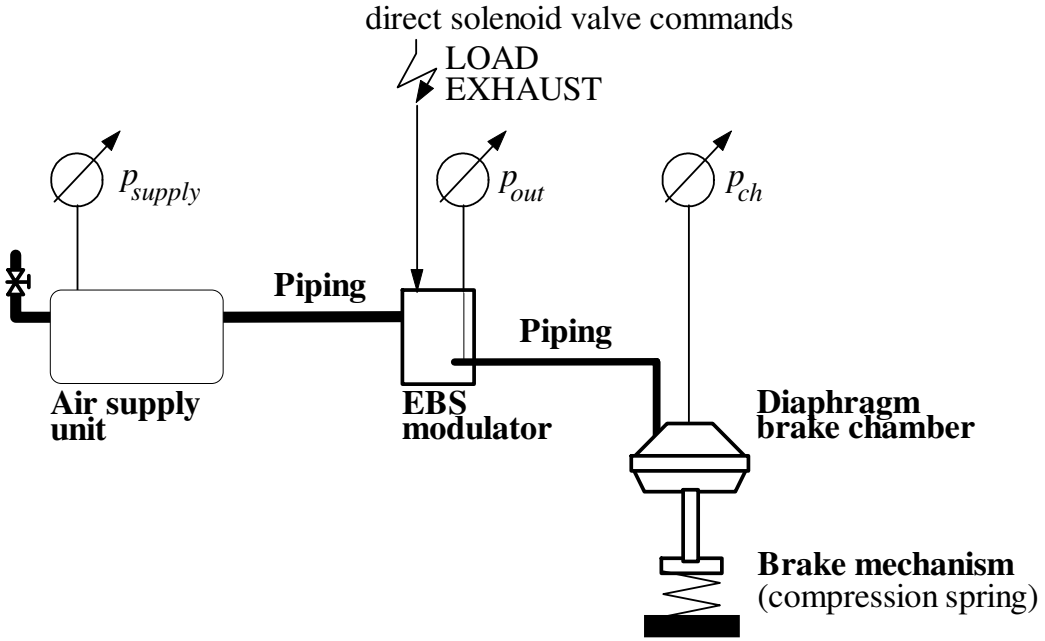
5. MEASUREMENT OF UNSTEADY PRESSURE

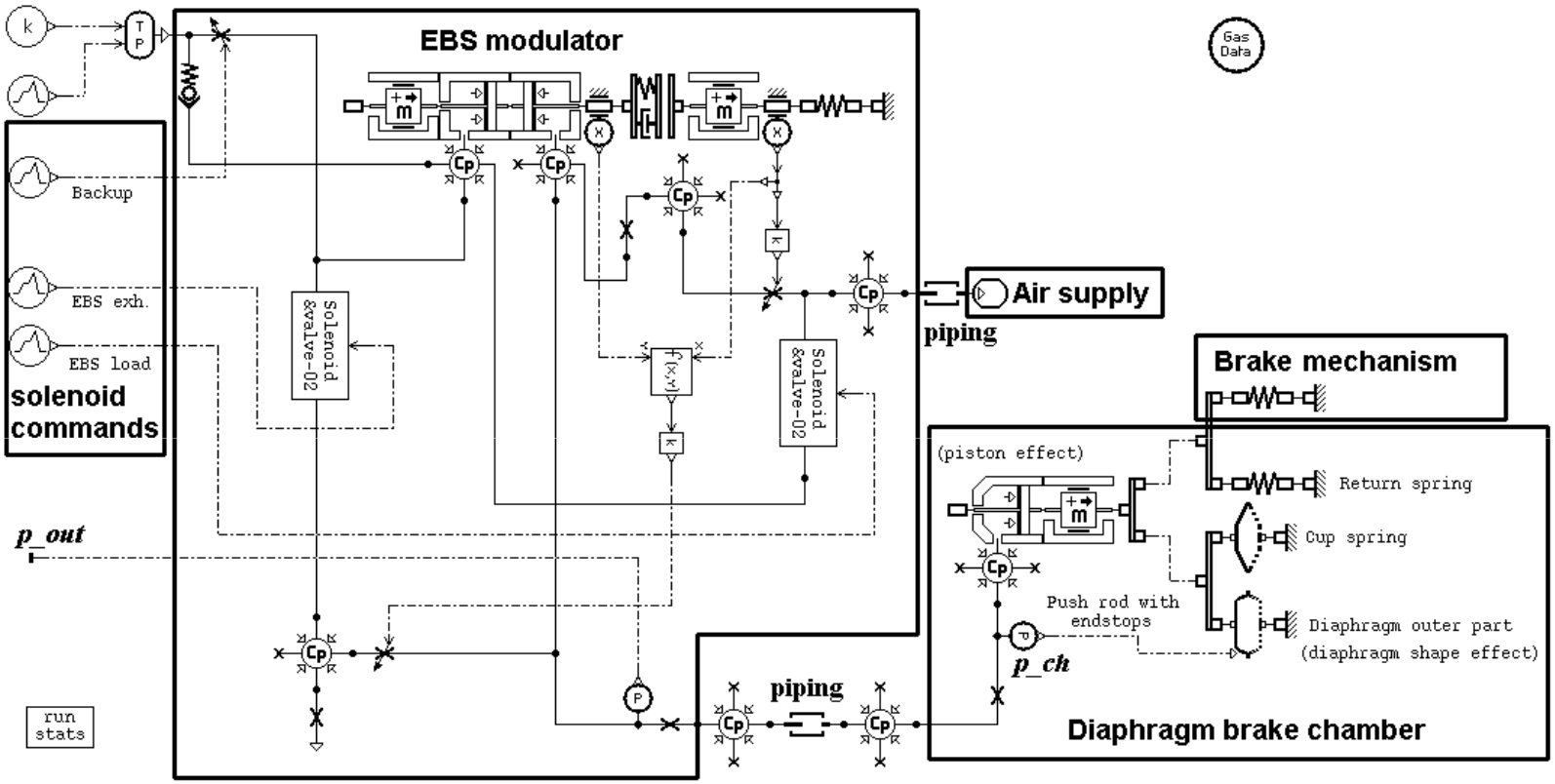
5.1. Examples for practical use

