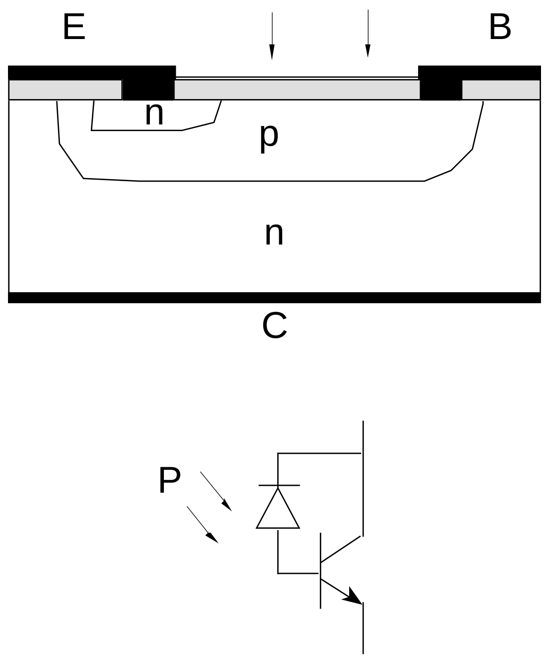
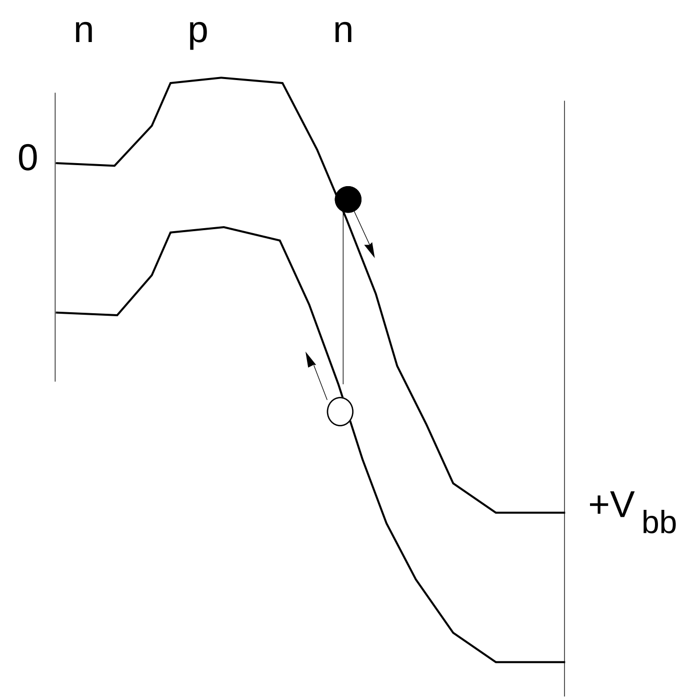
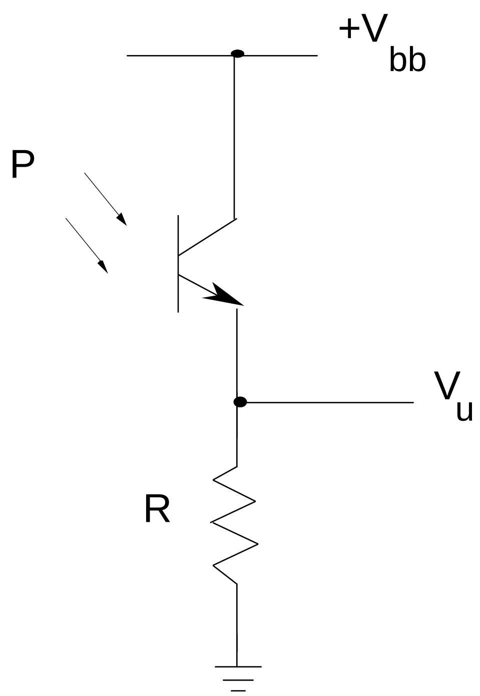
Bipolar Phototransistor





Bipolar transistor has a wide C-B junction adequate for photon dissipation, and an internal current amplification mechanism

