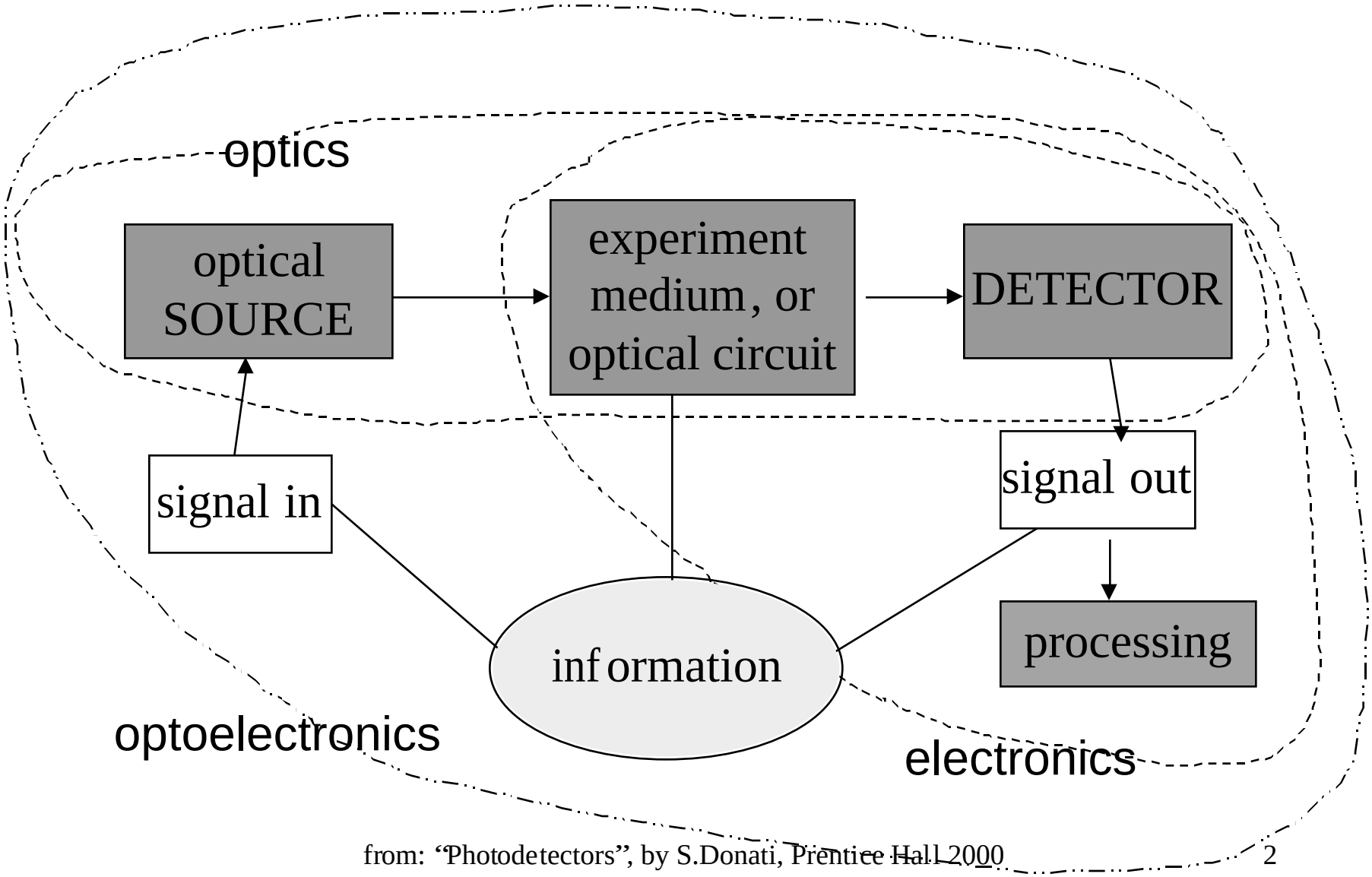
Photodetectors

by S. Donati
University of Pavia, Italy

The Paradigm of Optoelectronics



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

a good photodetector is like a good source

$$S/N = (\text{atten}) \cdot P_{source} / P_{noise}$$

$P_{received}$

system quality factor

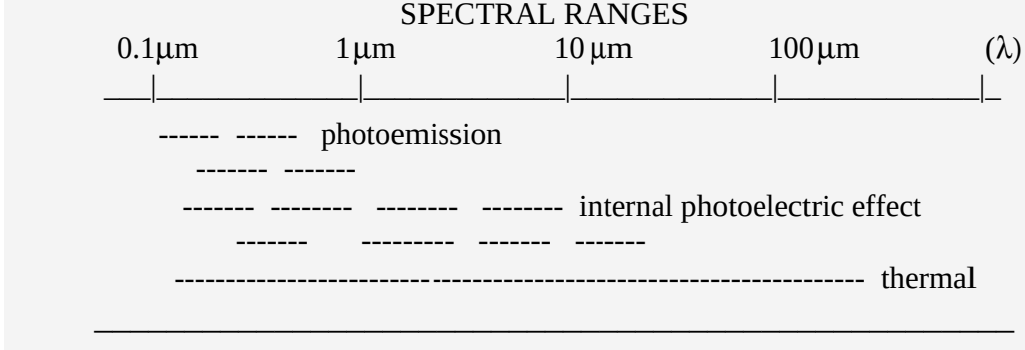
decreasing detector noise by K is the same as increasing source power by K .!.!

