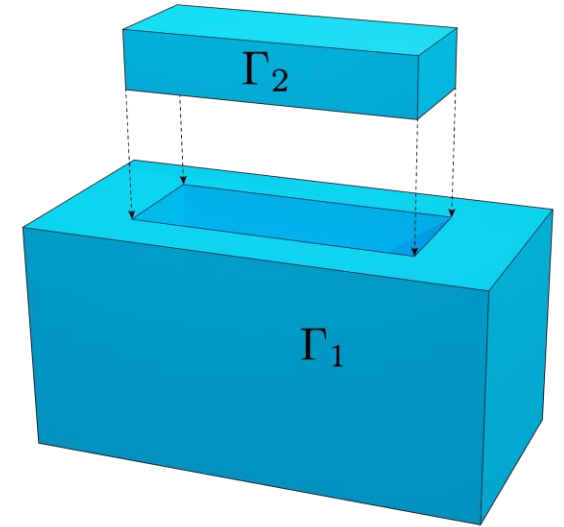
NEW IN V6.0 BETA



THEORY

VARIABLE RESOLUTION ALGORITHM

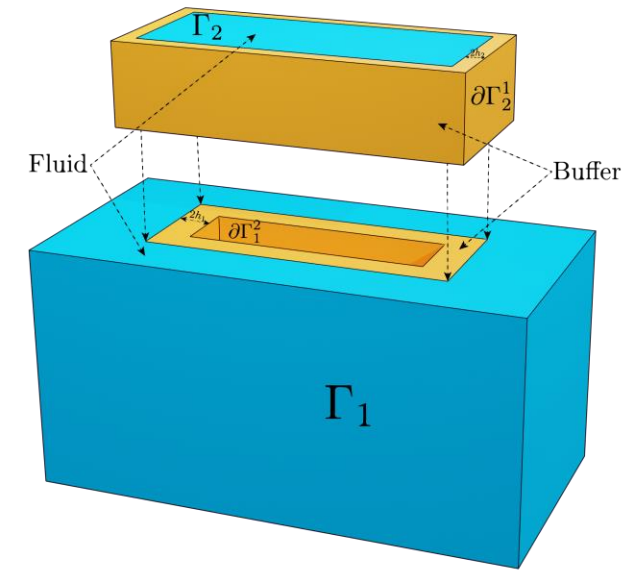
1. Computational domain is partitioned in sub-domains, each with its own resolution.



THEORY

VARIABLE RESOLUTION ALGORITHM

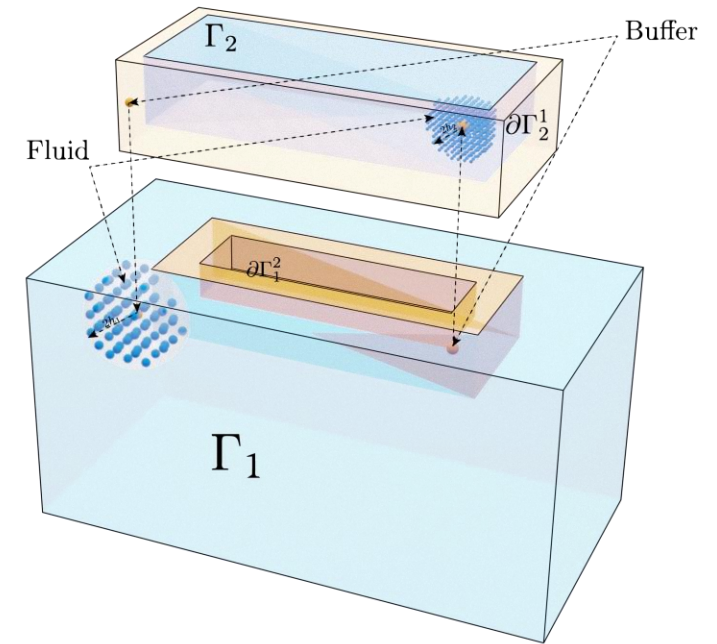
1. Computational domain is partitioned in sub-domains, each with its own resolution.
2. Each sub-domain is extended by a buffer region, populated by buffer particles.



THEORY

VARIABLE RESOLUTION ALGORITHM

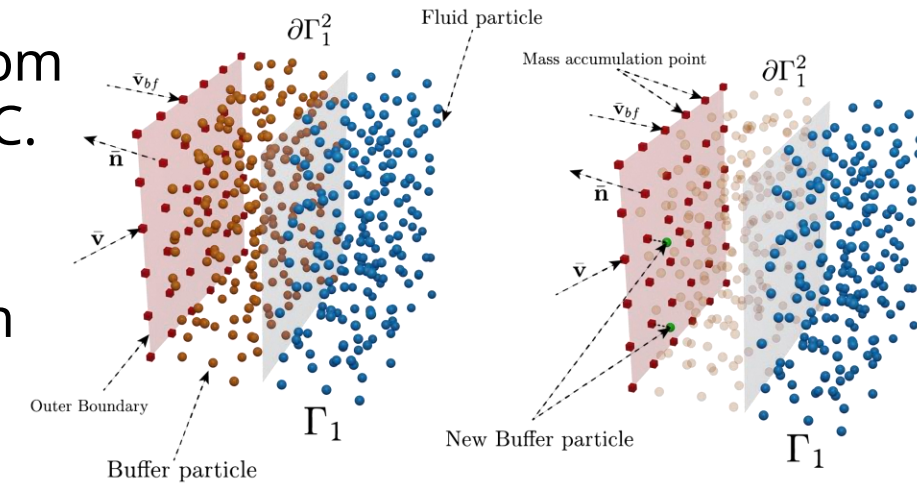
1. Computational domain is partitioned in sub-domains, each with its own resolution.
2. Each sub-domain is extended by a buffer region, populated by buffer particles.
3. These buffer particles obtain their physical properties from coupled(adjacent) sub-domain and enforce Dirichlet BC.



