University of Maryland Baltimore County - UMBC
Phys650 - Special Topics in Experimental Atmospheric Physics
(Spring 2009)

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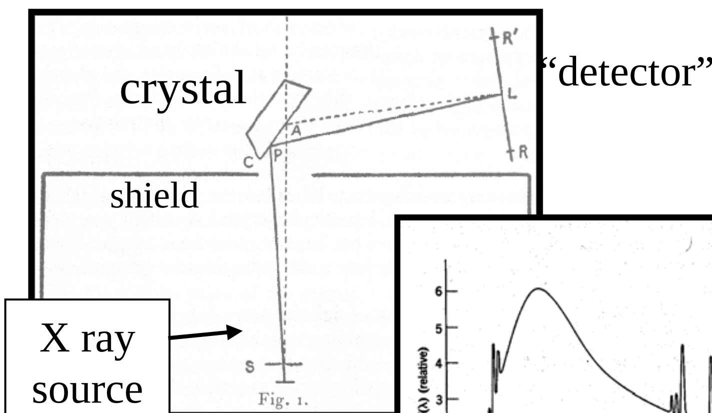
http://userpages.umbc.edu/~martins/PHYS650/

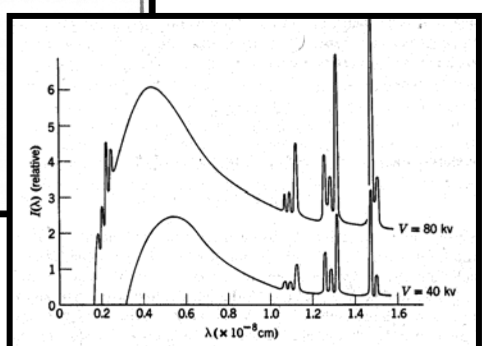
CLASS7 – 3/11/2009

X-Ray analysis of single particles

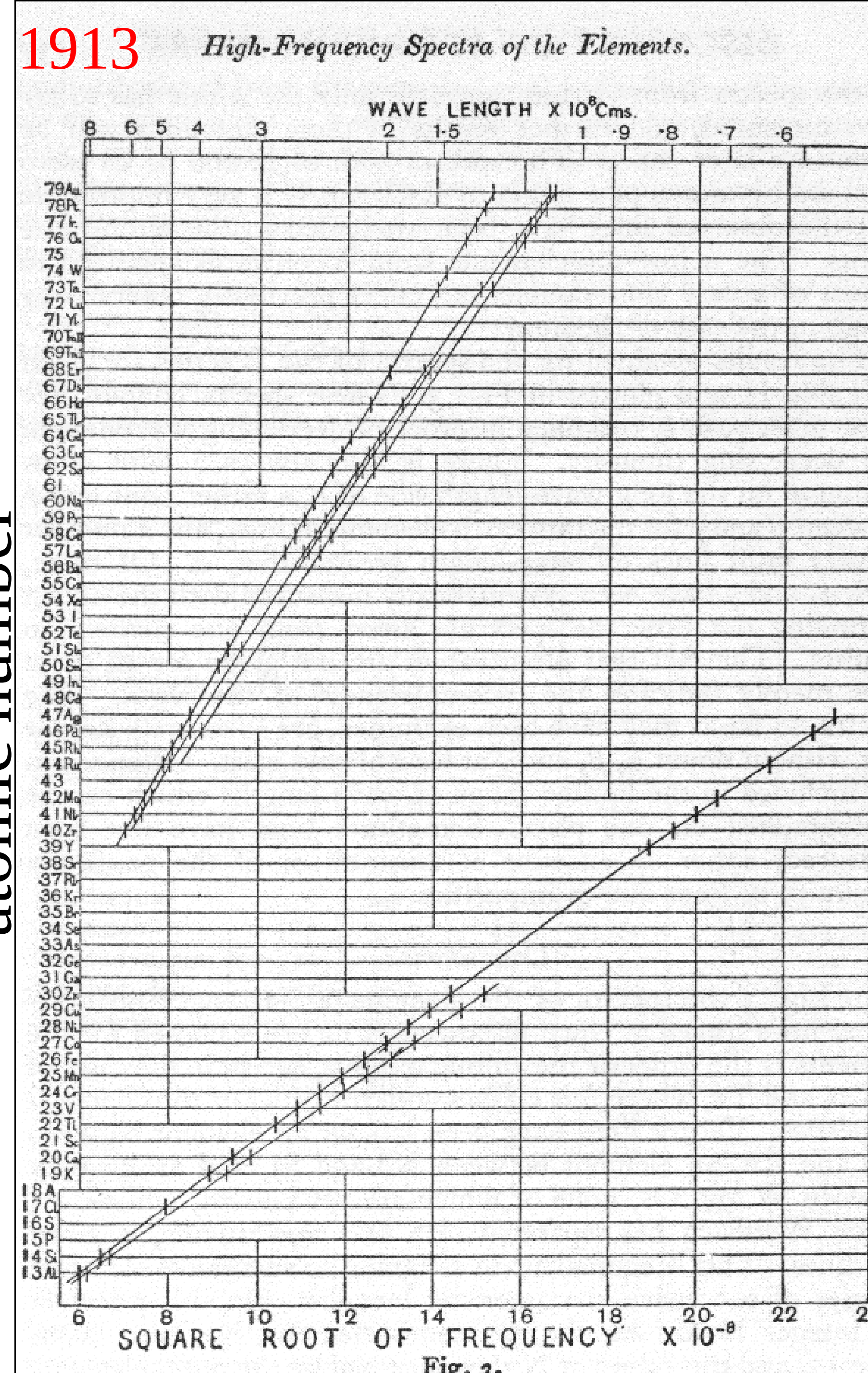
Henry Moseley (1887-1915)

