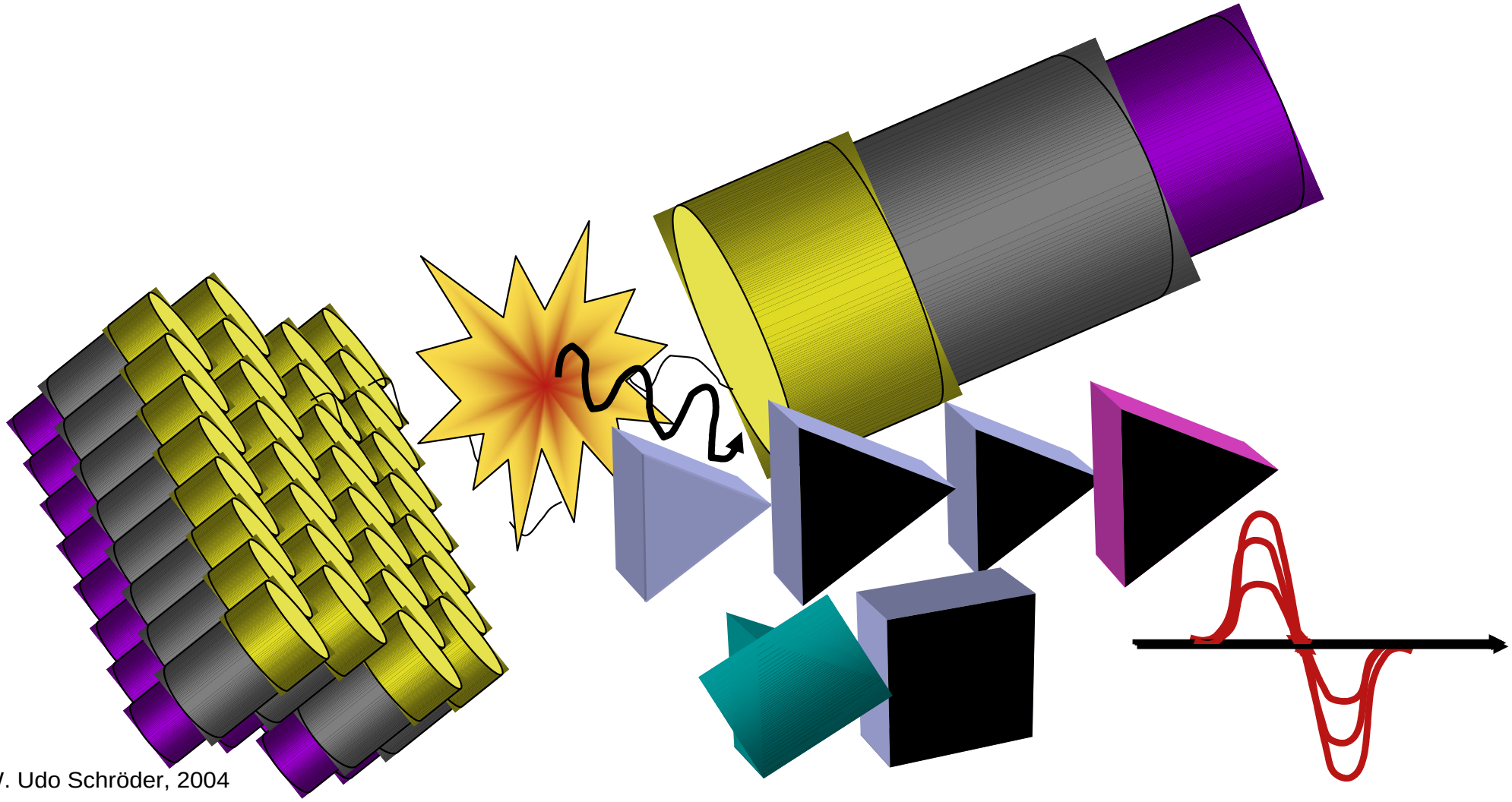
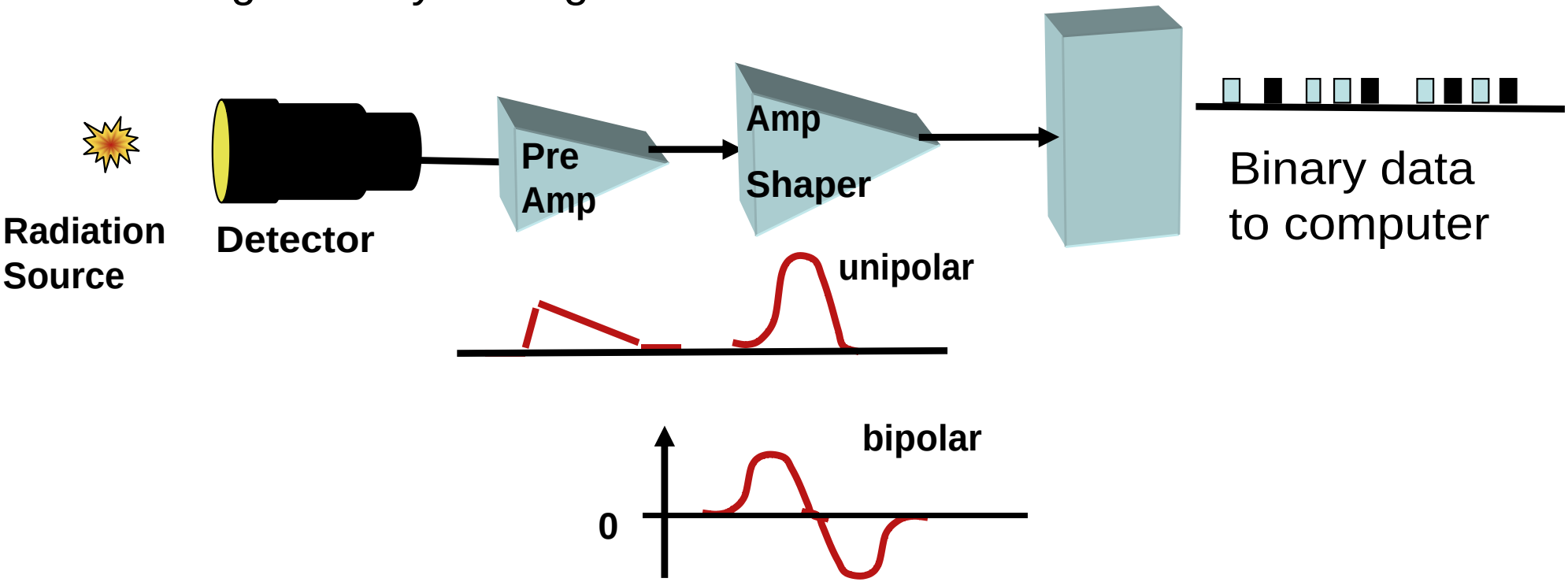
Nuclear Counter Measurement Techniques



