

# Description of work for the ESFR project

**D. Rochman, NRG**

*Nuclear Research and Consultancy Group,*

*NRG, Petten, The Netherlands*

February 25, 2010

① Person-month:

⇒ 3

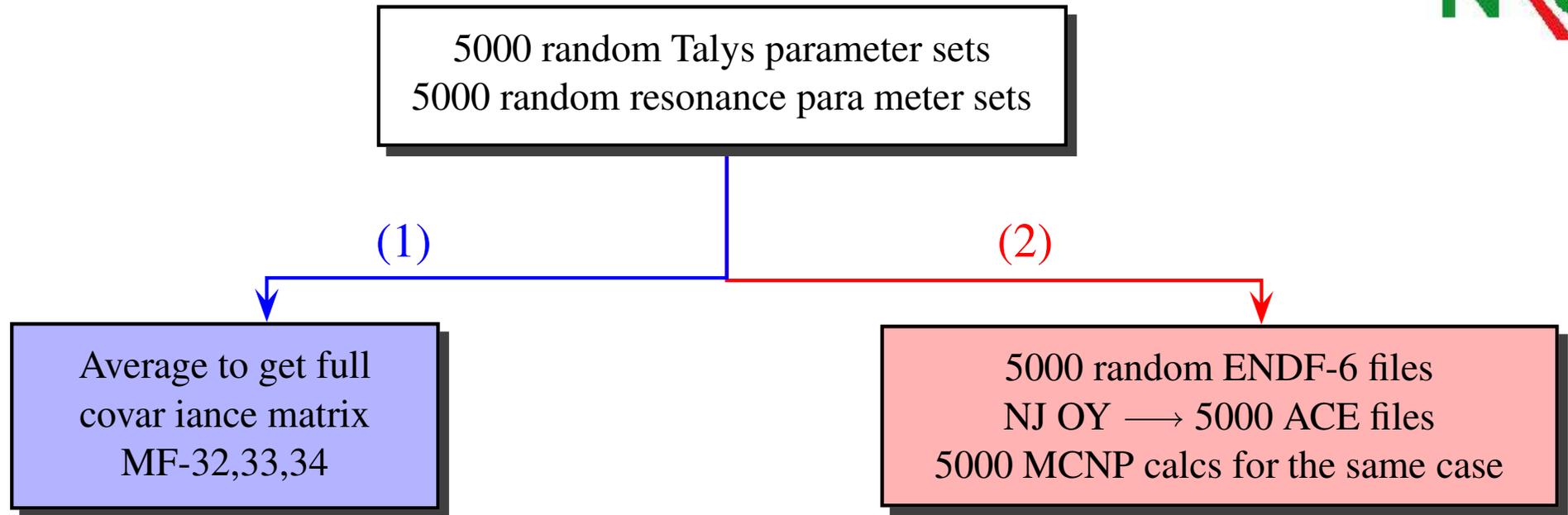
② Task 3.1.3:

⇒ *"The sensitivities and uncertainties, including those originated from the uncertainties in the nuclear data, will be quantified for the void coefficient. The full Monte Carlo uncertainty evaluation of the void coefficient will be performed using BOLNA."*

③ Based on ESFR MCNP model obtained from JRC Petten (received from H. Tsige-Tamirat in November 2009), ⇒ Is there a more precise model available ?

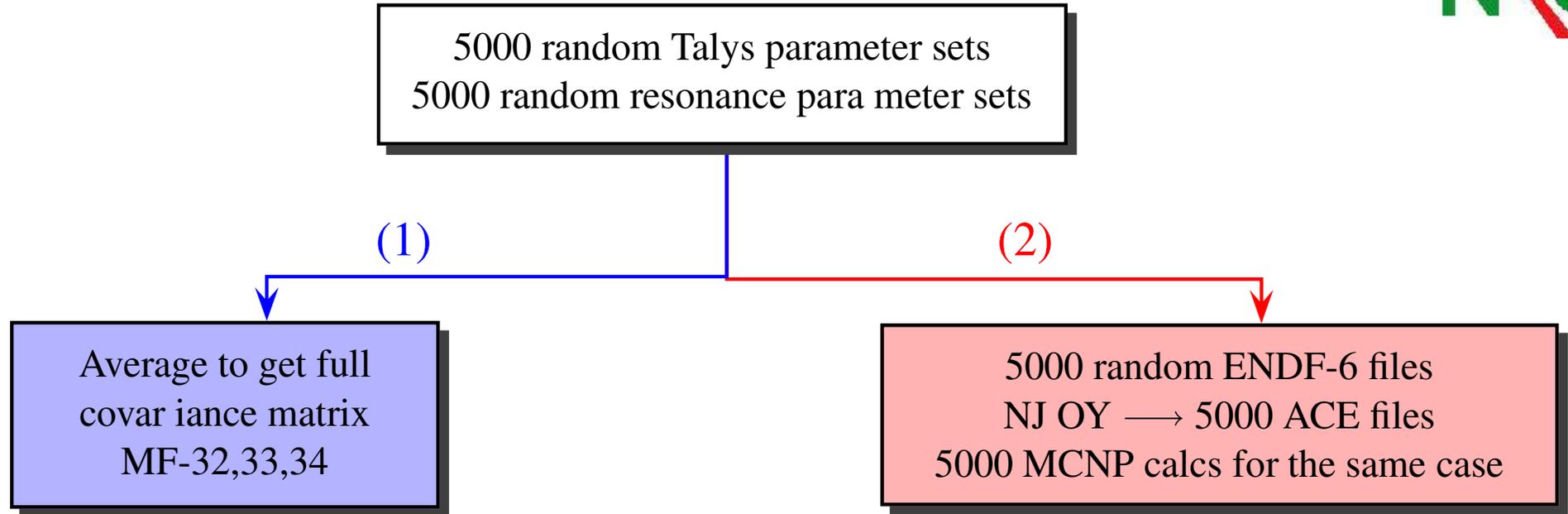
④ Start: Probably second half of 2010.

# Nuclear data propagation: Monte Carlo approach (TALYS+MCNP)



We have both routes, but one is easier and more exact to take than the second one.

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In solution (1):

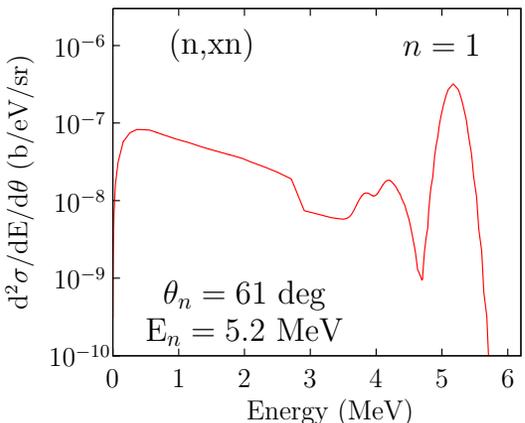
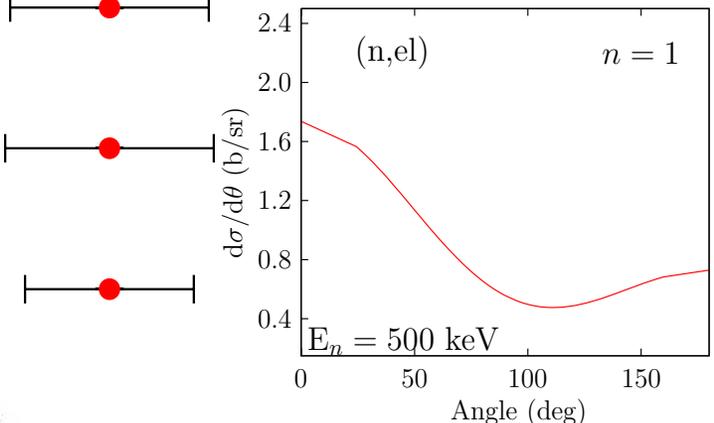
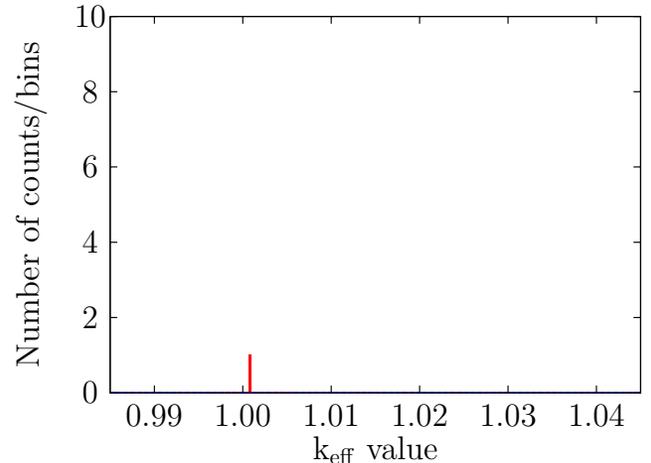
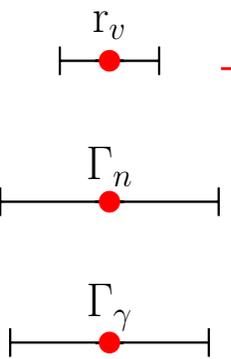
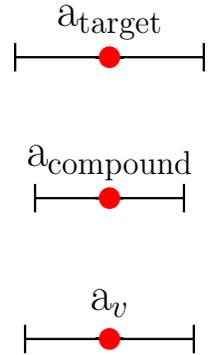
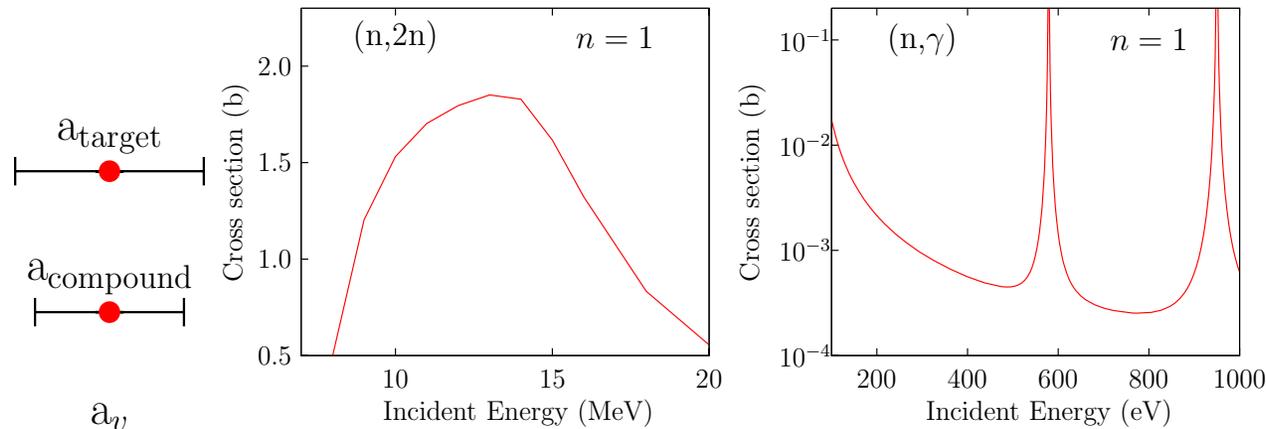
Problem 1: ENDF format for covariances for fission yields, thermal scattering, branching ratios, DDX,  $\gamma$ -production

