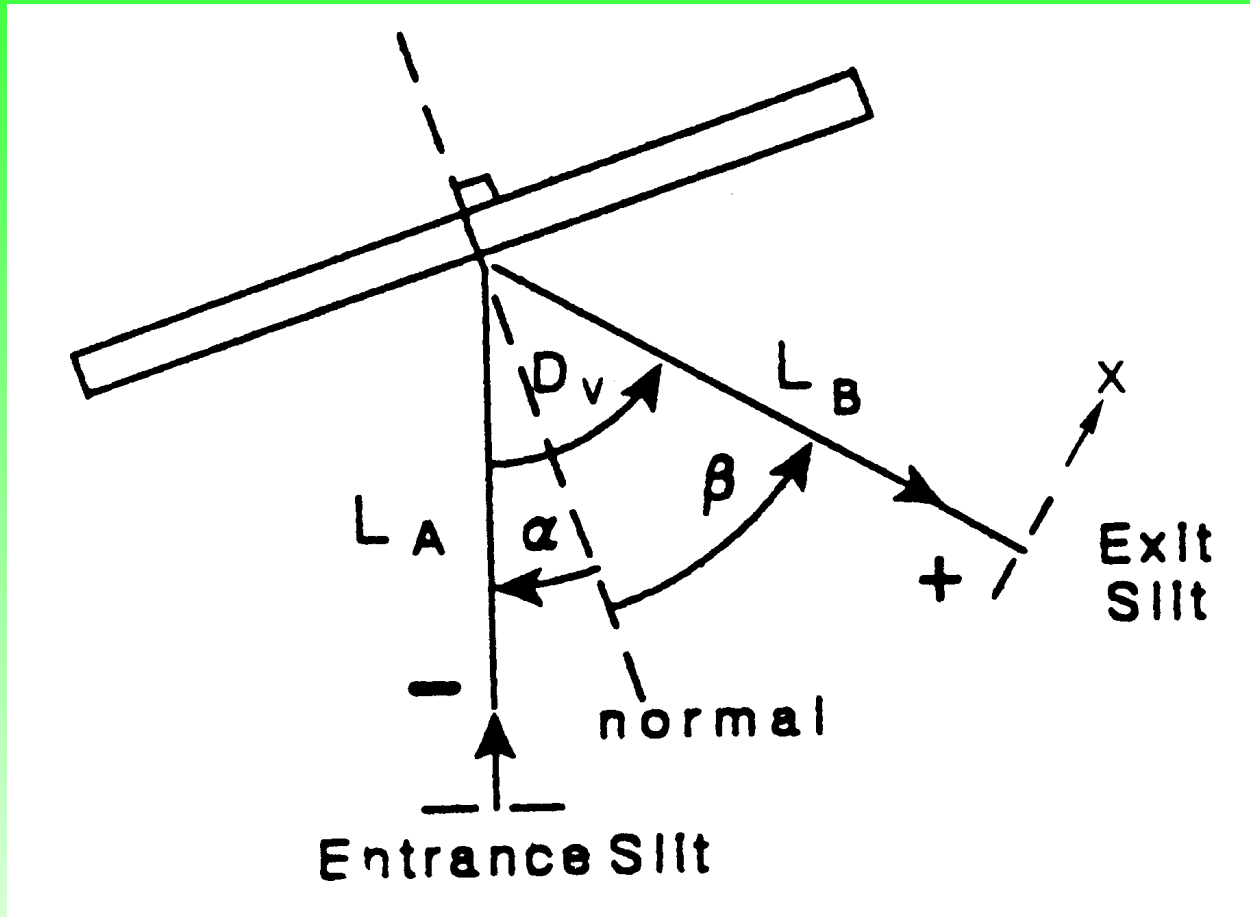


Moderní mřížkové spektrometry

- monochromátor, skanovací monochromátor, polychromátor, spektrograf, zobrazovací spektrograf
- vstupní/výstupní štěrbina/clona, kolimátor, disperzní element, fokusační element
- detektor - fotonásobič, CCD element
- řízení a sběr dat

Difrakční rovnice: $\sin \alpha + \sin \beta = 10^{-6} K n \lambda$



α úhel dopadu

β difrakční úhel

K difrakční řád

n hustota vrypů/mm

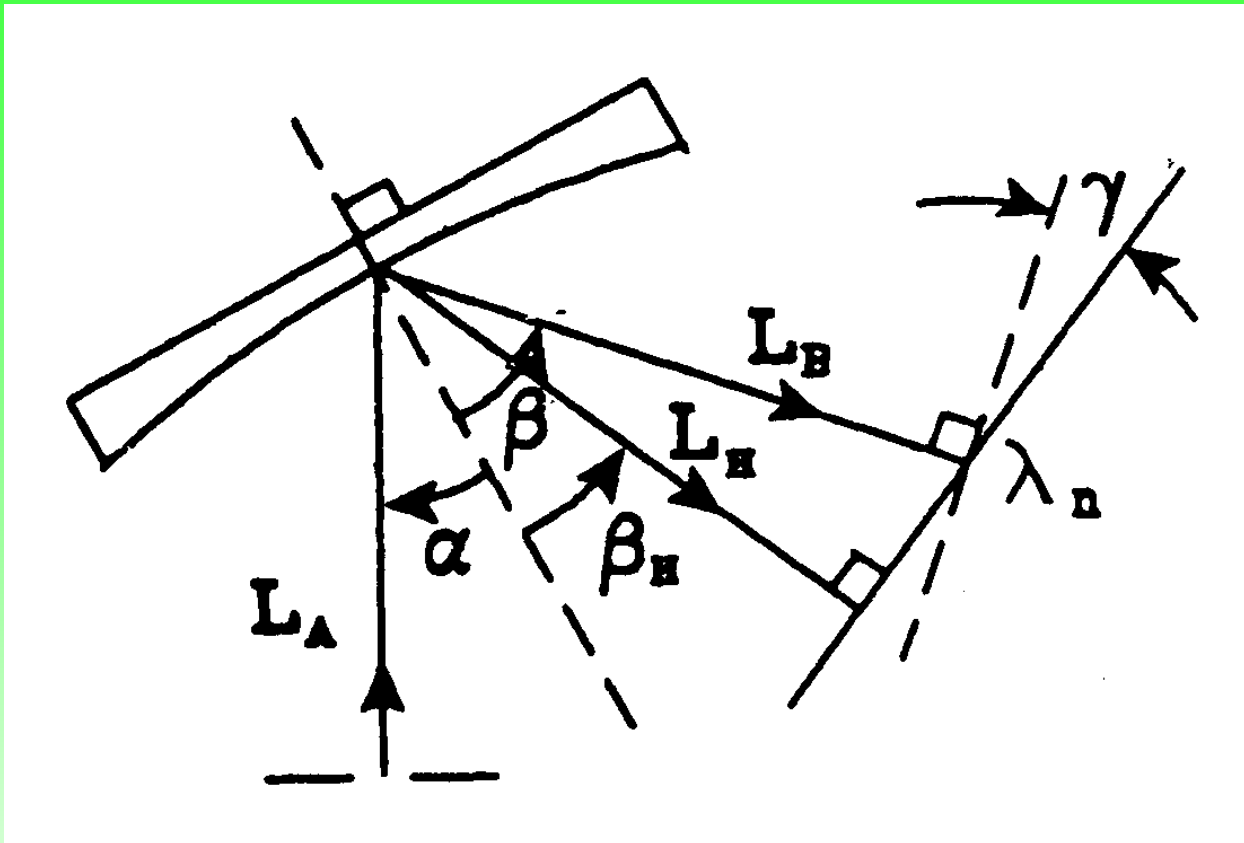
λ vlnová délka [nm]

$D_v = \beta - \alpha = \text{const}$

úhlová disperze:

$$\frac{d\beta}{d\lambda} = \frac{10^{-6} K n}{\cos \beta} \text{ [rad/mm]}$$

Disperze a rozlišovací schopnost



lineární disperze:

$$\frac{d\lambda}{dx} = \frac{10^6 \cos \beta}{KnL_B} \text{ [nm/mm]}$$

lineární disperze spektrografu:

$$\frac{d\lambda_n}{dx} = \frac{10^6 \cos^2 \beta}{KnL_H} \text{ [nm/mm]}$$

$K\lambda = \text{const.}$ pro pevné α, β

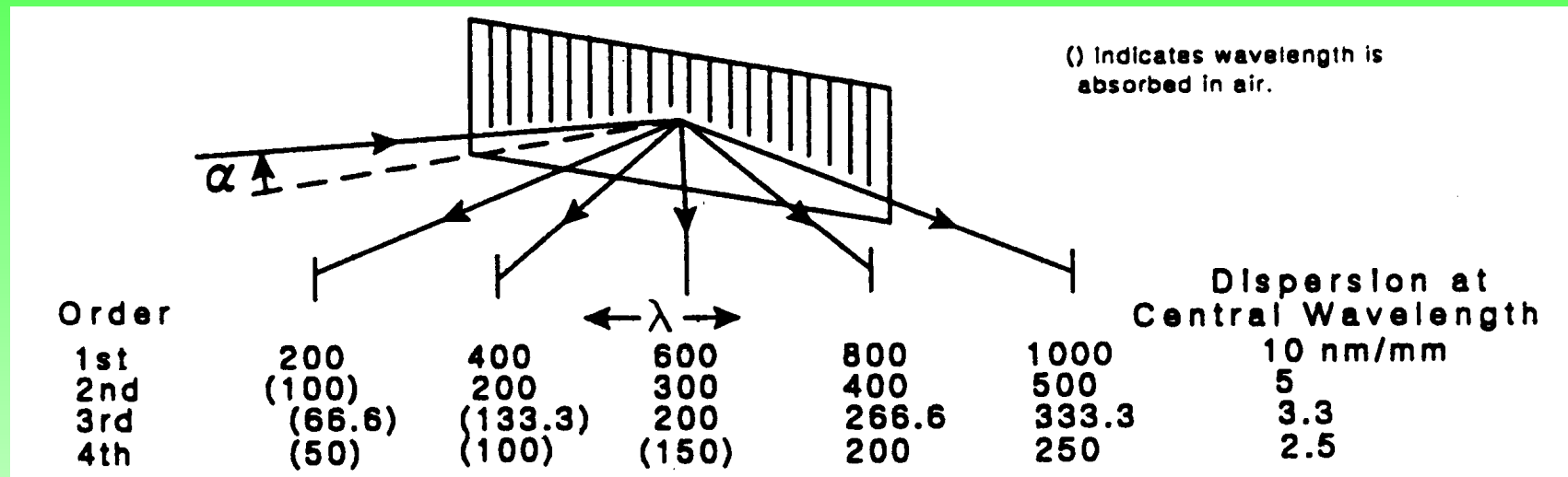
rozlišovací schopnost:

$$R = \frac{\lambda}{d\lambda} = KnW_g = KN$$

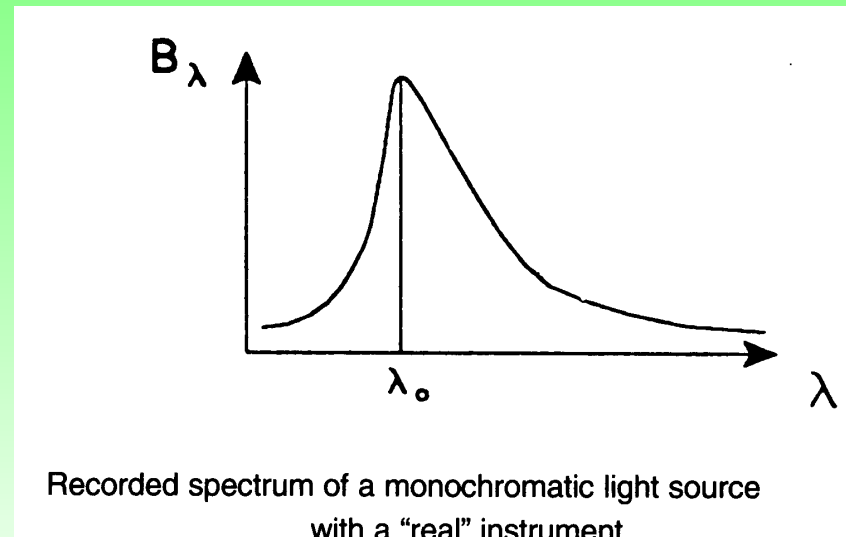
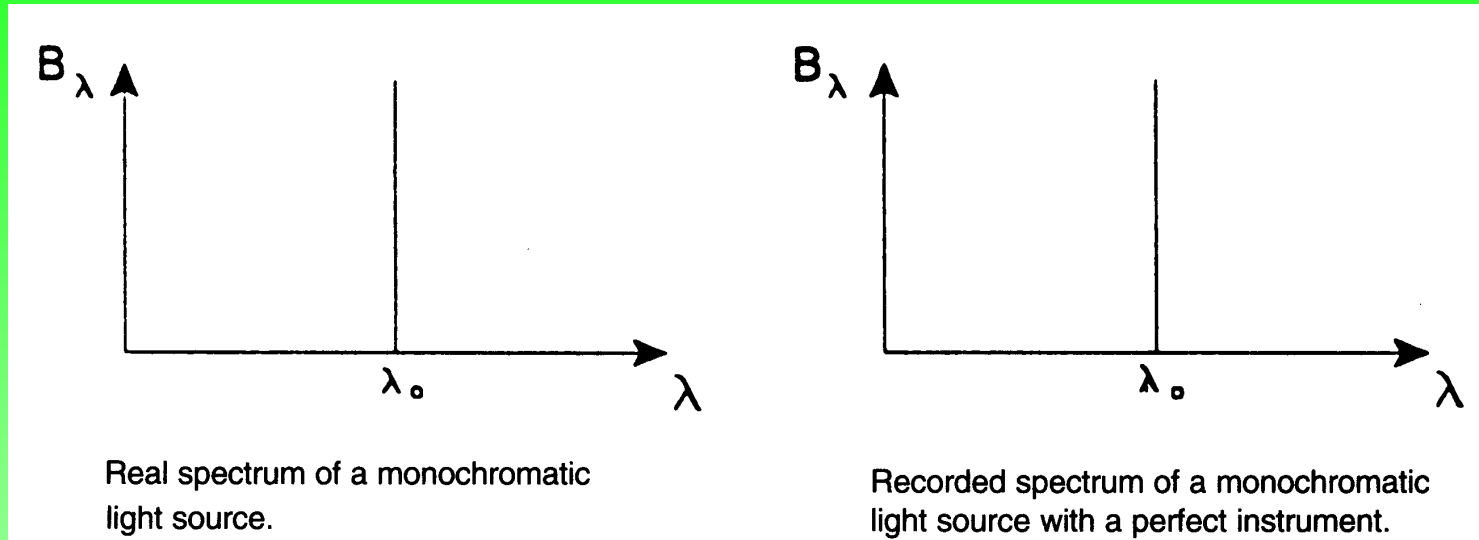
W_g osvětlená šířka mřížky