THEORY

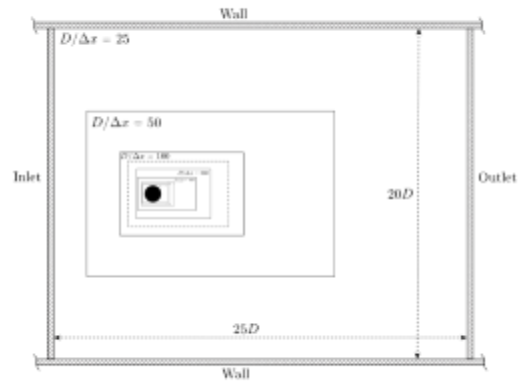
VARIABLE RESOLUTION ALGORITHM

1. Computational domain is partitioned in sub-domains, each with its own resolution.
2. Each sub-domain is extended by a buffer region, populated by buffer particles.
3. These buffer particles obtain their physical properties from coupled(adjacent) sub-domain and enforce Dirichlet BC.
4. Transfer of mass between sub-domain is calculated by means of the eulerian flux at points on the sub-domain limits.



APPLICATIONS

FLOW PAST A CYLINDER



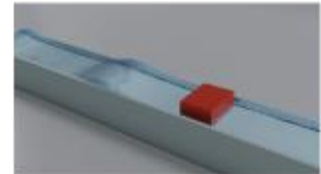
Flow around cylinder, FlowView



FlowView, 2020, 2021, 2022, 2023, 2024

WAVES

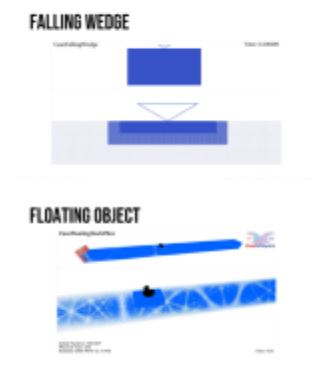
(PLEASE USE ADVANCED SHIFTING!)



Flow around cylinder, FlowView

FlowView, 2020, 2021, 2022, 2023, 2024

MOVING OBJECTS

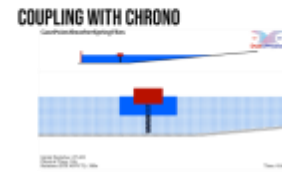


Flow around cylinder, FlowView

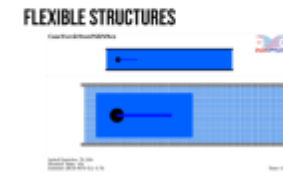


FlowView, 2020, 2021, 2022, 2023, 2024

COUPLING WITH OTHER METHODS

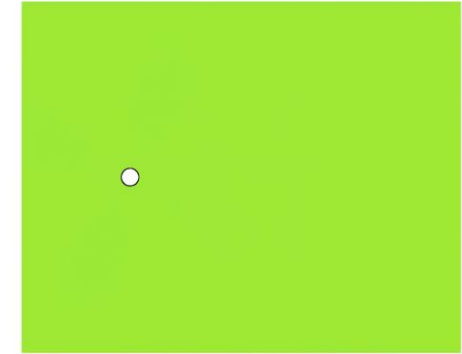
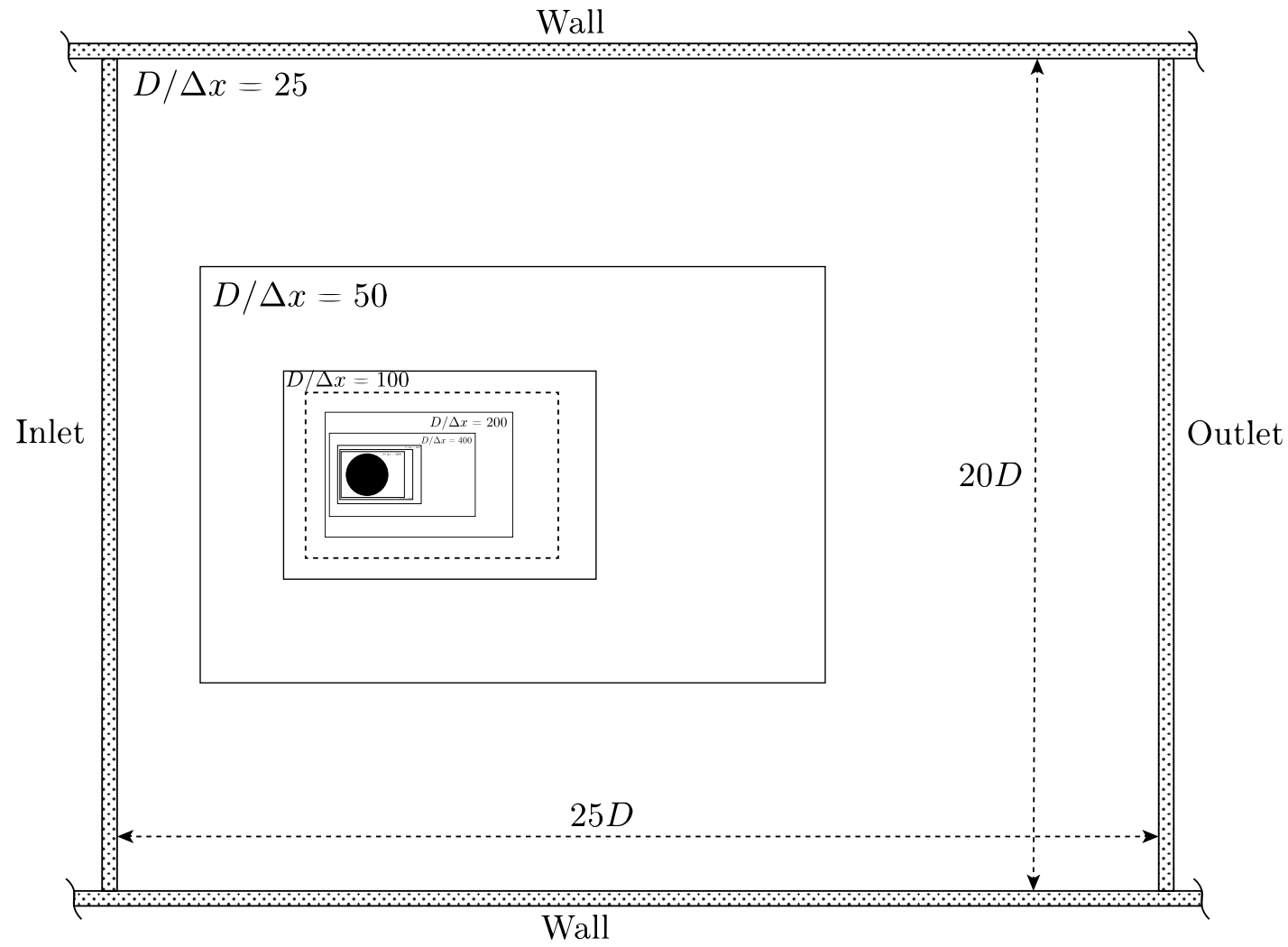


