

Detectors

Faraday-cup

- ▶ **Ions = charged particles → detection as current**

- ▶ Directly: Faraday cup

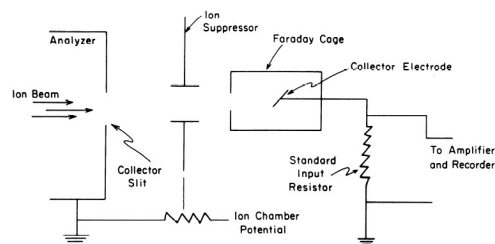


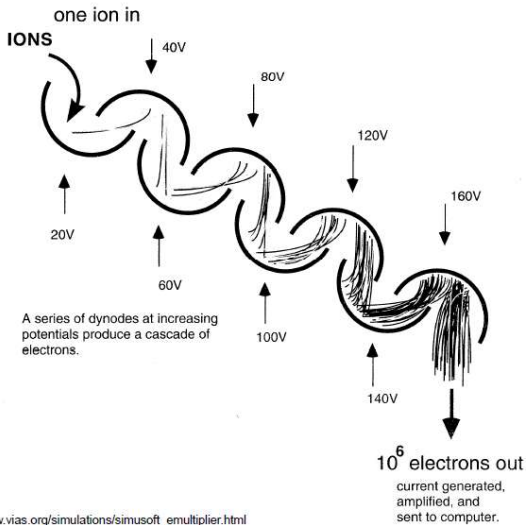
FIG. 13.1. Conceptual diagram of Faraday-cup detector. (From Watson JT. Mass spectrometry instrumentation. In: Waller GR, ed. *Biochemical Applications of Mass Spectrometry*. Wiley-Interscience, New York, 1972, with permission.)

- ▶ Works only for large ion currents
 - ▶ 1 ion: $1,6 \times 10^{-19}$ C
 - ▶ 1 ion/s: $1,6 \times 10^{-19}$ A = $1,6 \times 10^{-4}$ fA
 - ▶ The most sensitive measurement of the current:
 - ▶ Noise level ~ 0.4 fA \rightarrow i.e., ~ 2500 ions/s
 - ▶ Detection limit: $S/N \sim 3 \rightarrow 7500$ ions/s

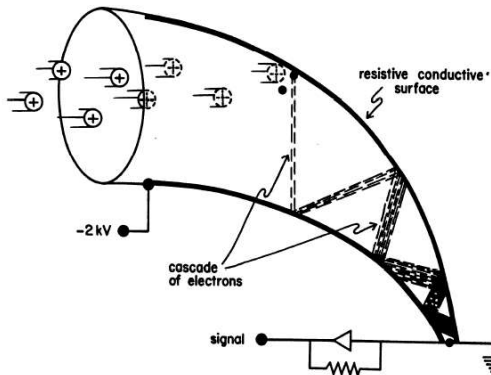
Electron multiplier

- ▶ Ion collides with the first dynode → emission of electrons
- ▶ Electrons are attracted by the second dynode → each electron knocks out further electrons
- ▶ And so on

- ▶ Multiplication by $\sim 10^6$
- ▶ High sensitivity
- ▶ Low noise level
- ▶ Life-span 1-2 years



Continuous electron multiplier



From Watson **FIG. 13.3.** Conceptual diagram of a nonmagnetic electron multiplier; the field gradient along the resistive conductive internal surface of the cornucopia attracts the cascading electrons toward the preamplifier.

Conversion dynode

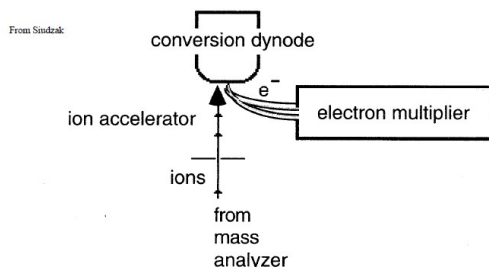


Figure 2.21 High-energy dynode detector.

- ▶ Ions are first converted to electrons and only the electrons enter the electron multiplier
- ▶ Suitable for larger masses, because with higher m/z decreases the response of the classical detectors



Daly detector

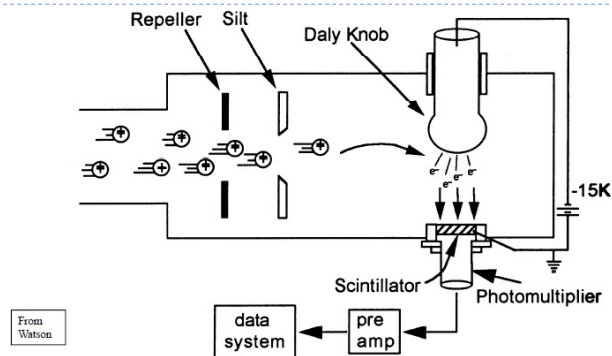


FIG. 13.4. The Daly detector is a manifestation of a postacceleration detector that provides the advantage of external access to all components of the detector except the Daly knob. The secondary electrons from the Daly knob impact a phosphor, which emits photons that enter a photomultiplier.

Photomultiplier

- ▶ Usual signal multiplication on the order of $10^4 - 10^5$
- ▶ Longer life span



Summary

- ▶ Ions are detected as a current → **Faraday cup**

 - ▶ Usually, the number of ions is insufficient for direct detection → multipliers
 - ▶ **Electron multiplier** – discrete dynodes
 - ▶ Continuous dynode

 - ▶ **Conversion dynode** – ions are converted to electrons before entering a multiplier

 - ▶ **Daly detector** – ions are converted to electrons, electrons are converted to photons, photons are detected in a **photomultiplier**
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