Cambridge Ultrasonics

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# Modelling Ultrasonic Transducers

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# Application examples

- Inspecting rivets in aluminium body panels for automotive industry.
- Filtering wood pulp from flowing water.
- Inspecting nuclear fuel rods in pressurized water or liquid sodium.
- Inspecting steel riser in oil-wells.
- Scattering of sound from submarines (sonar).
- Cambridge Ultrasonics' logo.

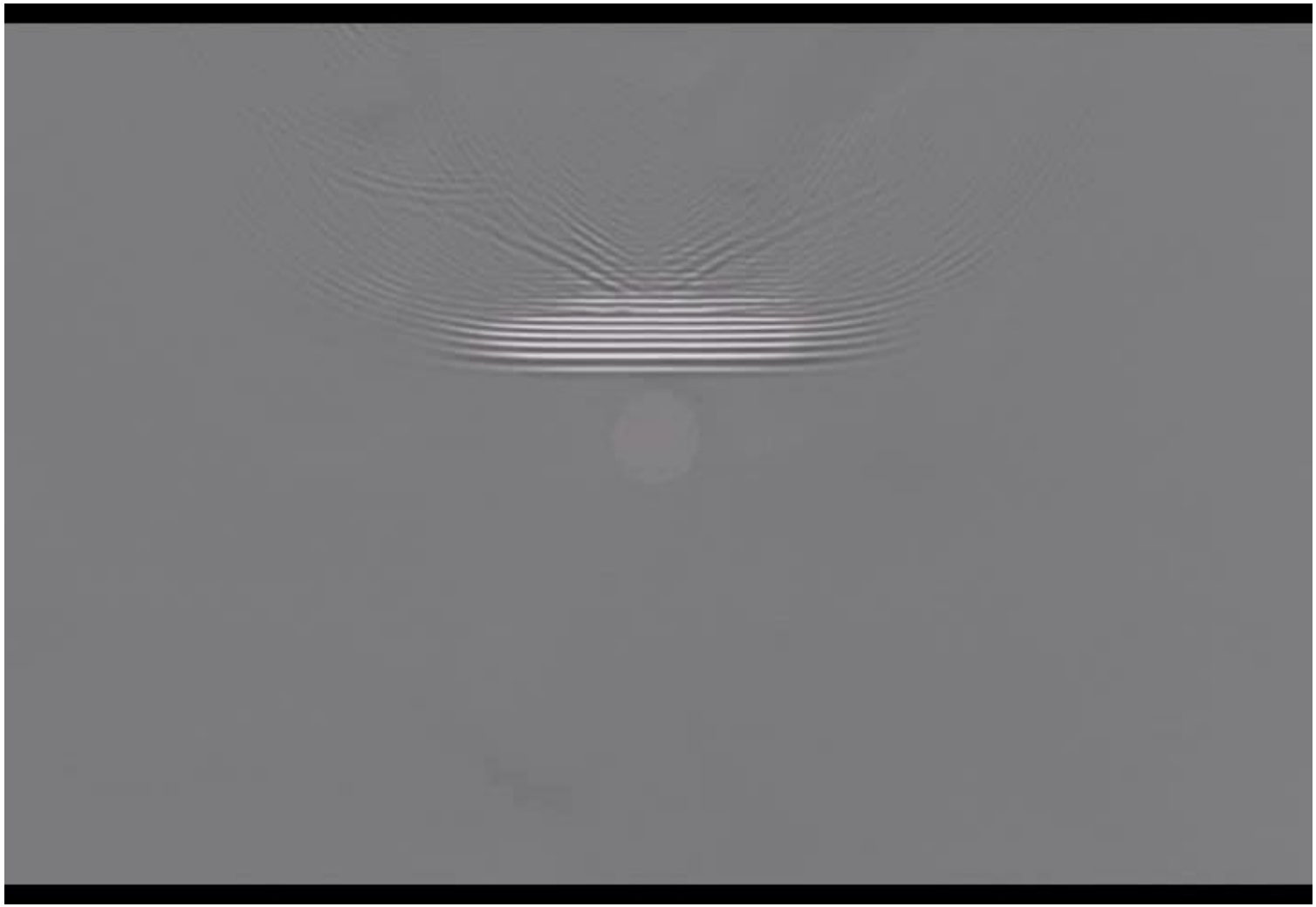
# FE settings and problems

- Multiphysics: transient elasticity and/or acoustics and possibly piezoelectric materials and possibly heat diffusion.
- What is a suitable mesh size?
- What is a suitable time-step?
- Solver can fail to converge or a solution is produced but does not represent reality.

