

This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 847552.



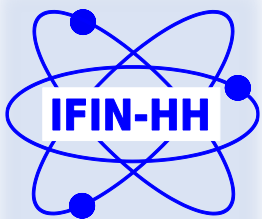
Deliverable D2.4: Report on the ^{239}Pu , ^{233}U , ^{14}N and $^{35,37}\text{Cl}$ inelastic cross section measurements at GELINA (M48)

Responsible: IFIN-HH

Speaker: Adina Coman

Partners: CNRS/IPHC, JRC-Geel





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Deliverable D2.4: Report on the ^{239}Pu , ^{233}U , ^{14}N and $^{35,37}\text{Cl}$ inelastic cross section measurements at GELINA

Main results expected in the deliverable

- γ production cross sections following the $(n, xn\gamma)$ reaction on: ^{239}Pu , ^{233}U , ^{14}N and $^{35,37}\text{Cl}$

The experiments were planned at the GELINA neutron source of the EC-JRC, Geel, Belgium



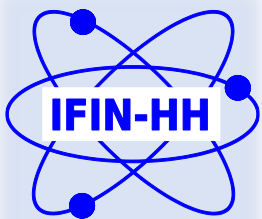
GAINS:

Cross section measurements of structural materials: ^{14}N , $^{35,37}\text{Cl}$.

GRAPhEME:

Cross section measurements of actinides: ^{233}U , ^{239}Pu





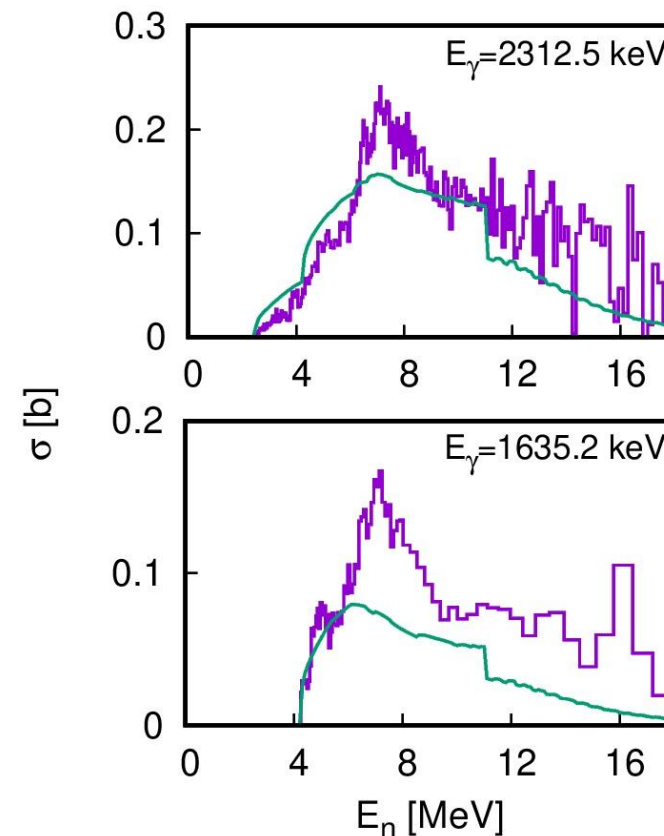
$^{14}\text{N}(n, \text{inl})$ cross sections at GELINA (IFIN-HH, EC-JRC, CNRC/IPHC)

- ✓ Measurements performed using the GAINS spectrometer
 - 12 HPGe detectors (110° , 150° and 125°)
 - ^{235}U fission chamber
 - ACQIRIS and STRUCK digitizers in parallel
 - 10x10 cm plate of Si_3N_4 (0.411 g/cm^2 of ^{14}N)
 - the production cross sections of the first 2 transitions were produced

✓ Data taking and data analysis done.

