

A Custom Real-Time Ultrasonic Instrument for Simultaneous Mixture and Flow Analysis of Binary Gases in the CERN ATLAS Experiment

Custom ultrasonic instruments have been developed for simultaneous monitoring of binary gas mixture and flow in the ATLAS Inner Detector. Sound transit times are measured in opposite directions in flowing gas. Flow rate and sound velocity are respectively calculated from their difference and average. Gas composition is evaluated in real-time by comparison with a sound velocity/composition database, based on the direct dependence of sound velocity on component concentrations in a mixture at known temperature and pressure. Five devices are integrated into the ATLAS Detector Control System. Three instruments monitor coolant leaks into N₂ envelopes of the SCT and pixel detectors. Resolutions better than $\pm 5 \times 10^{-5}$ and $\pm 10^{-4}$ are respectively seen for C₃F₈ and CO₂ leak concentrations in N₂. A fourth instrument detects sub-percent levels of air ingress into the C₃F₈ condenser of the new thermosiphon coolant recirculator. Following extensive studies a fifth instrument was built as an angled sound path flowmeter to measure the high returning C₃F₈ vapour flux (~1.2 kg/s). A precision of < 2% F.S. for flows up to 15 m/s was demonstrated. This device can also monitor C₃F₈ and C₂F₆ concentrations to better than $\pm 3 \times 10^{-3}$. These blends allow for lower temperature silicon tracker operation.

The instrument has many potential applications where continuous binary gas composition measurement is required, including hydrocarbon and anaesthetic gas mixtures.

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Track Classification: Gaseous Detectors