N celkový počet vrypů

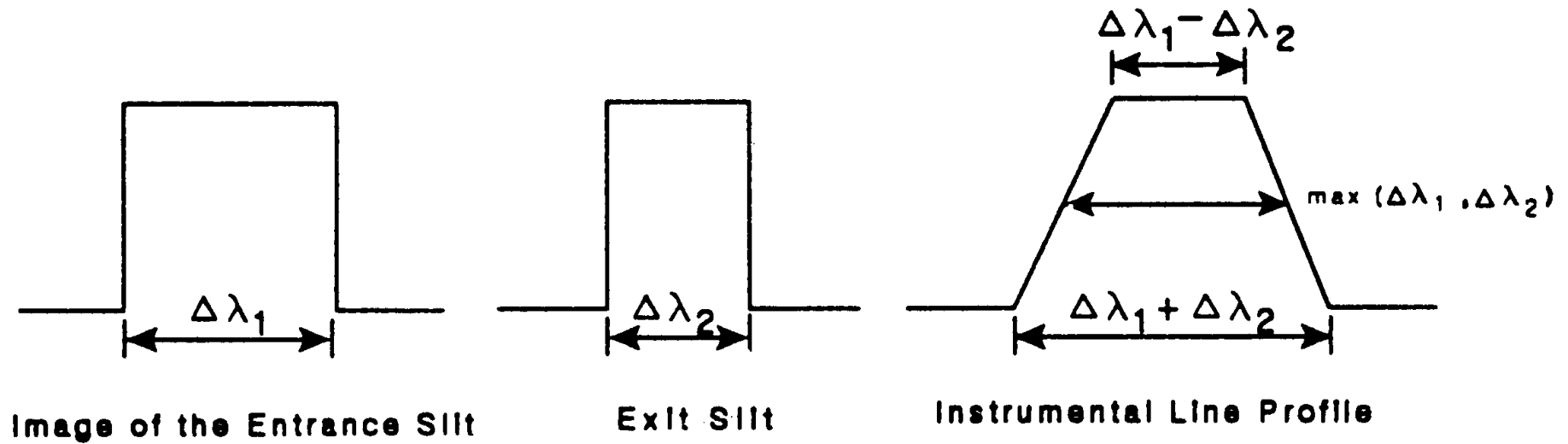
Difrakční řády



šířka pásma a rozlišení: $F = P \star F$, $P(\lambda) = P_1(\lambda) \star P_2(\lambda) \star P_3(\lambda) \star P_4(\lambda) \star \dots$



Obdélníkové štěrby: $\Delta\lambda_1 = D_1\Delta W_1$, $\Delta\lambda_2 = D_2\Delta W_2$

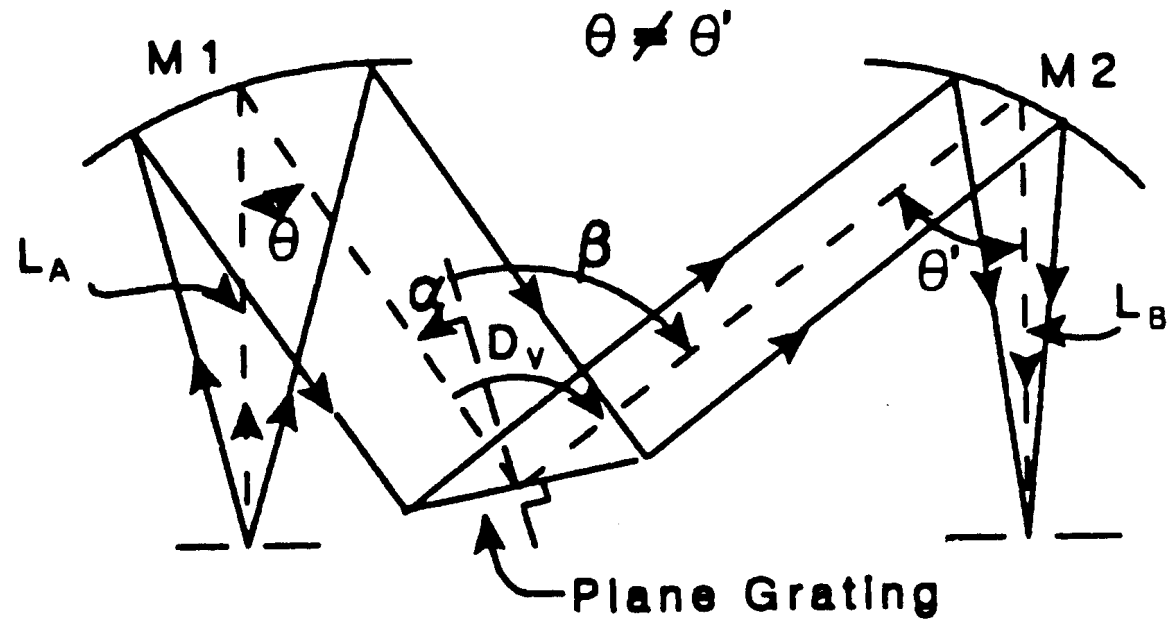


Convolution of entrance with exit slits.

konfigurace Czerny-Turner a korekce vad

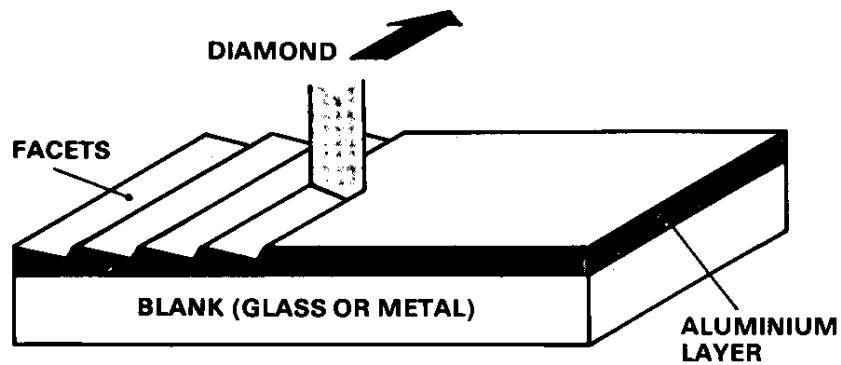
Definitions

- L_A Entrance arm length.
- L_B Exit arm length.
- α Angle of incidence.
- β Angle of diffraction.
- D_v Deviation angle.

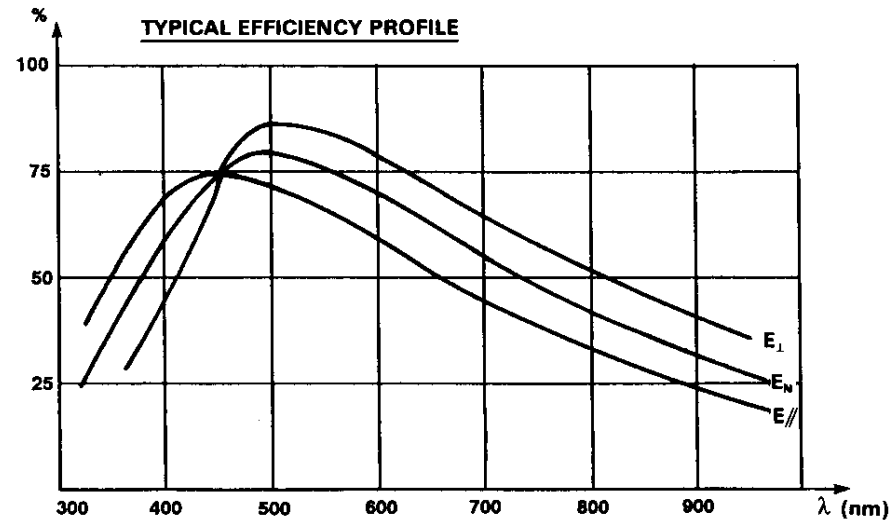


Czerny-Turner configuration.

ryté mřížky: do 1800 vr/mm, výhodné pro < 600 vr/mm

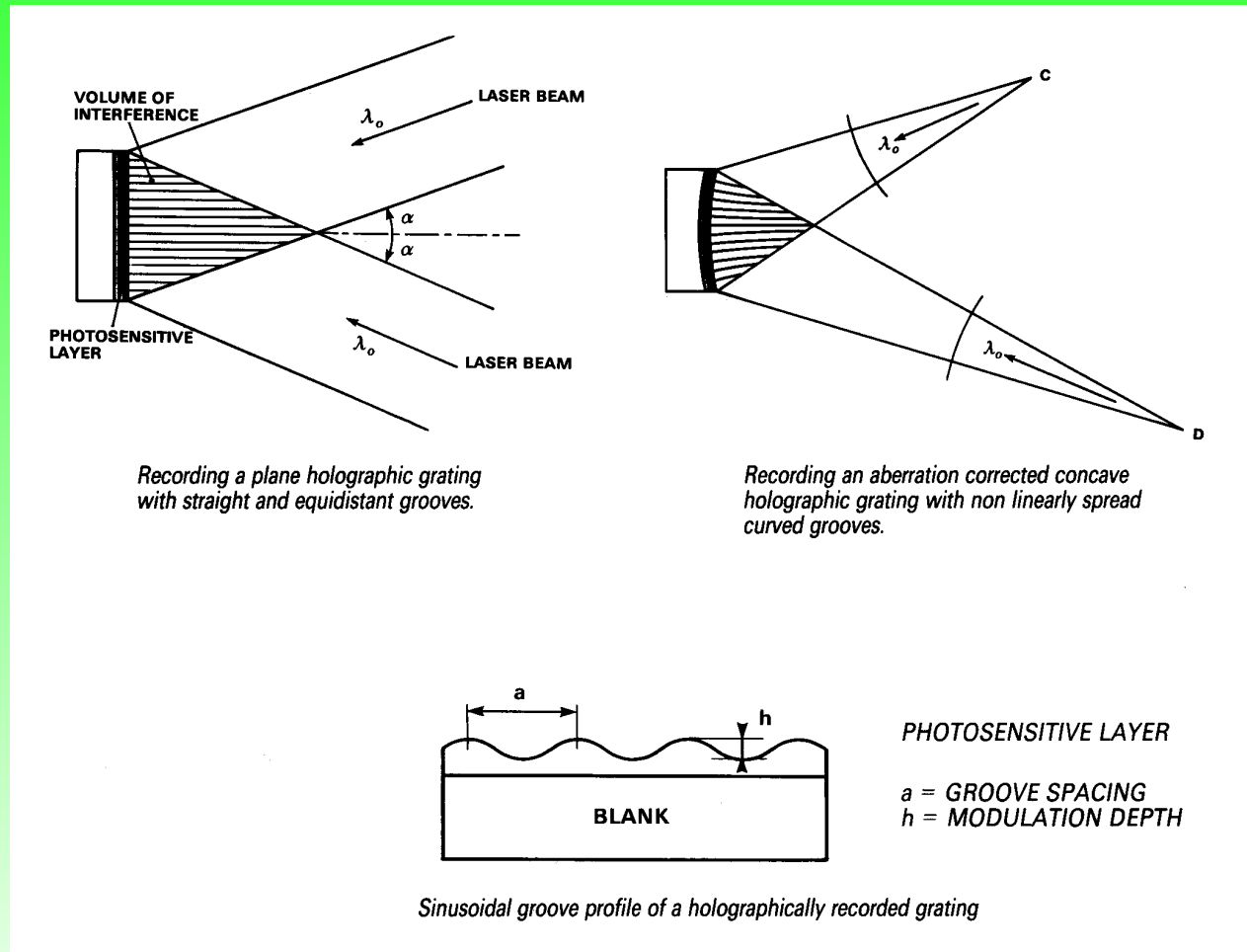


Mechanical ruling using a diamond tool

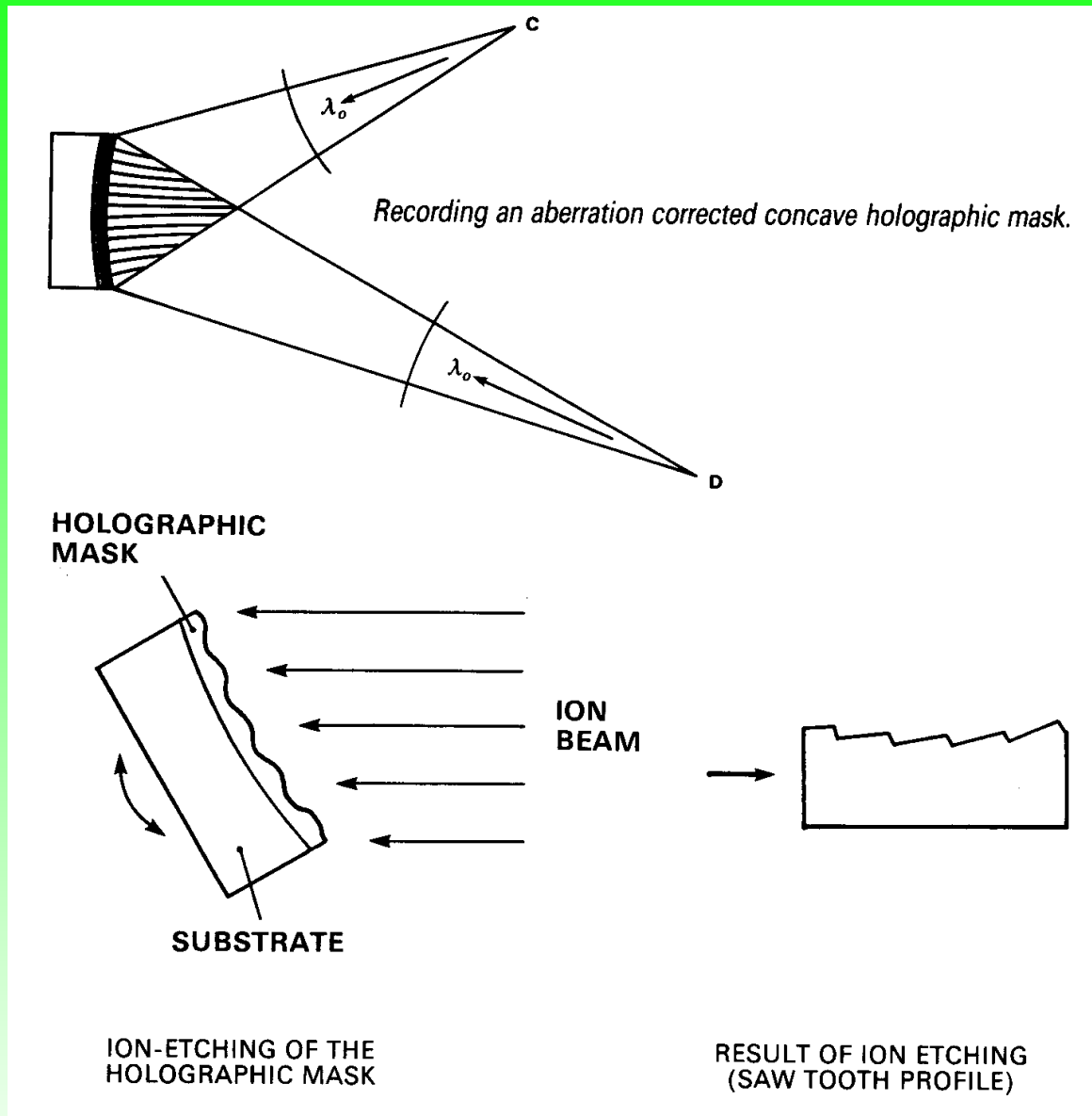


*Mechanically ruled grating
Blaze wavelength : 500 nm,
Number of grooves : 600 gr/mm
Deviation angle : 8 degrees*

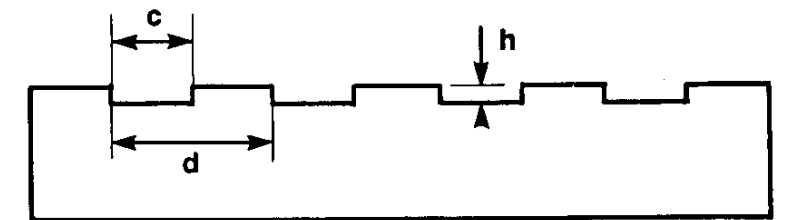
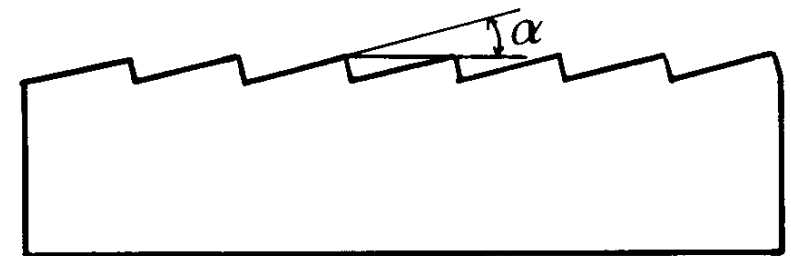
holografické mřížky: konkávní mřížky, Ramanova spektroskopie, laserová fluorescence,
 > 1200 vr/mm, < 200 nm



blazed ion etched holographic gratings: korekce vad, malý rozptyl světla, ...