Milestones in Photodetection

1829-33: Nobili(I) and Macedonio Melloni (I) invent the thermopile
1873: W. Smith (UK) discovers photoconductivity in Selenium
1905: A.Einstein explains photoemission by the quanta hypotesis
1910s: first S-1 photocathodes and vacuum-photodiodes
1919: J. Slepian (USA) invents the photomultiplier
1930: V. Zworikyn and G. Morton (USA) demonstrate television
1930: Image converter tubes and streak-camera tubes developed
1940s: The 'Sniperscope' image converter tubes used as night-vision aid
1950s: Solid-state theory developed, first Ge-photodiodes
1965: Planar Si-photodiodes, EBS camera tubes, InSb IR-detectors
1967: Apollo 11 send images of the moon taken with EBS
1967: Avalanche photodiodes invented
1970: first CCD image-pickup devices
1970: The Apollo 15 Lunar Ranging Experiment
1975: Compound semiconductor photodiodes cover all the IR bands
1980: Camcorders with CCDs are mass produced
1995: room-temperature Thermovisions
199 6:Hubble Space Telescope is equipped with a CCD camera

Photodetectors and their spectral ranges

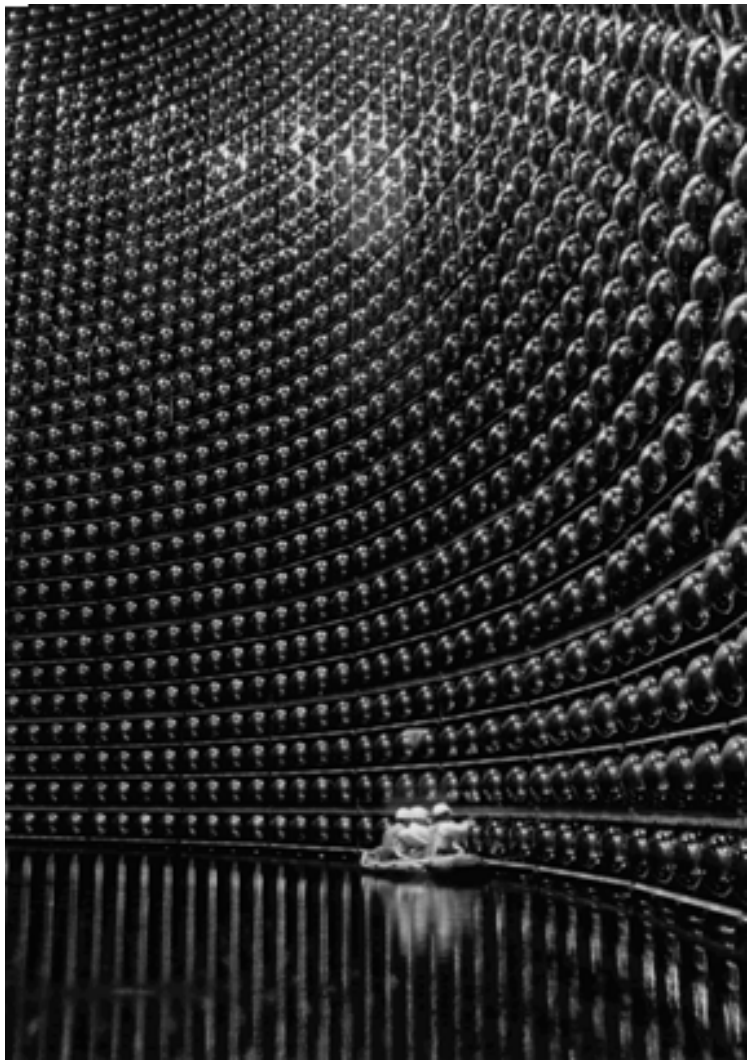
	SINGLE ELEMENT	IMAGE
- *PHOTOEMISSION devices (or external photoelectric devices)*	vacuum photodiode gas photodiode photomultiplier	pickup tubes image intensifiers and converters
- *internal PHOTOELECTRIC DEVICES*	semiconductor photodiode avalanche photodiode phototransistor (BJT, FET) photoresistance photoSCR	CCD's vidicon
- *THERMAL DETECTORS*	thermocouple (or photopile) thermistor (or bolometer) pyroelectric	 IR vidicon
- *WEAK INTERACTION DEVICES*	photon drag Golay cell photoelectromagnetic point contact diode	
- *PHOTOCHEMICAL EFFECTS*	*photographic film* *retina*	



