

Mini-Inca

Integral Measurements Relevant for Nuclear Waste Transmutation Systems

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Scientific Goals

Develop a set of experimental procedures to obtain in a fast and reliable way nuclear parameters for transmutation systems.

◆ **Capture and Fission Cross Sections at the thermal energy**

◆ **Integral capture and fission cross sections and “transmutation potential” in specific neutron fluxes (NOT only thermals**

◆ **For Actinides :U, ^{241}Am , ^{242}Cm , ^{238}Pu , ^{237}Np**
◆ **and Fission-Fragments : ^{129}I , ^{99}Tc , ^{133}Cs **

◆ **Request to GEDEON for ^{243}Cm and ^{244}Cm at thermal energy**

Experimental Requirements

SIMPLE experiments to minimize corrections :

a) Small samples (<100 μg) mono-isotopic or known mixtures of **Fission-Products or Actinides**.

- negligible influence on the neutron flux
- no correction related to the sample thickness
- low radioactivity

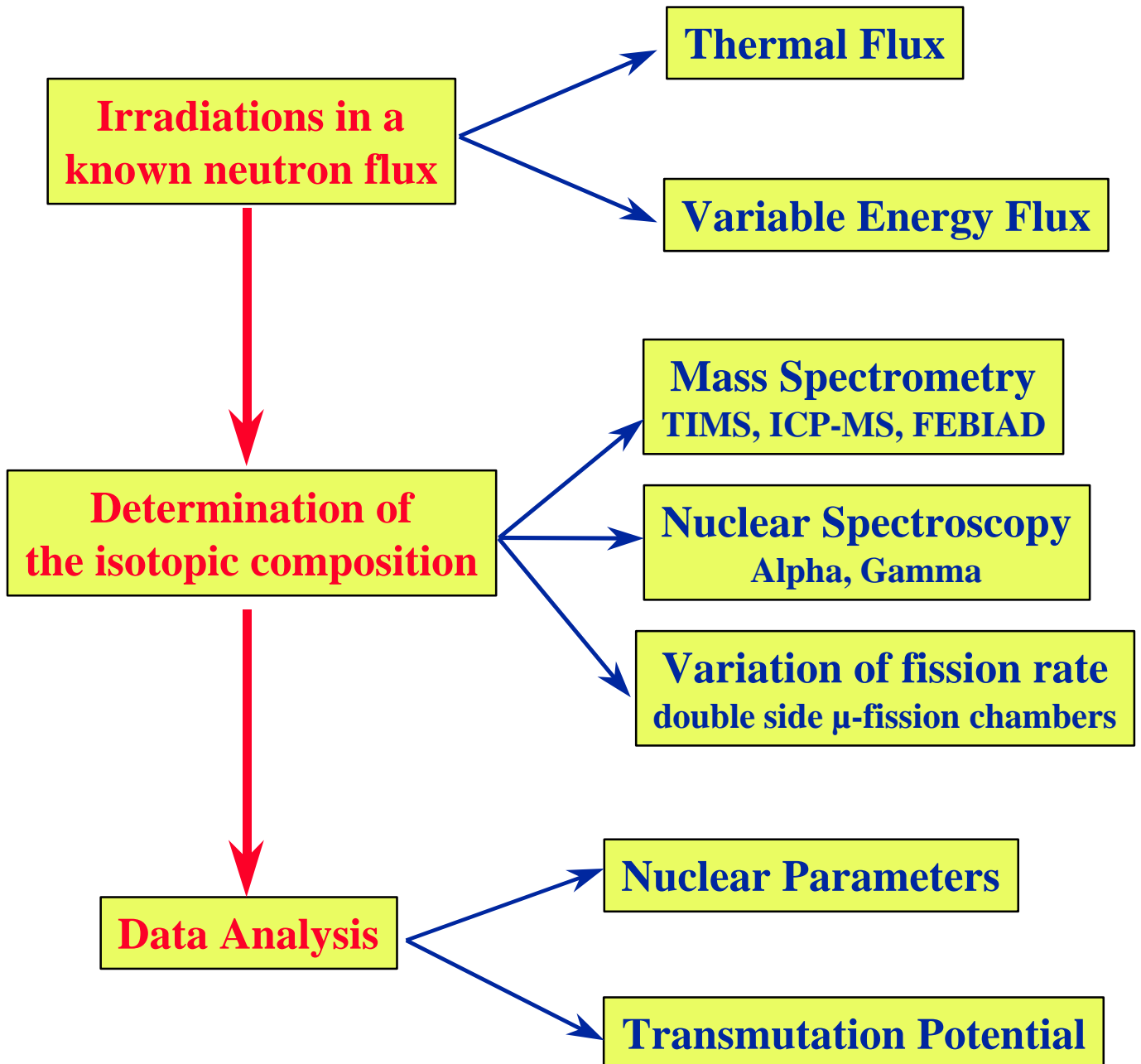
b) Neutron flux

