TECHNISCHE UNIVERSITÄT DRESDEN

LPS ORSAY

Institut für Strömungsmechanik

Numerical Simulation of Bubble collisions with PRIME.

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CECAM Dublin, 09.01.2012

Example

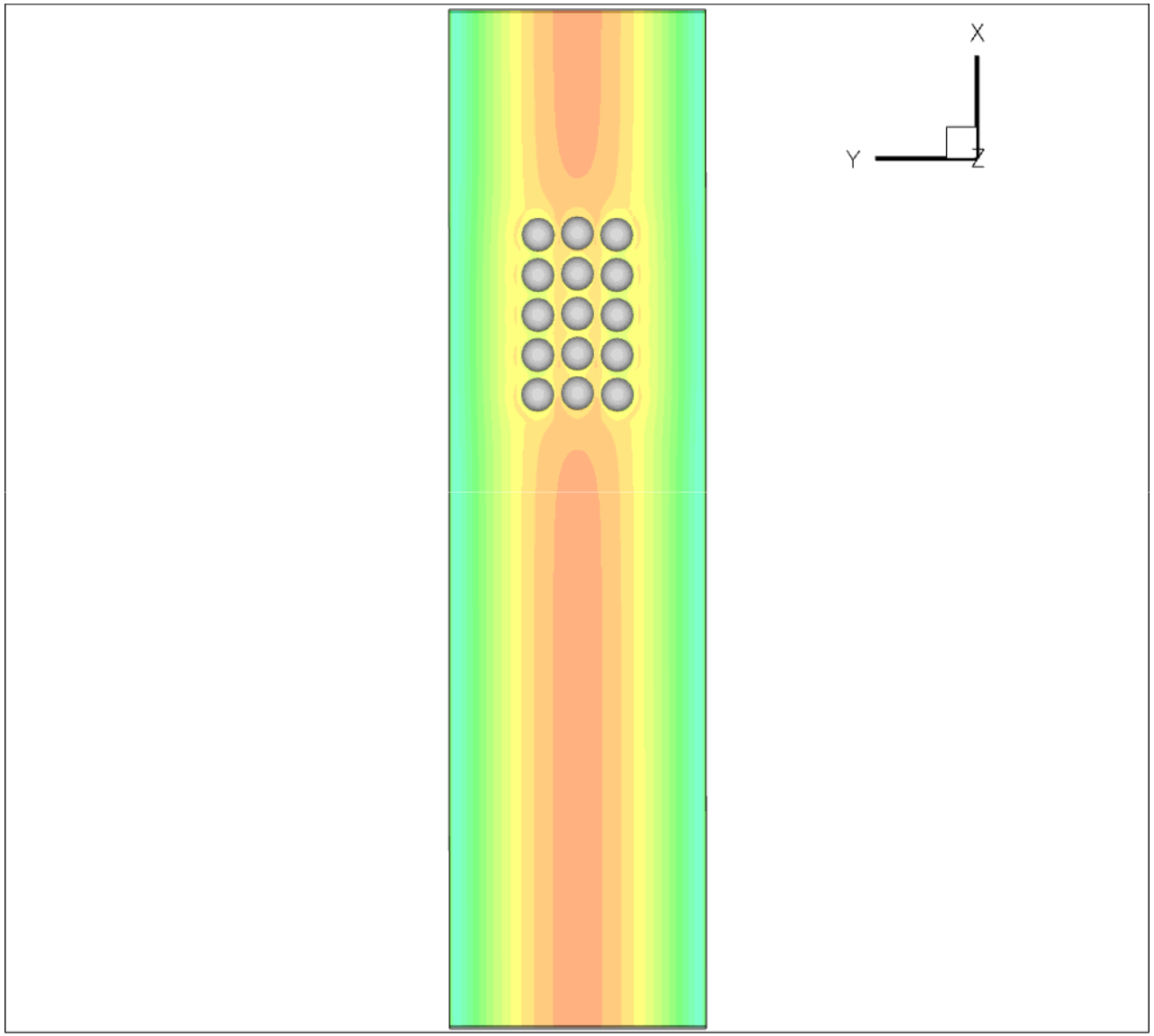
CFD-Solver

3-dimensional

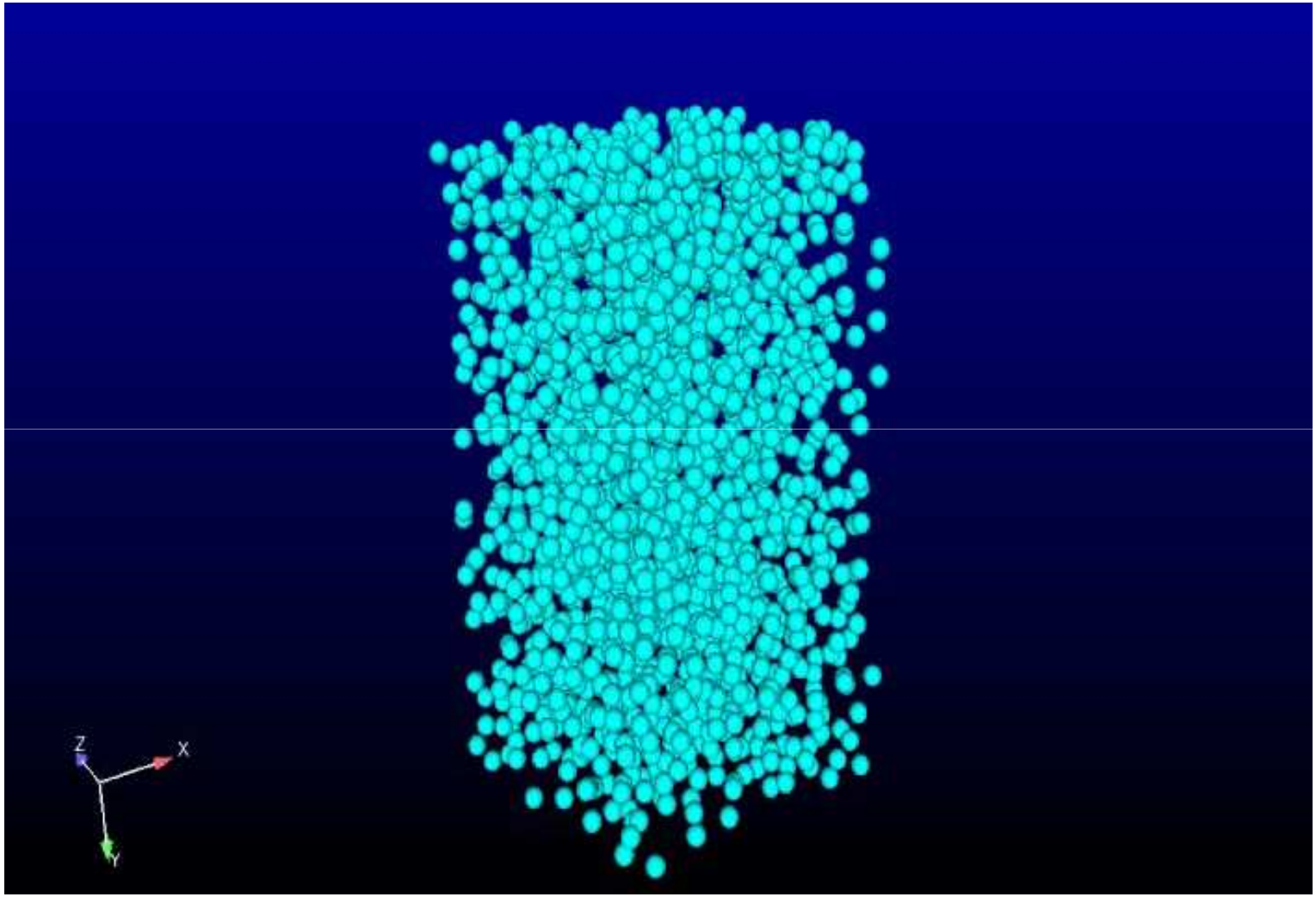
Phase resolving

Rigid particles (Spheres)

