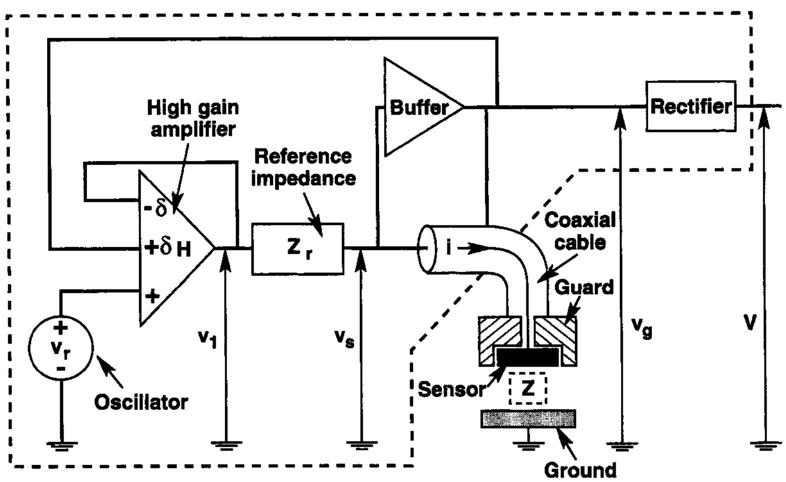
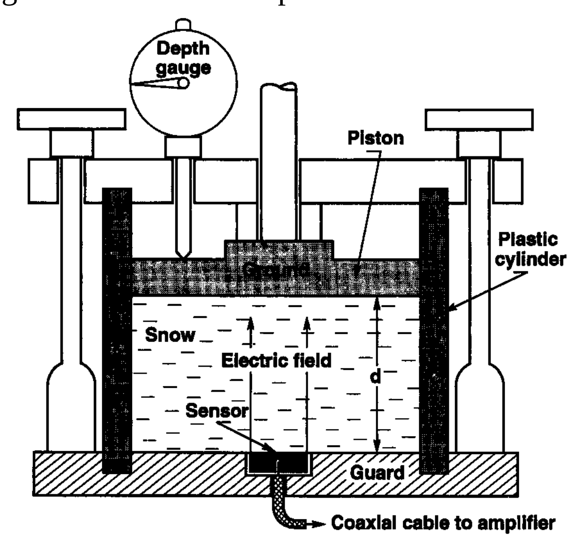
Louge M.Y., Steiner R., Keast S.C., Decker R., Dent J. and Schneebeli M.: "Application of Capacitance Instrumentation to the Measurement of Density and Velocity of Flowing Snow," *Cold Regions Science and Technology* **25**, 47-63 (1997).

We describe capacitance instrumentation suitable for the measurement of density and velocity of flowing snow with moderate liquid-phase water content. A wand, consisting of two adjacent sensors protected by guard circuits, produces signals that are related to snow density through calibration. Cross-correlation of the signals permits velocity measurements. Calibration is accomplished using a capacitance device that records the dielectric properties of a snow sample while subjecting it to controlled levels of compaction and volume change. Non-invasive probe geometries are also presented. The instrumentation is tested in artificial and natural avalanches.