- ➔ SOON Comparison with theoretical and previous available results in progress
- ➔ SOON Article in preparation.
- ➔ SOON The data will be submitted to EXFOR

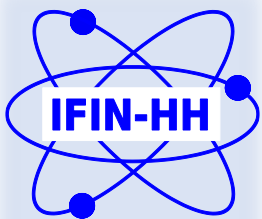
no problem foreseen to deliver the report



Publications/workshops/Conferences :

- A. Olacel, et al., PRC 106, 024609 (2022)
- A. Olacel, et al., EPJ Web of Conferences 284, 01007 (2023)
- M. Boromiza, et al., EPJ Web of Conferences 284, 01010 (2023)
- ND2022, WINS2023

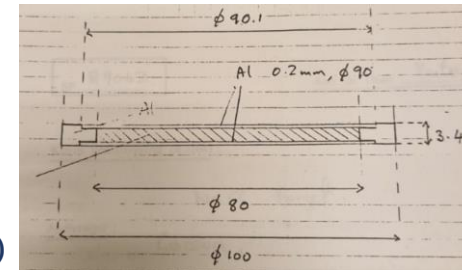




$^{35,37}\text{Cl}(n, \text{inl})$ cross sections at GELINA (IFIN-HH, EC-JRC, CNRC/IPHC)

⚠ Measurement planned to start early 2024

- GAINS - 12 HPGe detectors (110° , 150° and 125°)
- ^{235}U fission chamber
- ACQIRIS and STRUCK digitizers in parallel
- 8 cm diam. disk of NaCl encapsulate in 0.02 cm Al (0.247 g/cm^2 of ^{35}Cl and 0.079 g/cm^2 of ^{37}Cl)
- expected the production cross sections of the first transitions in ^{35}Cl and ^{37}Cl
- needed $\cong 1500$ h of beam time ($\cong 3$ months)



🚧 GELINA is stopped since September 2023 with no news on when it will start again

⚠ When GELINA starts, NaCl is the second target on the list to be measured

😊 Data taking starts in May at the latest

- ✓ Data taking done
- ✓ Preliminary results available

👉 The report will include preliminary results

😞 Data taking starts in July at the latest

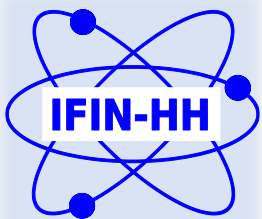
- ✓ Partial data taking
- ✓ Preliminary data available

👉 The report will include preliminary data

😞 GELINA starts after July

👉 No data will be available for the report





$^{233}\text{U}(n, \text{inel})$ cross sections at GELINA (CNRS/IPHC, JRC-Geel, IFIN-HH)

✓ Measurement performed with the GRAPhEME setup

- 5 planar HPGe + 1 segmented – 6 x 6 pixels
- ^{235}U fission chamber
- ^{233}U sample (8.3 g of metallic ^{233}U , thickness of 0.64 mm, A= 3 GBq)
- TNT digitizers
- \cong 4500 h of beam time collected.

✓ The data taking, the analysis have been done

✓ Thesis defended 03/2023 (François Claeys)

➔ SOON The comparison with theoretical predictions is in progress.

