DE LA RECHERCHE À L'INDUSTRIE

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INTEGRAL MEASUREMENT OF THE ^{235M}U ISOMER BY NEUTRON INELASTIC SCATTERING

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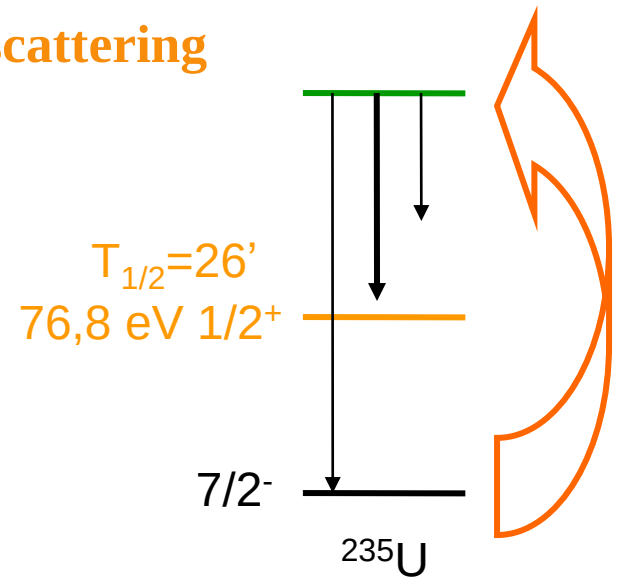
MOTIVATIONS

Fission cross section of the isomer:

- Experiment: A.D'Eer & al. Phys. Rev. C38(1988)1270 → $\sigma^m / \sigma^{gs} = 2,5$ at 25,3 meV
- Theory: J.E.Lynn *& al.* LA-UR-01-426(2001)21 → $\sigma^m < \sigma^{gs}$ E_n<0.5 MeV

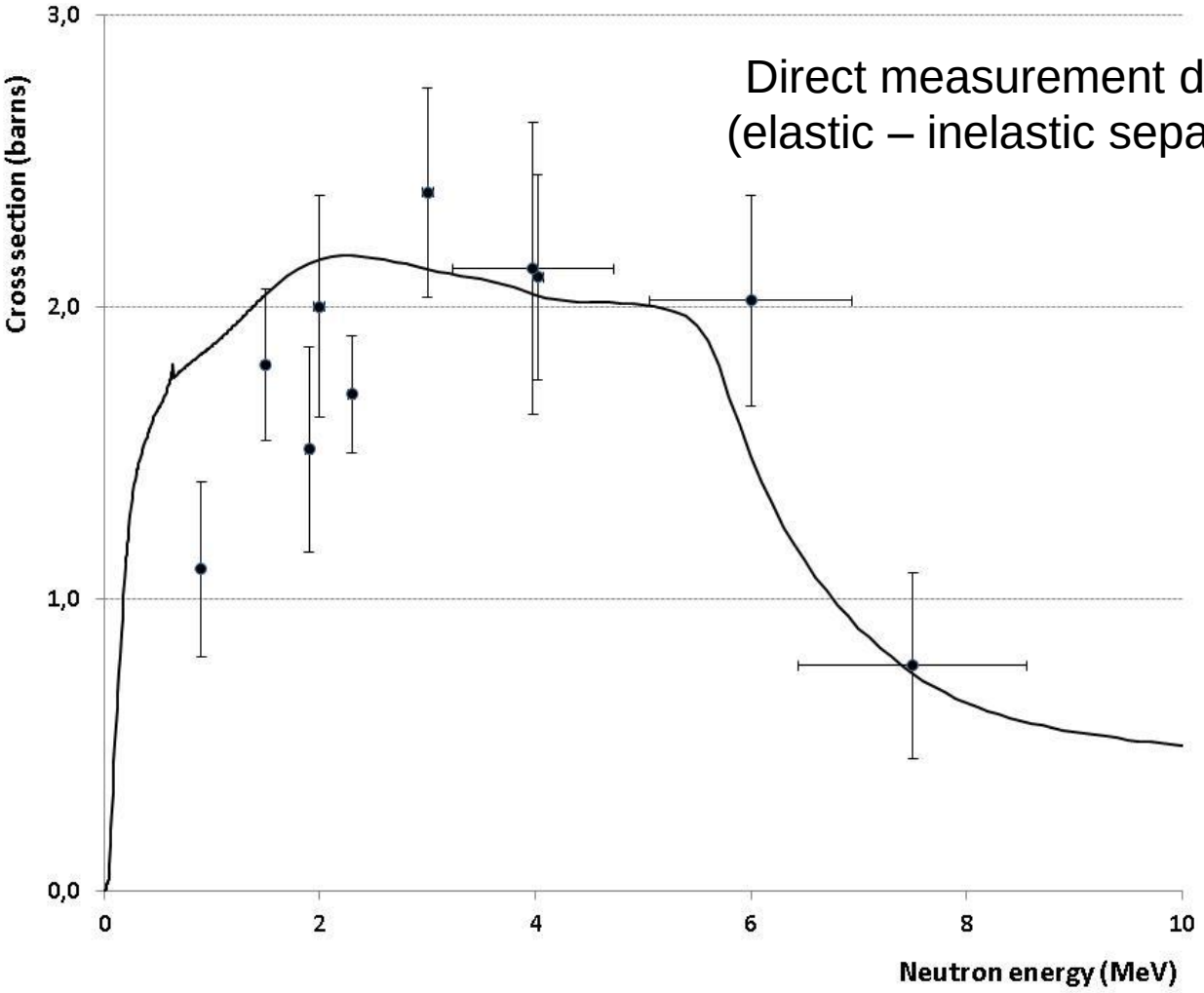
Isomer excitation?

