$$W = 0.5\ \ \mu\text{m} \times \sqrt{\rho(V + V_{bi})} \quad \text{for } n\text{-type material,} \tag{12.7}$$

and

$$W = 0.3\ \ \mu\text{m} \times \sqrt{\rho(V + V_{bi})} \quad \text{for } p\text{-type material,} \tag{12.8}$$

where V is in volts and ρ is in Ω cm.

The corresponding capacitance per unit area is

$$C = \frac{\epsilon}{W} \approx 1\,[\text{pF/cm}]\,\frac{1}{W}\ . \tag{12.9}$$

In strip detectors the capacitance is dominated by the strip-to-strip fringing capacitance of $\sim$ 1–1.5 pF cm^{-1} of strip length at a strip pitch of 25–50 μm.

About 3.6 eV is required to create an electron-hole pair. For minimum-ionizing particles, the most probable charge deposition in a 300 μm thick silicon detector is about 4 fC (25000 electrons). Readily available photodiodes have quantum efficiences $>$ 70% for wavelengths between 600 nm and 1 μm. UV extended photodiodes have useful efficiency down to 200 nm. In applications in which photodiodes detect light from scintillators, care must be taken so that signal from the scintillator is larger than that produced by particles going through the photodiode.

Collection time decreases with increased depletion voltage, and can be reduced further by operating the detector with "overbias," *i.e.*, a bias voltage exceeding the value required to fully deplete the device. The collection time is limited by velocity saturation at high fields; at an average field of 10^4 V/cm, the collection times is about 15 ps/μm for electrons and 30 ps/μm for holes. In typical strip detectors of 300 μm thickness, electrons are collected within about 8 ns, and holes within about 25 ns.

Position resolution is limited by transverse diffusion during charge collection (typically 5 μm for 300 μm thickness) and by knock-on electrons. Resolutions of 3–4 μm (rms) have been obtained in beam tests. In magnetic fields, the Lorentz drift can increase the spatial spread appreciably (see "Hall effect" in semiconductor textbooks).

Radiation damage is discussed in the full *Review*.

12.6. Proportional and drift chambers

Proportional chamber wire instability. The limit on the voltage V for a wire tension T, due to mechanical effects when the electrostatic repulsion of adjacent wires exceeds the restoring force of wire tension, is given by (SI units) [22]

$$V \leq \frac{s}{\ell C}\sqrt{4\pi\epsilon_0 T}\ , \tag{12.10}$$

where s, ℓ, and C are the wire spacing, length, and capacitance per unit length. An approximation to C for chamber half-gap t and wire