Types of X-ray Detectors

- Gas detectors
  - Ionization chamber
  - Proportional counter
  - Geiger-Muller tube

- Scintillation counters

- Solid state detectors
  - Intrinsic semiconductor
  - P-I-N junction
  - Silicon drift

- Charge coupled device detectors
  - Indirect
  - Direct coupled
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Scintillation counters
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Solid state detectors
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Charge coupled device detectors
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When x-ray interacts with gas atom, photoionized electrons swept rapidly to positive electrode and current (nano Amperes) is measured.

Count rates up to $10^{11}$ photons/s/cm$^3$

22-41 eV per electron-hole pair (depending on the gas) makes this useful for quantitative measurements.
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Useful for photon counting experiments

- NaI(Tl), Yttrium Aluminum Perovskite (YAP) or plastic which absorb x-rays and fluoresce in the visible spectrum.
- Light strikes a thin photocathode which emits electrons into the vacuum portion of a photomultiplier tube.
- Photoelectrons are accelerated in steps, striking dynodes and becoming amplified.
- Output voltage pulse is proportional to initial x-ray energy.
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When reverse biased, the depletion region grows
Open circuit p-n junction has a natural depletion region

When reverse biased, the depletion region grows creating a higher electric field near the junction
Ge Detector Operation

The diagram shows a Ge detector with a depletion region. A gamma (γ) ray enters the detector, creating a hole (h) and an electron (e) in the depletion region. These charge carriers are then collected by the electric field, with the hole moving towards the positive (+) end and the electron towards the negative (-) end.
Silicon Drift Detector

Same principle as intrinsic or p-i-n detector but much more compact and operates at higher temperatures

Relatively low stopping power is a drawback
Absorption of x-ray photon in Silicon produces multiple electron-hole pairs.
CCD Detectors - Indirect

X-Ray Photon → Phosphor

Visible photons emitted in all directions → CCD detects visible photons
Visible photons emitted by phosphor

X-Ray photon

Phosphor coating on fibre optic

Only a fraction of the photons emitted by the phosphor will propagate down the fibre optic and be detected by the CCD

Fibre Optic

CCD