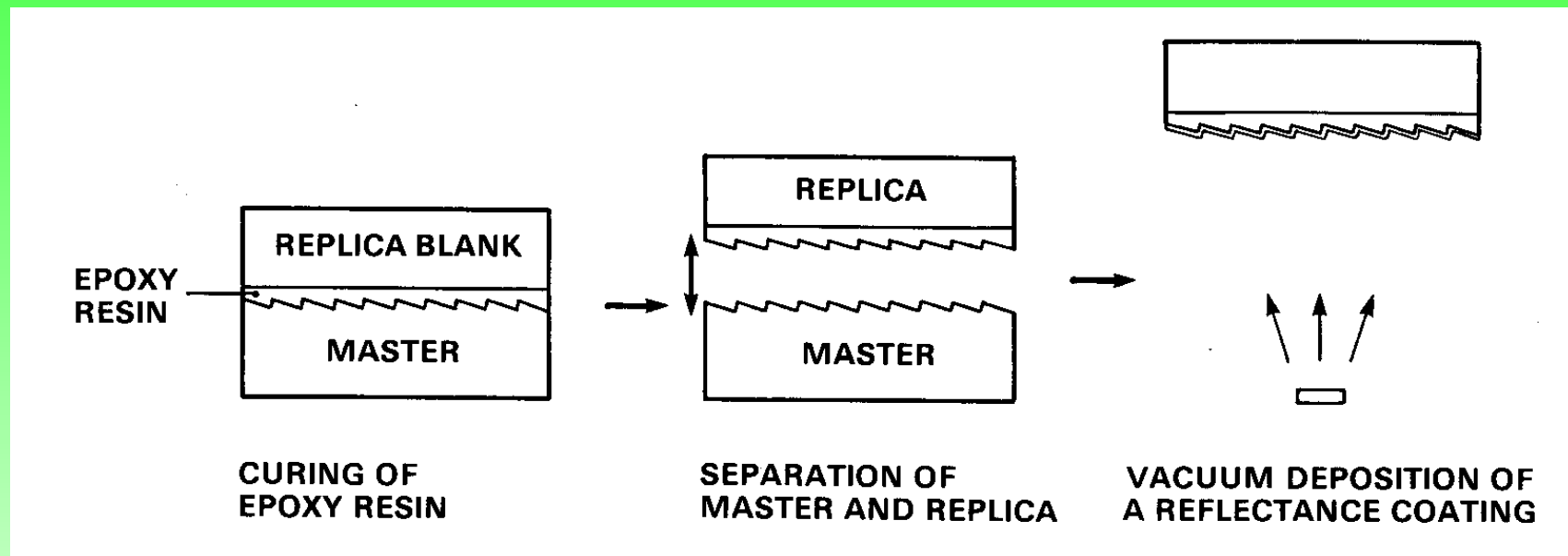
α = Blaze angle



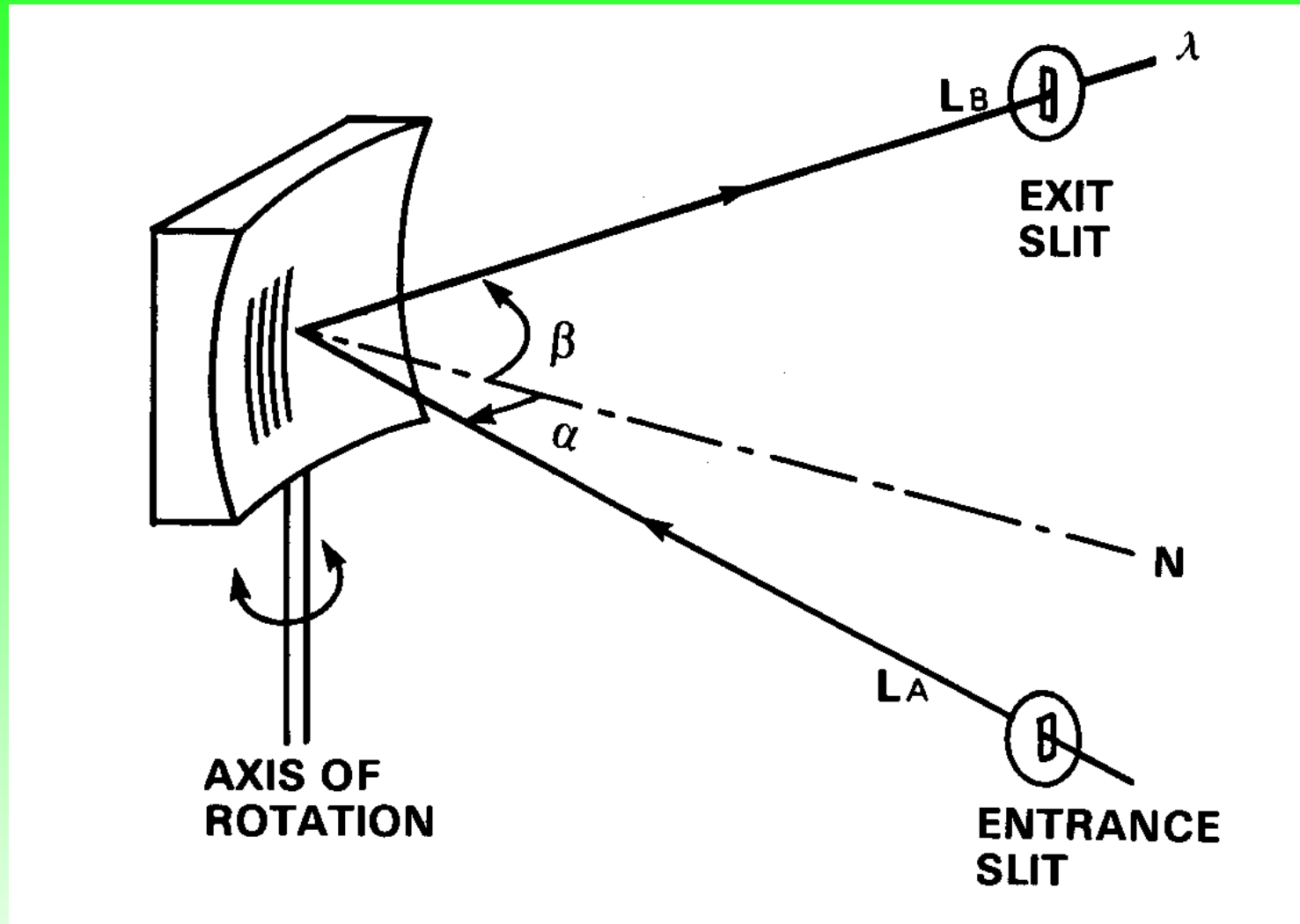
$\frac{c}{d}$ = groove width to groove spacing ratio

h = groove depth

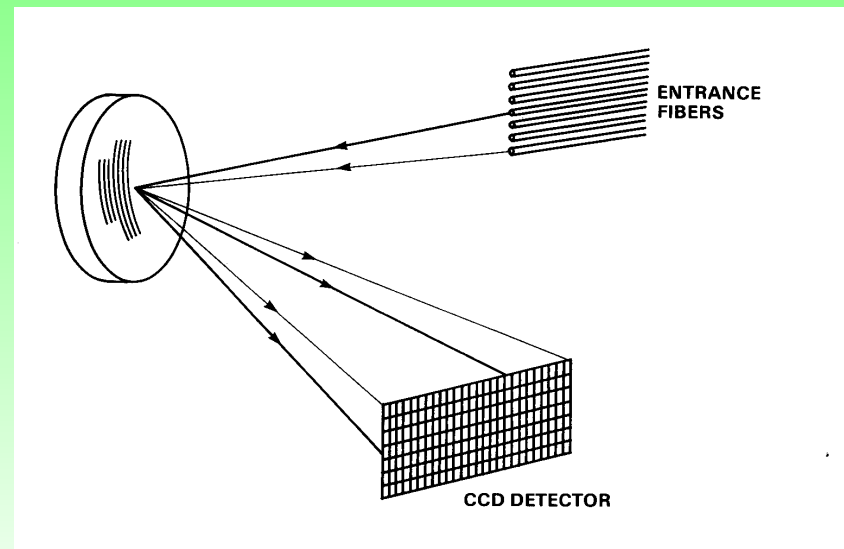
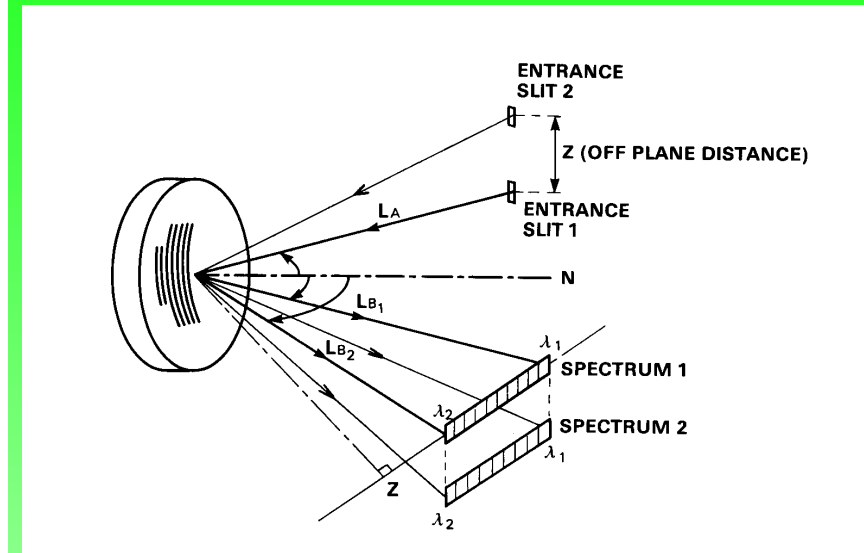
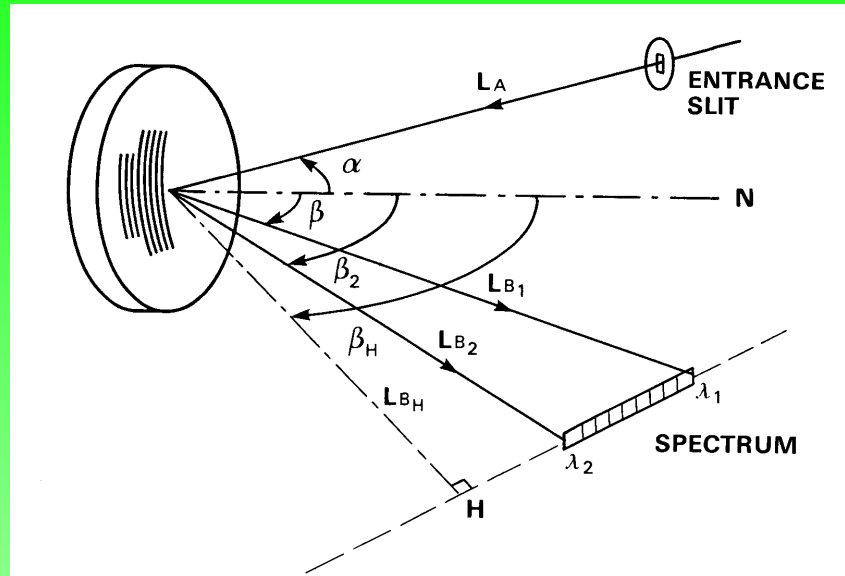
replication of master gratings: výroba přesných kopií



monochromátor - minimální astigmatismus a koma (Rowlandova kružnice)



holographic flat field and imaging gratings PDA, 2 nezávislé zdroje, CCD



Detektory: spektrální oblast, citlivost

1. fotoemisní detektory - fotonásobiče pro UV-VIS-NIR
2. polovodičové detektory (Si fotodiody pro UV-VIS-NIR), solid state detectors
3. teplotní (termické) detektory - pyroelektrické detektory
4. photodiode arrays (PDA's] - mnohokanálové detektory
5. Charge Coupled Device Arrays (CCD's) - mnohokanálové detektory

Základní charakteristiky detektorů: R , NEP , $1/NEP$, dark current, QE , noise

responsivity $R = S/PA$ (výstupní signál/dop. energie/plocha) - neuvažuje se šum

noise equivalent power $NEP = \frac{P.A}{S/N \cdot \sqrt{\Delta f}}$ - mez detekce detektoru s ohledem na vlastní šum (N - velikost šumu, Δf - šířka pásma šumu)

detectivity $D = 1/NEP$

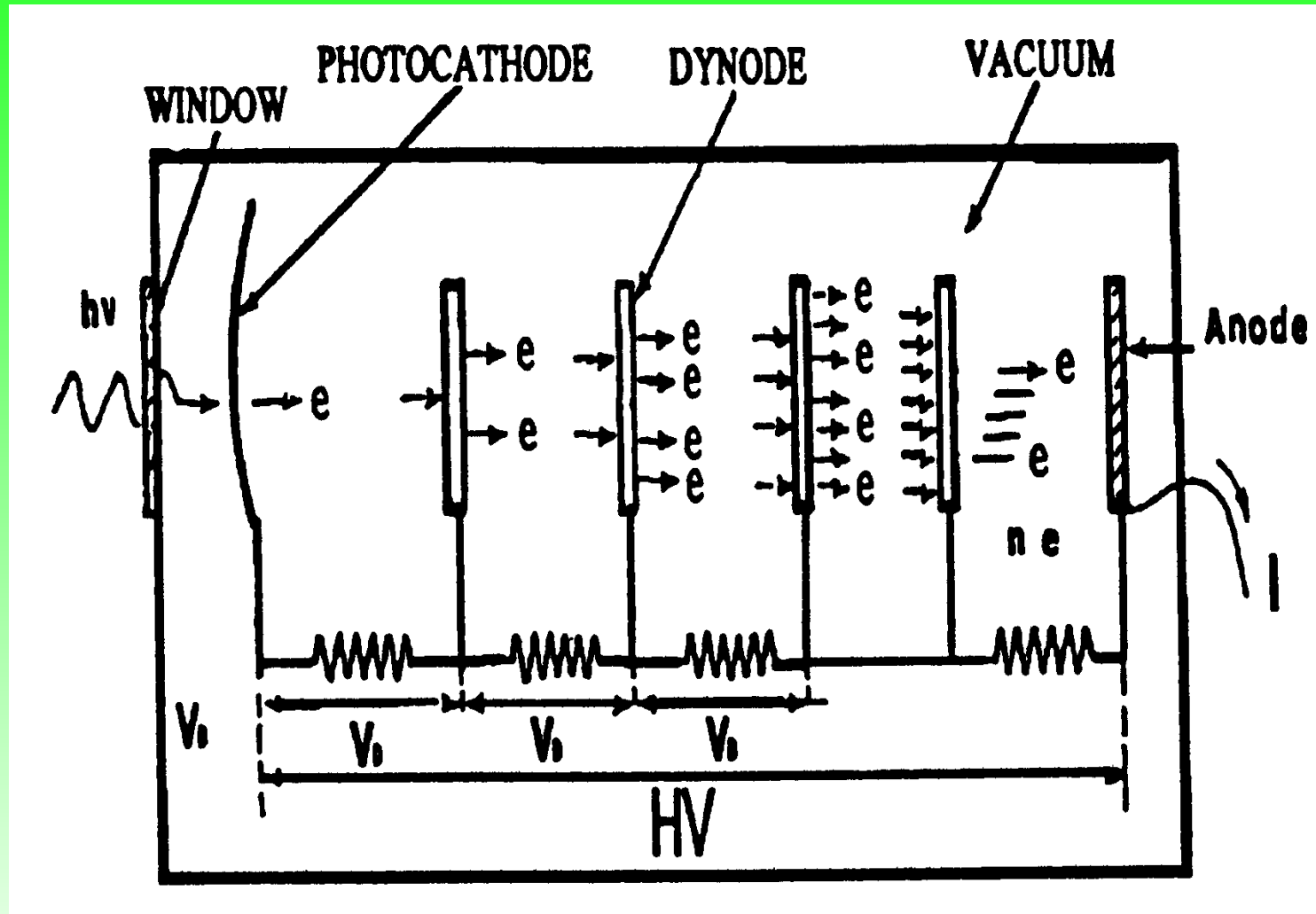
normalized detectivity $D^* = \frac{S/N \cdot \sqrt{\Delta f}}{P \cdot \sqrt{A}} = \frac{\sqrt{A}}{NEP}$