Flow around cylinder, FlowView



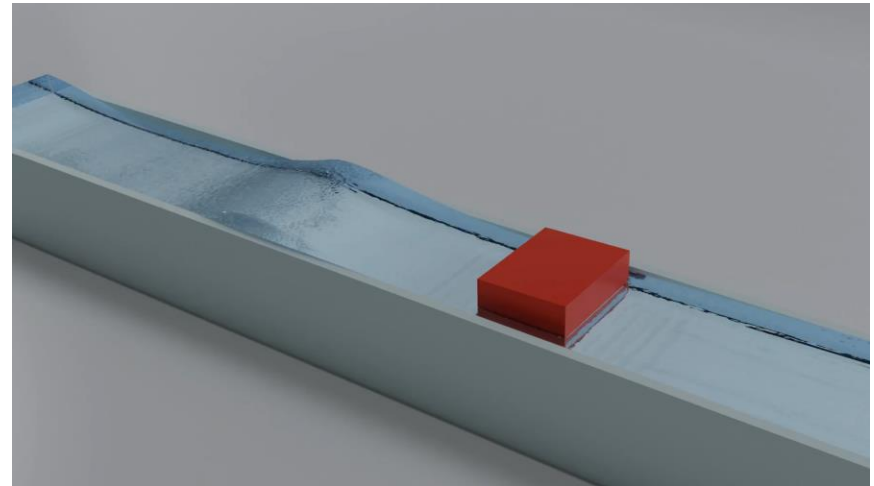
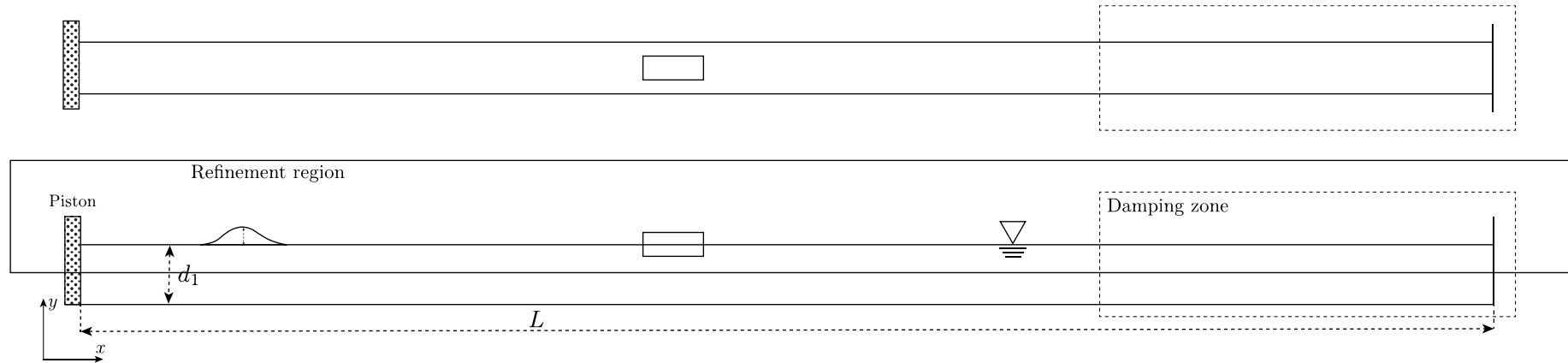
FlowView, 2020, 2021, 2022, 2023, 2024

