# Status update on the analysis of $^{80}$Se(n,γ)

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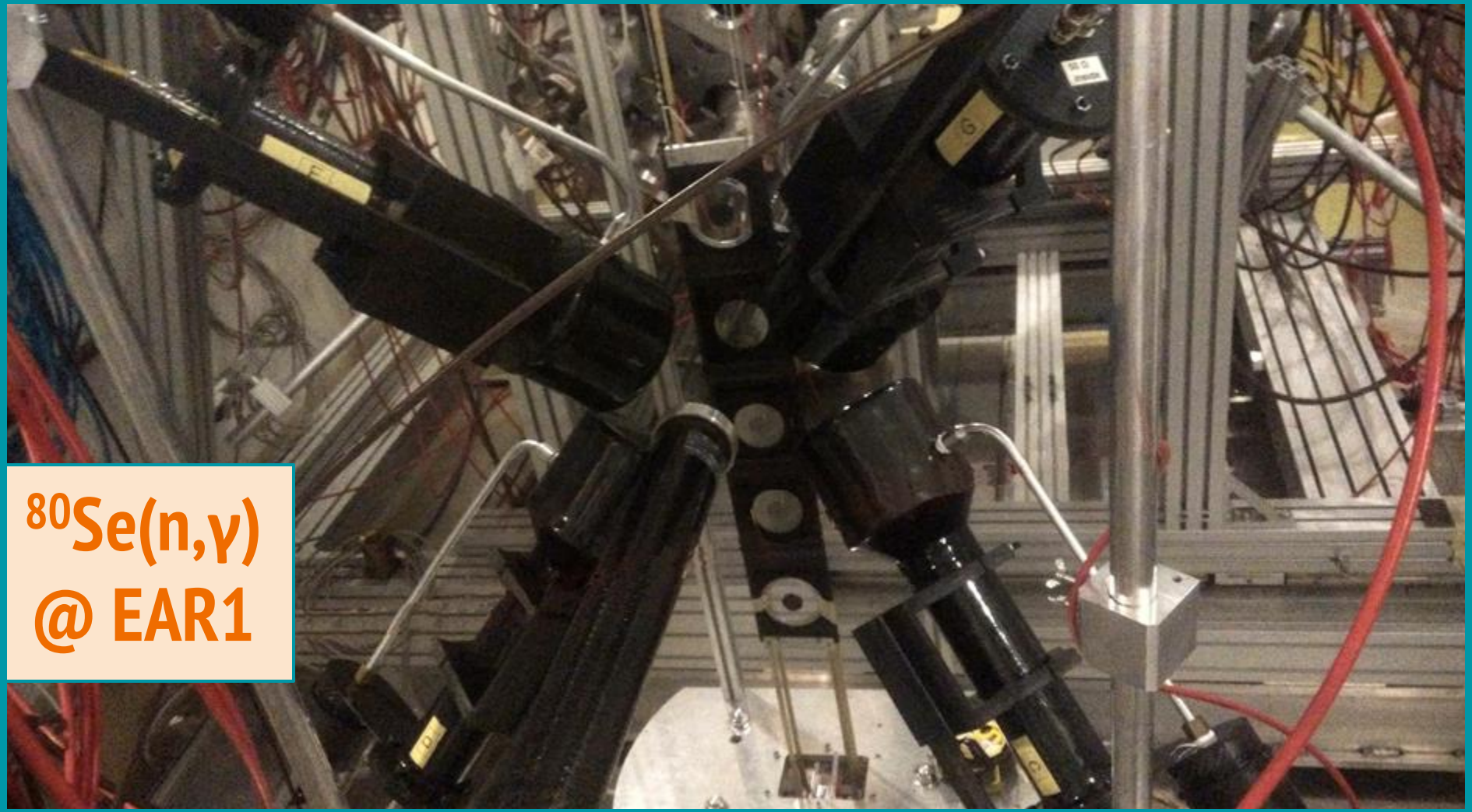
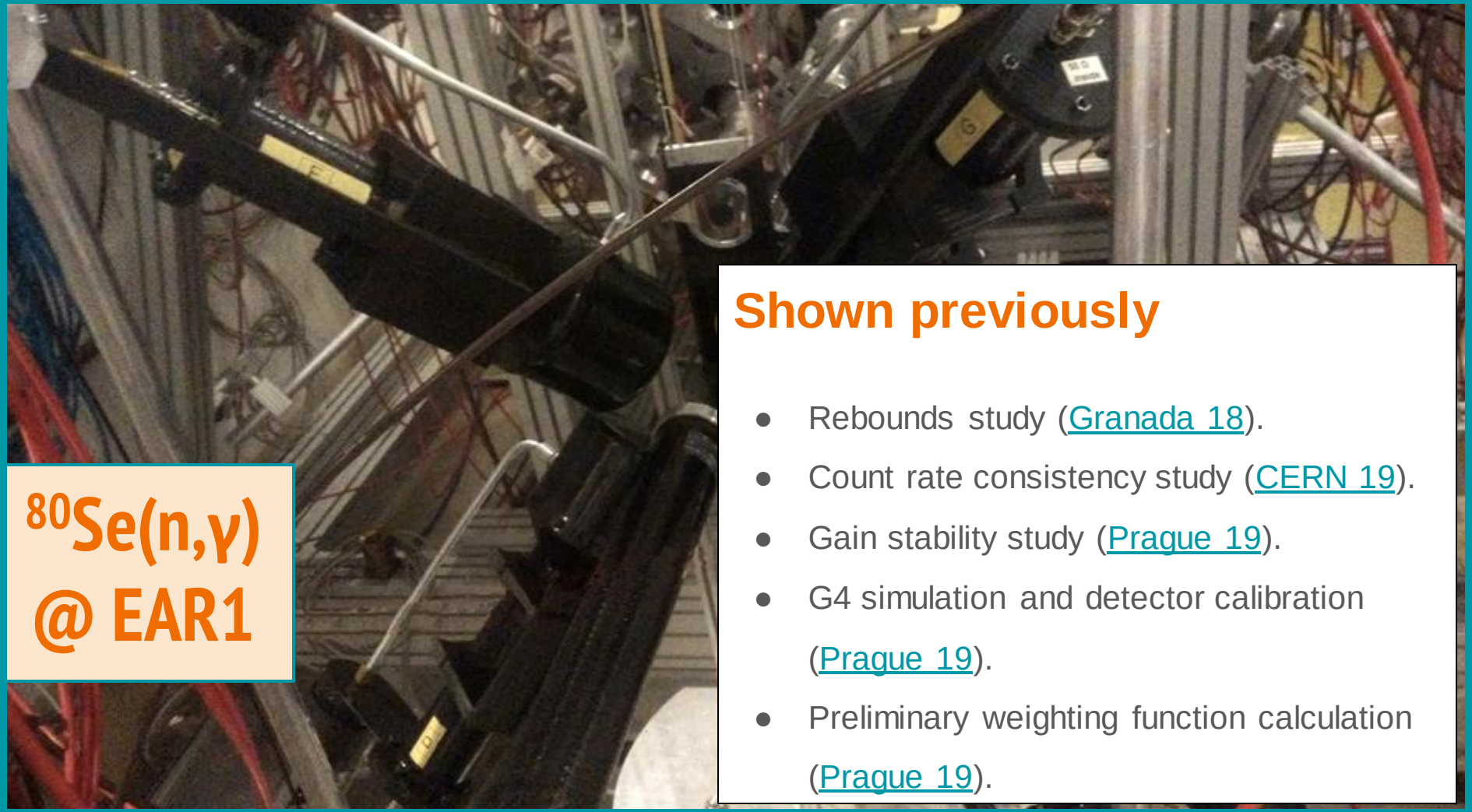
Victor Alcayne, Daniel Cano (CIEMAT)

Carlos Guerrero, Mª Ángeles Millán, Mª Teresa Rodríguez (US)

n_TOF local team and the n_TOF Collaboration



# $^{80}$Se(n,γ) @ EAR1



# $^{80}$Se(n,γ) @ EAR1

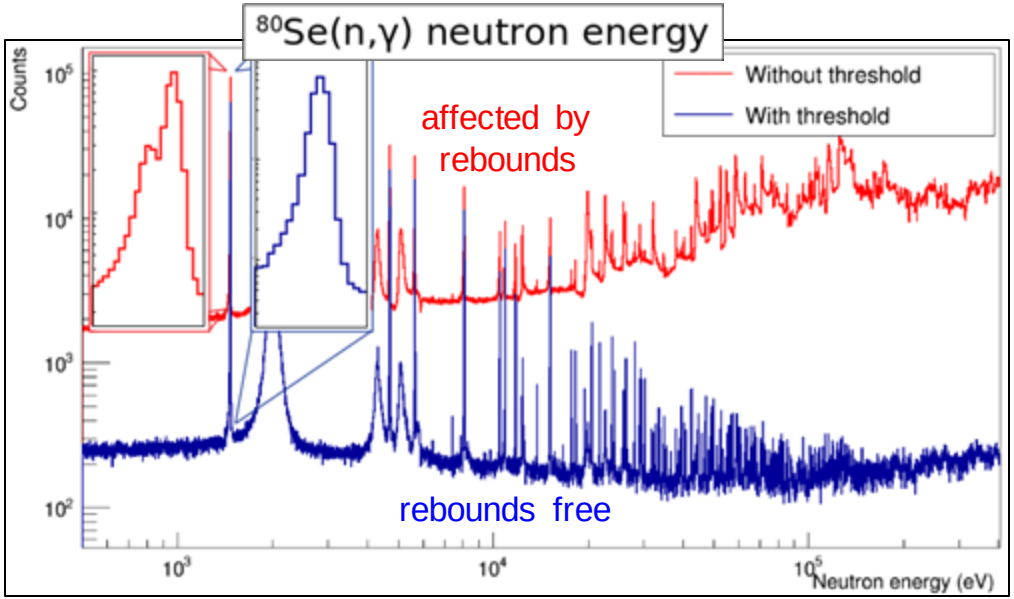
## Shown previously

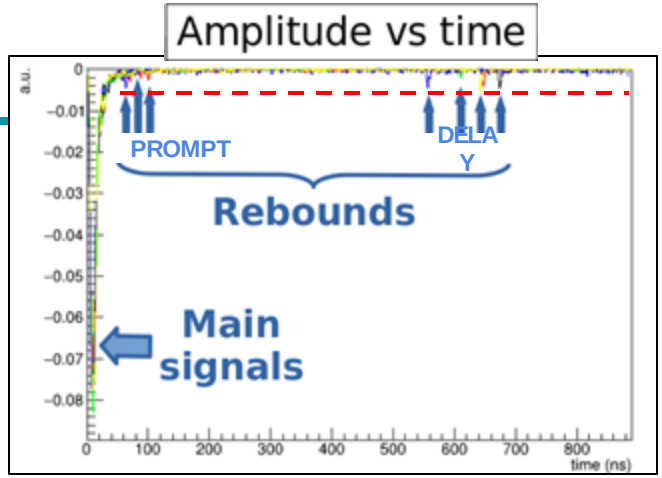
- Rebounds study (Granada 18).
- Count rate consistency study (CERN 19).
- Gain stability study (Prague 19).
- G4 simulation and detector calibration (Prague 19).
- Preliminary weighting function calculation (Prague 19).

