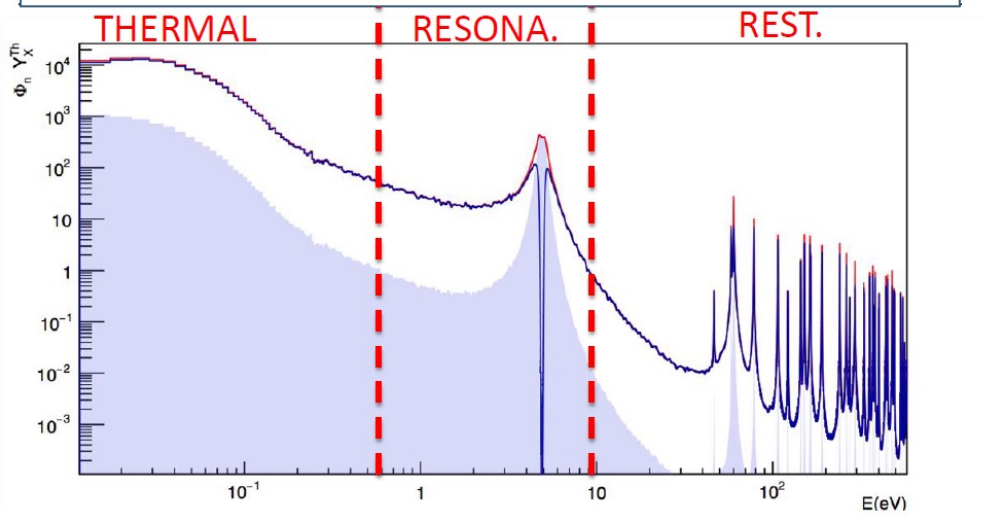
Determination of the neutron flux by activation

DR. ELIZABETH MUSACCHIO GONZALEZ

Work of A. Villacorta and C. Guerrero

Activation of ^{197}Au foils: calculations

	Thickness	Thermal	1-10 eV.	>10 eV
(n,γ) react.	100 μm@EAR2	59%	36%	5%



After the activation of two foils with the same thickness making the difference in neutron captures the estimation of the flux can be determined as:

$$A_{first} - A_{second} = \sigma\ \Phi\ N$$

A Number of capture reactions (n/pulse)

σ Cross section at the resonance (barn)

Φ Flux at the resonance (n/pulse)

N Sample thickness (at/barn)

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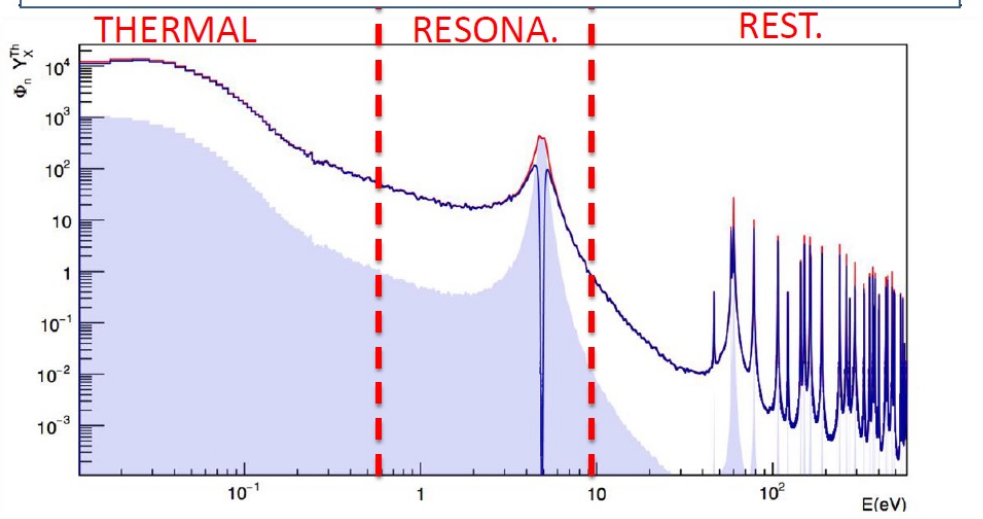

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A Number of capture reactions (n/pulse)

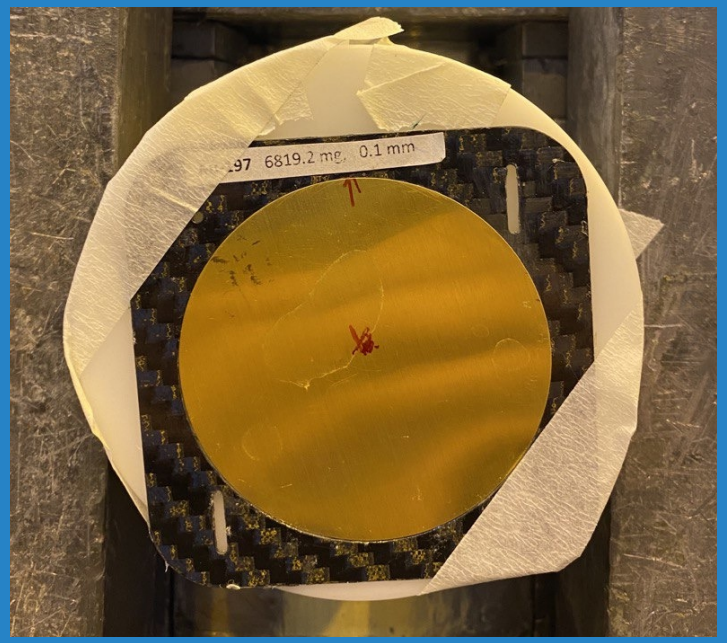
σ Cross section at the resonance (barn)

Φ Flux at the resonance (n/pulse)

N Sample thickness (at/barn)

RESULTS FOR BOTH EXPERIMENTAL AREAS

EAR2 (2021)



Activation of two 197- Au foils back-to-back:

- 80 x 0.1090 mm (upstream, bottom)
- 65 x 0.1064 mm (downstream, top)
- Mylar foil between the gold samples (0.006 mm)

Irradiation time: Start @ 23/09/2021 21:00:26

Stop @ 24/09/2021 08:34:45

Total: 11:34:19 h → 41659 s

In the HPGe detector: 3 measurements per foil

	REAL_meas (t_m) (s)	LIVE_meas (s)	START		Waiting time (t_w)	t_w (s)
Au_65_1	3.748E+04	3.723E+04	10/15/2021	11:06:24	2:31:39	9099
Au_80_1	8.162E+04	8.102E+04	10/16/2021	21:37:30	13:02:45	46965
Au_65_2	9.290E+04	9.242E+04	10/16/2021	9:42:51	1:08:06	263286
Au_80_2	8.829E+04	8.783E+04	10/16/2021	11:37:13	3:02:28	356548
Au_65_3	1.111E+05	1.106E+05	10/17/2021	12:13:20	3:38:35	445115
Au_80_3	8.707E+04	8.666E+04	10/18/2021	19:10:00	10:35:15	556515

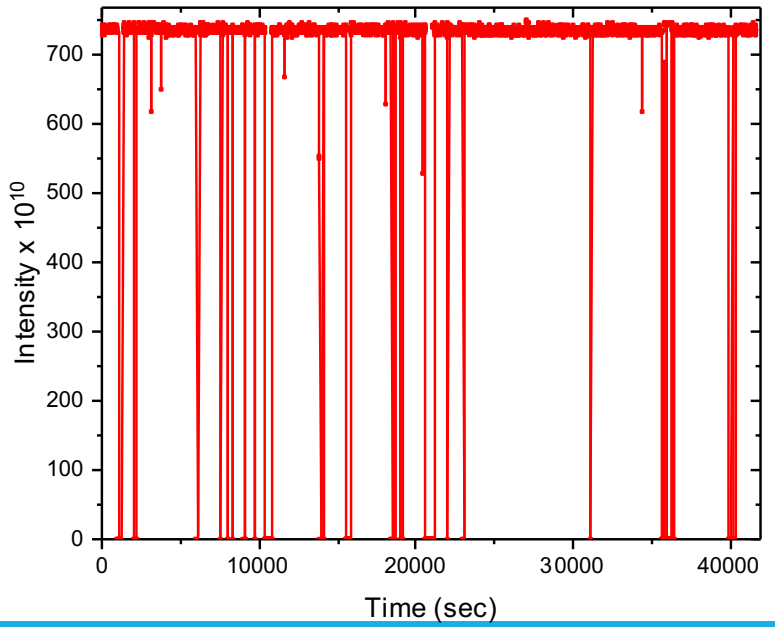
Activation analysis

The number of activations after the irradiation:

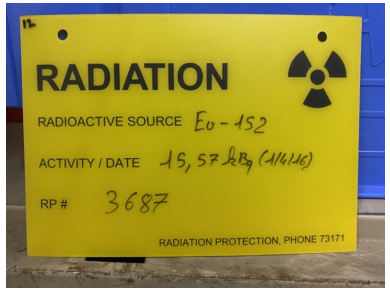
$$A_x = \frac{C_x}{I_{\gamma x} f_{dx} k_{\gamma x} \varepsilon_{\gamma x}}$$

$$f_{dx} = \underbrace{\left(1 - e^{-\lambda t_m}\right) e^{-\lambda t_w} e^{-\lambda t_i} \int_0^{ti} \Phi(\tau) e^{\lambda \tau} \mathrm{d}\tau \Big/ \int_0^{ti} \Phi(\tau)\, \mathrm{d}\tau}_{f_d}$$