Problem 2: Processing of these covariances

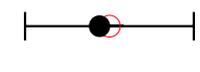
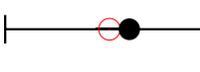
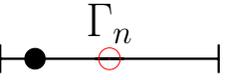
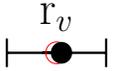
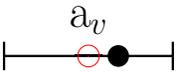
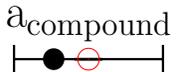
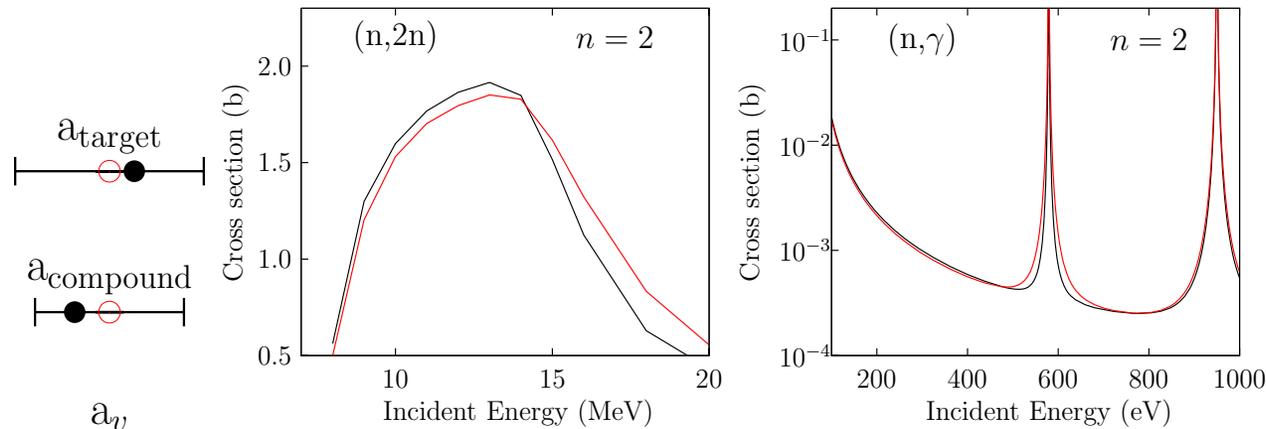
Problem 3: Neutronics with covariances: perturbation codes.

Are these generally available and working?

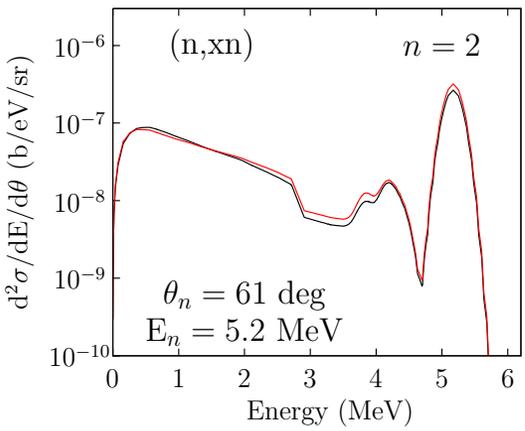
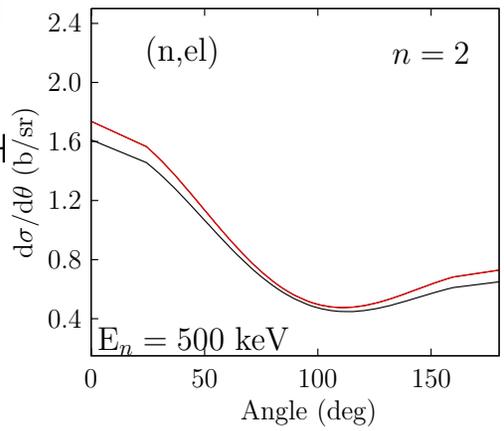
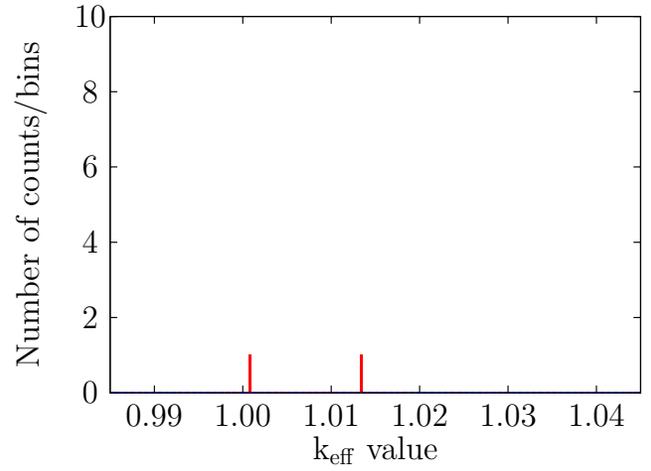
# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”



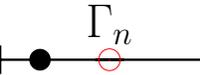
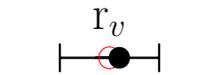
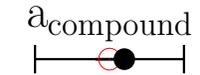
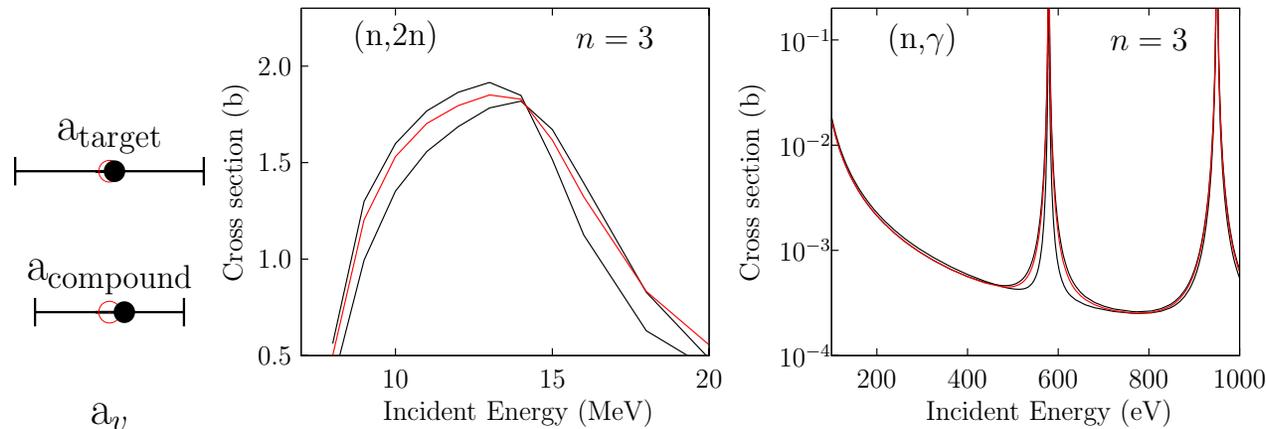
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TALYS → MCNP

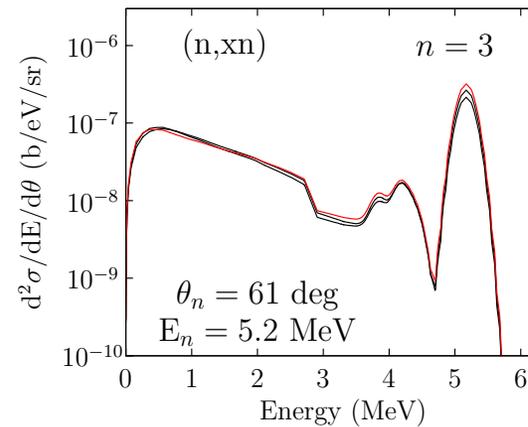
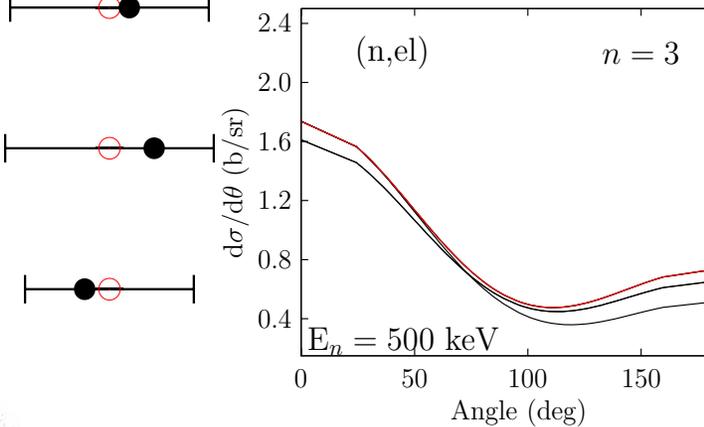
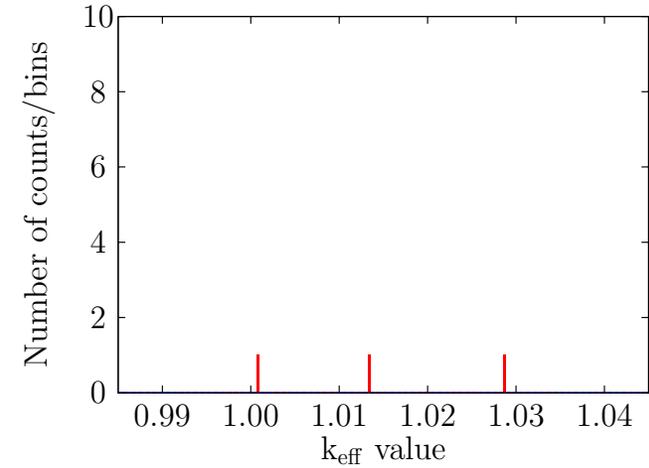