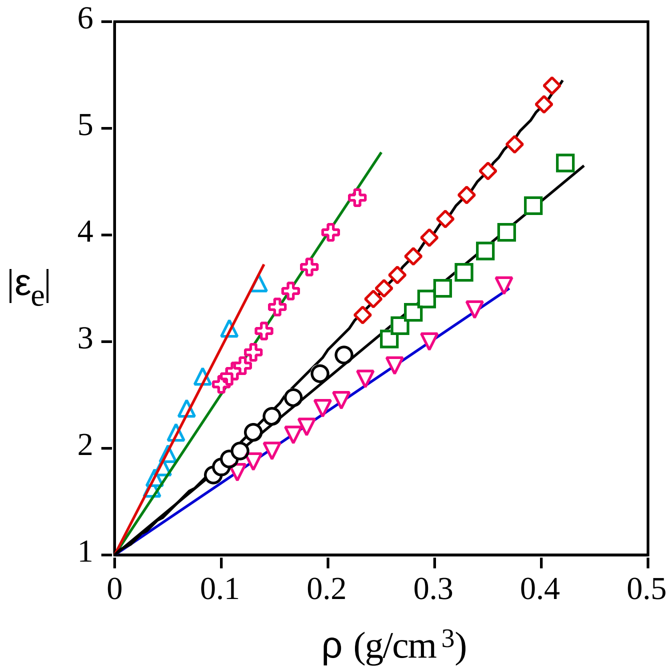
Figure excerpts



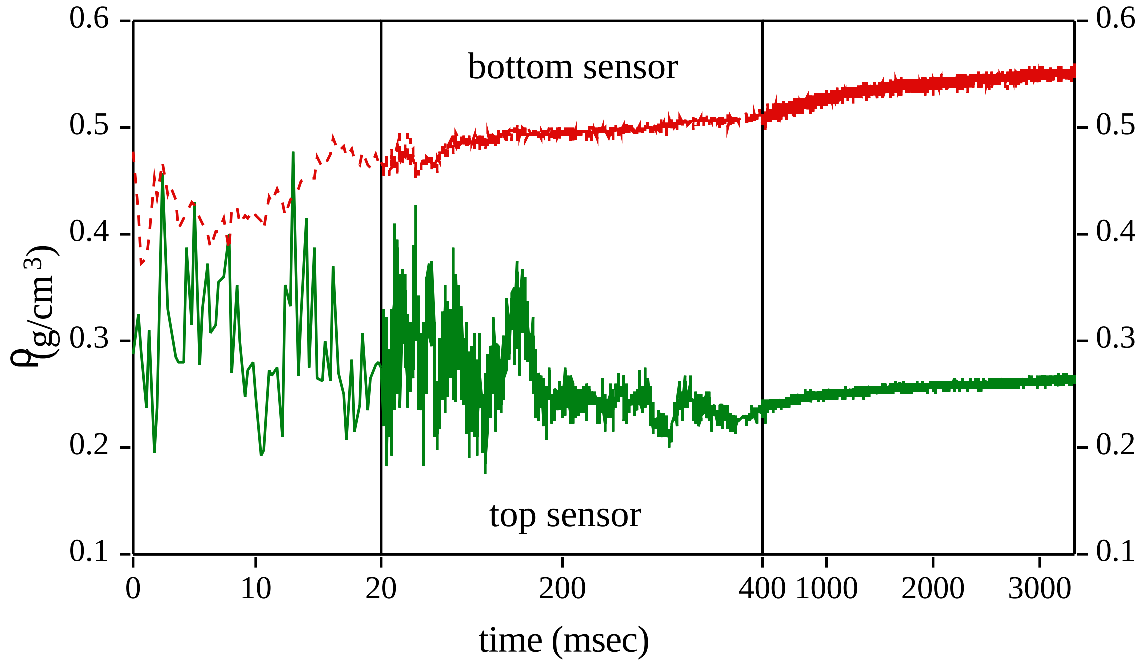
Schematic of the electronic system. The dashed lines represent the physical boundary of the processing circuits. Z is the impedance between sensor and ground.

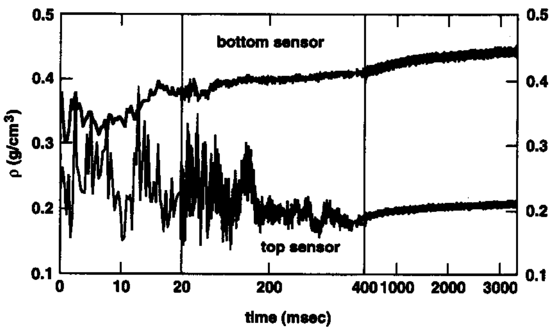


The "snow press".