X-ray spectroscopy

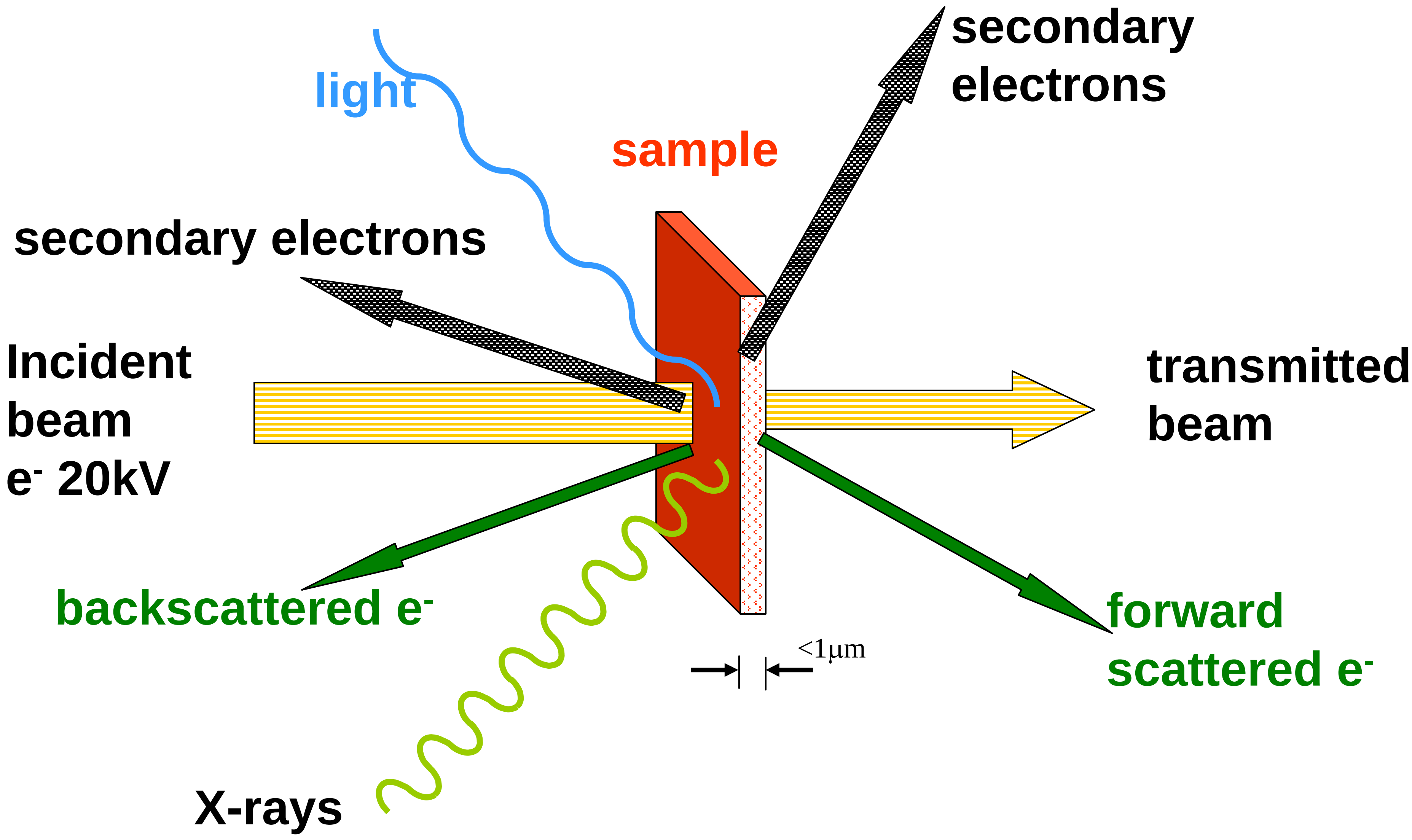




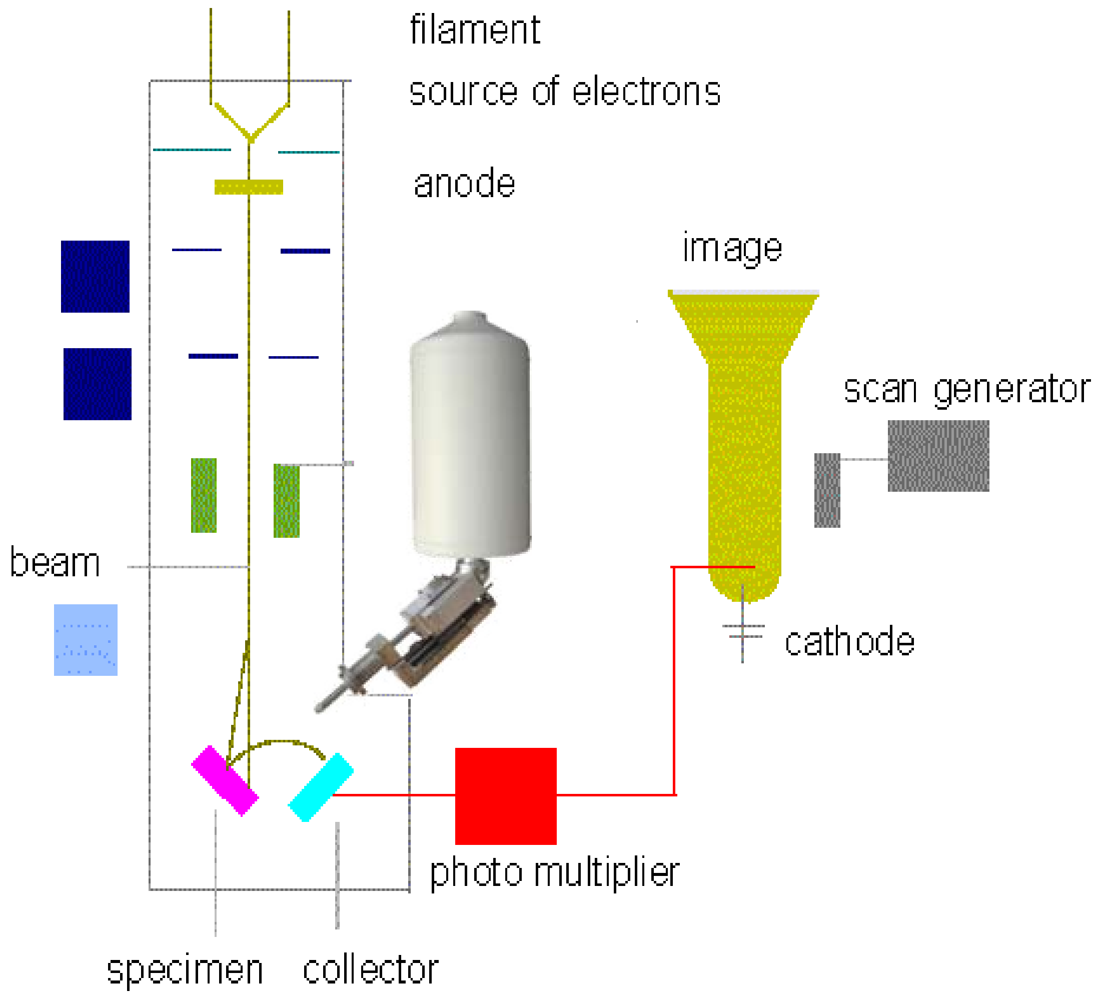
atomic number



e⁻ X-ray excitation

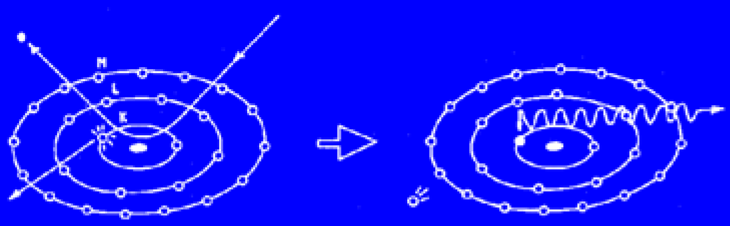


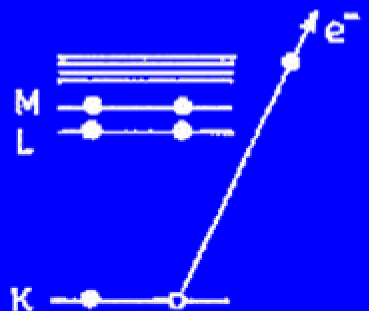
SEM+Si(Li)



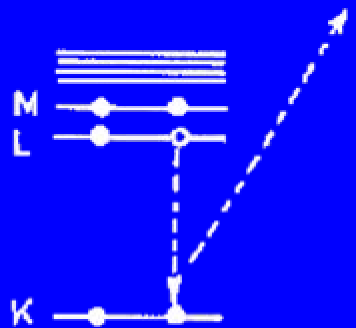
Adapted from Oxford Materials, University of Oxford. http://www-em.materials.ox.ac.uk/