Basic Scheme



$$I_C = (h_{fe}+1)I_{ph} + I_{CE0} + h_{fe}I_B$$

$$V_u = R\,[(h_{fe}+1)\,\sigma P + I_{CE0}]$$

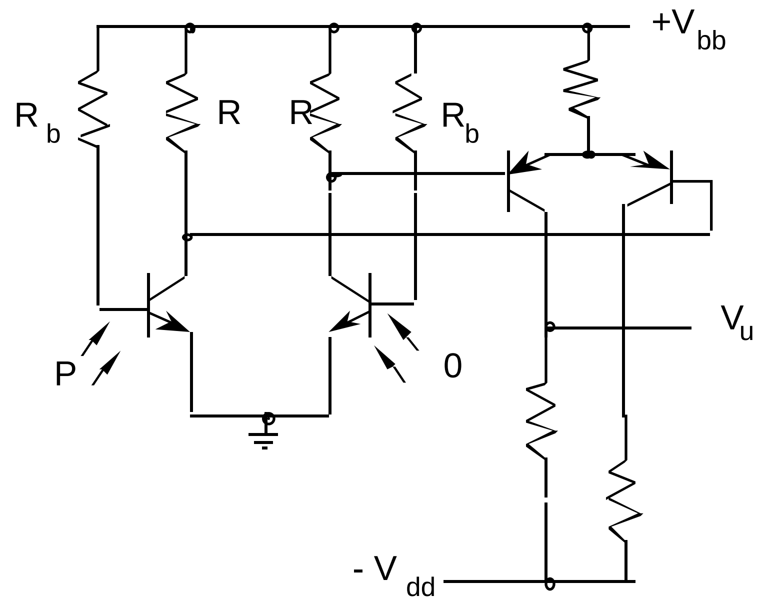
$$f_{hfe} = f_T / h_{fe}$$

$$v_u^2 = 2eB(h_{fe}+1)^2(\sigma P + I_{CB0})R^2 + 4kTBR$$

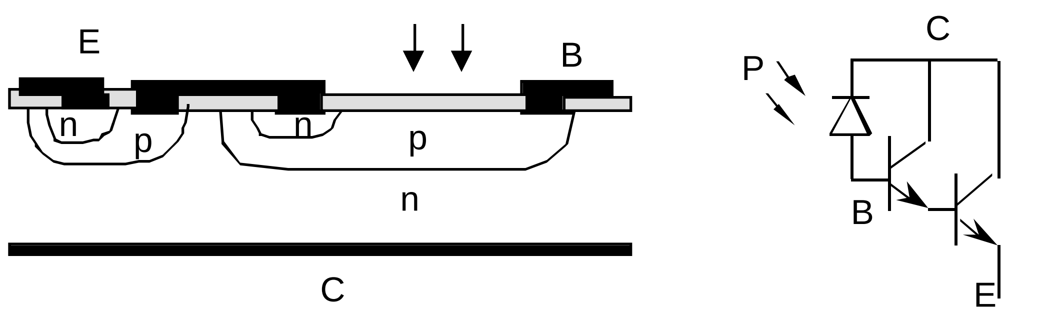
from:"Photodetectors", by S.Donati, Prentice Hall 2000