dark current bez přítomnosti měřeného světla

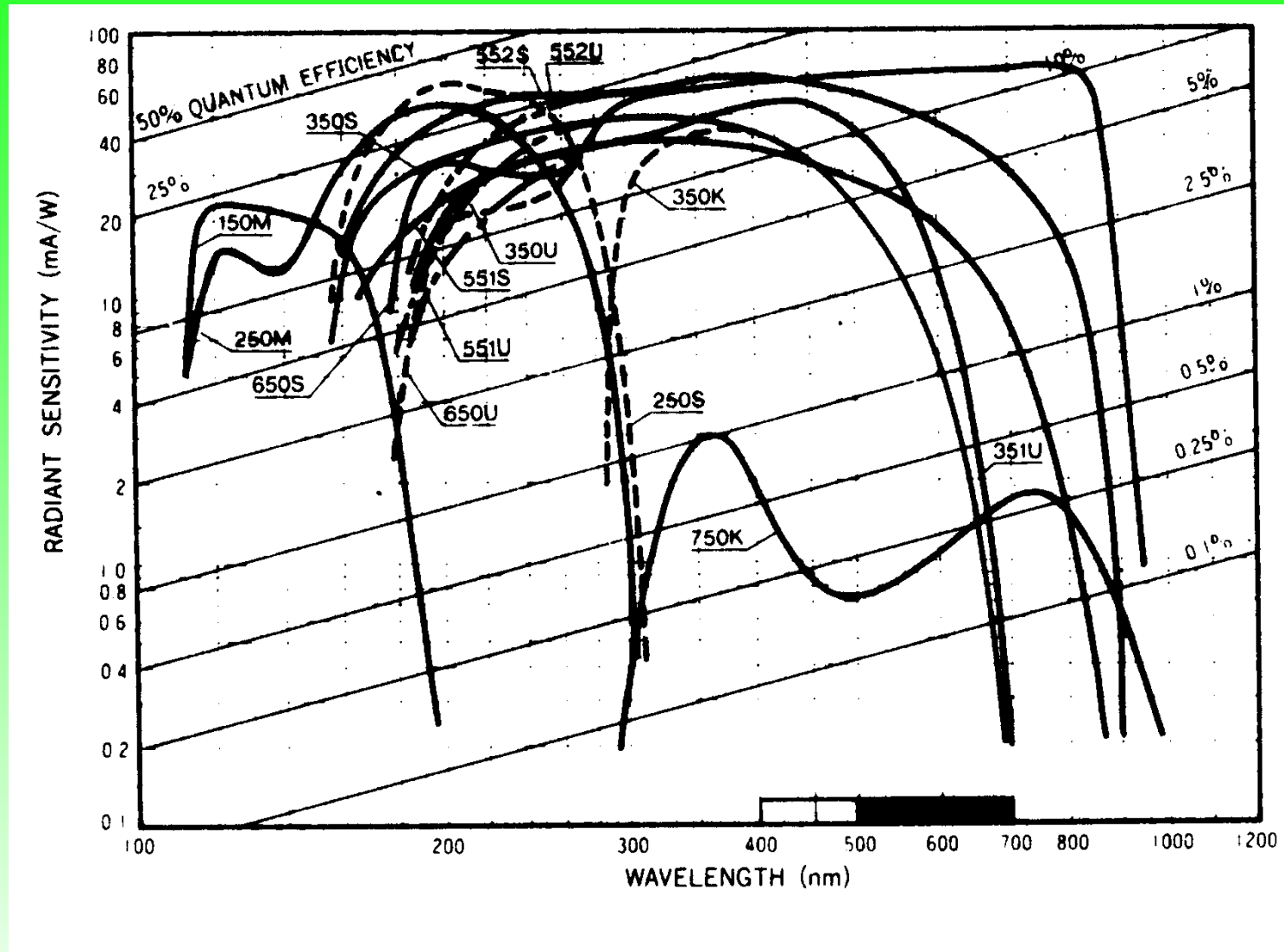
quantum efficiency QE electron/foton = $f(\lambda, \text{materiál detektoru, tvar, ...})$

noise - shot, dark, readout

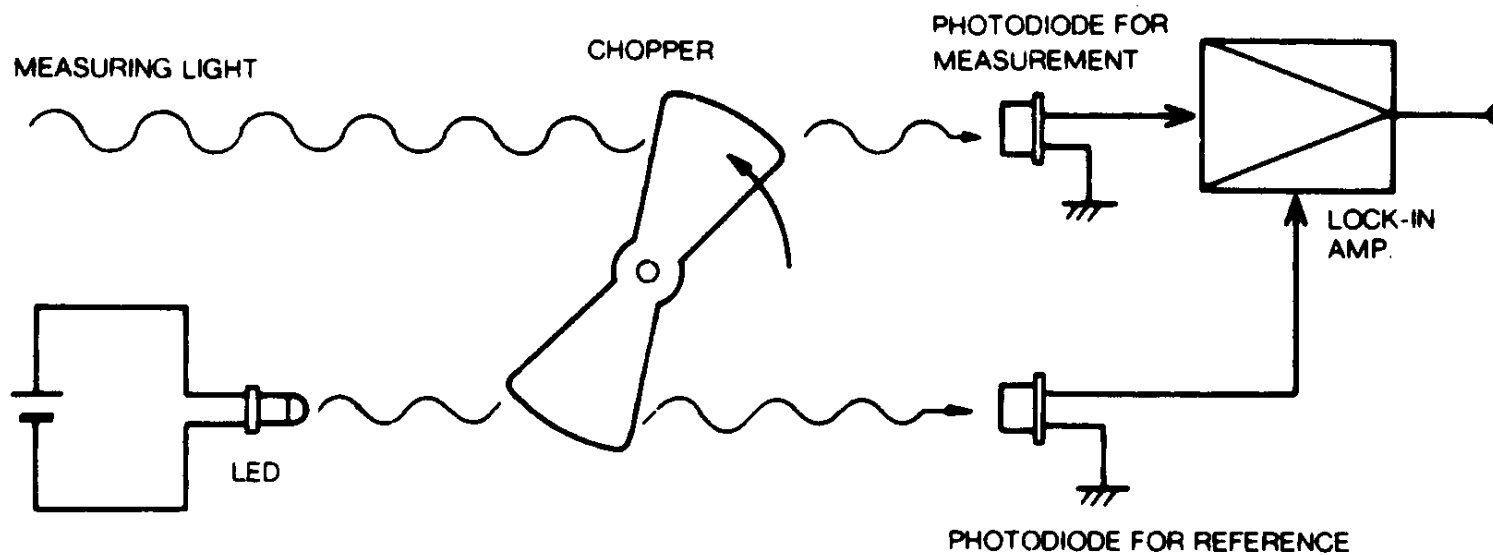
Fotonásobiče - princip, vlastnosti



citlivost fotonásobiče

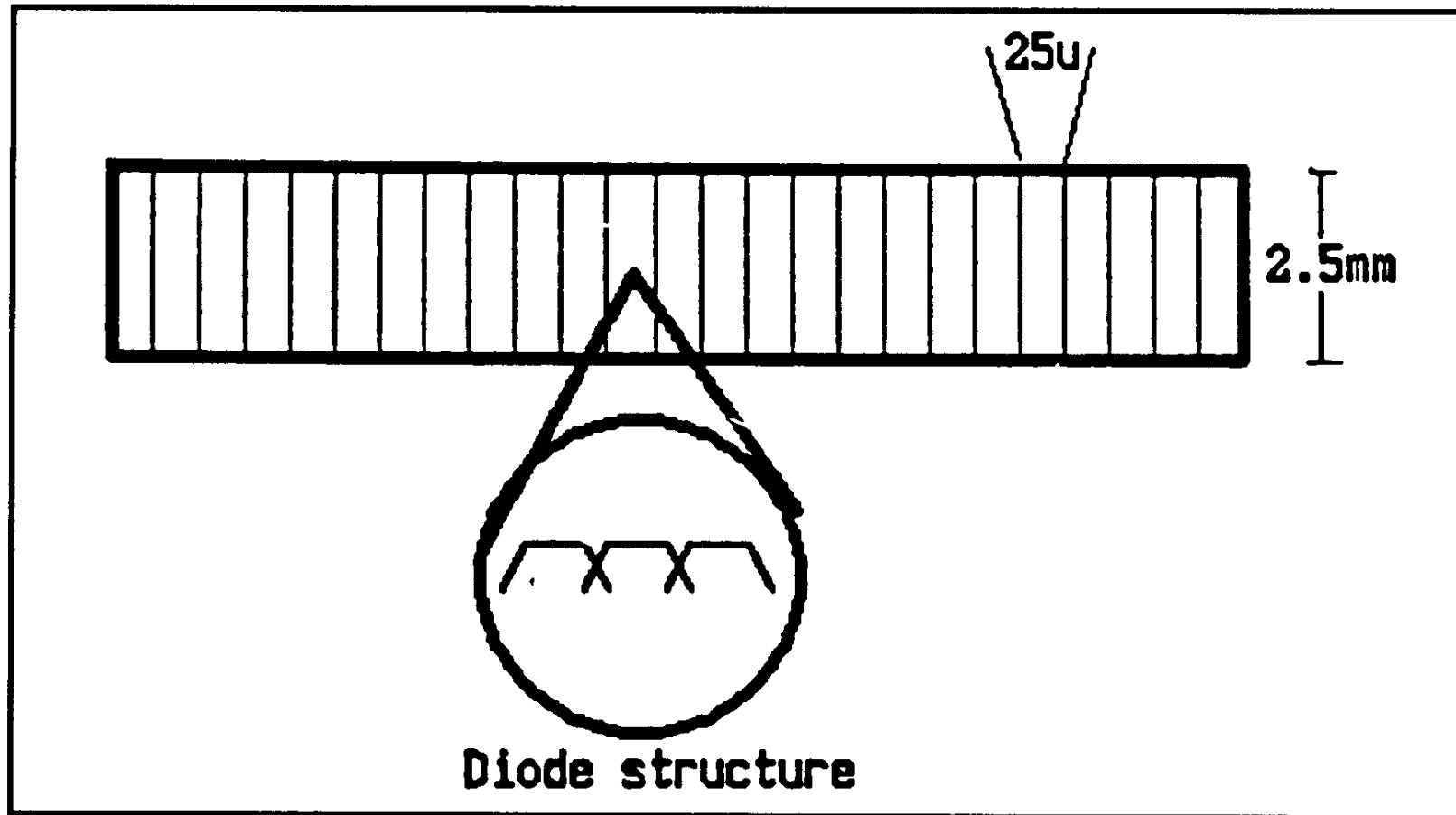


Polovodičové detektory photoconductive (PbS) - změna vodivosti, photovoltaic (Si, Ge, InGaAs) - p-n přechod se silným el. polem, rychlá odezva



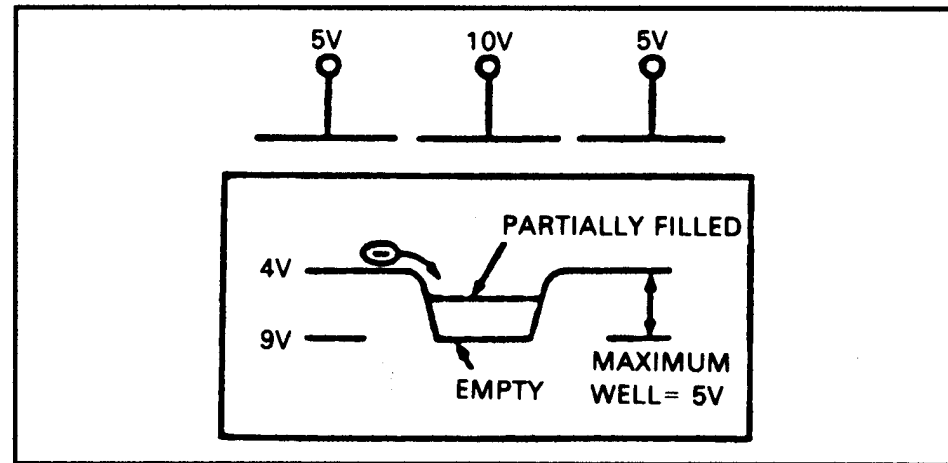
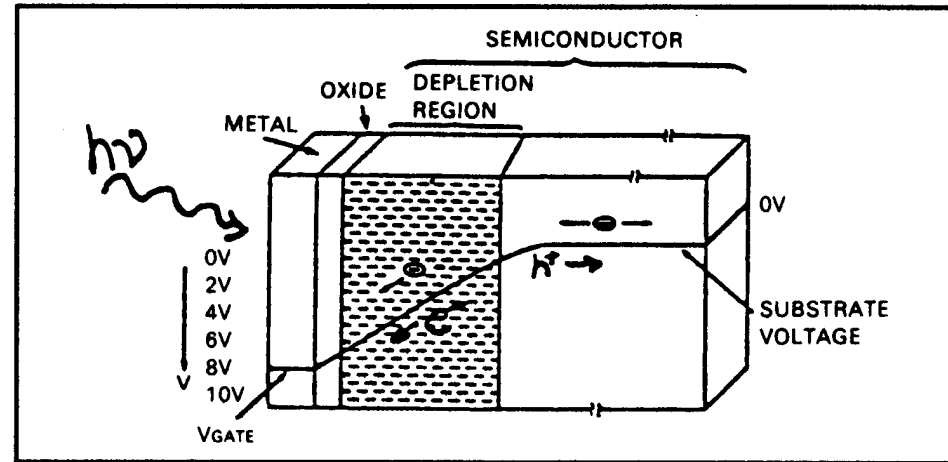
Synchronous measurement technique.