- high intensity (access to short lived-isotopes)
- as stable as possible

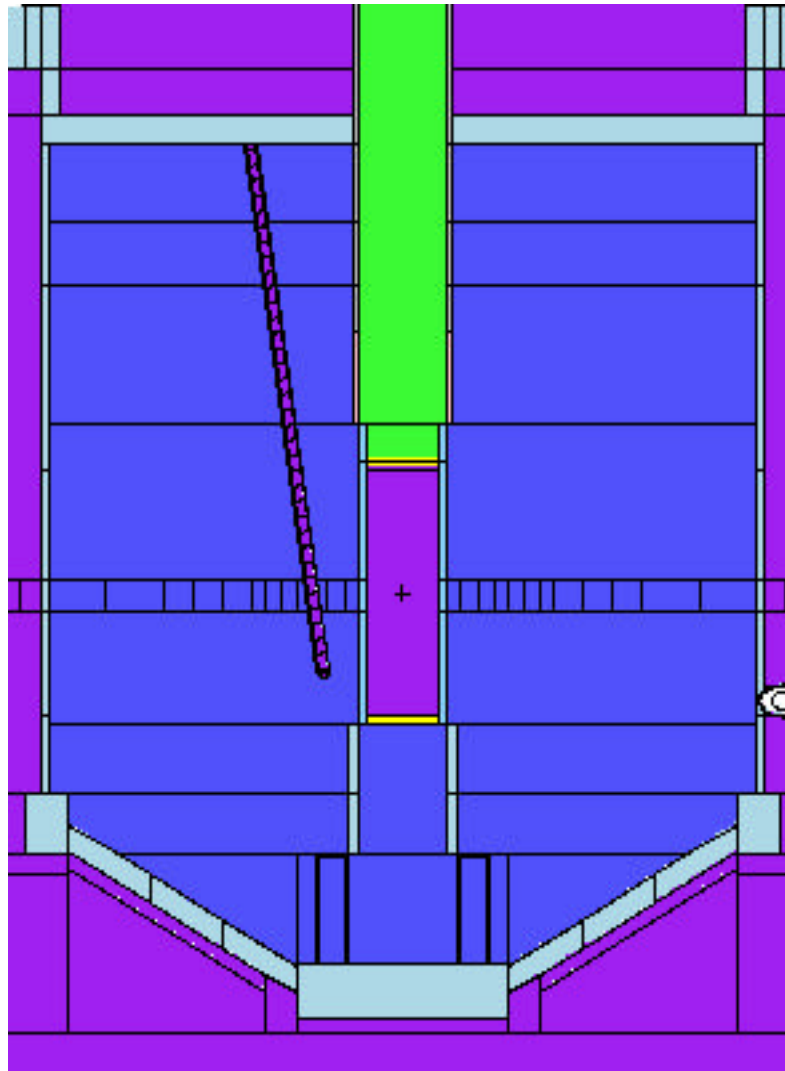
c) Isotopic Analysis

- fast
- preserve “nuclear information”
- on-line

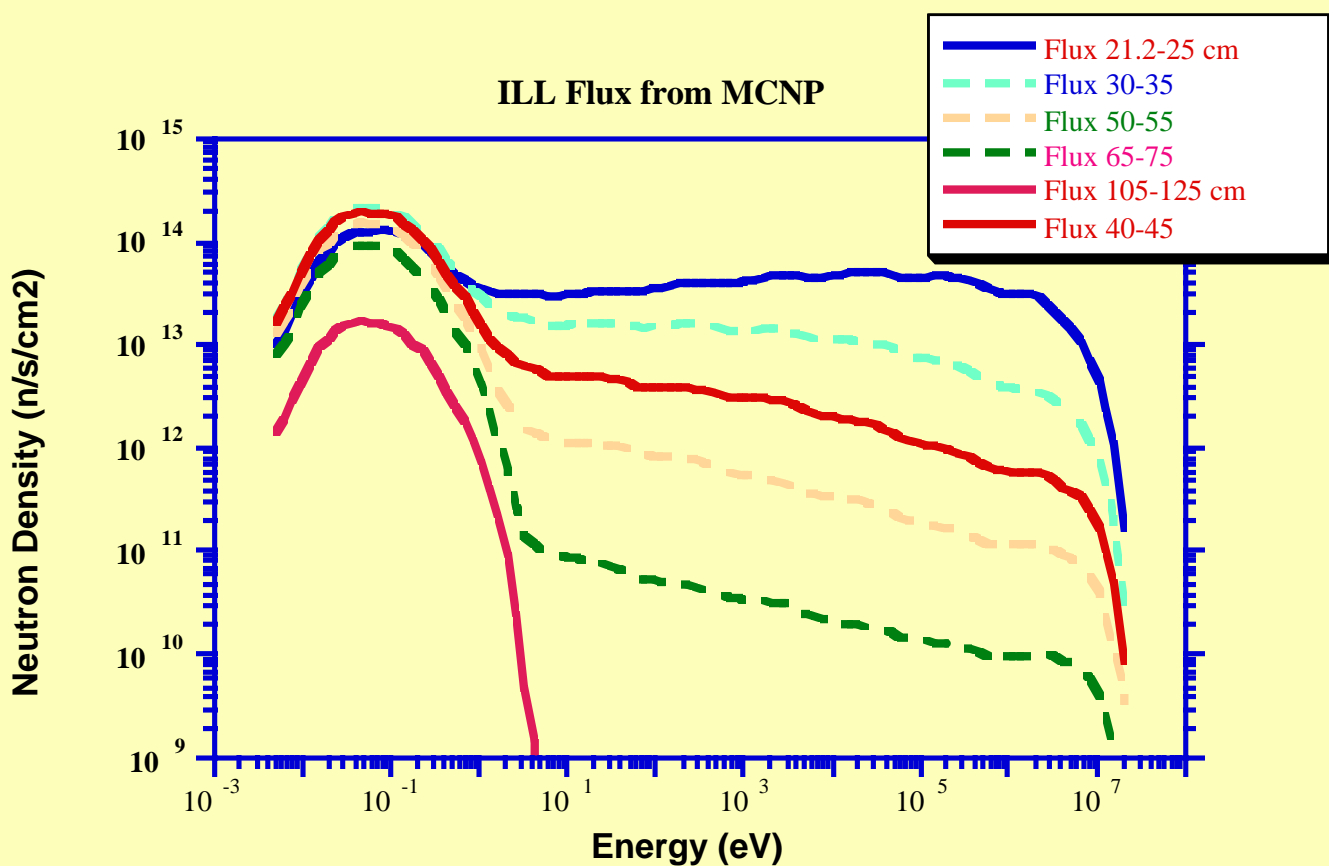
Experimental Method



The Vertical Beam Tube V4

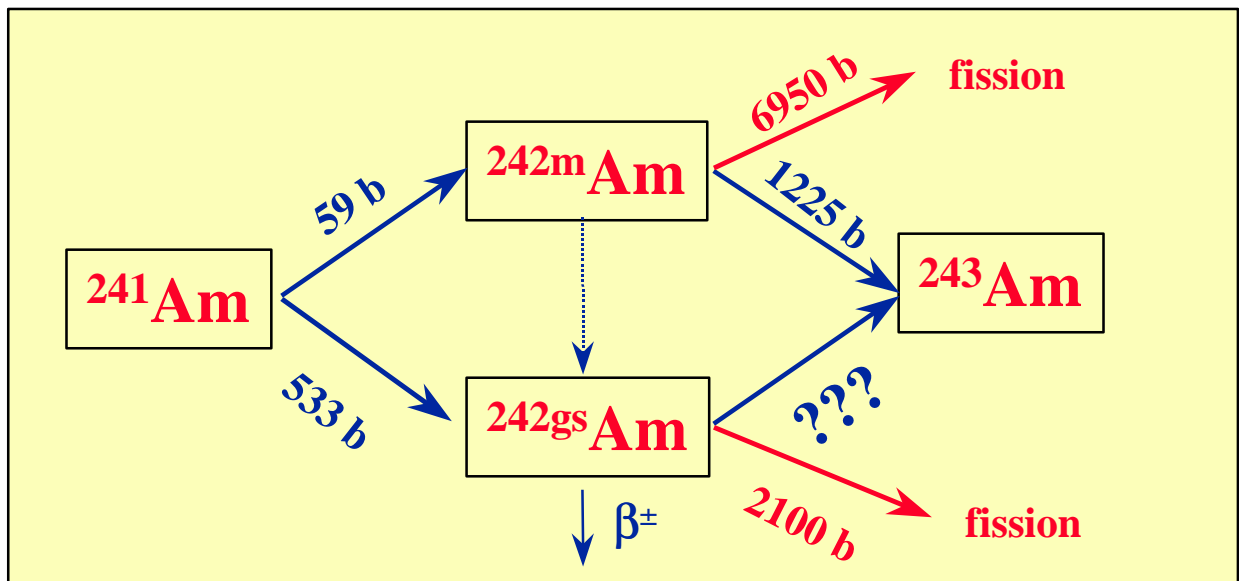


Neutron Fluxes at the ILL



Thermal Neutron Capture Cross Section of $^{242\text{gs}}\text{Am}$

$$\sigma_{\gamma} = \begin{cases} 5511 \text{ Barns, JEF-2} \\ 252 \text{ Barns, ENDF-B/VI} \end{cases}$$