electron ionization and de-excitation

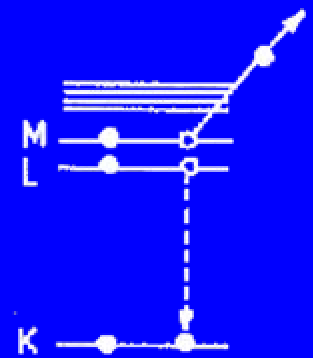




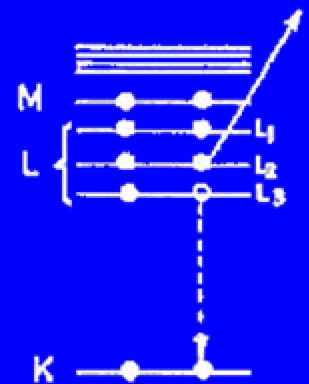
ionization



X-Ray emission



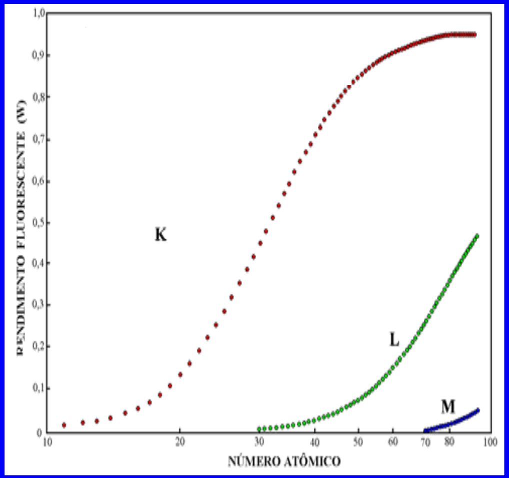
Auger electrons



Koster-Krönig transitions

Fluorescent yield

$$\omega = \frac{N_X}{N_X + N_e}$$

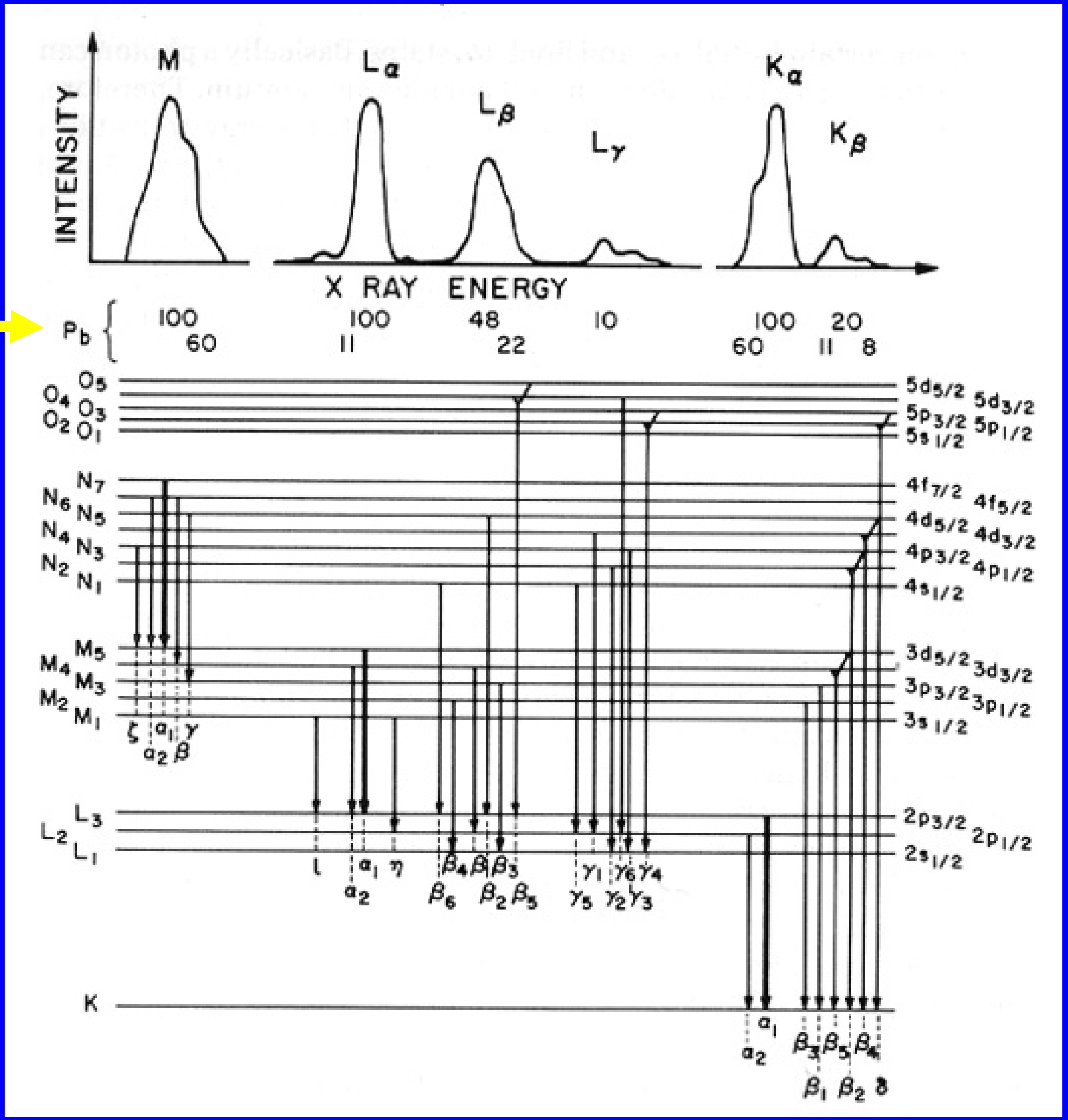