Cheap particles

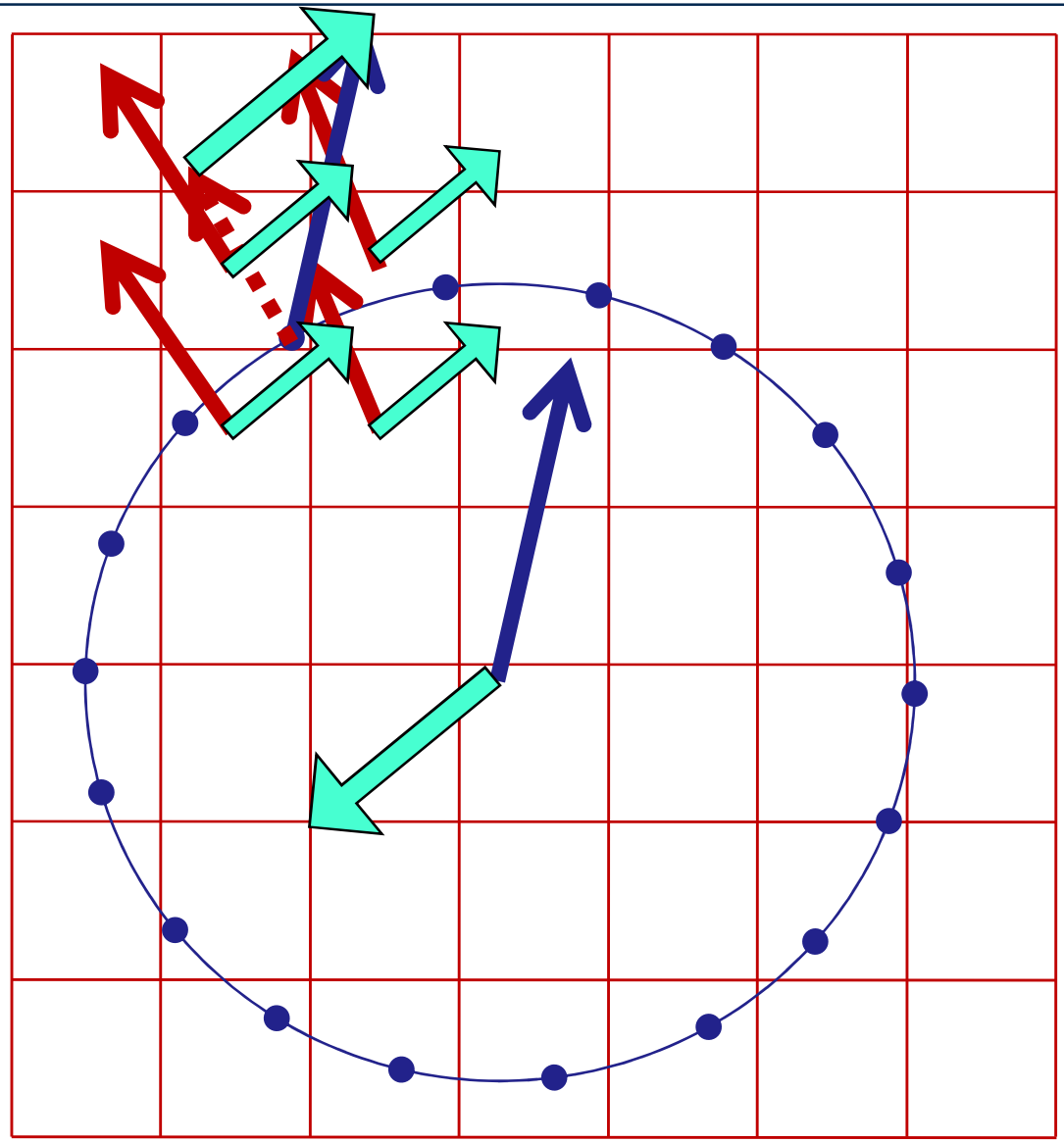


Simulation of foam

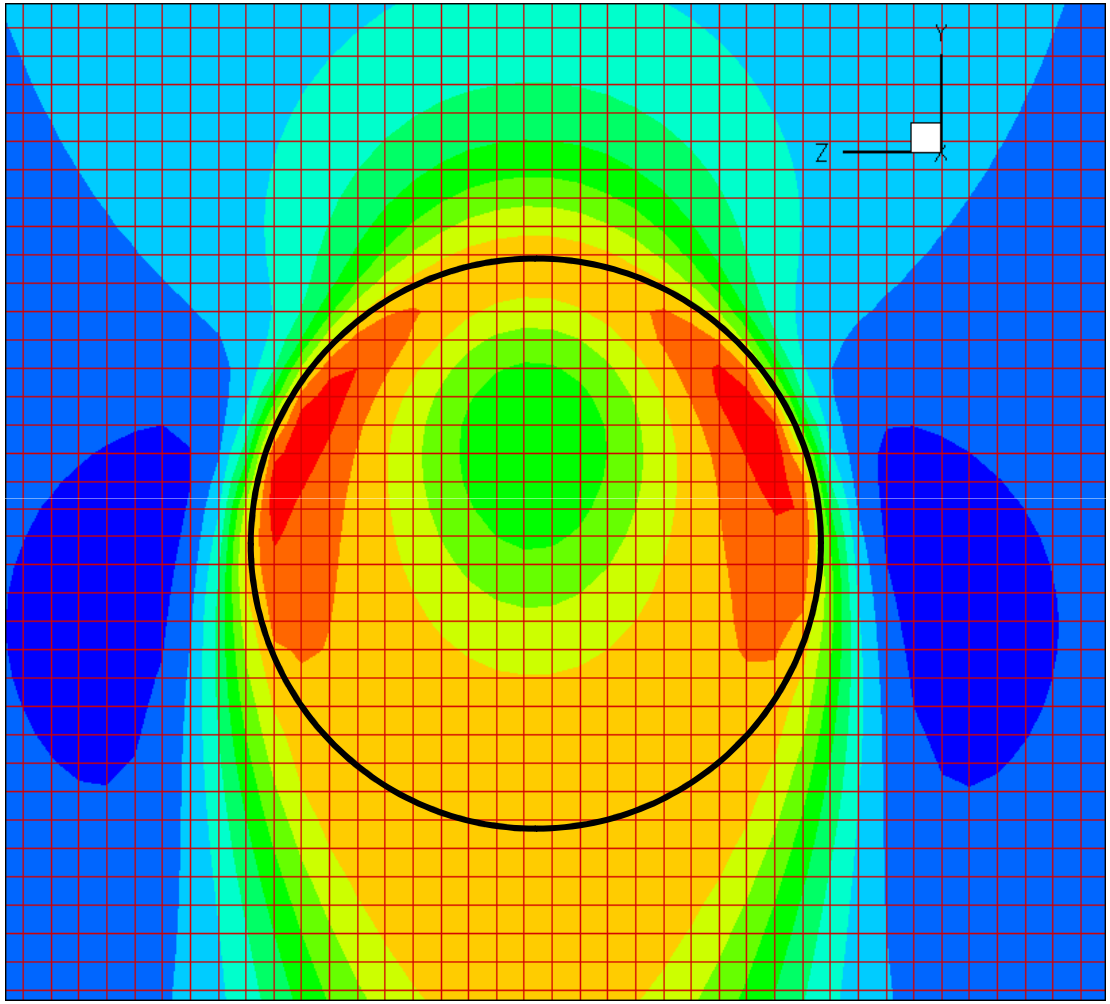


Immersed Boundary Method

- Forcing points on particle surface
- Additional volumetric force in NSE to set boundary conditions (no-slip)
- Equation of motion (rigid particle) for bubble



Particles/Bubbles