- Electromagnetic processes– V.Méot *& al.* CEA report R-5944
- **Neutron inelastic scattering**

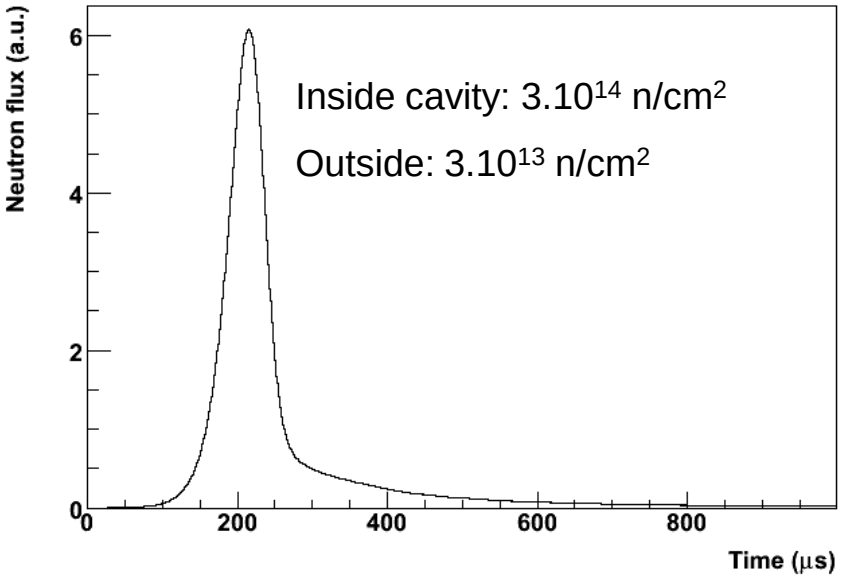


MOTIVATIONS

Total inelastic neutron sattering

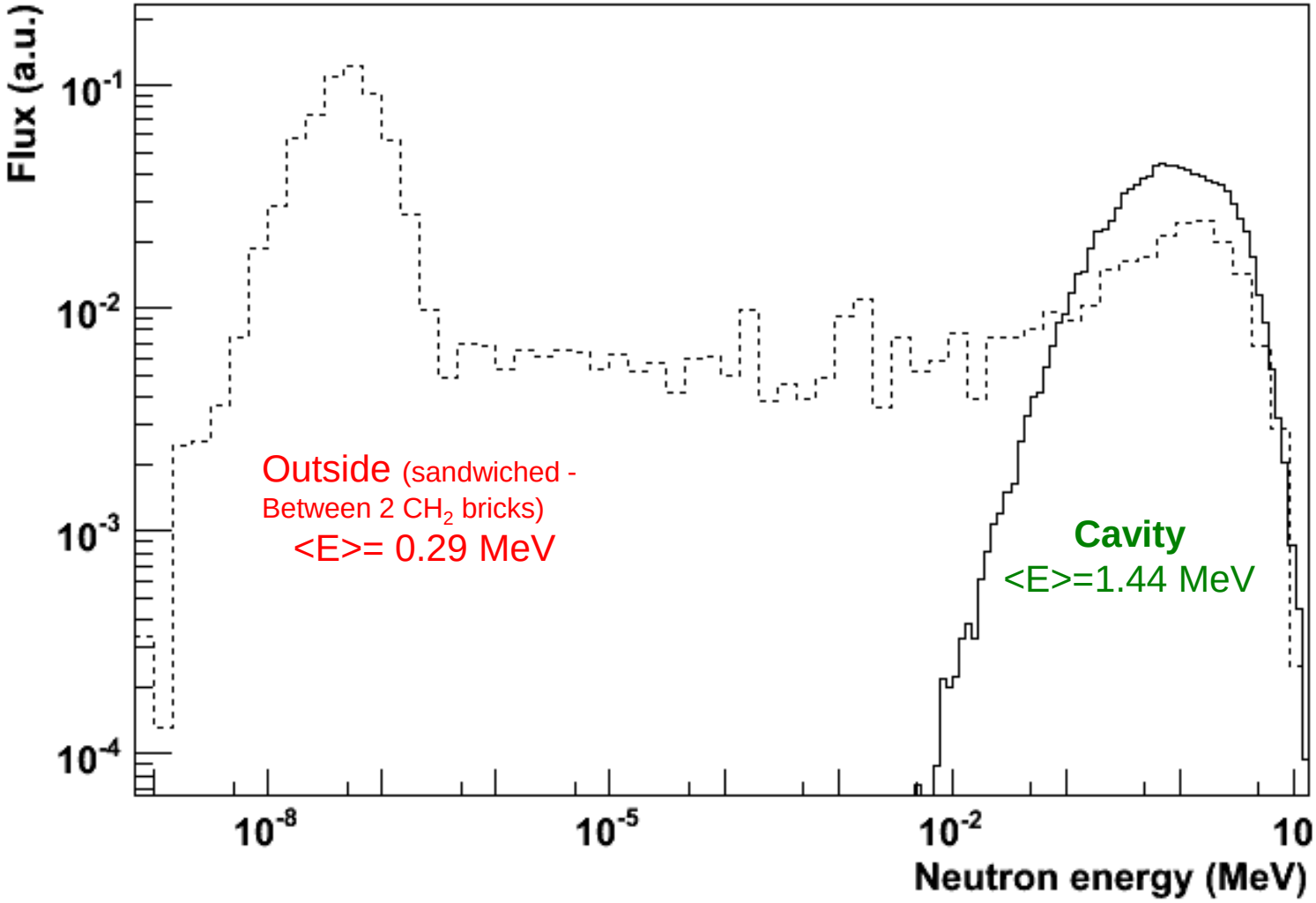


THE CALIBAN CRITICAL ASSEMBLY - VALDUC



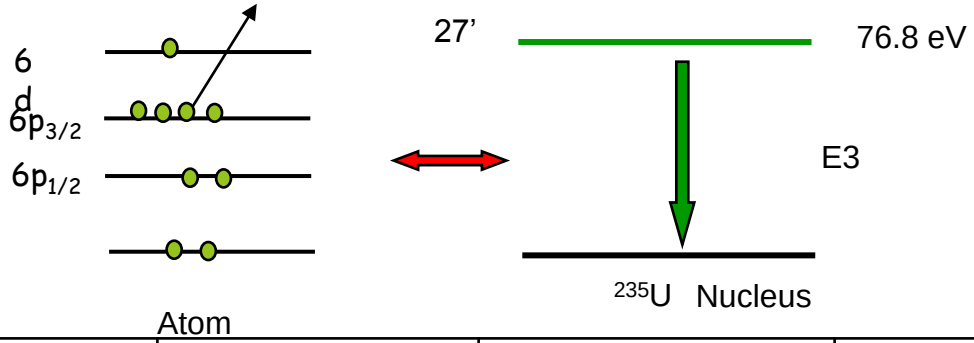
- ✓ Shot duration ~60 μs