- C_x- Number of counts
- $I_{\gamma x}$- Gamma intensity - $\mathrm{I}_\gamma(411.8\ \mathrm{keV}) = 0.9562 \pm 0.0006$
- f_{dx}- Disintegration factor - $f_d = 0.927$
- $\varepsilon_{\gamma x}$- Detection efficiency
- $k_{\gamma x}$- Transmission factor



Detection efficiency (^{152}Eu source)

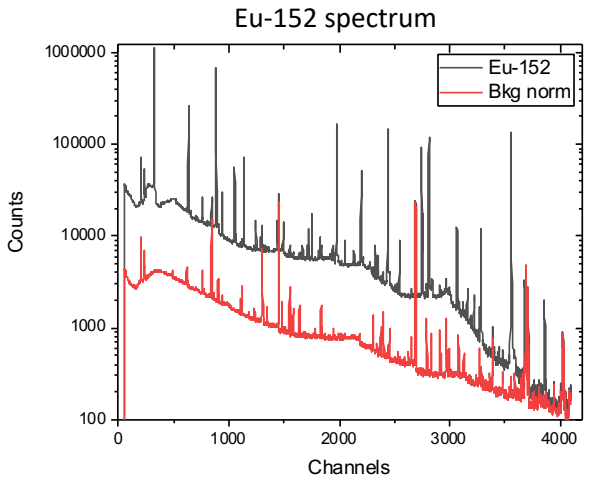


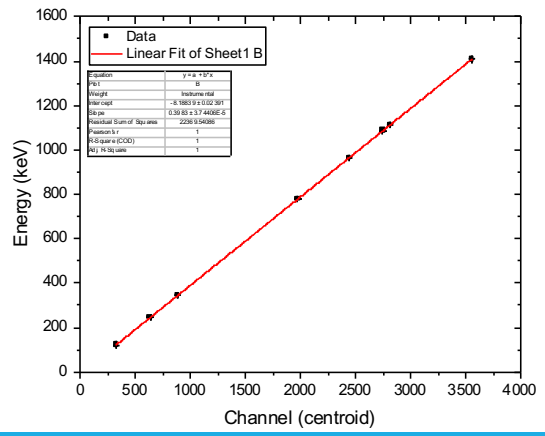
$$\varepsilon_\gamma = \frac{C_{peak} \cdot \lambda}{A_0 \cdot I_\gamma \cdot e^{-\lambda t_c} \cdot (1 - e^{-\lambda t_m})}$$

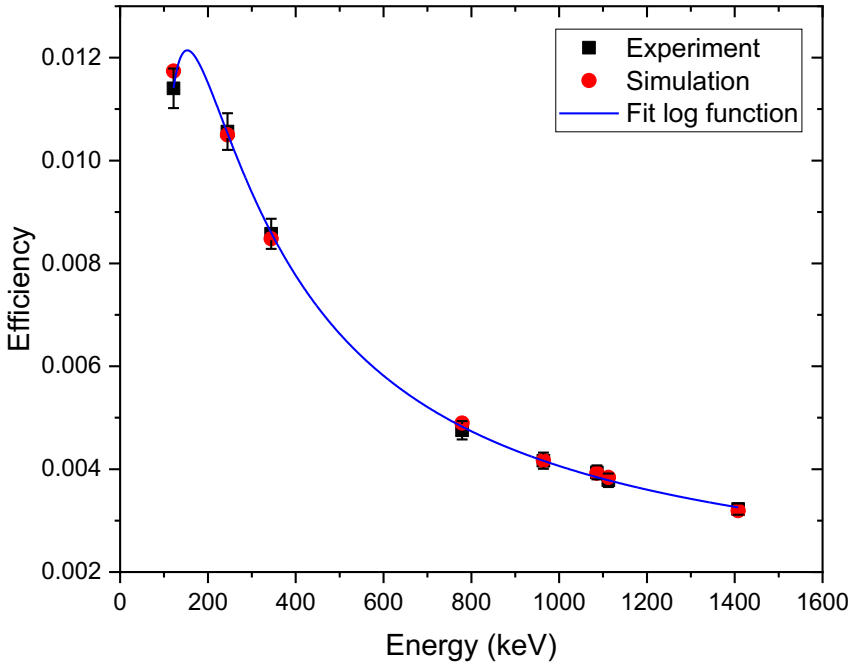
Source #3687(Eu-152)		
Initial Activty (A_0)	15570	Bq
ΔA_0	514	Bq
Date	01.04.2016	
Actual Date	03.10.2021	
Time passed (t_c)	1.74E+08	sec
λ	1.625E-09	sec-1
$\Delta\lambda$	1.000E-12	sec-1
Measure time	9.895E+04	sec
Live time	9.696E+04	sec
Δt_m	1.990E+03	sec

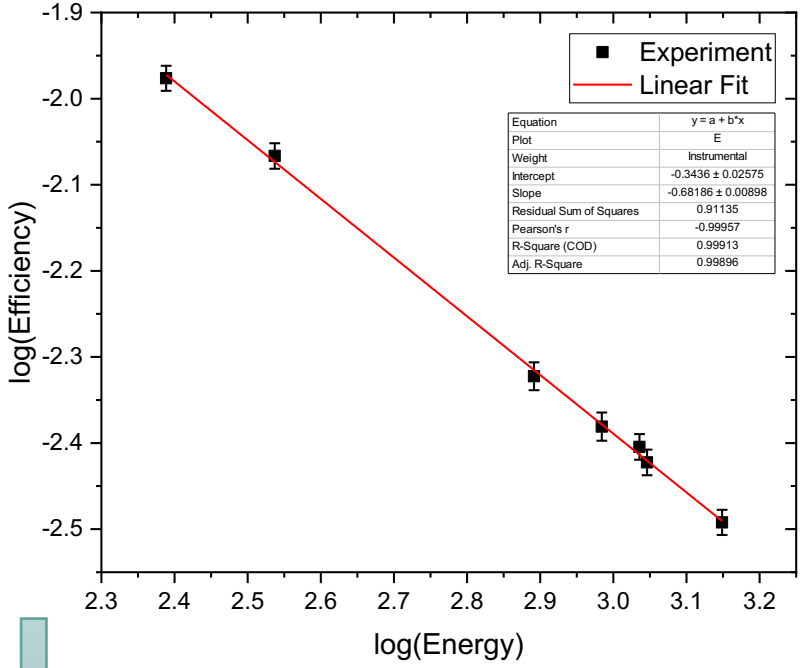
Energy (keV)	ΔE (keV)	Intensity (Iɣ)	ΔIɣ
1.218E+02	3.000E-04	2.853E-01	1.600E-03
2.447E+02	8.000E-04	7.550E-02	4.000E-04
3.443E+02	1.200E-03	2.659E-01	2.000E-03
7.789E+02	2.400E-03	1.293E-01	8.000E-04
9.641E+02	5.000E-03	1.451E-01	7.000E-04
1.086E+03	1.000E-02	1.011E-01	5.000E-04
1.112E+03	3.000E-03	1.367E-01	8.000E-04
1.408E+03	3.000E-03	2.087E-01	9.000E-04

Efficiency of HPGe detector (^{152}Eu source)









$$\varepsilon_{\gamma x}(411.8\ keV) = 7.54\text{E}{-}03 \pm 2.63\text{E}{-}04$$ Experiment

$$\varepsilon_{\gamma x}(411.8\ keV) = 7.56\text{E}{-}03 \pm 2.65\text{E}{-}04$$ Simulation

Activation analysis

The number of activations after the irradiation:

$$A_x = \frac{C_x}{I_{\gamma x} f_{dx} k_{\gamma x} \varepsilon_{\gamma x}}$$

- C_x- Number of counts
- $I_{\gamma x}$- Gamma intensity - $\mathrm{I}_\gamma(411.8\ \mathrm{keV}) = 0.9562\ \pm 0.0006$
- f_{dx}- Disintegration factor - $f_d = 0.927$
- $\varepsilon_{\gamma x}$- Detection efficiency (extended source - 0.973):

$$\varepsilon_{\gamma x}(411.8\ \mathrm{keV}) = 7.36\mathrm{E}{-}03 \pm 2.58\mathrm{E}{-}04$$

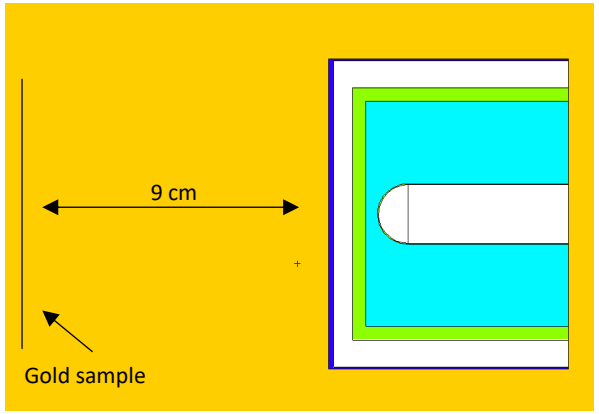
- $k_{\gamma x}$- Transmission factor

$$k_\gamma = \frac{\epsilon_\gamma}{\varepsilon_\gamma}$$

← Considering complete geometry (gold)

← Considering empty geometry (void)