Differential scheme and photo-Darlington

Differential cheme
for base current
cancellation



Darlington
phototransistor



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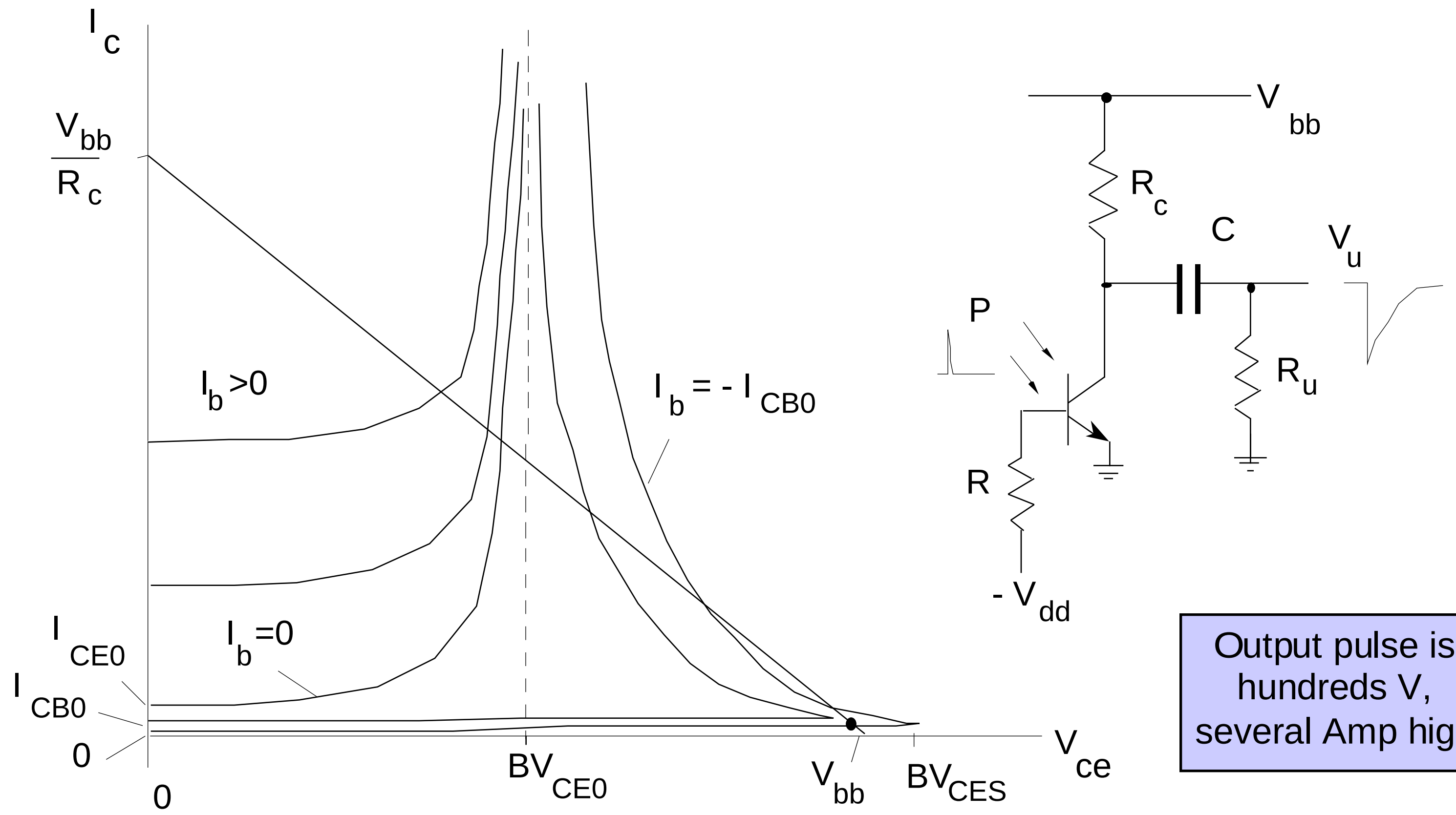
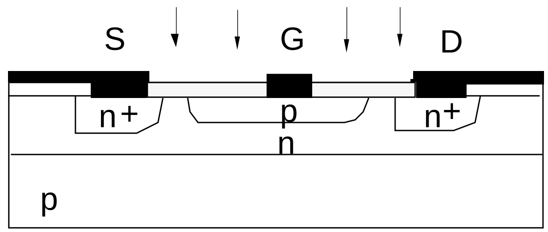
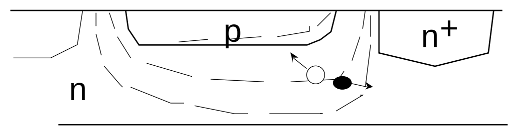
Avalanche Phototransistor

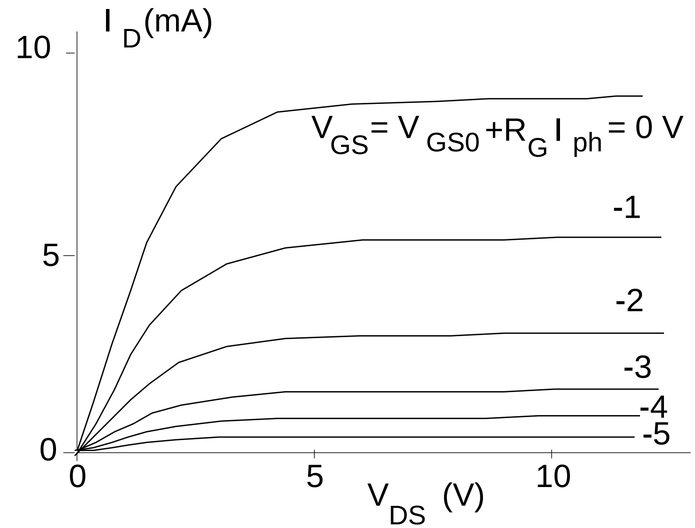


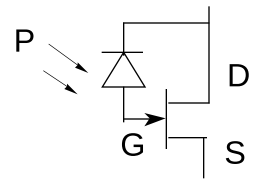
Output pulse is hundreds V, several Amp high