Mnohokanálové detektory - PDA



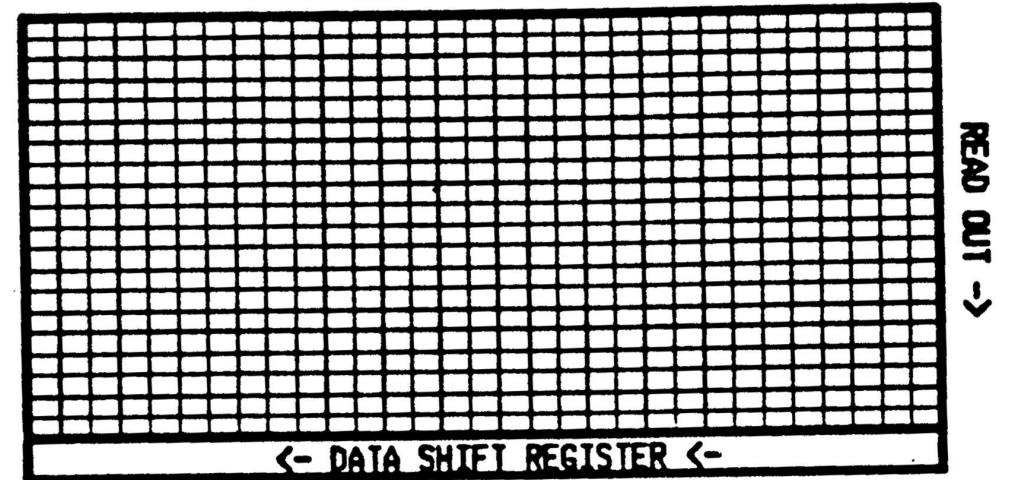
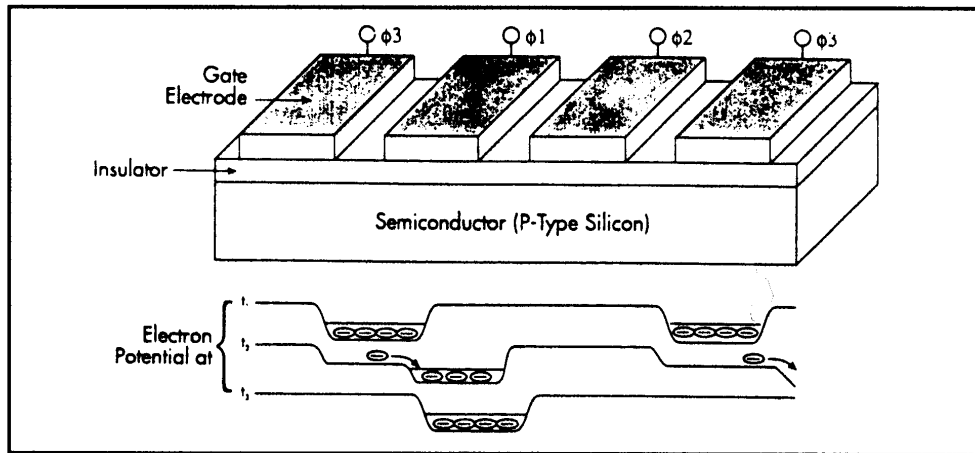
Diode structure.

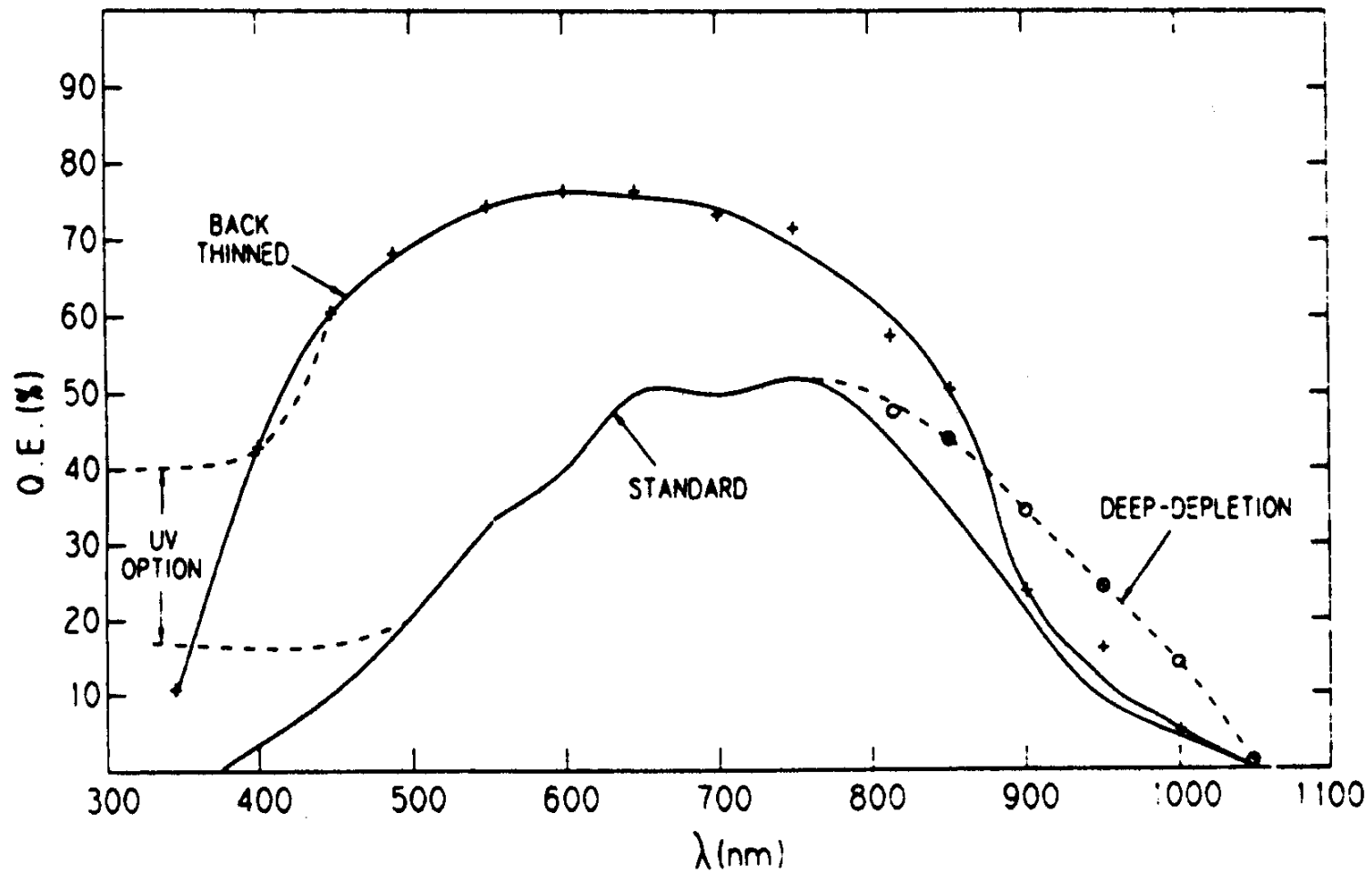
Charge Coupled Device CCD



Potential well formation.

Charge transfer





CCD spectral response.

Intensified Charge Coupled Device Horiba Jobin Yvon ICCD

Obsah

- Úvod
- Princip ICCD
- cw/pulse regime, vnitřní/vnější spouštění (Triggering) signálu
- PCI Controller Card, LabSpec software
- Sensor (AN_32), Mode (Image/Spectrum), High Speed, High Gain, Offset
- Trigger (External/Internal), Integrated on chip, Frequency, Delay, Pulse width, Delay Output, MCP Gain
- Parametry ICCD Horiba Jobin Yvon

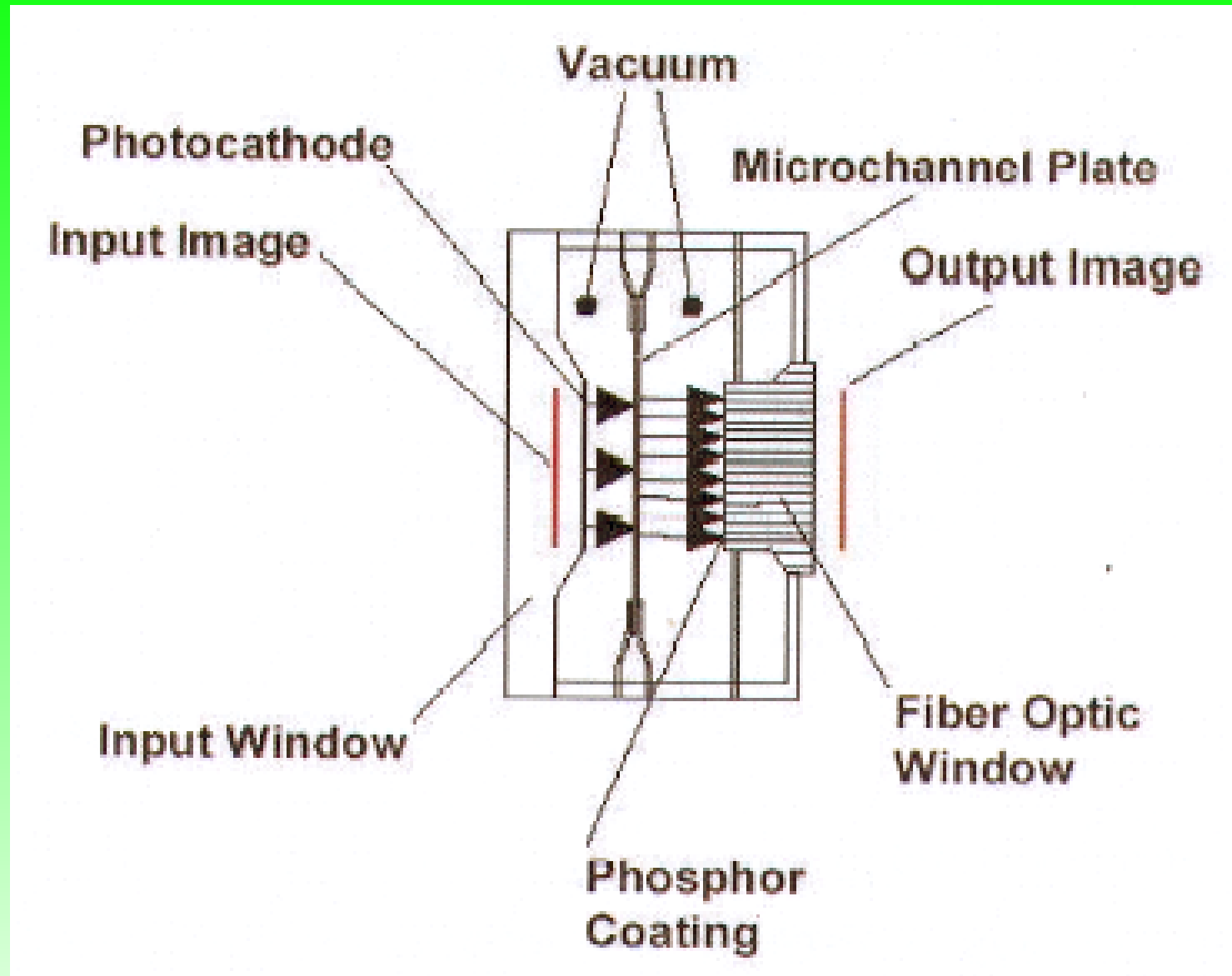
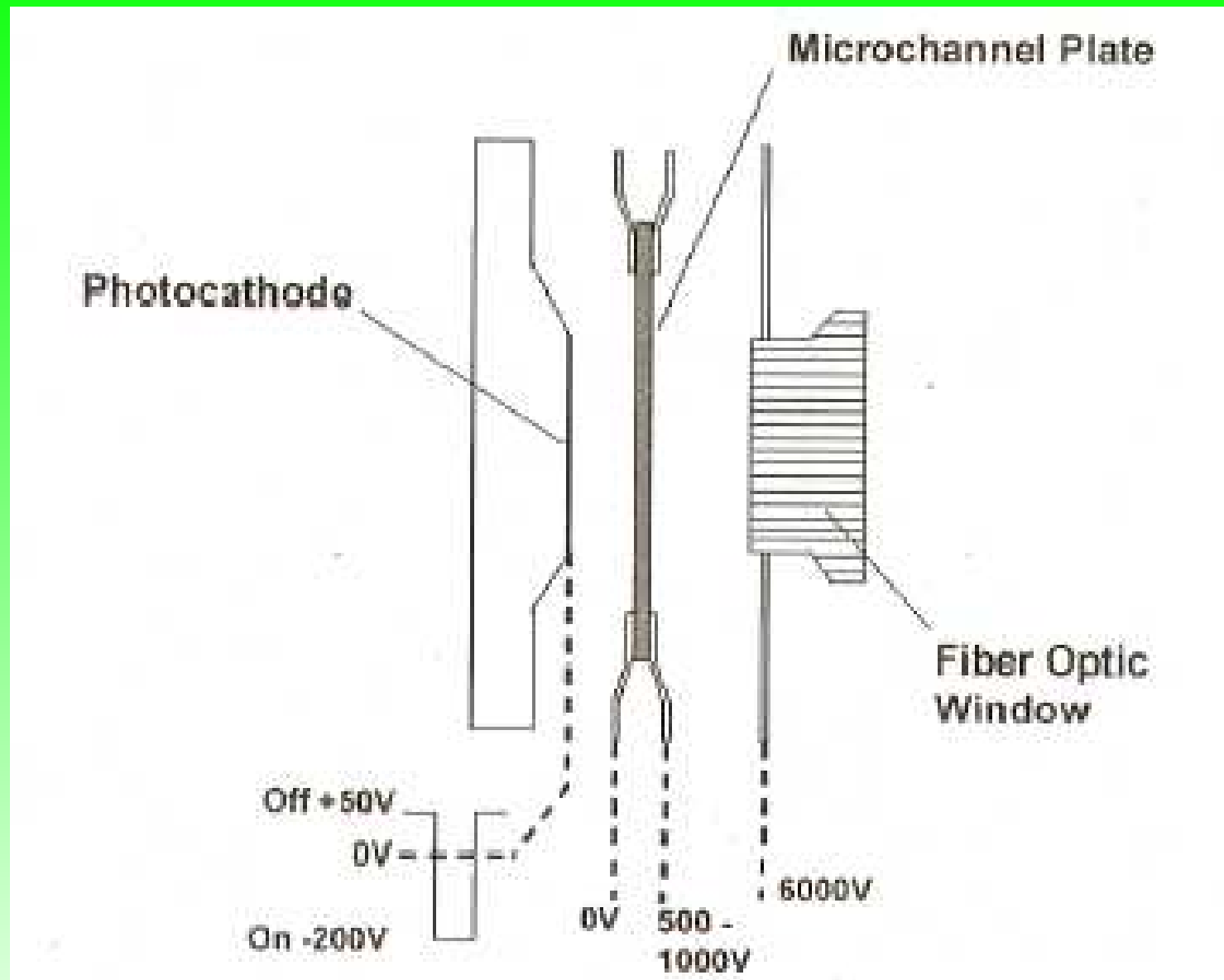
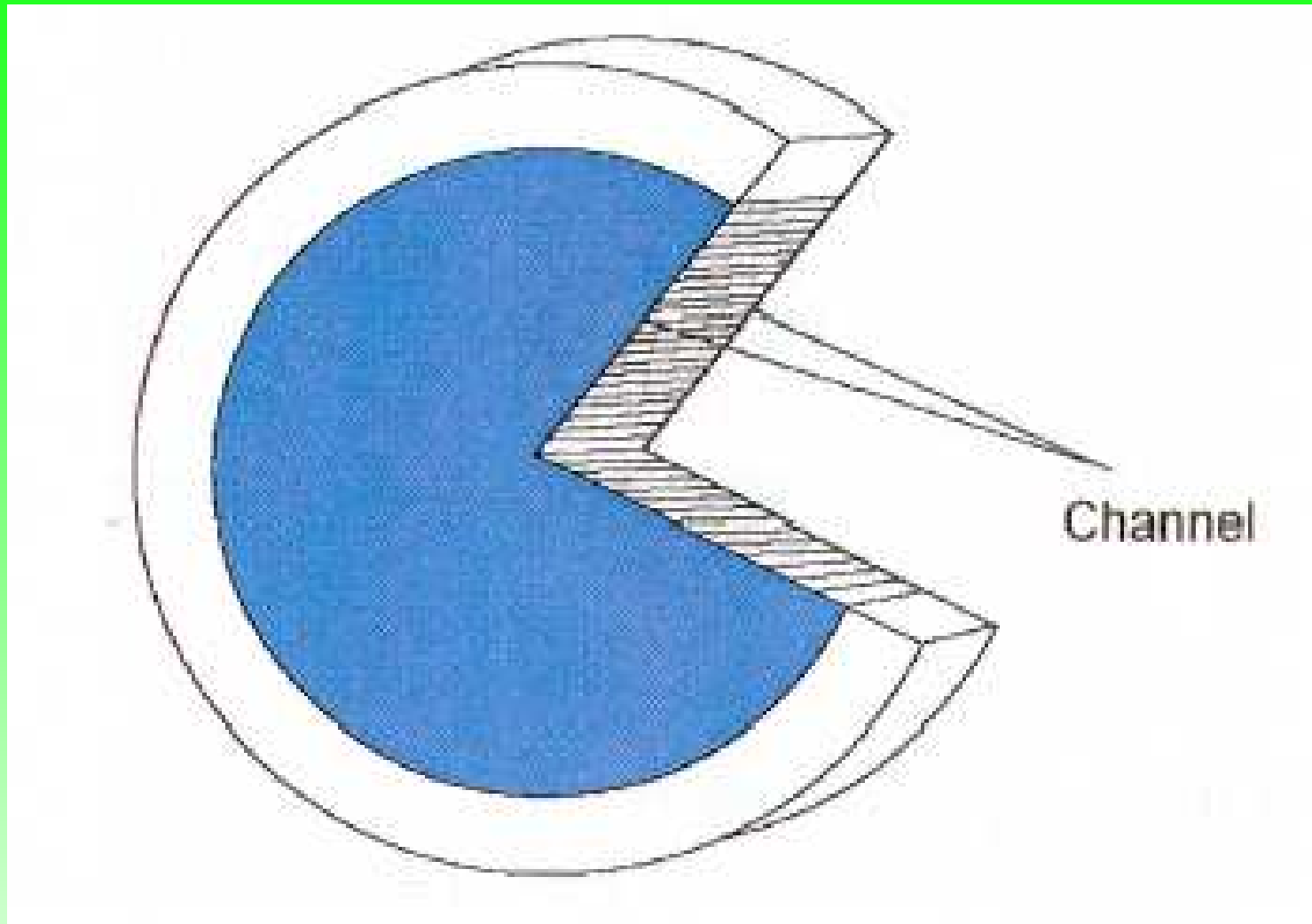