HPGe geometry MCNP (by Francisco)



$$k_\gamma(80) = 0.984 \pm 0.004$$
$$k_\gamma(65) = 0.985 \pm 0.004$$

Activation analysis

	f_d	Δf	C_x	ΔC_x	A	ΔA	ΔA (rel %)
Au_65_1	9.528E-02	7.287E-05	9.848E+05	3.001E+03	1.492E+09	5.279E+07	3.54
Au_65_2	1.023E-01	1.472E-04	1.051E+06	3.116E+03	1.484E+09	5.252E+07	3.54
Au_65_3	6.940E-02	1.084E-04	7.184E+05	2.164E+03	1.494E+09	5.290E+07	3.54
Au_80_1	1.739E-01	3.085E-04	2.568E+06	7.498E+03	2.133E+09	7.553E+07	3.54
Au_80_2	7.413E-02	1.026E-04	1.091E+06	3.209E+03	2.126E+09	7.524E+07	3.54
Au_80_3	4.038E-02	4.956E-05	6.006E+05	1.862E+03	2.149E+09	7.606E+07	3.54

	A65	A80	Diff
Mean	1.490E+09	2.136E+09	6.460E+08
Error	3.095E+07	4.517E+07	5.476E+07
Rel Error (%)	2.08	2.11	8.48

$$A = A_{80} - A_{65}$$

$$\delta A_x = \sqrt{\delta A_{exp}{}^2 + \delta A_{stat}{}^2}$$

Flux and Neutron captures

$$A = \sigma\ \Phi\ N$$

A Number of capture reactions

σ Cross section (barn)

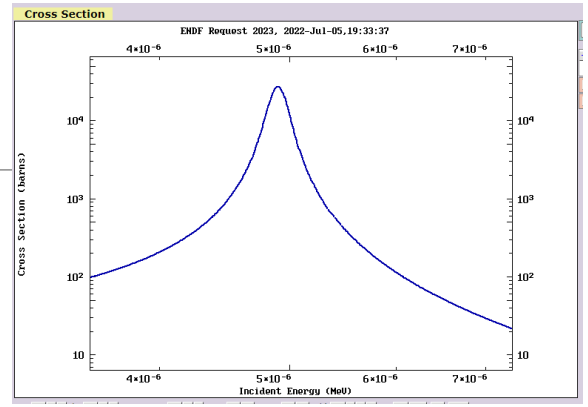
Φ Neutron Flux

N Sample thickness (at/barn)

$N = 6.43E - 04$ at/barn

$A = A_{80} - A_{65} = 6.460E + 08 \pm 5.48E + 07$

How to if the cross section change a lot?




```
gRandom = new TRandom3();
 double sacssum=0, Neutrons_With_XS_SACS=0;
 double BinCont=0;
 cout<<endl<<"**********************************"<<endl;
 printf("\n\tBin / Final bin\n");
 for (int i=1; i<BINS+1; i++) {  //loop in flux histogram bins
   if (Flux_Histo->GetBinContent(i)==0) continue;

   if (Flux_Histo->GetXaxis()->GetBinCenterLog(i) < FIRST_XS_ENERGY) {sacssum += 0; Neutrons_With_XS_SACS += Flux_Histo->GetBinContent(i); continue;}
   if (Flux_Histo->GetXaxis()->GetBinCenterLog(i) > LAST_XS_ENERGY) {sacssum += 0; Neutrons_With_XS_SACS += Flux_Histo->GetBinContent(i); continue;}

   for (int j=0; j<Flux_Histo->GetBinContent(i)/1000000; j++) { //loop the number of neutrons in this bin
       //printf("second loop");
     sacssum += XS_Graph->Eval( pow(10., gRandom->Uniform( log10(Flux_Histo->GetBinLowEdge(i)), log10( (Flux_Histo->GetBinLowEdge(i)+Flux_Histo->GetBinWidth(i)) ) ) ) );
       //BinCont=Flux_Histo->GetBinContent(i);
} //...loop in neutrons
     //cout<<"Get_Bin_Content: "<<endl<<BinCont<<endl;

   Neutrons_With_XS_SACS += Flux_Histo->GetBinContent(i); // total neutrons/cm2
   printf("\t %d / %d\n", i, BINS);
 } //...loop in flux histogram bins

 double Neutrons;
 Neutrons=Neutrons_With_XS_SACS/1000000;

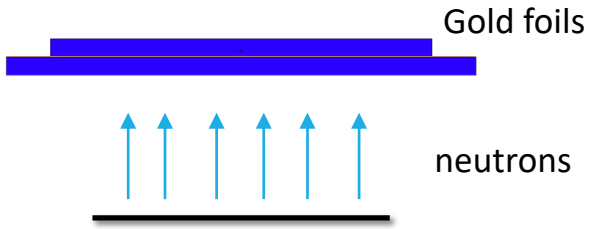

double sacs=sacssum/Neutrons;
cout<<endl<<"SACS [b]: "<<sacs<<endl;
```

Part of the code: thanks to Elisso!!!

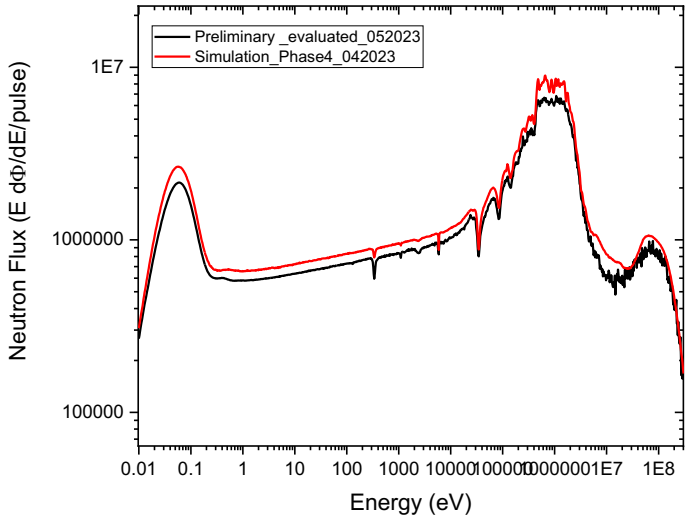
$$\sigma_{int} = \frac{\int \sigma \cdot \Phi}{\int \Phi} \longrightarrow \sigma_{int} = 1708.96 \text{ barn}$$

Simulations: Flux and Neutron captures

- Input geometry:



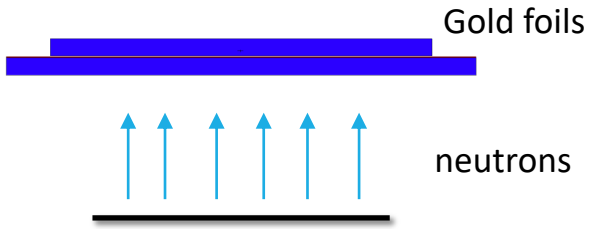
- The flux was used as input in the MCNPX file with the geometry.



- The output file contain the number of capture reactions (Tally F4).

Simulations: Flux and Neutron captures

- Input geometry:



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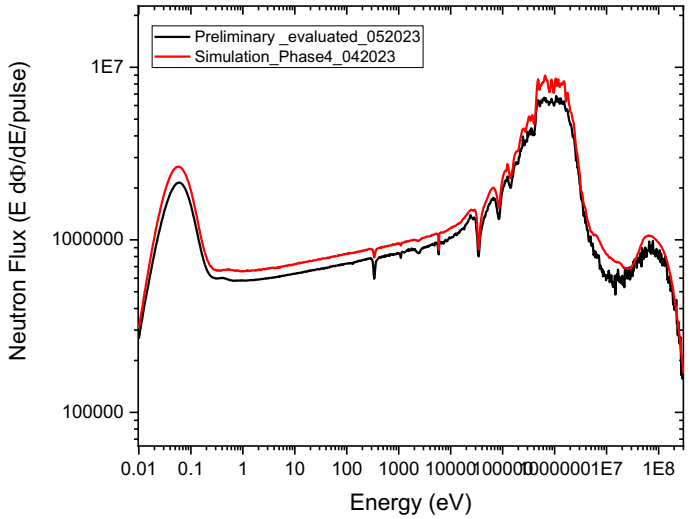

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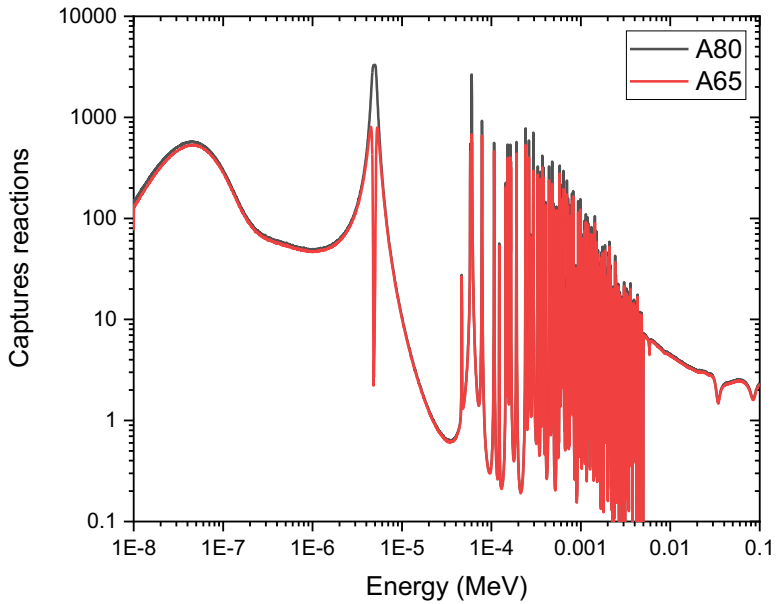
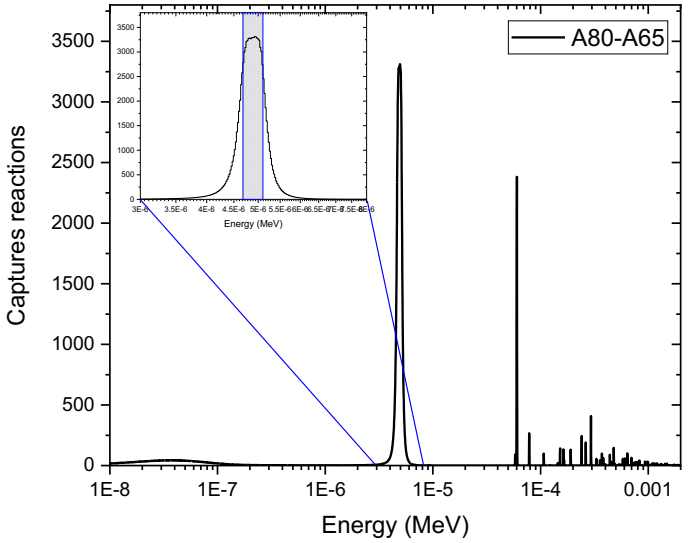


