4.2 Apparatives

4.2.1 Detektoren

a) Zylindersektoranalysator

electrostatic cylinder sector analyser (auch 127°-Analysator)

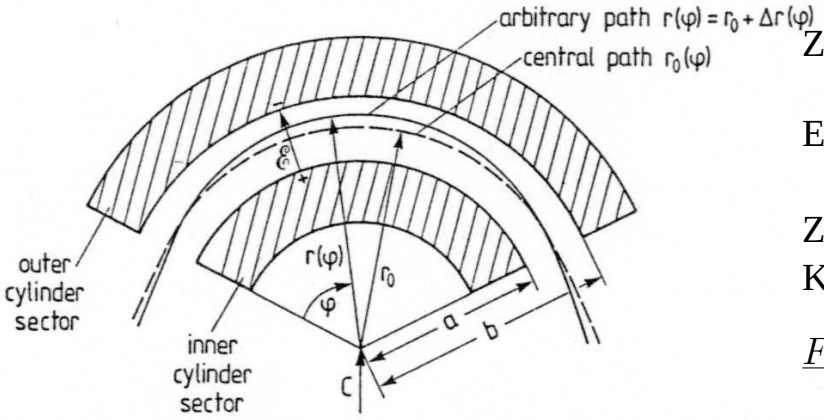


Fig.II.6. Electrostatic cylinder sector energy analyzer (schematic). The electric field between the two cylinder sectors (*shaded*) exactly balances the centrifugal force for an electron on the central path r_0.
An arbitrary electron path around the central path is described by the deviation $\Delta r(\varphi)$ from the central path

Zylinderkondensator:

El. Feld $\underline{\mathcal{E}} = -\frac{U}{r \cdot ln\frac{b}{a}}$

Zentralbahn r_0 aus Kräfte-Gleichgewicht:

$\underline{F_e} = \underline{F_Z}$

$\Rightarrow \frac{mv_0^2}{r_0} = -e\underline{\mathcal{E}}_0 = \frac{eU}{r_0 ln\frac{b}{a}}$

Pass-Energie E_0:

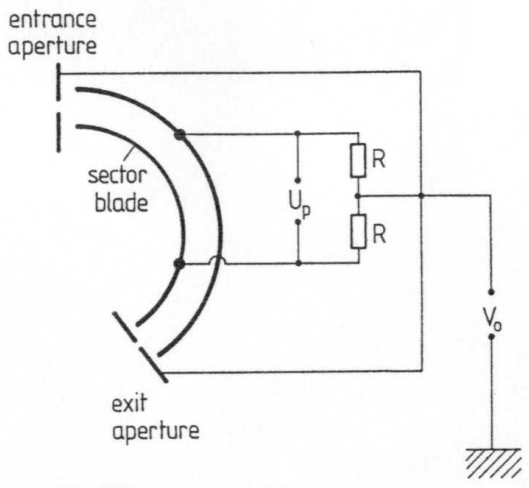


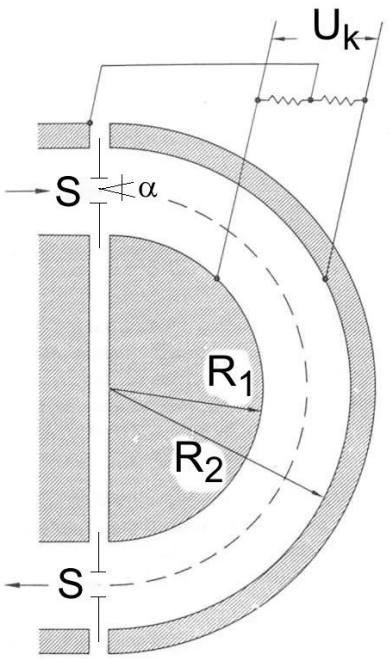
Fig.II.10. Simple electronic circuit for supplying the appropriate voltages to an electron energy analyzer

Energieauflösung:

Spannungen

b) Kugelanalysator

Concentric hemisperical analyser (CHA)



$U_k = U_e(\frac{R_2}{R_1} - \frac{R_1}{R_2})$

$E_{kin}(r_0) = eU_e = eU_k \frac{R_1 R_2}{R_2^2 - R_1^2}$

2 focal planes (spherical geometry)