Photo J-FET



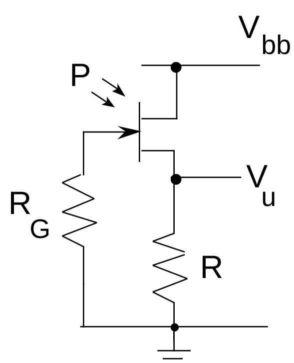






$$A_I = G_m R_G$$

$$f_2 = 1/2\pi R_G C_p$$



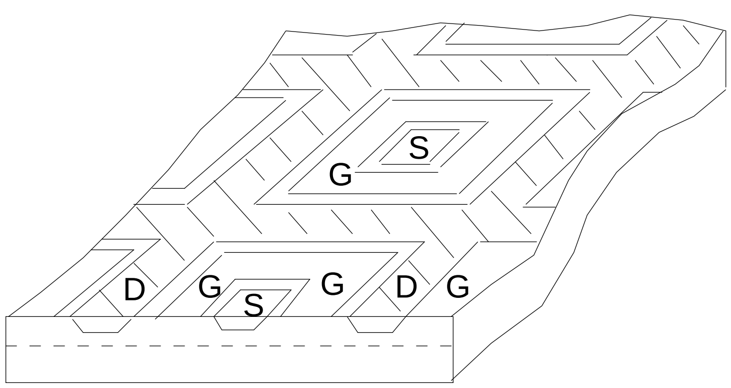
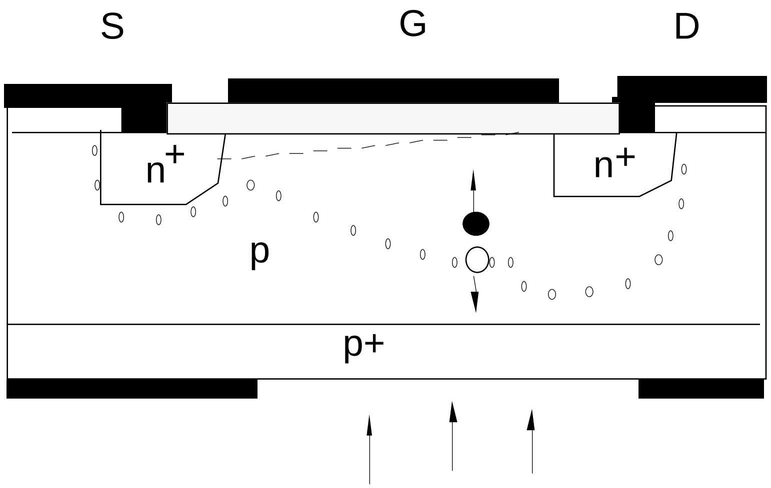