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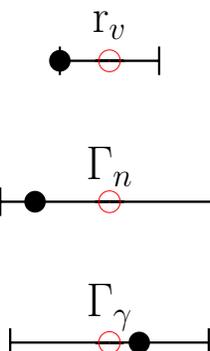
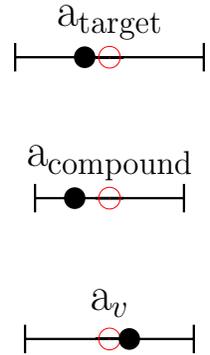
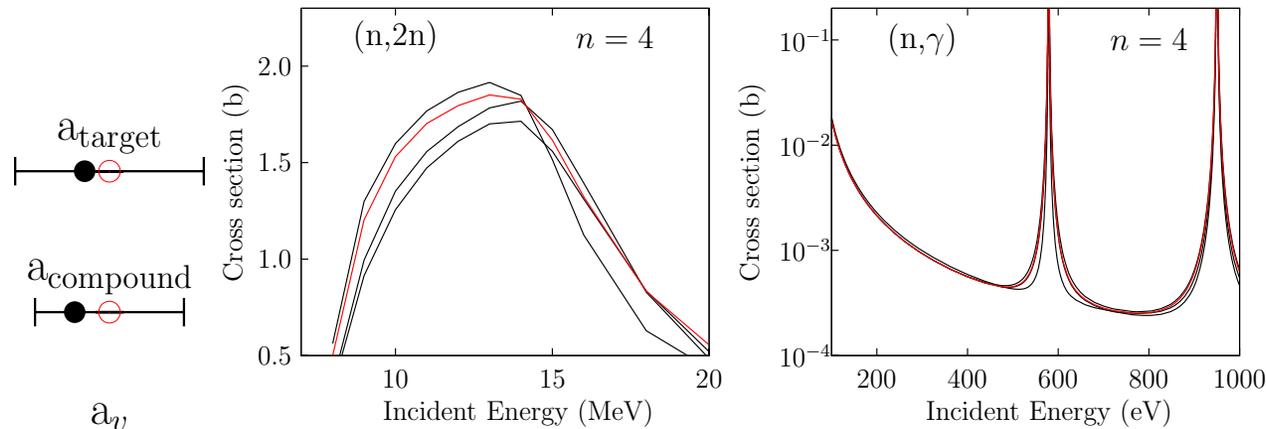


TALYS

MCNP

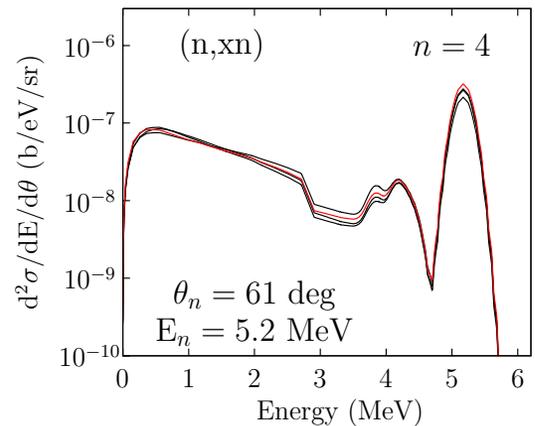
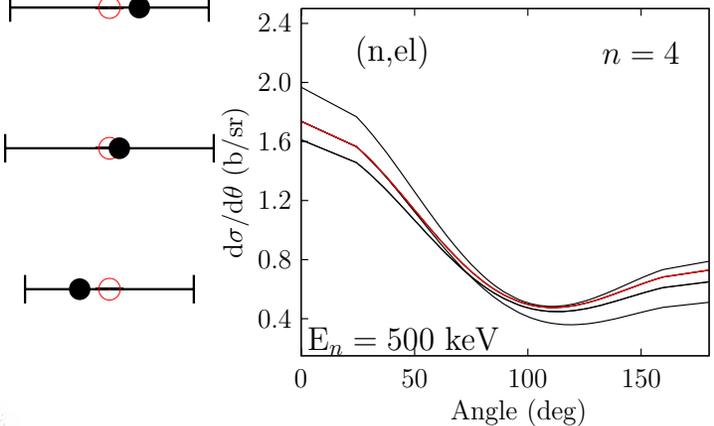
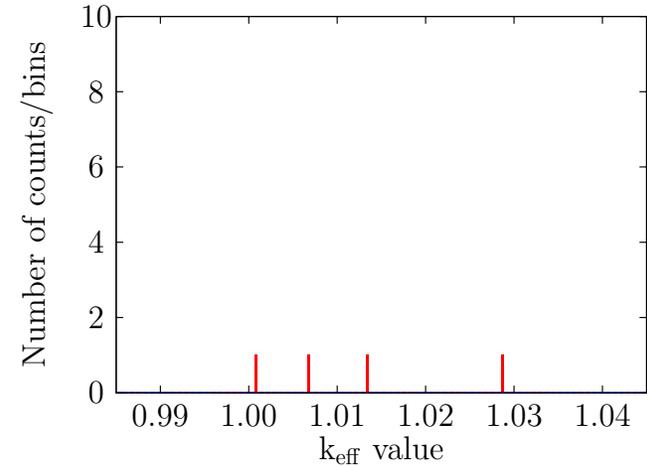


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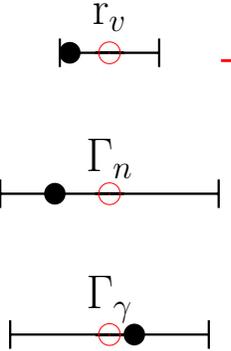
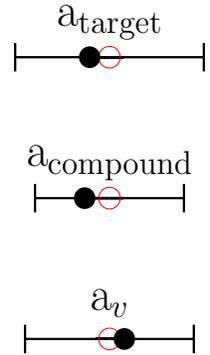
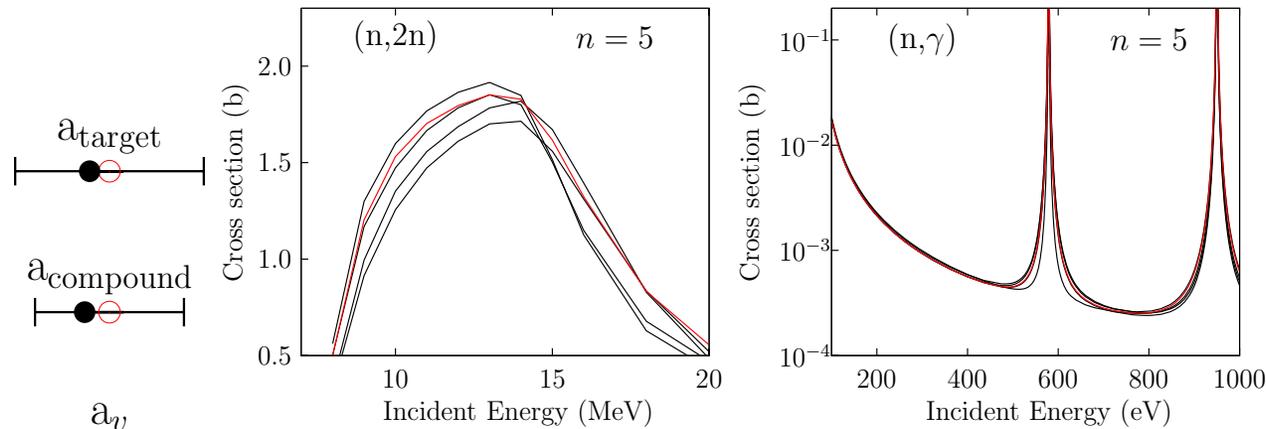


TALYS

MCNP

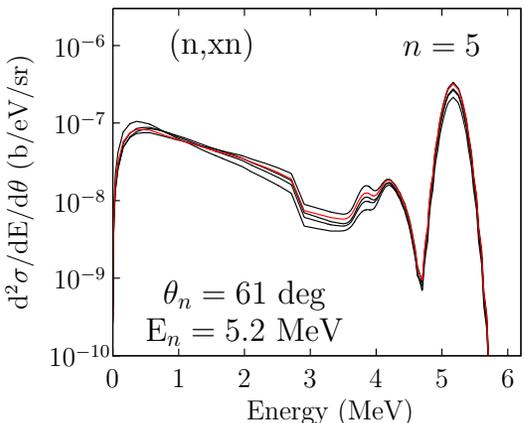
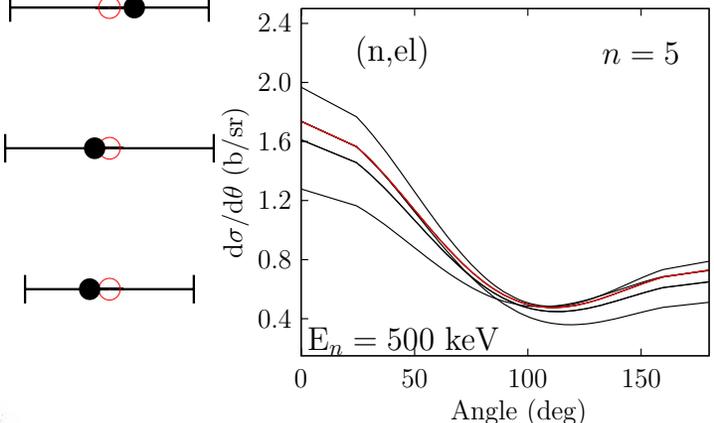
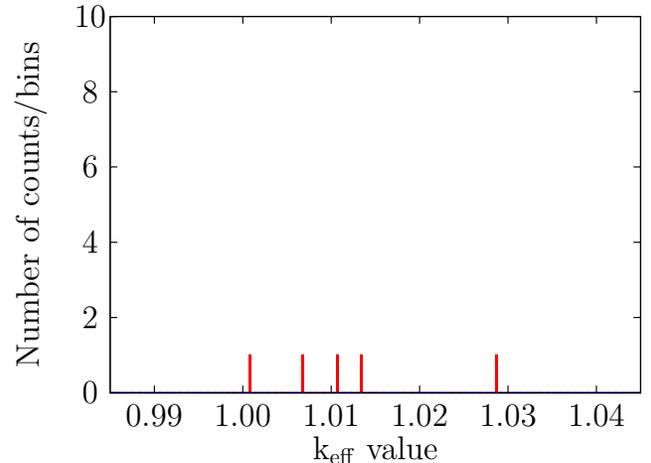