$\phi_f = 180\circ$

$\frac{\Delta E}{E} \sim \frac{\omega}{2r_0} + \alpha^2$

α entrance divergence

$\Rightarrow$2 measurement modes:

a) CRR = constant retard ratio

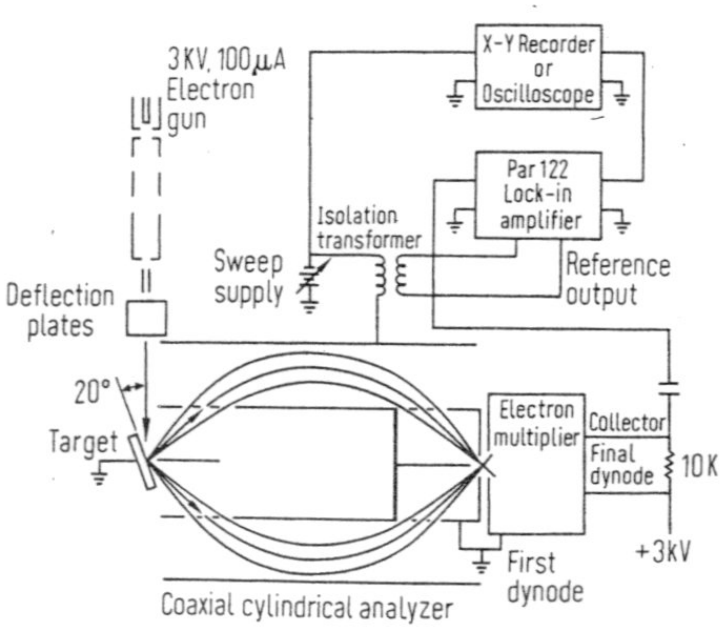
$\Rightarrow \frac{\Delta E}{E} = const$

b) CAE = constant analyser (pass) energy

$\Rightarrow \Delta E = const$

c) Zylinder-Spiegel-Analysator

cylindric mirror analyser (CMA)



$E_0 = \frac{eU}{\kappa \cdot ln\frac{b}{a}}$

$\kappa = \kappa(\alpha)$

$\kappa(\alpha = 41°) \approx 0.77$

$\frac{\Delta E}{E} \sim const$

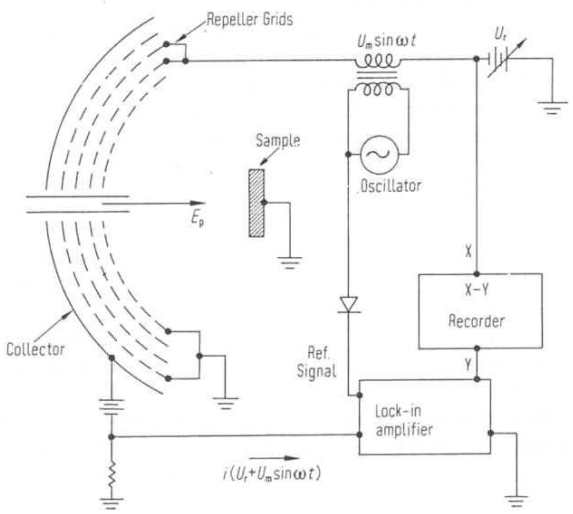
$\frac{\Delta E}{E} = const \Rightarrow I \sim N(E) \cdot E$!!

$\Rightarrow$ Rauschproblem bei niedrigen Energien

Lösung: Vorverzögerung, aber Intensität sinkt

d) Gegenfeldspektrometer

Retarding field analyser (RFA)