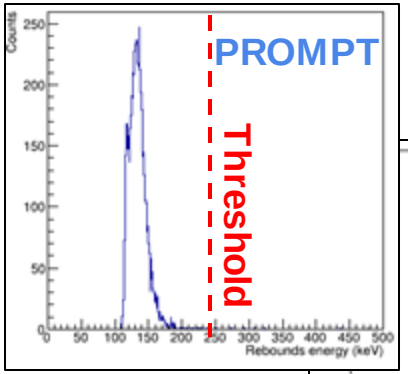
# Results shown in the last meetings

- Rebounds:

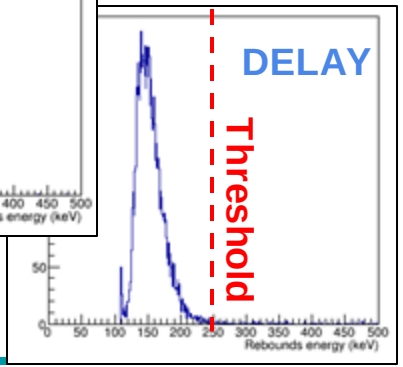
(signals appear after the main pulses of the $C_6D_6$ detectors)




Deposited energy

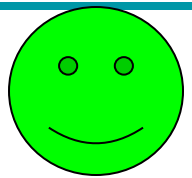



Solution found → Set a sufficiently high threshold allows to eliminate rebound-effects

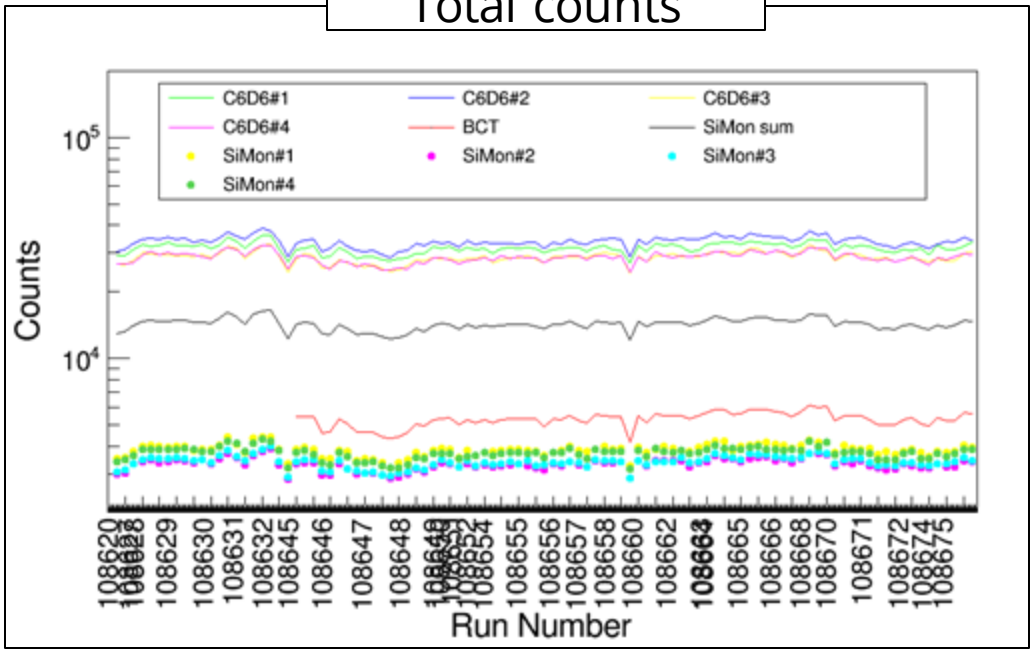
# Results shown in the last meetings

- Count rate consistency study

(check the consistency of the $C_6D_6$ count rates along the experiment)



Total counts

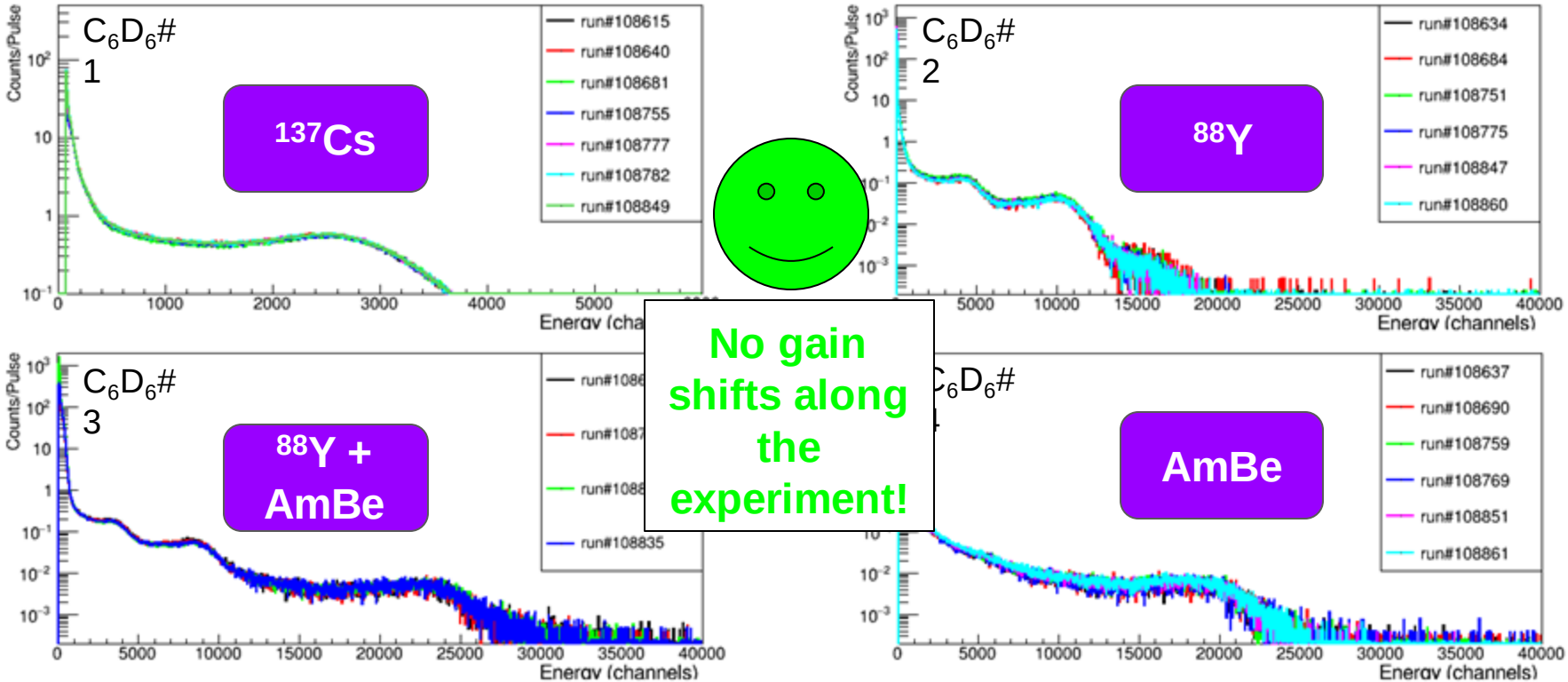



All the statistic has been verified

| Sample | % |
|---|---|
| Au | 100 |
| Empty | 100 |
| Empty + Filters | 100 |
| Se Thick | 100 |
| Se Thick + F | 100 |
| Se Thin | 100 |