FLOW PAST A CYLINDER



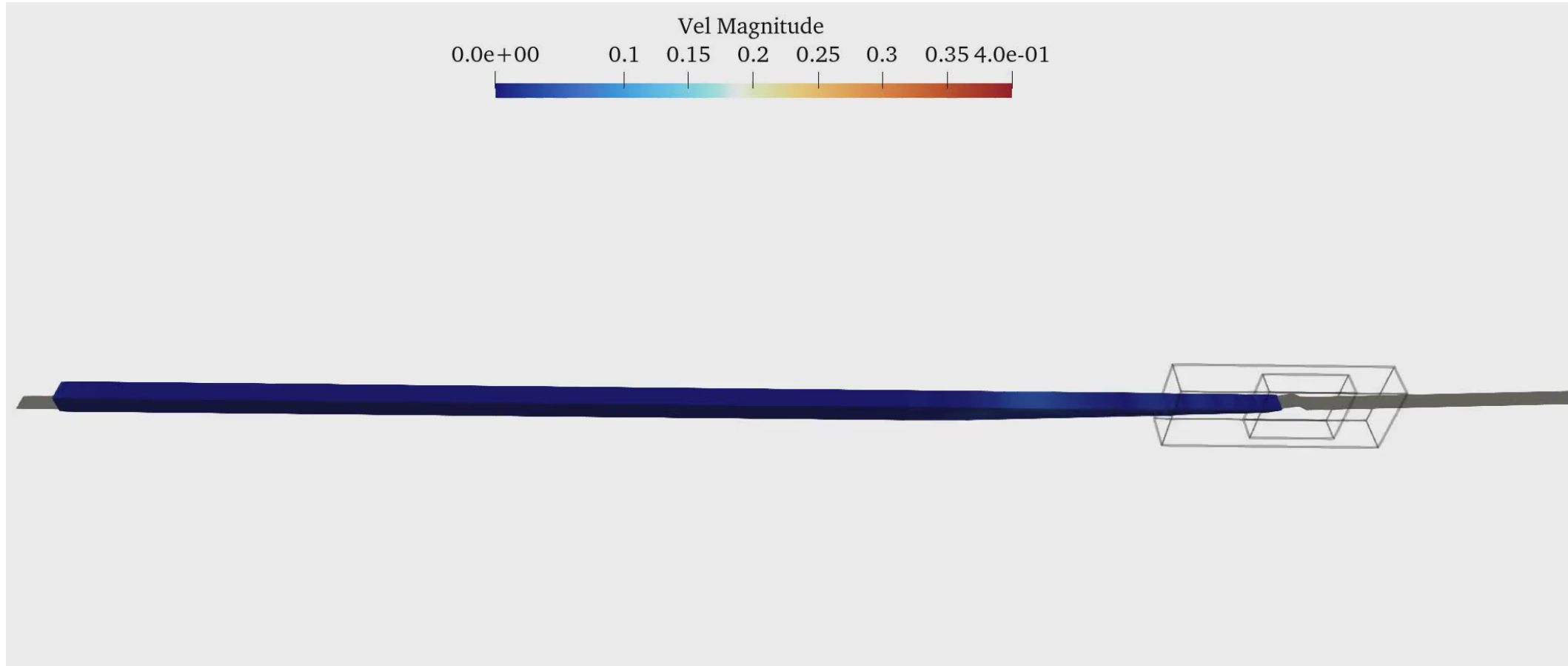
WAVES

(PLEASE USE ADVANCED SHIFTING!)



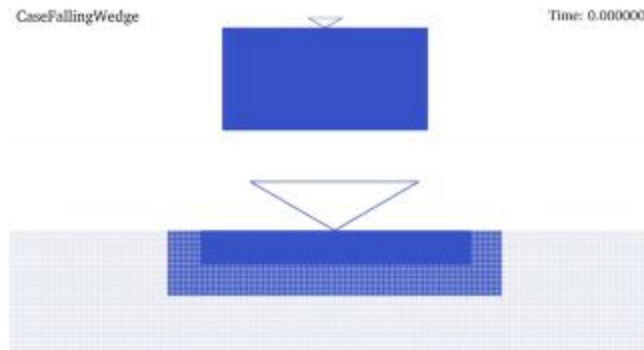
WAVES

(PLEASE USE ADVANCED SHIFTING!)