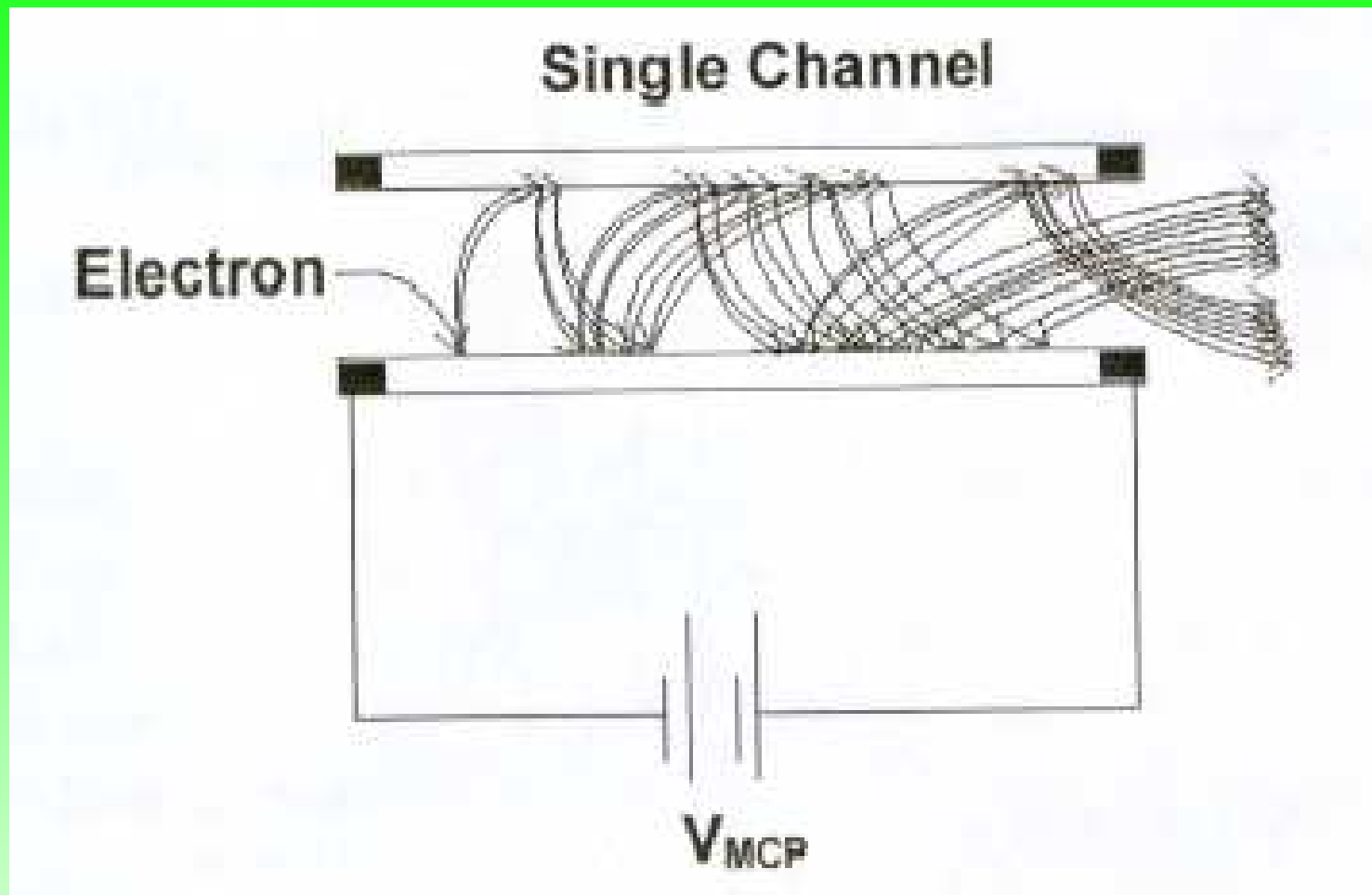
Schéma ICCD.



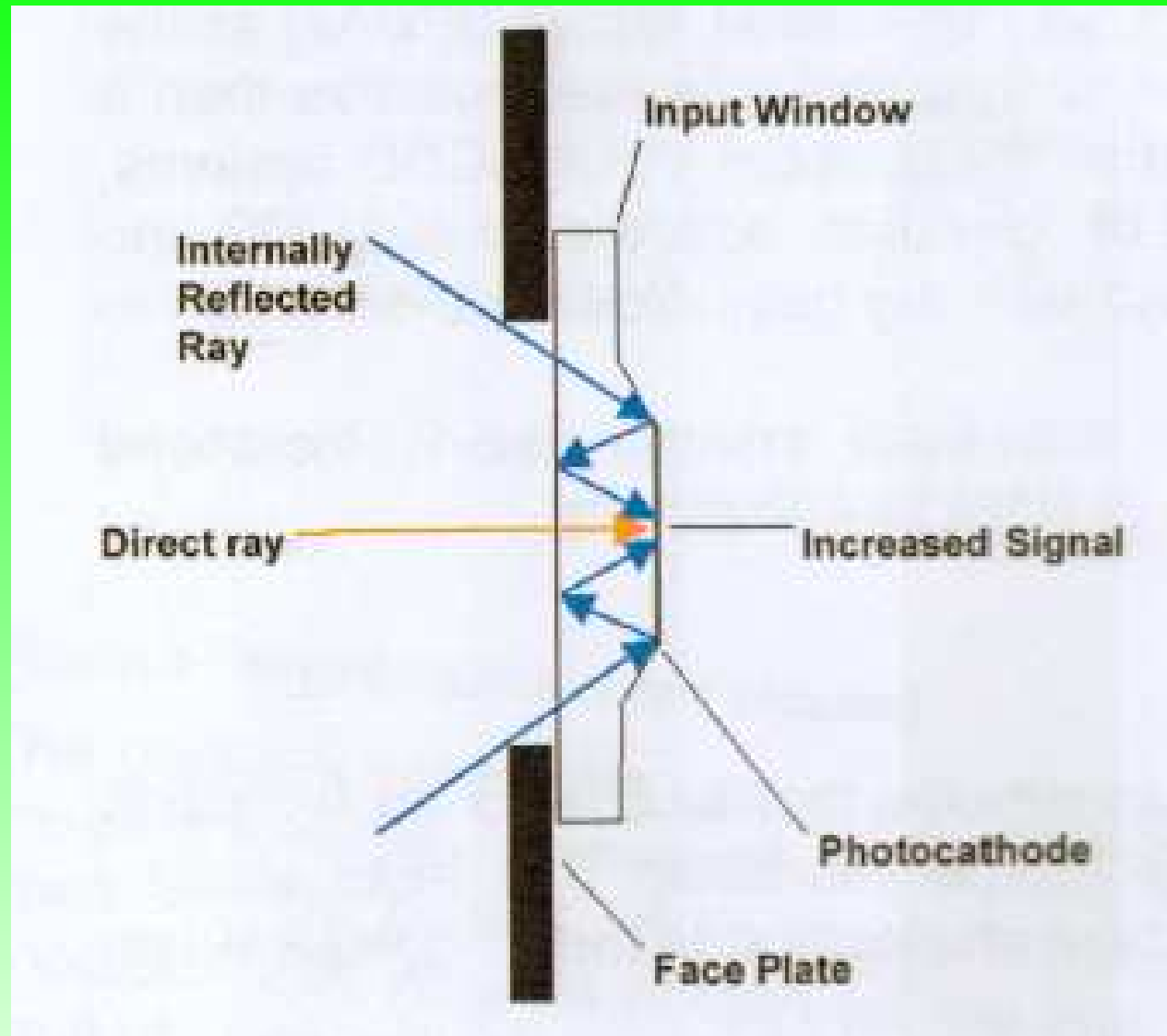
Pracovní napětí.



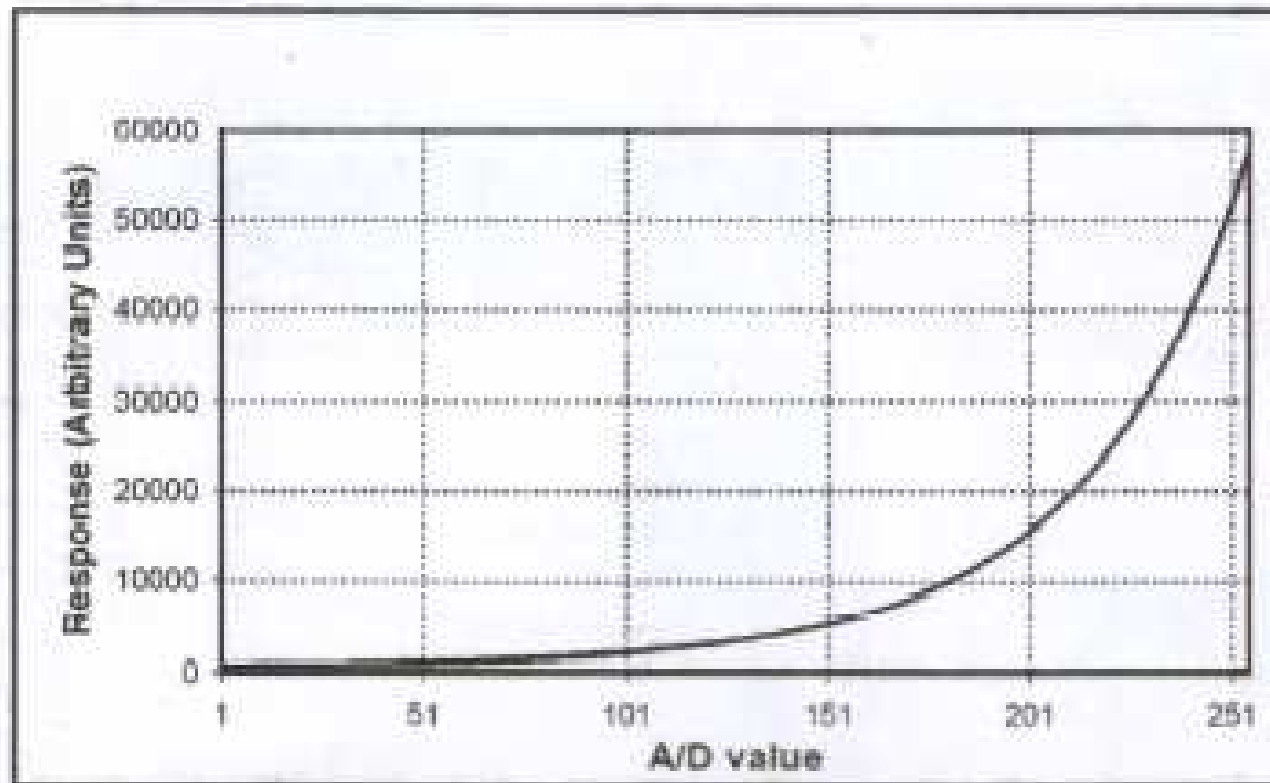
Microchannel Plate.



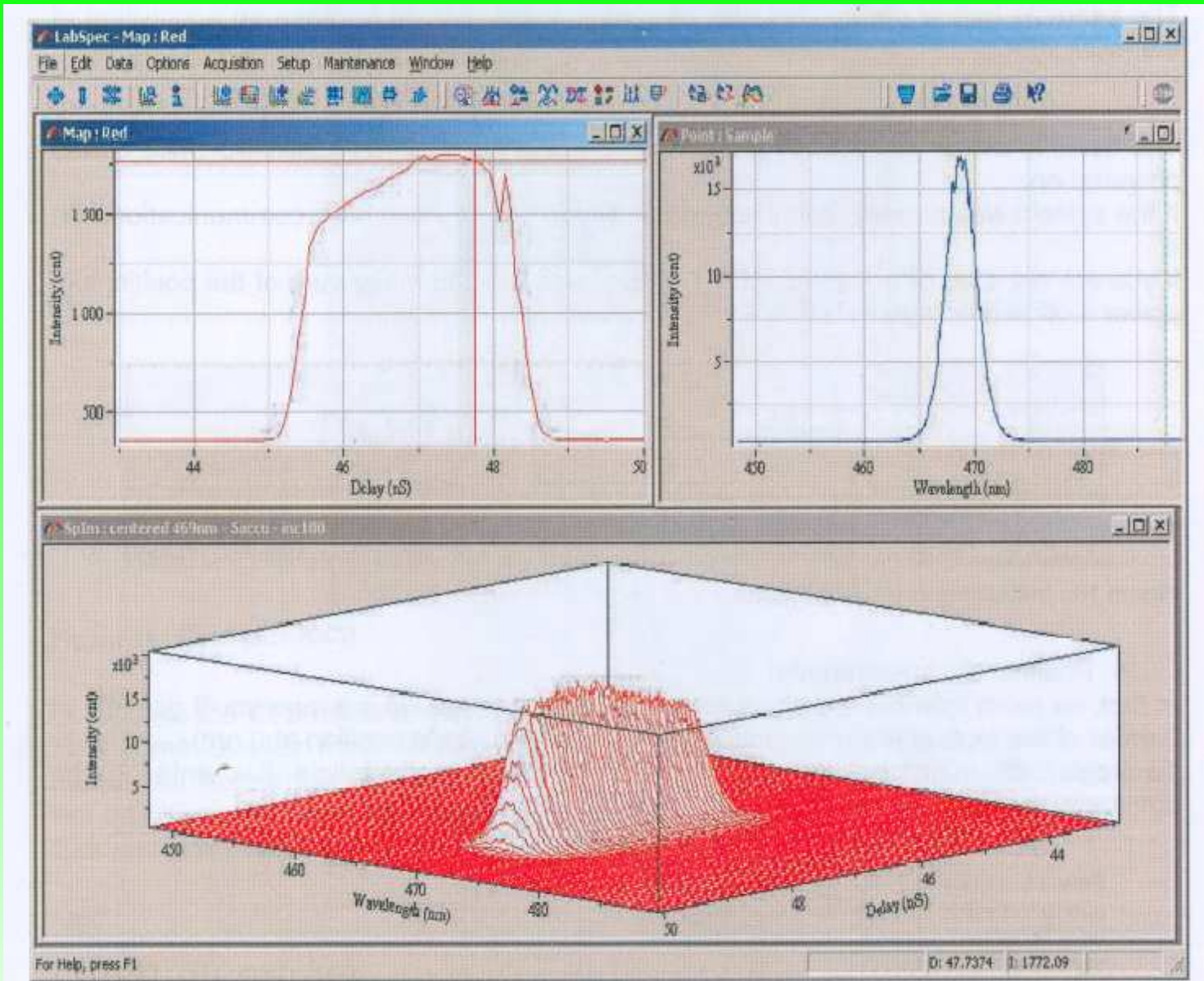
Detail jedného kanálku.



