Identification of heavy fission products with Lohengrin

Director of thesis: G. Barreau, CENBG Bordeaux

Co-director of thesis: O. Serot, CEA Cadarache

Local supervisors: H. Faust, ILL Grenoble

U. Köster, ILL Grenoble

ILL Clip-session, 13/04/07

Outline

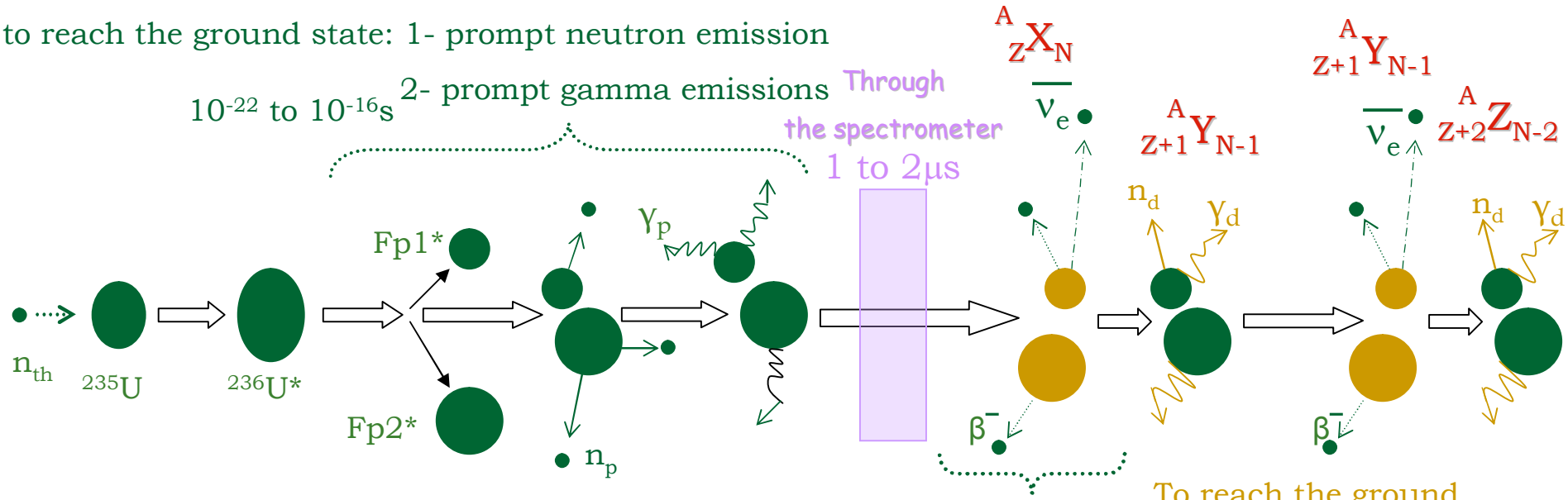
- The fission process.
- The recoil-mass spectrometer Lohengrin.
- Mass yields.
- Isotopic yields.
- Experiments.