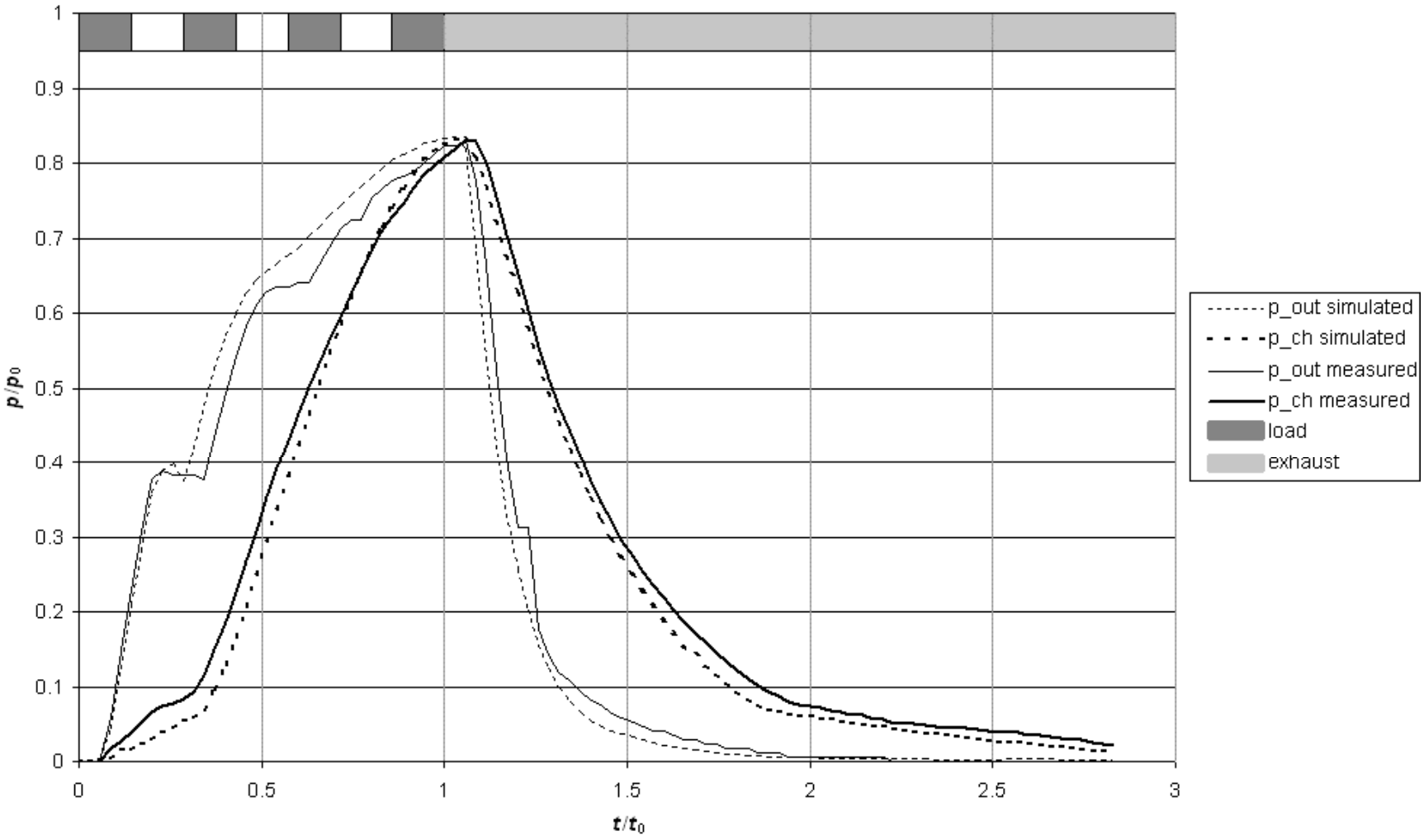
•In controlled technological and other industrial flow processes which are highly unsteady by nature