Photo-MOS



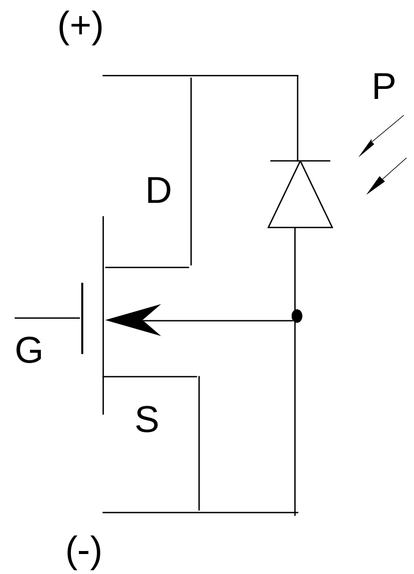


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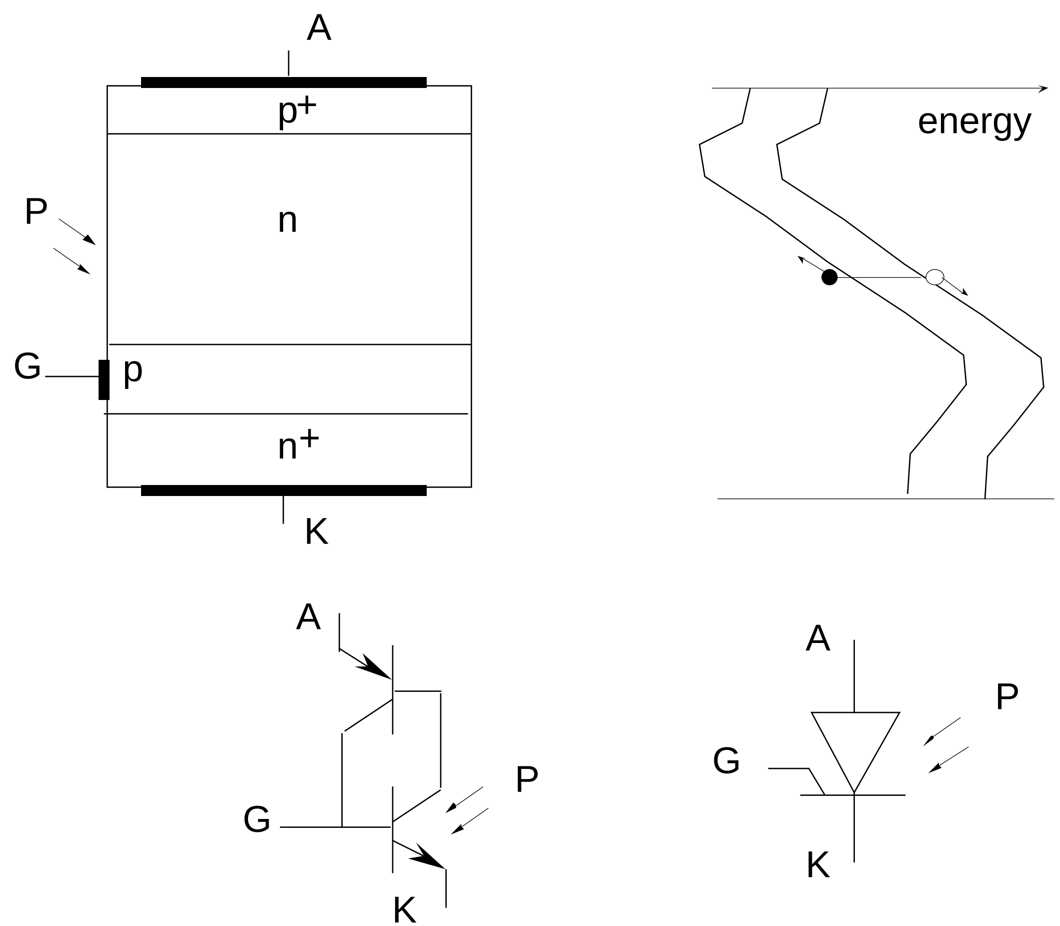
Photo -LASCR



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General

- photoconductivity was the first photoelectric effect being observed (in selenium, by W. Smith, **1873**)
- only requires a polycrystalline or amorphous semicon-ductor, deposited by evaporation or sputtering
- has **low cost** and on very **large areas**
- response covers **UV through FIR** spectral ranges
- has **internal gain**, though at expense of **bandwidth**
- leads **development** of other photodetectors in new materials/ spectral ranges

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Fields of application

- single-element detectors for **industrial controls** (item counters, presence/proximity sensors, flame detectors, etc.);
- photometric devices for **exposure meters** and **luxmeters**;
- **thermal IR detectors** for detection, sensing, and non-contact thermometry;
- photosensitive layers (or **targets**) of vidicons and other image-pickup tubes;
- **photosensitive elements** of reprographic apparatus (photo-copiers, laser printers) for transfer of toner to the paper copy

