

Particle-Charge Spectrometer

A flow of gas carries charged particles through a charge-sensing cylindrical electrode.

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An instrument for rapidly measuring the electric charges and sizes (from ≈ 1 to $\approx 100 \mu\text{m}$) of airborne particles is undergoing development. Conceived for monitoring atmospheric dust particles on Mars, instruments like this one

could also be used on Earth to monitor natural and artificial aerosols in diverse indoor and outdoor settings — for example, volcanic regions, clean rooms, powder-processing machinery, and spray-coating facilities.

The instrument incorporates a commercially available, low-noise, ultrasensitive charge-sensing preamplifier circuit. The input terminal of this circuit — the gate of a field-effect transistor — is connected to a Faraday-cage cylindrical electrode. The charged particles of interest are suspended in air or other suitable gas that is made to flow along the axis of the cylindrical electrode without touching the electrode. The flow can be channeled and generated by any of several alternative means; in the prototype of this instrument, the gas is drawn along a glass capillary tube (see upper part of figure) coaxial with the electrode.

The size of a particle affects its rate of acceleration in the flow and thus affects the timing and shape of the corresponding signal peak generated by the charge-sensing amplifier. The charge affects the magnitude (and thus also the shape) of the signal peak. Thus, the signal peak (see figure) conveys information on both the size and electric charge of a sensed particle.

In experiments thus far, the instrument has been found to be capable of measuring individual aerosol particle charges of magnitude $>350 e$ (where e is the fundamental unit of electric charge) with a precision of $\pm 150 e$. The instrument can sample particles at a rate as high as several thousand per second.

This work was done by Stephen Fuerstenau and Gregory R. Wilson of Caltech for NASA's Jet Propulsion Laboratory.

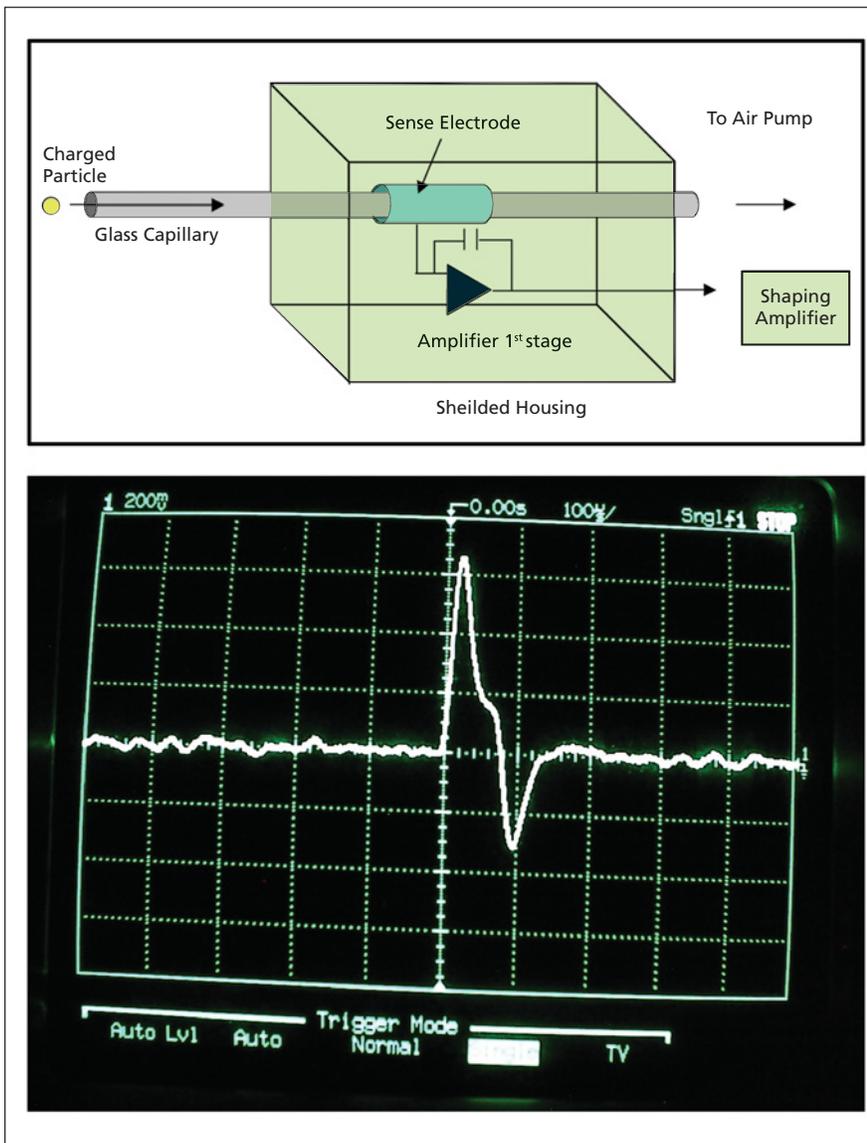
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The Prototype Particle-Charge Spectrometer includes a capillary tube that enters a shielded housing containing a Faraday-cage cylindrical electrode and charge-sensing electronic circuitry. The oscilloscope trace depicts the charge-sensing output signal in response to a particle of charge $\approx 1,560 e$.