The fission process

The fission products are excited ⟶

to reach the ground state: 1- prompt neutron emission

10^{-22} to 10^{-16}s 2- prompt gamma emissions



To reach the valley of stability

⟶ β-emissions

To reach the ground state

- delayed γ-emissions
- delayed neutron emissions

β-decay

$$^{A}_{Z}X_{N} \longrightarrow {}^{A}_{Z+1}Y_{N-1} + e^- + \overline{\nu}_e$$

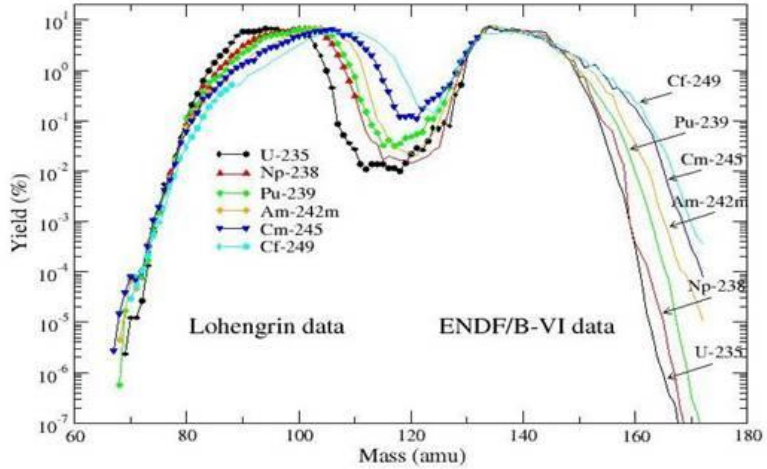
The fission process

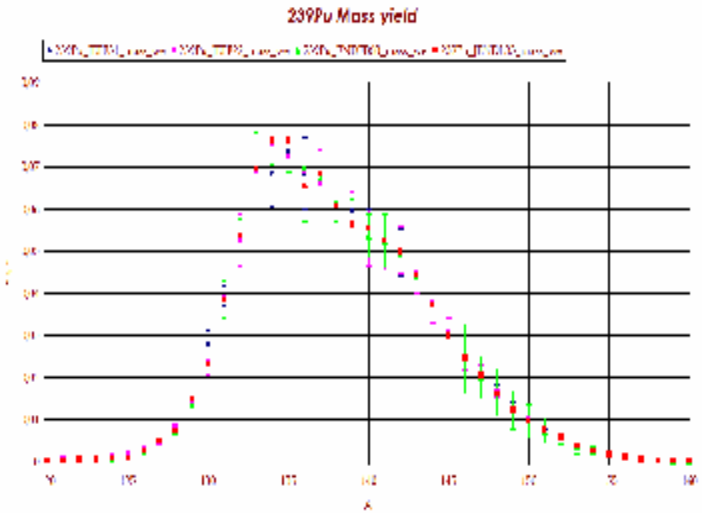
needs to be still investigated:

-to improve the efficiency of nuclear power reactors: some fission product yields are known with too low accuracy

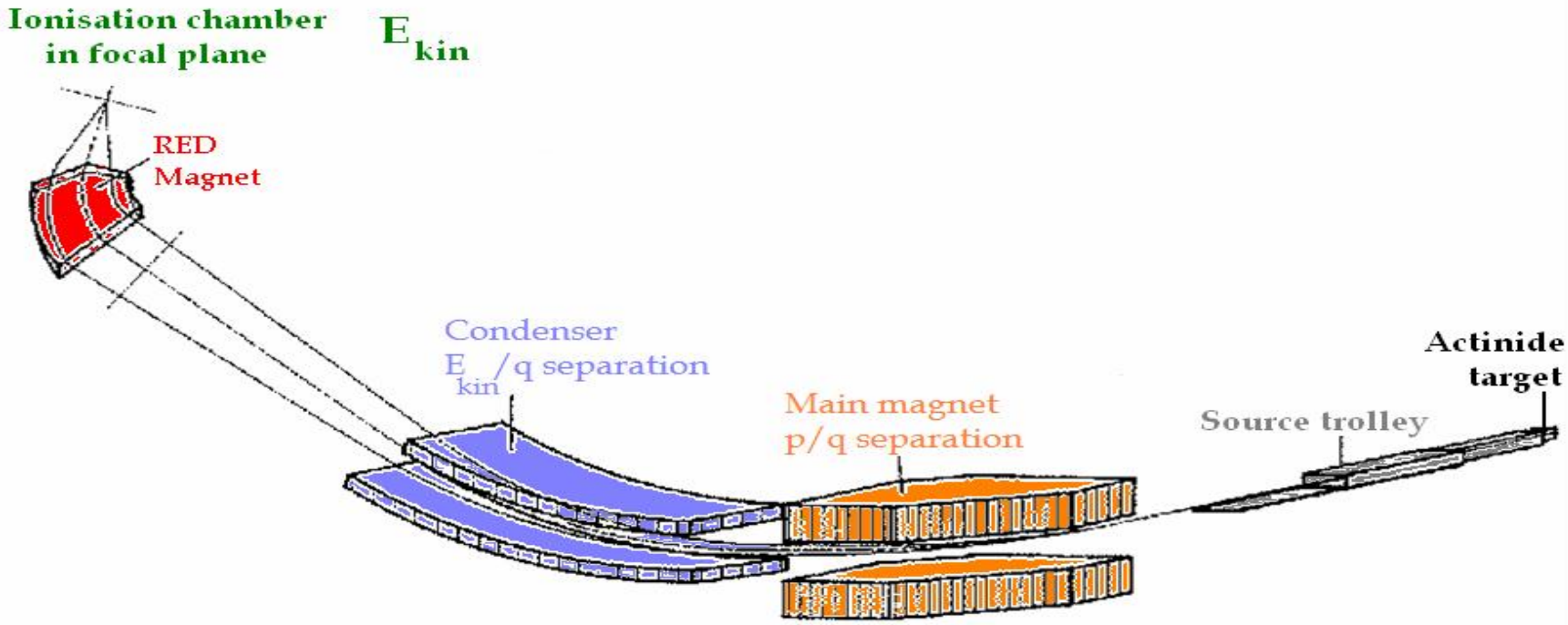
- to improve the theory of fission: the fission models need experimental values to be compared with, in particularly in the heavy fission products region