W. Udo Schröder, 2004

Basic Counting System

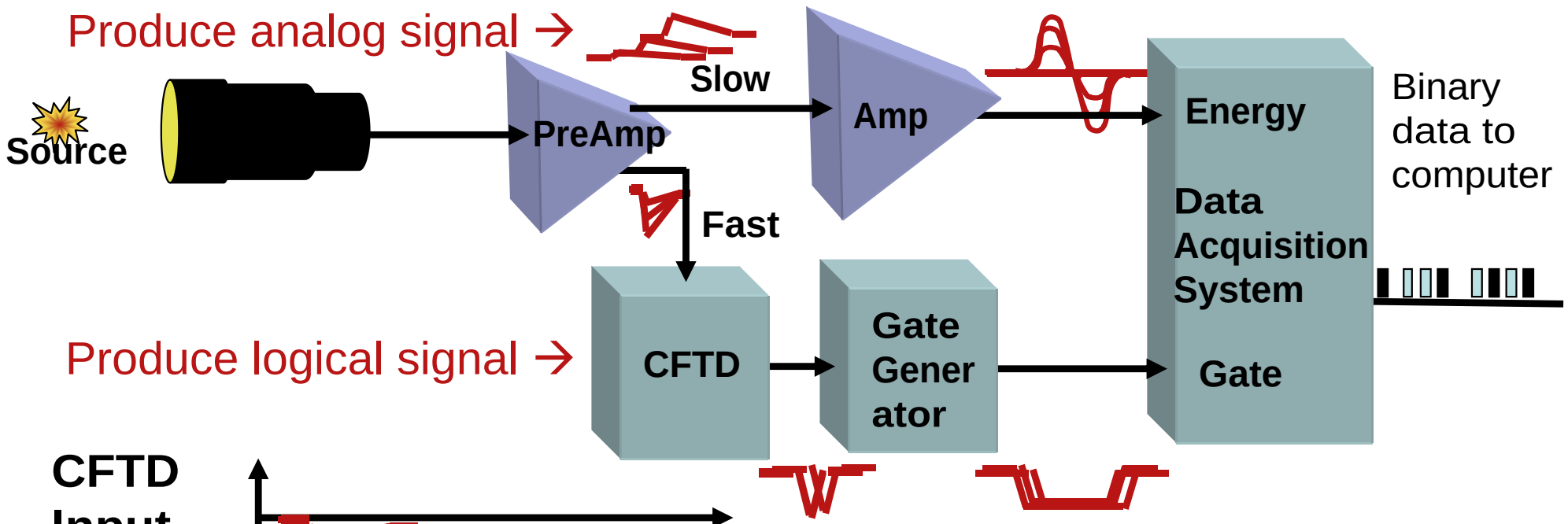
Pulse Height Analysis/ Digitization

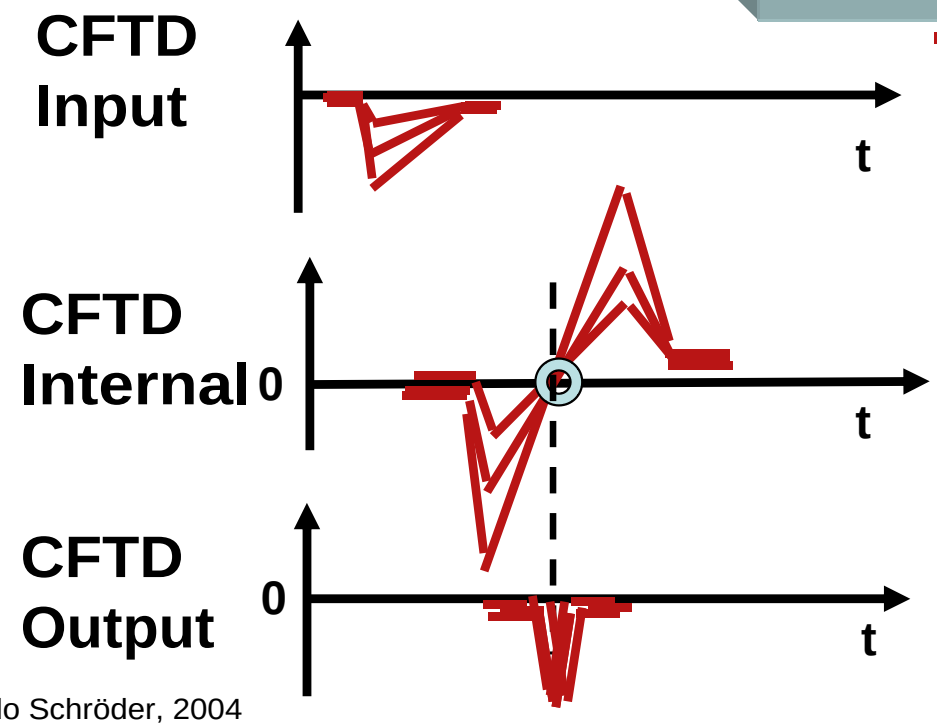


Amplifier/ Shaper: differentiates (1x or 2x)

Final amplitude 2-10V

Fast-Slow Signal Processing





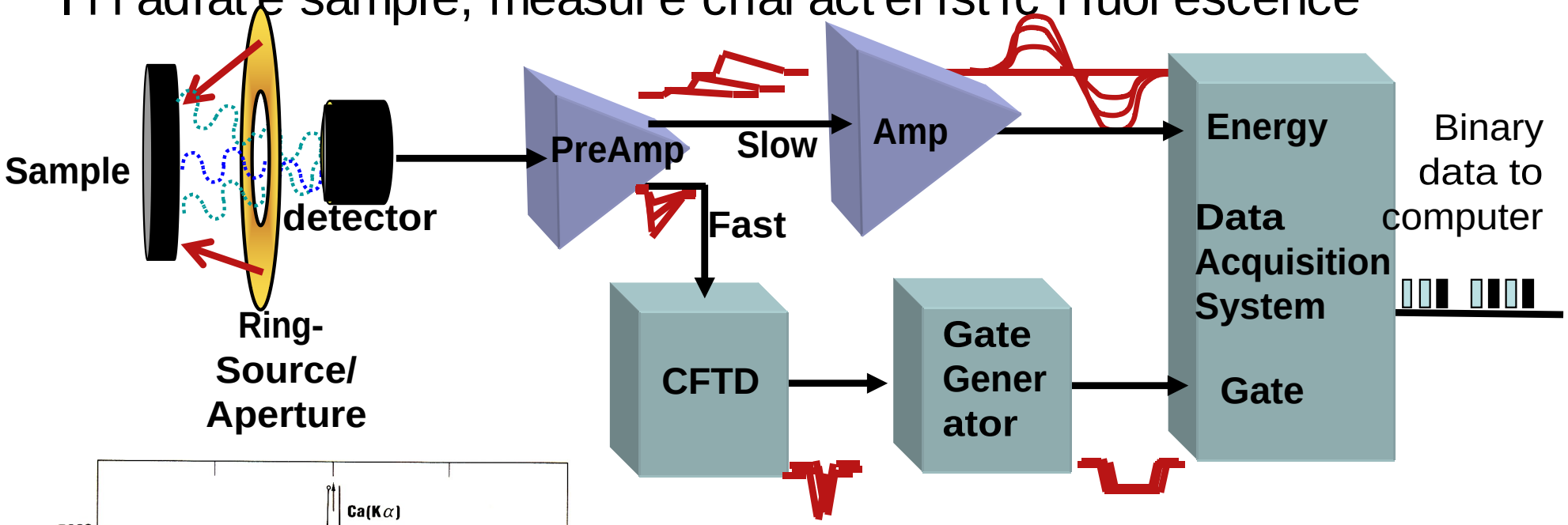
Principle of a Constant-Fraction Timing Discriminator:

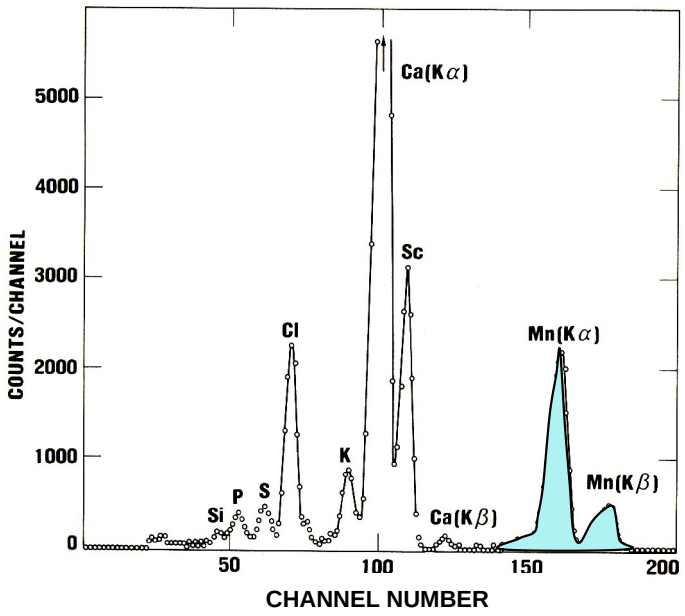
→**t independent of E**

here f = 0.5

Trace Element Analysis: X-Ray Fluorescence

Irradiate sample, measure characteristic fluorescence





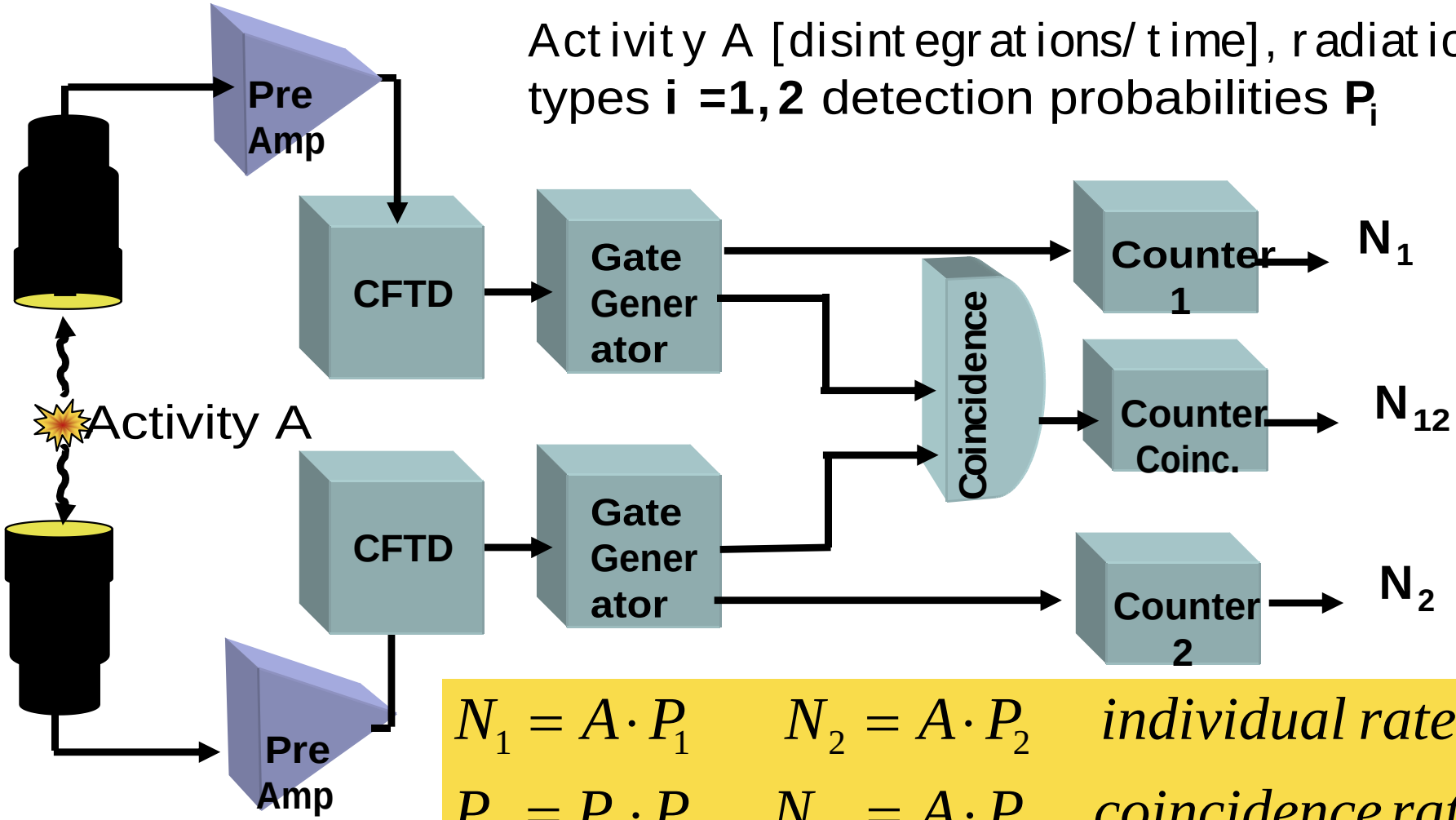
Water sample from treatment plant
Source: 25 mCi ^{55}Fe (2.60 a) Mn-X rays
Kα 5.898 keV, Kβ 6.490 keV

Off-line n activation analysis: irradiate with ^{252}Cf neutrons, measure γ-rays

Lab. Invest. Nucl. Sci,
The Nucleus/Tennelec, 1988

Coincidences: Absolute Emission Rate (Activity)

Activity A [disintegrations/time], radiation types **i =1, 2** detection probabilities P_i