Adapted from Govil, I. M., Current Science, Vol. 80, No. 12, 25 June 2001

X-ray spectrum

M lines L lines K lines

relative intensities



Dipole transitions

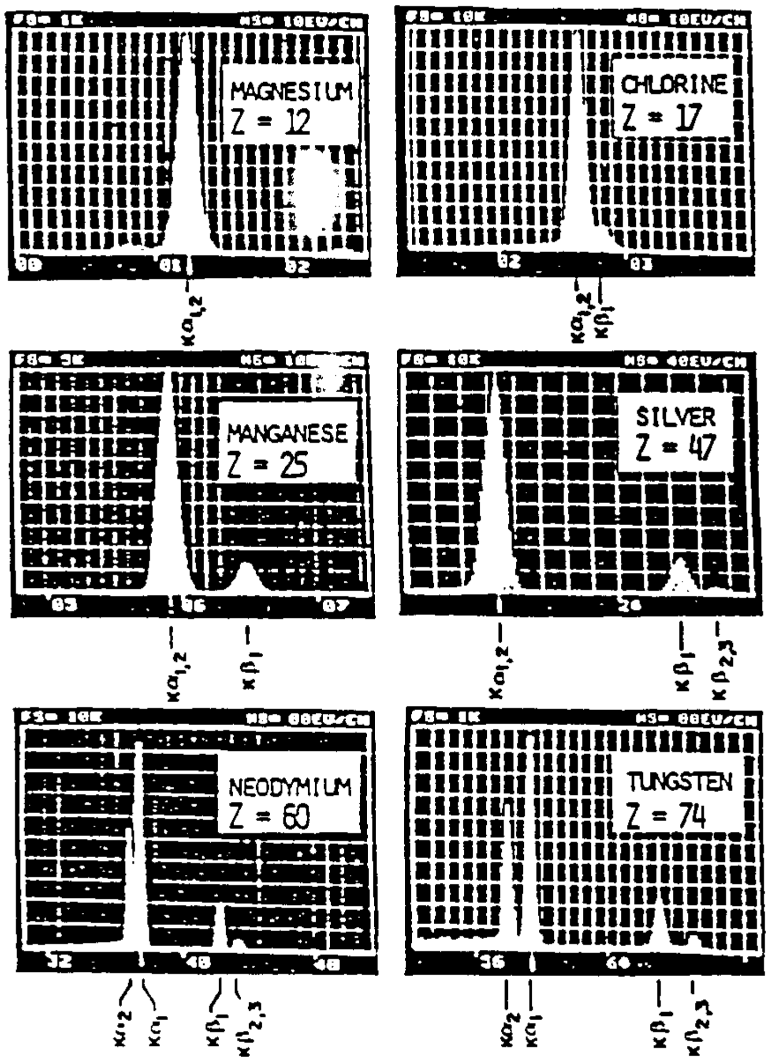
$$\Delta s \neq 0$$

$$\Delta j = 0, \pm 1$$

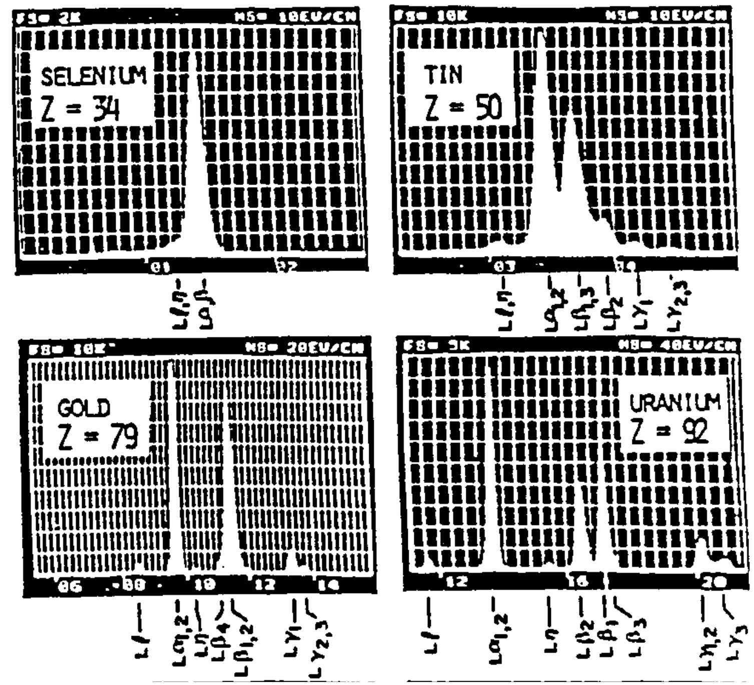
$$j = \ell \pm |s|$$

Important characteristic X-Ray lines

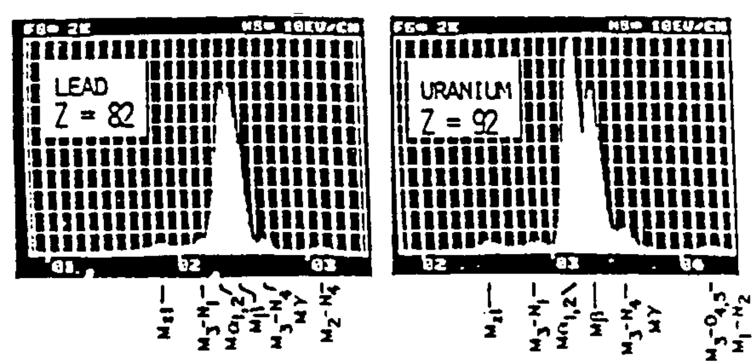