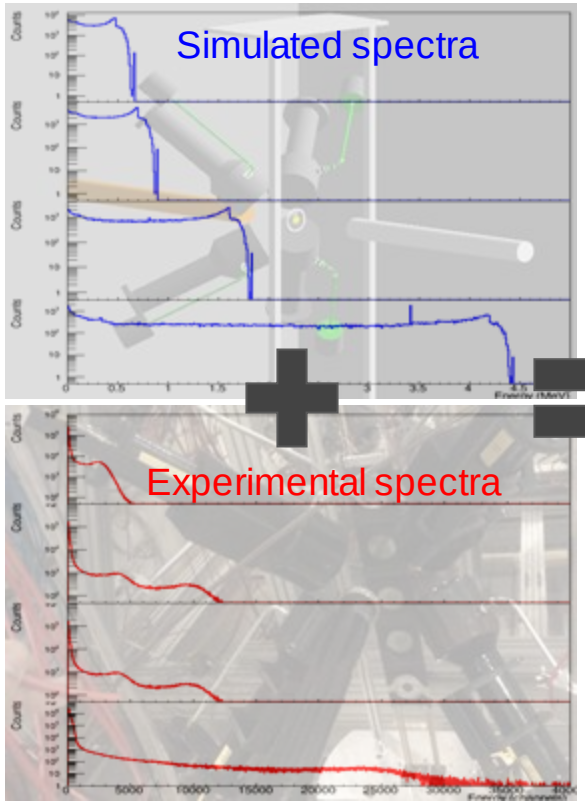
# Results shown in the last meetings

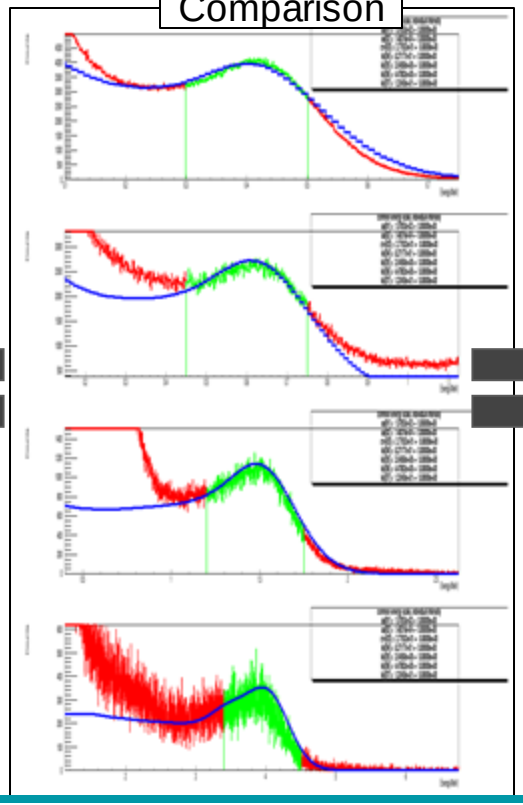
- Gain stability study (check the gain stability of all C6D6)