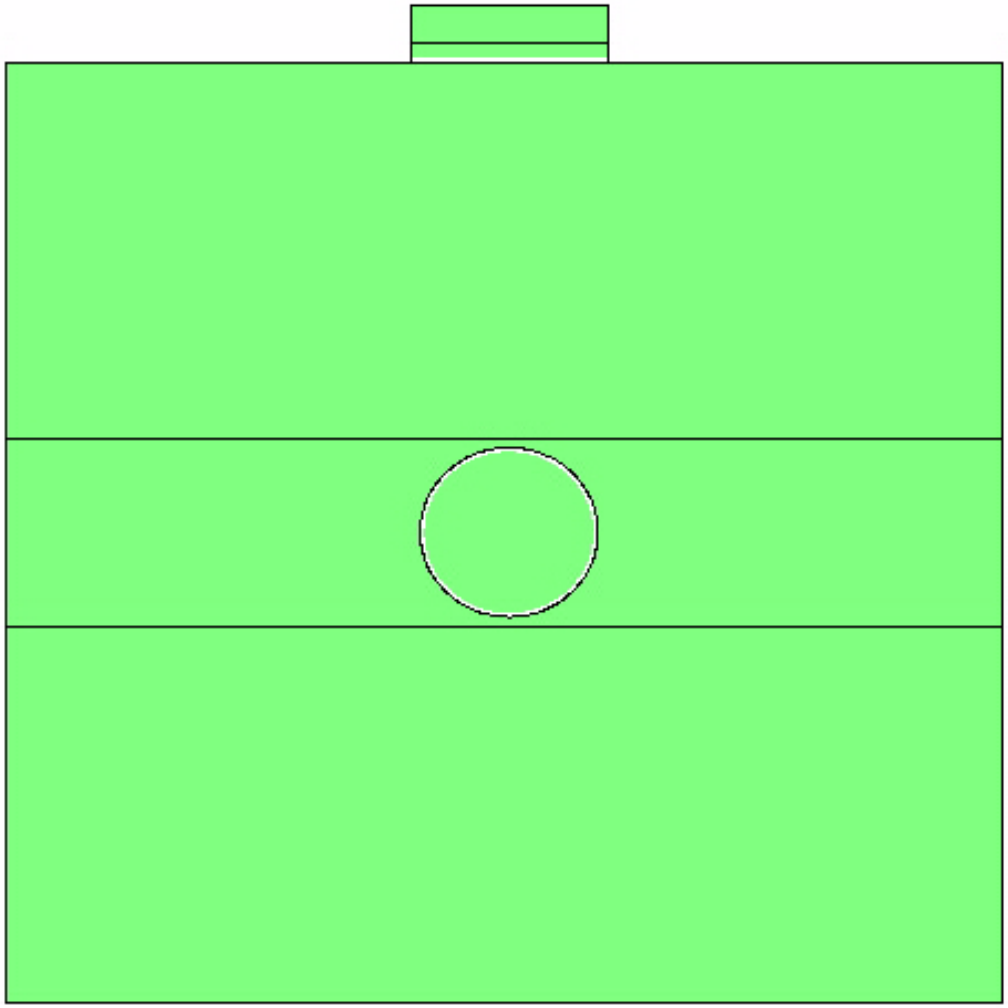
# Experimental validation

- Schlieren visualization – provides still pictures and video that can be compared with FE solutions.
- Use experiments to validate closely related FE models: adjust mesh size and time-steps or model physics to make FE solutions like experimental results.
- Schlieren is better than other experimental methods.

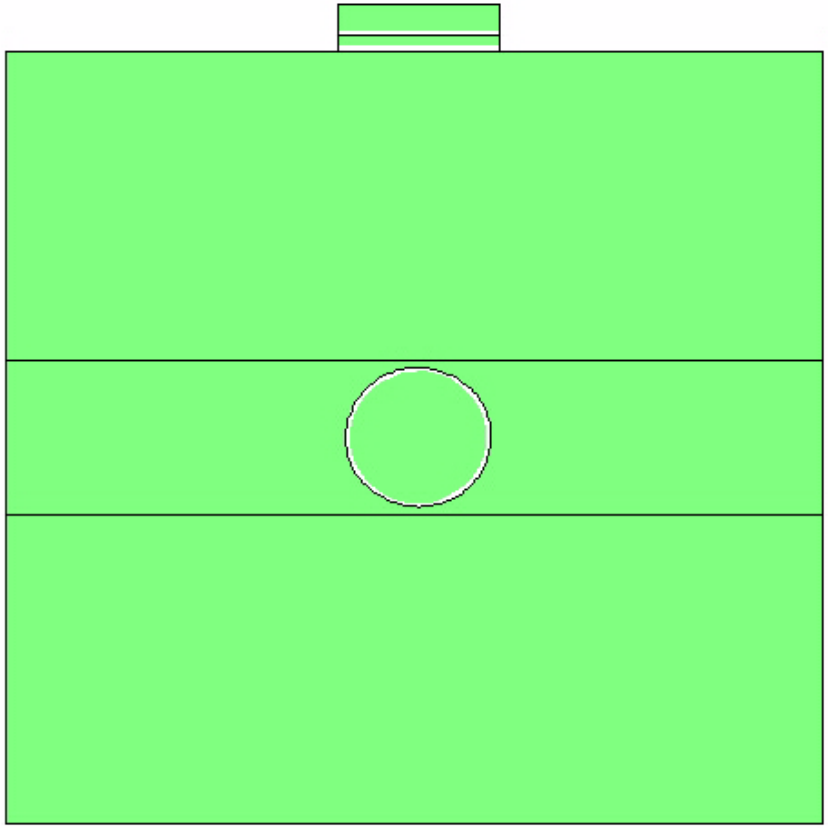
# Schlieren experiments – logo



# FE model – logo



# Error FE model



# Good FE solutions

- Estimate the shortest wavelength in FE model – highest frequency, lowest wave speed, non-linear propagation.
- Set mesh size to much less than half shortest wavelength.
- Set time-step to be much less then half shortest period ($1/frequency_{highest}$).
- Compare experiments for validation.

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# Summary

- Ultrasonic wave propagation using time-stepping allows errors to propagate and grow.
- Remember Nyquist/Shannon sampling for signals.
- Ensure mesh is much smaller than smallest wavelength and time-step is much smaller than smallest wave period.
- Use experiments to verify FE model results.