- 48.2 % of the captures are in the resonance region (4.67-5.12 eV)



Final Flux from the activation measurement

$A = \sigma\ \Phi\ N$

A Number of capture reactions

σ Cross section (barn)

Φ Flux

N Sample thickness (at/barn)

$N = 6.43E - 04$ at/barn

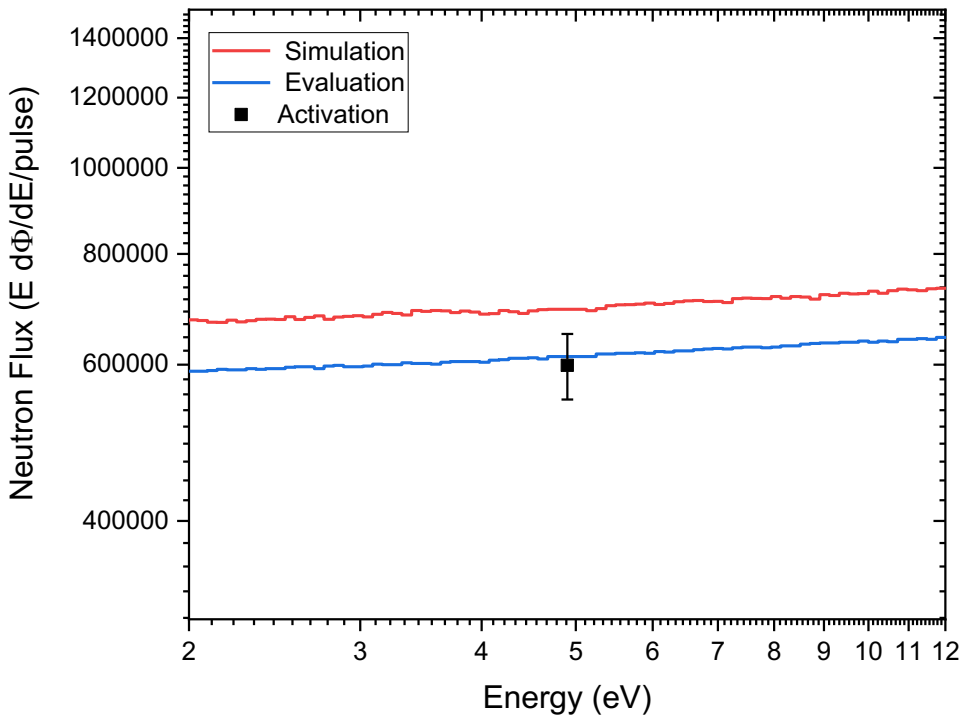
$A = A_{80} - A_{65} = 6.46E + 08 \pm 5.48E + 07$

$\sigma_{int} = 1708.96$ barn

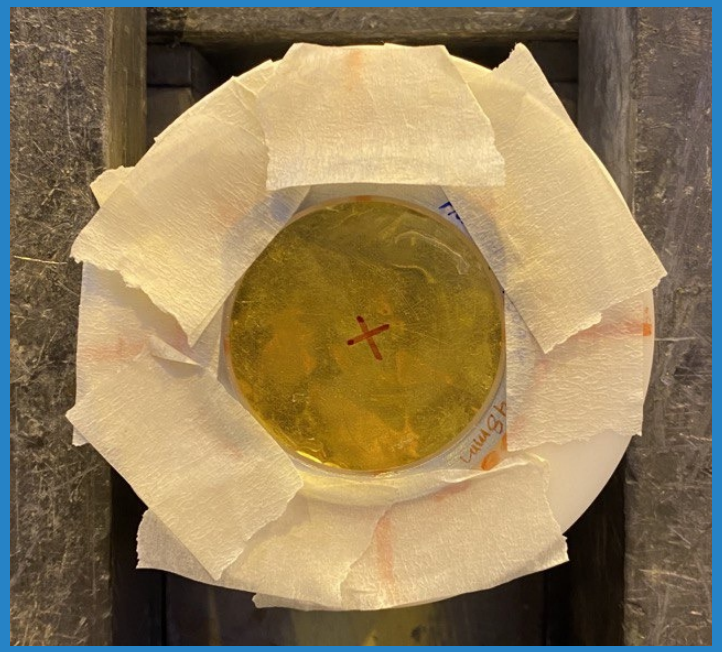
$$\Phi = \frac{A \cdot 0.482}{N \cdot \sigma_{int}}$$

$\Phi = 5.99E + 05 \pm 5.08E + 04$

$\Delta\Phi/\Phi = 8.5\ \%$



EAR1 (2021)



Activation of two 197- Au foils back-to-back:

- 45 x 0.0509 mm (upstream, bottom)
- 48 x 0.1033 mm (downstream, top)
- Mylar foil between the gold samples (0.006 mm)

Irradiation time: Start @ 13/10/2021 19:09:26

Stop @ 15/10/2021 15:09:51

Total: → 158425 s

In the HPGe detector: 3 measurements per foil

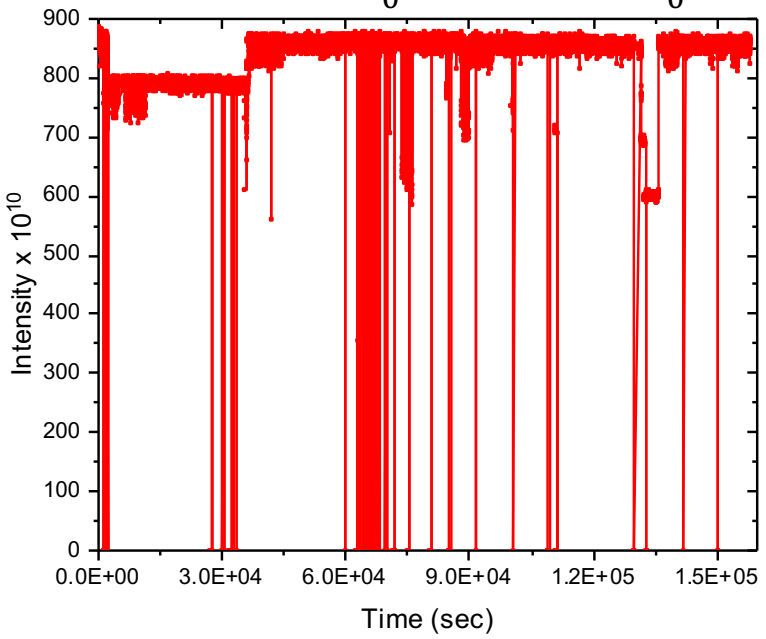
	REAL_meas (t_m) (s)	LIVE_meas (s)	START		Waiting time (s)
Au_45_1	6.136E+04	6.115E+04	10/15/2021	16:01:30	3099
Au_48_1	2.220E+04	2.212E+04	10/16/2021	9:08:17	64706
Au_45_2	1.649E+04	1.644E+04	10/16/2021	15:27:15	87444
Au_48_2	4.986E+04	4.969E+04	10/16/2021	20:09:09	104358
Au_45_3	7.978E+04	7.953E+04	10/17/2021	10:05:55	154564
Au_48_3	1.751E+05	1.746E+05	10/18/2021	8:17:26	234455

Activation analysis

$$A_x = \frac{C_x}{I_{\gamma x} f_{dx} k_{\gamma x} \varepsilon_{\gamma x}}$$

- C_x- Number of counts
- $I_{\gamma x}$- Gamma intensity - $\mathrm{I}_\gamma(411.8\ \mathrm{keV}) = 0.9562 \pm 0.0006$
- f_{dx}- Disintegration factor - $f_d = 0.799$
- $\varepsilon_{\gamma x}$- Detection efficiency
- $k_{\gamma x}$- Transmission factor

$$f_{dx} = \left(1 - e^{-\lambda t_m}\right) e^{-\lambda t_w}\, e^{-\lambda t_i} \int_0^{ti} \Phi(\tau) e^{\lambda \tau} \mathrm{d}\tau \Big/ \int_0^{ti} \Phi(\tau)\, \mathrm{d}\tau$$



Activation analysis

$$A_x = \frac{C_x}{I_{\gamma x} f_{dx} k_{\gamma x} \varepsilon_{\gamma x}}$$

- C_x- Number of counts
- $I_{\gamma x}$- Gamma intensity - $\mathrm{I}_\gamma(411.8\ \mathrm{keV}) = 0.9562\ \pm 0.0006$
- f_{dx}- Disintegration factor - $f_d = 0.799$
- $\varepsilon_{\gamma x}$- Detection efficiency - $\varepsilon_{\gamma x}(411.8\ \mathrm{keV}) = 7.56\mathrm{E}-03 \pm 2.65\mathrm{E}-04$
- $k_{\gamma x}$- Transmission factor $k_\gamma(45) = 0.993 \pm 0.004$