K lines



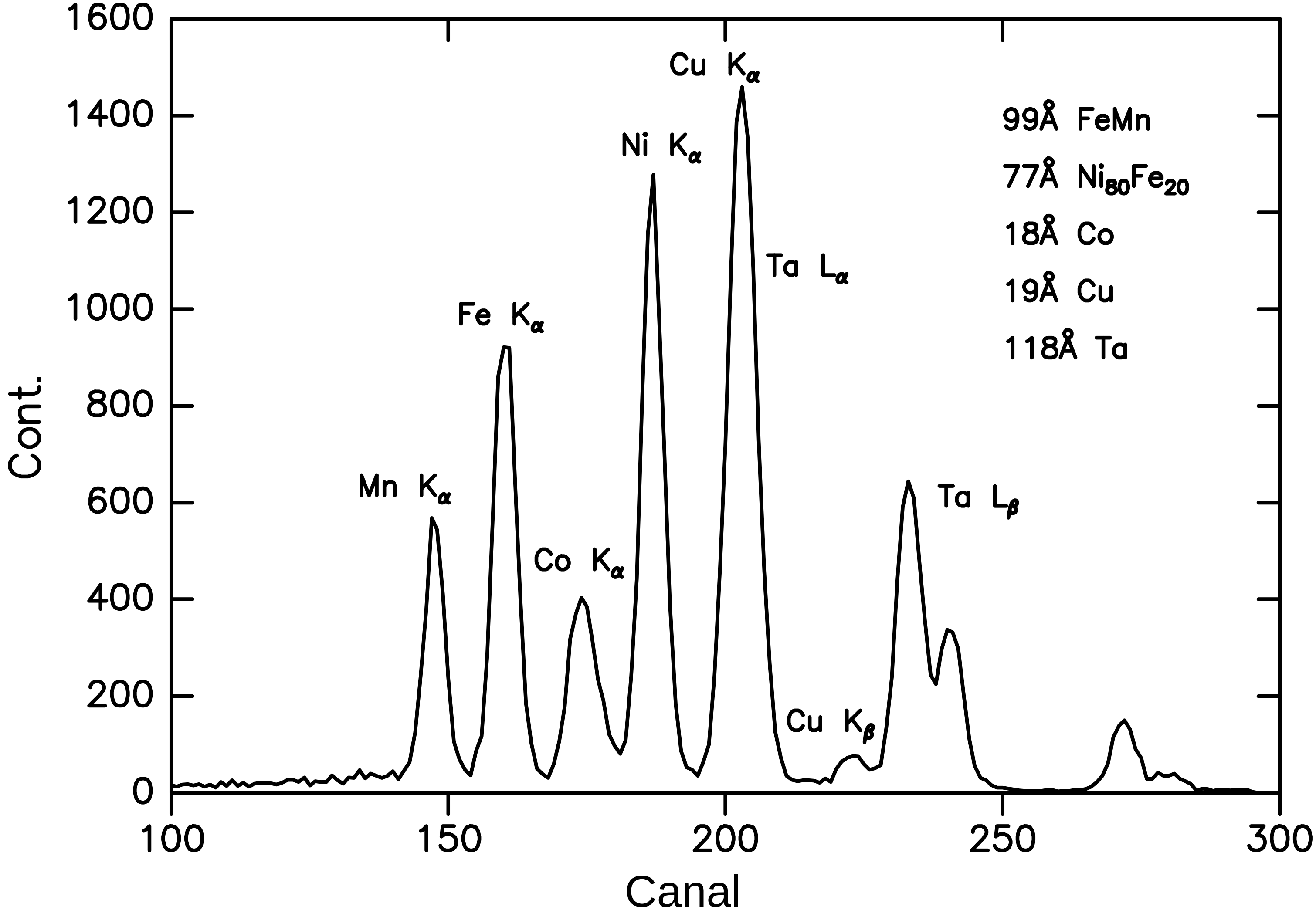
L lines



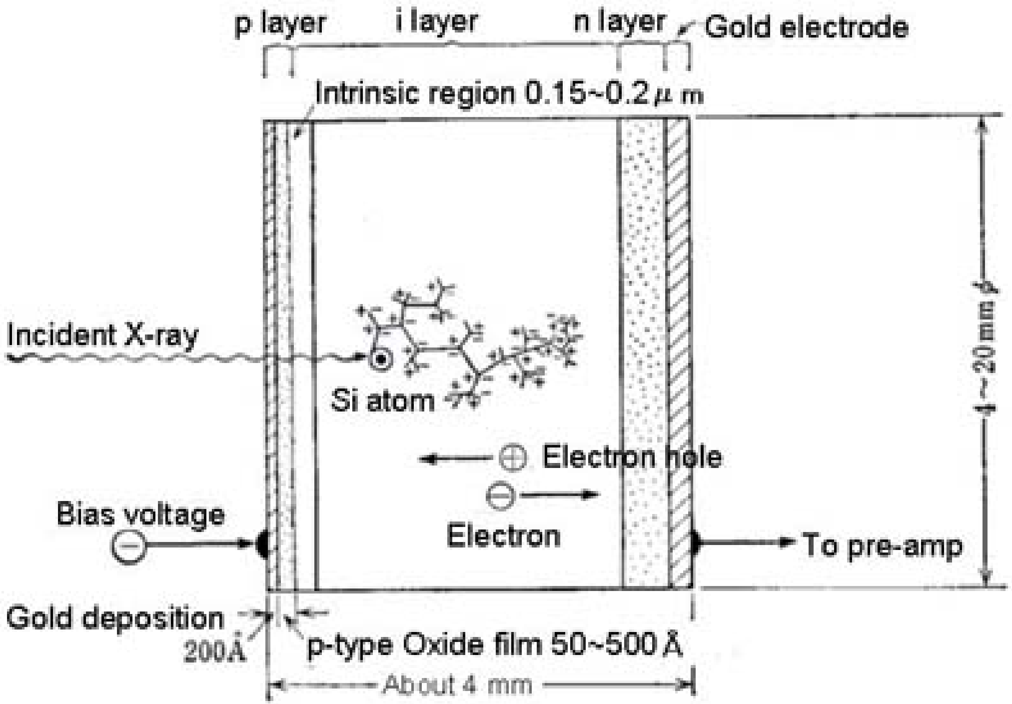
M lines



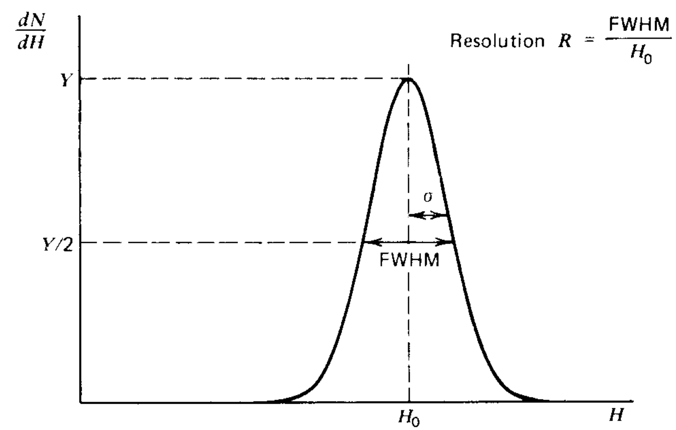
A real multielement X-ray spectrum (thin film)



The X-Ray detector: Biased diode



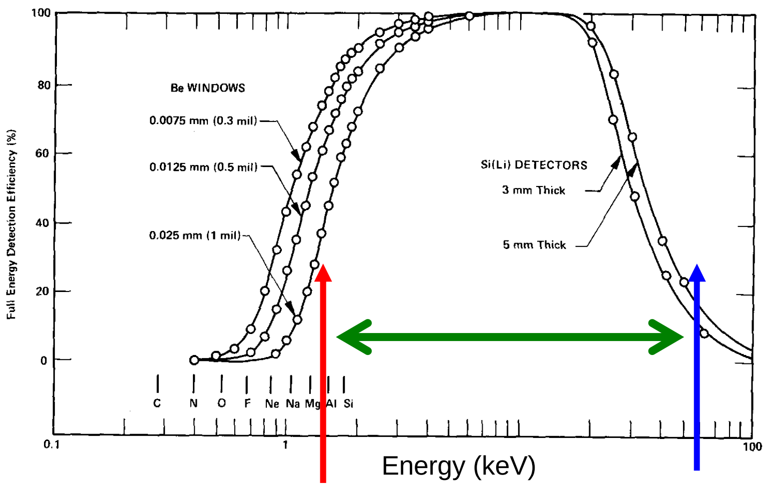
$\boldsymbol{E}$ = 2500 V/cm



(Jenkins et al, 1981)

