Capacitance

- What is it? $C=Q/V$ $Q=CV$ $W=Q^2/2C$

measure of how much charge can be stored at fixed potential

or how much energy can be stored

frequently used - sampling, ADC,...

generalise (1st year electrostatics) - system of conductors

potentials U_j charges Q_j $Q_i = \sum_j c_{ij} U_j$ $W_i = (1/2) \sum_i \sum_j c_{ij} U_i U_j$

Capacitance in a multi-electrode system not defined by single number.

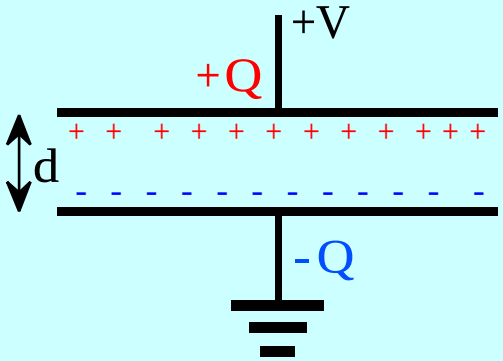
but we encounter many components which appear to conform

Consider most elementary example: parallel plate capacitor

$E = V/d = \sigma/\varepsilon = Q/\varepsilon A$

apply Gauss' law $C = Q/V = \varepsilon A/d$

put charge +Q on plate 1,
induce charge -Q on plate 2 with ground connection



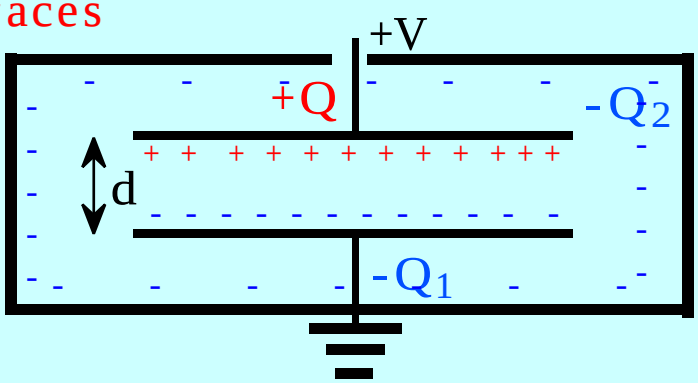
- Is life really so simple?

Capacitance (2)

•More realistic situation - capacitor near to other surfaces

eg in box, likely to be grounded for safety

some induced charge likely to end up on box



•Even more realistic case segmented detector

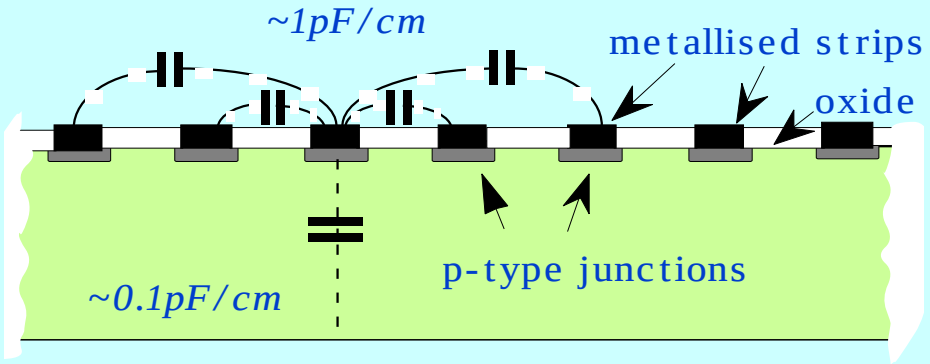
typical of many ionisation detectors (strips, pads, multiwire)

capacitance of strip made up of several contributions

C to near neighbours

C to next nearest...

C to opposite surface



In physical terms

put small charge on electrode - disturb system a small amount

all other charges in system rearrange themselves (according to EM laws)

coefficients of capacitance are measure of this

Capacitance (3)

•why is this important?

many situations - working with small signals

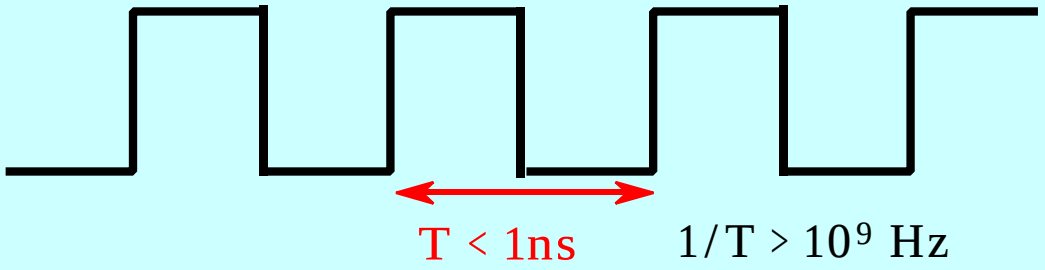
will need care to measure them

many modern situations - working with high speed signals (high *f*)

eg. modern optical communication links $\gg$ *Gb/s*

$Z_c = 1/\omega C = 1/2\pi fC$

$f \gg 10^9$ *Hz*



•"small signal" capacitance

in many circumstances, C = dQ/dV is a more appropriate definition

C can be a function of f - eg semiconductor devices

•what magnitudes of capacitance can we expect to encounter?