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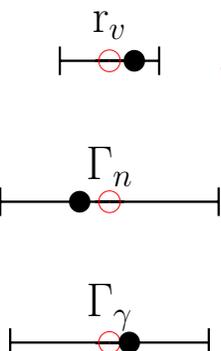
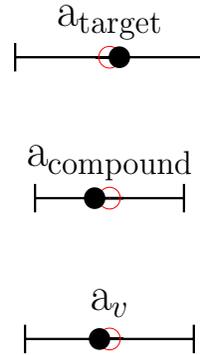
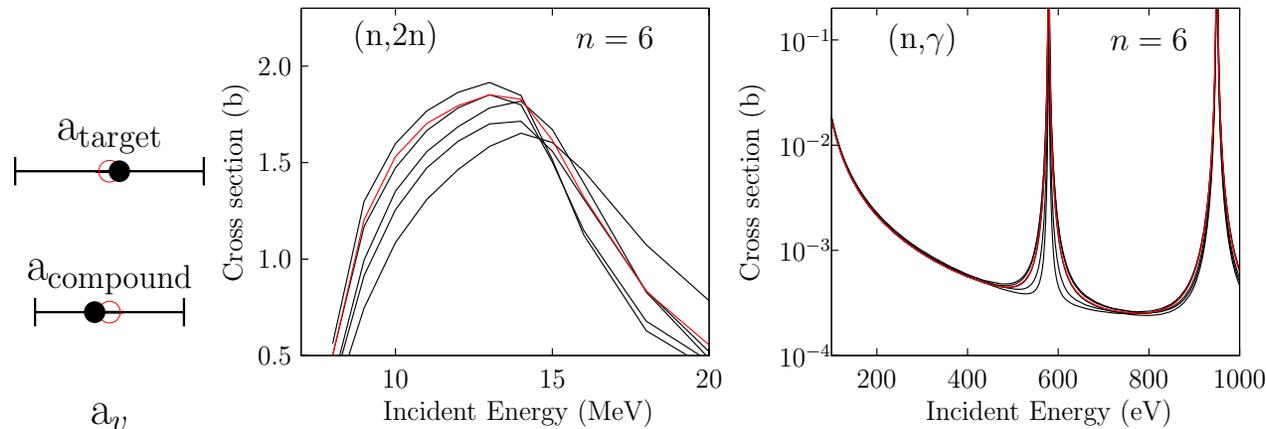


TALYS

MCNP

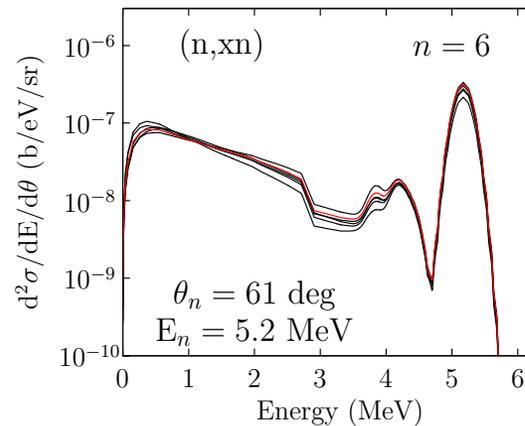
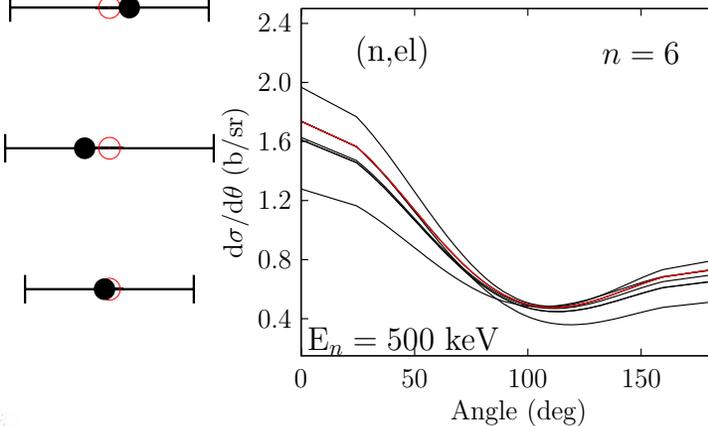
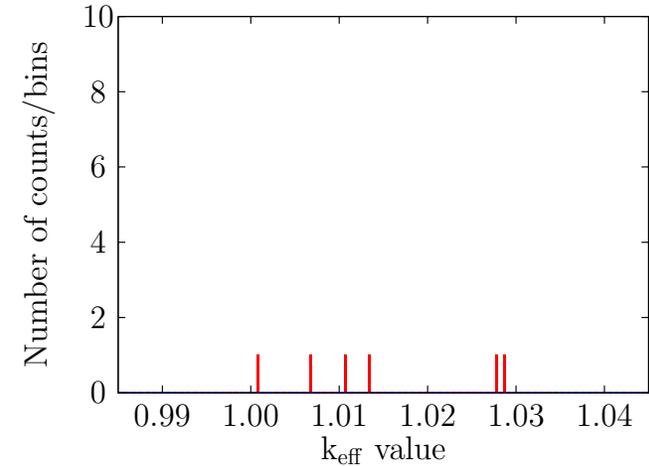


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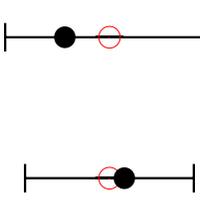
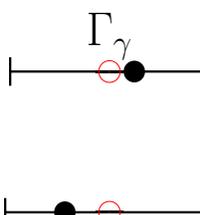
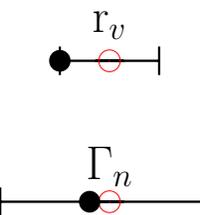
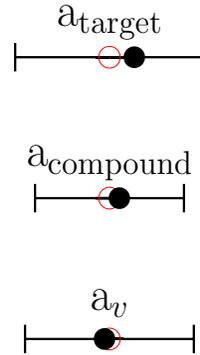
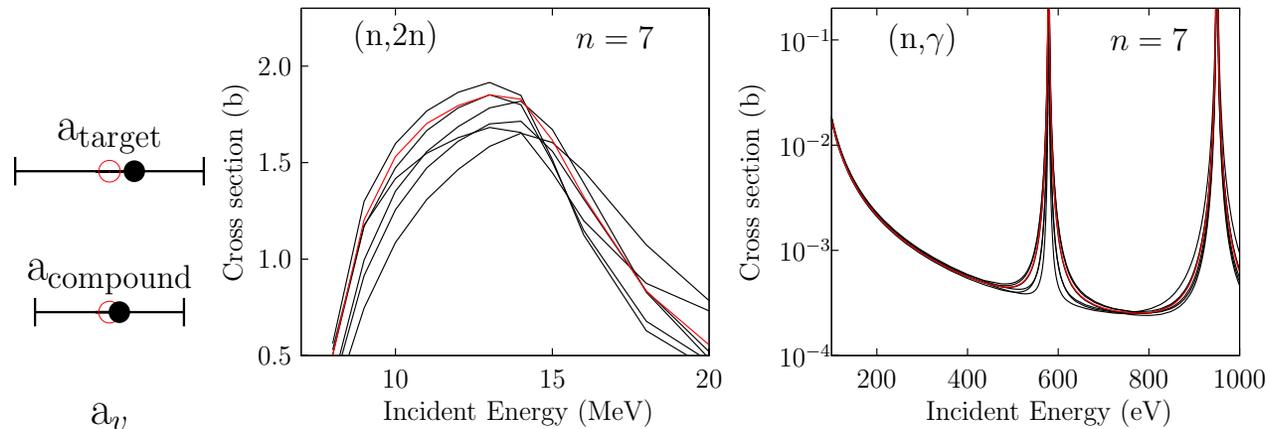


TALYS

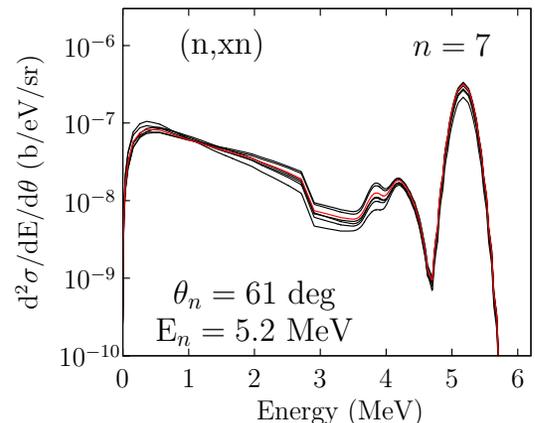
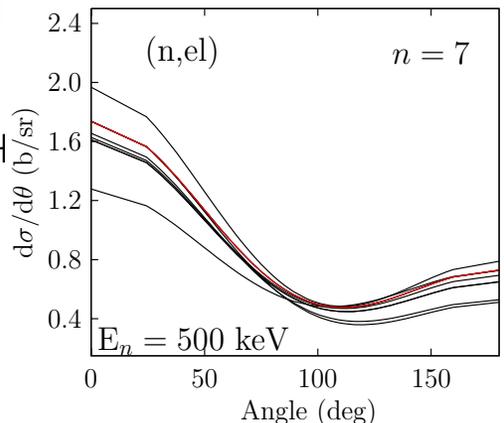
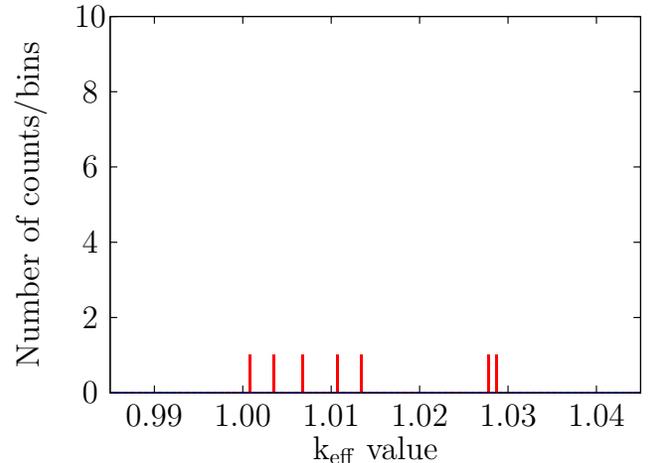
MCNP