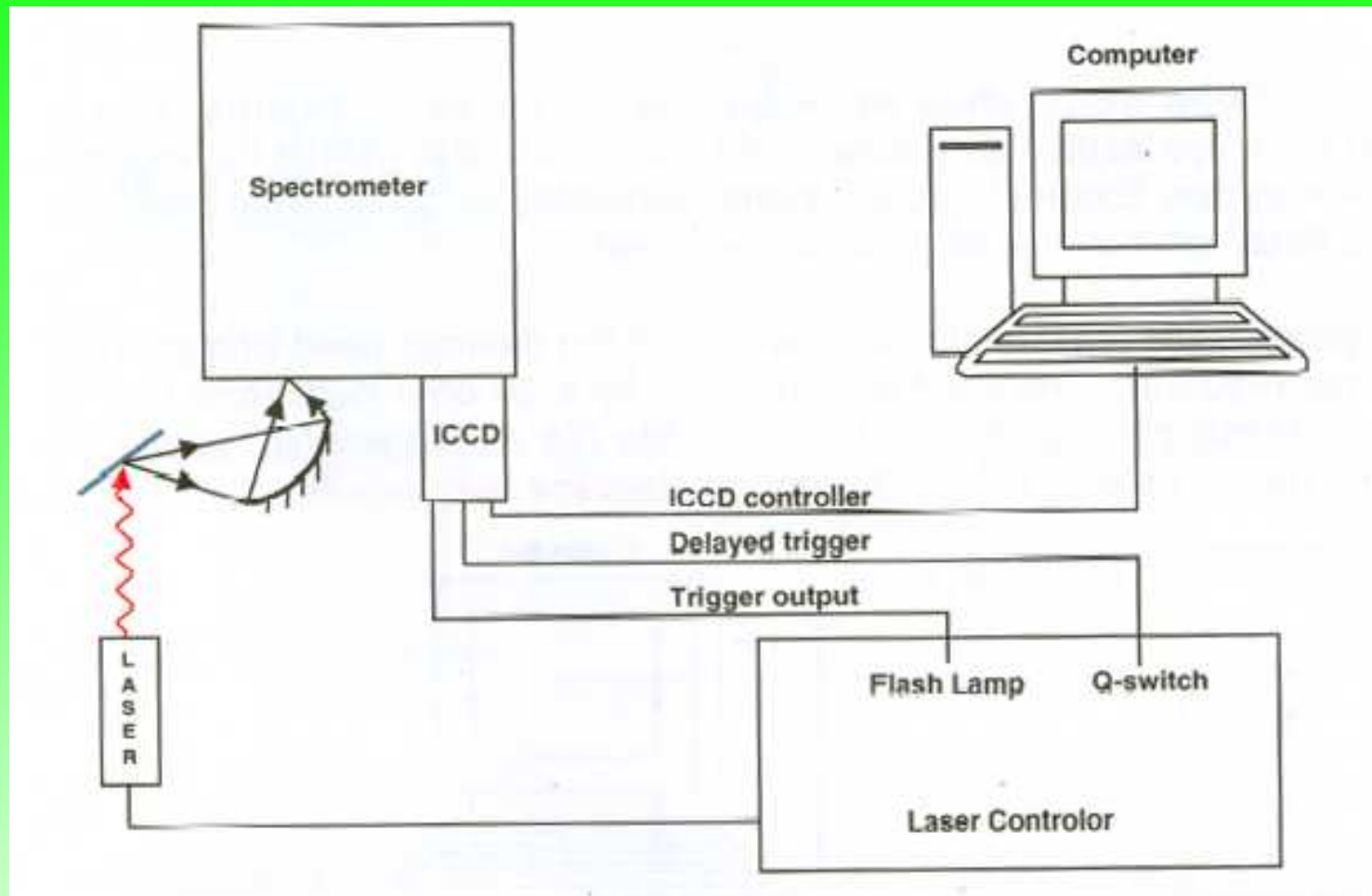
Průchod světla vstupním okénkem.



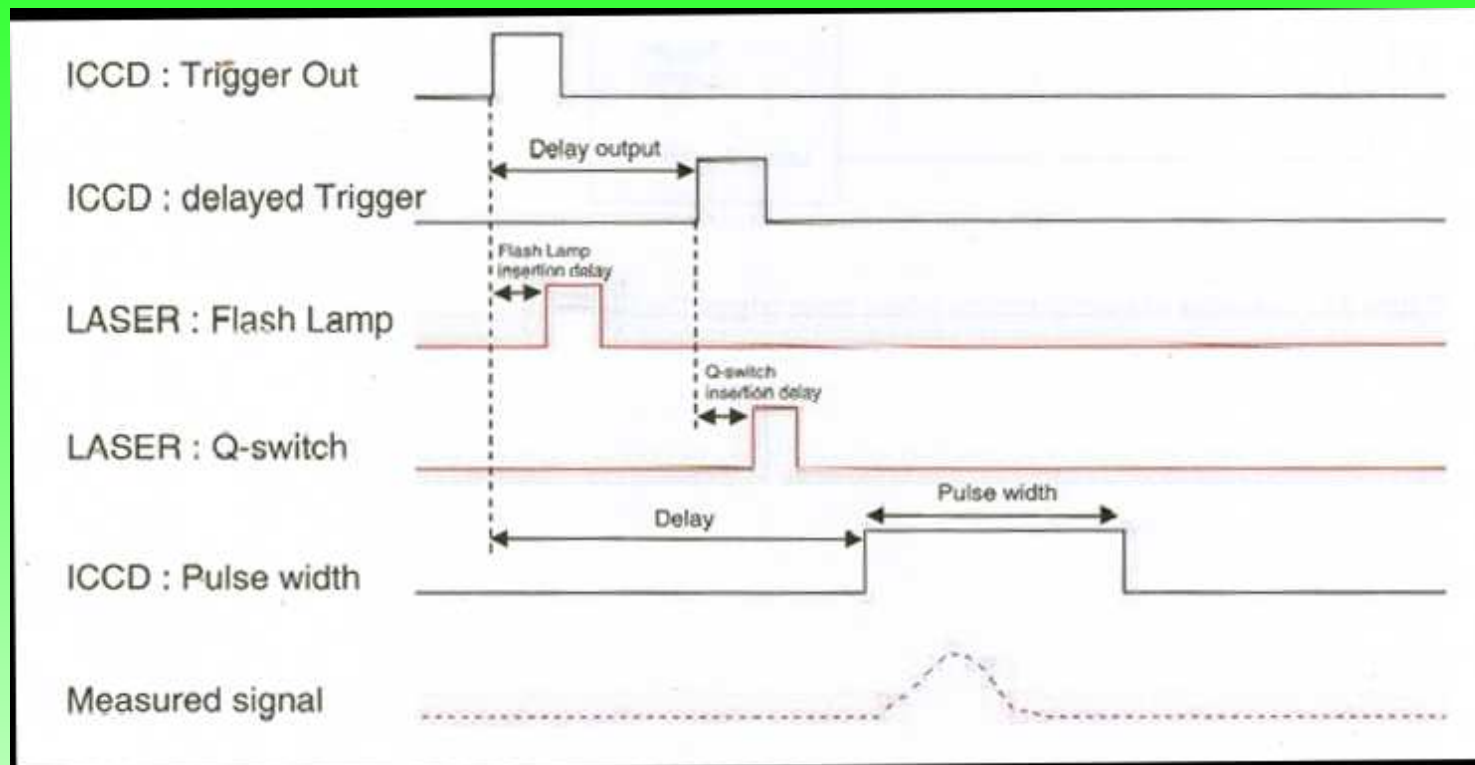
Úroveň signálu v závislosti na zesílení (Gain).



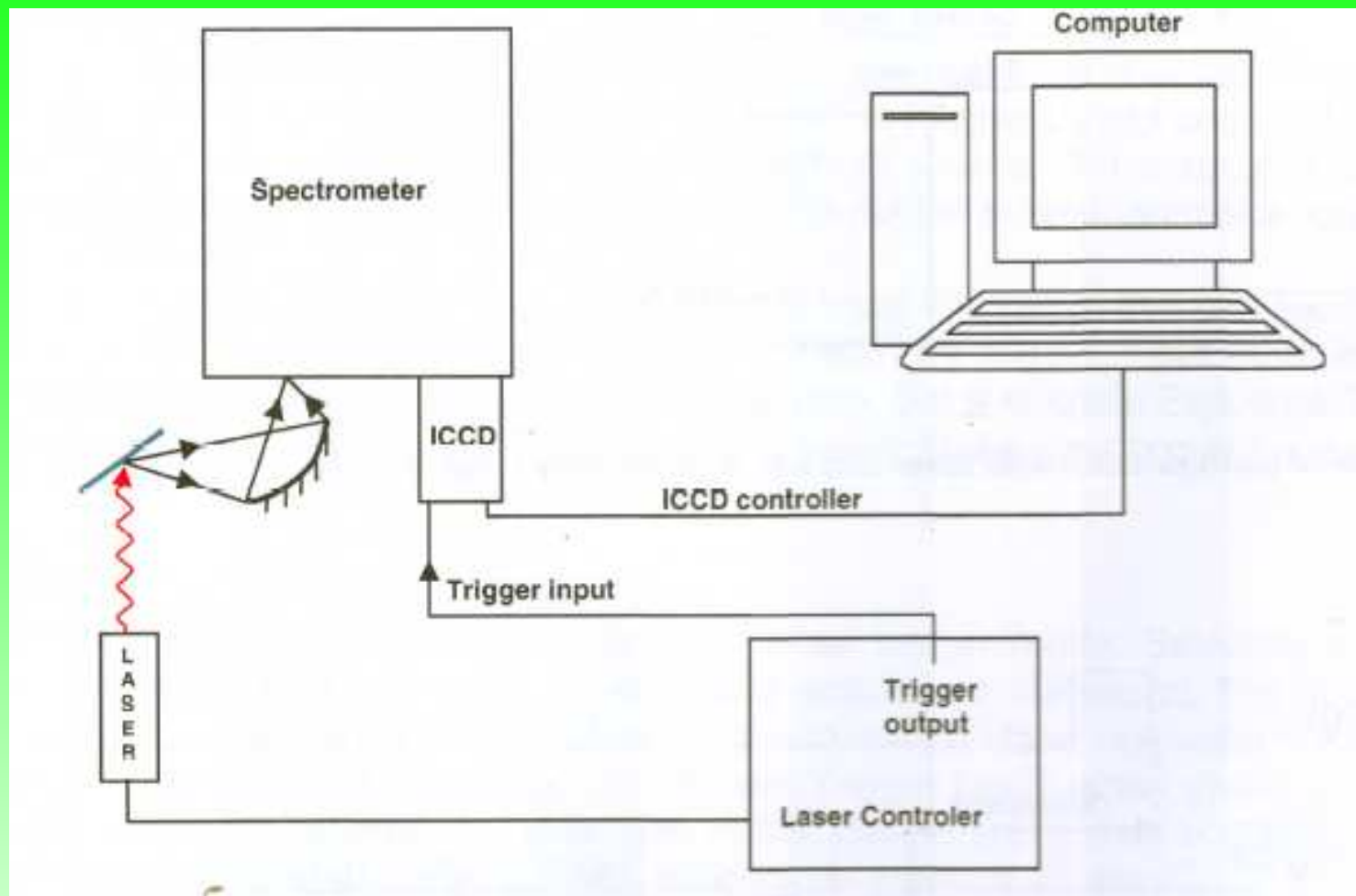
Typické mapování signálu - výstup programu LabSpec.



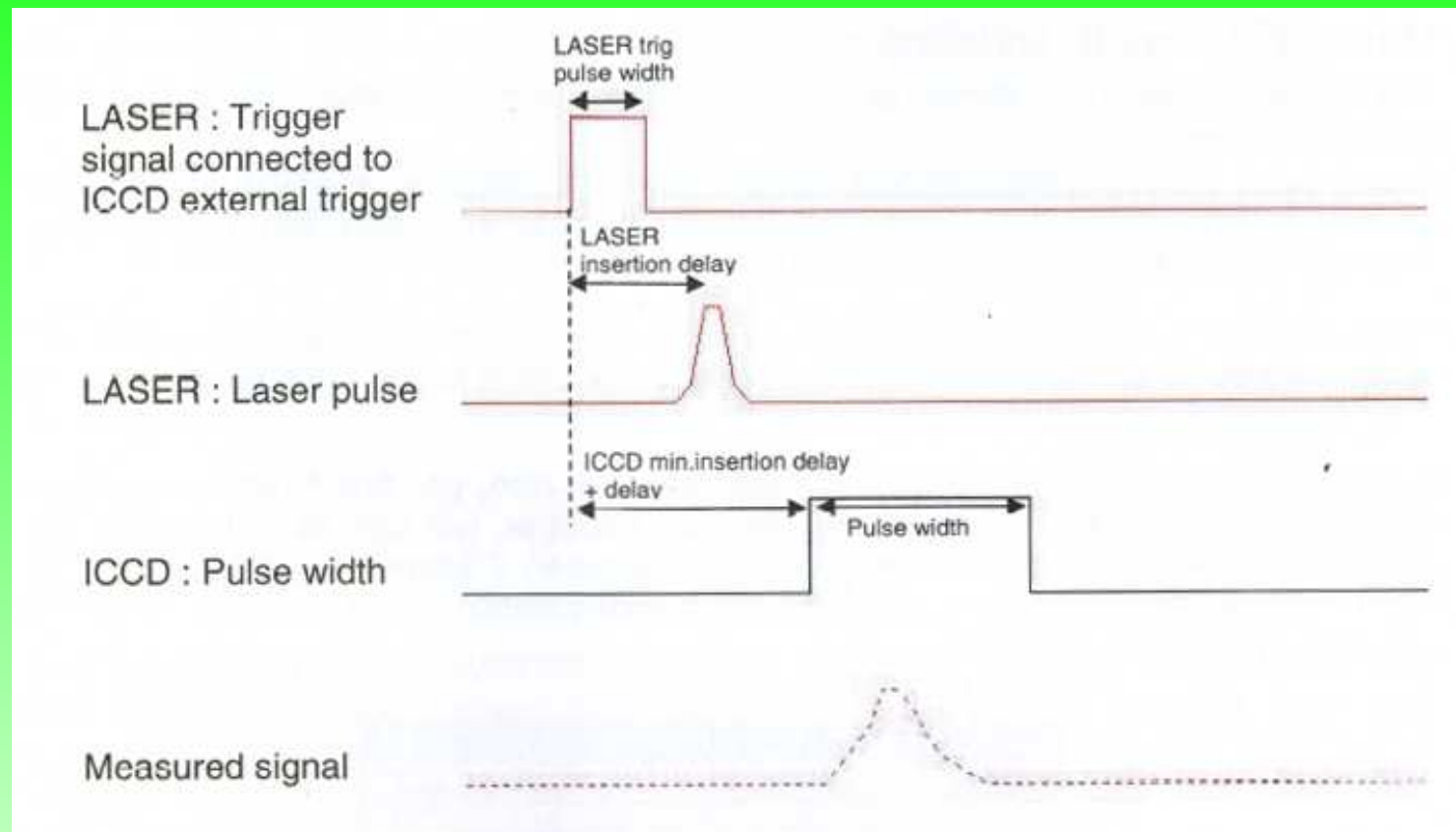
Externí spouštění - ICCD jako master, pulzní zdroj světla (laser).