- for many nuclear applications which use yield data bases: these are not always concordant.





The recoil-mass spectrometer Lohengrin

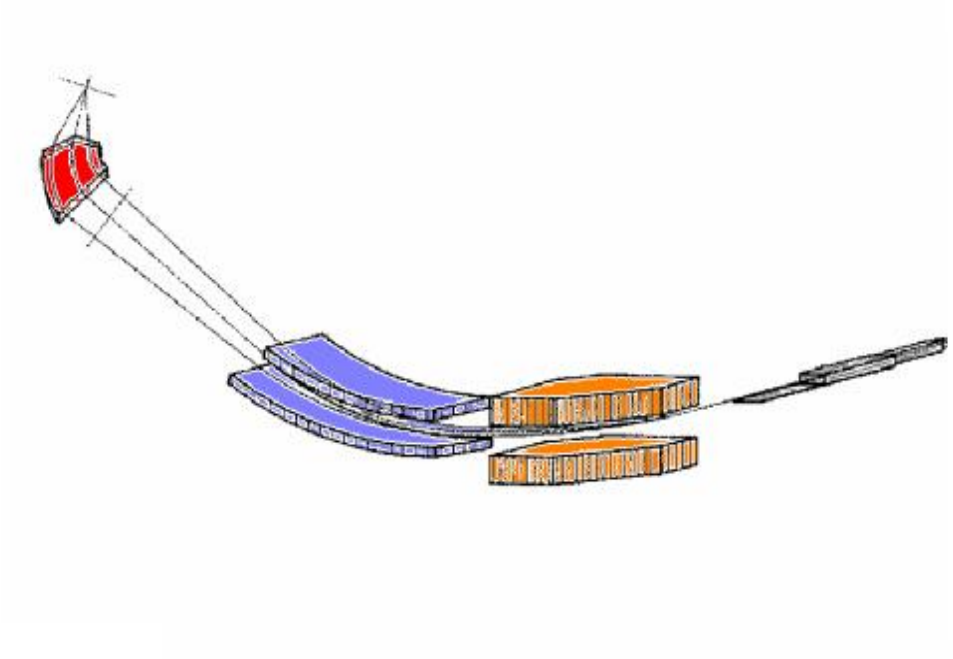


$$mv^2/r_{el} = qE \qquad mv^2/r_{magn} = qvB$$

$$E_{kin}/q = E/2r_{el} \qquad mv/q = Br_{magn}$$

Mass yields

Determine the mass yields => Determine the probability to obtain a fragment with a nuclear mass A by reaction.