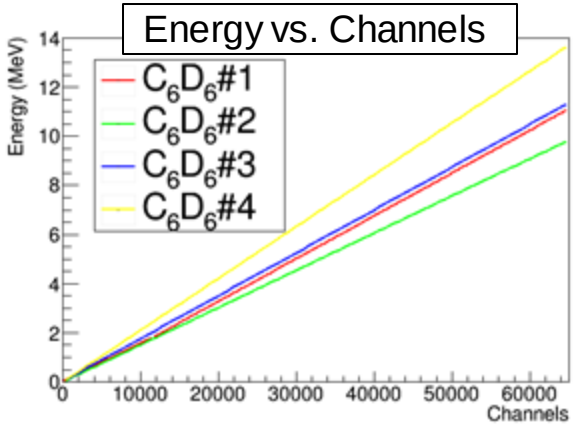


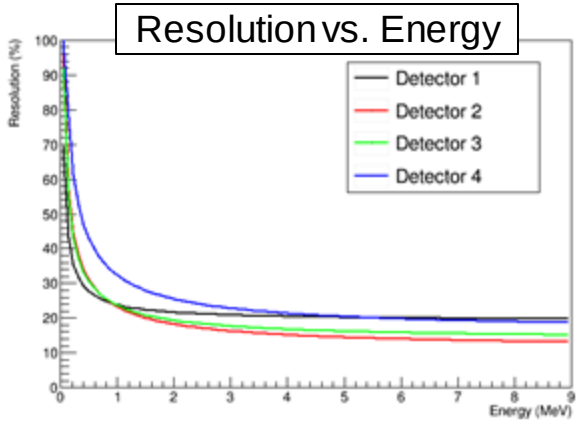
# Results shown in the last meetings

- Geant4 simulation and detector calibration



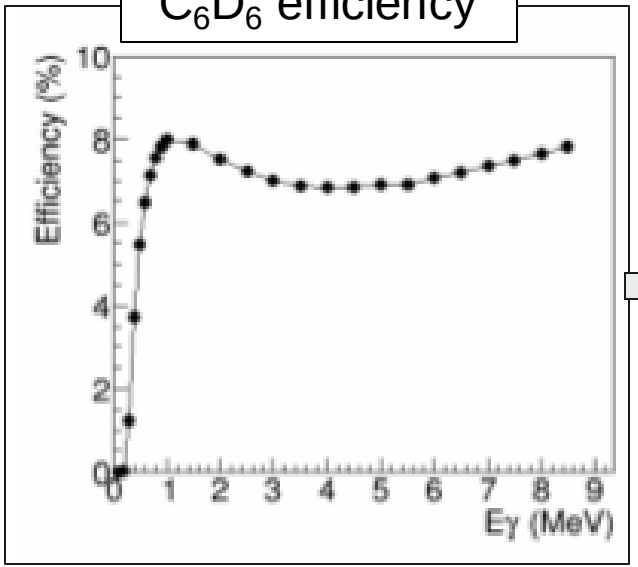



# Results shown in the last meetings

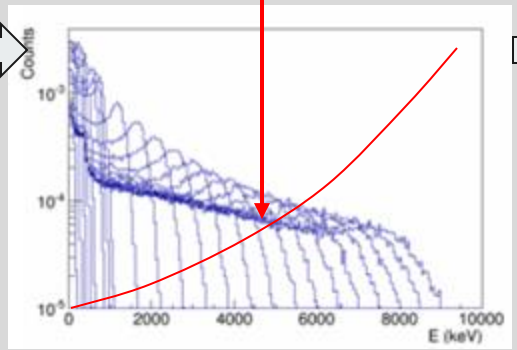
- Weighting function calculation

Experimental $C_6D_6$ efficiency

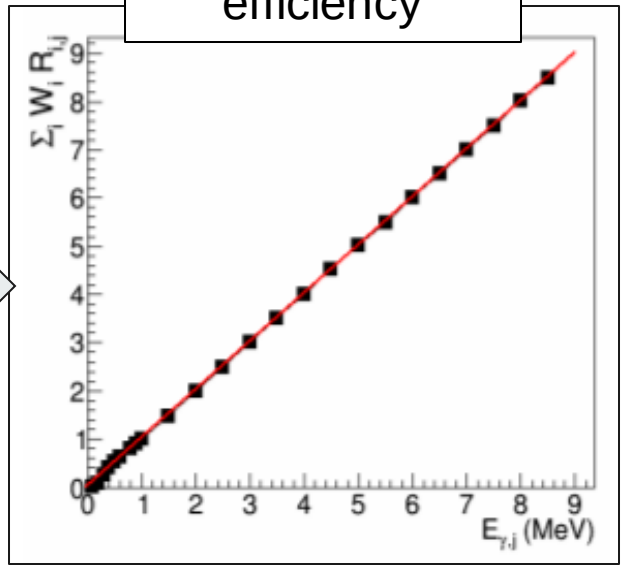



$$\min\sum(\sum W_i R_i^j - \alpha E_j^{\gamma})^2$$

$$W_i = \sum_{k=0}^{n} a_k E^k$$

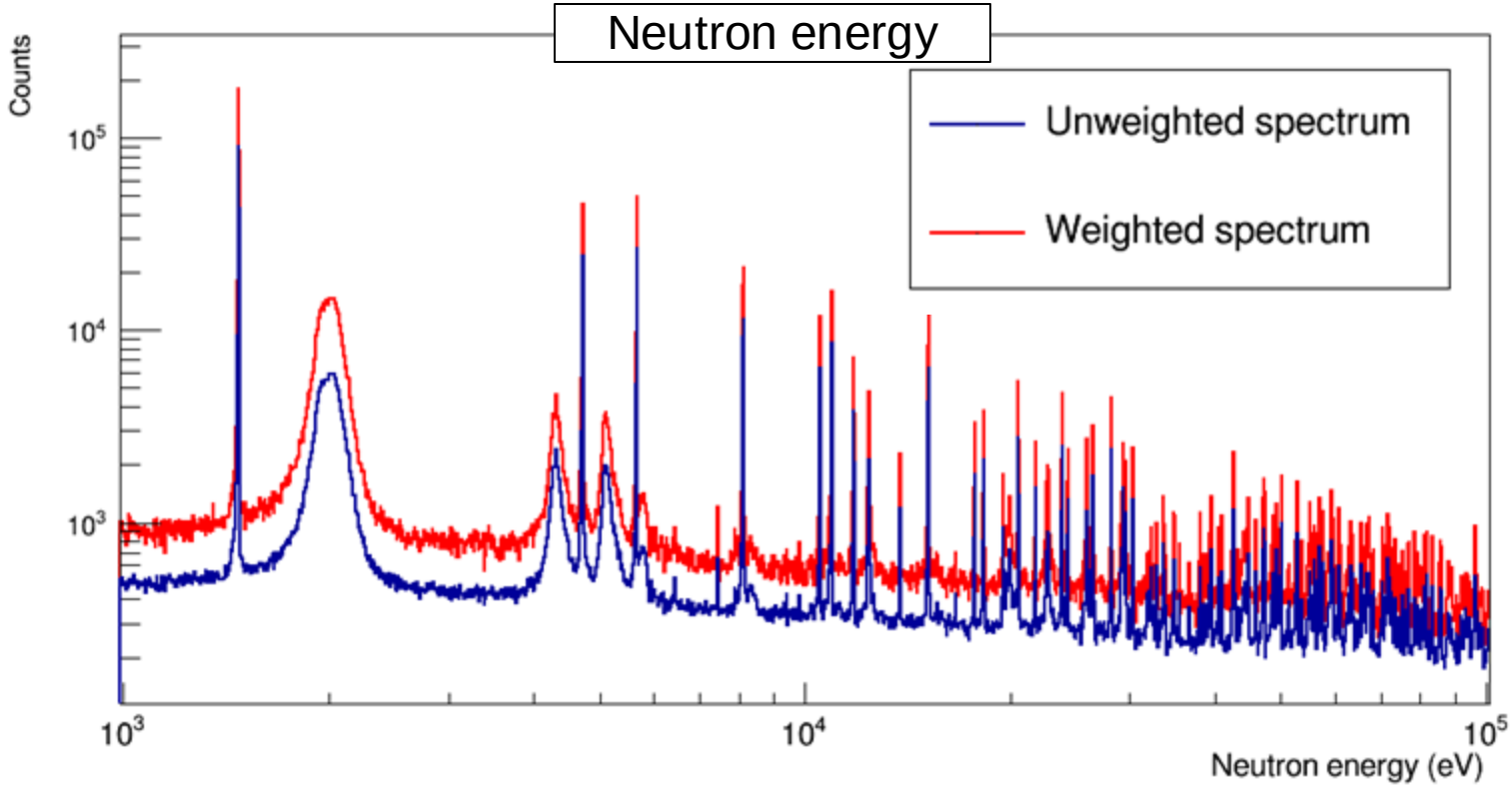



Weighted $C_6D_6$ efficiency



# Results shown in the last meetings

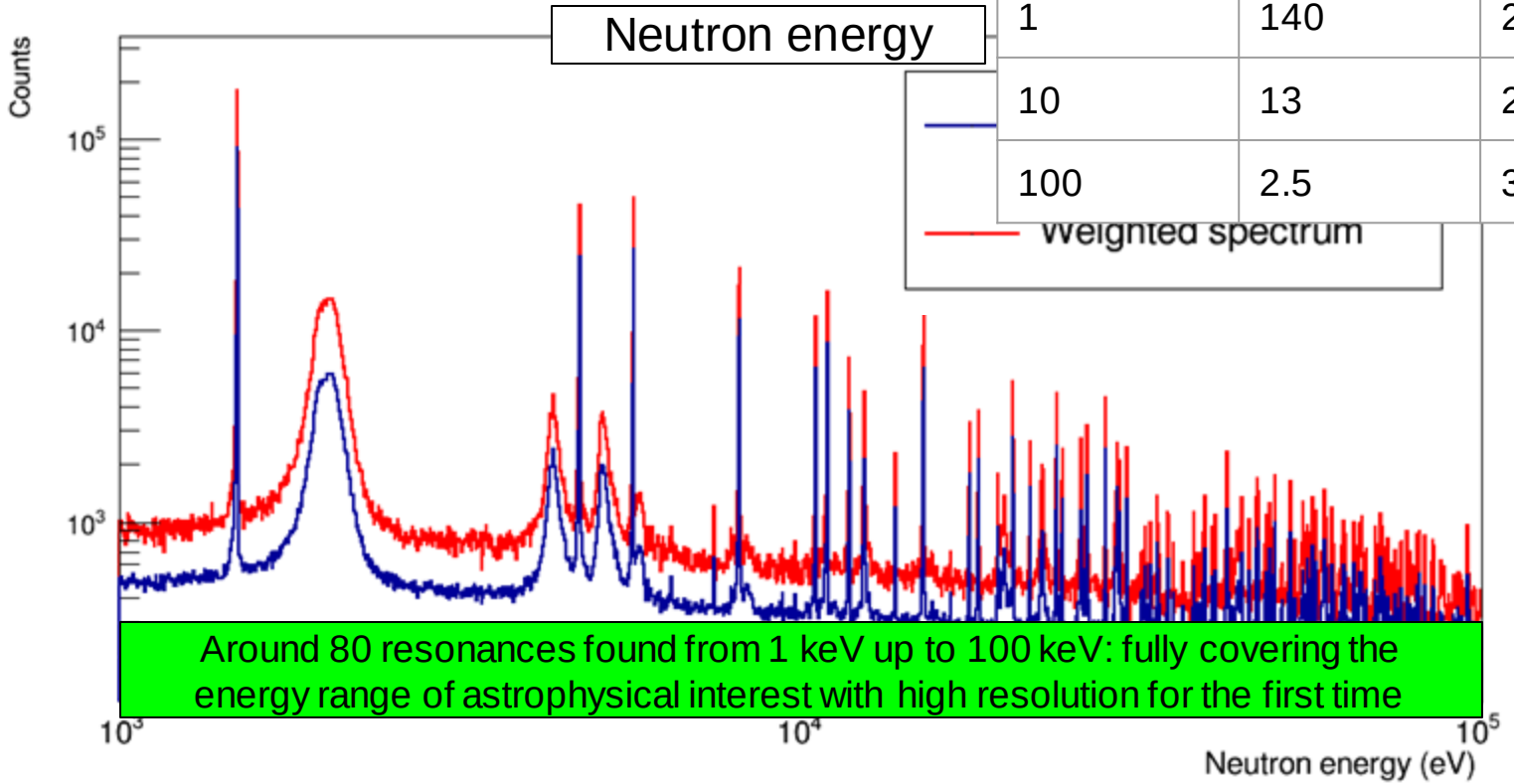
- Preliminary weighted spectra



# Results shown in the last meetings

- Preliminary weighted spectra

| Resonance energy (keV) | Signal to noise ratio Unweight. | Signal to noise ratio Weight. |
|---|---|---|
| 1 | 140 | 200 |
| 10 | 13 | 20 |
| 100 | 2.5 | 3 |



# Ongoing work

Cascades simulation:

An event generator for simulations of complex $\beta$-decay experiments

D. Jordan [a,*], A. Algora [a,b], J.L. Tain [a]

Why? Calculate uncertainties in the weighting function and threshold correction factors (particularly important for the threshold used to reject rebounds).

How? Create cascades with CAPTUGENS, and simulate them using Geant4.

- Check methodology with Au cascade.
- Obtain the $^{80}$Se cascade:
  - Select model to parametrize statistical part of nuclei.
  - Calculate Photon Strength Function.
  - Simulate cascade and check with experimental spectra.

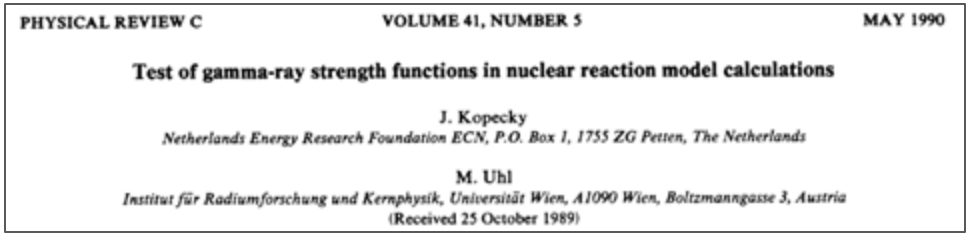
# Ongoing work: $^{197}$Au cascade simulation

- Generating the cascade for 4.9 eV resonance

- Photon Strength function:

| | E1 | | M1 | E2 |
|---|---|---|---|---|
| E (MeV) | 13.72 | 5.8 | 7.05 | 10.81 |
| Γ (MeV) | 4.61 | 1.5 | 4.00 | 3.73 |
| $\sigma_0$ (mb) | 541.0 | 6.0 | 1.12 | 5.03 |

E1: two giant resonances parametrized with generalized lorentzians.
M1, E2: parametrized with lorentzians.



PHYSICAL REVIEW C VOLUME 41, NUMBER 5 MAY 1990

**Test of gamma-ray strength functions in nuclear reaction model calculations**

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M. Uhl
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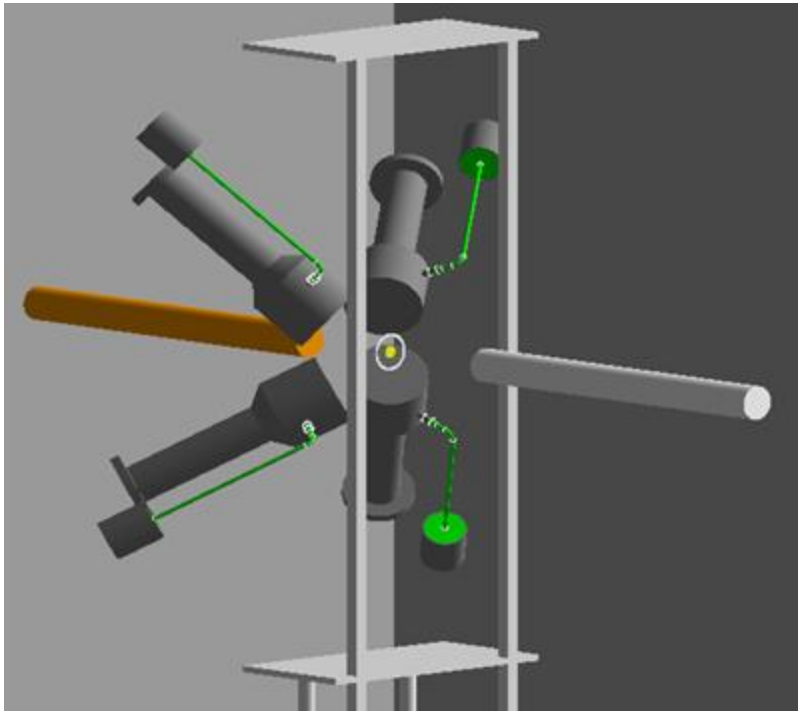
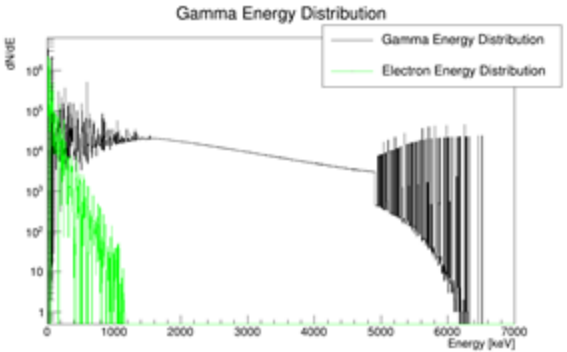
(Received 25 October 1989)



# Ongoing work: $^{197}$Au cascade simulation

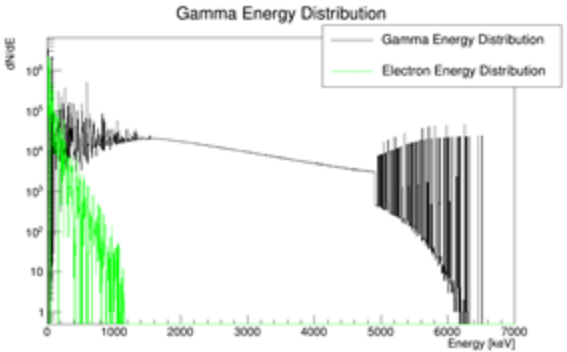
- Simulated cascade for 4.9 eV resonance