  $k_\gamma(48) = 0.983 \pm 0.004$

	f_d	Δf	C_x	ΔC_x	A	ΔA	ΔA (rel %)
Au_45_1	1.323E-01	7.967E-05	6.569E+04	3.894E+02	6.960E+07	2.487E+06	3.57
Au_45_2	2.954E-02	4.721E-06	1.470E+04	1.524E+02	6.978E+07	2.563E+06	3.67
Au_45_3	1.067E-01	8.197E-05	5.381E+04	3.197E+02	7.068E+07	2.526E+06	3.57
Au_48_1	4.219E-02	9.058E-06	2.055E+04	1.745E+02	6.899E+07	2.501E+06	3.63
Au_48_2	8.087E-02	3.912E-05	3.947E+04	2.742E+02	6.913E+07	2.483E+06	3.59
Au_48_3	1.617E-01	2.685E-04	7.902E+04	4.191E+02	6.922E+07	2.469E+06	3.57

	A45	A48	Diff
Mean	7.002E+07	6.911E+07	9.055E+05
Error	1.568E+06	1.439E+06	2.129E+06
Rel Error (%)	2.24	2.08	

Activation analysis

$$A_x = \frac{C_x}{I_{\gamma x} f_{dx} k_{\gamma x} \varepsilon_{\gamma x}}$$

- C_x- Number of counts
- $I_{\gamma x}$- Gamma intensity - $\mathrm{I}_\gamma(411.8\ \mathrm{keV}) = 0.9562\ \pm 0.0006$
- f_{dx}- Disintegration factor - $f_d = 0.799$
- $\varepsilon_{\gamma x}$- Detection efficiency - $\varepsilon_{\gamma x}(411.8\ \mathrm{keV}) = 7.56\mathrm{E}-03 \pm 2.65\mathrm{E}-04$
- $k_{\gamma x}$- Transmission factor $k_\gamma(45) = 0.993 \pm 0.004$

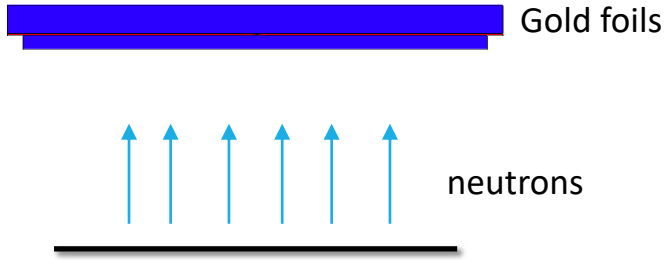
  $k_\gamma(48) = 0.983 \pm 0.004$

	f_d	Δf	C_x	ΔC_x	A	ΔA	ΔA (rel %)
Au_45_1	1.323E-01	7.967E-05	6.569E+04	3.894E+02	6.960E+07	2.487E+06	3.57
Au_45_2	2.954E-02	4.721E-06	1.470E+04	1.524E+02	6.978E+07	2.563E+06	3.67
Au_45_3	1.067E-01	8.197E-05	5.381E+04	3.197E+02	7.068E+07	2.526E+06	3.57
Au_48_1	4.219E-02	9.058E-06	2.055E+04	1.745E+02	6.899E+07	2.501E+06	3.63
Au_48_2	8.087E-02	3.912E-05	3.947E+04	2.742E+02	6.913E+07	2.483E+06	3.59
Au_48_3	1.617E-01	2.685E-04	7.902E+04	4.191E+02	6.922E+07	2.469E+06	3.57

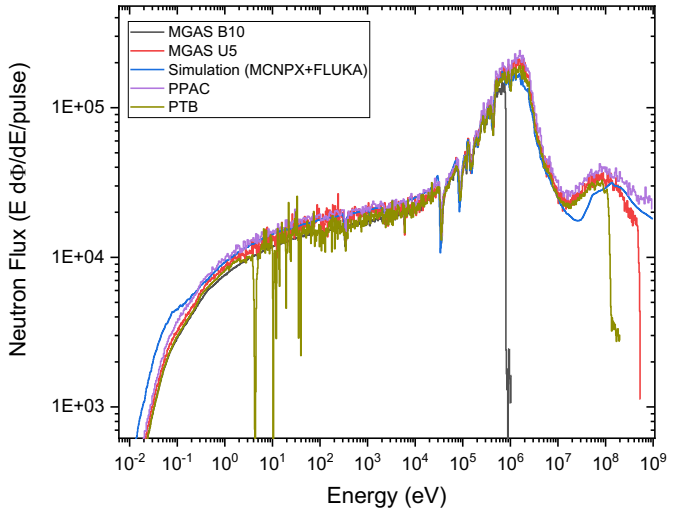
	A45	A48	Diff
Mean	7.002E+07	6.911E+07	9.055E+05
Error	1.568E+06	1.439E+06	2.129E+06
Rel Error (%)	2.24	2.08	

Simulations: Flux and Neutron captures

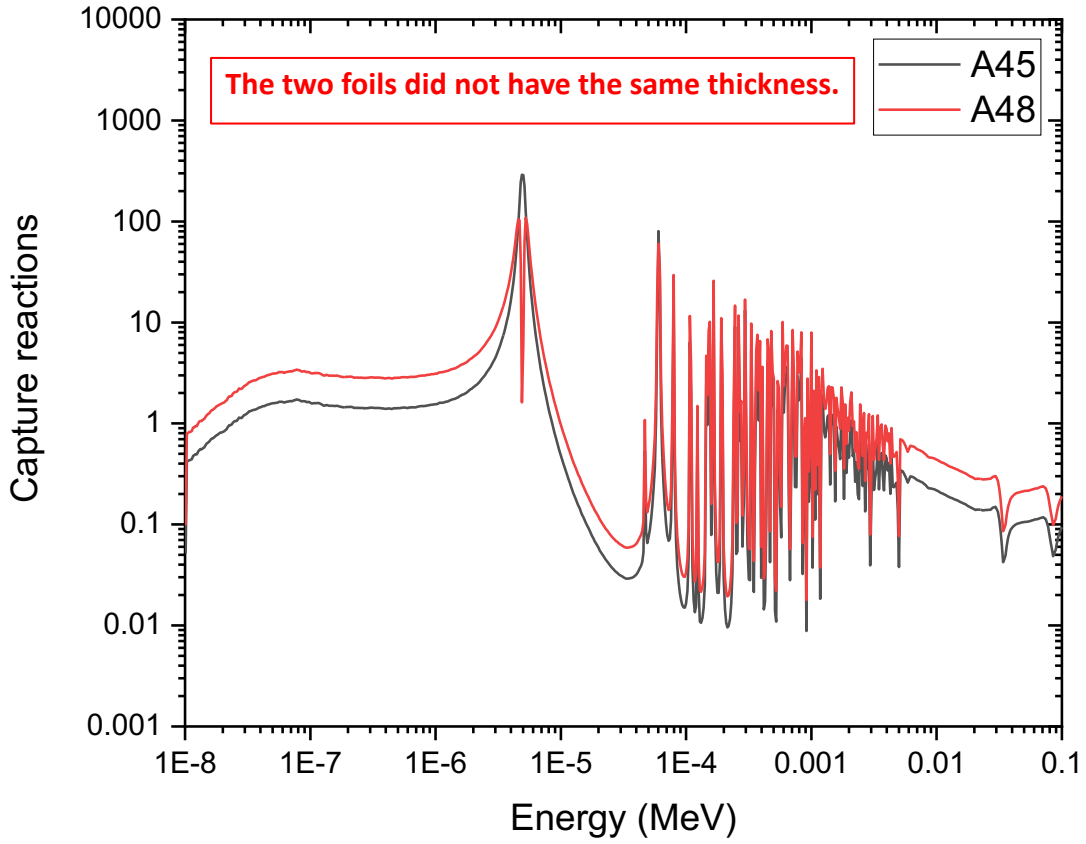
- Input geometry:



- The flux was used as input in the MCNPX file with the geometry.