Upward velocity distribution of a rising bubble

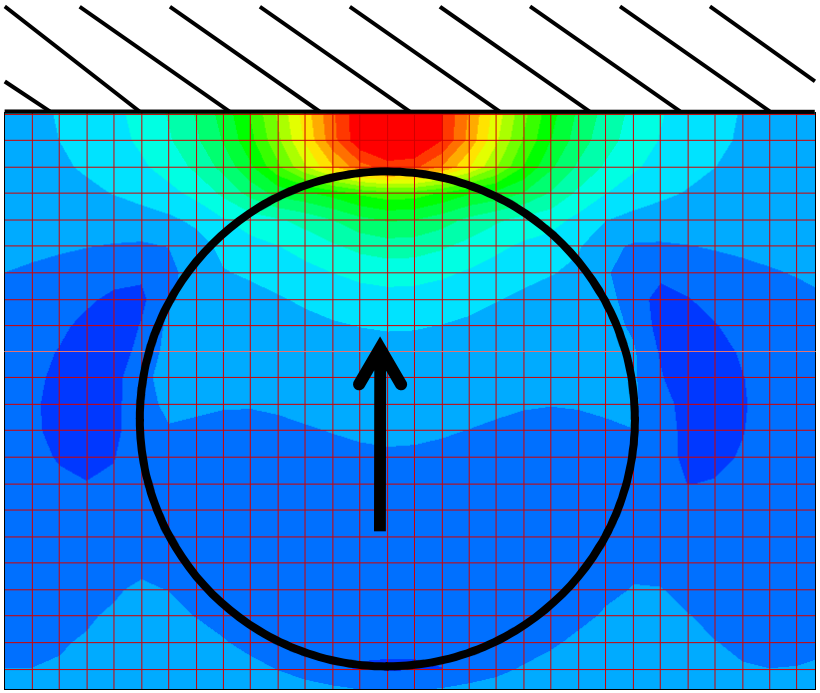
- Very fast
- Lots of particles
- No coalescence

- Interpolation

➔ Surface is blurred

Bubble collision

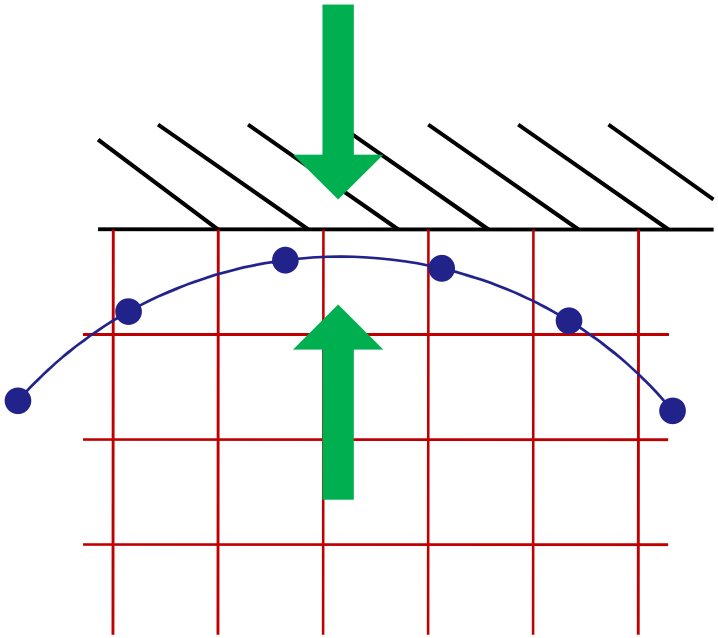
Flow field not completely resolved



Pressure field of a bubble-wall-collision

Lamella thickness << Grid resolution

→ Local force model= ?