$^{241}\text{Am} (n, \gamma)$ branching ratio : 0.91 ± 0.01

$^{241}\text{Am} (n, \gamma) = (695 \pm 30) \text{ barns}$

$^{242\text{gs}}\text{Am} (n, \gamma) = (280 \pm 40) \text{ barns}$

^{243}Cm and ^{244}Cm at thermal energy

^{243}Cm	FE 2.2	JENL -3.	END F B/V .
Capture	108.5	125.22 (+14.9%)	56.77 (-47% .)
Fission	423.9	676.9 (+3.1%)	604.29 (+2.6%)
^{244}Cm			
Capture	14.04	14.70 (+4%)	10.10 (-28% .)
Fission	1.00	1.00	0.58 (-42%)

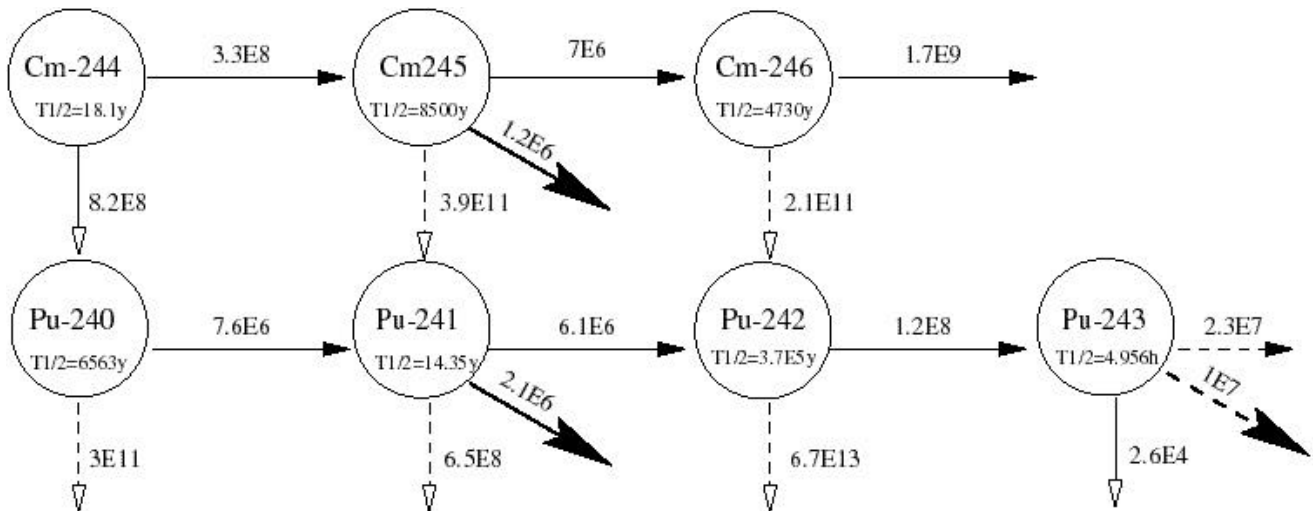
Irradiations of 1 to 10 μg samples in a $5 \cdot 10^{14}$ n/s/cm² thermal neutron flux at ILL

◆ On-line alpha spectrometry on Lohengrin

and

◆ Alpha - gamma spectroscopy

Measurement of ^{244}Cm



A total of 20 days irradiation :

- **After two days : alpha spectroscopy to measure ^{245}Cm (5.362 MeV line).**
- **On-line alpha spectrometry with Lohengrin to follow the sample evolution**
- **Final alpha-gamma spectroscopy for ^{245}Cm (and Pu?) cross sections**

Nuclear “SpectroSCOMetry” on Lohengrin

On-line : standard spectrometry experiment

Off-line : Sample up with the changer and placed in a “reaction chamber” for nuclear spectroscopy (alpha-gamma)

Isotope	Mass [μg]	irradiation time
Am-241	10	4 days
Am-243	10	4 hours
Am - 243	5	20 days
Am - 244	10	20 days
Am - 247	10	20 days
Pu- 242	5	2 days
Np 237	10	10 days
(...)		
Fission fragments		

Conclusions on Mini-Inca

At thermal : several measurements are possible with accuracy of some %.

Integral Measurements : a different approach to obtain in a fast way parameters of interest for transmutation systems, in **any** neutron spectra, provided that a 5 cm diameter channel is available for irradiation.