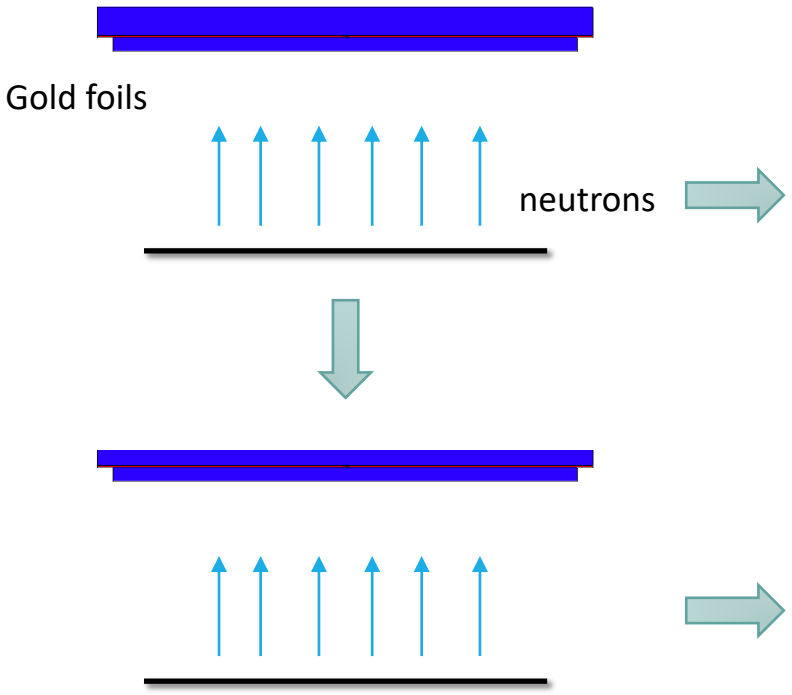


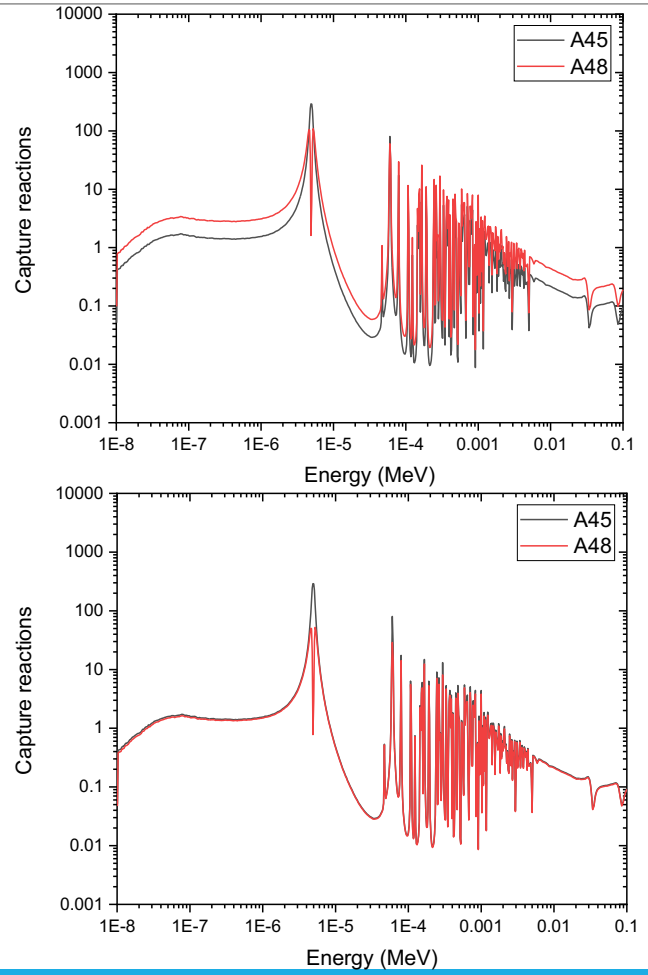
- The output file contain the number of capture reactions (Tally F4).

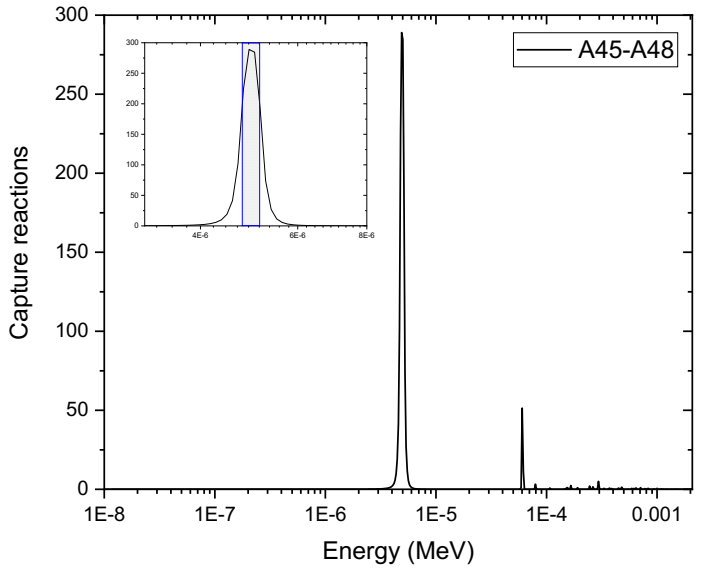


Simulations: Flux and Neutron captures

- New simulation assuming two foils with the same thickness (50 µm) to find a normalization factor for the second foil. **(A48=A48*0.48)**







- 69 % of the captures are in the resonance region (4.67-5.12 eV)

	A45	A48	Diff
Mean	7.002E+07	3.248E+07	3.753E+07
Error	1.568E+06	6.764E+05	1.714E+06
Rel Error (%)	2.24	2.08	4.57

Final Flux from the activation measurement

$A = \sigma\ \Phi\ N$

A Number of capture reactions

σ Cross section (barn)

Φ Flux

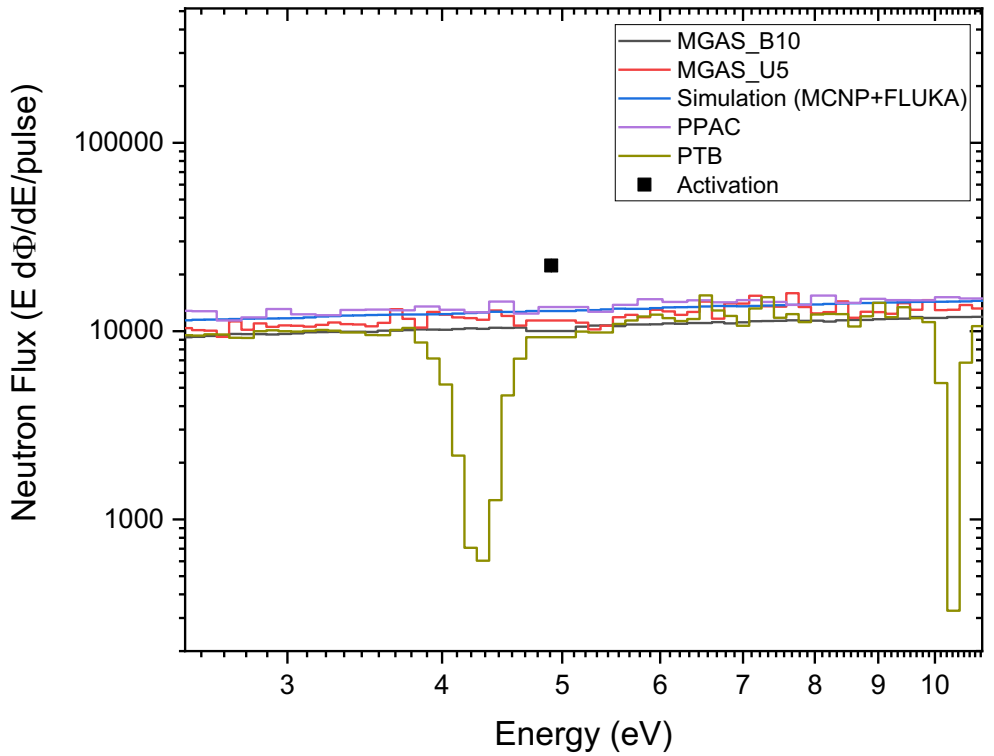
N Sample thickness (at/barn)

$N = 3.00E - 04$ at/barn

$A = A_{45} - A_{48} = 3.68E + 07 \pm 1.71E + 06$

$\sigma_{int} = 1756.26$ barn

$$\Phi = \frac{A \cdot 0.69}{N \cdot \sigma_{int}} \longrightarrow \Phi = 2.23E + 04 \pm 1.04E + 03$$



Final Flux from the activation measurement

$A = \sigma\ \Phi\ N$

A Number of capture reactions

σ Cross section (barn)

Φ Flux

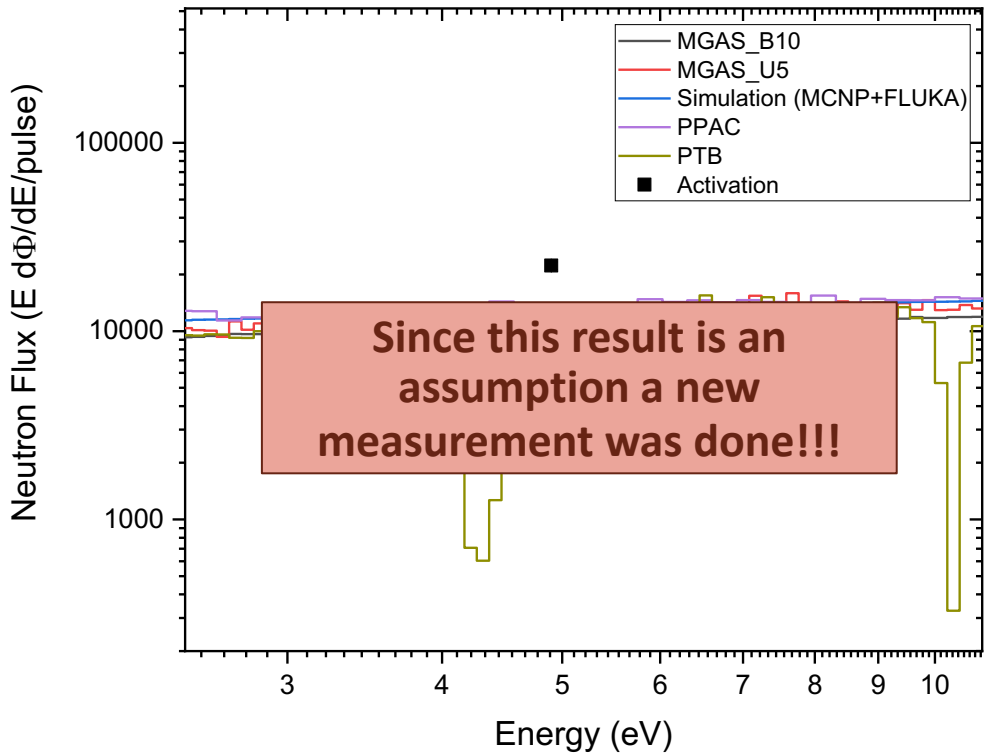
N Sample thickness (at/barn)

