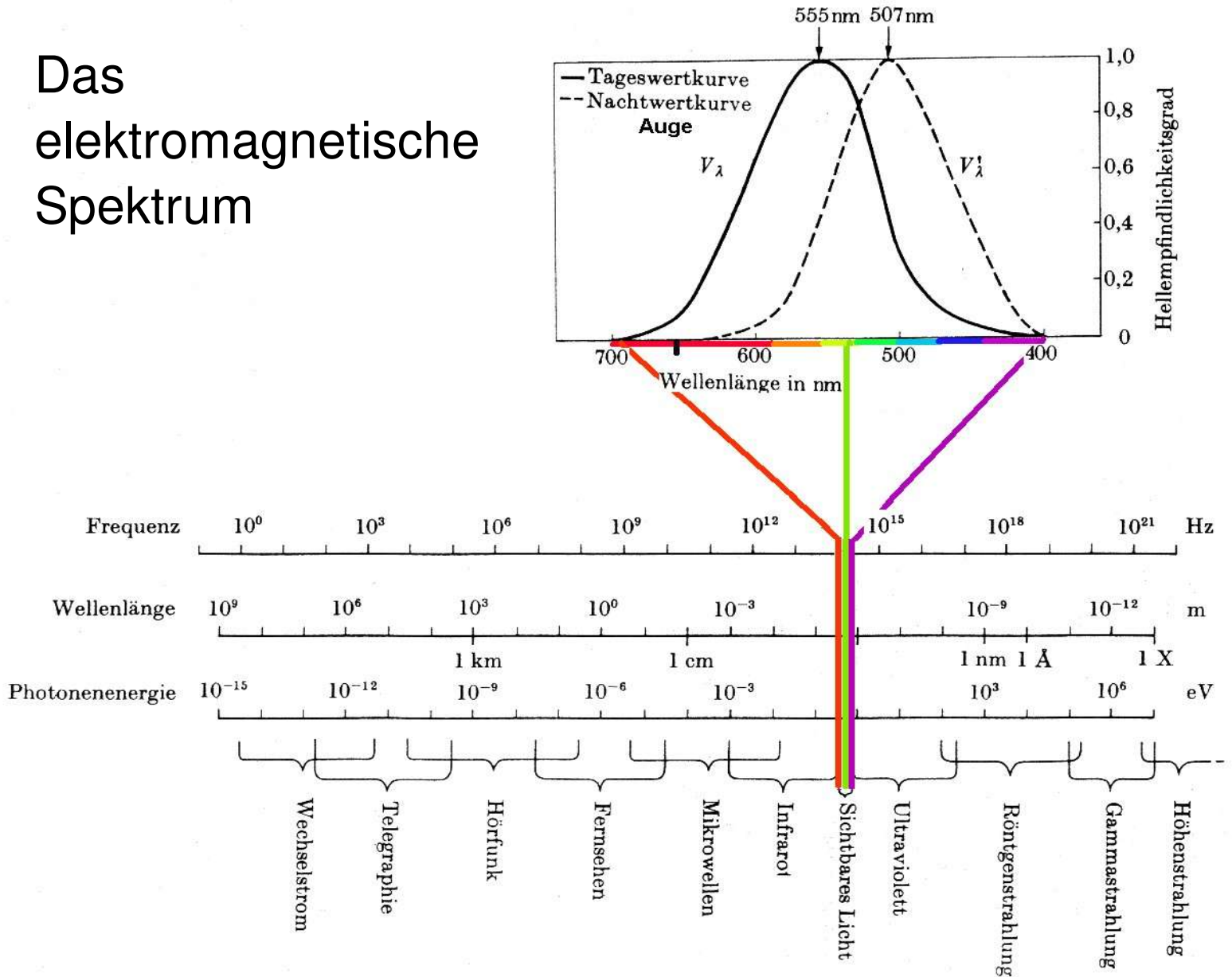
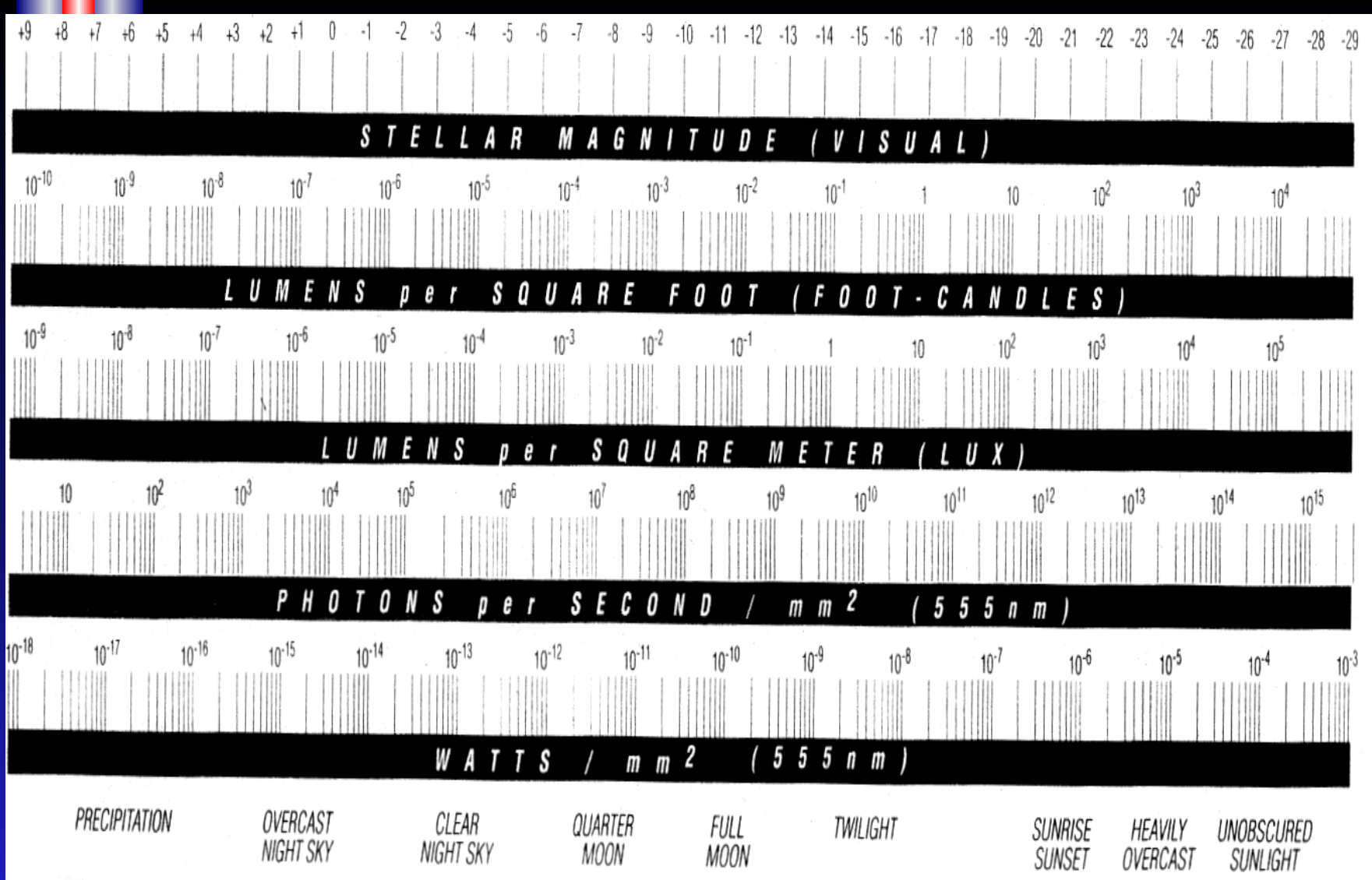