- ✓ Fast sample retrieval ~ 30 minutes

NEUTRON SPECTRUM



ISOMER DE-EXCITATION

Very low energy transition + high multipolarity → completely converted



Atomic sub-shell	$6p_{1/2}$	$6p_{3/2}$	6d
Kinetic electron energy (eV)	42.6±0.5	52.6. ±0.5	64.4±0.5

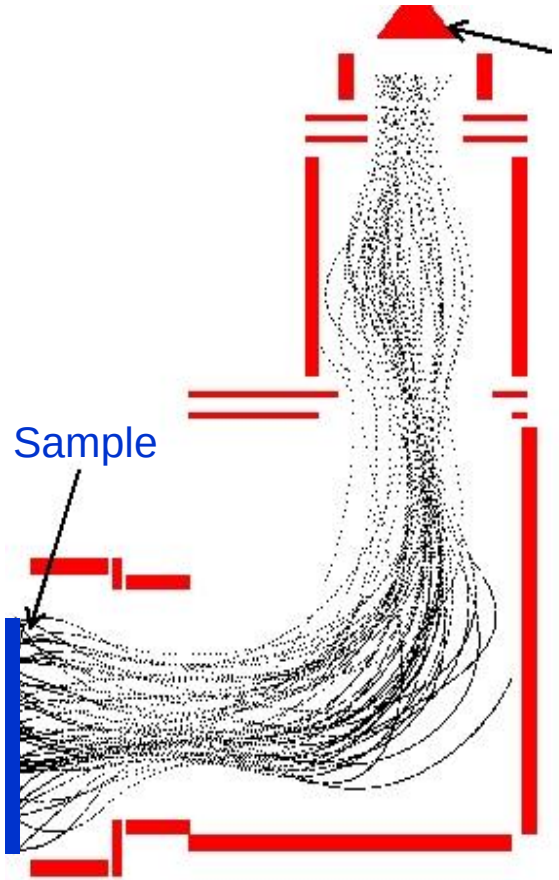
→ Electrons of very low energies ($E_e \leq 10$ eV) have to be detected