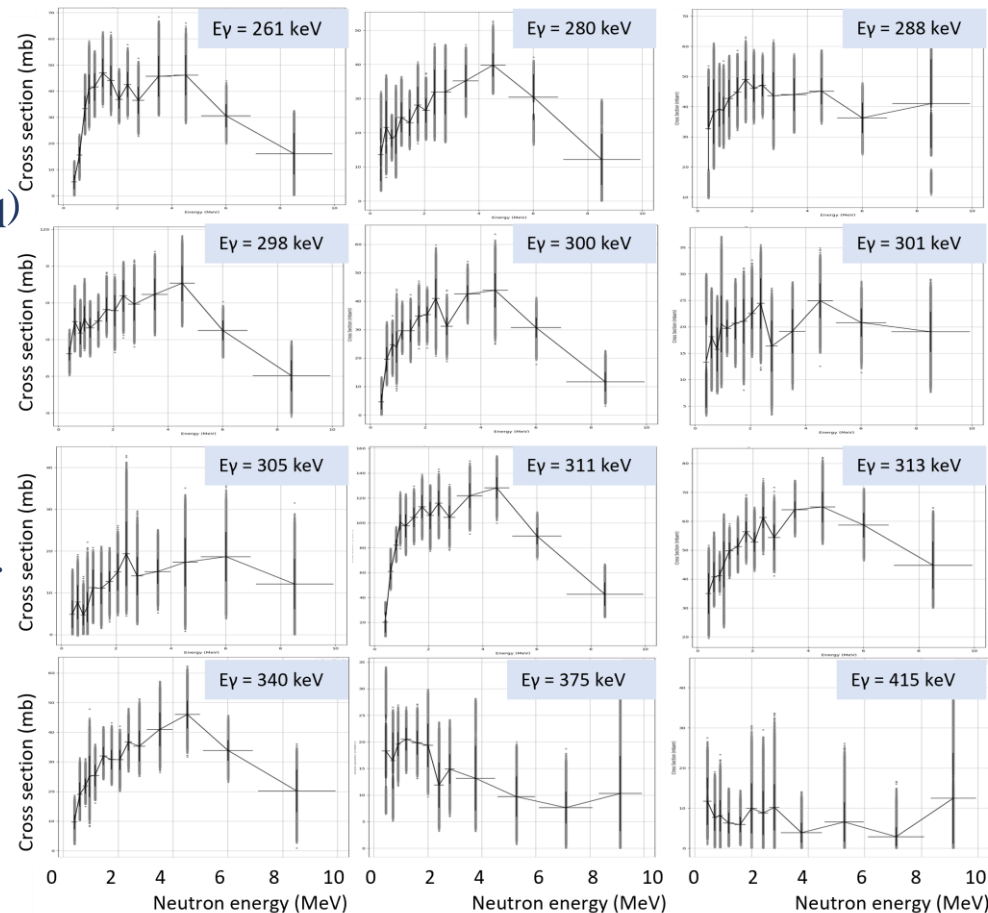
➔ SOON Article in preparation.

➔ SOON The data will be submitted to EXFOR

- 12 $^{233}\text{U}(n, n'\gamma)$ cross sections

👉 The first measurement of $^{233}\text{U}(n, n'\gamma)$ cross sections.

📄 no problem foreseen to deliver the report



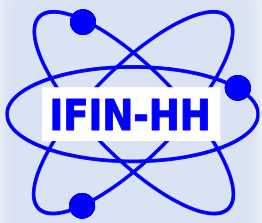
Publications/workshops/Conferences :

- Measurement of partial (n, n'γ) reaction cross-sections on highly radioactive nuclei of interest for energy production application.

F.Claeys, et al. EPJ Web of Conferences 284, 01014 (2023)

- ND2022, JEFF NDW (11/2020), SANDA meeting (03/2022)





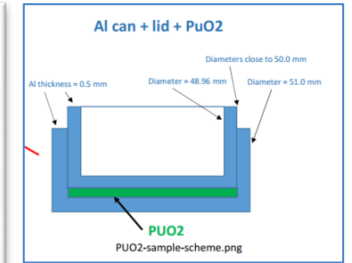
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Deliverable D2.4: Report on the ^{239}Pu , ^{233}U , ^{14}N and $^{35,37}\text{Cl}$ inelastic cross section measurements at GELINA

$^{239}\text{Pu}(n, \text{inel})$ cross sections at GELINA (CNRS/IPHC, JRC-Geel, IFIN-HH)

Measurement in progress with the GRAPhEME setup,

- 6 planar HPGe + 1 segmented – 6 x 6 pixels
- ^{235}U fission chamber
- ^{239}Pu sample (2.3 g of PuO_2 compressed powder, $A = 5.2 \text{ GBq}$, purified by SCK-CEN, made by JRC-Geel, in the frame id WP3 SANDA)
- FASTER digitizers



$m = 2,3 \text{ g}$
 $\varnothing = 49,95 \text{ mm}$, $A = 5,2 \text{ GBq}$

delay for the making of the sample (COVID crisis)