Electro-pneumatic braking systems of commercial vehicles



AMESim simulation model of the case study





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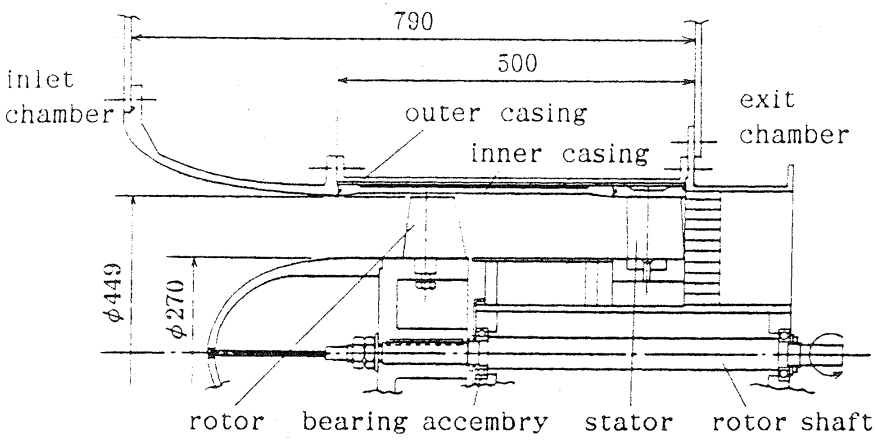
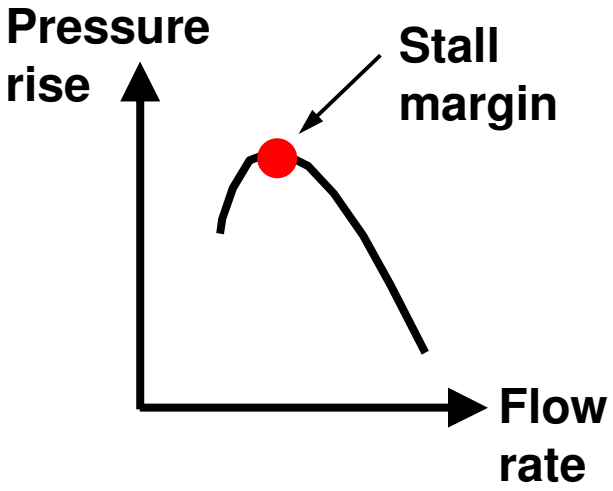
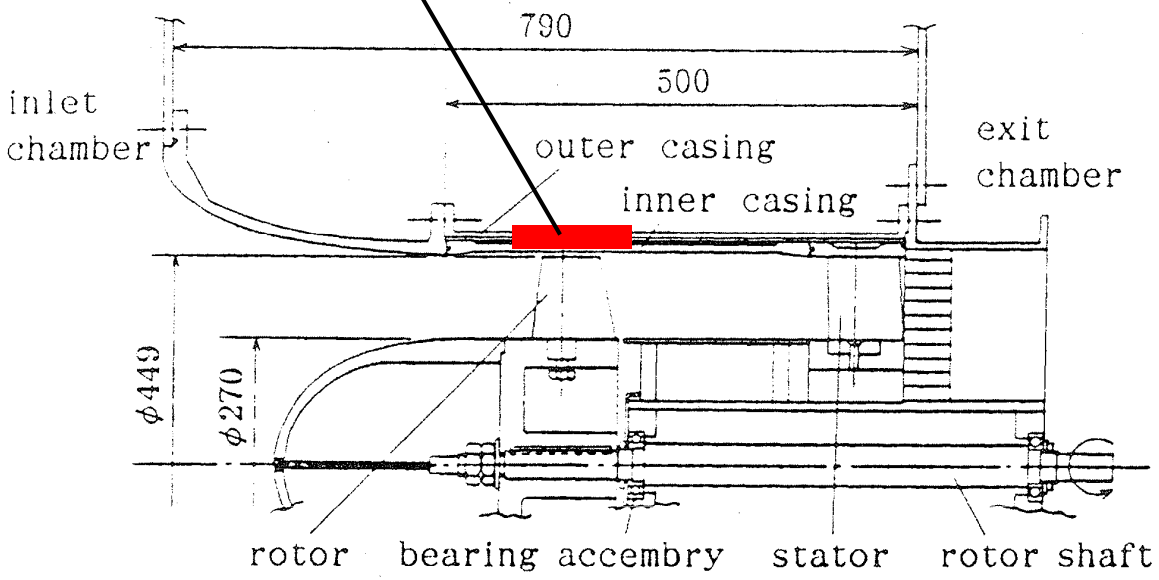
•Measurement of **turbulence-related** pressure fluctuations

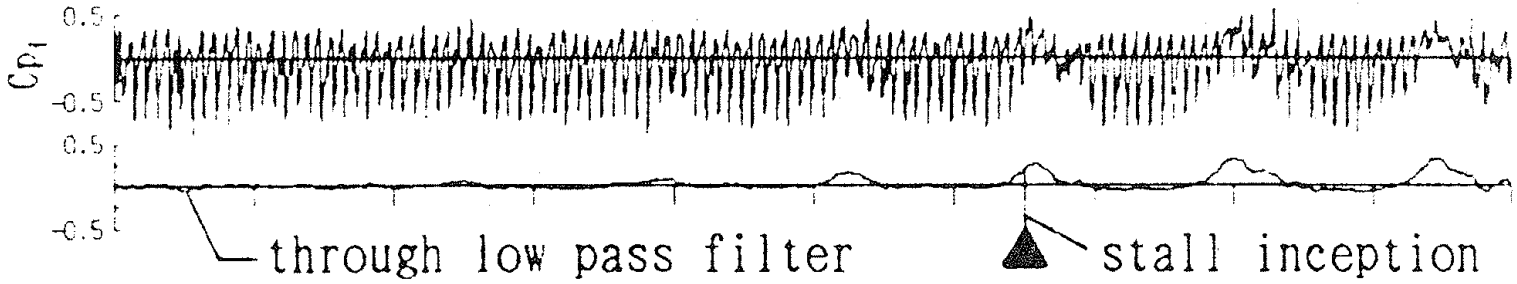
Axial flow fan / compressor:





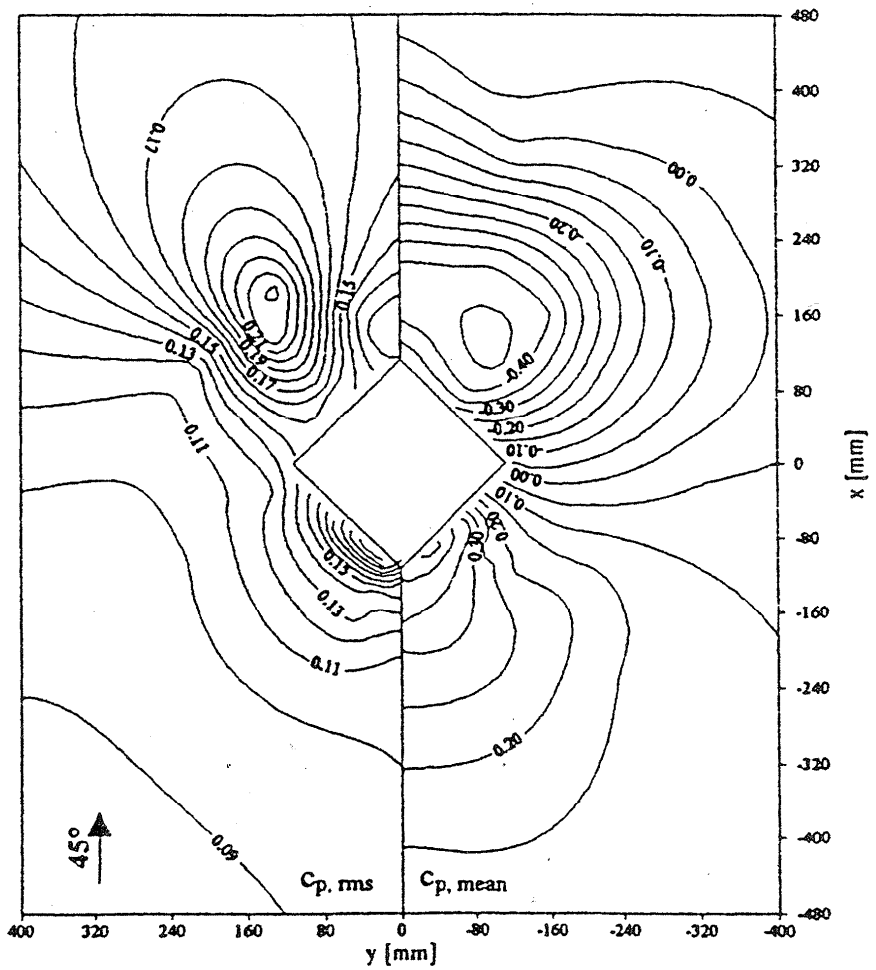
Zone of pressure transducers



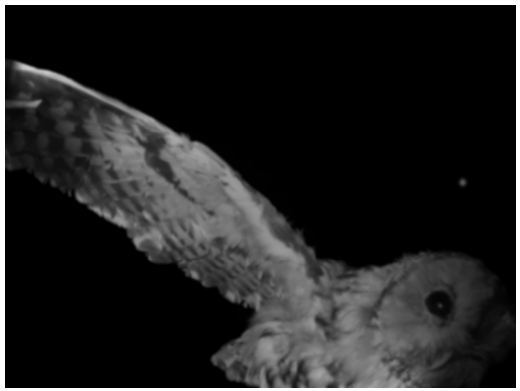


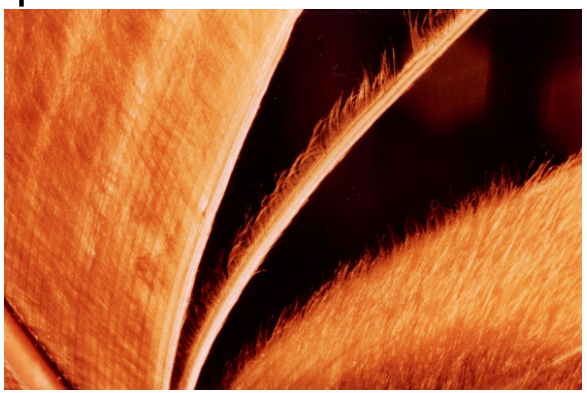
•Fluid mechanics R&D. Measurements for validation and further development of turbulence models and CFD tools.

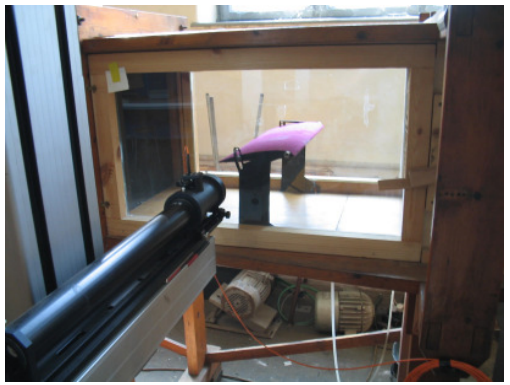
Wind tunnel measurements: flow past a building block model