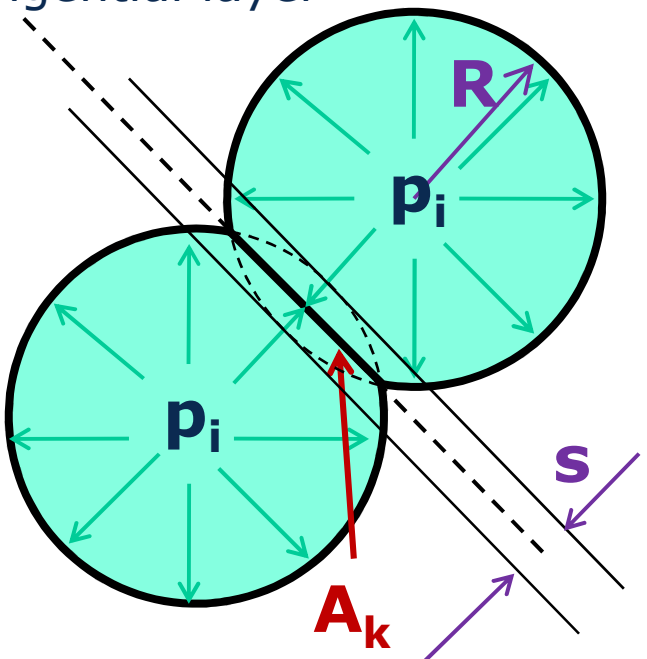


Normal forces

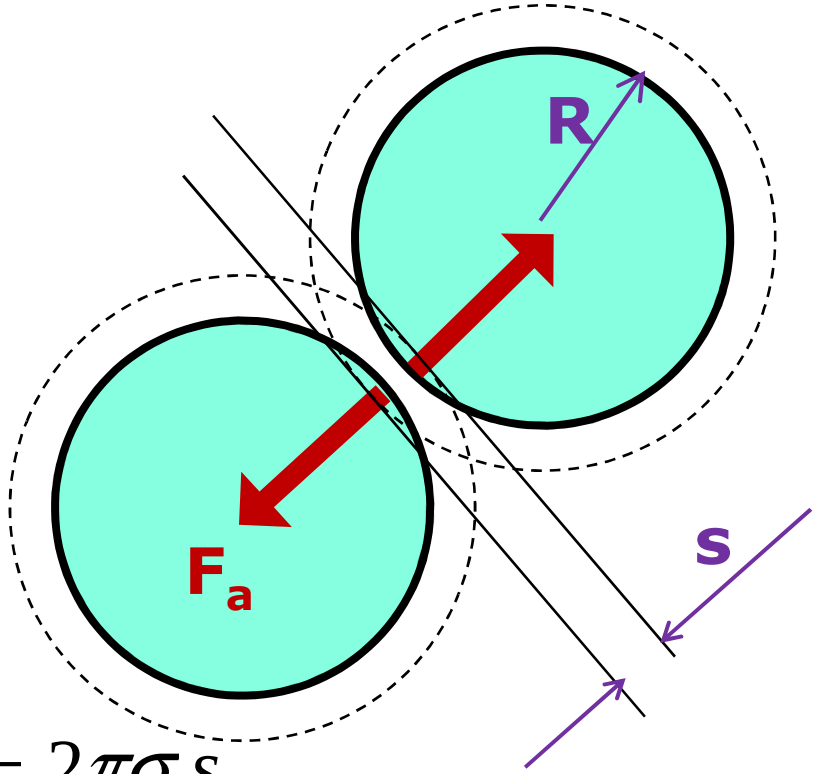
- Additional force in particle equation-of-motion