Lohengrin spectrometer

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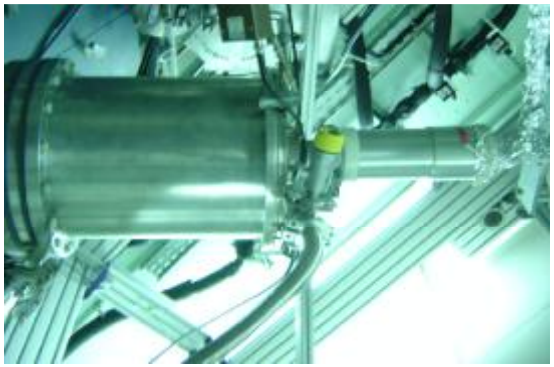
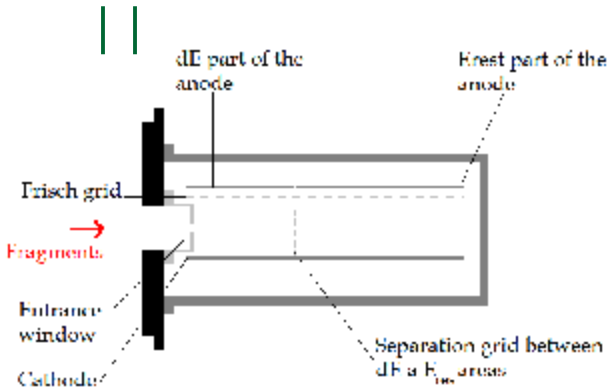
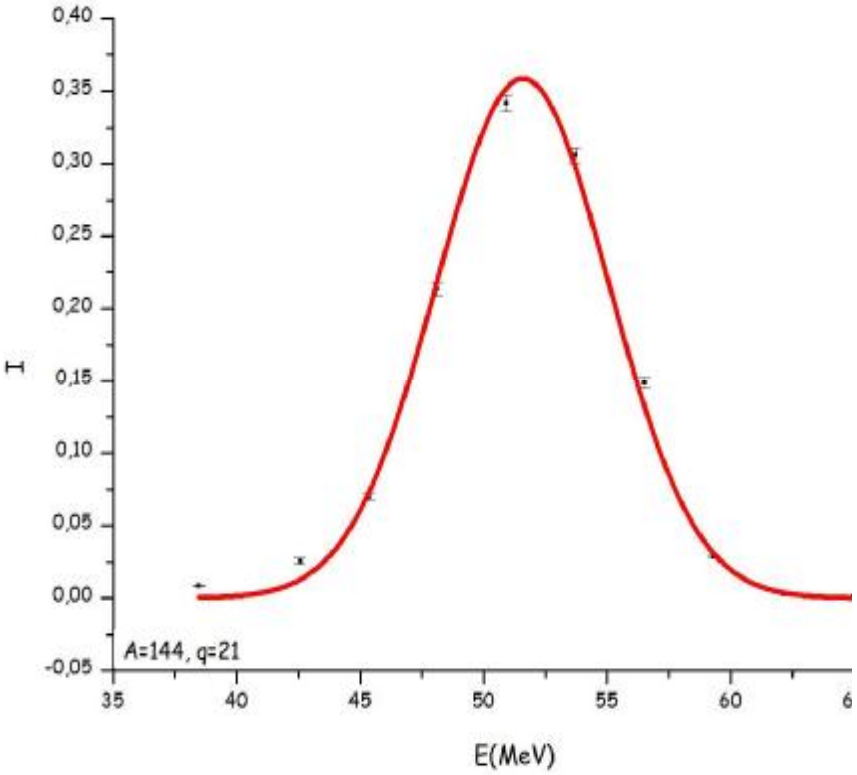
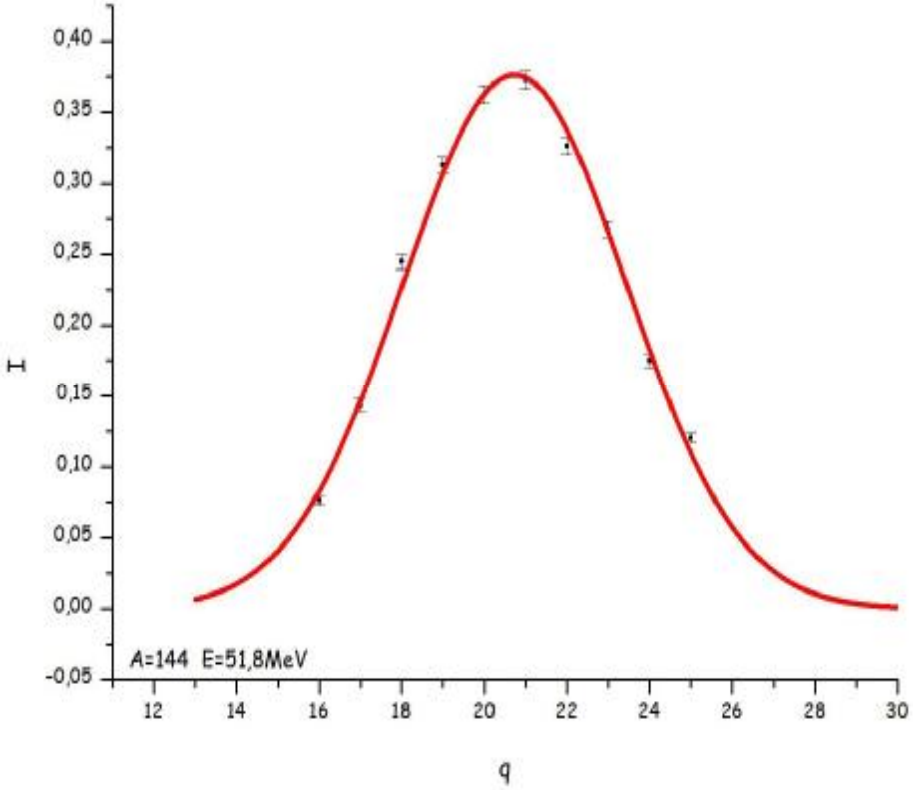