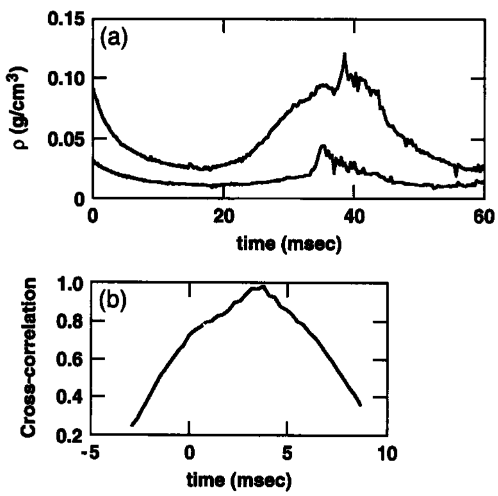


Modulus of the effective dielectric constant versus density for a variety of crystalline snows. The circles, squares and diamonds represent, respectively, fresh snow, old snow, and "graupel" with fresh snow collected in Alta at -6.5°C; the downward triangles are fresh snow from Bridger Bowl at -11°C; the upward triangles are Cornell snow at -6.9°C; the crosses are other, likely purer, Cornell snows at -4.2°C.

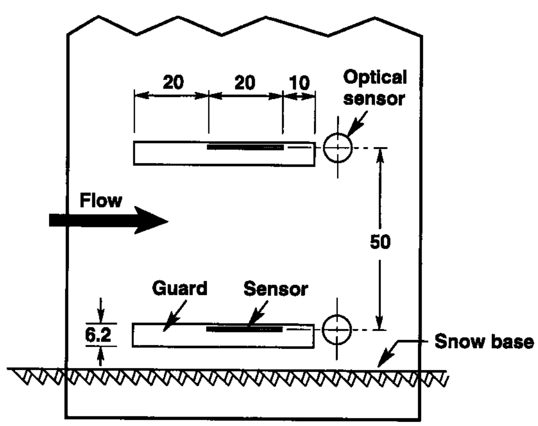




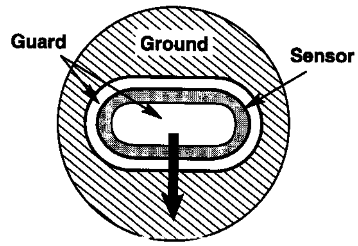
Density time-histories at two elevations above the base of the Revolving Door avalanche at -15°C. Triggering failed to capture the avalanche front occurring approximately 35 msec before signal acquisition. Progressive expansion of the time axis underlines signal features.



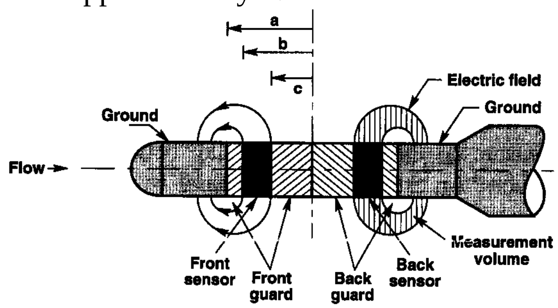
Density time-history recorded by the upstream sensor of the "snow wand" with a snow temperature of -3°C. Densities were calculated from Eq. (24) using $|\varepsilon_e| = 32.6$.
(a) Detail near t = 150 msec in Fig. 18. The top trace is from the downstream sensor.
(b) $\tau_m = 3.71\pm0.14$ msec i.e., $v_m = 7.4\pm0.3$ m/sec.



Side view of the "strip" probe face. The flow passes over the probe in the direction shown. Its characteristic length is $\ell \approx 5.5$ mm and its measurement volume extends approximately 2.7 mm from the wall of the chute.



Top view of the "wall" probe face. The flow passes over the probe in the direction shown. Its outer diameter is 50mm; its characteristic length is $\ell \approx 22$ mm and its measurement volume extends approximately 6.7 mm from the base of the chute.



Active electrical surfaces of the "snow wand". For clarity, internal connections of the respective coaxial cables are not shown. For this probe, a = 21.2, b = 17.3 and c = 10.4 mm.