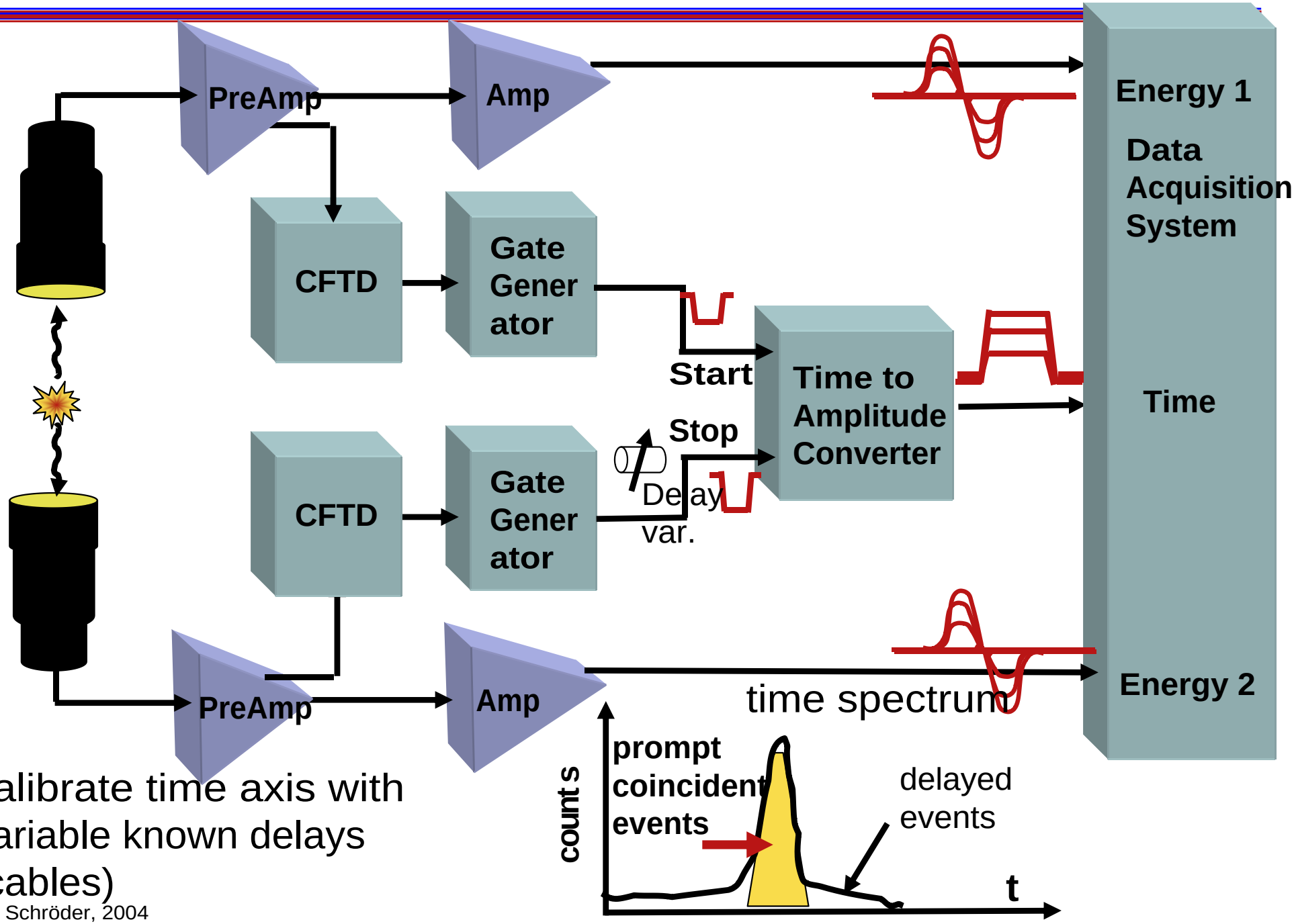


$$N_1 = A \cdot P_1 \qquad N_2 = A \cdot P_2 \qquad \textit{individual rates}$$

$$P_{12} = P_1 \cdot P_2 \qquad N_{12} = A \cdot P_{12} \qquad \textit{coincidence rate}$$

$$A = \frac{N_1 \cdot N_2}{N_{12}} = \frac{A \cdot P_1 \cdot A \cdot P_2}{A \cdot P_{12}} \qquad \textit{singles / coinc}$$

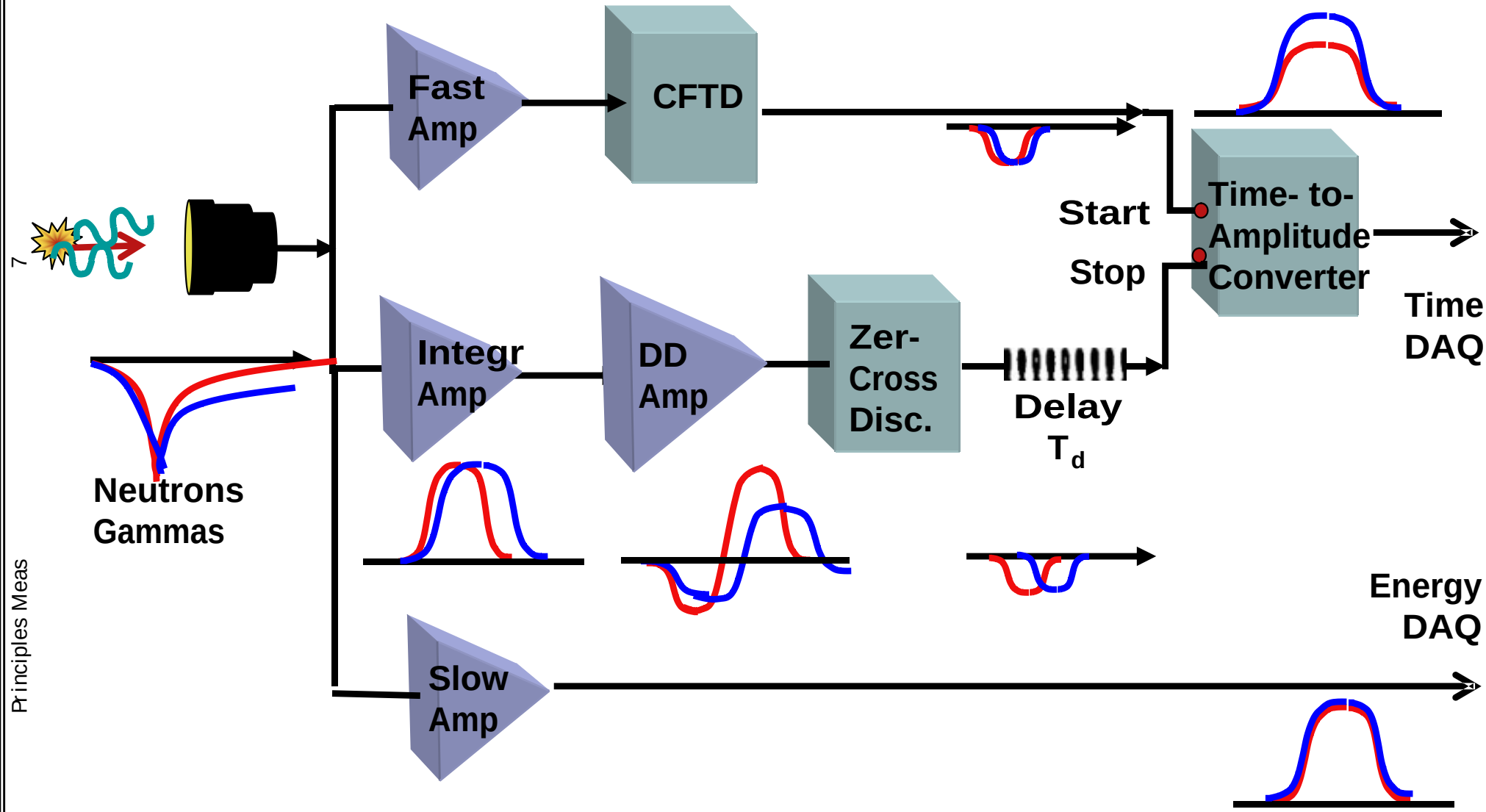
Time Measurement



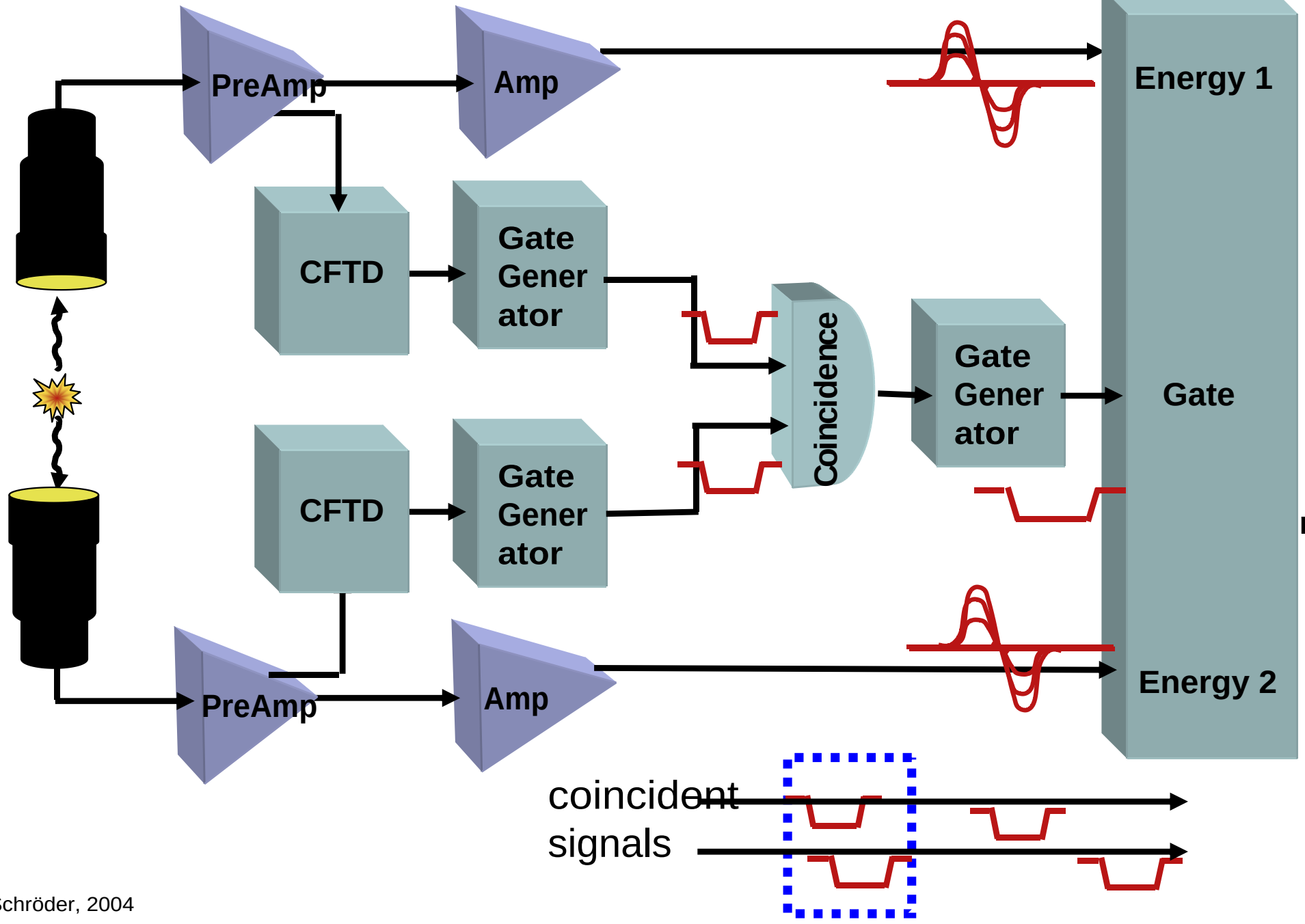
calibrate time axis with variable known delays (cables)