$N = 3.00E - 04$ at/barn

$A = A_{45} - A_{48} = 3.68E + 07 \pm 1.71E + 06$

$\sigma_{int} = 1756.26$ barn

$$\Phi = \frac{A \cdot 0.69}{N \cdot \sigma_{int}} \longrightarrow \Phi = 2.23E + 04 \pm 1.04E + 03$$



EAR1 (2023)

Same Au foils from EAR2 measurement (2021)

Activation of two 197- Au foils back-to-back:

- 80 x 0.1090 mm (upstream, bottom)
- 65 x 0.1064 mm (downstream, top)
- No Mylar foil between the gold samples

Irradiation time: Start @ 10/04/2023 00:10:00

Stop @ 12/04/2023 10:00:00

Total: → 208200 s

In the HPGe detector (**NEW**):

	REAL_meas (t_m) (s)	LIVE_meas (s)	START		Waiting time (s)
Au_65_1	2.166E+04	2.160E+04	4/13/2023	17:03:07	1.118E+05
Au_65_2	3.616E+04	3.600E+04	4/21/2023	10:39:45	7.800E+05
Au_65_3	3.615E+04	3.600E+04	4/21/2023	20:42:27	8.161E+05
Au_65_4	3.616E+04	3.600E+04	4/22/2023	6:45:03	8.523E+05
Au_65_5	3.615E+04	3.600E+04	4/22/2023	16:47:44	8.885E+05
Au_65_6	3.615E+04	3.600E+04	4/23/2023	2:50:15	9.246E+05
Au_80_1	4.325E+04	4.320E+04	–	–	6.822E+04
Au_80_2	3.615E+04	3.600E+04	4/25/2023	16:19:51	1.146E+06
Au_80_3	3.615E+04	3.600E+04	4/26/2023	2:22:25	1.182E+06
Au_80_4	5.958E+03	5.934E+03	4/26/2023	12:25:02	1.218E+06

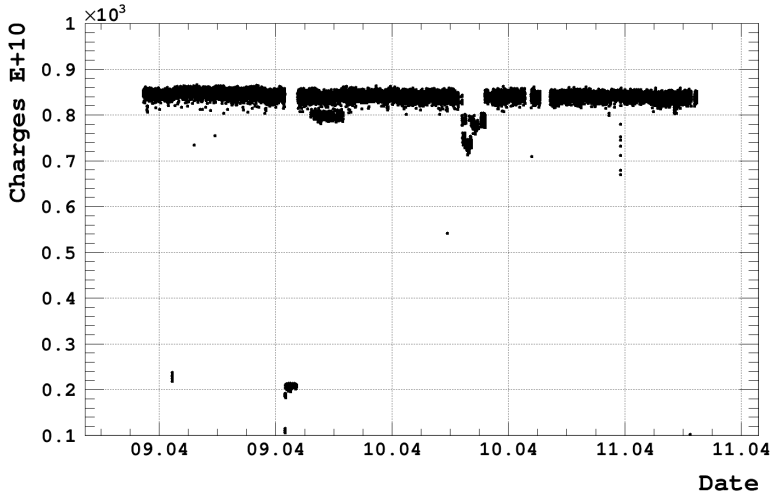
Activation analysis

The number of activations after the irradiation:

$$A_x = \frac{C_x}{I_{\gamma x} f_{dx} k_{\gamma x} \varepsilon_{\gamma x}}$$

$$f_{dx} = \left(1 - e^{-\lambda t_m}\right) e^{-\lambda t_w} \underbrace{e^{-\lambda t_i} \int_0^{ti} \Phi(\tau) e^{\lambda \tau} \mathrm{d}\tau \Big/ \int_0^{ti} \Phi(\tau)\, \mathrm{d}\tau}_{f_d}$$

- C_x- Number of counts
- $I_{\gamma x}$- Gamma intensity - $\mathrm{I}_\gamma(411.8\ \mathrm{keV}) = 0.9562 \pm 0.0006$
- f_{dx}- Disintegration factor - $f_d = 0.73519$
- $\varepsilon_{\gamma x}$- Detection efficiency
- $k_{\gamma x}$- Transmission factor



Activation analysis

The number of activations after the irradiation:

$$A_x = \frac{C_x}{I_{\gamma x} f_{dx} k_{\gamma x} \varepsilon_{\gamma x}}$$

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HPGe characteristics:   (by Elisso)
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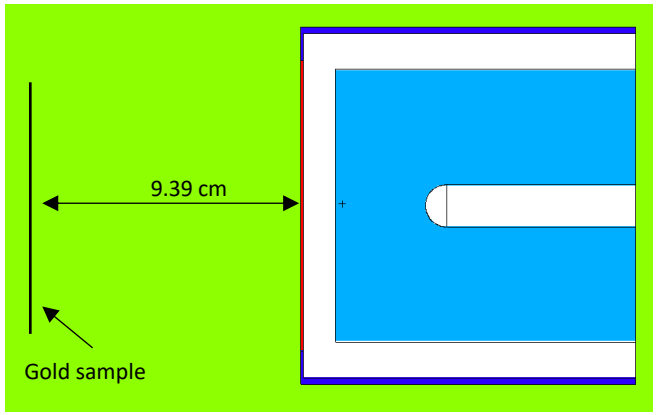
Tuned values from characterisation:
   - Detector window to crystal = 7.5mm
   - Dead layer = 0.6e-3mm
   - Crystal radius = 32mm
   - Crystal length = 70mm
   - Hole considered (it's coaxial in shape so...): 44mm x 5mm
```

HPGe geometry MCNP



- C_x- Number of counts
- $I_{\gamma x}$- Gamma intensity - $\mathrm{I}_\gamma(411.8\ \mathrm{keV}) = 0.9562\ \pm 0.0006$
- f_{dx}- Disintegration factor - $f_d = 0.73519$
- $\varepsilon_{\gamma x}$- Detection efficiency (extended source - 0.988):

$$\varepsilon_{\gamma x}(411.8\ \mathrm{keV}) = 8.58\mathrm{E}{-03} \pm 2.92\mathrm{E}{-05}$$

- $k_{\gamma x}$- Transmission factor

$$k_\gamma = \frac{\epsilon_\gamma}{\varepsilon_\gamma}$$

← Considering complete geometry (gold)

← Considering empty geometry (void)

$$k_\gamma(80) = 0.976 \pm 0.004$$
$$k_\gamma(65) = 0.977 \pm 0.004$$

Activation analysis

	f_d	Δf	C_x	ΔC_x	A	ΔA	ΔA (rel %)
Au_65_1	3.291E-02	5.431E-06	2.370E+04	1.706E+02	8.988E+07	8.069E+05	0.90
Au_65_2	7.358E-03	3.513E-06	5.302E+03	8.004E+01	8.992E+07	1.441E+06	1.60
Au_65_3	6.606E-03	3.021E-06	4.750E+03	7.606E+01	8.973E+07	1.516E+06	1.69
Au_65_4	5.933E-03	2.795E-06	4.278E+03	7.240E+01	8.999E+07	1.598E+06	1.78
Au_65_5	5.326E-03	2.369E-06	3.890E+03	6.921E+01	9.115E+07	1.694E+06	1.86
Au_65_6	4.783E-03	2.143E-06	3.679E+03	6.768E+01	9.600E+07	1.840E+06	1.92
Au_80_1	7.250E-02	1.111E-05	1.125E+05	3.500E+02	1.936E+08	1.200E+06	0.62
Au_80_2	2.474E-03	1.121E-06	3.452E+03	6.548E+01	1.741E+08	3.433E+06	1.97
Au_80_3	2.222E-03	1.025E-06	3.221E+03	6.360E+01	1.809E+08	3.702E+06	2.05
Au_80_4	3.437E-04	2.480E-08	4.967E+02	2.385E+01	1.803E+08	8.712E+06	4.83

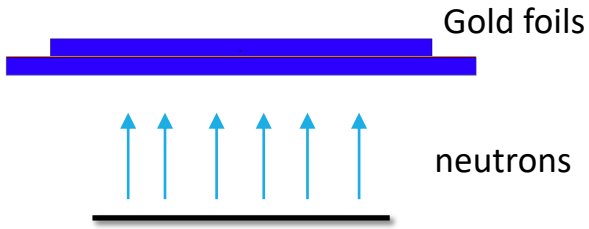
	A65	A80	Diff
Mean	9.111E+07	1.785E+08	8.734E+07
Error	2.526E+06	5.046E+06	5.643E+06
Rel Error (%)	2.77	2.83	6.46

$$A = A_{80} - A_{65}$$

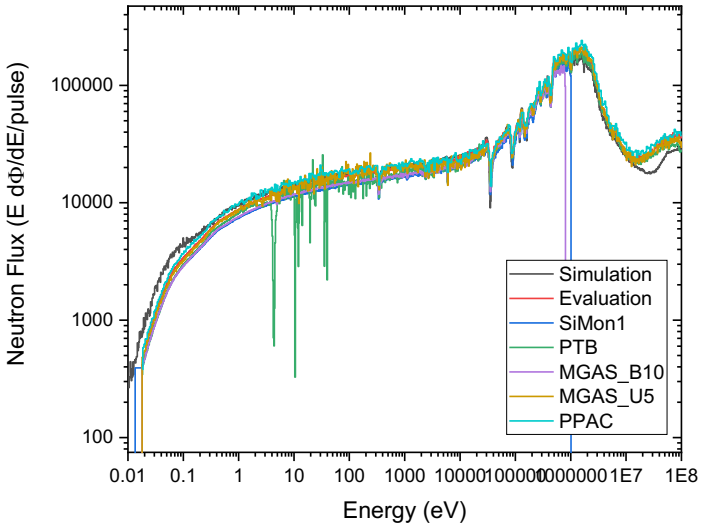
$$\delta A_x = \sqrt{\delta A_{exp}{}^2 + \delta A_{stat}{}^2}$$

Simulations: Flux and Neutron captures

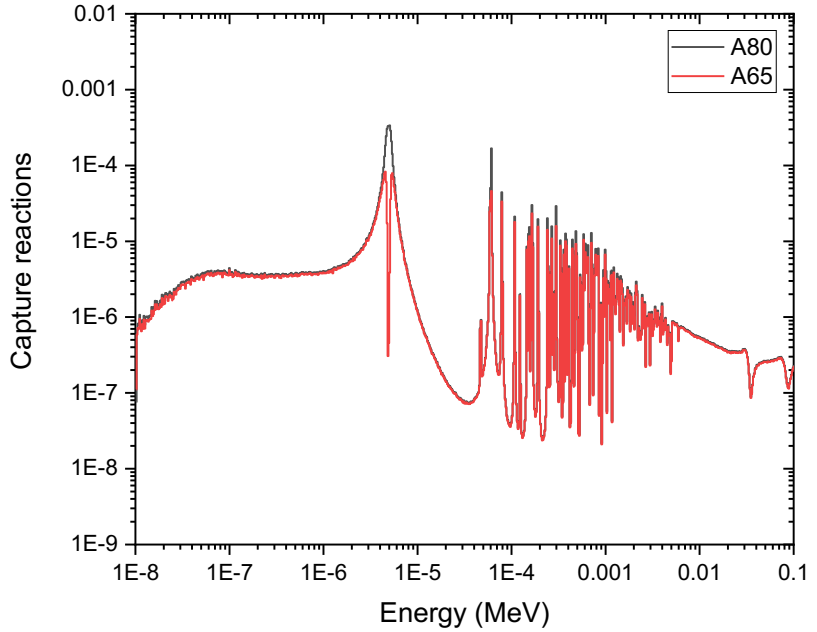
❖ Input geometry:



❖ The flux was used as input in the MCNPX file with the geometry.



❖ The output file contain the number of capture reactions (Tally F4).



❖ 54.8 % of the captures are in the resonance region (4.67-5.12 eV)

Final Flux from the activation measurement

$A = \sigma\ \Phi\ N$

A Number of capture reactions

σ Cross section (barn)

Φ Flux

N Sample thickness (at/barn)

$N = 6.43E - 04$ at/barn

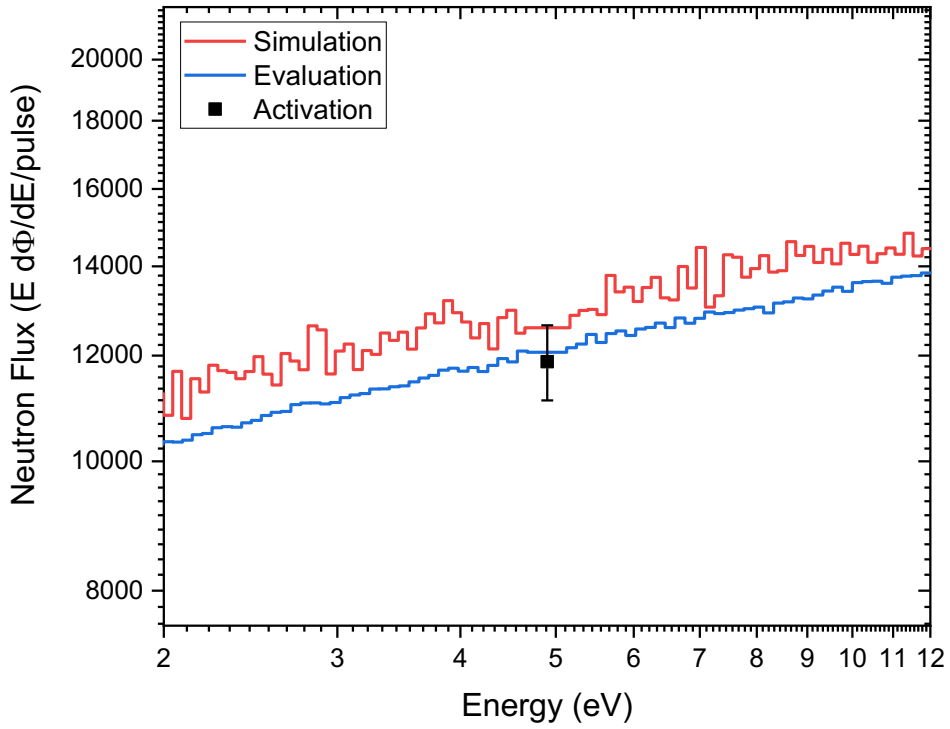
$A = A_{80} - A_{65} = 8.73E + 07 \pm 5.64E + 06$

$\sigma_{int} = 1756.26$ barn

$$\Phi = \frac{A \cdot 0.548}{N \cdot \sigma_{int}}$$

$\Phi = 1.19E + 04 \pm 7.67E + 02$

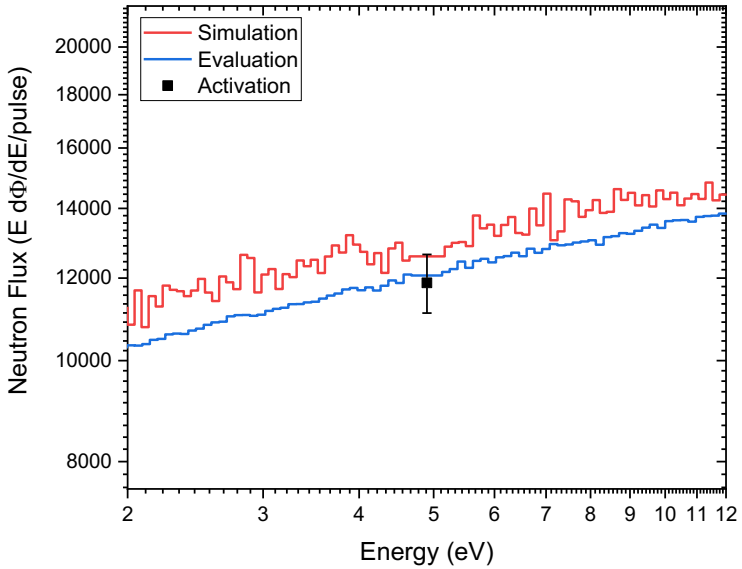
$\Delta\Phi/\Phi = 6.5\%$



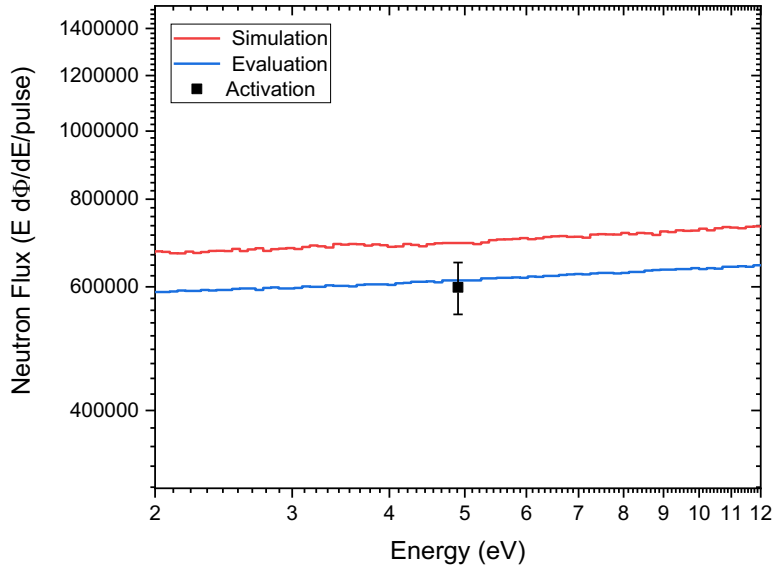
Conclusions

- The absolute flux at was determined from an activation measurement for both experimental areas.
- A good agreement was found with the simulated flux & evaluated flux.

EAR1



EAR2



Work of A. Villacorta and C. Guerrero

Activations of ^{197}Au foils ($t_{1/2}$=2.7d)

1. Calculation of the yield for each of two targets (ENDF 7.1).

$$Y_{x,A}^{th} = \left(1 - e^{n_A \sigma_t(E)}\right) \frac{\sigma_x(E)}{\sigma_t(E)}$$

$$Y_{x,B}^{th} = e^{-n_A \sigma_t(E)} \left(1 - e^{-n_B \sigma_t(E)}\right) \frac{\sigma_x(E)}{\sigma_t(E)}$$

2. Use the Geant4 expected flux to estimate number of capture reactions as function of neutron energy.

3. Calculate the differences and, more importantly, the sensitivity of this differences to each neutron energy range.

$$N(E) = \Phi_n(E)\left(Y_{x,A}^{th} - Y_{x,B}^{th}\right)$$

4. Irradiation of two ^{197}Au foils, back-to-back, and determine the number of capture reactions occurred in each of them.

Activation of ^{197}Au foils: calculations

	Thickness	Thermal	1-10 eV.	>10 eV
(n,γ) react.	100 μm@EAR2	59%	36%	5%