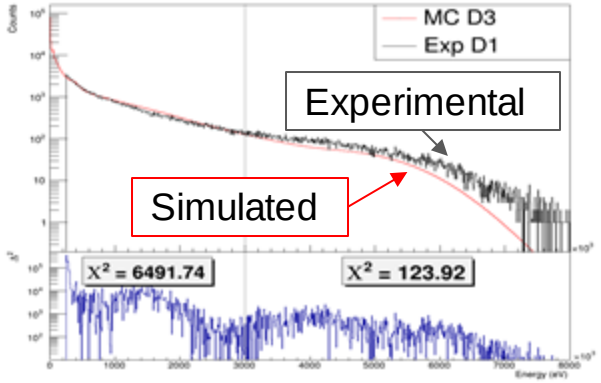



| $M_{\gamma}$ | $M_{e^-}$ |
|---|---|
| **4.51** | **1.72** |

# Ongoing work: $^{197}$Au cascade simulation

- Simulated cascade for 4.9 eV resonance




| $M_{\gamma}$ | $M_{e^-}$ |
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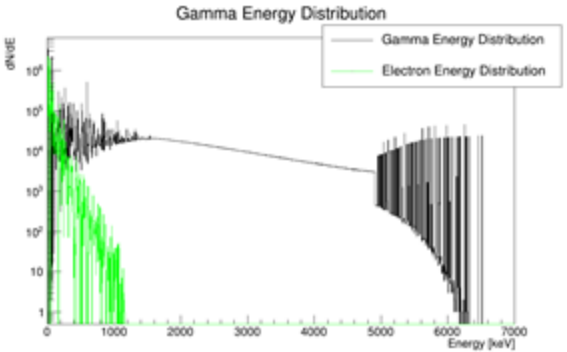
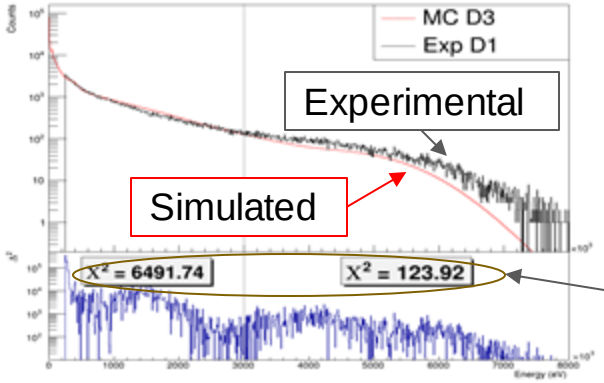
# Ongoing work: $^{197}$Au cascade simulation

- Simulated cascade for 4.9 eV resonance



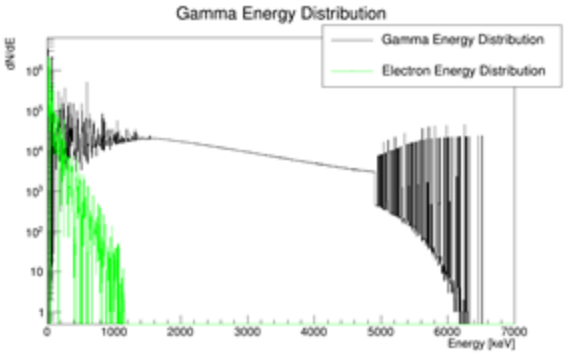

| $M_{\gamma}$ | $M_{e^-}$ |
|---|---|
| **4.51** | **1.72** |

Evaluating the goodness of the MC-model by means of the **Pearson chi2**:

$$\chi^2 = \frac{\sum_{i=1}^{nbins} \frac{(x_i - m_i)^2}{m_i}}{nbins}$$

# Ongoing work: $^{197}$Au cascade simulation

- Simulated cascade for 4.9 eV resonance




| $M_\gamma$ | $M_{e^-}$ |
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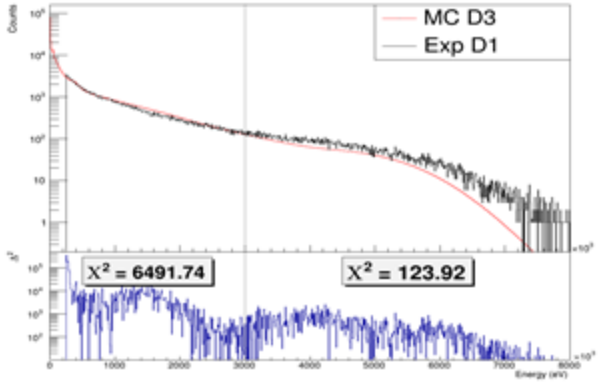
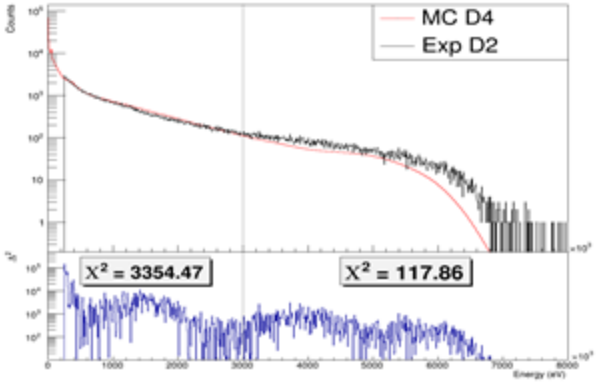
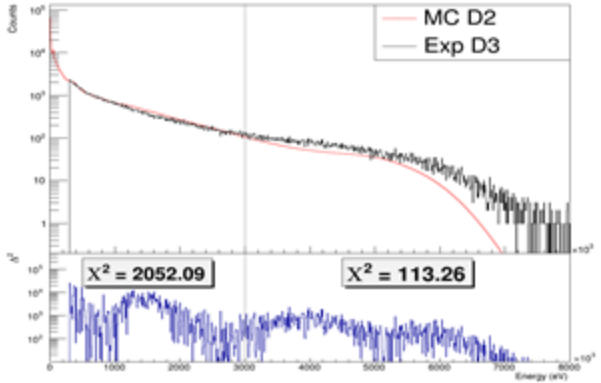
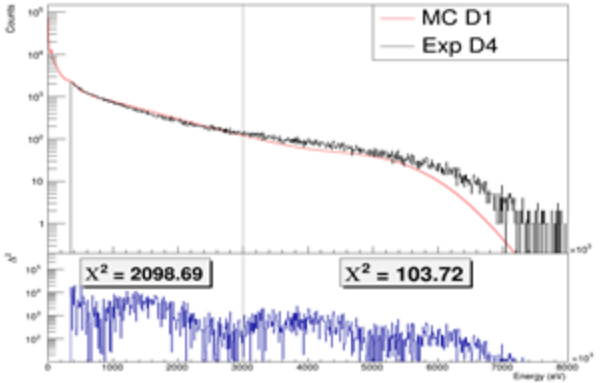


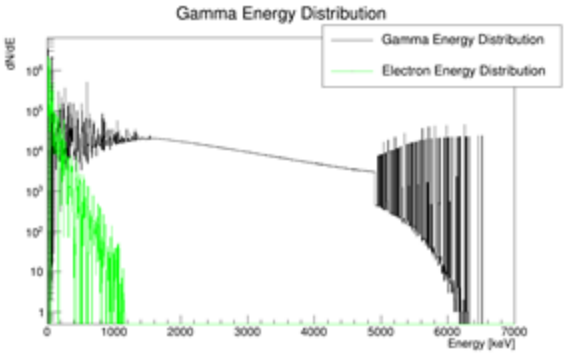



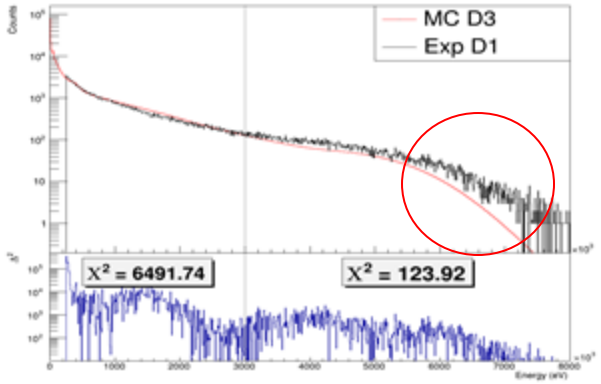



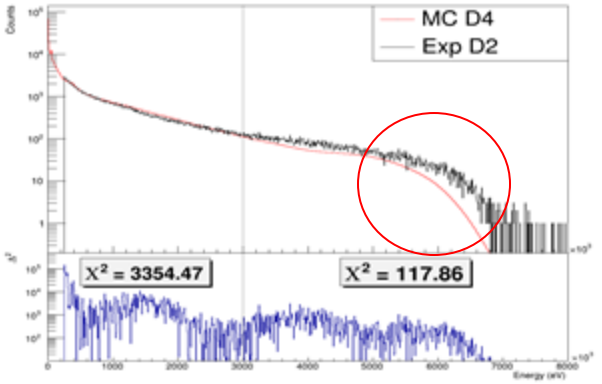
# Ongoing work: $^{197}$Au cascade simulation

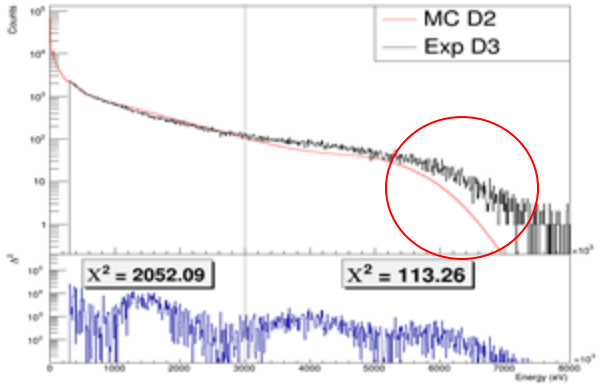
- Simulated cascade for 4.9 eV resonance