Pulse Shape Analysis

Different signal decay times for 2 radiation types are translated into different amplitudes

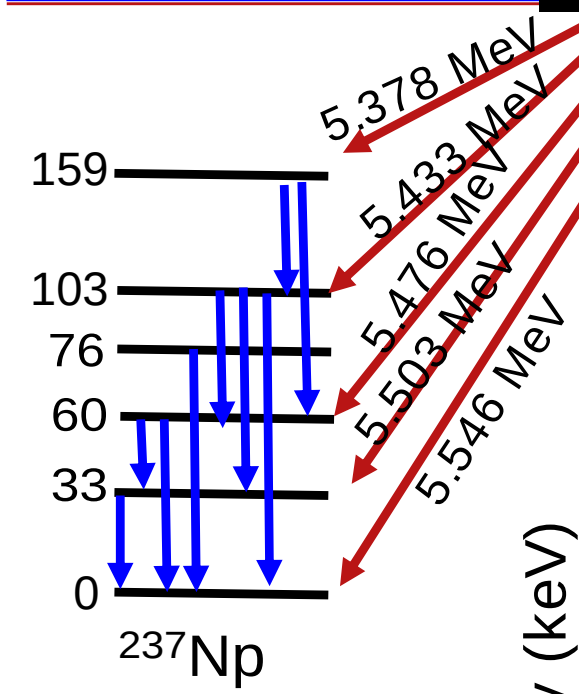


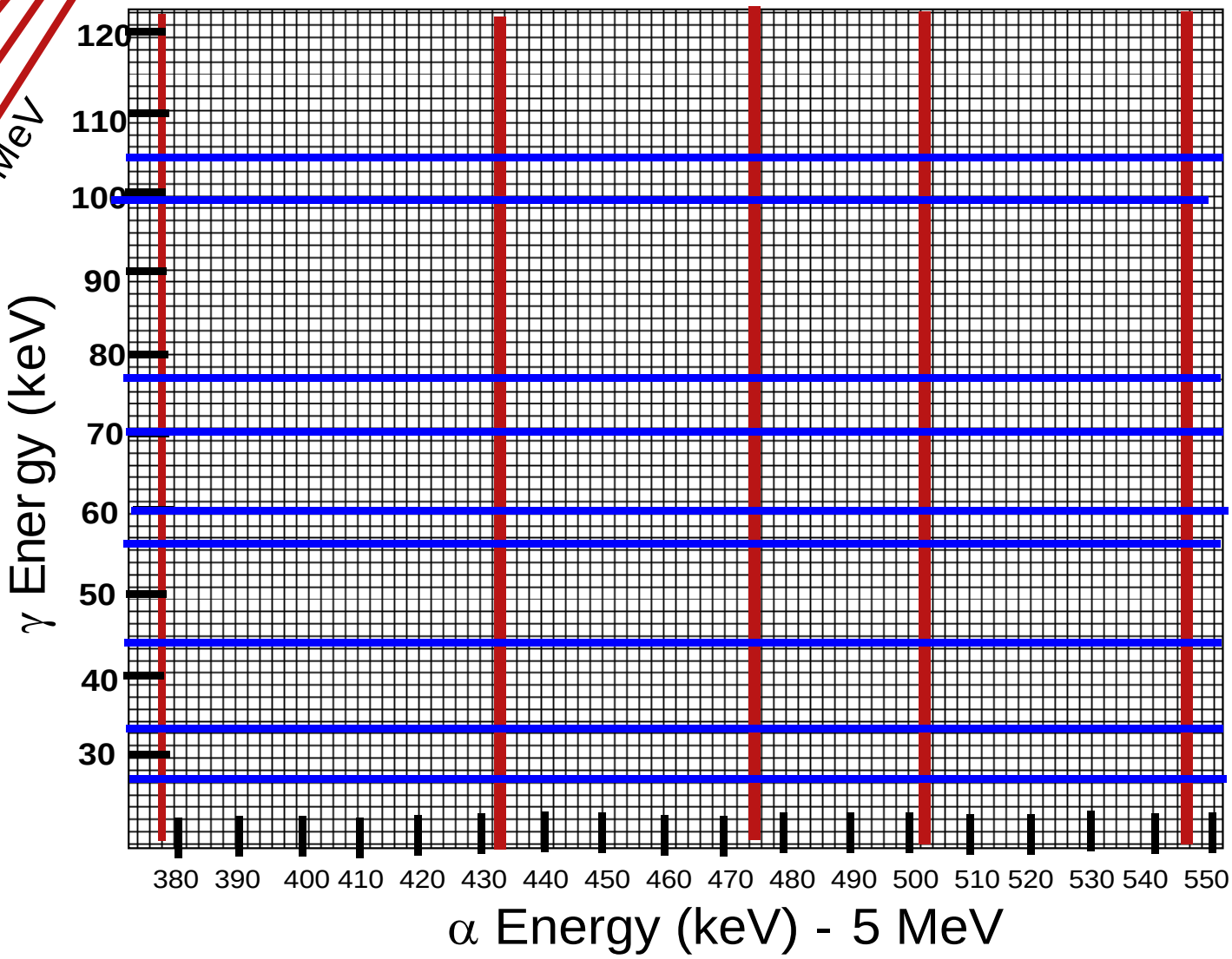
2- Dimensional Measurement



Example