Teil 2: CCD-Technik in der Astronomie

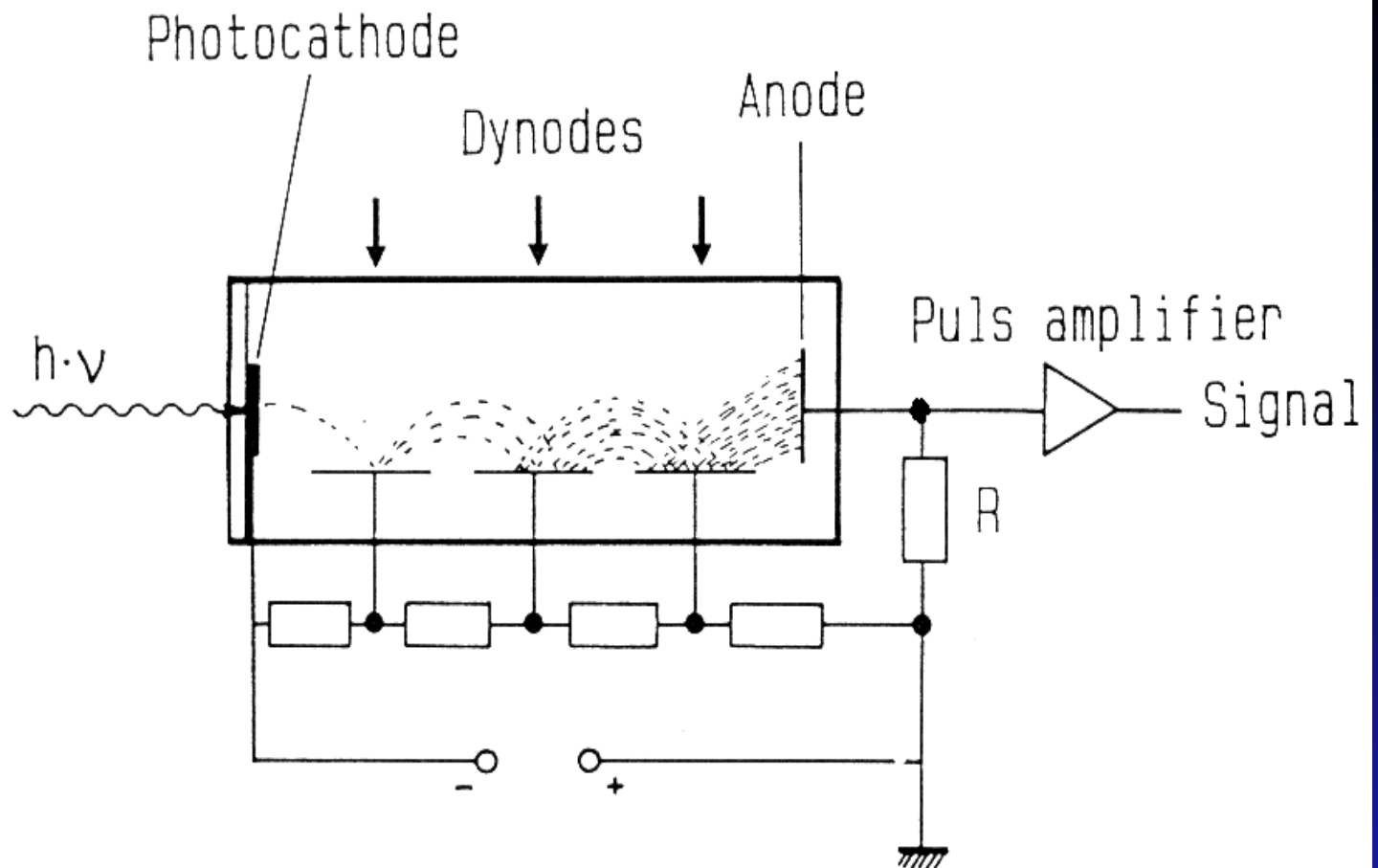
Das elektromagnetische Spektrum



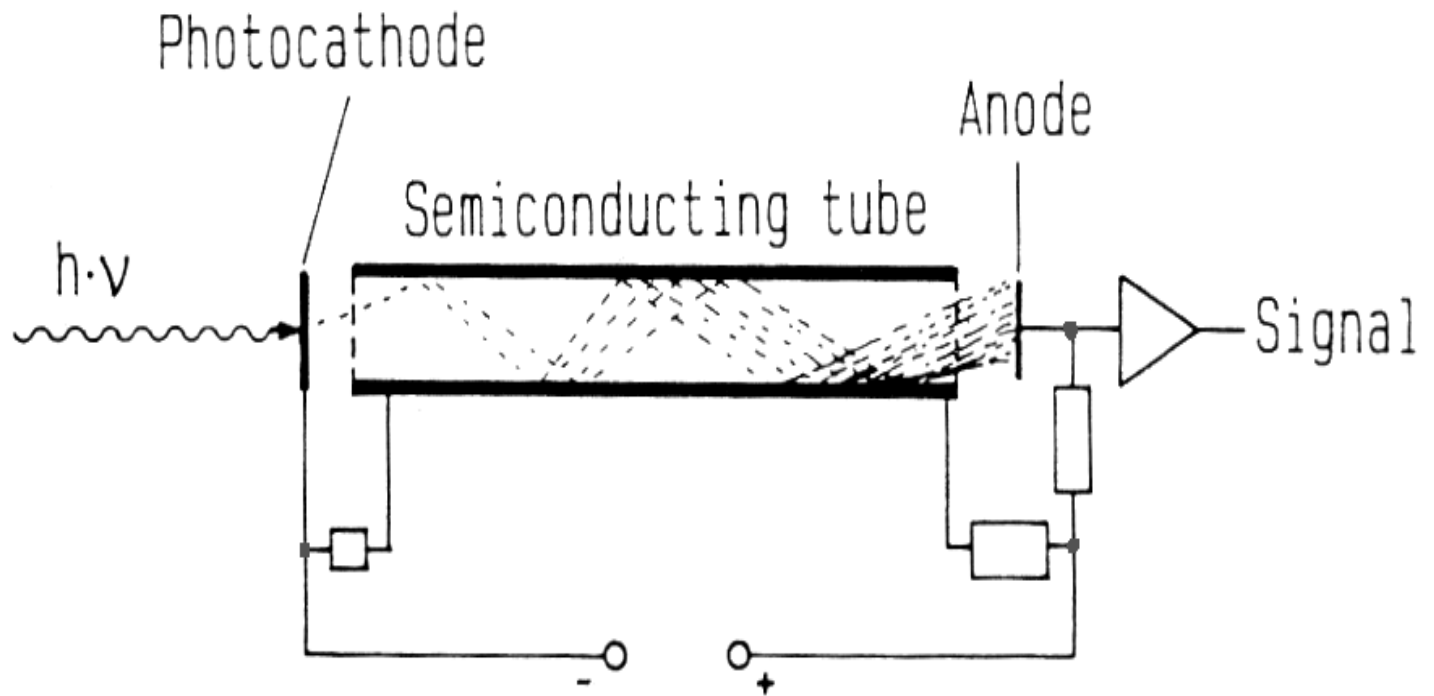


* Photopic to radiometric conversion based on 683 Lumens/Watt at 555 nm

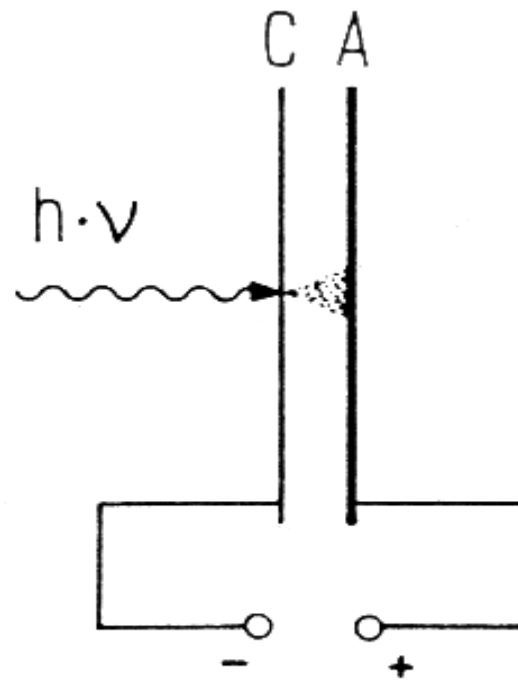
Energiebereich / Helligkeitsumfang



Photomultierröhre

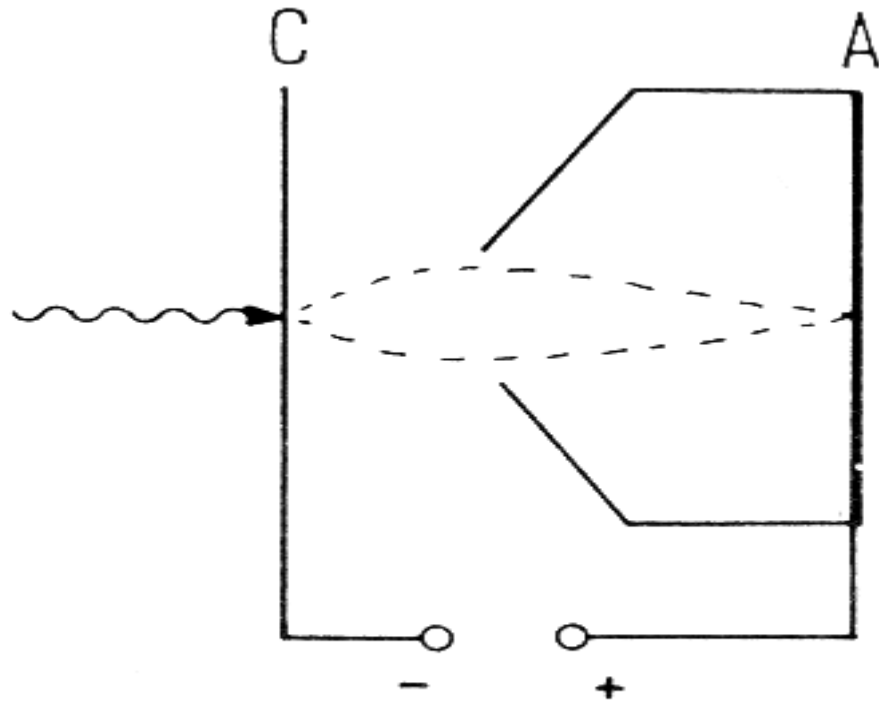