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

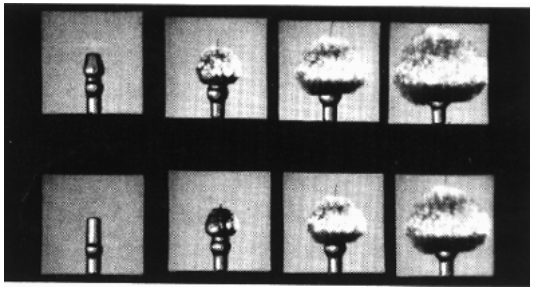
Aboard the 3-m diameter Hubble Sky Telescope, a 5000x5000 pixel CCD has provided this 10-days integration image of deep sky (HDS IS - Hubble Deep Field Survey). Faintest spots are 30th magnitude galaxies estimated 8 billion light-years away or, 1/3 the age of the universe

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

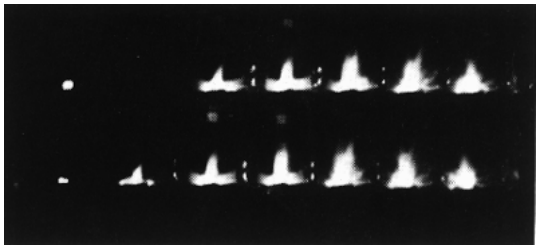


The SuperKamiokande facility employs 11200 giant PMTs valued about 80 million US$, paving the walls of a 40-m diameter tank of water to probe the most elusive nuclear particles - neutrinos

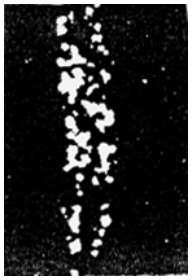
from: "Photodetectors", by S.Donati, Prentice Hall 2000

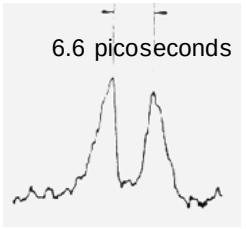


10^6 frame/second



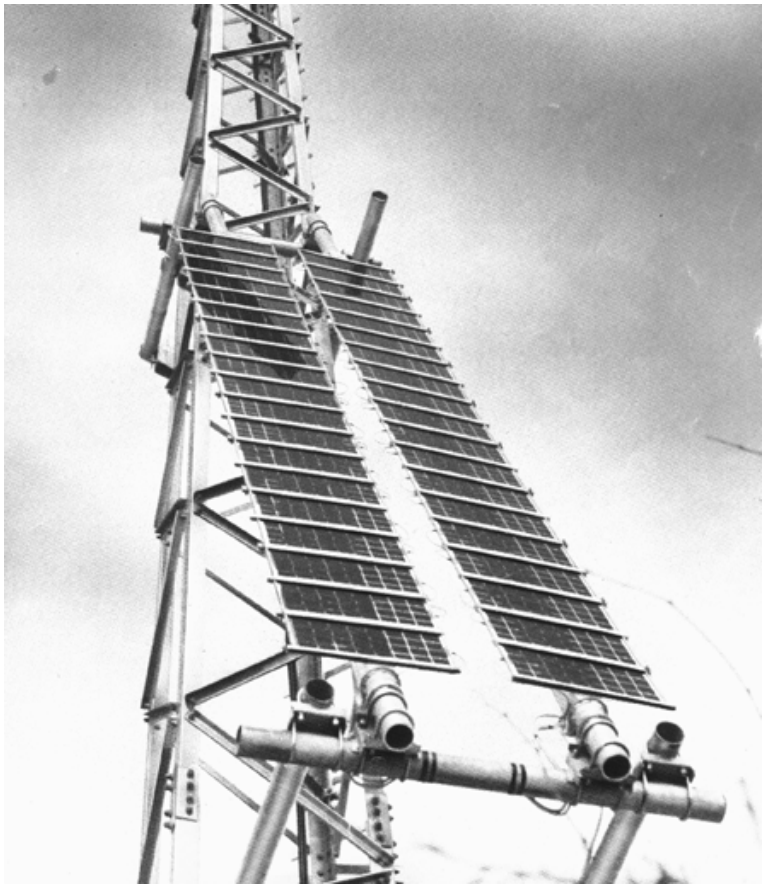
10^7 frame/second





Streak cameras collect frames at million per second rate, or, can resolve optical pulses spaced in time by a few picosecond

AEG-Telefunken
10×10 cm^2 poly-Si
solar cells (top)
are ued in a
module totalling a
surface 5.6 m^2 (bottom)
that supplies
$\approx$ 600 W (peak)



Solar cells are used in terrestrial generating plants and are unique in providing a reliable, long lif etime source of energy in space applications as well as remote areas power plants

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