α-Decay of 241Am, subsequent γ emission from daughter

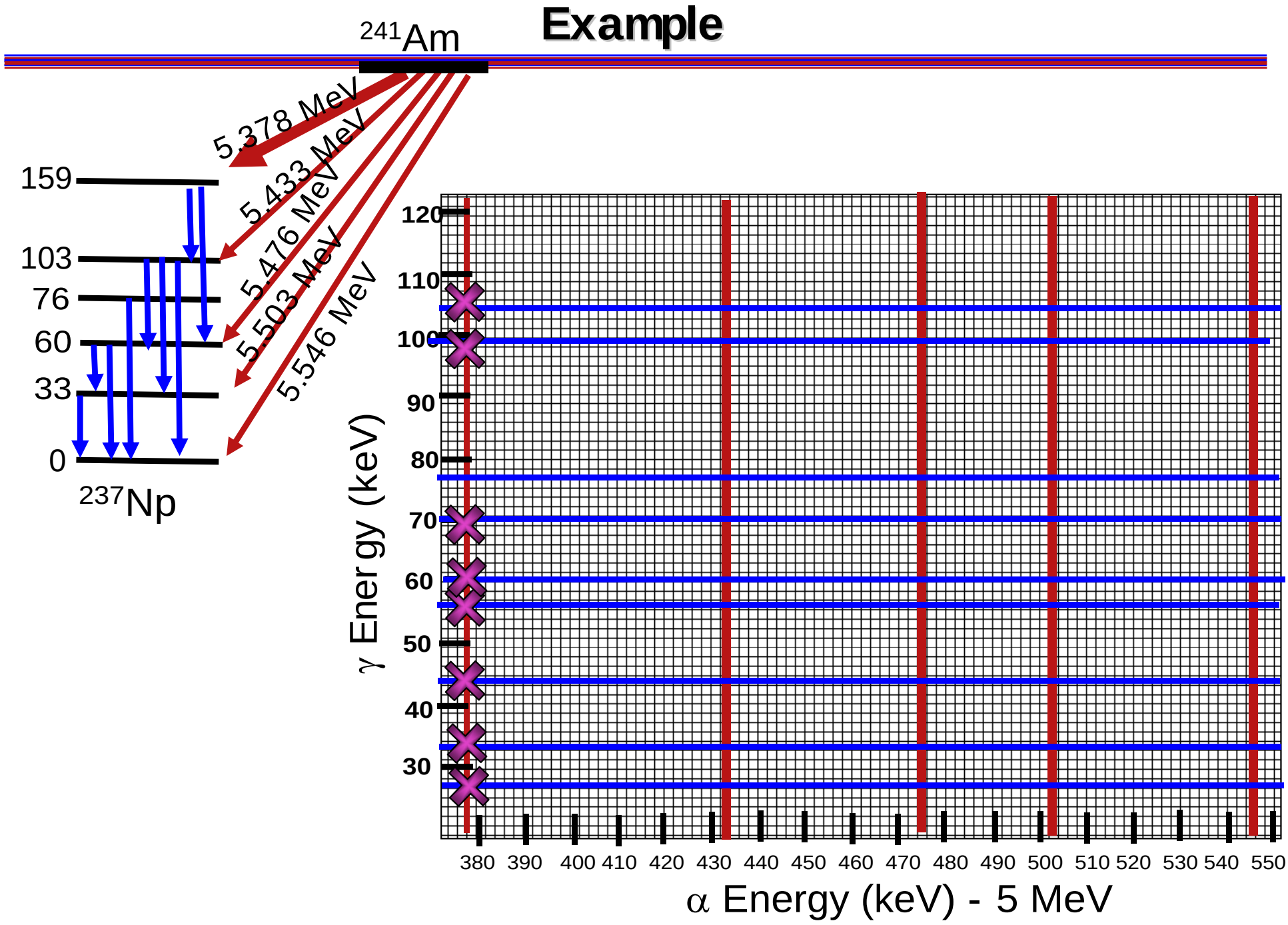




Find coincidences (E_α, E_γ)

9 γ-rays, 5 α

Example



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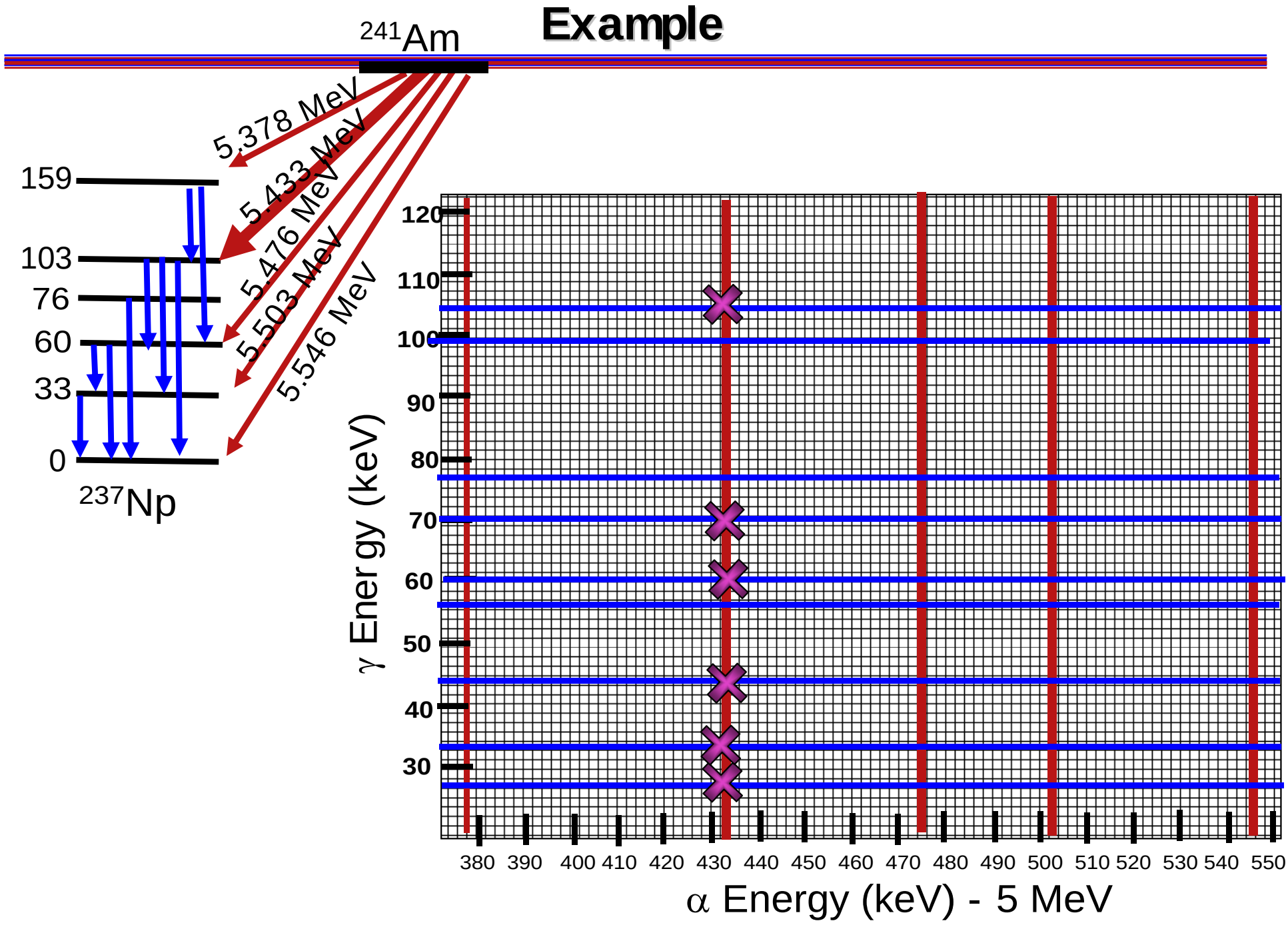
Example