Abstraction of the physics

Tangential layer



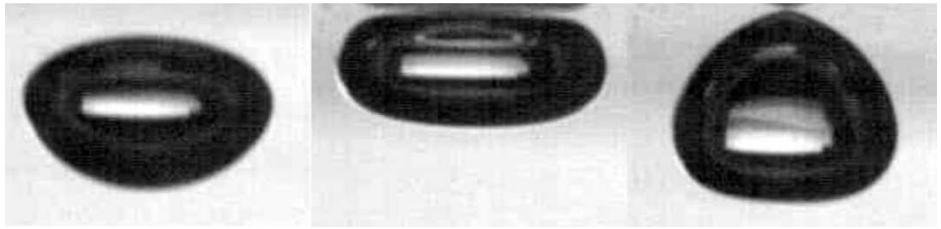
Numerical realisation



$$F_a = A_k \; p_i \; = 2\pi\sigma \, s$$

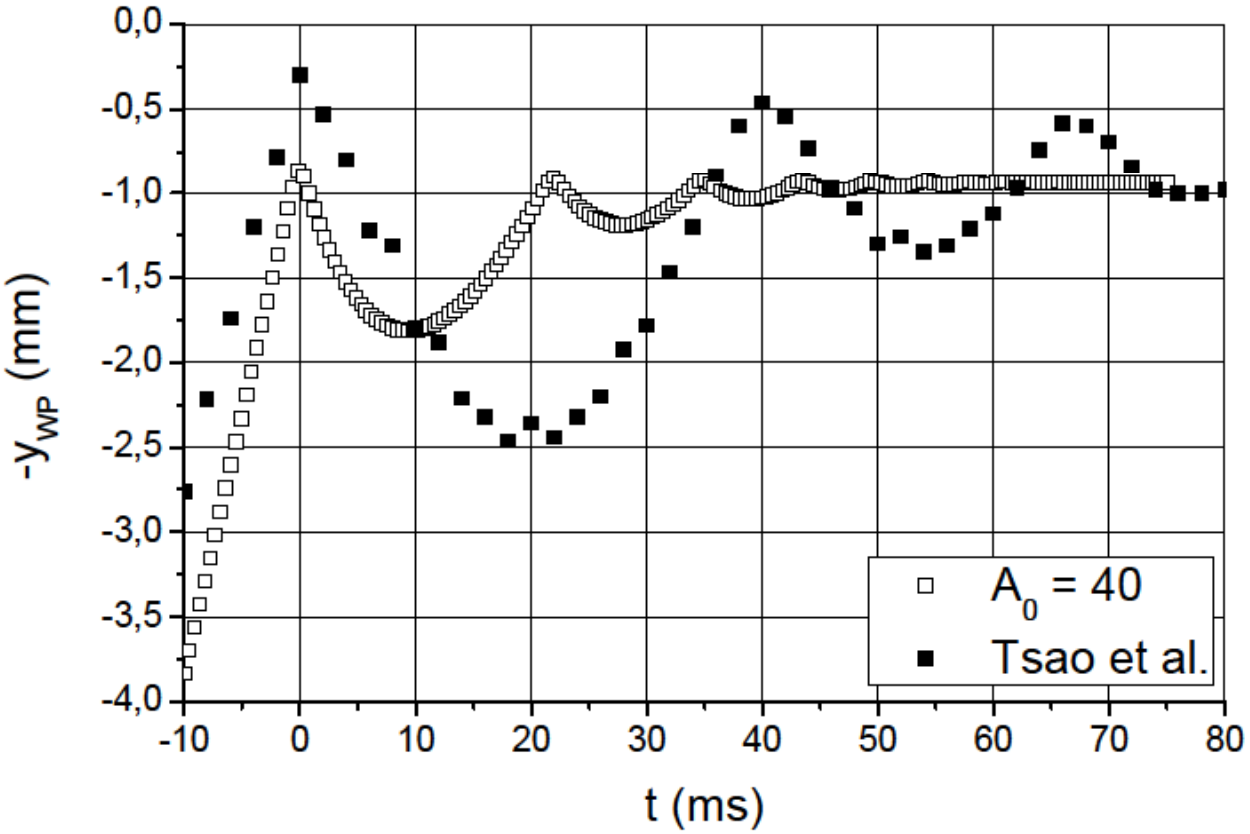
Few data to validate collision model!!!