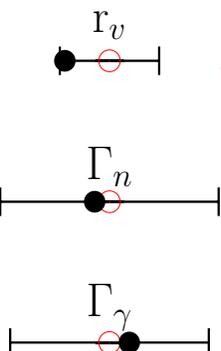
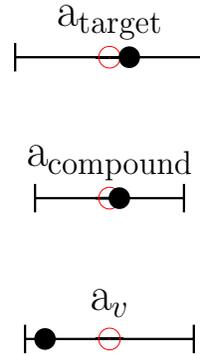
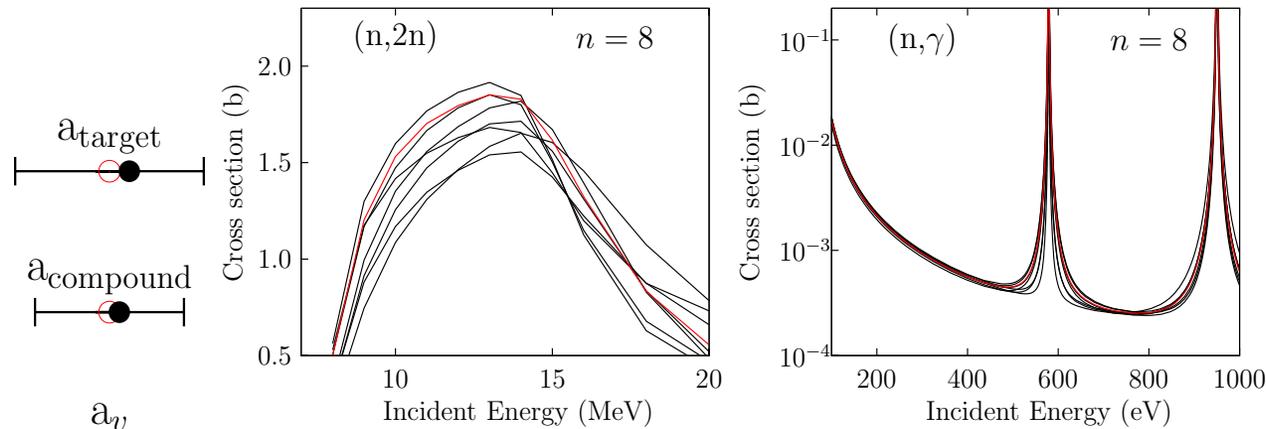
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TALYS → MCNP

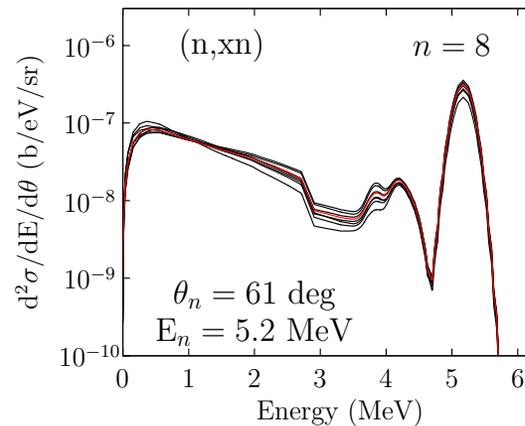
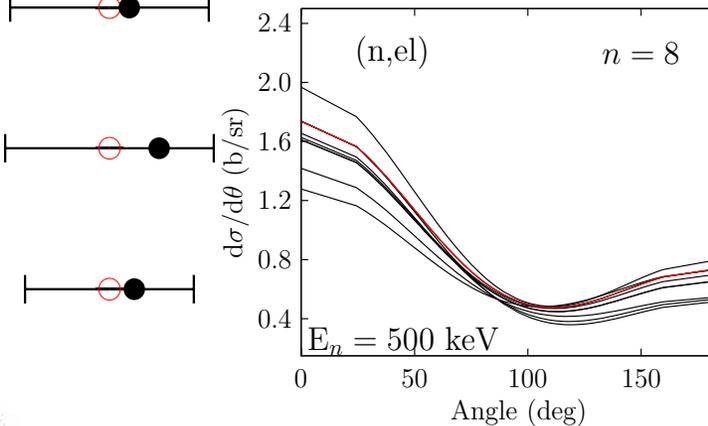
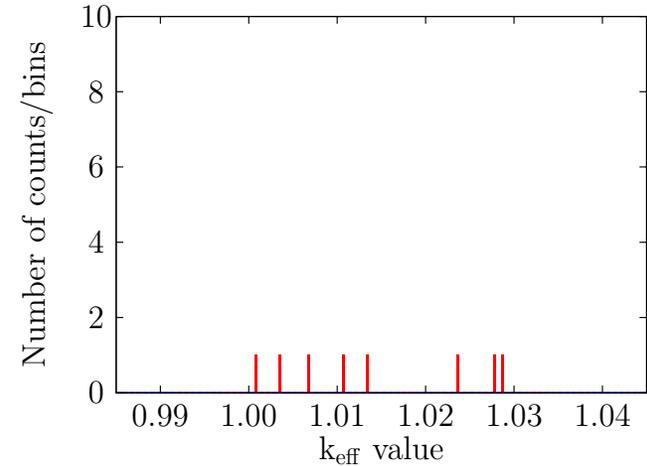


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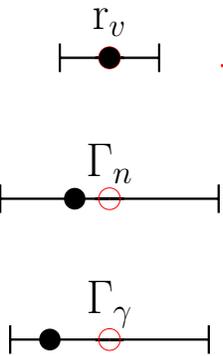
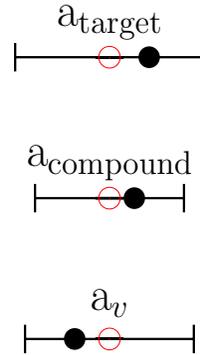
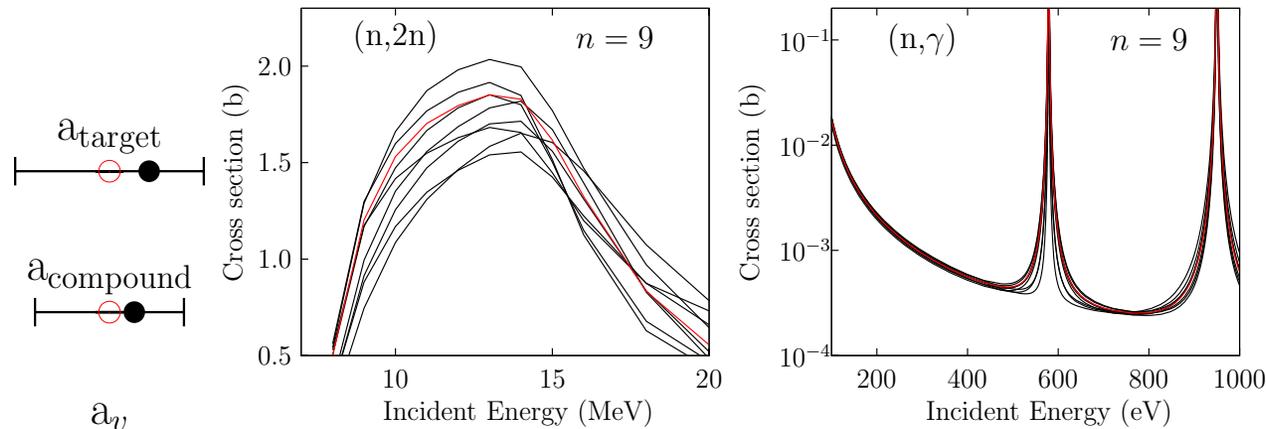


TALYS

MCNP

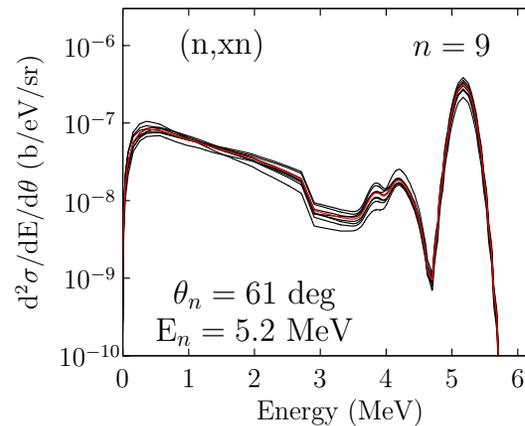
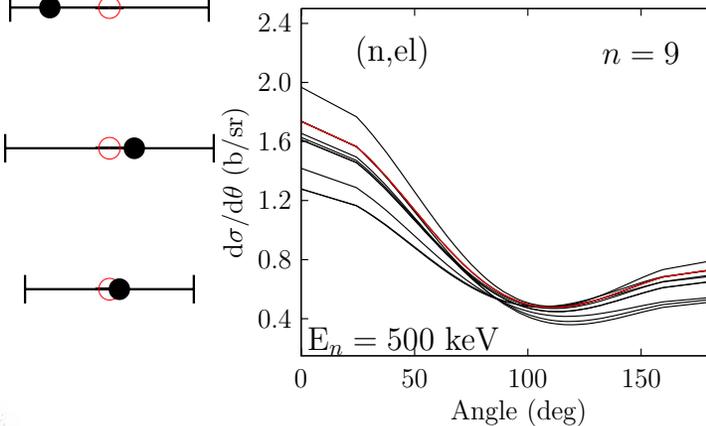
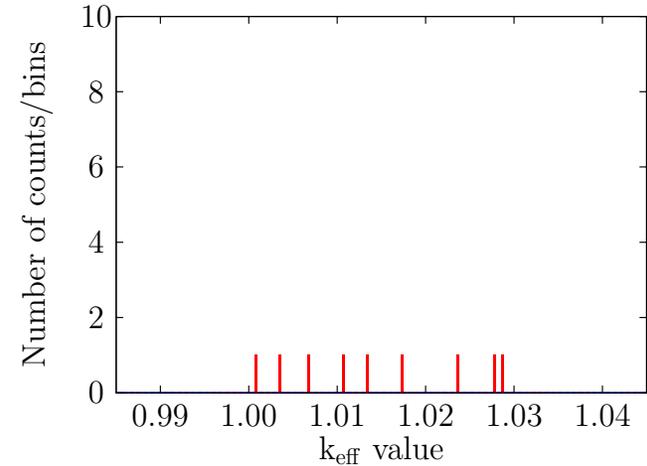