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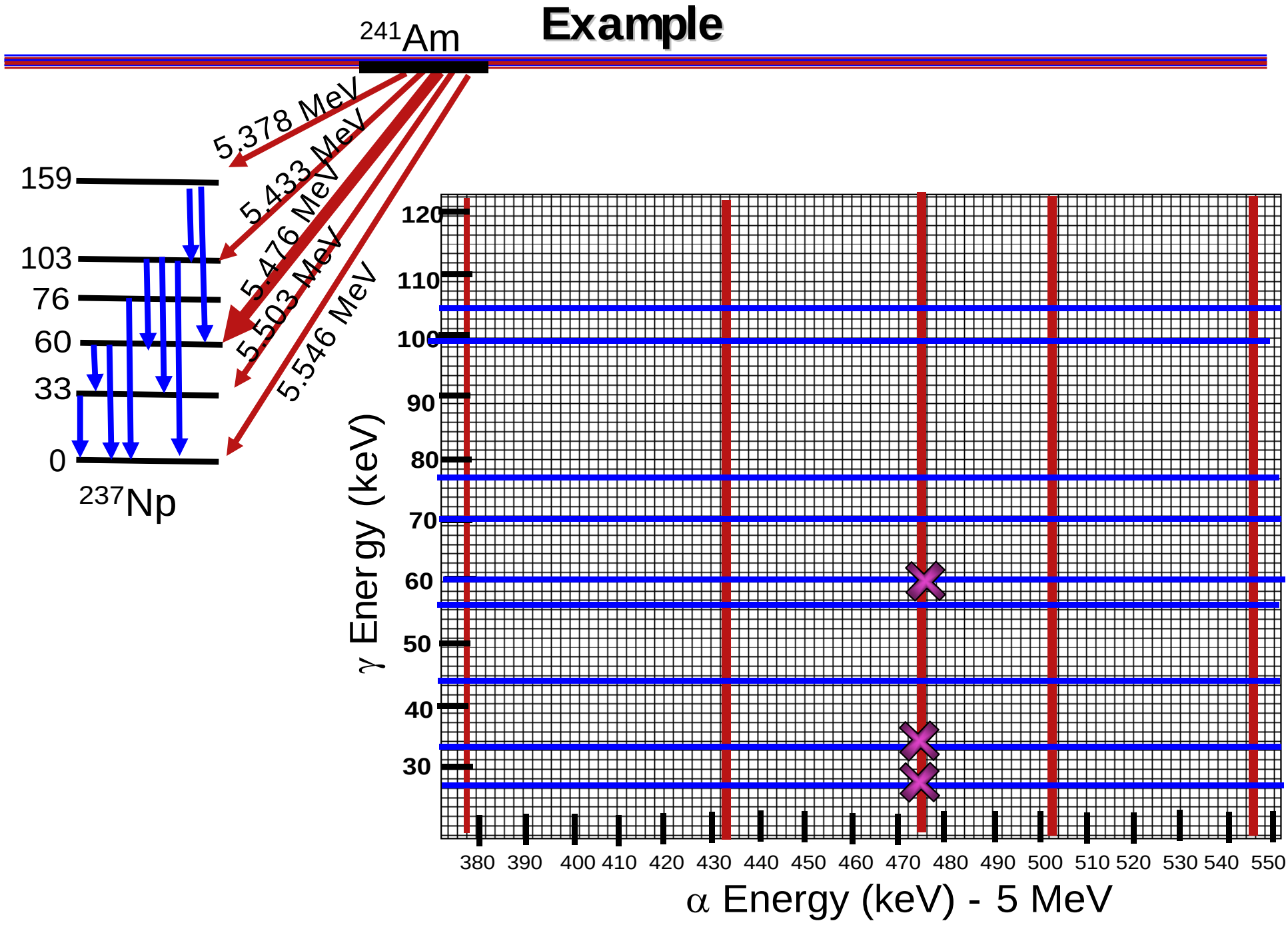
Example



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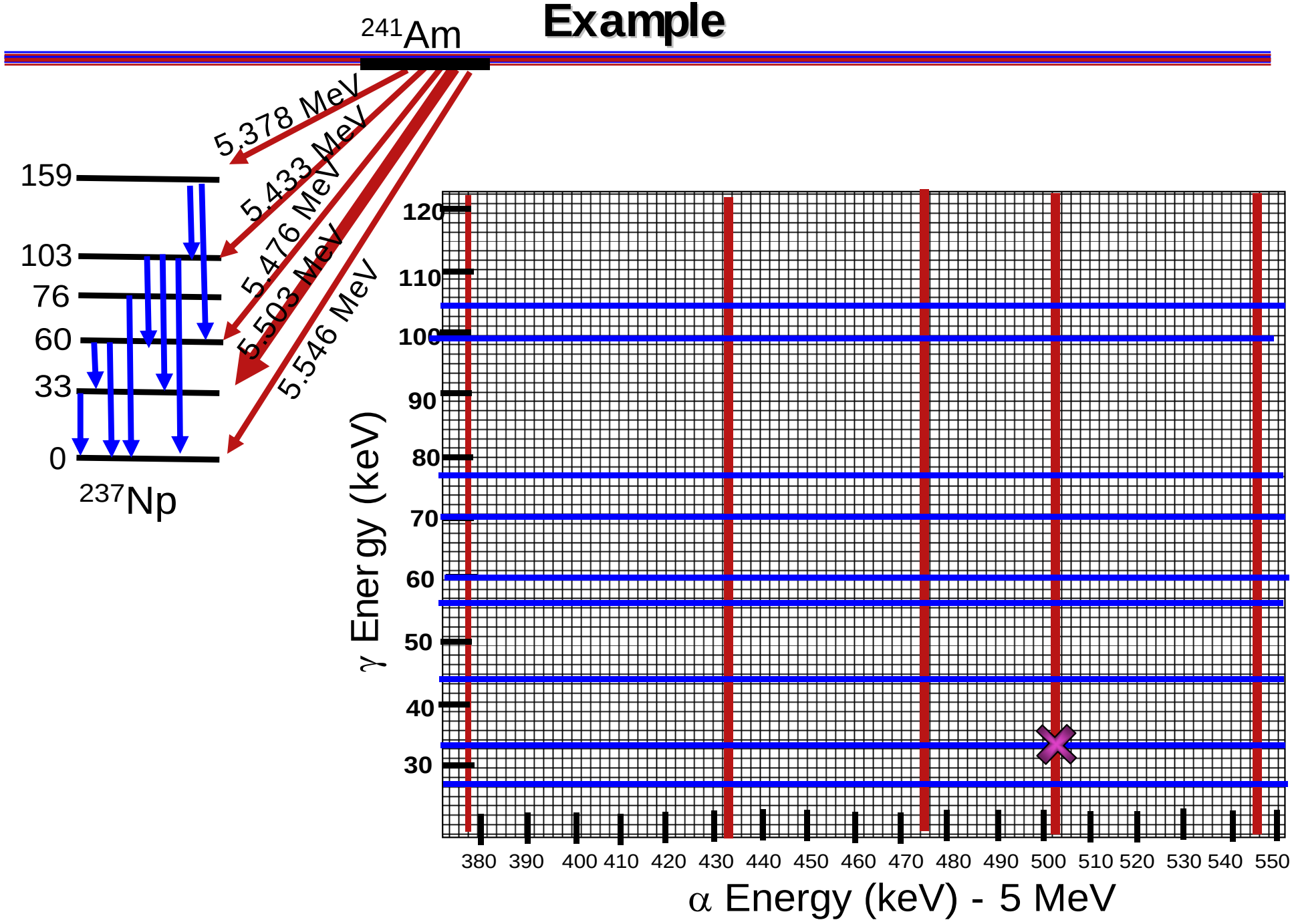
Example