The Si(Li) X-Ray detector

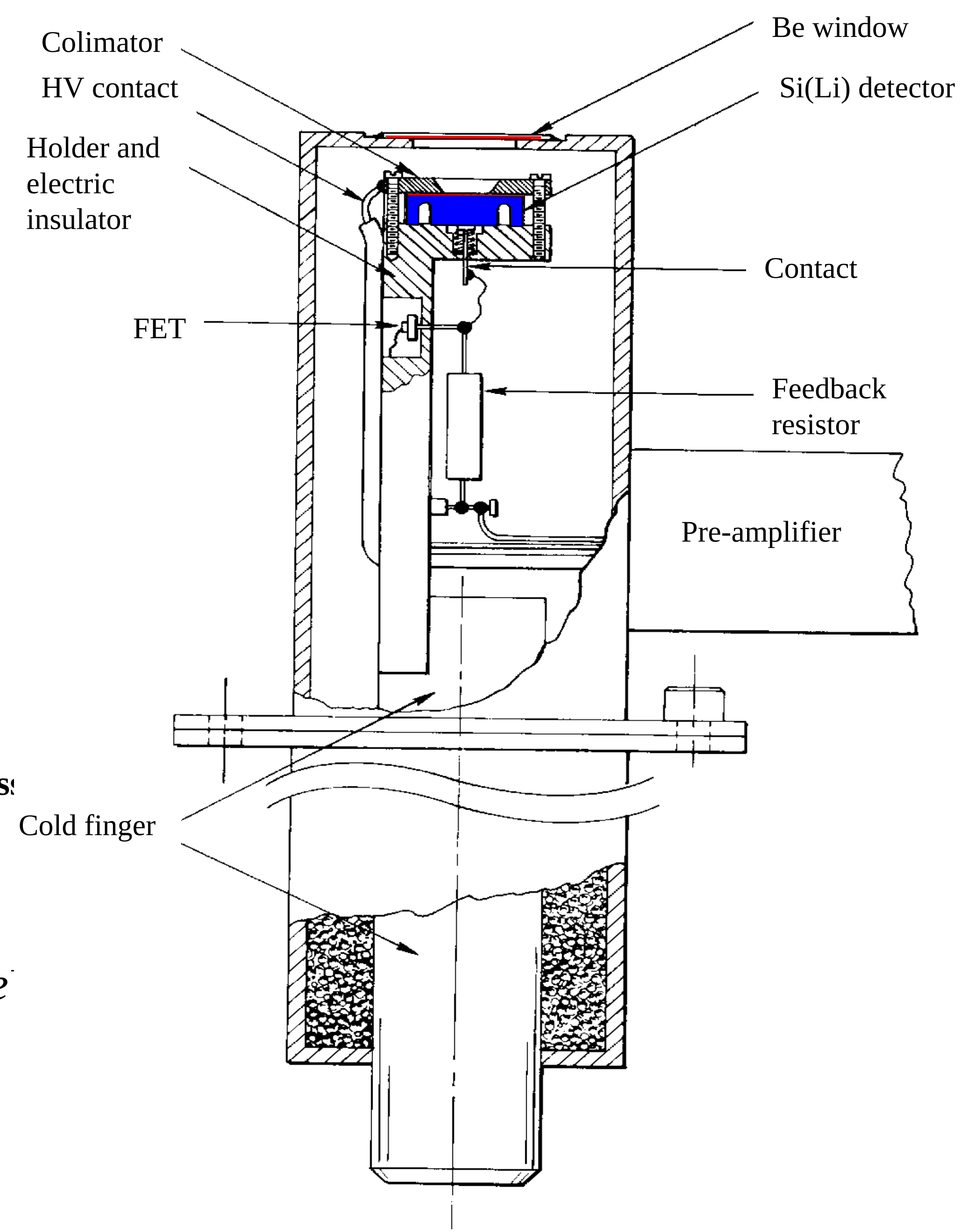
Relative efficiency of a Si(Li)



Absorption in the Be window

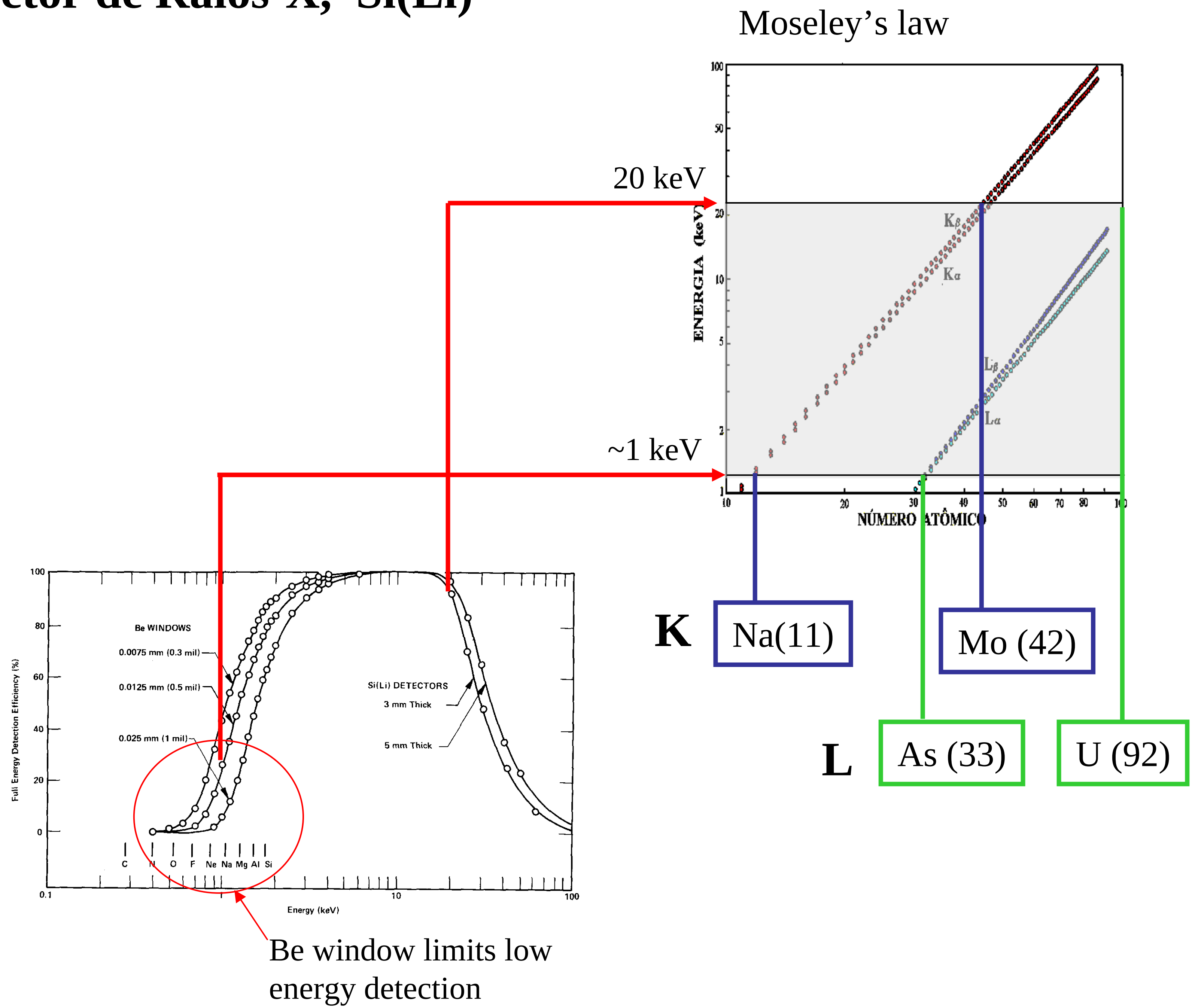
Crystal thicknes

$$\varepsilon_{det} = \frac{I}{I_0} = e^{-\mu_{Be} x_{Be}} .e^{-\mu_{Au} x_{Au}} .e^{-\mu_{Si} x_{dead}} .(1 - .e$$