MOVING OBJECTS

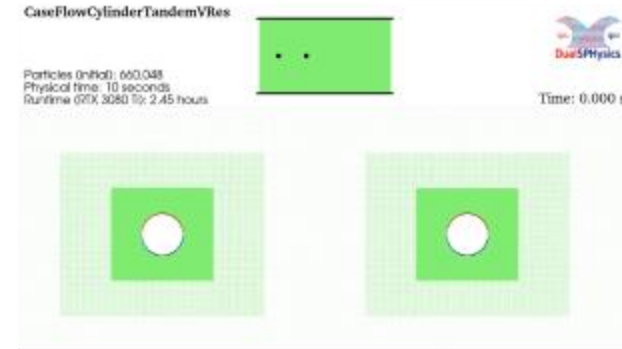
FALLING WEDGE



DualSPHysics - DualSPHysics

January XXVIII, 2026 - Ourense, Spain

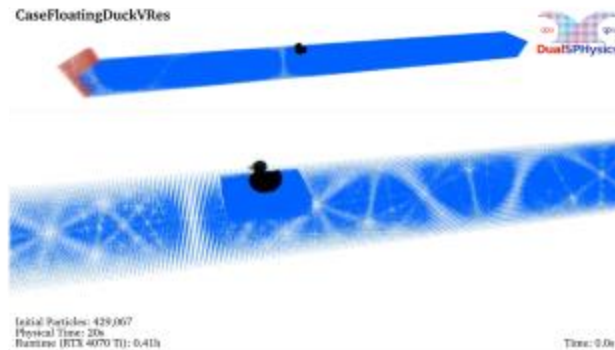
MOVING CYLINDER IN TANDEM



DualSPHysics - DualSPHysics

January XXVIII, 2026 - Ourense, Spain

FLOATING OBJECT



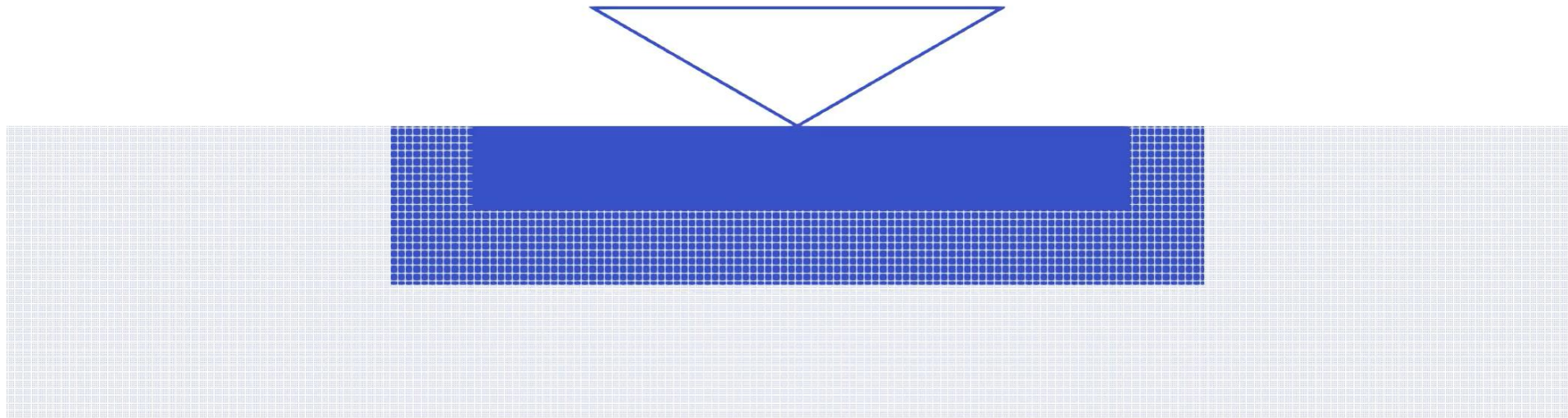
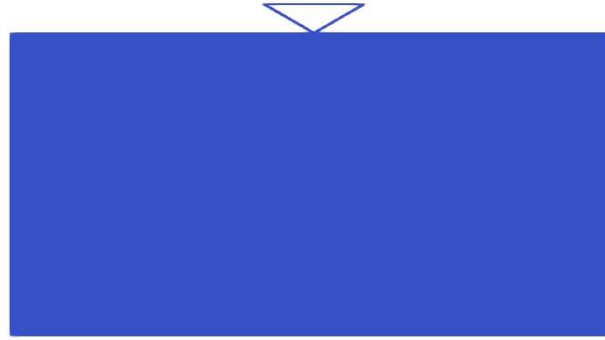
DualSPHysics - DualSPHysics