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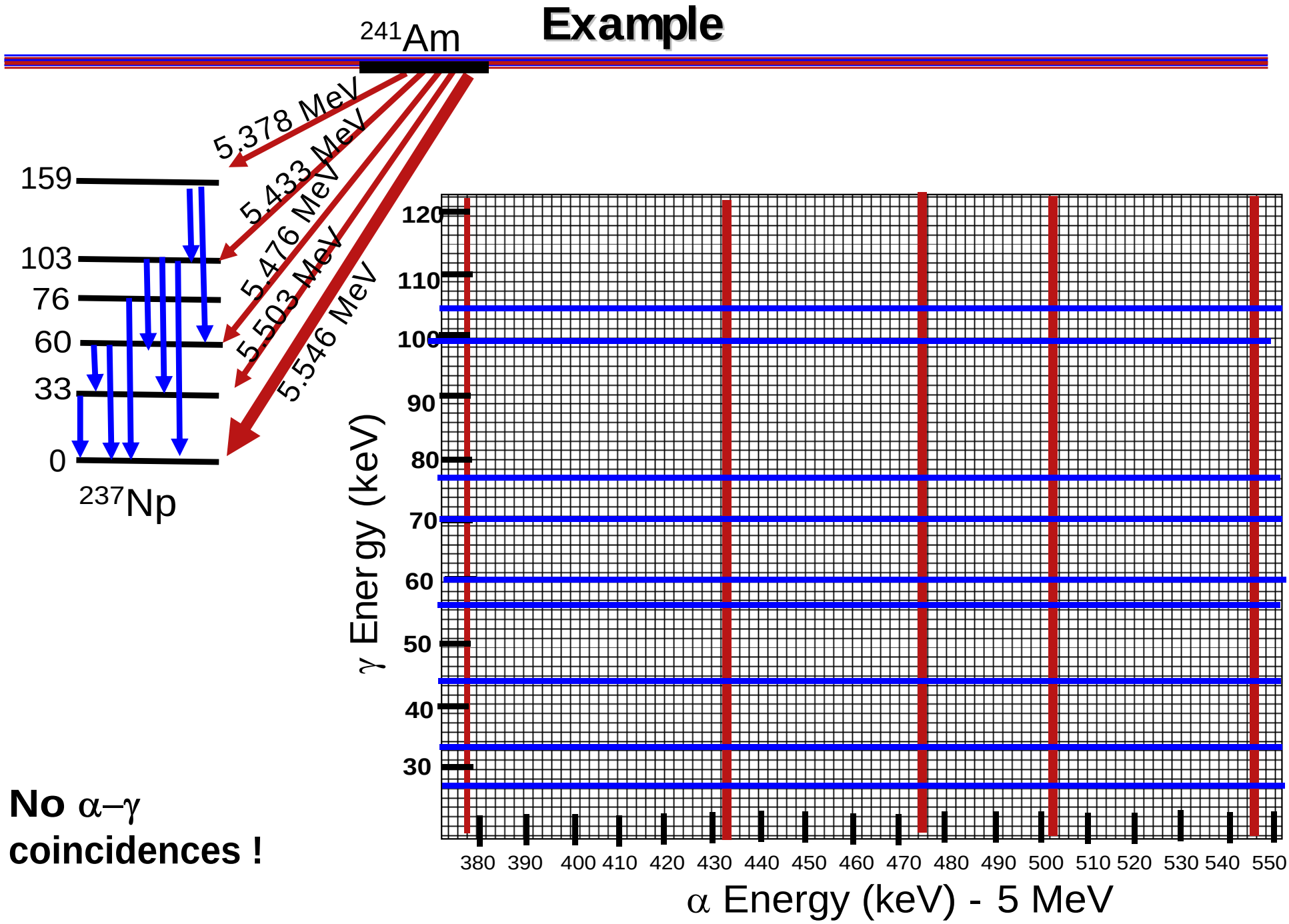
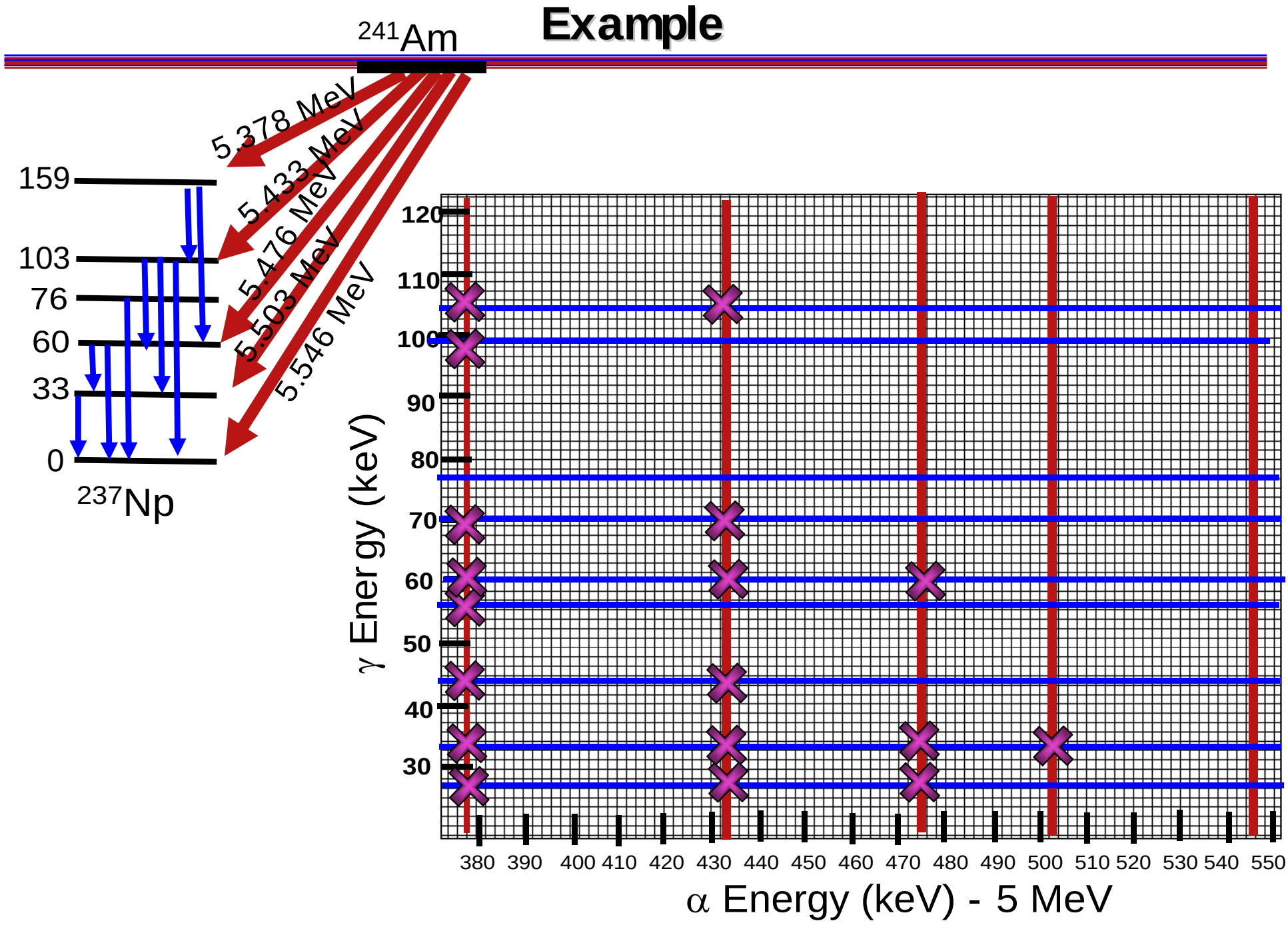
Example



No α–γ coincidences !

Example



W. Udo Schröder, 2004

The End