National Physical Laboratory

Pressure calibration of microphones using calculable pistonphones

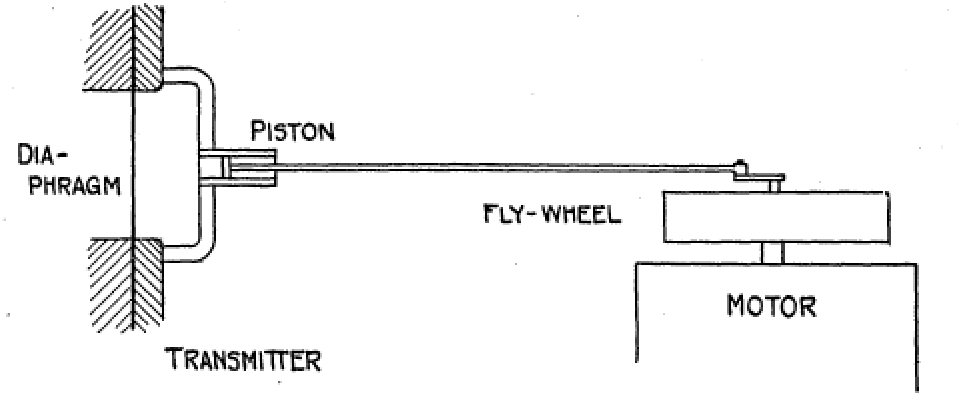
Richard Barham

Basic principle

- If a small volume displacement is introduced into a sealed cavity
- Then the increase in pressure is calculable from the adiabatic gas law

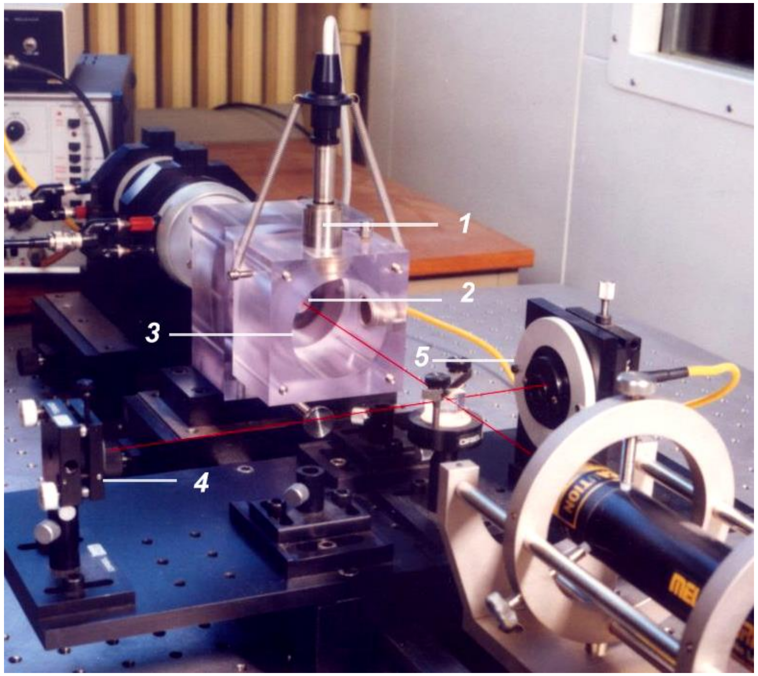
$$\delta p = \frac{\gamma P_0 \delta V}{V}$$

- Wente first used the principle in 1917 to calibrate his condenser microphone



Laser pistonphones

- Modern implementations of this principle often use a laser interferometer to determine the volume displacement introduced by the piston