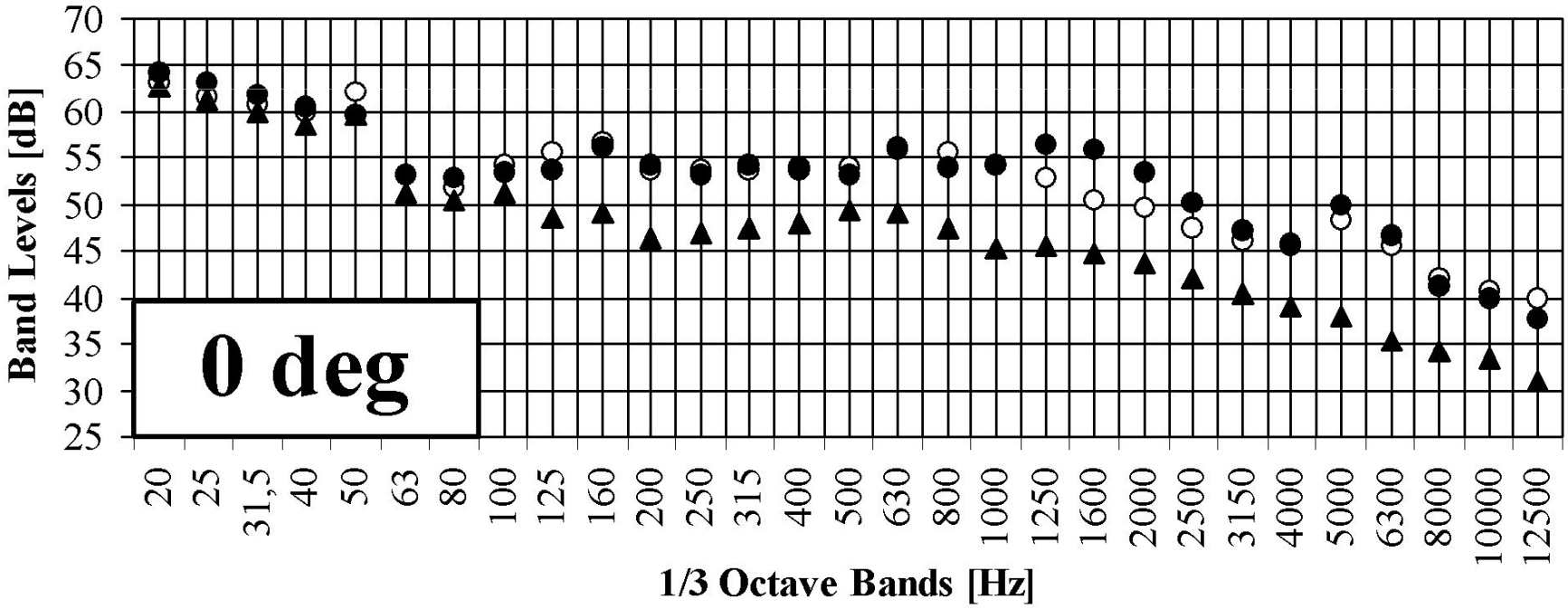


•Acoustics, sound pressure level measurements, spectral distribution of sound pressure



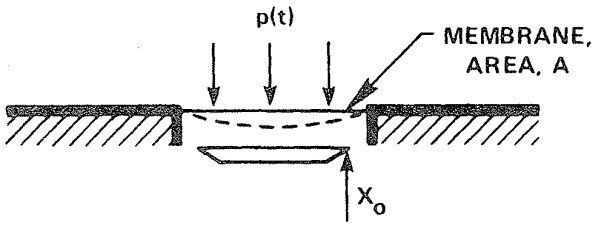


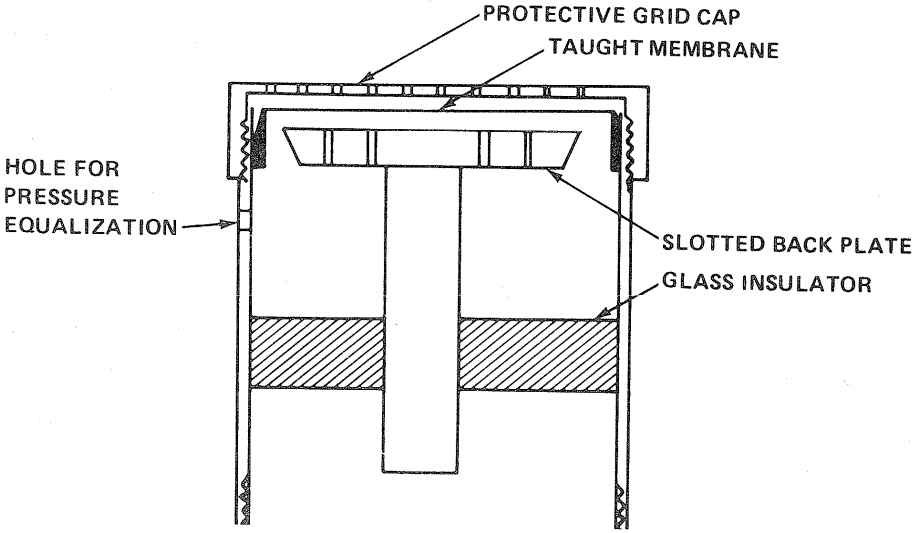




5.2. Instruments

5.2.1. Capacitor principle (condenser microphone)





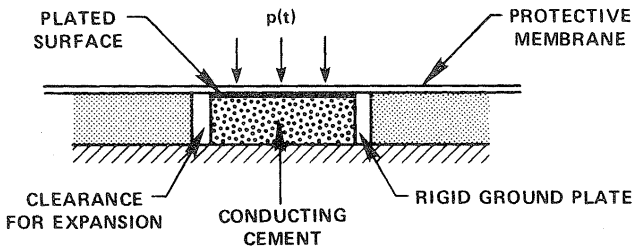
$$Q = C\,U$$

$$L = 20 \lg \frac{p}{p_0}$$

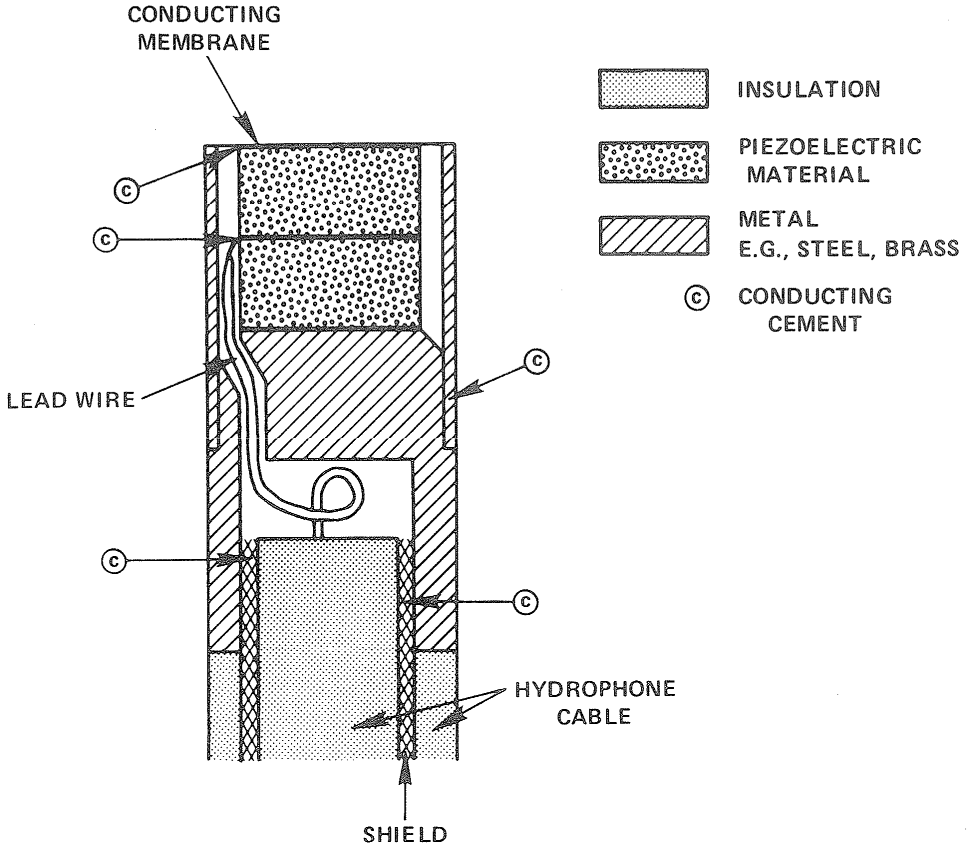
0 ÷ 120 dB: 6 orders of magnitude!