→ Energy very degraded

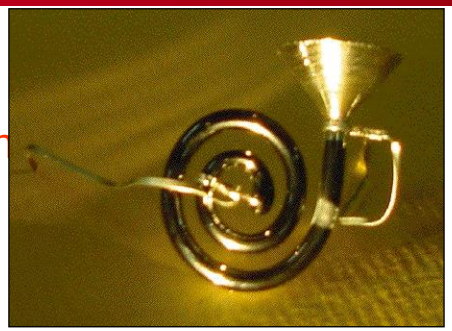
→ Isomer identification by its period only

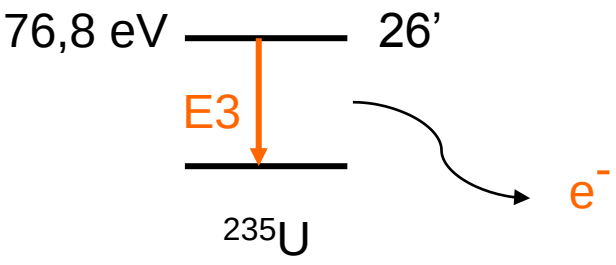
Half life depends on the chemical environment !!!! ~ 26 minutes

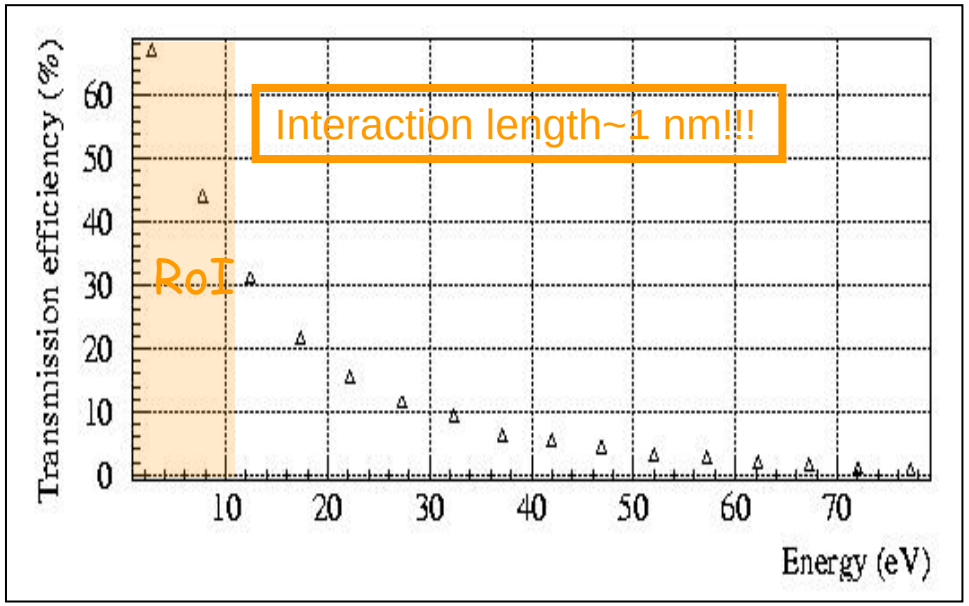
ELECTRON DETECTOR



E.Sauvan, V.Méot et J.C. Baudin



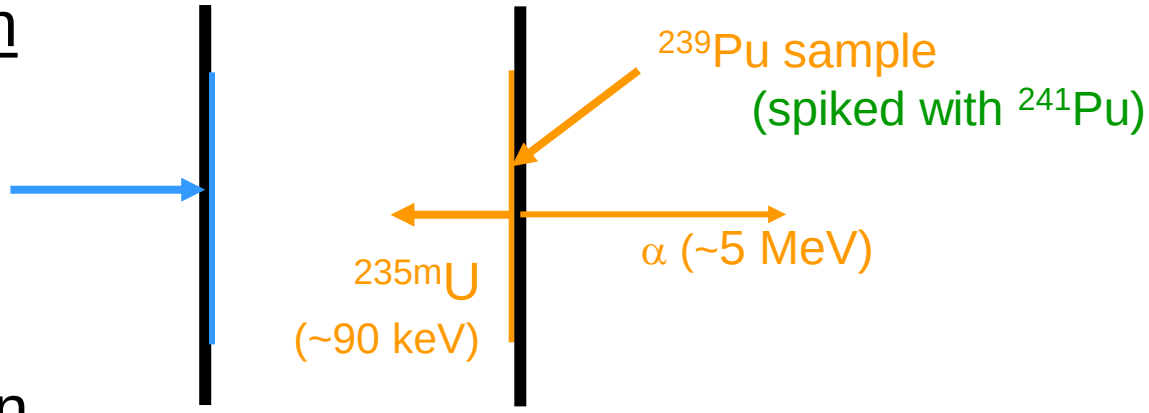




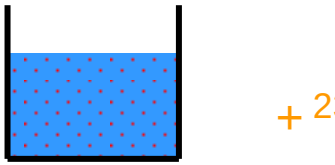
SAMPLE PREPARATION- EFFICIENCY MEASUREMENTS