Kapillar-Verstärkerröhre



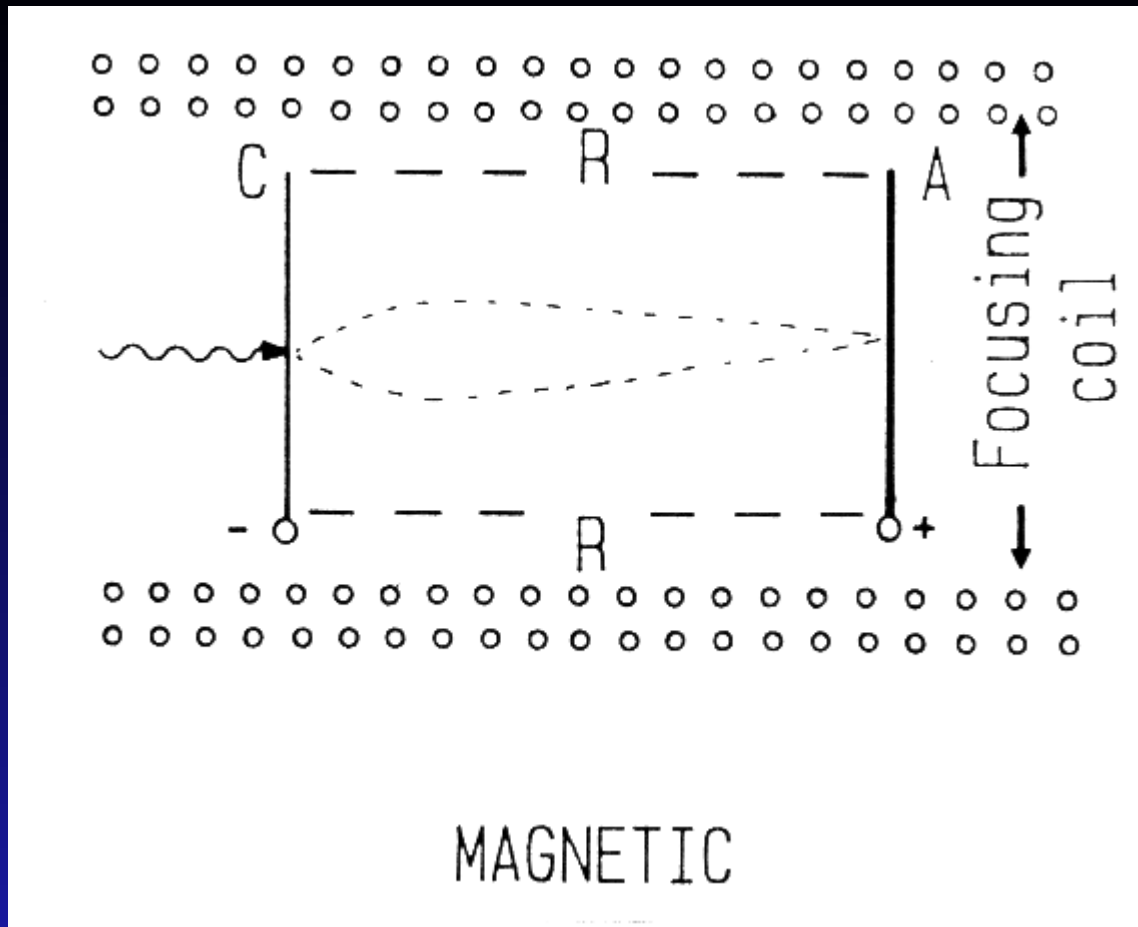
"PROXIMITY FOCUS"

Nahfocus-Bildverstärker

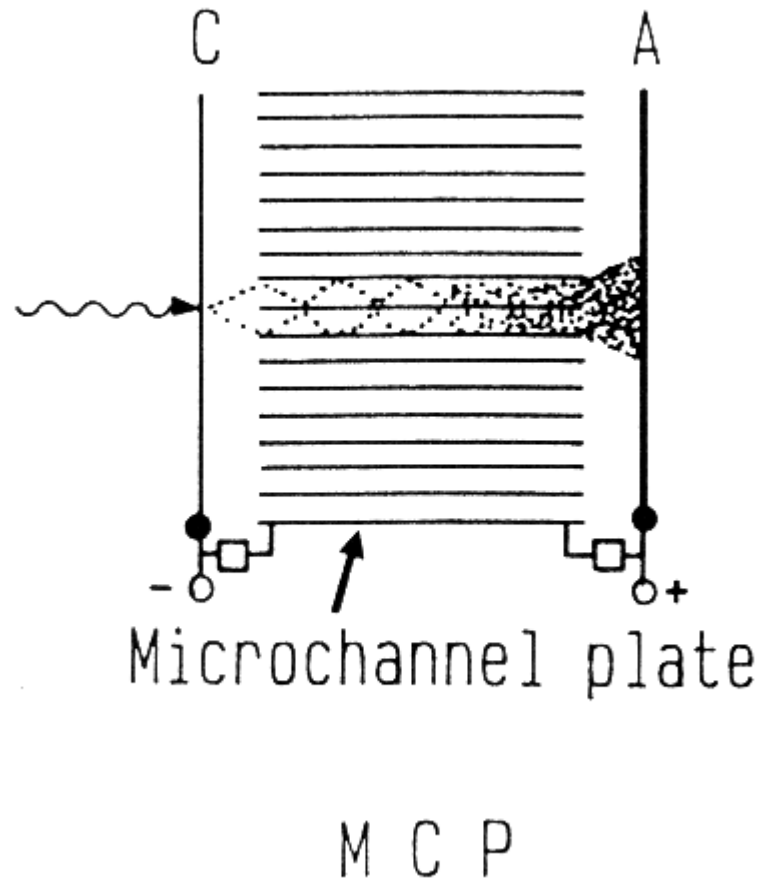


ELECTROSTATIC

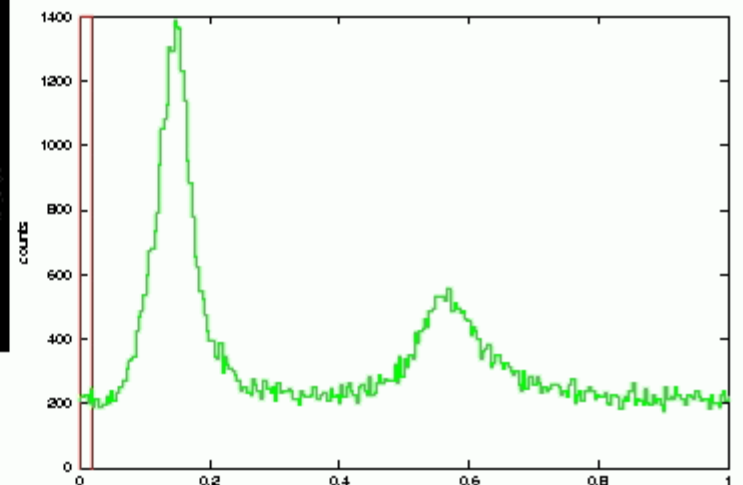
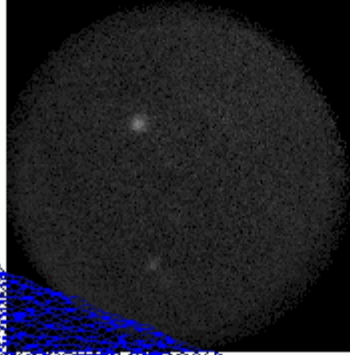
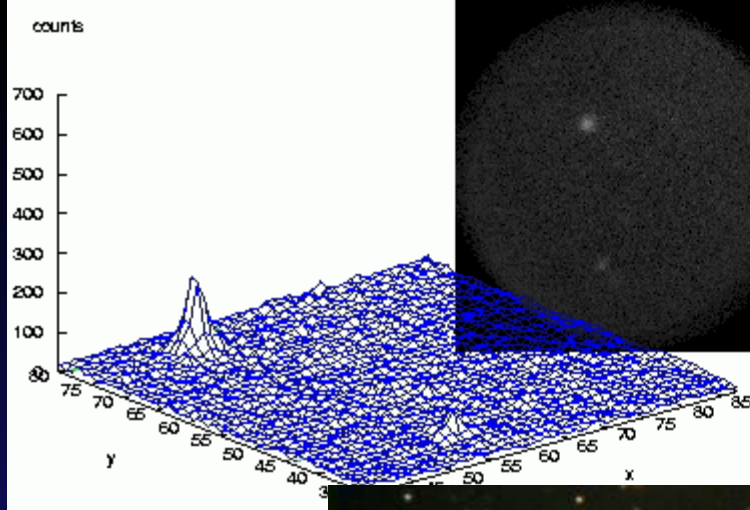
Elektrostatischer Bildverstärker