– received spring 2022

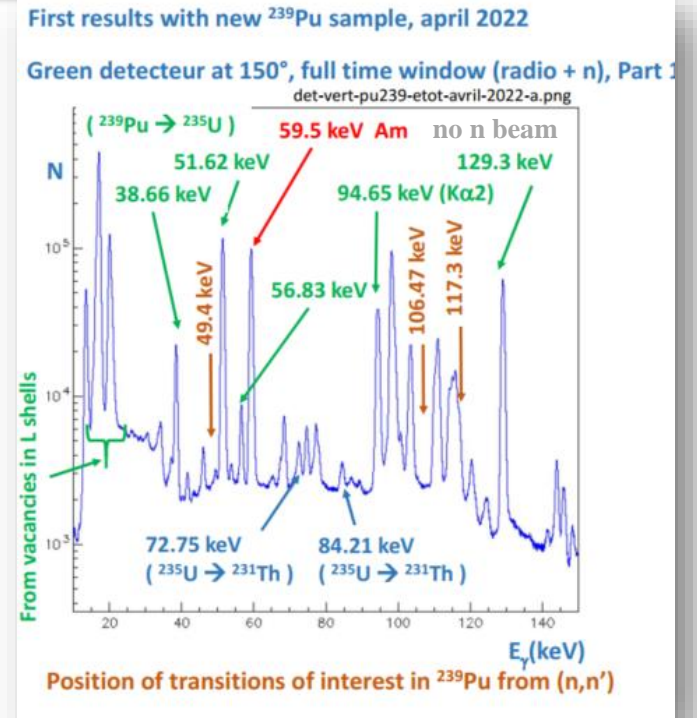
▶ beam start in June 2022 (low beam intensity) for setting up

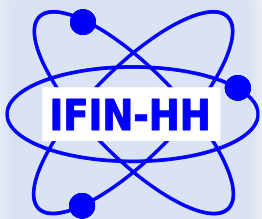
GELINA is stopped since September 2023 with no news on when it will start again

Only ~1300 h of beam time (with different DAQ setting) collected up to now.

impossible to obtain the request statistic before the end of the SANDA project.

no data will be available for the report





$^{239}\text{Pu}(n, \text{inel})$ cross sections at GELINA (CNRS/IPHC, JRC-Geel, IFIN-HH)

✓ Mitigation strategy

- We propose to provide $^{186,184,182}\text{W}(n, n'\gamma)$ cross sections (isotopic samples) measured at GELINA in the same conditions as ^{238}U .

👉 The data taking, the analysis have been done.

α more than 60 $^{18i}\text{W}(n, n'\gamma)$ cross sections have been produced

➔ SOON The comparison with theoretical predictions is in progress (almost finished).

➔ SOON The article will be submitted to PRC soon

➔ SOON The data will be transferred to EXFOR soon

👉 This work allowed a deep test of γ -strength functions and level density models.

🔑 if this proposal is accepted, no problem foreseen to deliver the report

Publications/workshops/Conferences :