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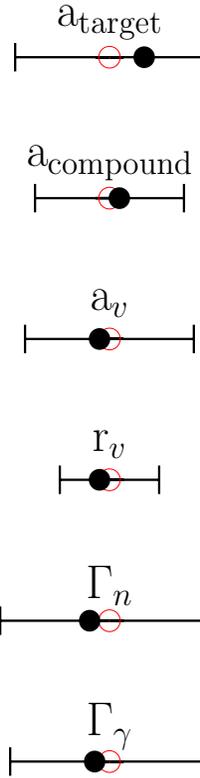
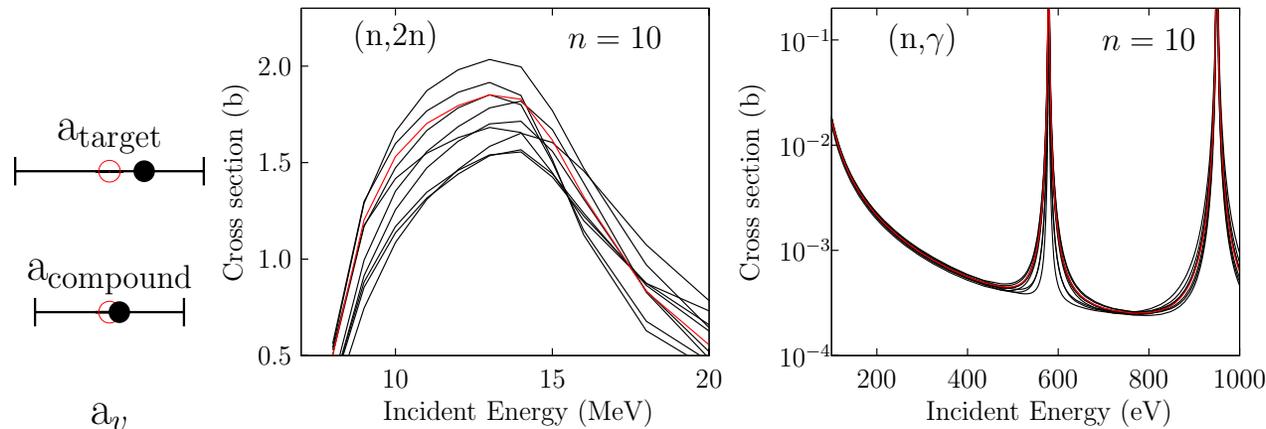


TALYS

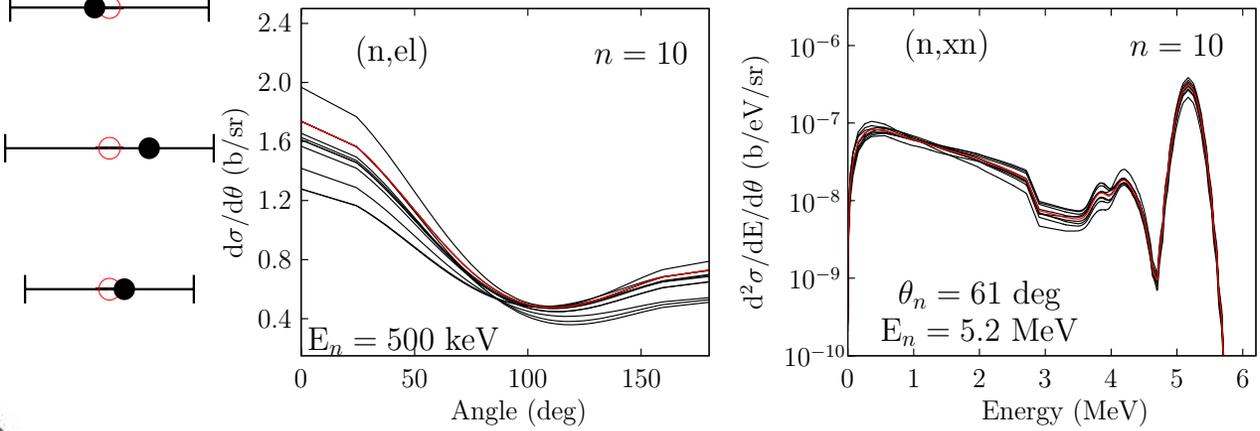
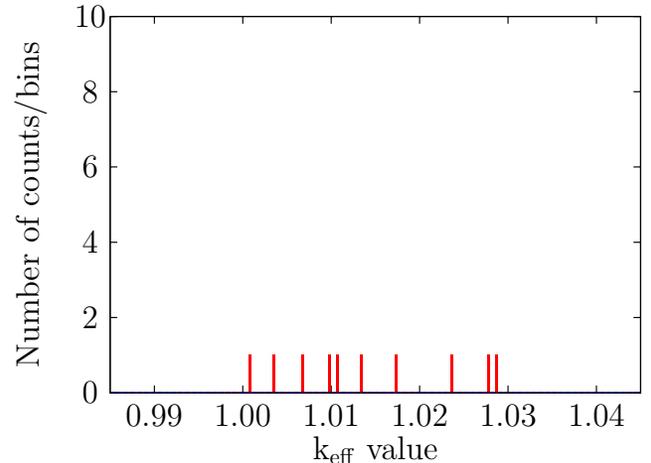
MCNP



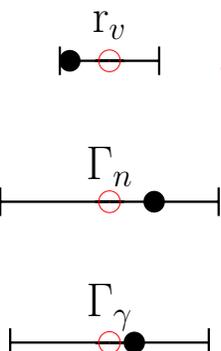
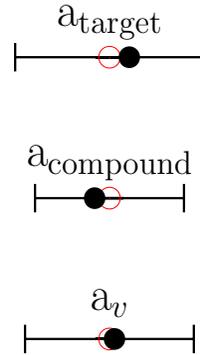
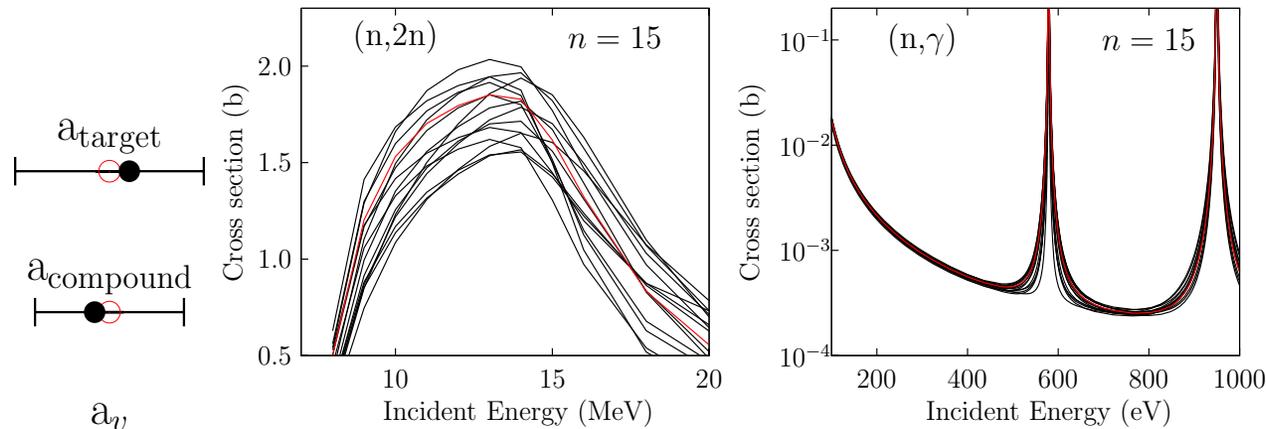
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TALYS → MCNP

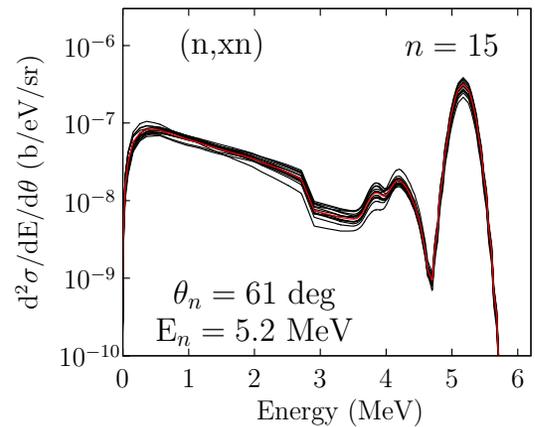
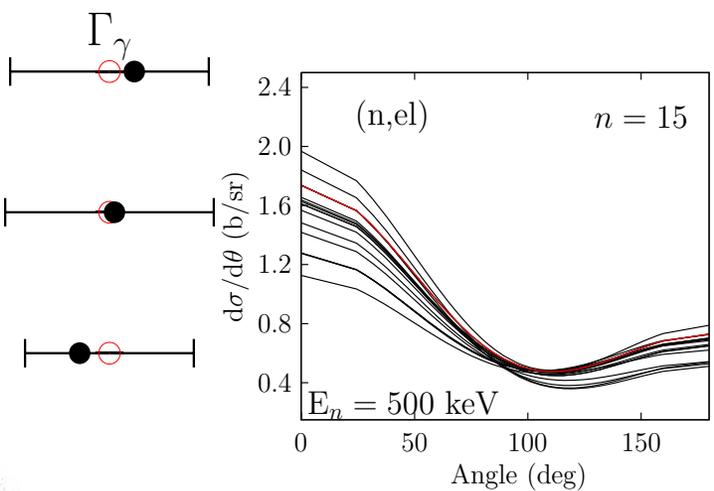
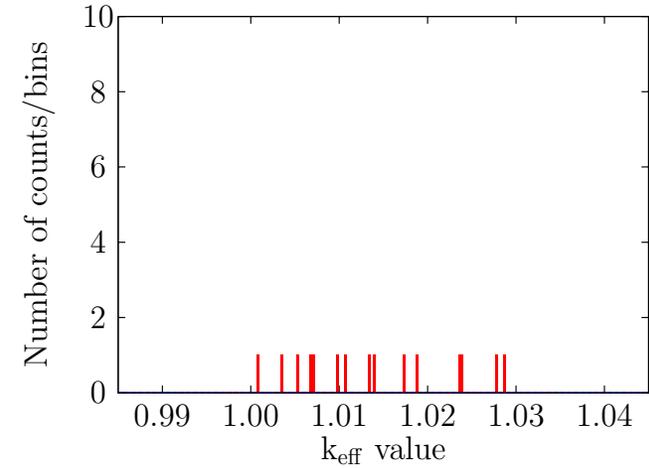