1. Isomer collection

NaCl deposit
1 mg/cm^2



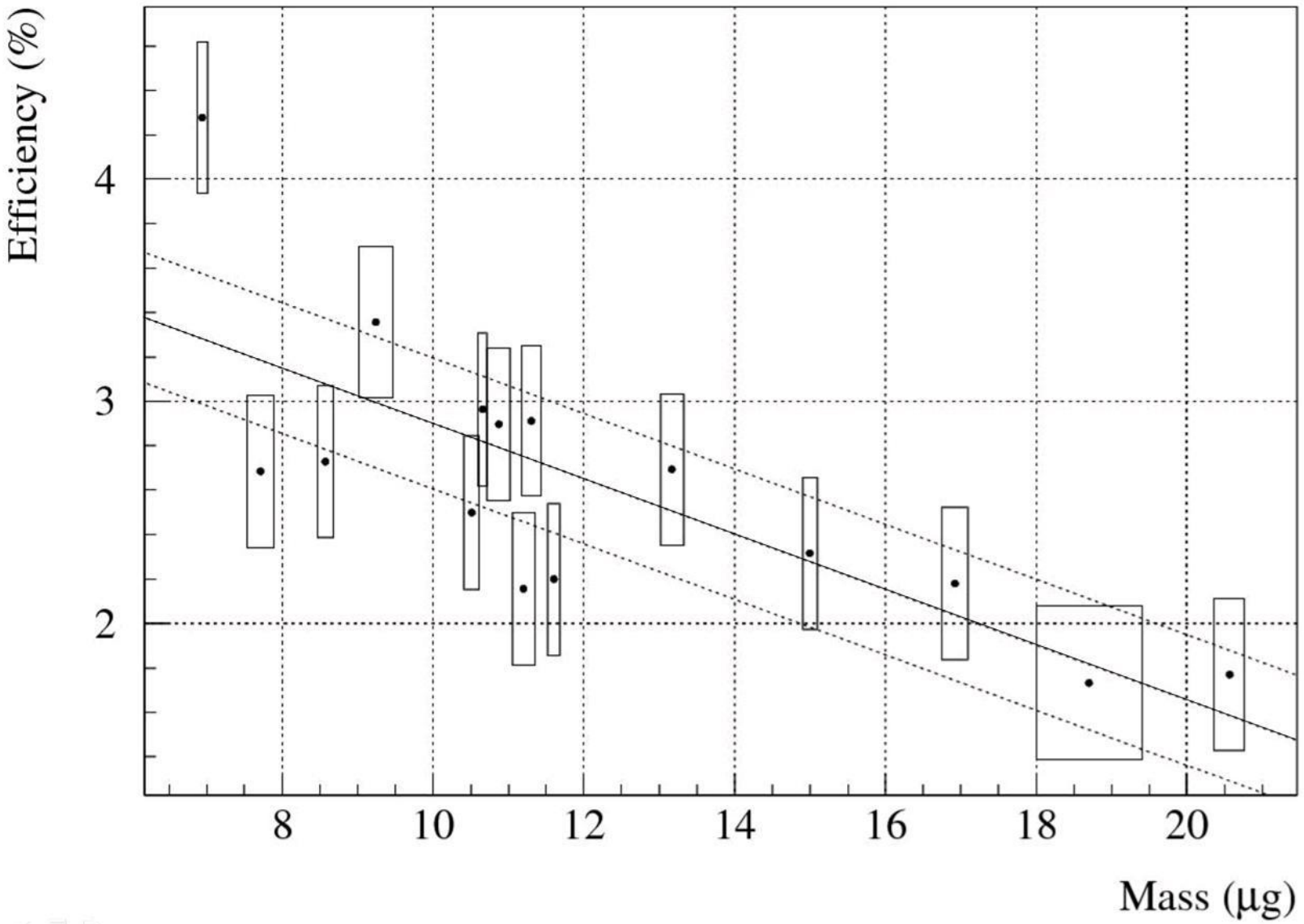
2. Electrodeposition



+ ^{235}U (10μg)