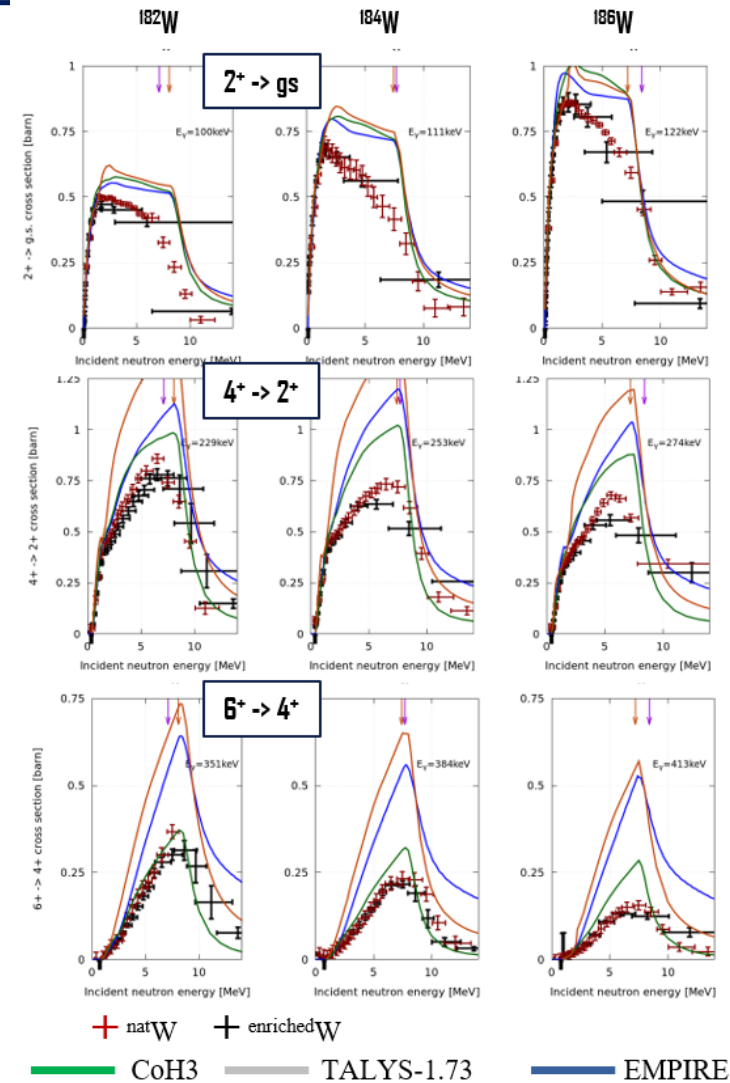
- Measurement of $^{182,184,186}\text{W}(n, n'\gamma)$ cross sections and what we can learn from it

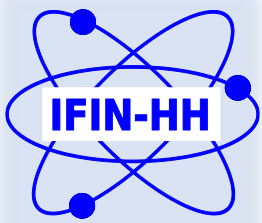
G. Henning, et al. EPJ Web of Conferences 247, 09003 (2021) PHYSOR 2020

- Measurement of (N, XN gamma) reaction cross section in W isotopes

G. Henning, et al. Eur. Phys. J Web of Conferences 146, 11016 (2017) ND2016

- ND2016, WINS2023, JEFF NDW



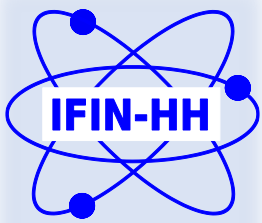


In conclusion..

The report should contain 4 datasets:

- ✓ 1 The cross sections of the $^{14}\text{N}(n, n'\gamma)$ reaction
- 2 {
 - If GELINA starts before July
 - If GELINA doesn't start before July
 - ✓ The preliminary cross sections of the $^{35,37}\text{Cl}(n, n'\gamma)$ reactions
 - ✗ No data will be available for $^{35, 37}\text{Cl}(n, n'\gamma)$ reactions
- ✓ 3 The cross sections of the $^{233}\text{U}(n, n'\gamma)$ reaction
- 4 {
 - If mitigation proposal accepted
 - If mitigation proposal is not accepted
 - ✓ The cross sections of the $^{186,184, 182}\text{W}(n, n'\gamma)$ reactions
 - ✗ No data will be available for $^{239}\text{Pu}(n, n'\gamma)$ reaction





In conclusion..

The report should contain 4 datasets:

- ✓ 1 The cross sections of the $^{14}\text{N}(n, n'\gamma)$ reaction
- 2

| | | |
|---|-------------------------------------|--|
| { | If GELINA starts before July | ✓ The preliminary cross sections of the $^{35,37}\text{Cl}(n, n'\gamma)$ reactions |
| | If GELINA doesn't start before July | ✗ No data will be available for $^{35,37}\text{Cl}(n, n'\gamma)$ reactions |
- ✓ 3 The cross sections of the $^{233}\text{U}(n, n'\gamma)$ reaction
- 4

| | | |
|---|--|---|
| { | If mitigation proposal accepted | ✓ The cross sections of the $^{186,184,182}\text{W}(n, n'\gamma)$ reactions |
| | If mitigation proposal is not accepted | ✗ No data will be available for $^{239}\text{Pu}(n, n'\gamma)$ reaction |

Problems & delays outside the control of the research team