January XXVIII, 2026 - Ourense, Spain

FALLING WEDGE

CaseFallingWedge

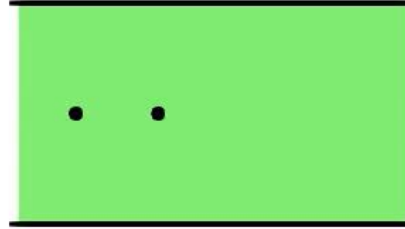
Time: 0.000000



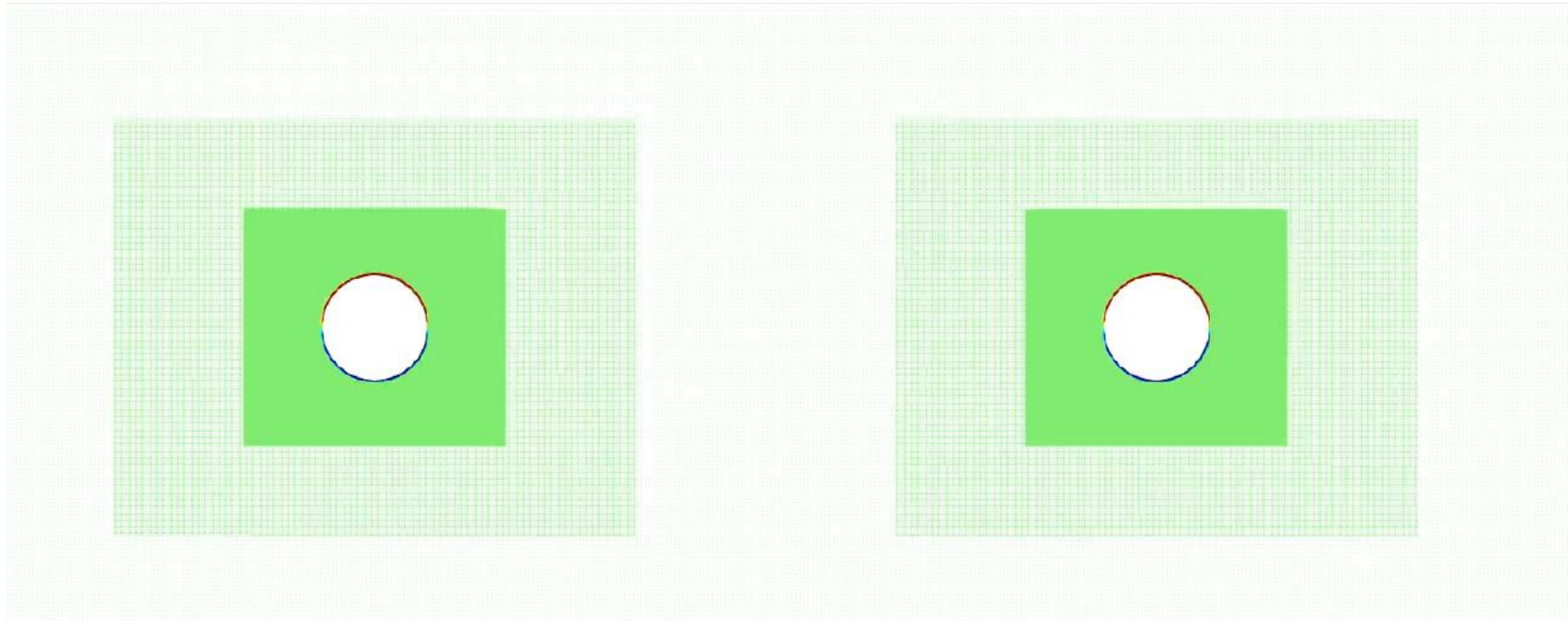
MOVING CYLINDER IN TANDEM

CaseFlowCylinderTandemVRes

Particles (initial): 660,048
Physical time: 10 seconds
Runtime (RTX 3080 Ti): 2.45 hours

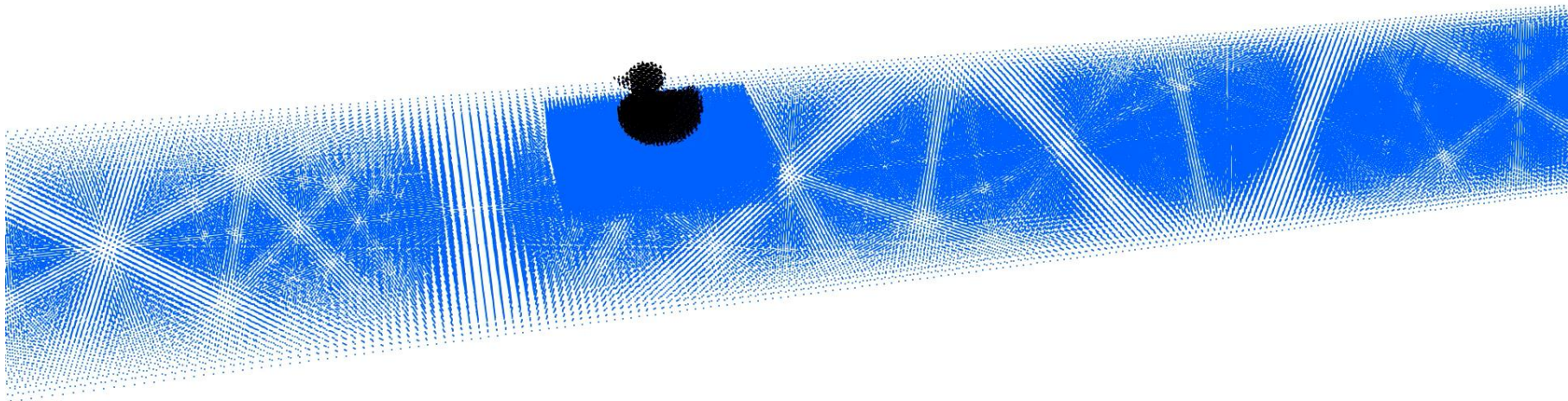
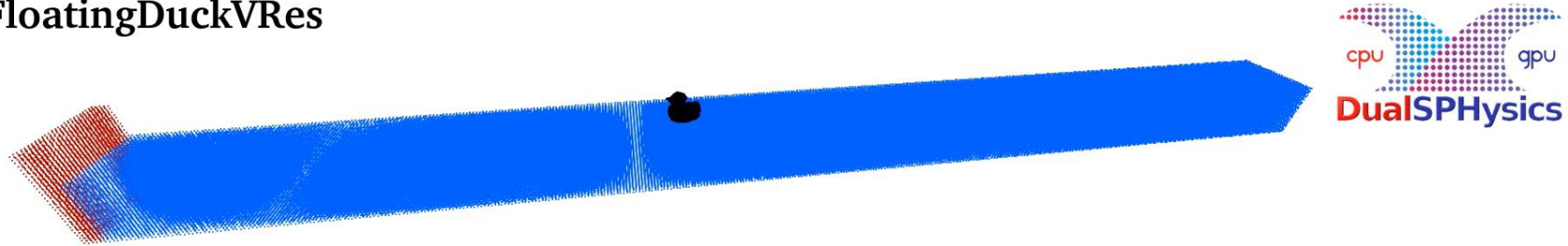


Time: 0.000 s



FLOATING OBJECT

CaseFloatingDuckVRes



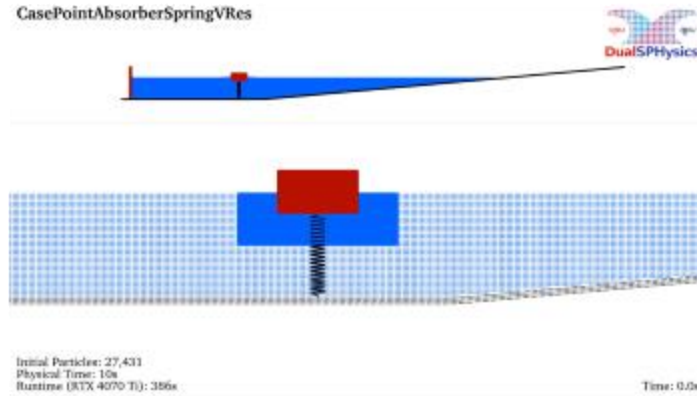
Initial Particles: 429,067
Physical Time: 20s
Runtime (RTX 4070 Ti): 0.41h