5.2.2. Piezo-inductive principle

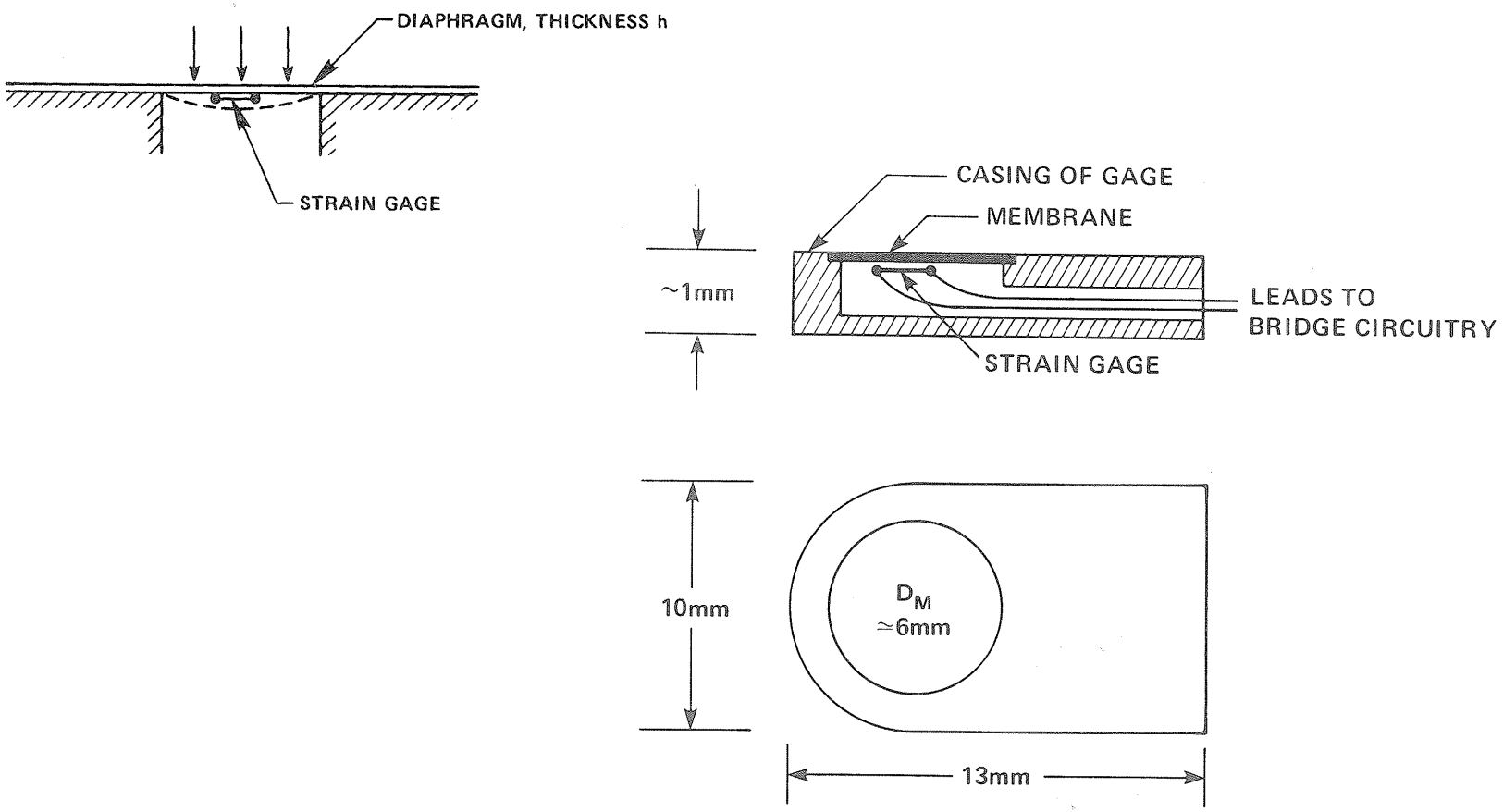
- Hydrophones
- Indication of IC engines