Test setup for collision

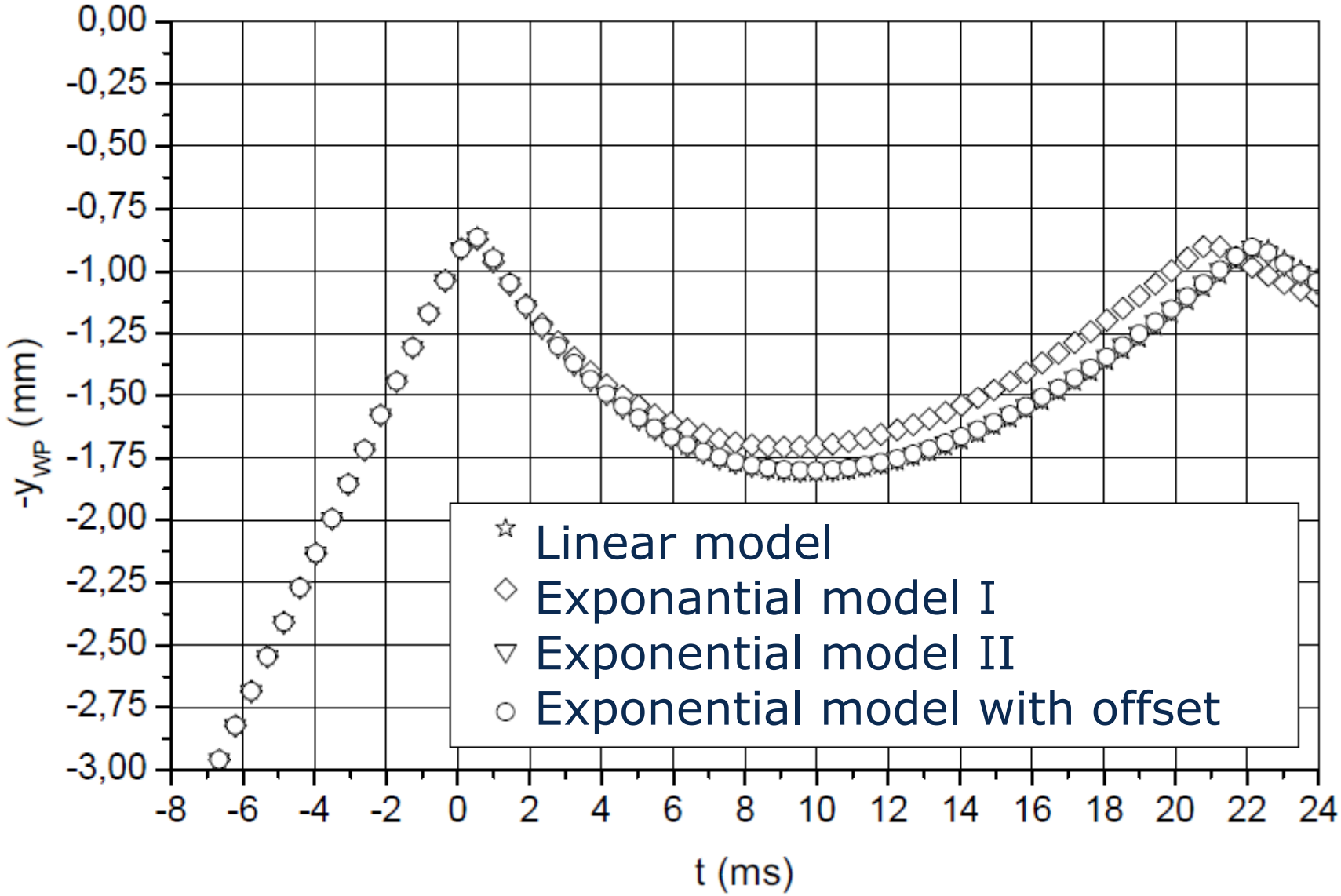


Zenit et al.: The coefficient of restitution for air bubbles colliding against solid walls in viscous liquids, 2009

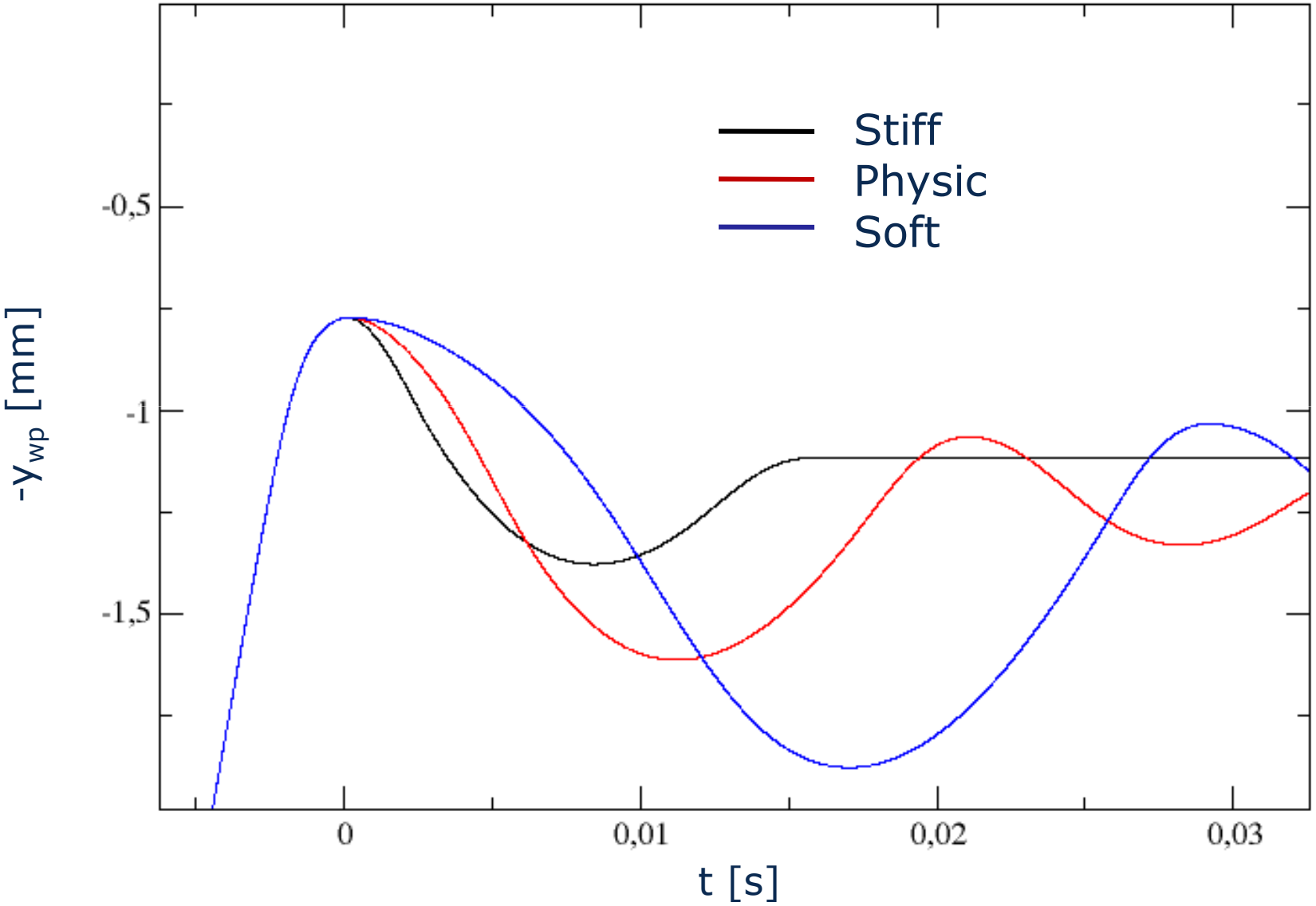
- Very soft
- Large deformation
- Collision model fails