Magnetfocussierter Bildverstärker

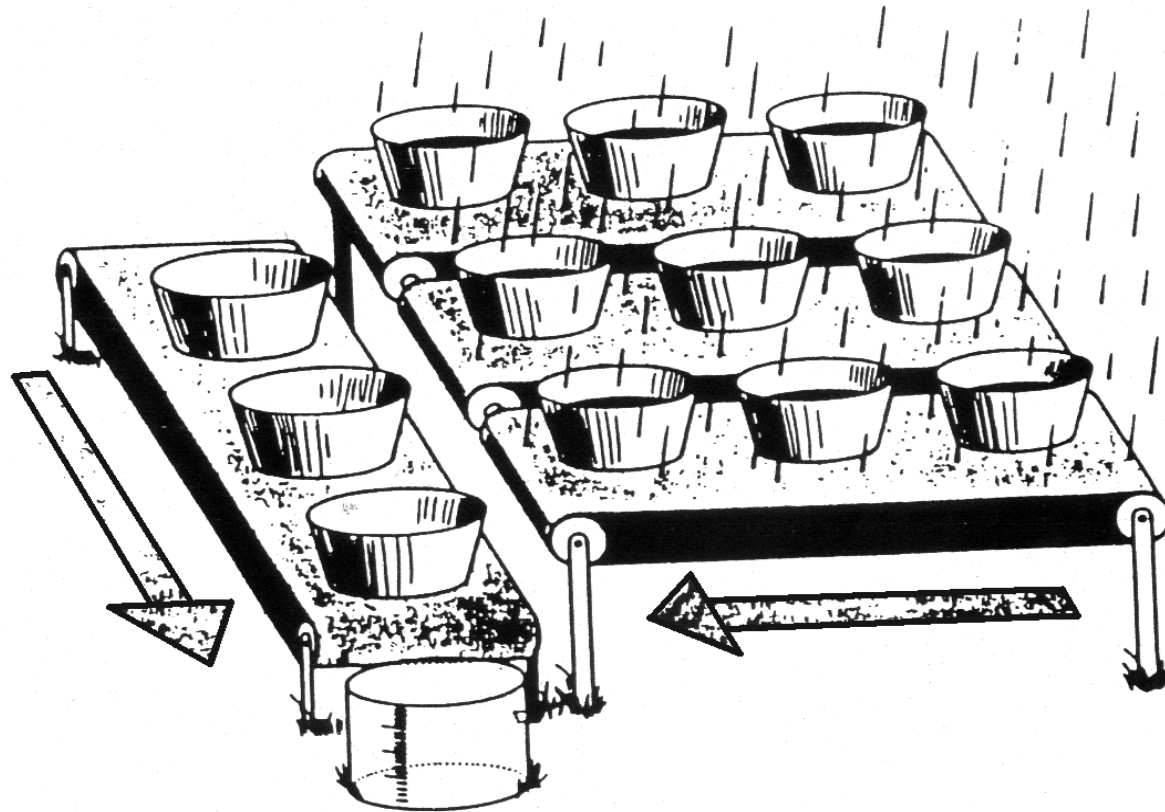


Mikrokanalplatten-Bildverstärker



M1
Crab-
Pulsar



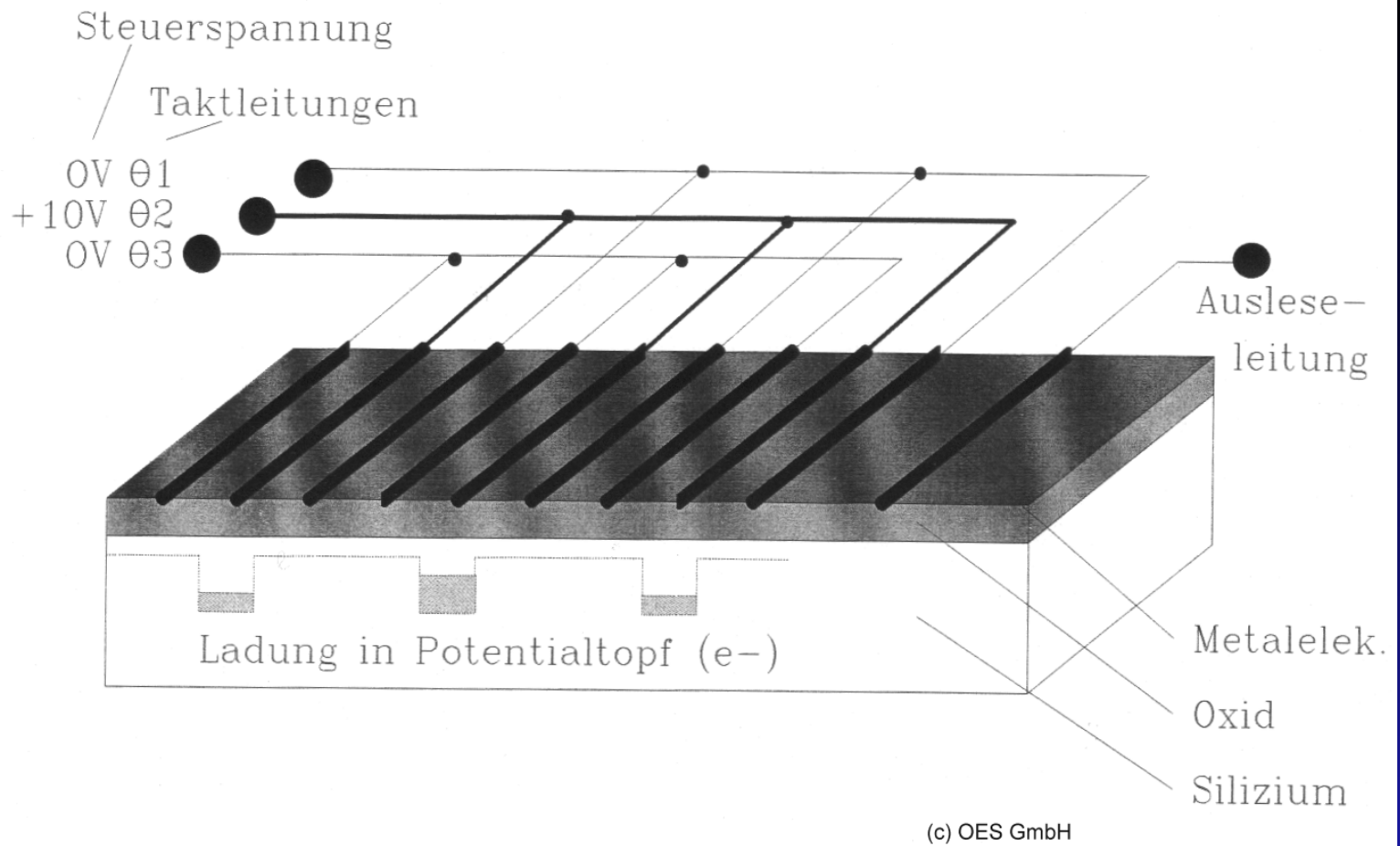


CCD - Theory

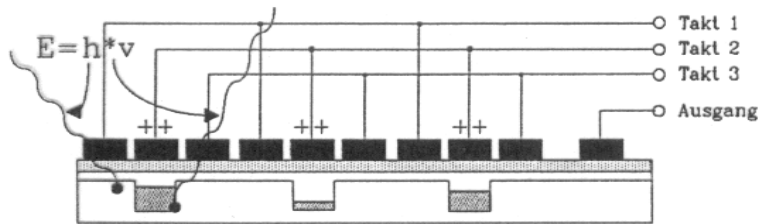
(c) unbekannt

CCD-Theorie

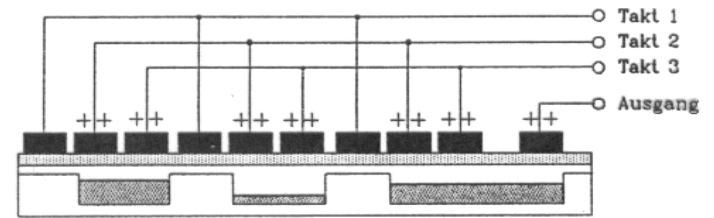
ChargeCoupledDevice / Eimerkettenschaltung