1 Microphone under test
2. Piston
3. Cavity
4. Fixed mirror
5. Optical detector and fibre

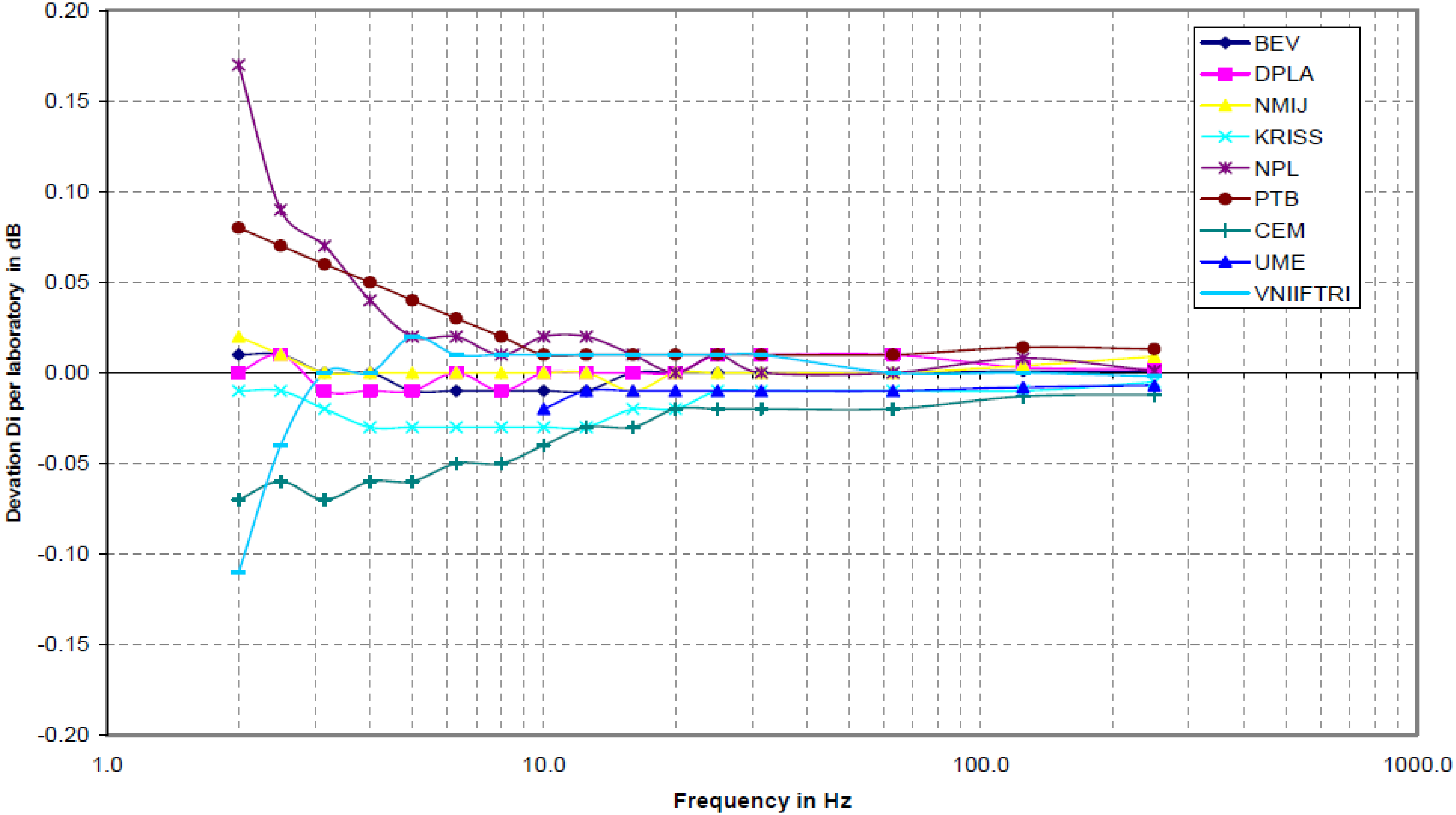
- Such devices have been developed in the UK, Japan, Turkey, S. Korea and elsewhere

Absolute low frequency calibration

- Geometrical constraints limit the operating range to low frequencies, typically below 100 - 200 Hz
- However a laser pistonphone delivers an absolute calibration and can achieve measurement uncertainties comparable with reciprocity calibration in the infrasound range.
- This provides a valuable opportunity to realise primary standards for sound pressure by independent methods

- NPL used its laser pistonphone in CCAUV.A-K2 on calibration of laboratory standard microphone at low frequencies (2 Hz – 250 Hz)

Data from CCAUV.A-K2



Other results

- Few results have been published
- UME, NMIJ, and KRISS have some data which indicates the same phenomenon
- However results are masked by uncertainty, especially in the key area below 10 Hz, and more are needed

- NPL are planning further laser pistonphone experiments to compare the acoustic pascal with that determined for static pressure

- There is therefore an excellent opportunity for multilateral validation of primary standards for LF sound pressure