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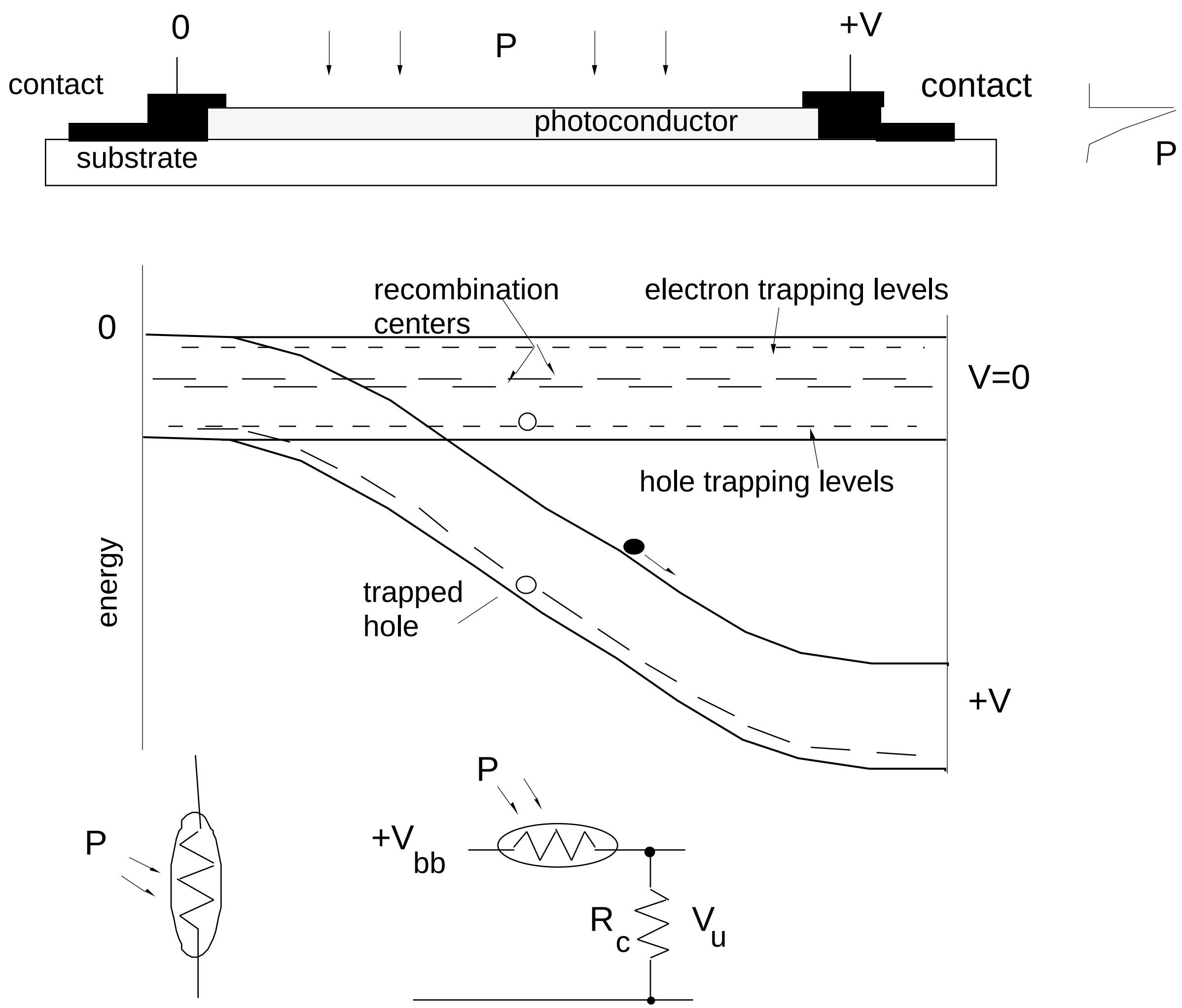
Principles



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Gain and frequency response

gain: $M = 1+\tau_{n,p}/T$

drift time: $T = L/v_{n,p} = L/\mu_{n,p}E = L^2/\mu_{n,p}V$

$$M = 1+\tau_{n,p}\,\mu_{n,p}\,V/L^2$$

$f_2 = 1/2\pi\,\tau_{n,p}$ so that $f_2 M \approx 1/2\pi\,T \approx \text{const}$

conductance:

$$G = (I_b+M I_{ph})/V = G_b+M\sigma P/V = G_b+(1+\tau_{n,p}\,\mu_{n,p}V/L^2)\sigma P/V$$