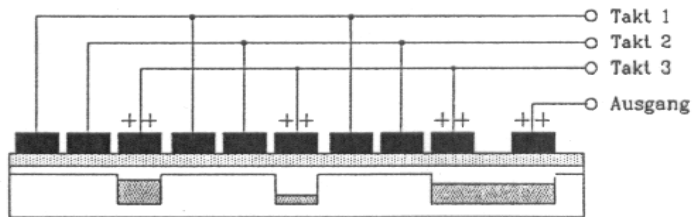
Prinzip der **Ladungstöpfe**



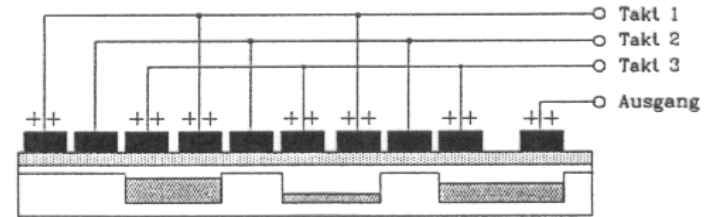
Schiebezyklus 1
(Integration von Ladungsträgern)



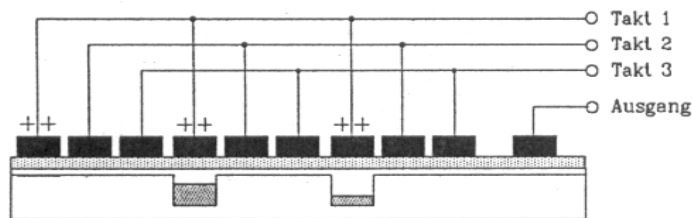
Schiebezyklus 2



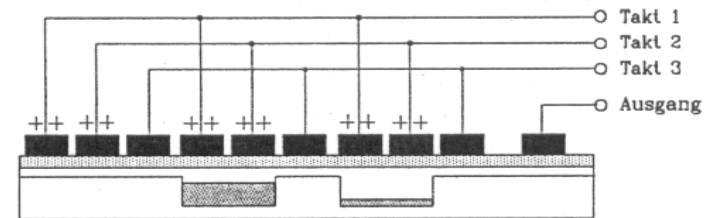
Schiebezyklus 3



Schiebezyklus 4



Schiebezyklus 5

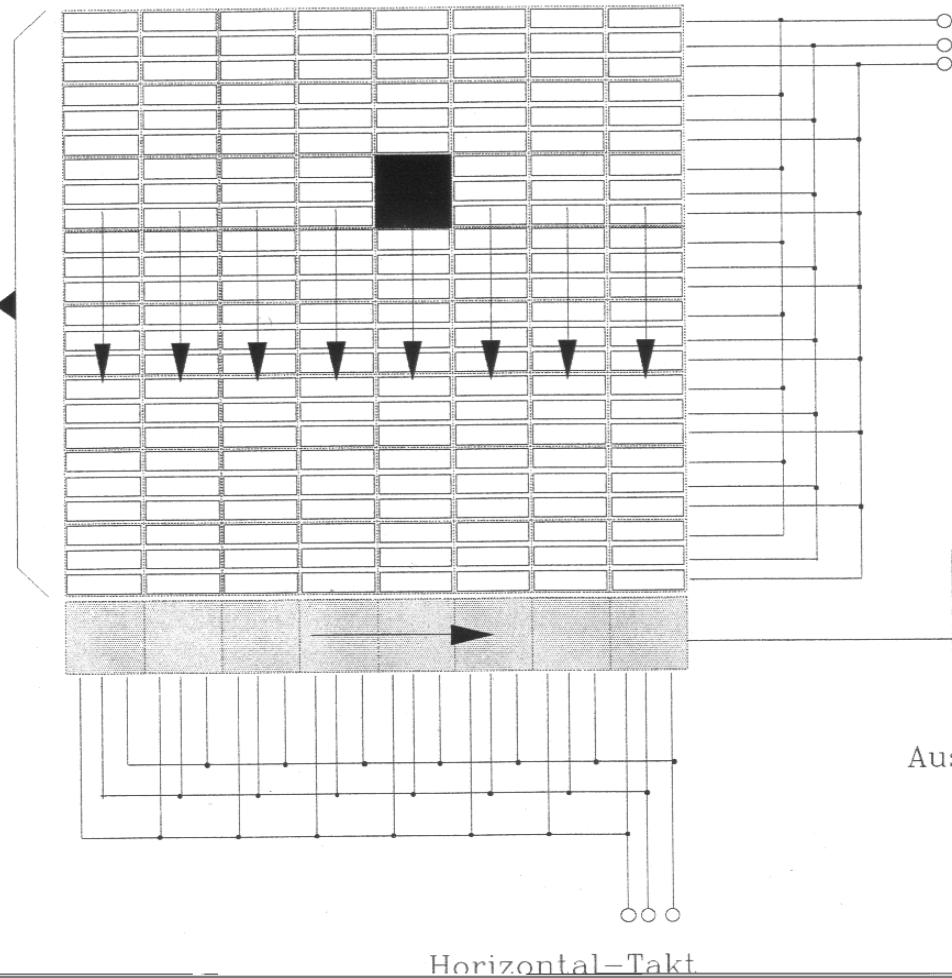


Schiebezyklus 6

(c) OES GmbH

Schiebemechanismus / Auslesen der CCDs

Optisch
empfindliche
Zone
(Integrations-
Zone)