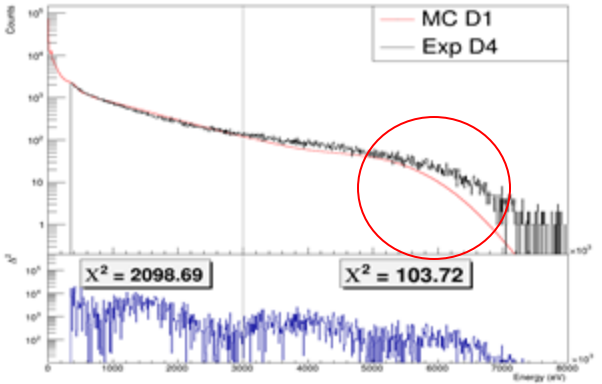



| $M_{\gamma}$ | $M_{e^-}$ |
|---|---|
| 4.51 | 1.72 |



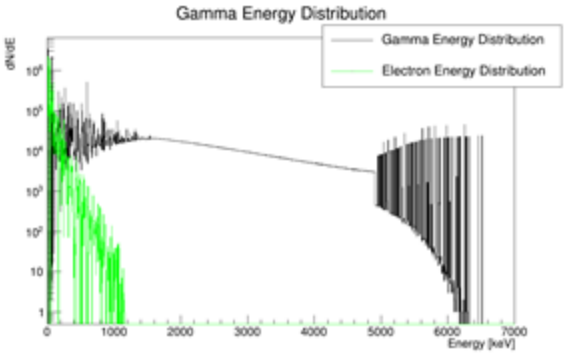



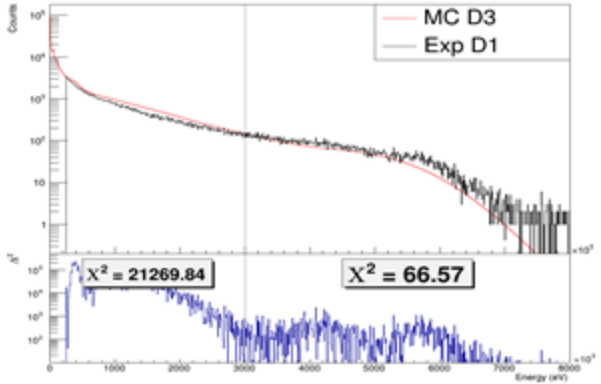



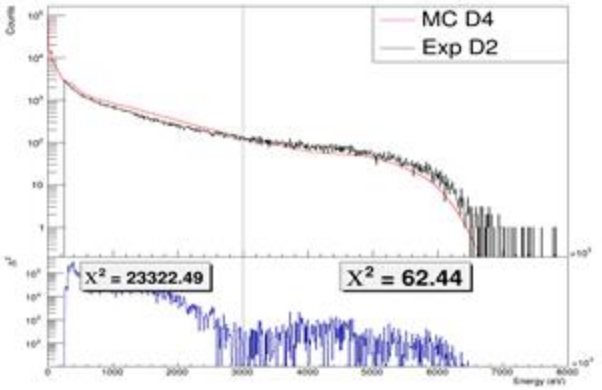
# Ongoing work: $^{197}$Au cascade simulation

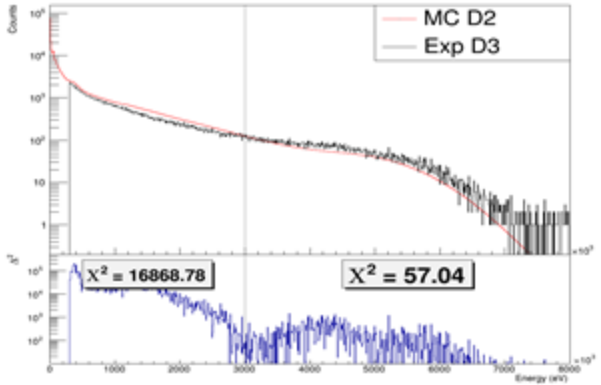
- Simulated cascade for 4.9 eV resonance as a calibration point

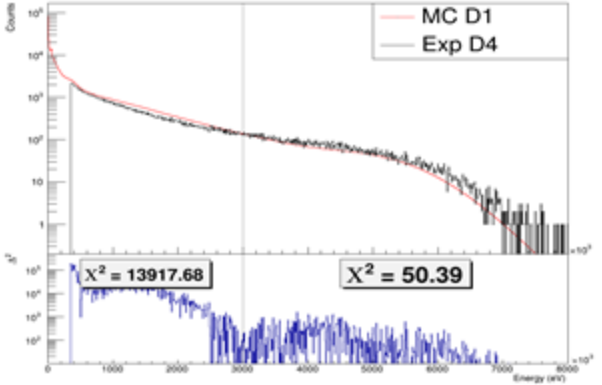



| $M_\gamma$ | $M_{e^-}$ |
|---|---|
| 4.51 | 1.72 |



# Ongoing work: $^{80}$Se cascade simulation

- Generating the cascade: known levels vs. statistical part .

| Dilg | Till | |
|---|---|---|
| BSFG | BSFG | CT |
| a = 10.20<br>Δ = -0.26<br>$I_{eff}$ = 0.5 | a = 10.83<br>Δ = -0.06<br>$I_{eff}$ = 0.5 | T = 0.83<br>$E_0$ = -1.00 |

**LEVEL DENSITY PARAMETERS**
**FOR THE BACK-SHIFTED FERMI GAS MODEL IN THE MASS RANGE**
**$40 < A < 250$**
W. DILG, W. SCHANTL† and H. VONACH
*Physik-Department der Technischen Universität München*

**Systematics of nuclear level density parameters**

Till von Egidy[1] and Dorel Bucurescu[2]
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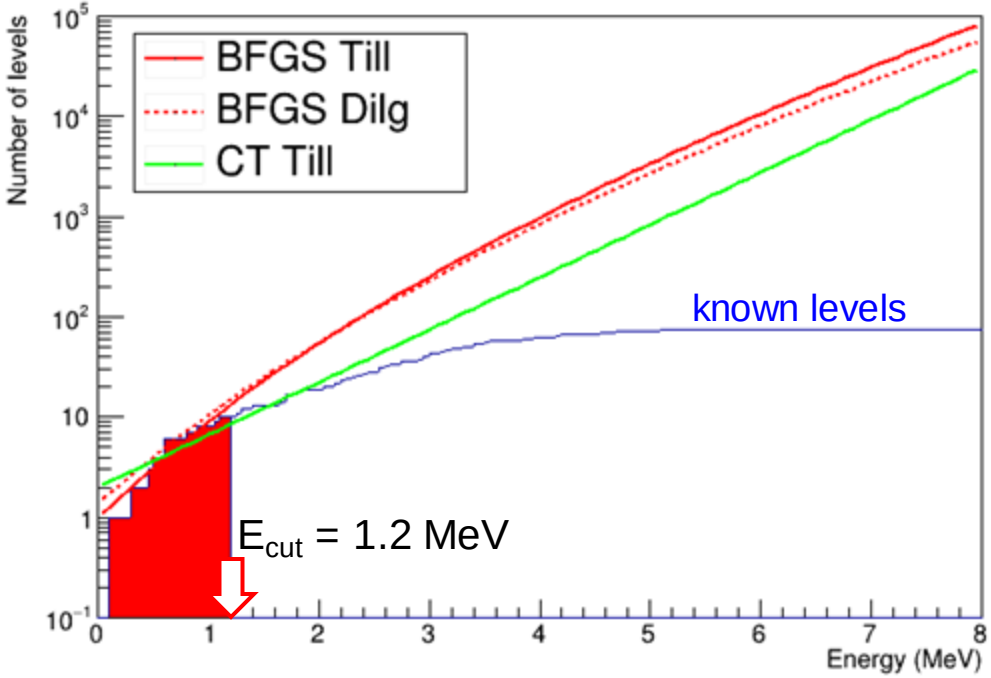
[2]*Horia Hulubei National Institute of Physics and Nuclear Engineering, R-76900 Bucharest, Romania*
(Received 1 July 2005; published 27 October 2005)



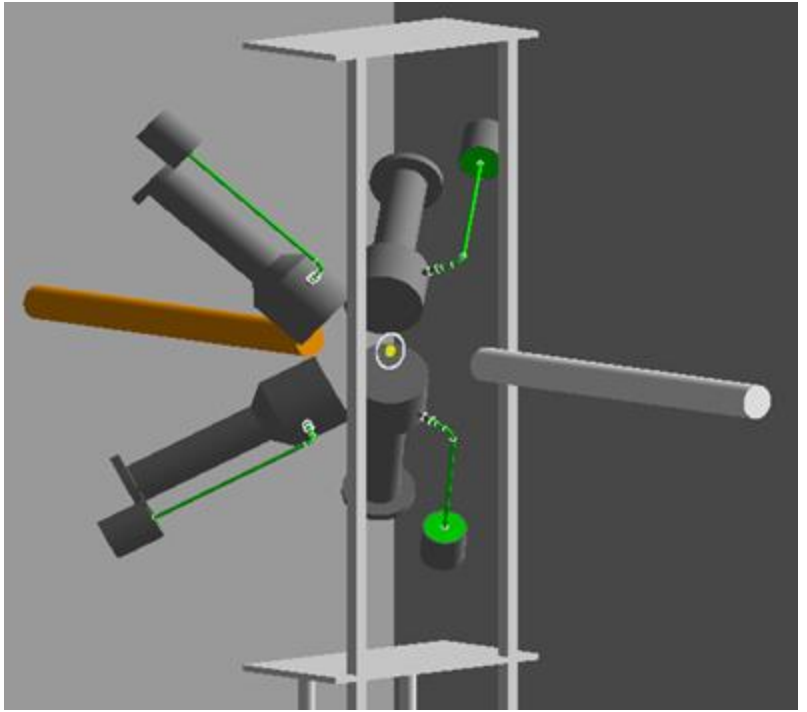
# Ongoing work: $^{80}$Se cascade simulation