or $G \approx G_b+(\sigma\tau_{n,p}\mu_{n,p}/L^2)P = G_b+\kappa P$

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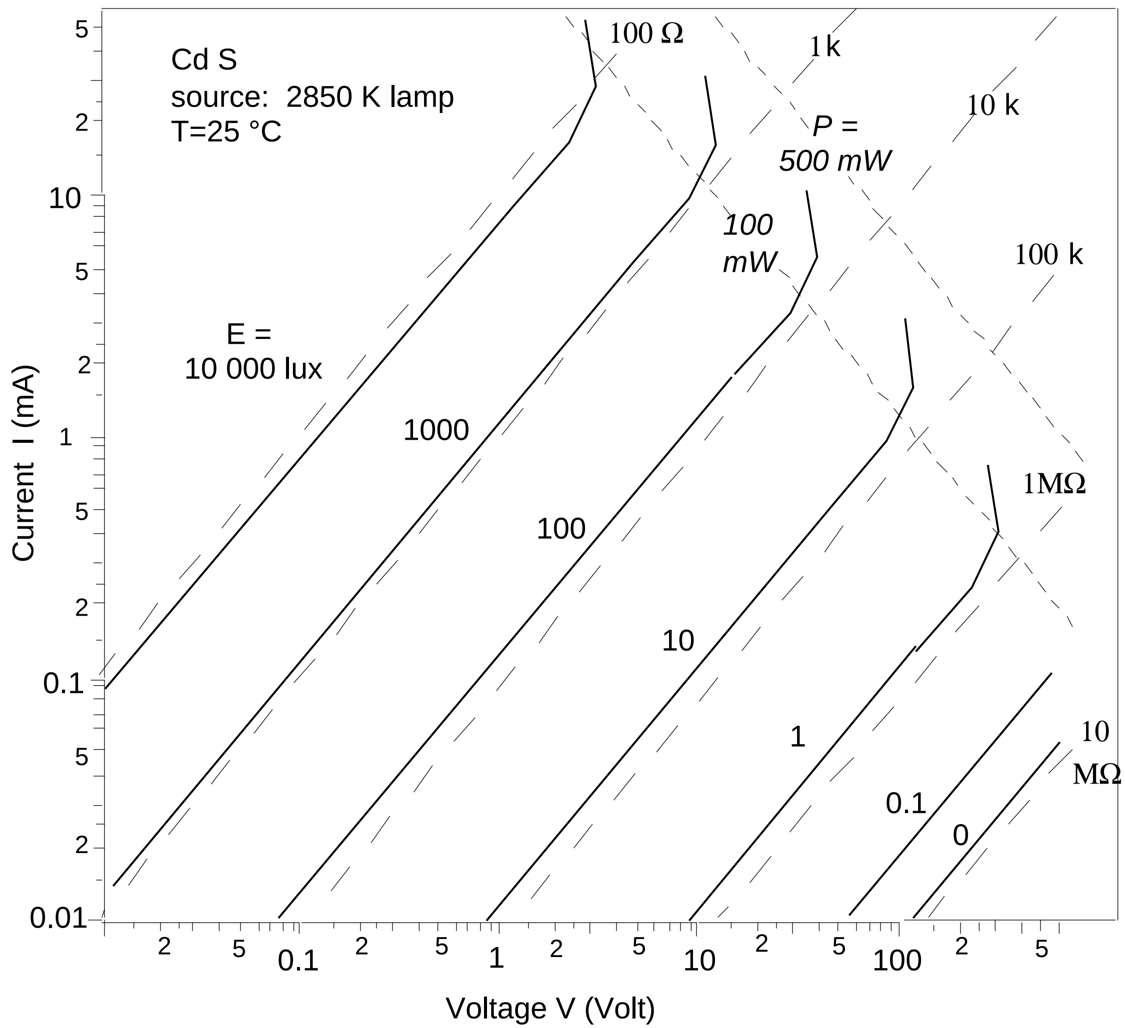
Photoconductance characteristics



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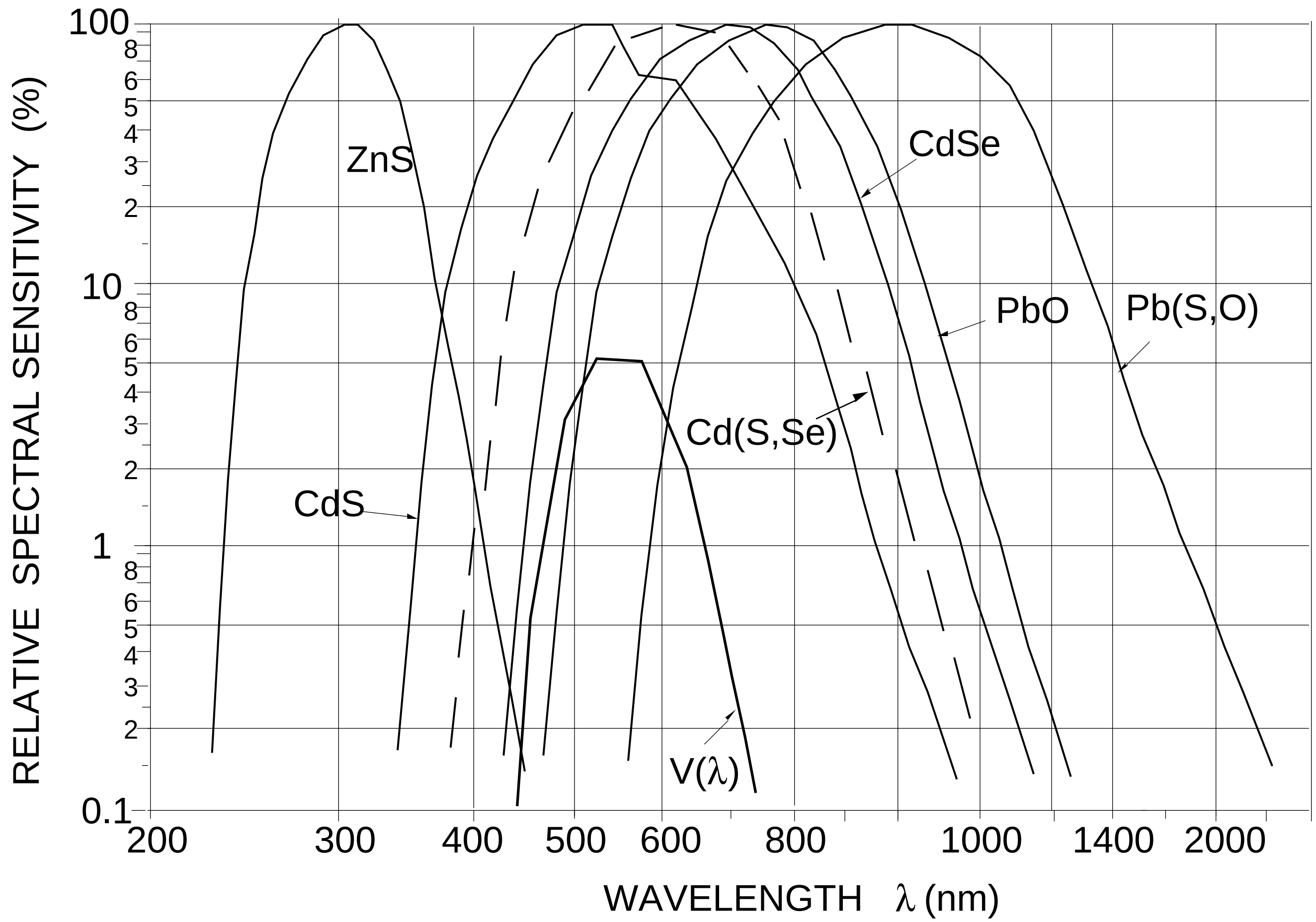
Spestral responses