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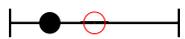
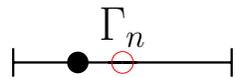
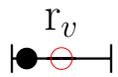
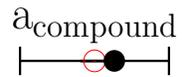


TALYS

MCNP



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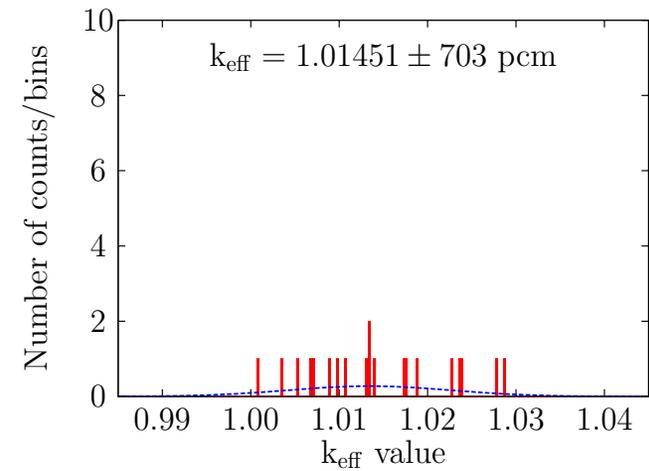


TALYS

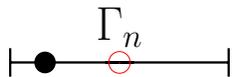
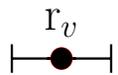
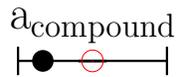
MCNP



$n = 20$



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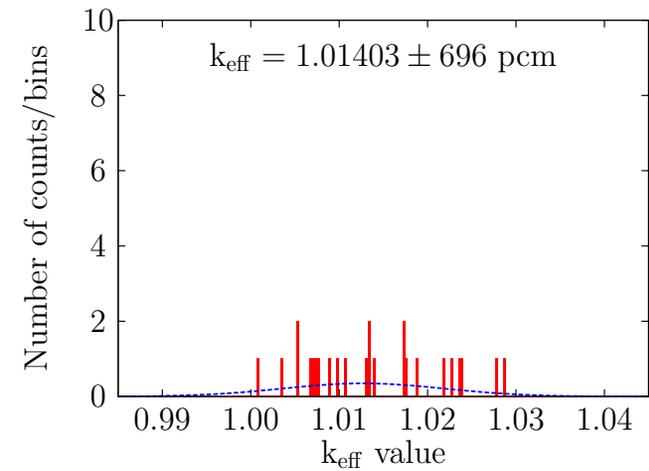


TALYS

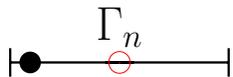
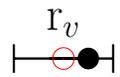
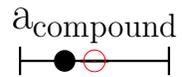
MCNP



$n = 25$



# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

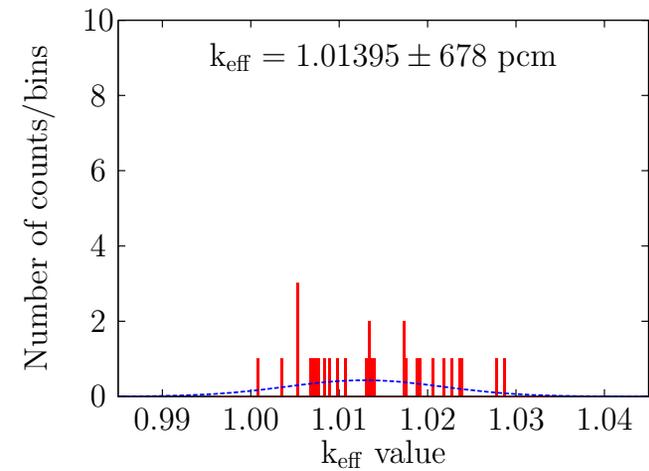


TALYS

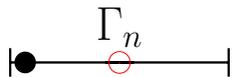
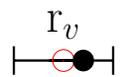
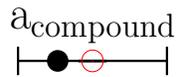
MCNP



$n = 30$



# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

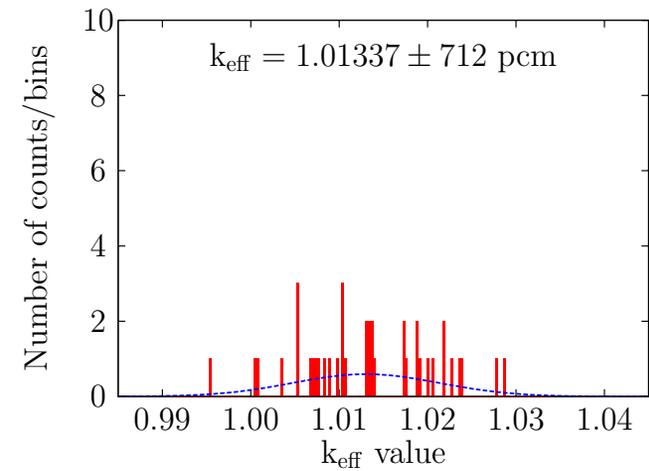


TALYS

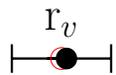
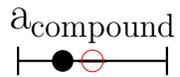
MCNP



$n = 40$



# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

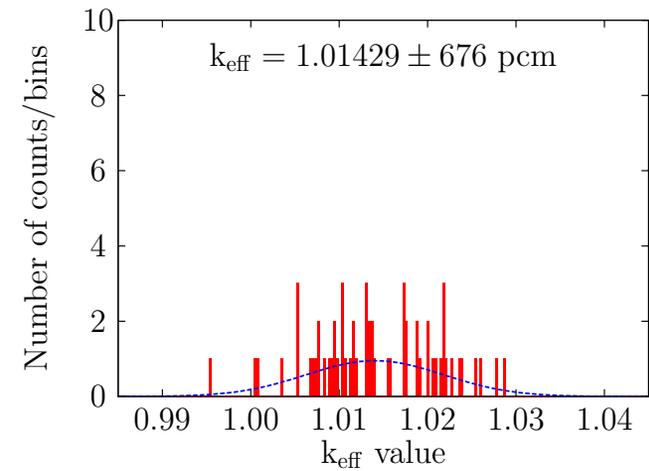


TALYS

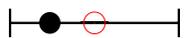
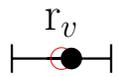
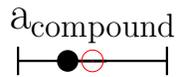
MCNP



$n = 60$



# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

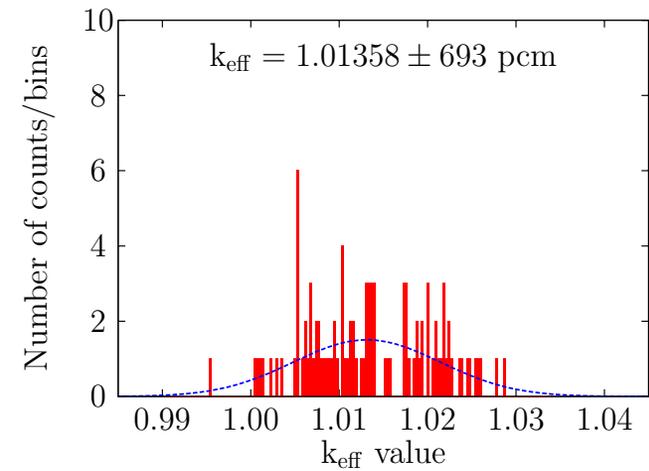


TALYS

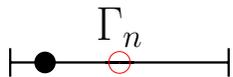
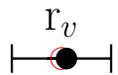
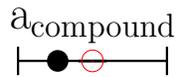
MCNP



$n = 100$



# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

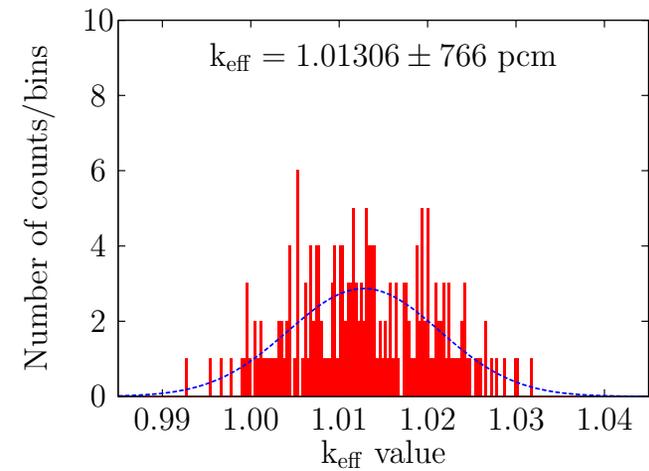


TALYS

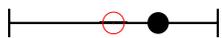
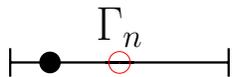
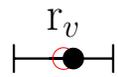
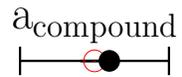
MCNP