- Generating the cascade: Photon Strength Function calculation.

| | E1 | | M1 | E2 |
|---|---|---|---|---|
| E (MeV) | 15.44 | 17.89 | 9.48 | 14.56 |
| Γ (MeV) | 4.85 | 6.42 | 4.00 | 4.41 |
| $\sigma_0$ (mb) | 51.16 | 102.31 | 12.46 | 0.14 |

RIPL – Reference Input Parameter Library for Calculation of Nuclear Reactions and Nuclear Data Evaluations

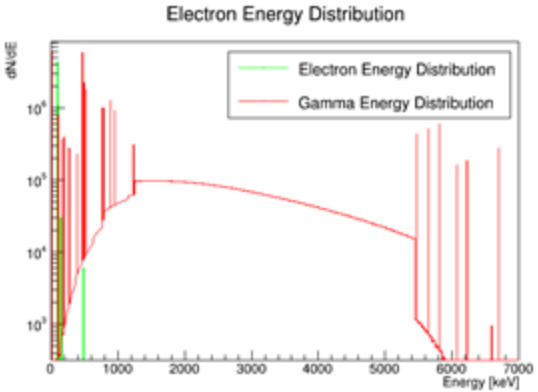
R. Capote,[1*] M. Herman,[1,2] P. Obložinský,[1,2] P.G. Young,[3] S. Goriely,[4] T. Belgya,[5] A.V. Ignatyuk,[6] A.J. Koning,[7] S. Hilaire,[8] V.A. Plujko,[9] M. Avrigeanu,[10] O. Bersillon,[8] M.B. Chadwick,[3] T. Fukahori,[11] Zhigang Ge,[12] Yinlu Han,[12] S. Kailas,[13] J. Kopecky,[14] V.M. Maslov,[15] G. Reffo,[16] M. Sin,[17] E.Sh. Soukhovitskii,[15] P. Talou[3]



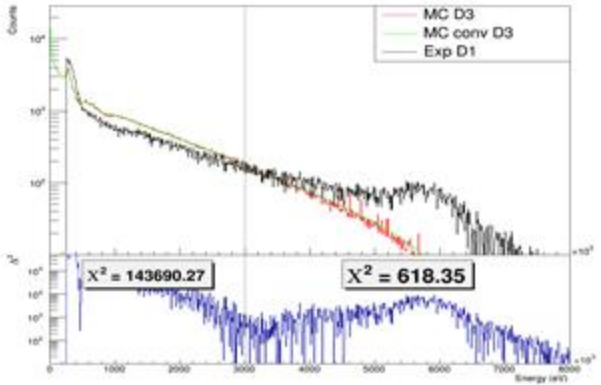
# Ongoing work: $^{80}$Se cascade simulation

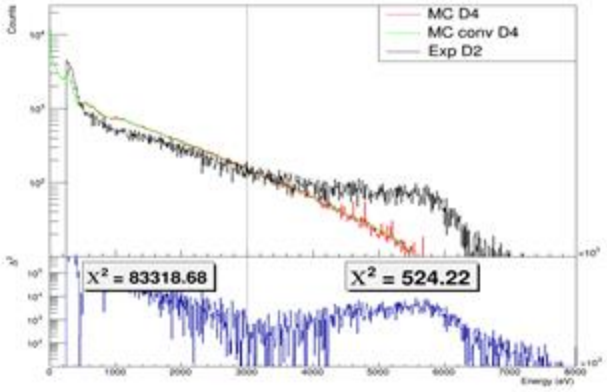
- Simulated cascade for 1.95 keV resonance: BSFG level-density.

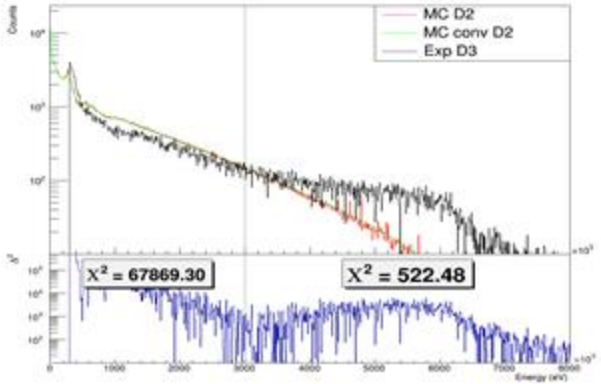
**BSFG**

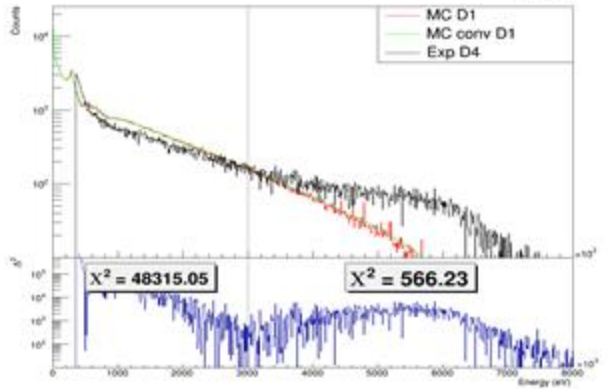



| $M_\gamma$ | $M_{e^-}$ |
|---|---|
| 3.07 | 0.33 |



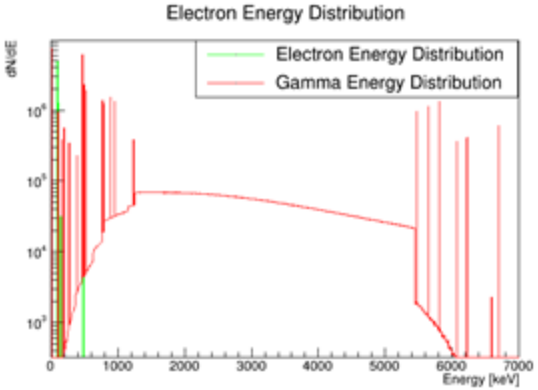



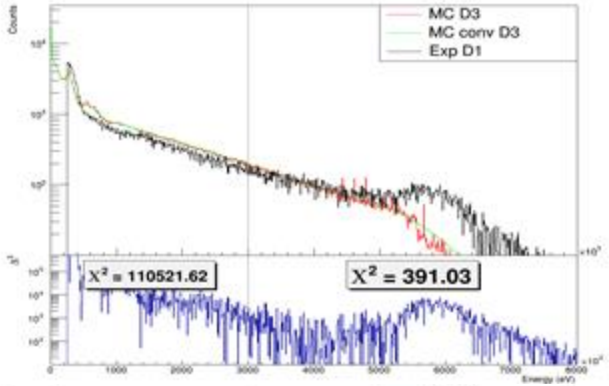
# Ongoing work: $^{80}$Se cascade simulation

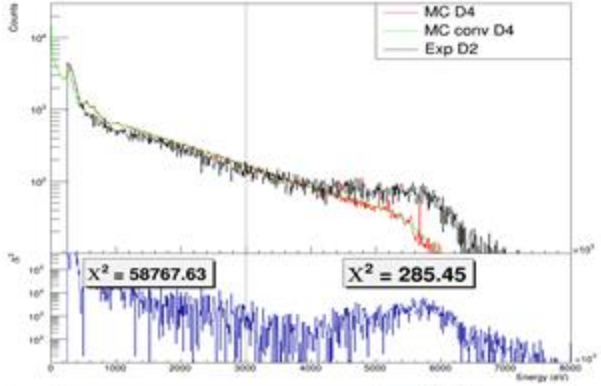
- Simulated cascade for 1.95 keV resonance: CT level-density.

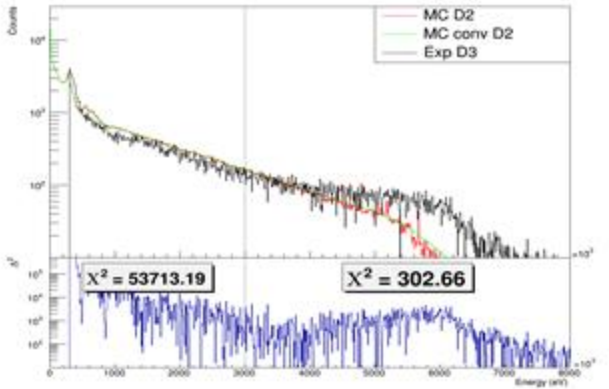
CT

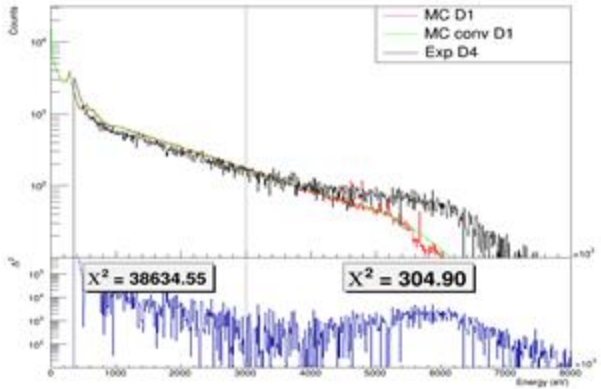



| $M_{\gamma}$ | $M_{e^-}$ |
|---|---|
| 2.95 | 0.39 |



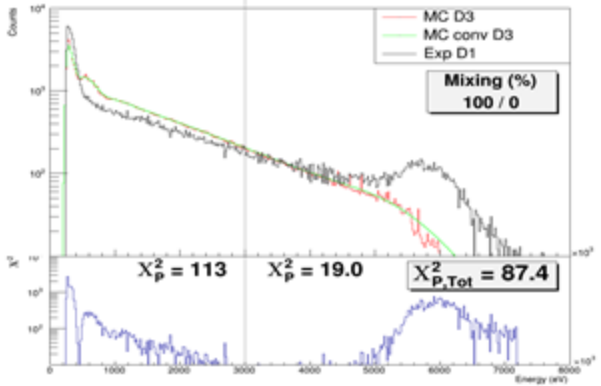
# Ongoing work: $^{80}$Se cascade simulation