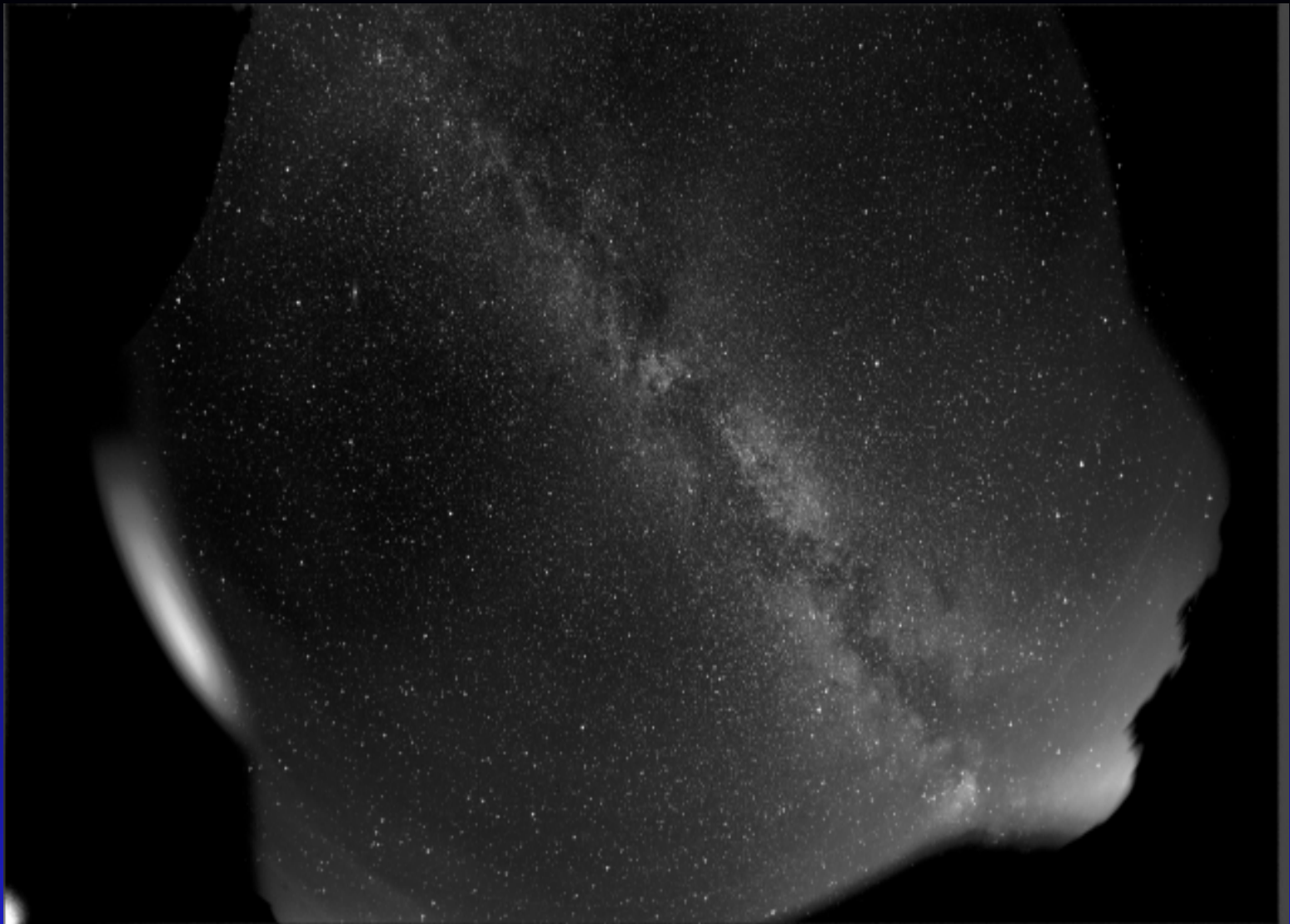


Phase 1, 2 und 3

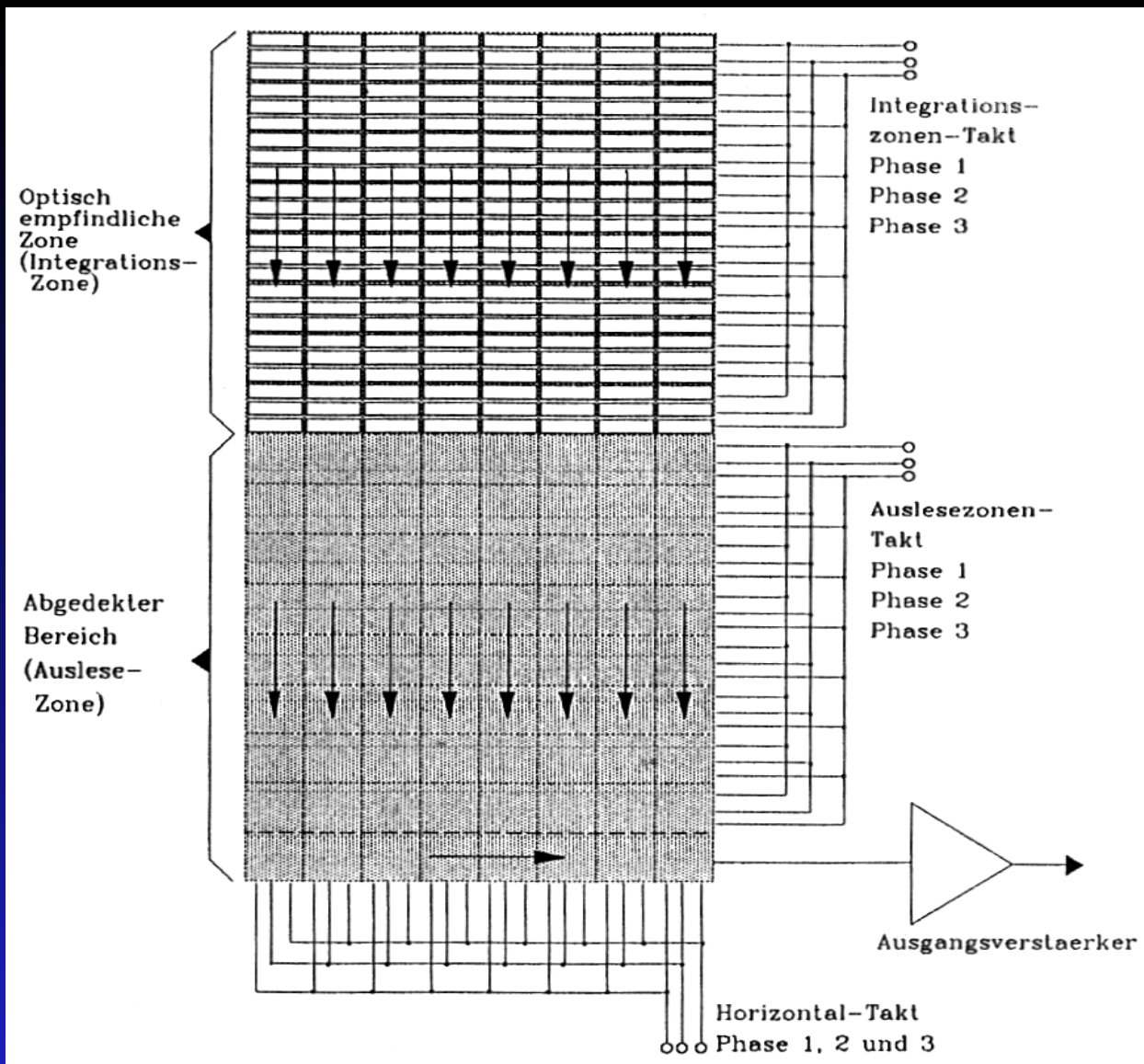
(c) OES GmbH

2-dimensionales Array



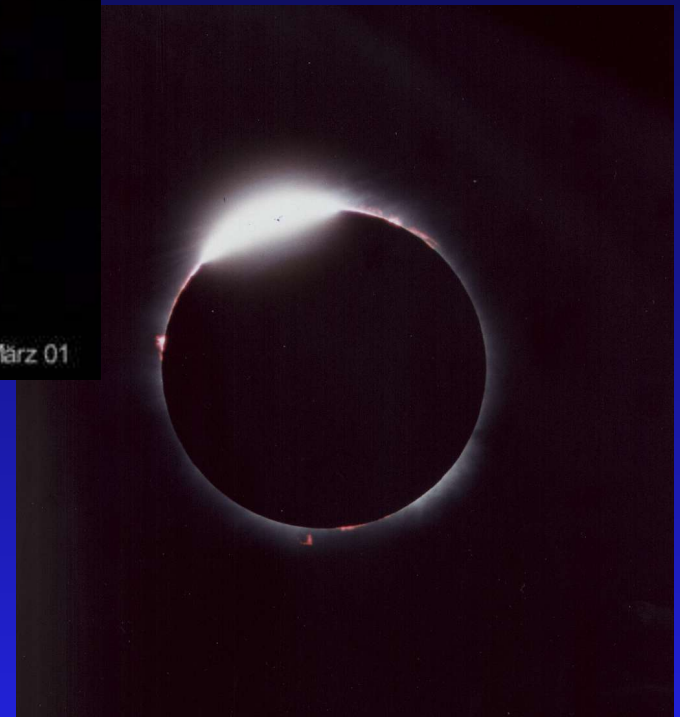


28MegaPixel-Bild (verkleinert)