$n = 200$



# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

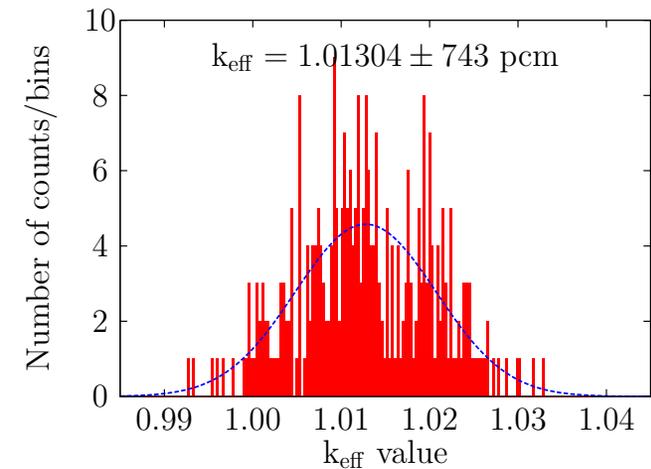


TALYS

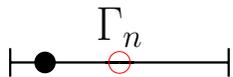
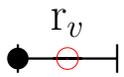
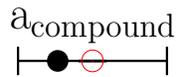
MCNP



$n = 300$

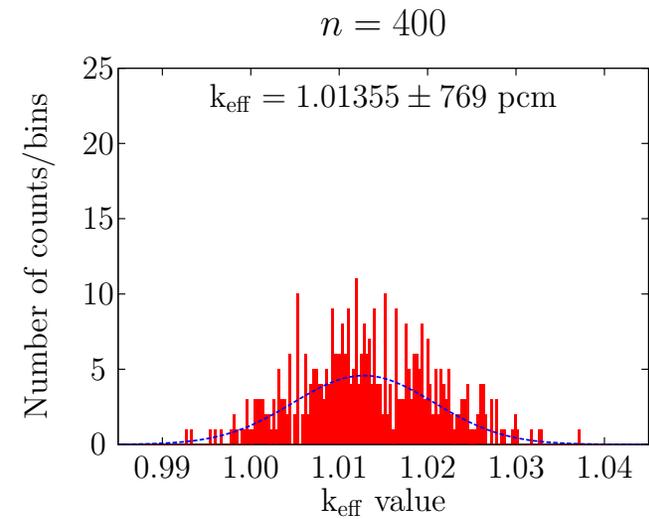


# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

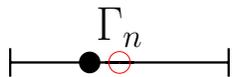
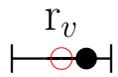
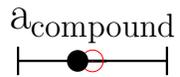


TALYS

MCNP

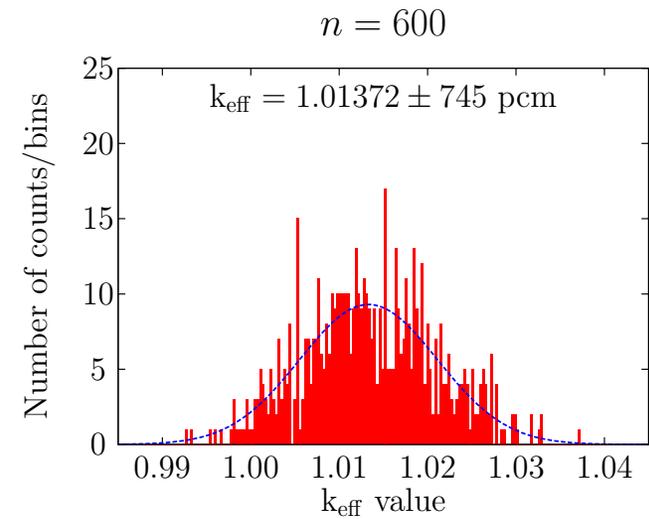


# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

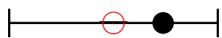
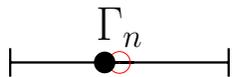
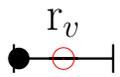
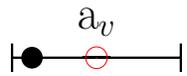
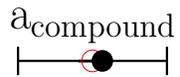


TALYS

MCNP

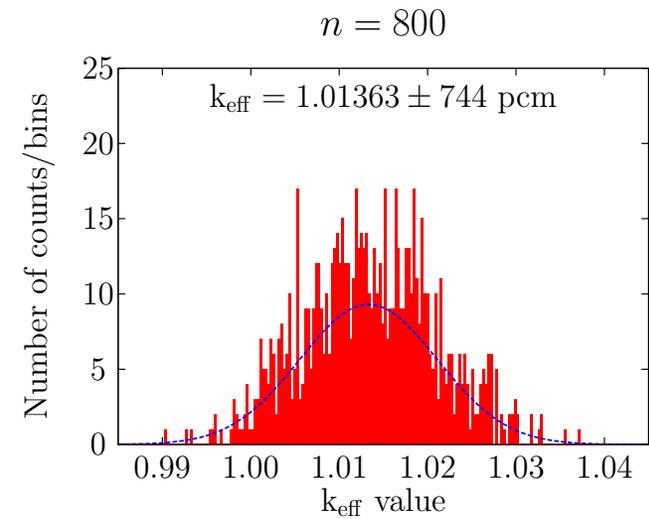


# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”

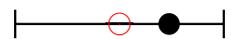
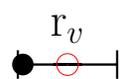
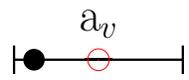
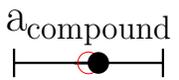


TALYS

MCNP

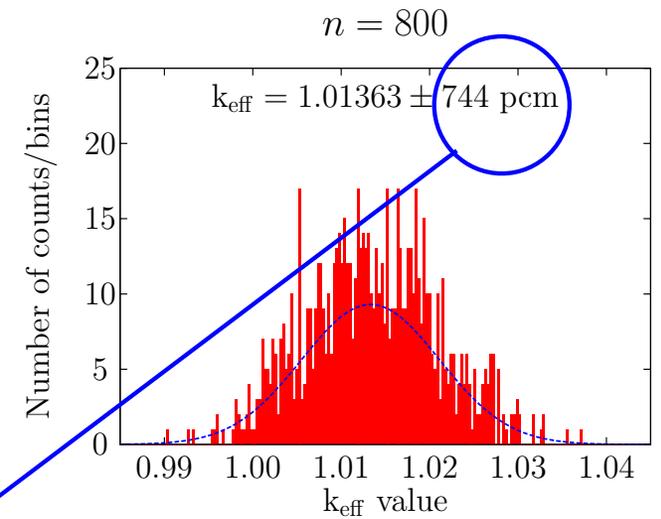


# Hands on “1000 × (Talys + ENDF + NJOY + MCNP) calculations”



TALYS

MCNP



Statistical uncertainty  $\simeq 68$  pcm  
 $\implies$  uncertainty due to nuclear data  $\simeq 740$  pcm

The sodium void reactivity (SVR) in units of dollars (\$) can be obtained from:



$$\text{SVR} = \frac{k_2 - k_1}{k_1 k_2} \frac{1}{\beta_{\text{eff}}} \times 10^5, \quad (1)$$

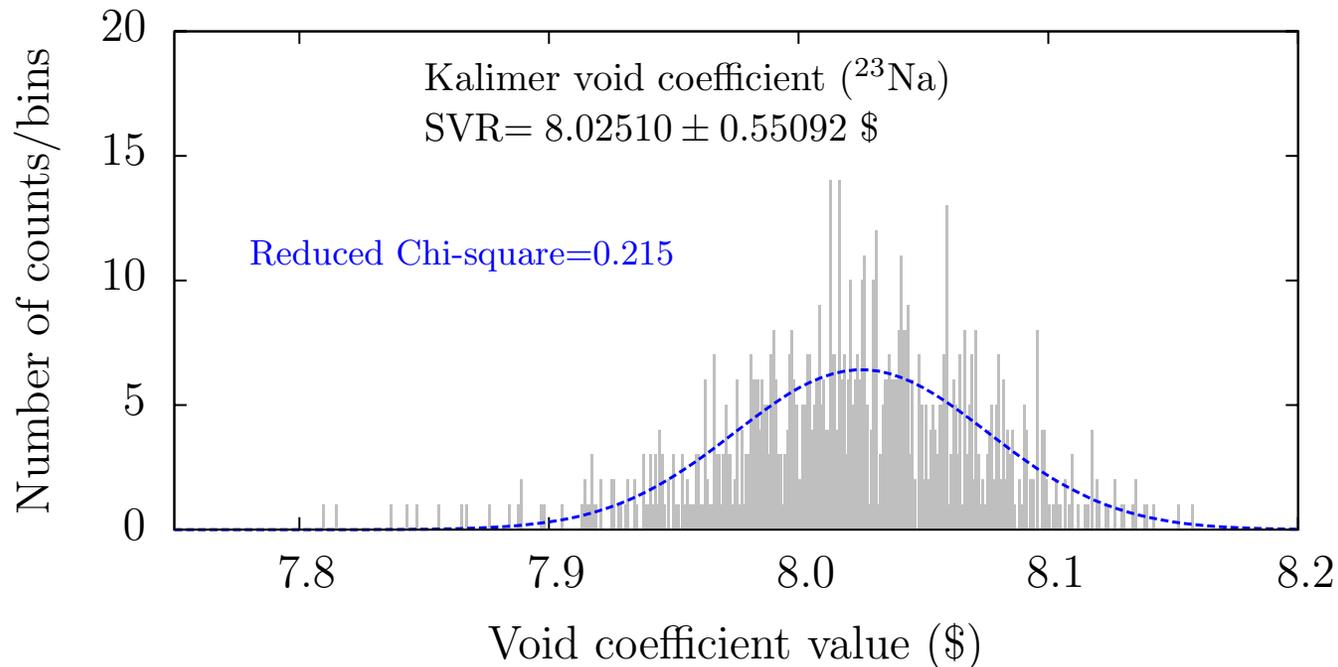


Figure 1: Calculated sodium void coefficient (SVR) for the Kalimer-600 design, varying the  $^{23}\text{Na}$  nuclear data file (*NIM/A 612 (2010) 374.*)

The final SVR is equal to 8.02510 ( $\pm 3\%$  statistical  $\pm 6\%$  nuclear data).