Deposit ^{235m}U+^{235}U
titanium foil

EFFICIENCY CURVE

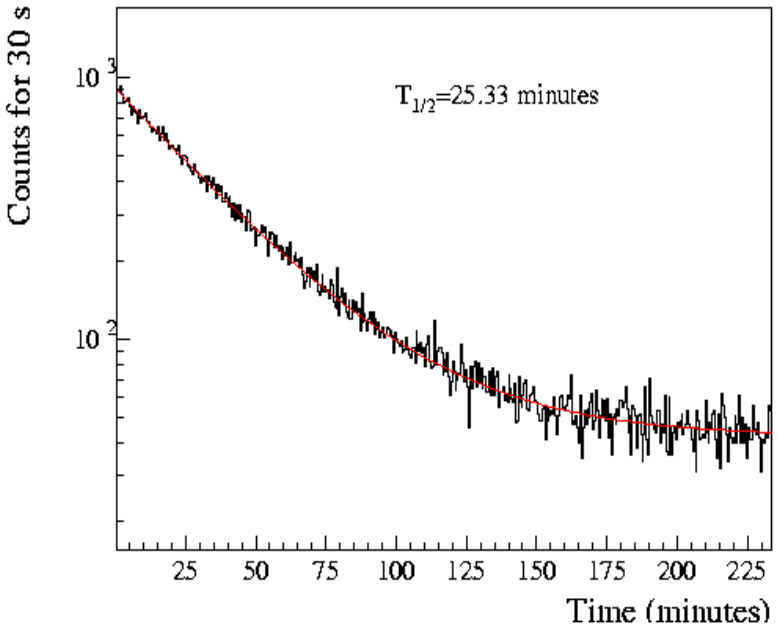


ISOMER HALF-LIFE ?

M. Neve de Mevergnies and P. Del Marmol, Physics Letters 49B(1974)428
Effect of the oxidation state on half-life of ^{235m}U

→ Variation of 10 % depending of the oxidation state

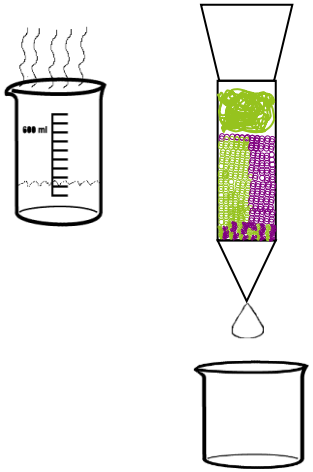
Our measurements:

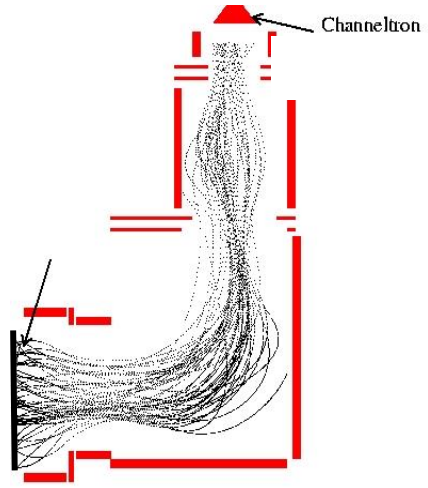


Support	Type of deposit	Half-life (minutes)
Al	Implanted	26,76±0,04
Ti	Implanted	27,4±0,7
Ti	**Deposited**	**25,46±0,04**
Pt	Deposited	26,37±0,05
Ag	Implanted	25,7±0,2
NaCl	Implanted	29,01±0,24
Stainless steel	**Deposited**	**25,6±0,1**

CALIBAN SHOTS TIMELINE

Chimical separation uranium –produits de fission
E.Bond *& al.* J. of Rad. and Nucl. Chem. 276(2008)549

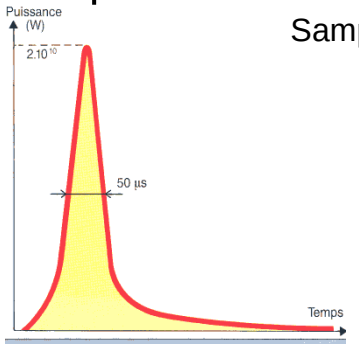




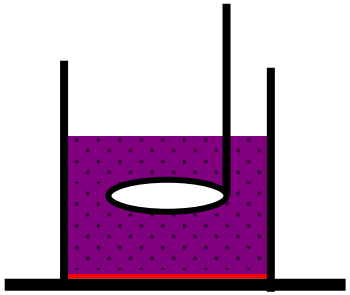
t_0 30' 40' 70'