Time: 0.0s

COUPLING WITH OTHER METHODS

COUPLING WITH CHRONO

CasePointAbsorberSpringVRes

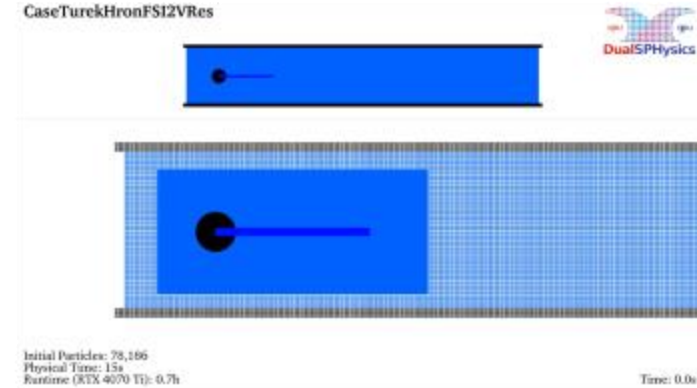


4D: Smoothed-Particle Hydrodynamics

Chrono: FEM, RBD + dynamics, PyFo

FLEXIBLE STRUCTURES

CaseTurekHronFSI2VRes

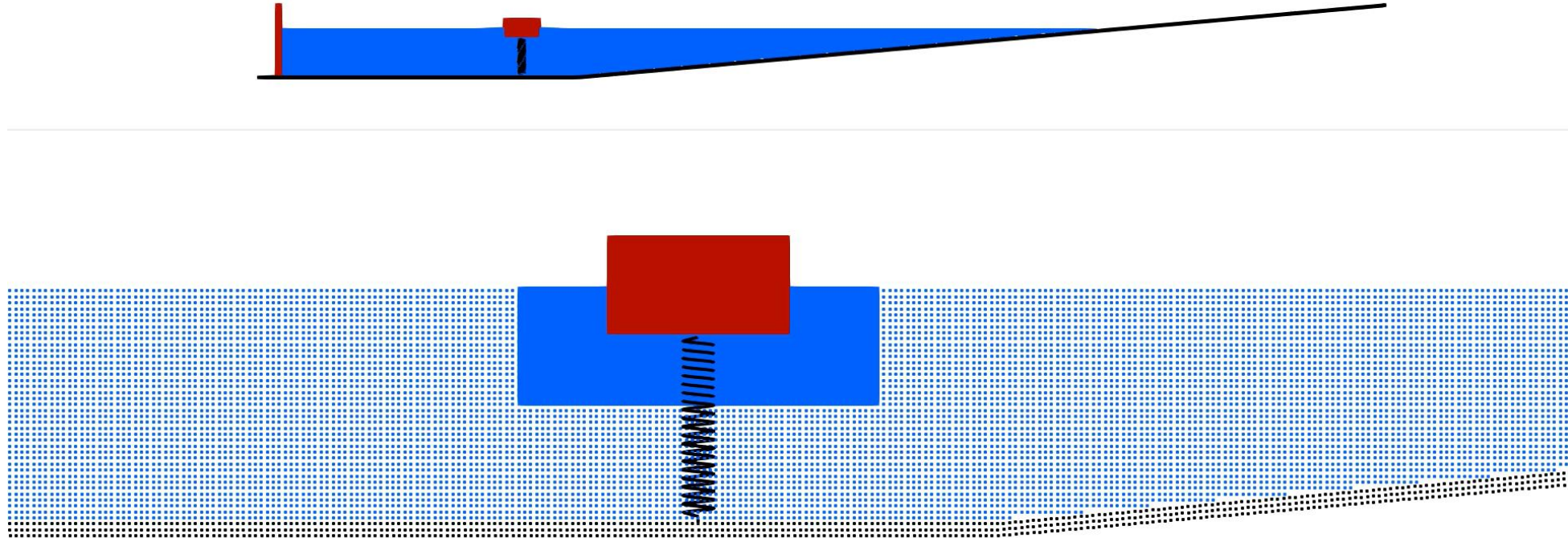


4D: Smoothed-Particle Hydrodynamics

Chrono: FEM, RBD + dynamics, PyFo

COUPLING WITH CHRONO