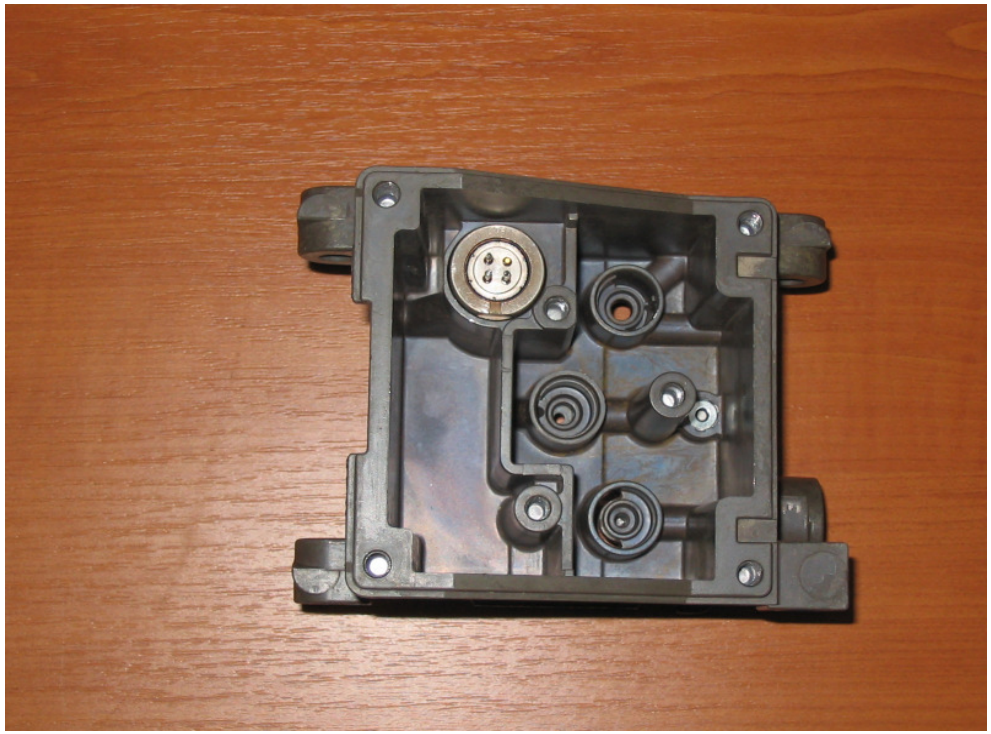
„Acceleration canceling”
⇔ Accelerometers!