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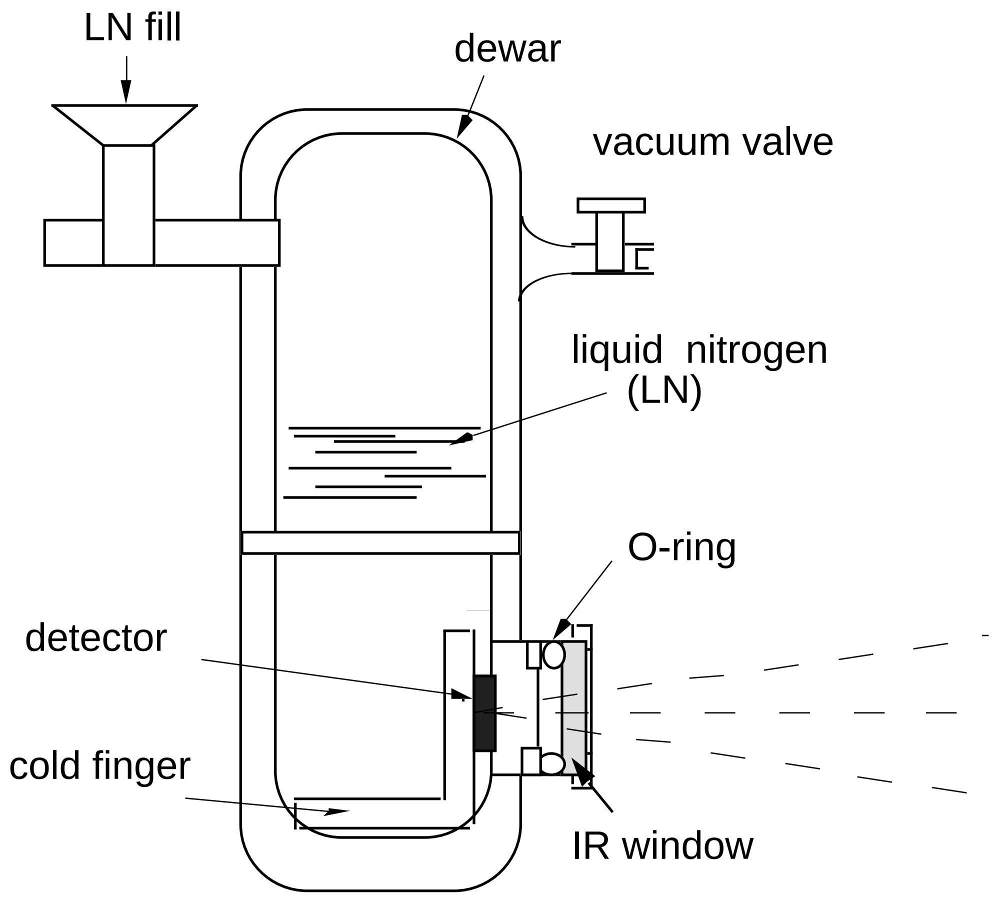
Cryostat for IR detectors



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