Ionization chamber

Mass yields



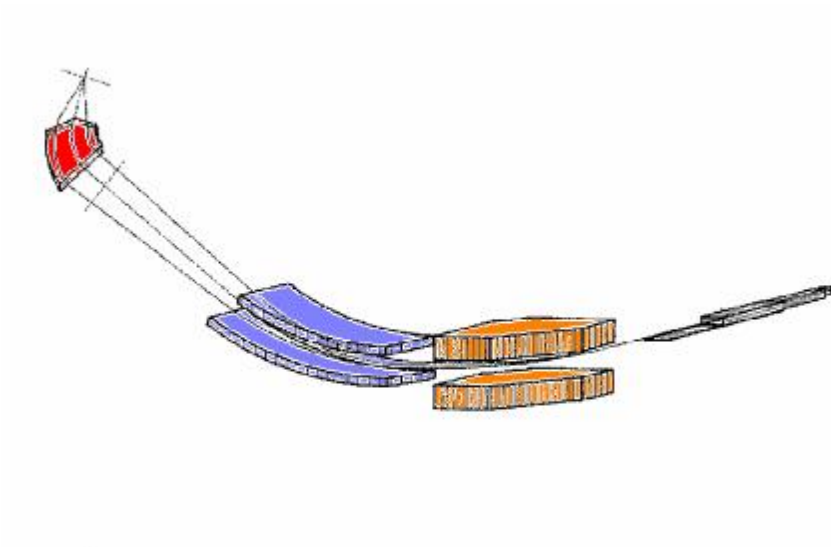


Kinetic energy and ionic charge distribution of $^{239}Pu(n_{th},f)$

Isotopic yields

Determine the isotopic yields => Determine the probability to obtain a fragment with a nuclear mass A and a nuclear charge Z by reaction.

Experimental device



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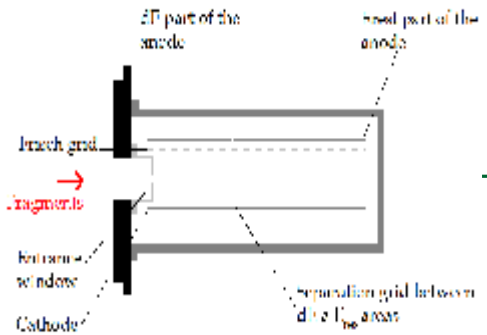