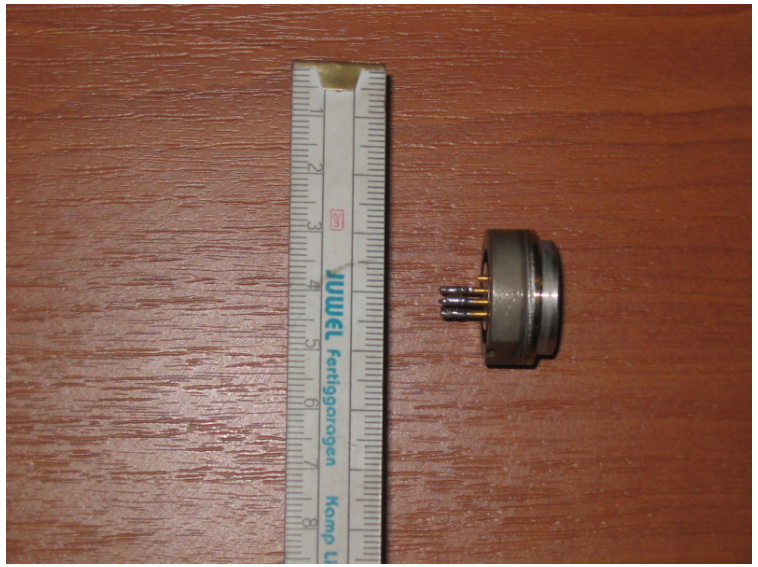


5.2.3. Piezo-resistive principle

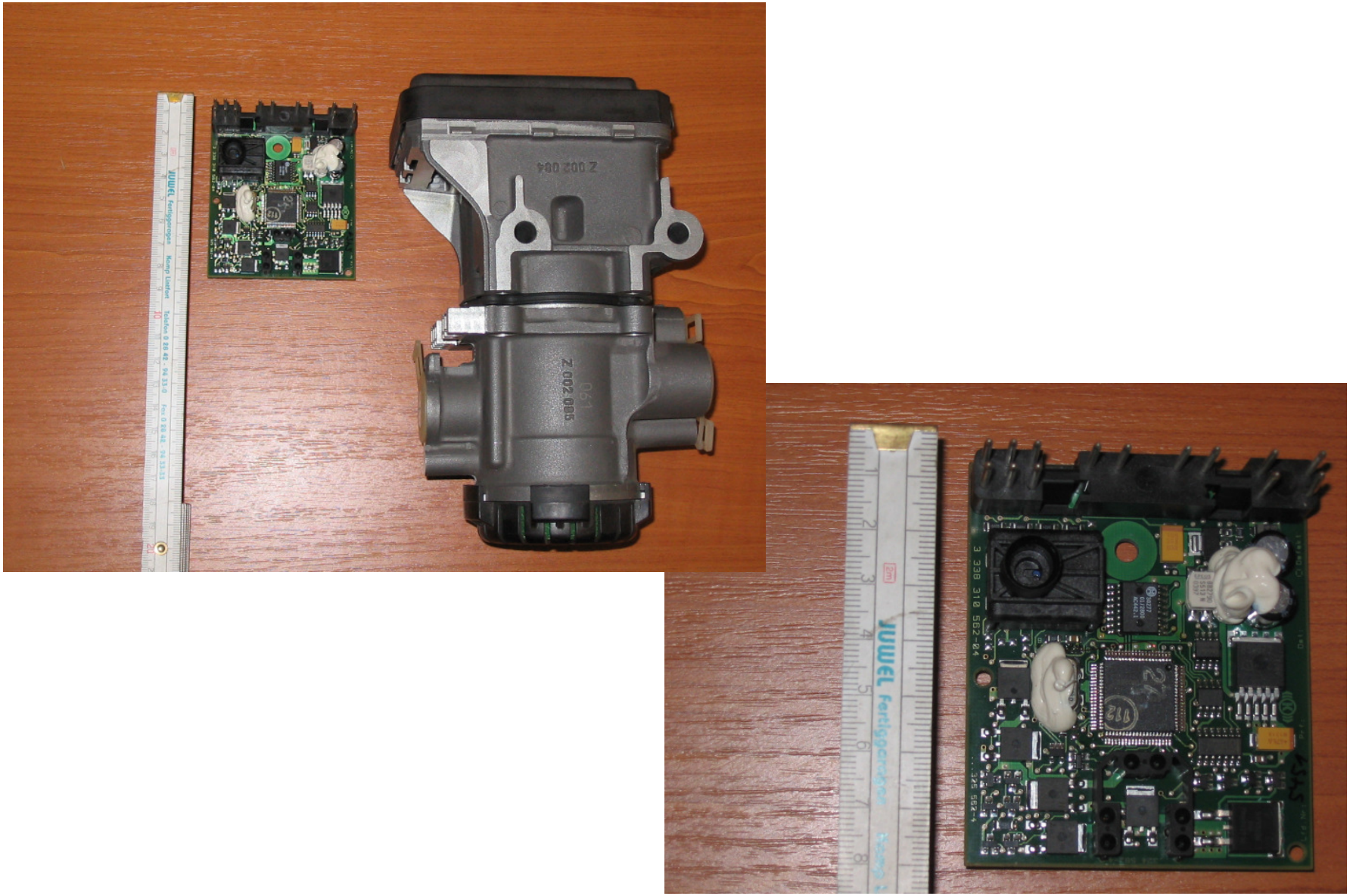


Kulite sensor





•EBS modulators



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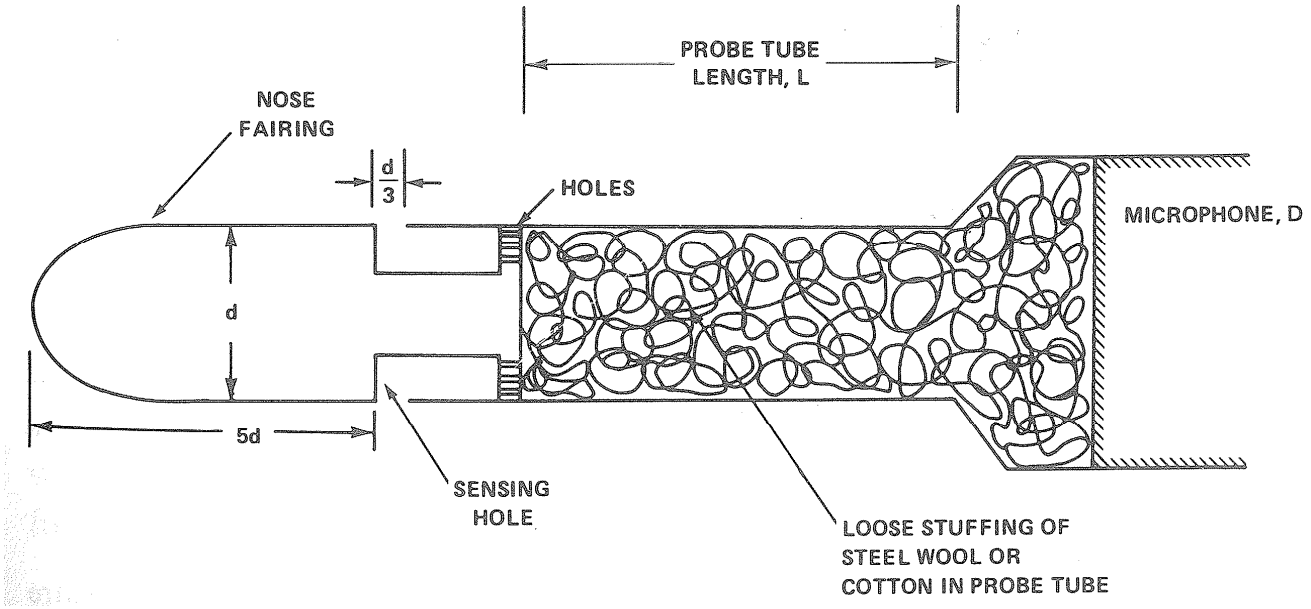
5.3. Applications in acoustics and in turbulence studies

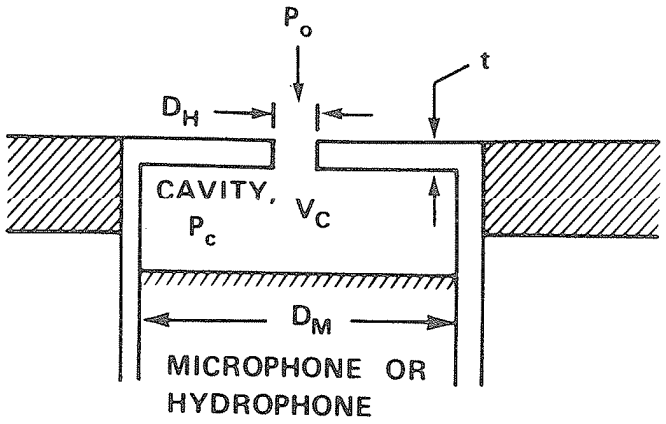
Pressure waves:

$$\lambda = \frac{a}{f} \approx \frac{340\ m/s}{10^4\ Hz} \approx 30\ mm$$



Turbulent pressure fluctuations:

$$\lambda = \frac{v}{f} \approx \frac{1\,m/s}{1000Hz} \approx 1\,mm$$



PINHOLE TRANSDUCER WITH HELMHOLTZ RESONATOR

Helmholtz resonator:

$$f_{Helm} \approx \frac{a}{2\pi}\sqrt{\frac{D_H^2\,\pi/4}{V_C\left(t + D_H\right)}}$$

$$f = \frac{f_{Helm}}{2}$$