CasePointAbsorberSpringVRes

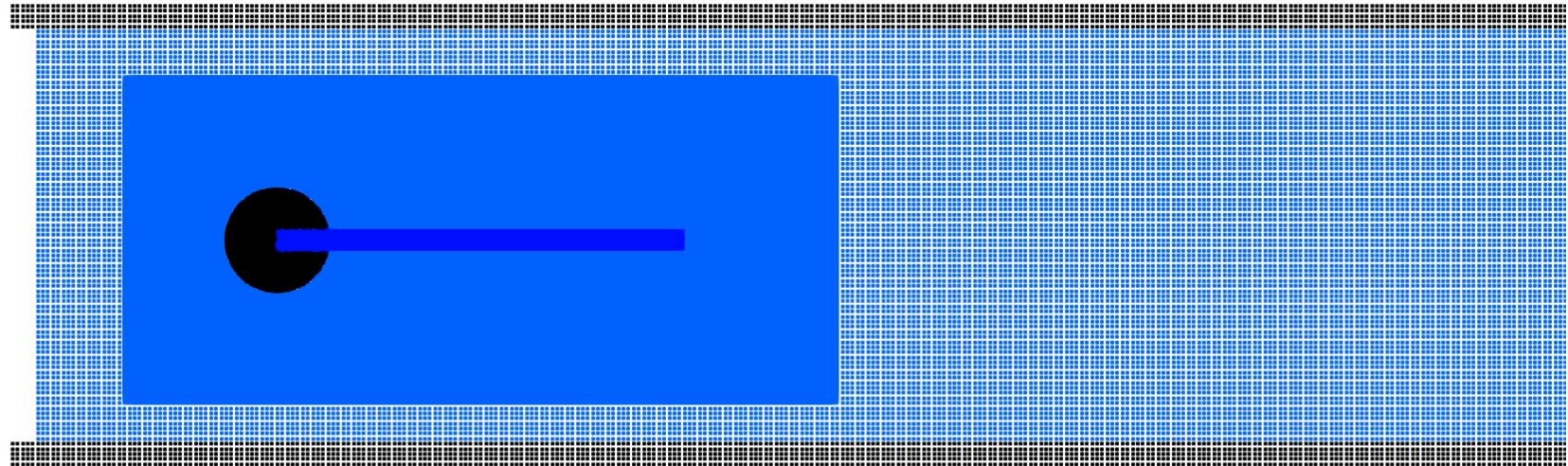


Initial Particles: 27,431
Physical Time: 10s
Runtime (RTX 4070 Ti): 386s

Time: 0.0s

FLEXIBLE STRUCTURES

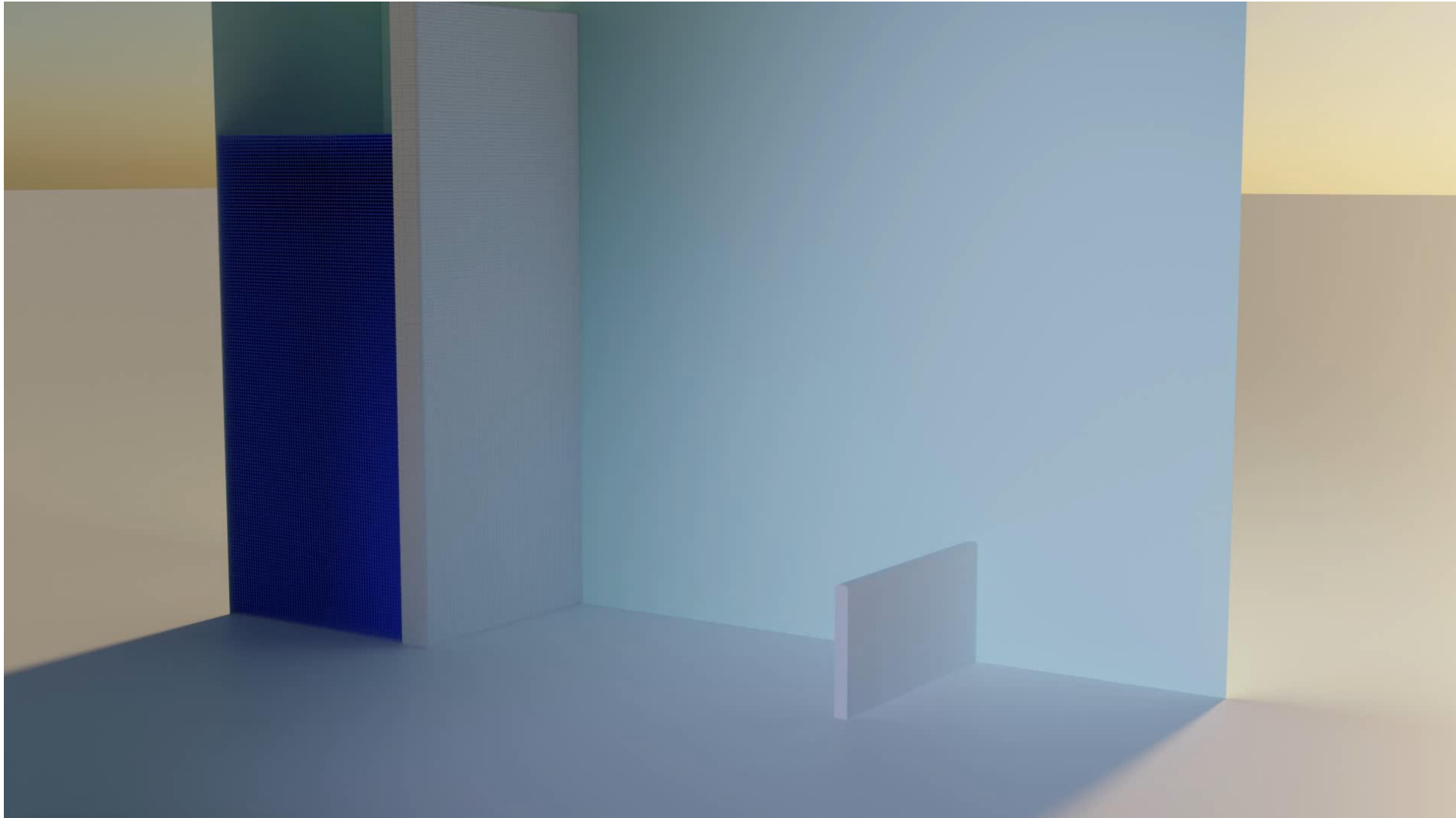
CaseTurekHronFSI2VRes



Initial Particles: 78,186
Physical Time: 15s
Runtime (RTX 4070 Ti): 0.7h

Time: 0.0s

FLEXIBLE STRUCTURES



FUTURE OUTLOOK