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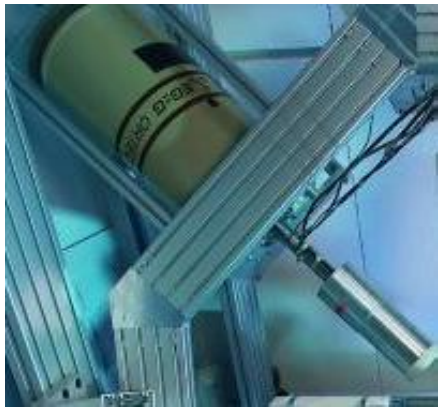
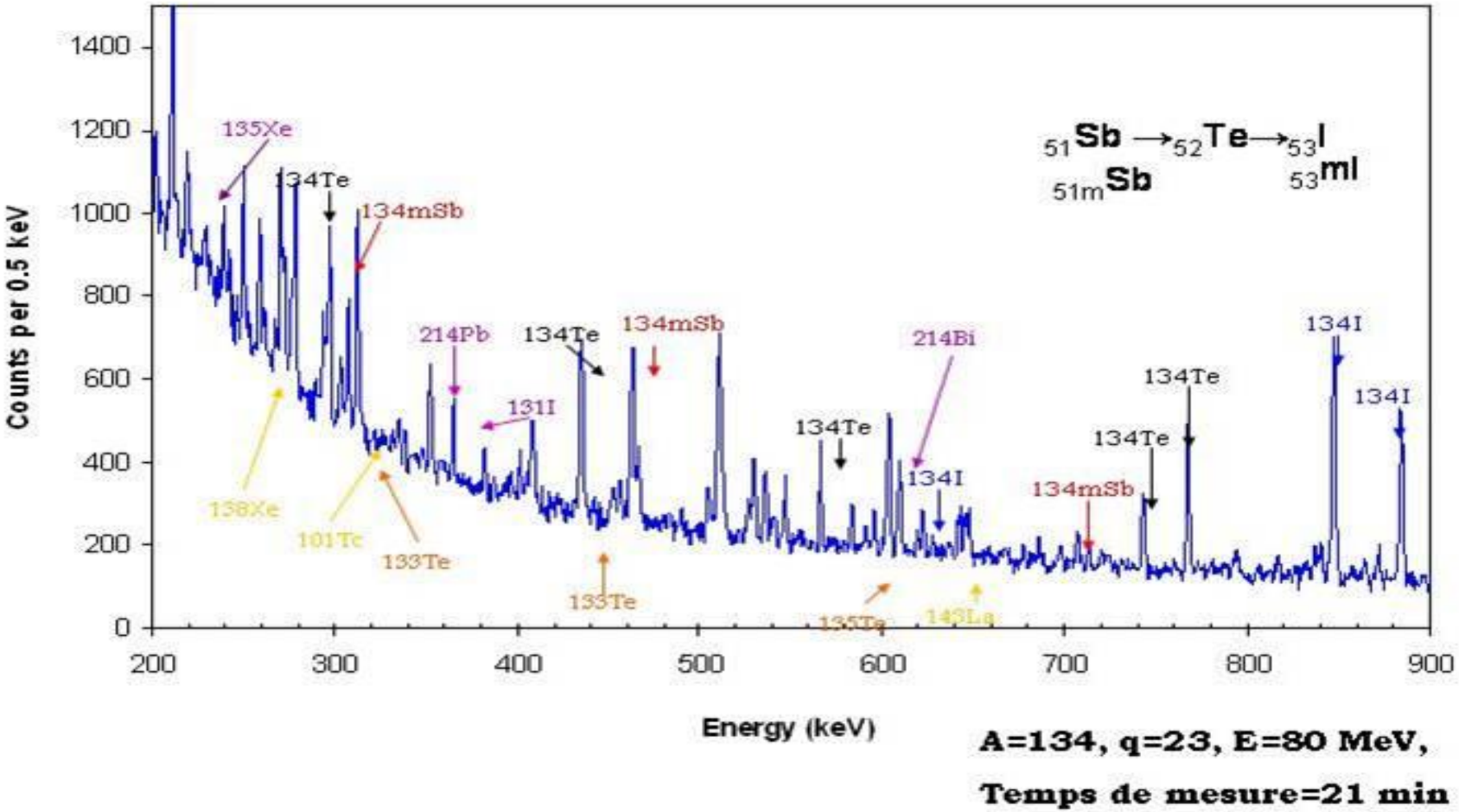


Determination by γ-Spectrometry

Isotopic yield



A=134, q=23, E=80 MeV,

Temps de mesure=21 min

Example of γ-spectrum from $^{241}Pu(n_{th},f)$ spectrum

Experiments

- Yields already measured:

Part of mass yields of $^{235}U(n_{th},f)$ and $^{239}Pu(n_{th},f)$

Part of isotopic yields of $^{241}Pu(n_{th},f)$

- Next experiment:

Isotopic yields of $^{239}Pu(n_{th},f)$

Mass yields of $^{241}Am(2n_{th},f)$