Different collision models

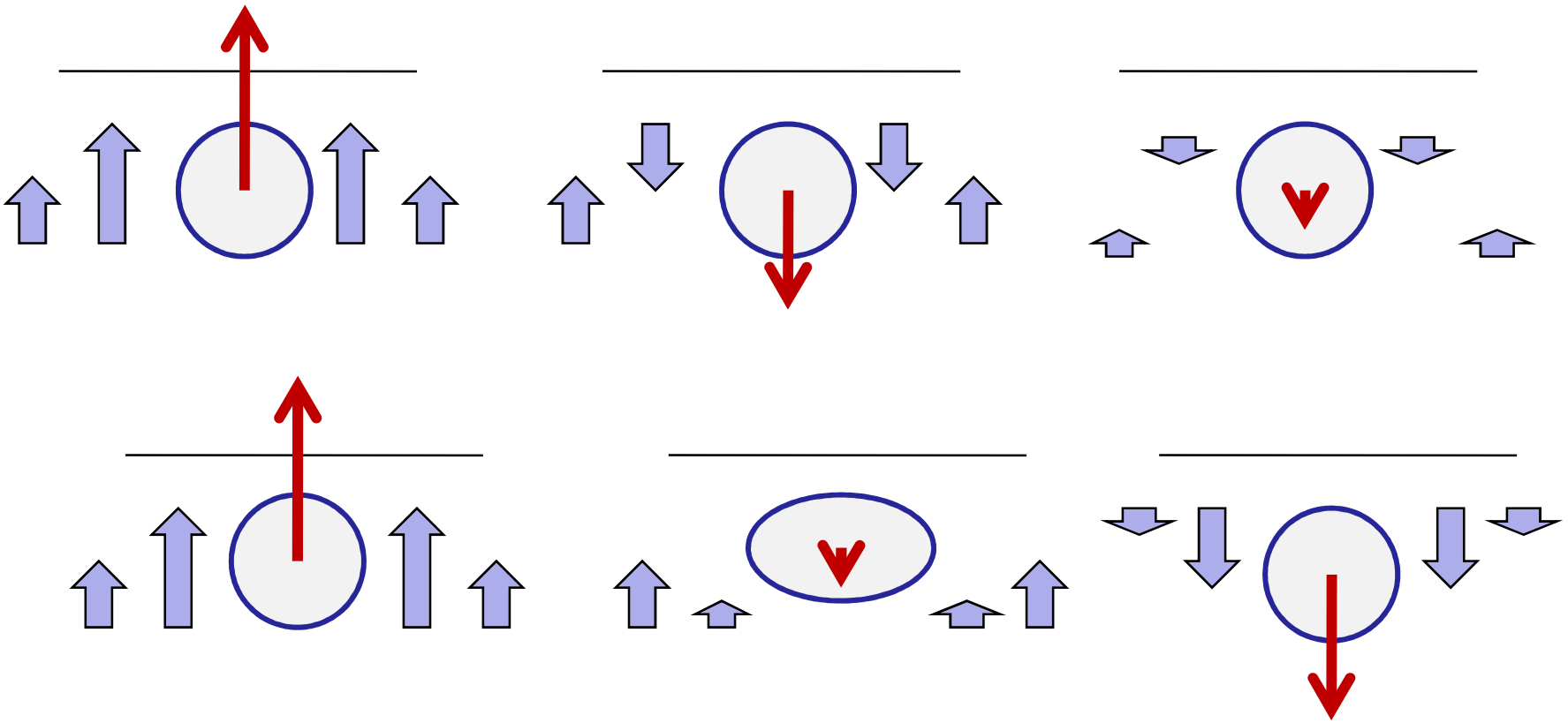


Different collision models



Explanation?

Virtual mass effect



Conclusion

- Low influence of shape of collison force
- Bubble is dominated by flow field
- Collision time important for dissipation (in flow field)

Thank you for your attention!

Questions?