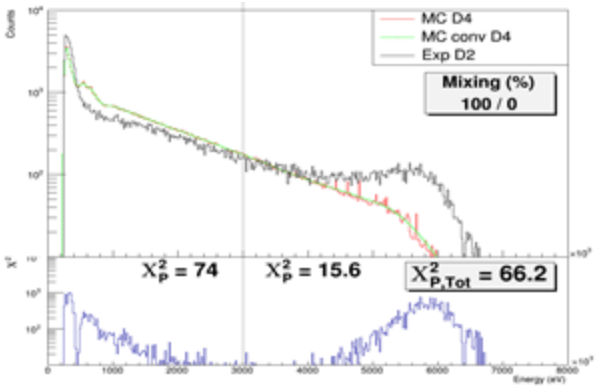
- Mixing cascade with monoenergetic gamma-rays of $E_g=S_n$

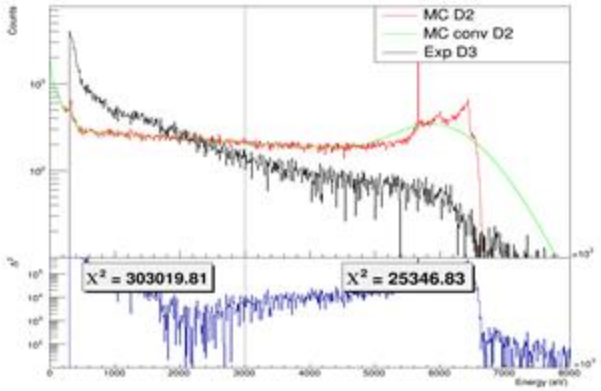
CT

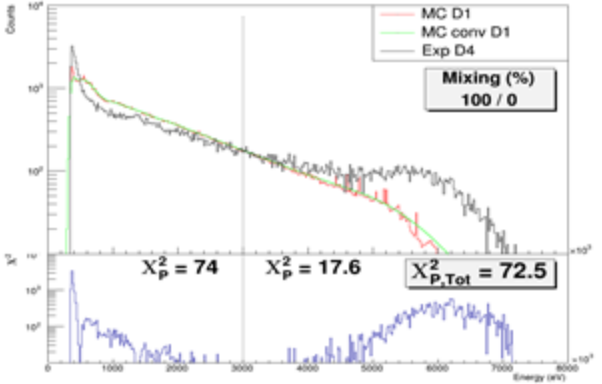
✚

6.701 MeV



# Ongoing work: $^{80}$Se cascade simulation

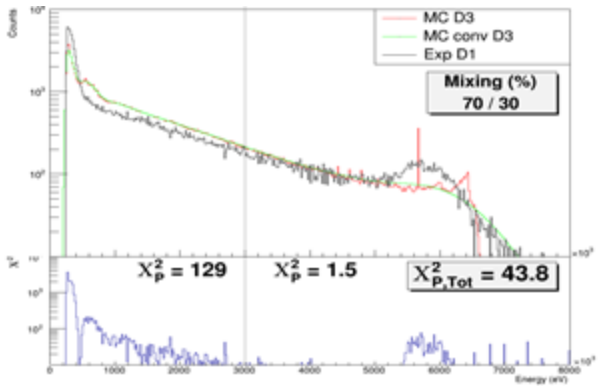
- Mixing cascade with monoenergetic gamma-rays of Eg=$S_n$

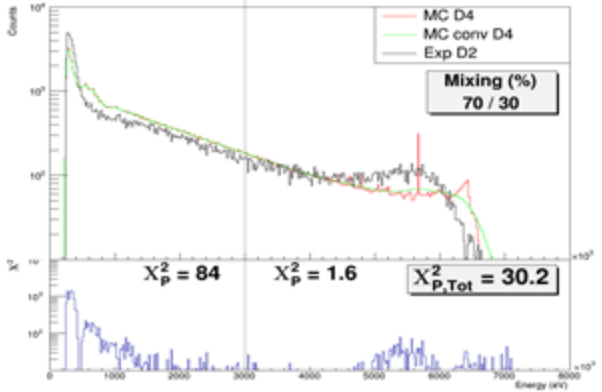
CT **70%**

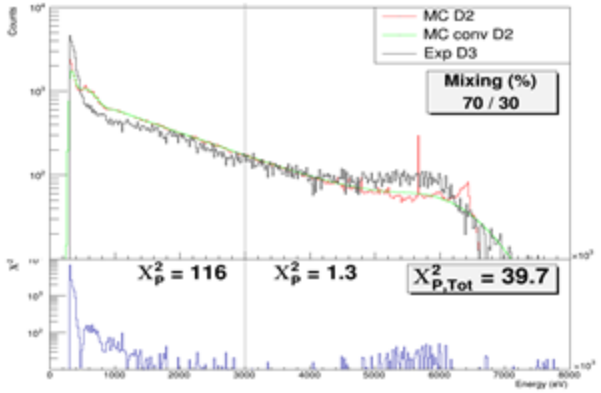
✚

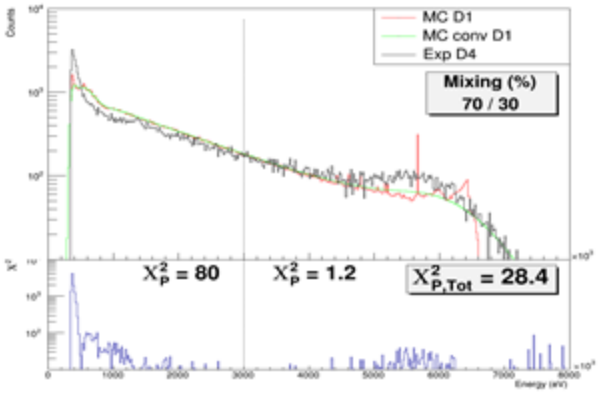
6.701 MeV **30%**

**BEST FIT**



# Ongoing work: $^{80}$Se cascade simulation

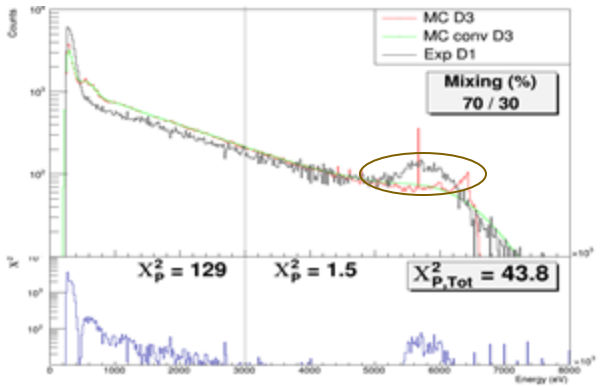
- Mixing cascade with monoenergetic gamma-rays of Eg=$S_n$

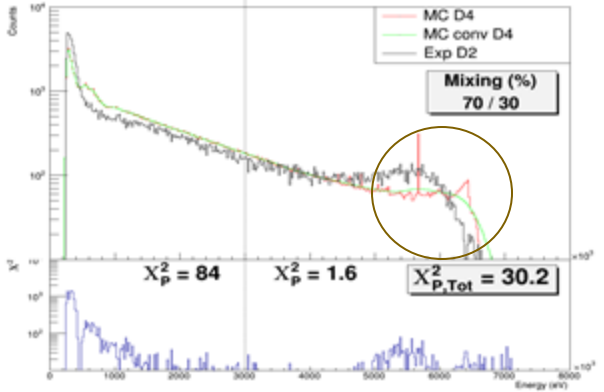
CT **70%**

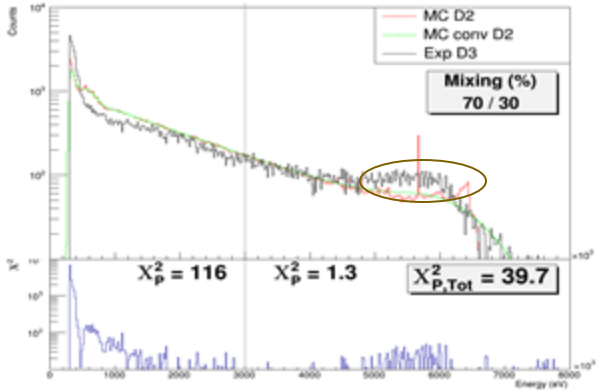
✚

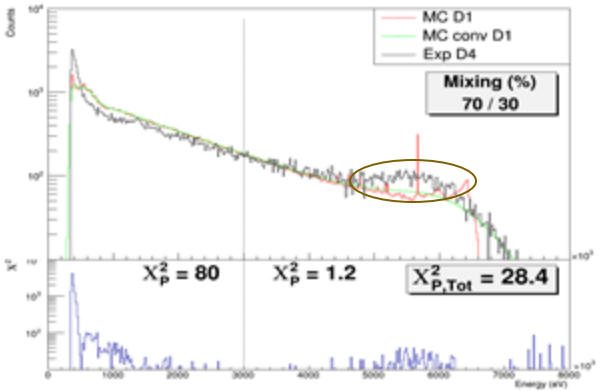
6.701 MeV **30%**

**BEST FIT**




But still with aspects to improve:

- High energy “bump” does not fully reproduce.
- Calibration problem (?) in Detector#2.

# Summary and outlook

Analysis of the experiment is now ongoing.

Until now, we have studied:

- Effects of rebounds.
- The count rate stability for $C_6D_6$.
- The gain stability of the $C_6D_6$.
- Weighting function.
- Geant4 simulations.

Study currently ongoing:

- Improve modeling of the cascades.
- Determine the WF accuracy.
- Determine corrections for the experimental effects of threshold

Next steps:

- Determine the experimental capture yield
- R-Matrix analysis with SAMMY.
- Astrophysical interpretations of the results.