e) Praktische Ausführungen

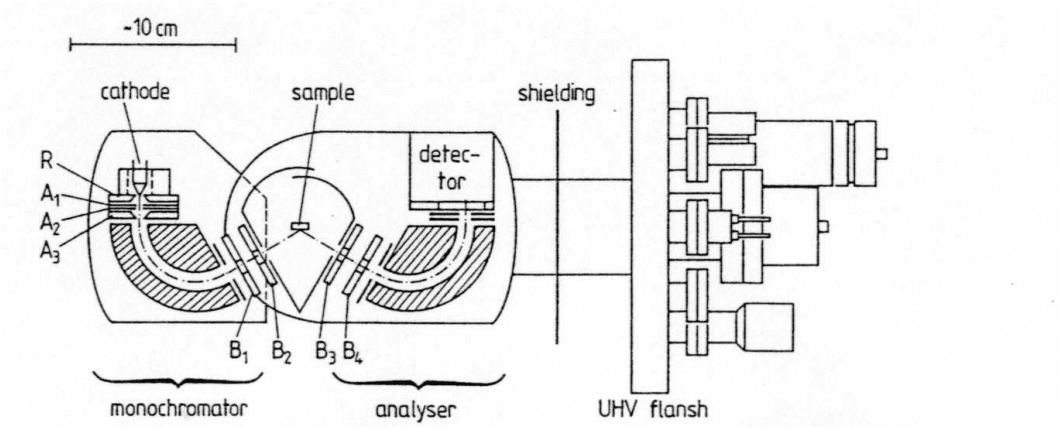


Fig.II.7. Schematic plot of a high-resolution electron energy loss spectrometer consisting of a cathode system (filament with lens system), a monochromator (cylindrical sectors), a similar analyzer and a detector. The monochromator can be rotated around an axis through the sample surface. The whole set up is mounted on a UHV flange

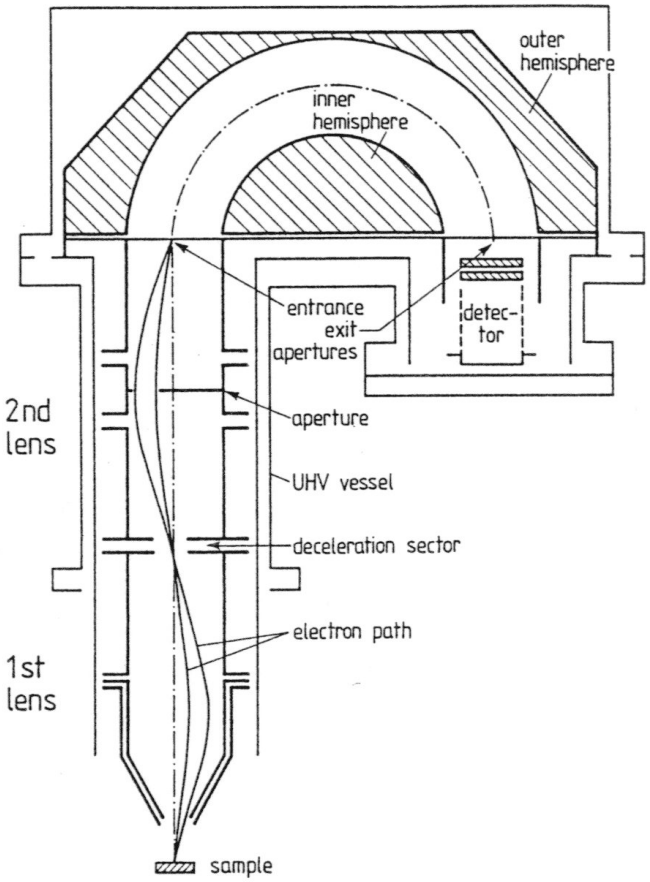


Fig.II.8. Schematic plot of a hemispherical electron energy analyzer consisting of two entrance lenses which focus the incoming electrons onto the entrance aperture, two hemispherical electrodes facilitating energy analysis and a detector (e.g., secondary-electron multiplier)

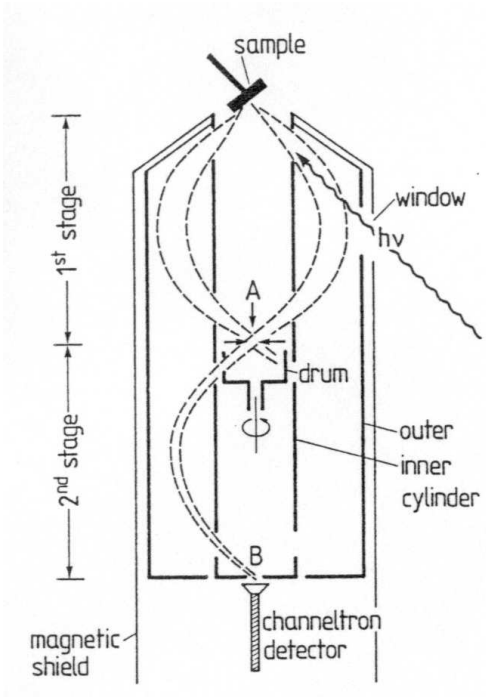


Fig.II.9. Double stage Cylindrical Mirror Analyzer (CMA) consisting of two analyzer units. For photoemission experiments the exciting light beam enters through a window and hits the sample surface. The emitted electrons enter the analyzer (outer and inner cylindrical mirror) within a certain cone. Measurements with angular resolution can be performed by means of a rotatable drum in front of the entrance to the second stage. A window in the drum selects electrons from one particular direction only. The second stage images point A into point B at the channeltron detector