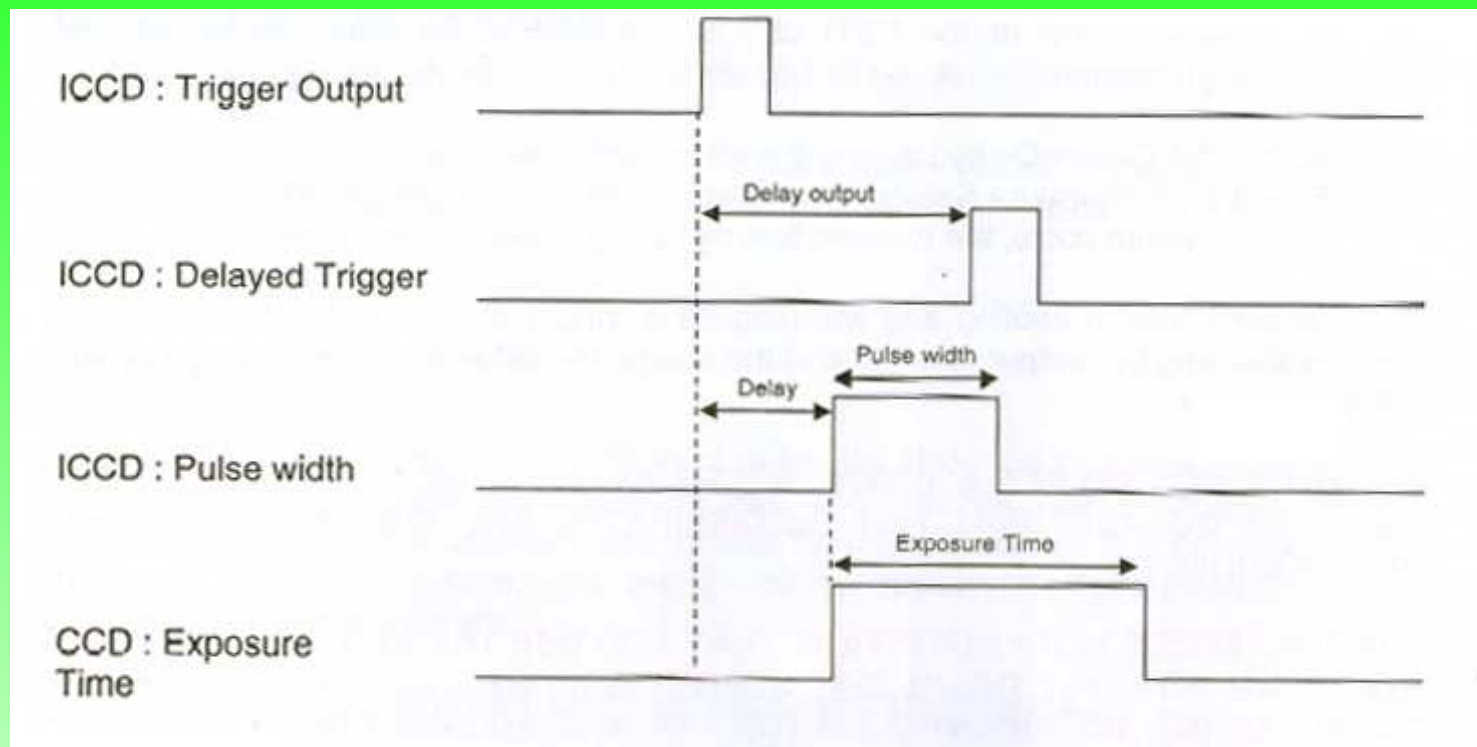
Časový diagram pro ICCD jako master.



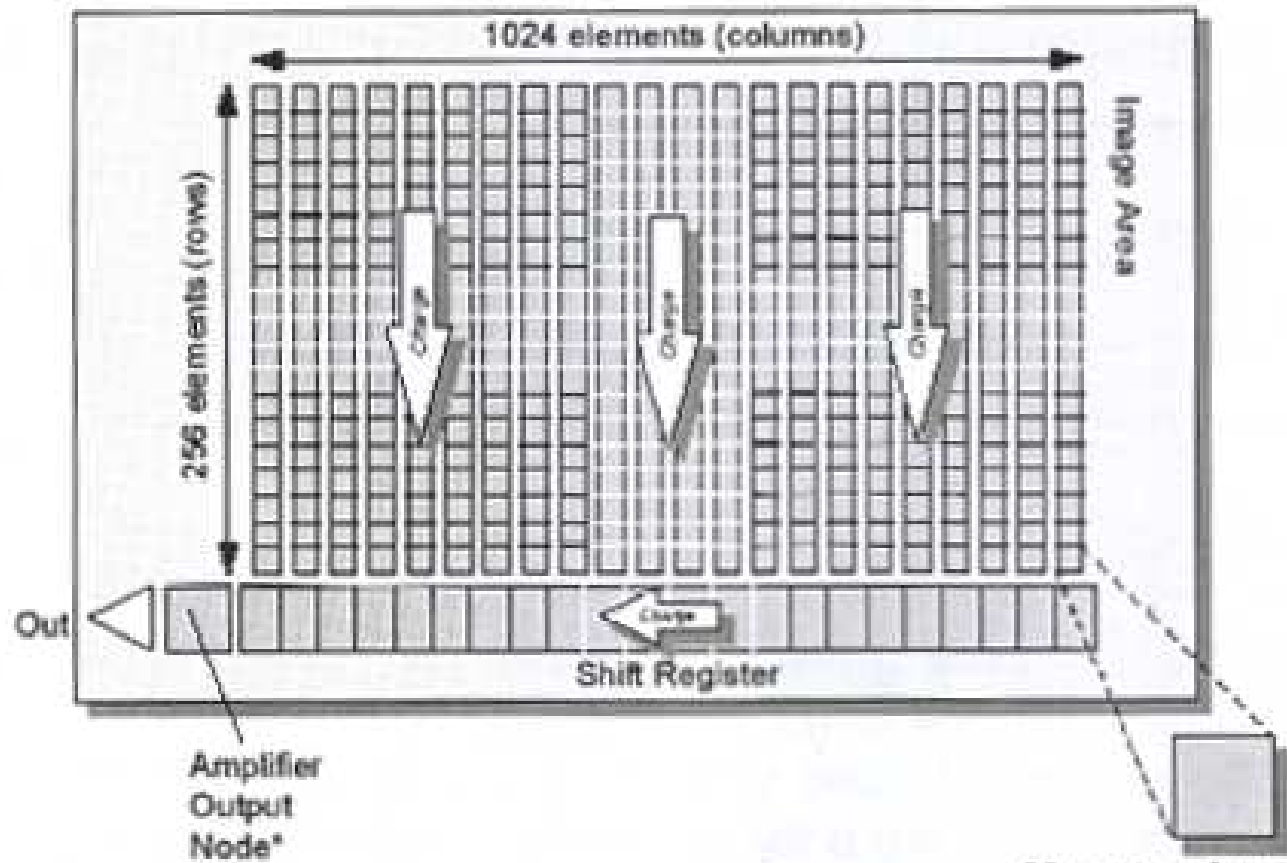
Externí spouštění - ICCD jako slave, pulzní zdroj světla (laser).



Časový diagram pro ICCD jako slave.

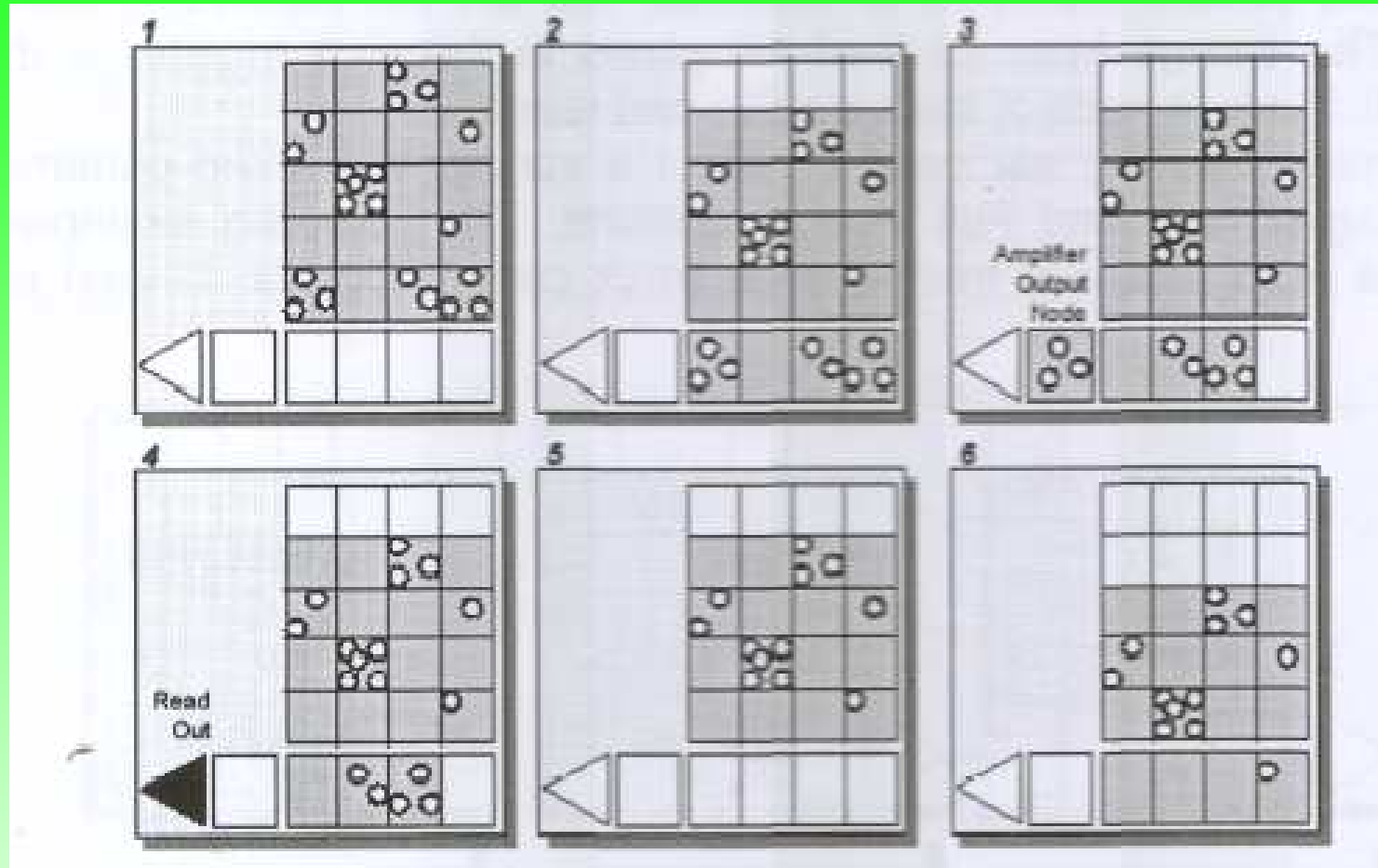


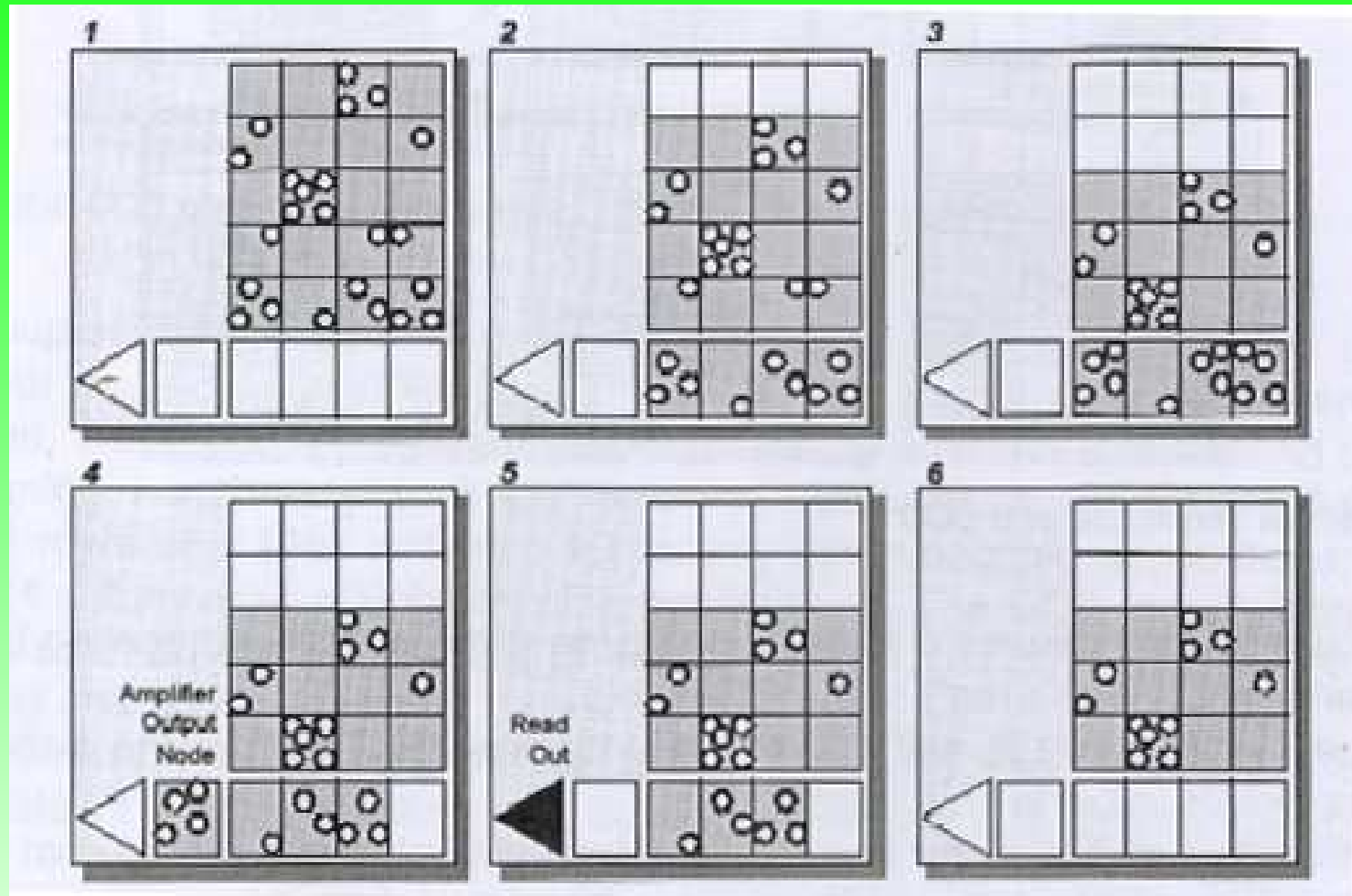
Časový diagram charakteristických veličin.



**Charge that is output from the shift register may be summed either on- or off-chip, depending on the chip model.*

26 square micron
element or pixel





Parametry ICCD Horiba Jobin Yvon 1024x256-18UVF

- UVF: 200 - 800 nm
- 18 mm Gen II intensifier with Suprasil window
- Fiber optic output window
- S20 photocathode
- P43 phosphor
- Standard 36 lp/mm MCP
- Fast gating down to 5 ns
- Digital delay generator on PCI controller card