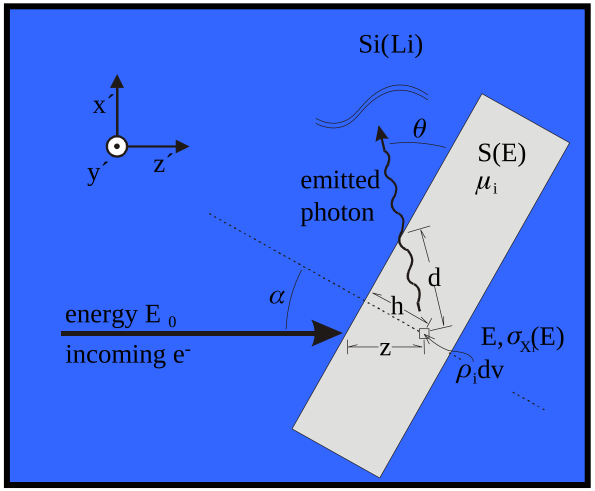


Adapted from Jenkins (1981)

Detector de Raios-X, Si(Li)



FPT – First Principles Totalization and ZAF correction



incident current

elemental concentration

Detetor efficiency

Solid angle

Self absorption

Number of X-ray photons

$$N_i = \frac{\Omega}{4\pi}\varepsilon_i \frac{it}{q\cdot e\cdot\cos\alpha}\frac{\rho_n N_0}{A_n}\int_{E_0}^{E}\frac{\sigma_{X_i}(E')\cdot e^{-\frac{\mu_i}{\rho}\frac{\cos\alpha}{sen\theta}\int_{E_0}^{E'}\frac{dE''}{S(E'')}}}{\rho.S(E')}dE'$$

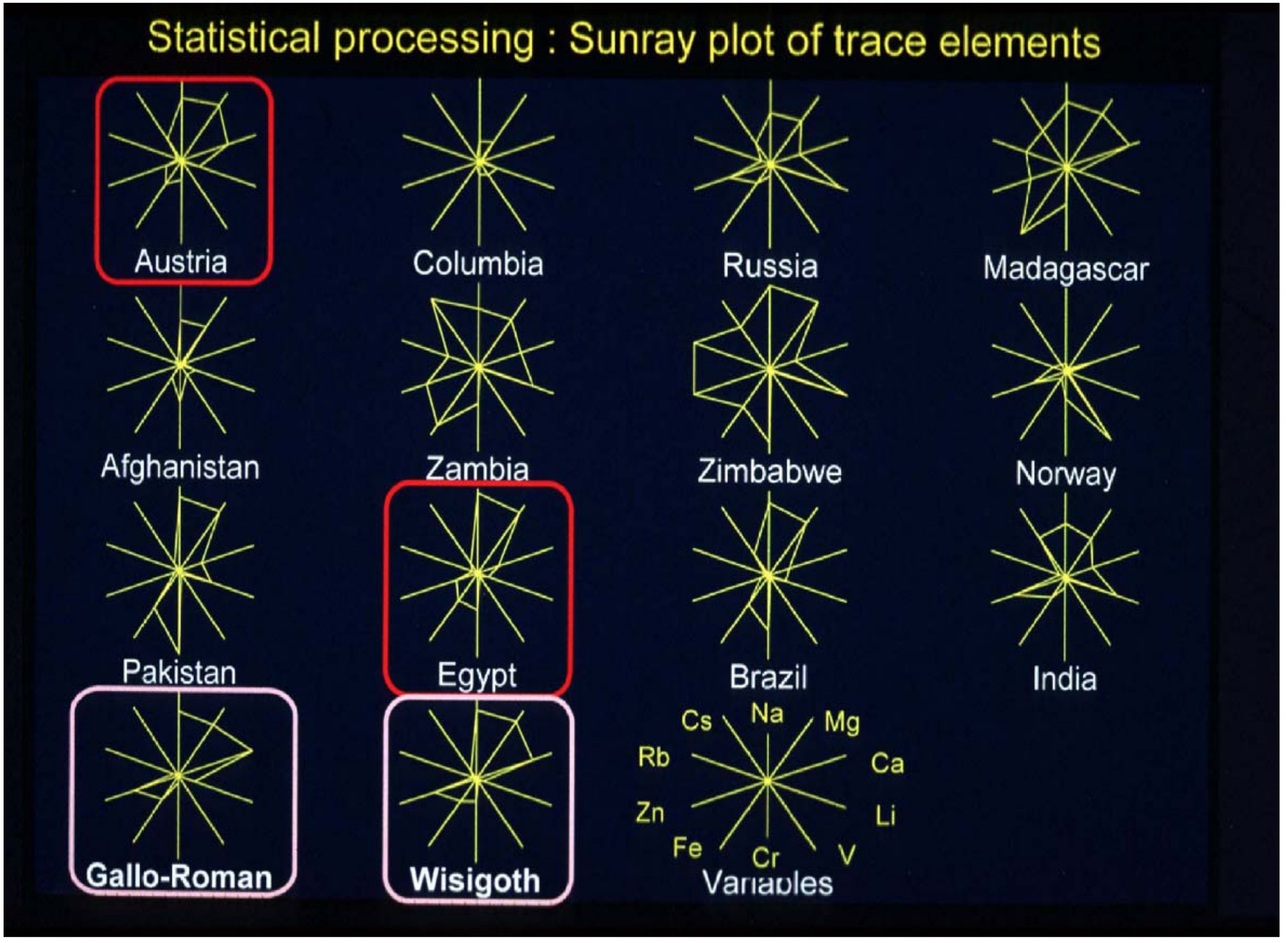
initial and final energy (=0)

X-Ray production cross section

e^- stopping

An example of Statistical analysis:

Merogovian emerald



JC Dram. AGLAE - Accélerateur Grand Louvre d'Analyse Elémentaire