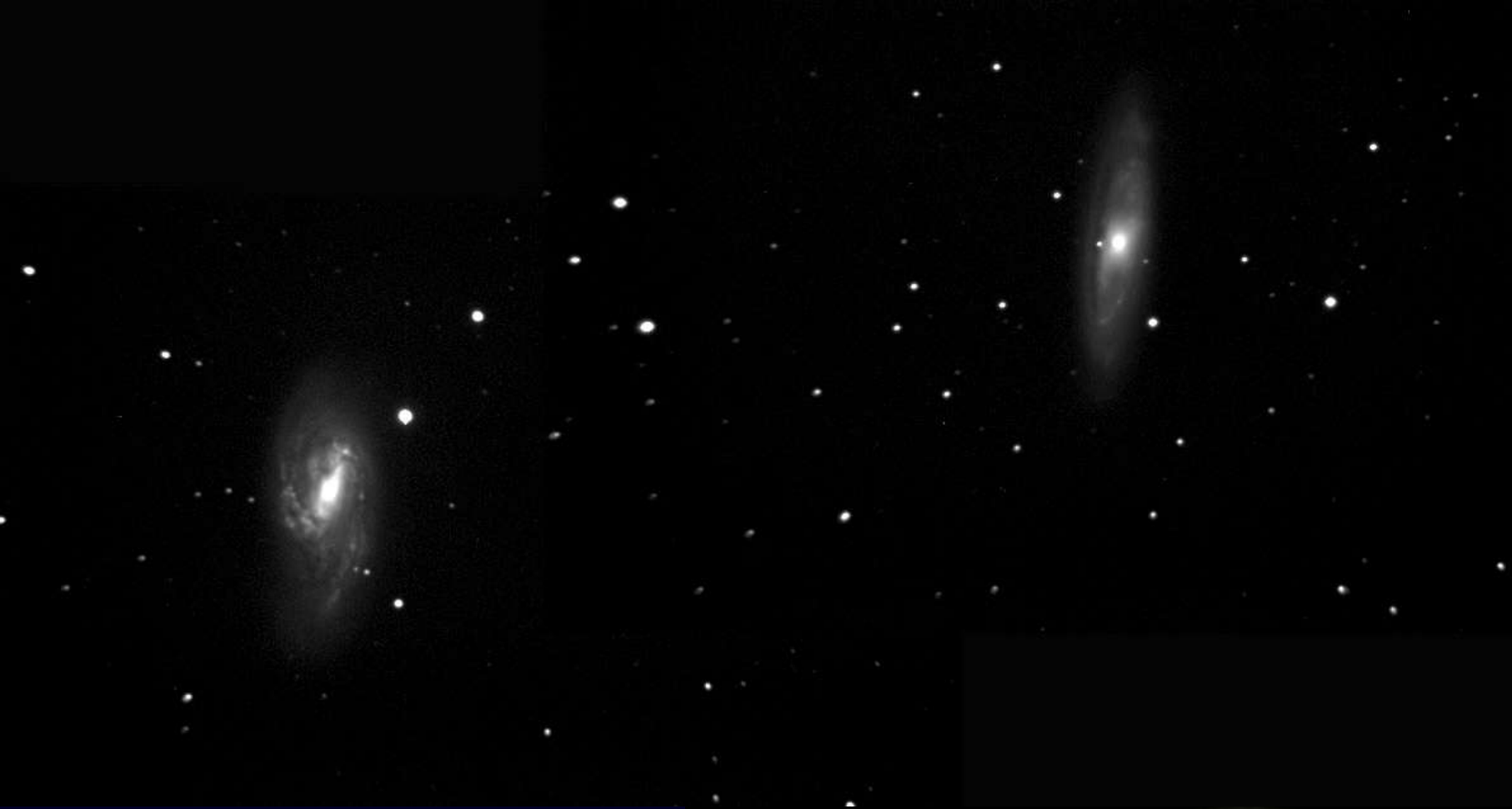


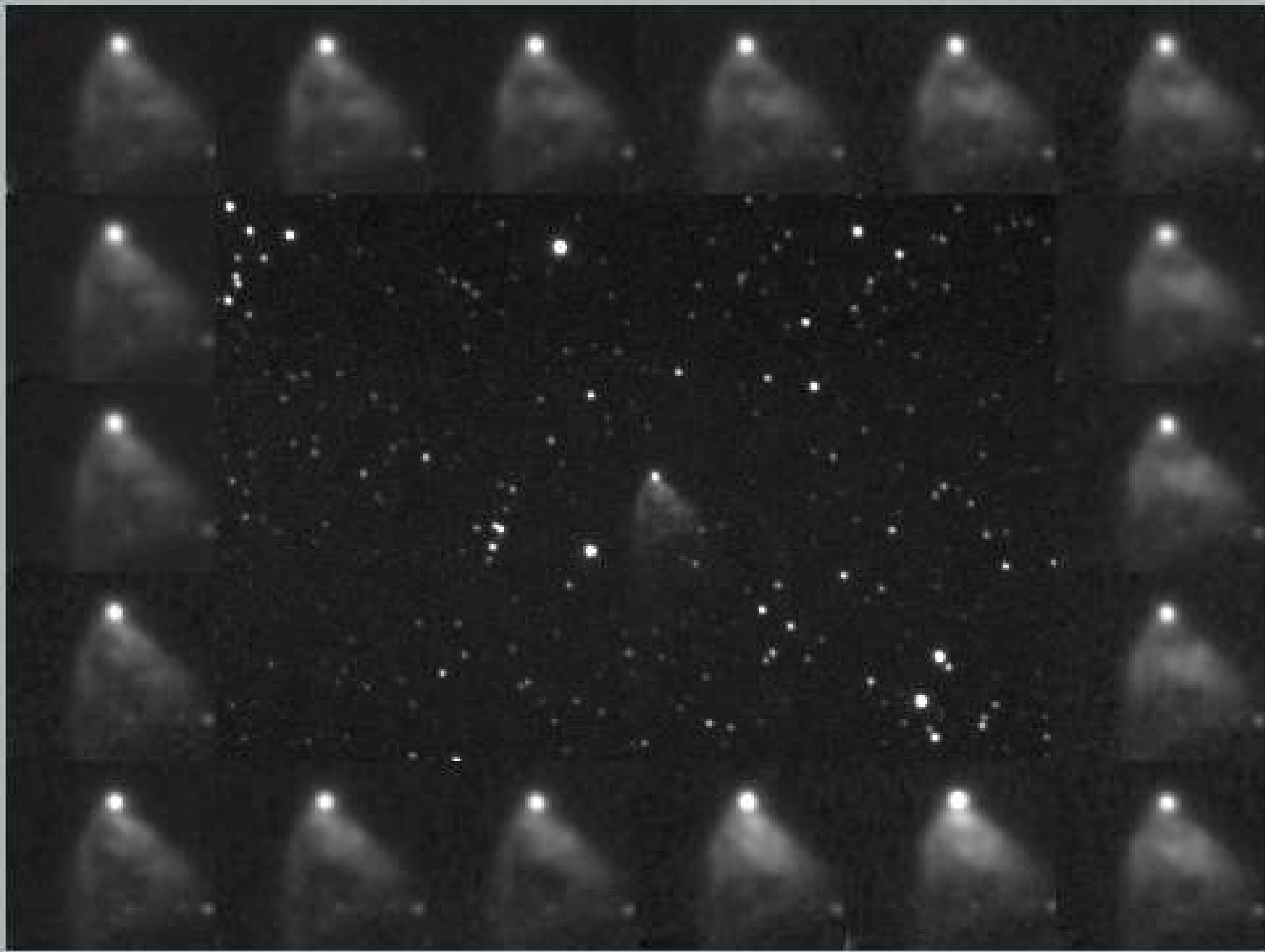
Elektronischer Verschuß



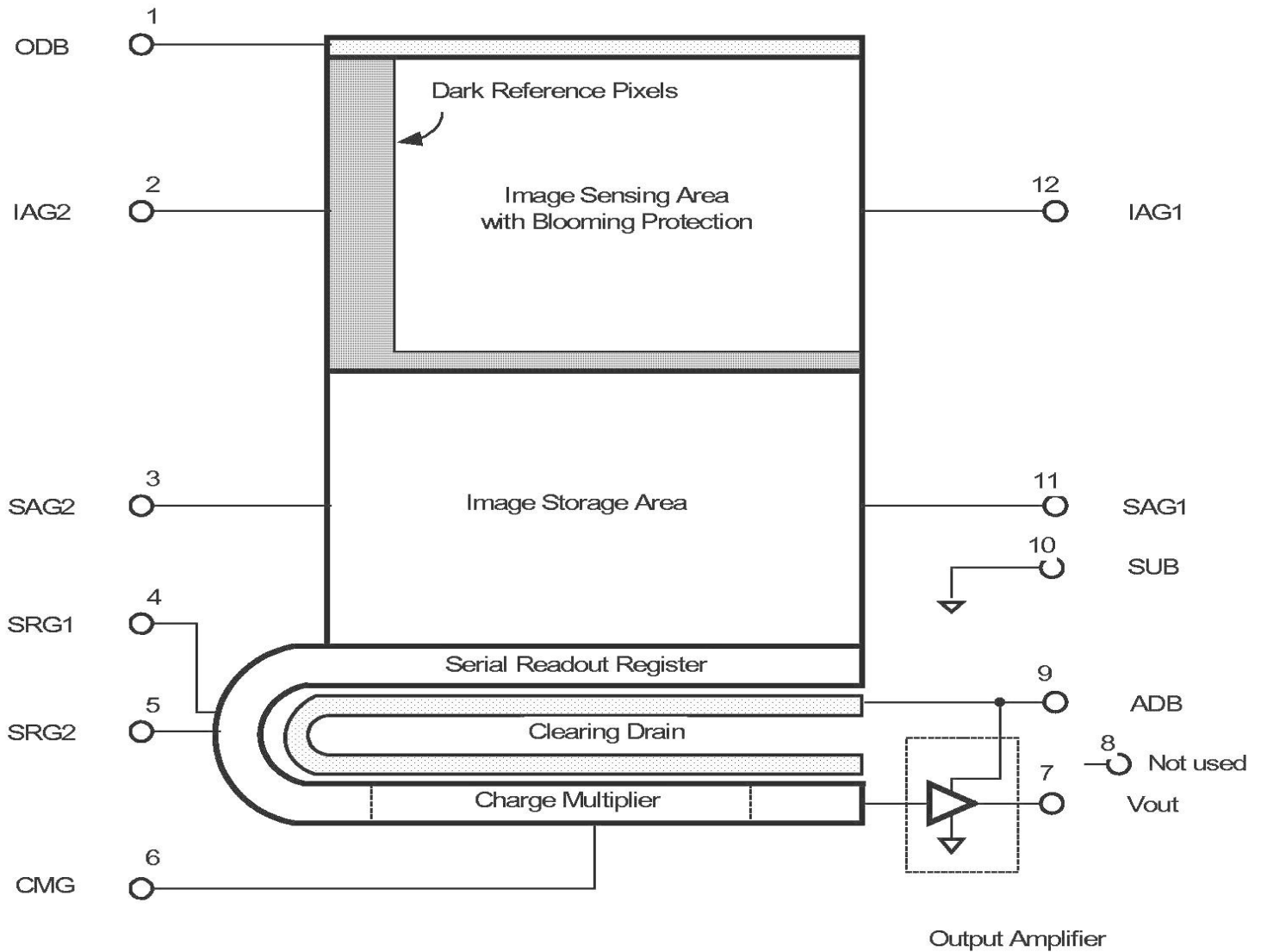






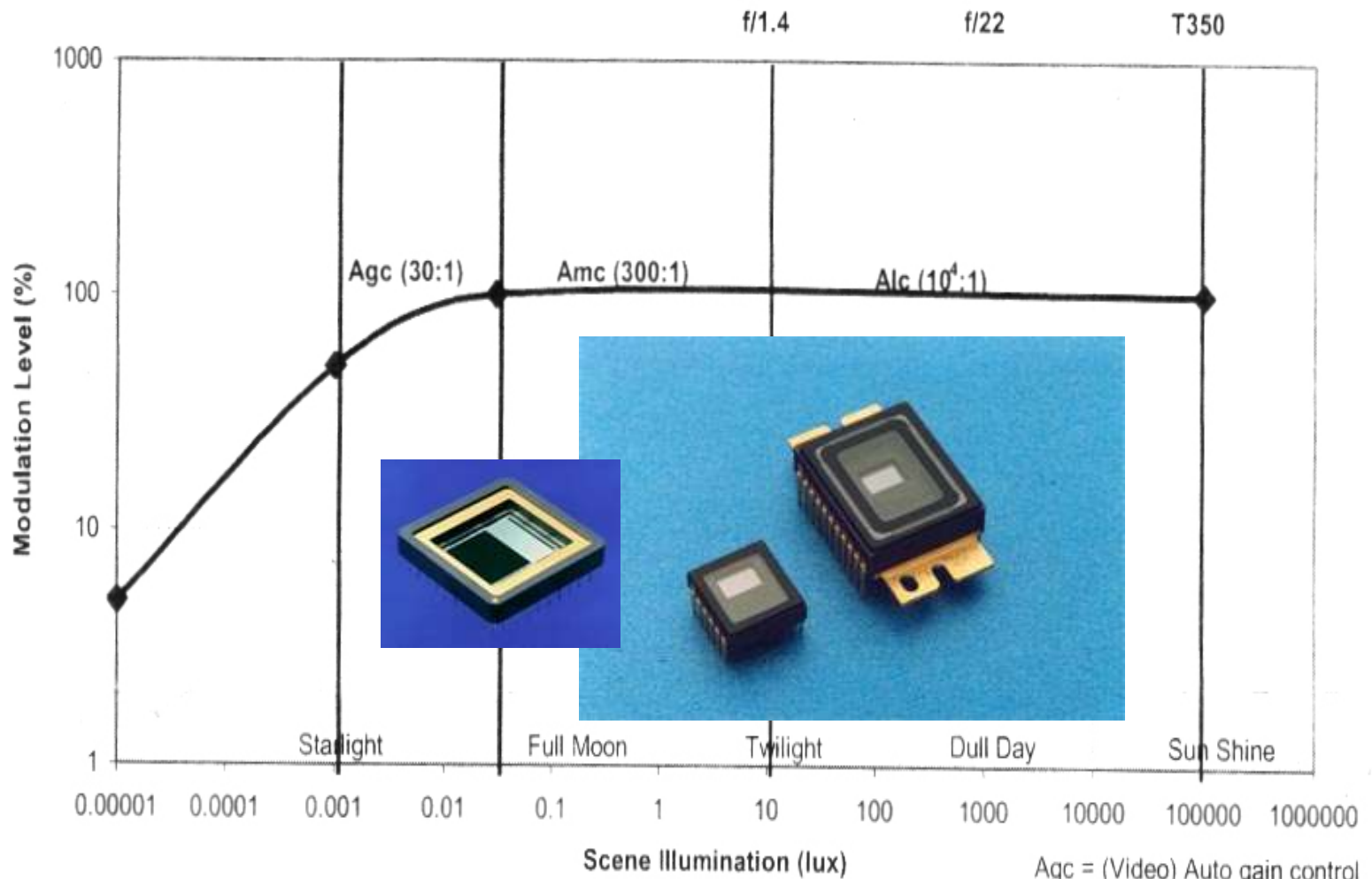






Lawinen-Verstärker

Typical Auto Level Control (ALC)

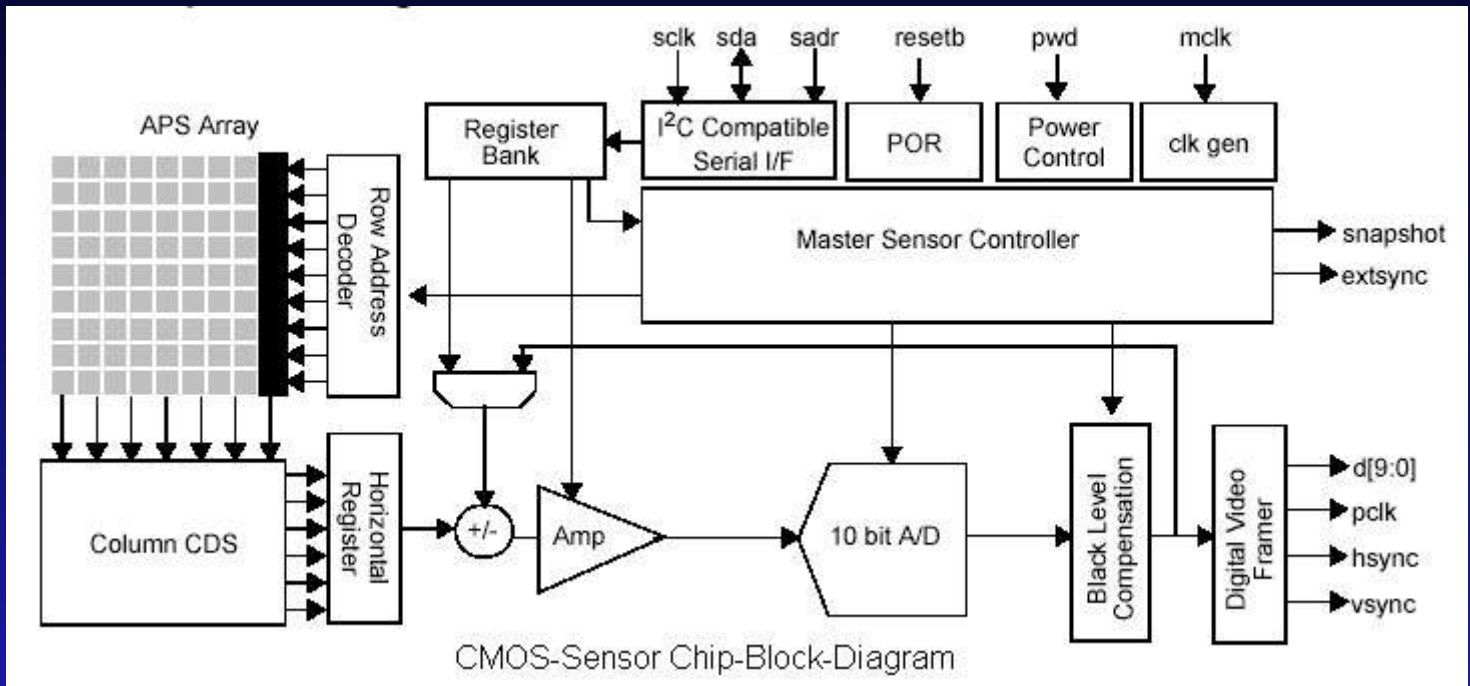


Agc = (Video) Auto gain control

Amc = Auto multiplier control

Alc = Auto lens (iris) control

Dynamik beim Lawinen-Verstärker-CCD





Auch wenn

- * die nachweisbare Zahl der Elektronen immer kleiner wird,
- * die Pixelzahl dramatisch ansteigt,
- * die Readout-Rate stetig in die Höhe klettert,
- * die Chips immer intelligenter werden

den Physikern und Technikern bleibt immer und immer wieder Unentdecktes und Ungedachtes um uns morgen wieder mit noch besseren Bildsensoren zu überraschen.

In diesem Sinne alles Gute und nur kein Quant verlieren!

Dr. Frank Fleischmann

OES - Optische und elektronische Systeme GmbH / Egloffstein

Sternwarte Feuerstein e.V. / Ebermannstadt