Sample retrieval

Electron count

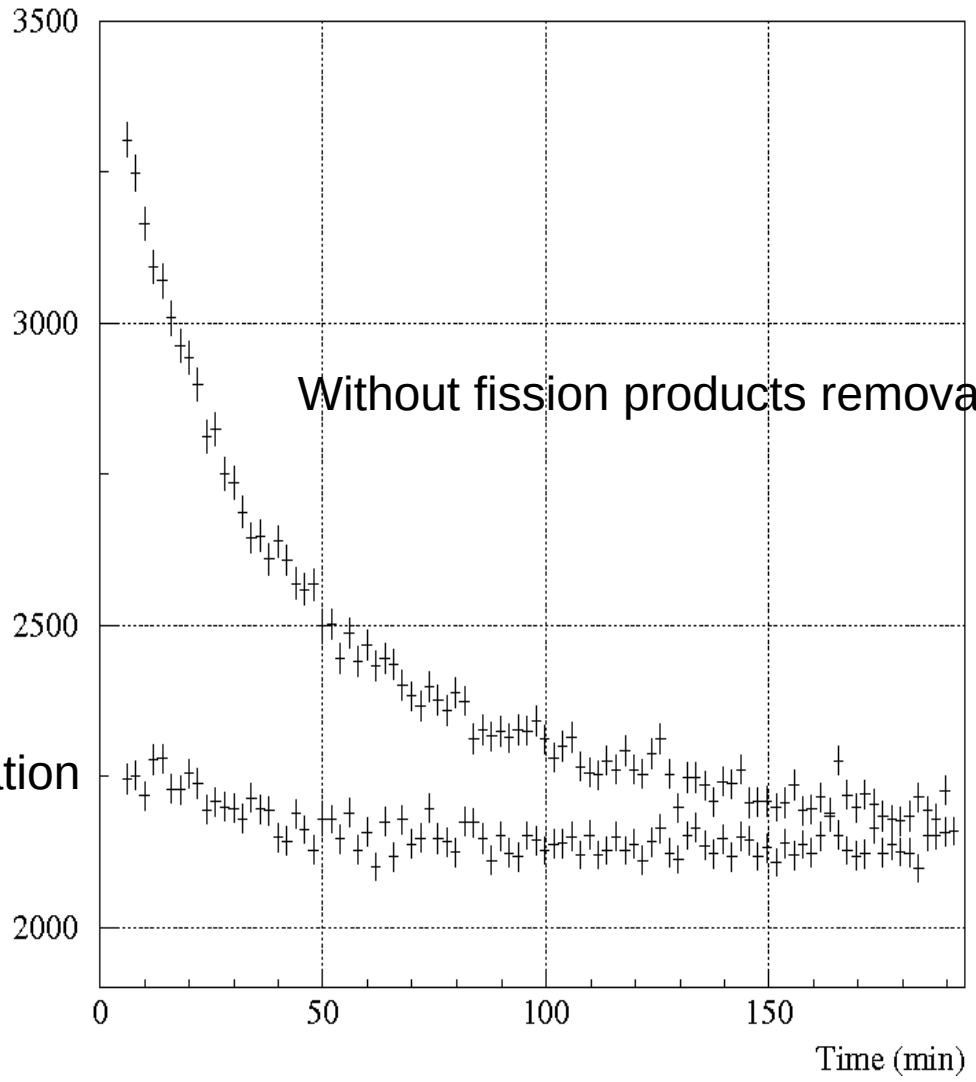


Irradiation



Electro-deposition

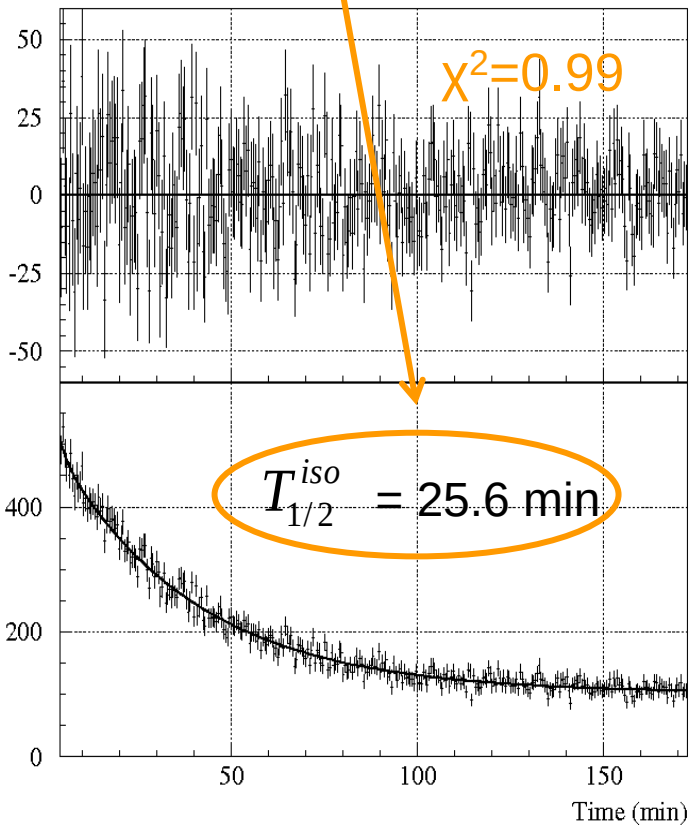
CHEMICAL SEPARATION: TEST WITH ^{236}U



ISOMER ACTIVATION: CAVITY SHOT WITH ON U235

$$f(t) = P_1 + P_2 \exp(-t / T_{1/2}^{iso}.\ln(2)) + P_3 * \exp(-t / T_{1/2}^{bckg}.\ln(2))$$

