

Photomultiplier Tube



Memoona Rafique

What is it?

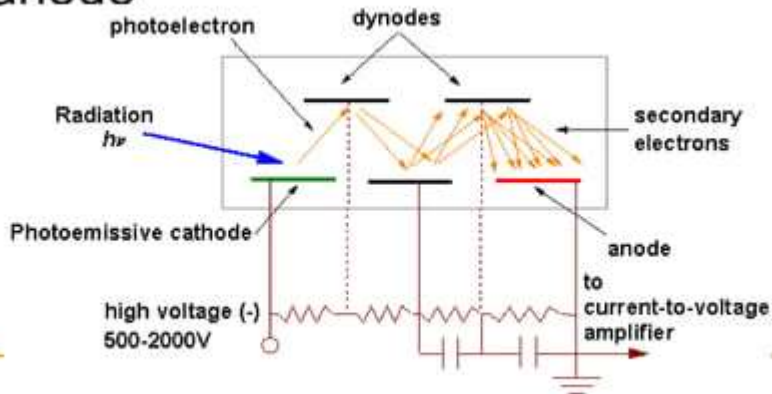
- Extremely sensitive detector of light in the ultraviolet, visible and near infrared
- Multiplies the signal produced by incident light by as much as 10^8
 - single photons can be resolved
- High gain, low noise, high frequency response, and large area of collection
- A tiny and normally undetectable current becomes a much larger and easily measurable current

Vs. Phototube

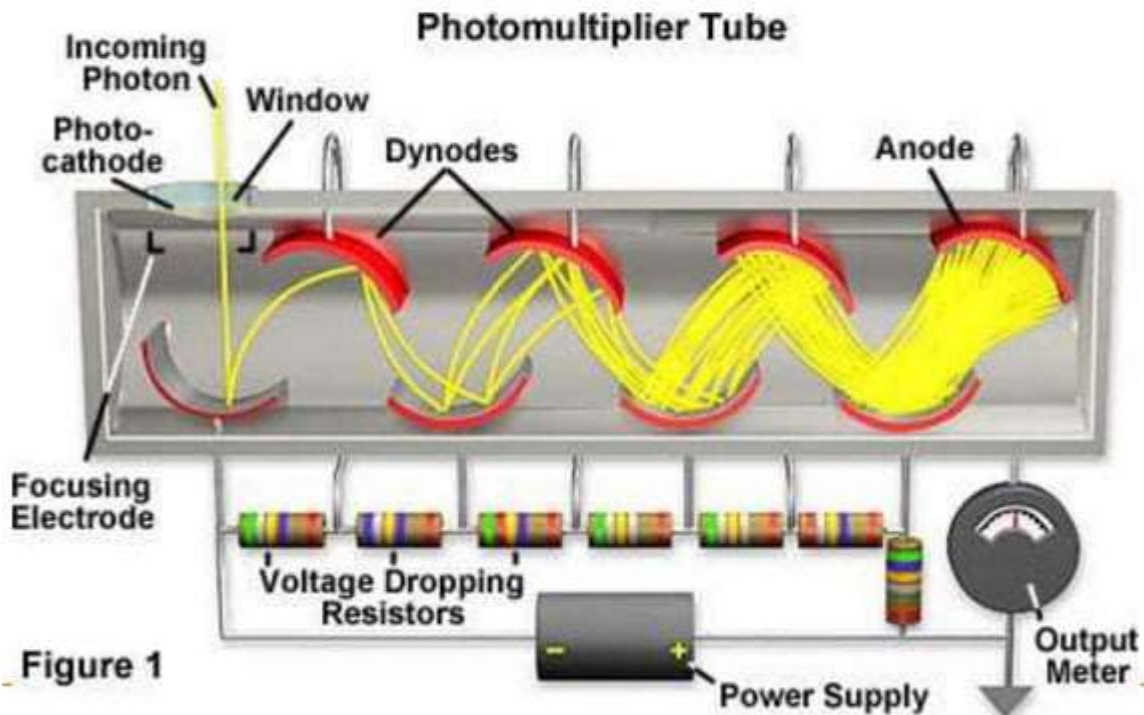
- In both, the photon strikes the photocathode and emits electrons (photoelectric effect)
 - In a phototube only these few electrons are collected
 - It can only be used for very low signals
 - In a photomultiplier tube these electrons are multiplied
 - This process is called secondary emission
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Components

- Made of a glass vacuum tube
- Photocathode
- Several dynodes
- One anode



How it works



OPERATING PRINCIPLES

- A photomultiplier converts light into an electrical signal then amplifies that signal to a useful level by emission of secondary electrons.
 - The **operating principle** is that – caused by the photoelectric effect – photons striking a photocathode at the entrance window of a **PMT** produce electrons, which are then accelerated by a high-voltage field and multiplied in number within a chain of dynodes by the process of secondary emission.
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Elements

- – a *photocathode which converts light flux into electron flux;*
- – an *electron-optical input system which focuses and accelerates the electron flux;*
- – an *electron multiplier consisting of a series of secondary-emission electrodes*
- *(dynodes); and, finally*
- – an *anode which collects the electron flux from the multiplier and supplies the output signals*

How it works

- Electron is released by the photocathode
 - Electron is then multiplied by the electrodes
 - Metal channel dynodes
 - At the end of the chain is the collection electrode
 - Anode
 - The current flowing from the anode to ground is directly proportional to the photoelectron flux generated by the photocathode
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The Variables

- Photocathode thickness
 - Too thick and more photons will be absorbed, less electrons will be emitted
 - Too thin and too many photons will pass through without being absorbed
- Semitransparent Photocathode
 - Multiplies the electrons to up to 100 million

Usage

- Require 1000 to 2000 volts
 - Negative voltage is connected to cathode and the positive to the anode
 - Distributed to the dynodes by a resistive voltage divider (series of resistors)
- Must be shielded from ambient light
 - To prevent destruction through over excitation
- If used in an area of high magnetic fields it must be shielded by a layer of mu-metal
 - Mu-metal is a nickel-iron alloy with a very high magnetic permeability

Cost

- The price ranges from \$175-300
 - Depends on size
 - Type of photocathode
 - Voltage
 - Number of dynodes
 - Cathode sensitivity
 - Anode sensitivity
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Sources - Websites

- <http://elchem.kaist.ac.kr/vt/chem-ed/optics/detector/pmt.htm>
 - <http://micro.magnet.fsu.edu/primer/digitalimaging/concepts/photomultipliers.html>
 - <http://en.wikipedia.org/wiki/Photomultiplier>
 - <http://www.aditpmt.com/products/b29b02h.htm>
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