Half-life fixed to its measured value

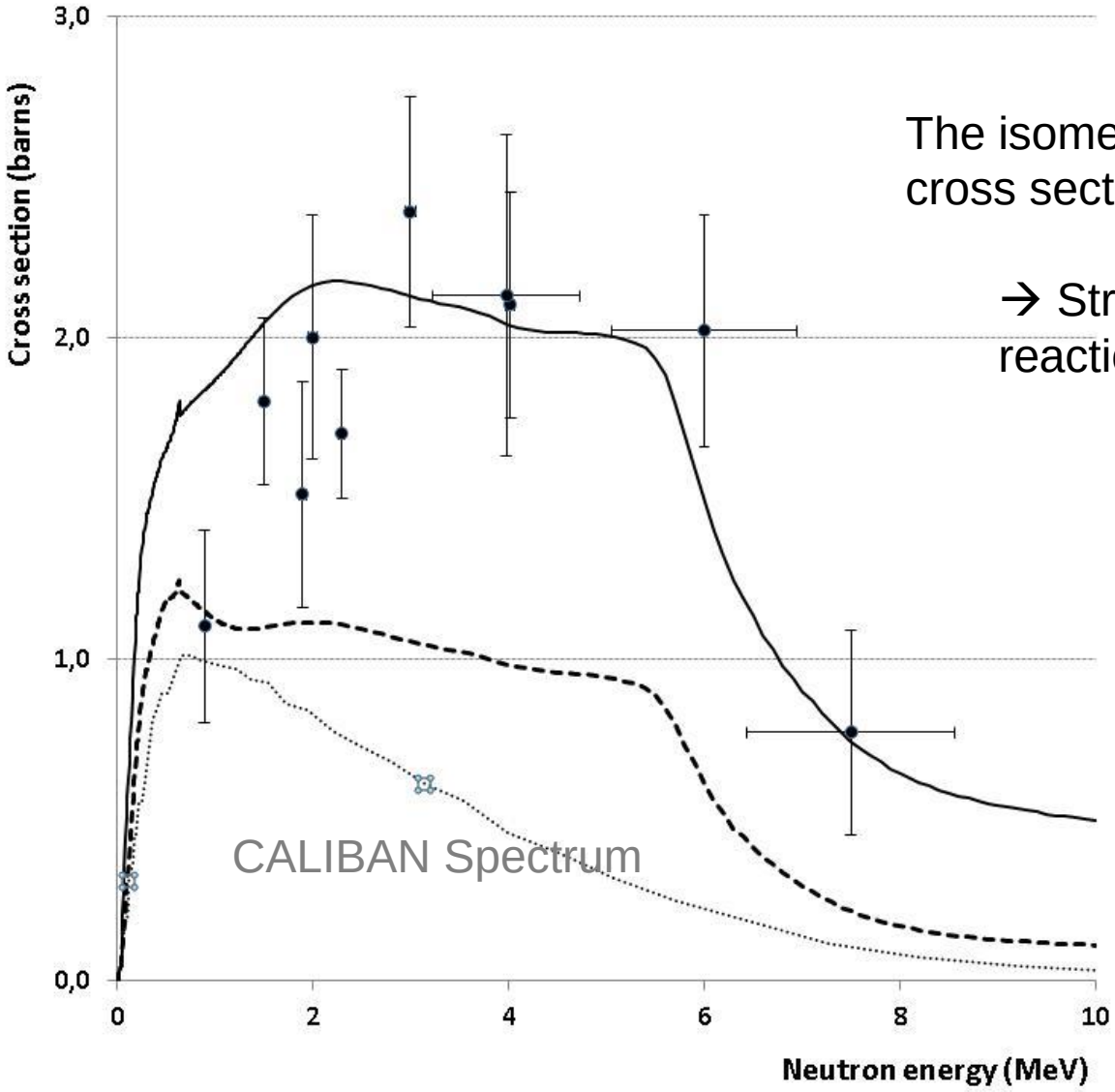


RESULT

1.00 ± 0.13 barns

Parameter	Relative uncertainties (%)
Detection efficiency	7.7
Isomer half-life in aqueous solution	5
Neutron flux measurement	4.7
Samples masses	3.2
Activation measurement	1
Half-lives associated to cooling	0.3

CONCLUSION



The isomer state exhausts 58.4 % of the cross section

→ Strong constrain the total (n,n') reaction

(n,n') total TALYS-1.4

(n,n') isomer TALYS-1.4