Neutron cross section measurements in the resonance region at GELINA

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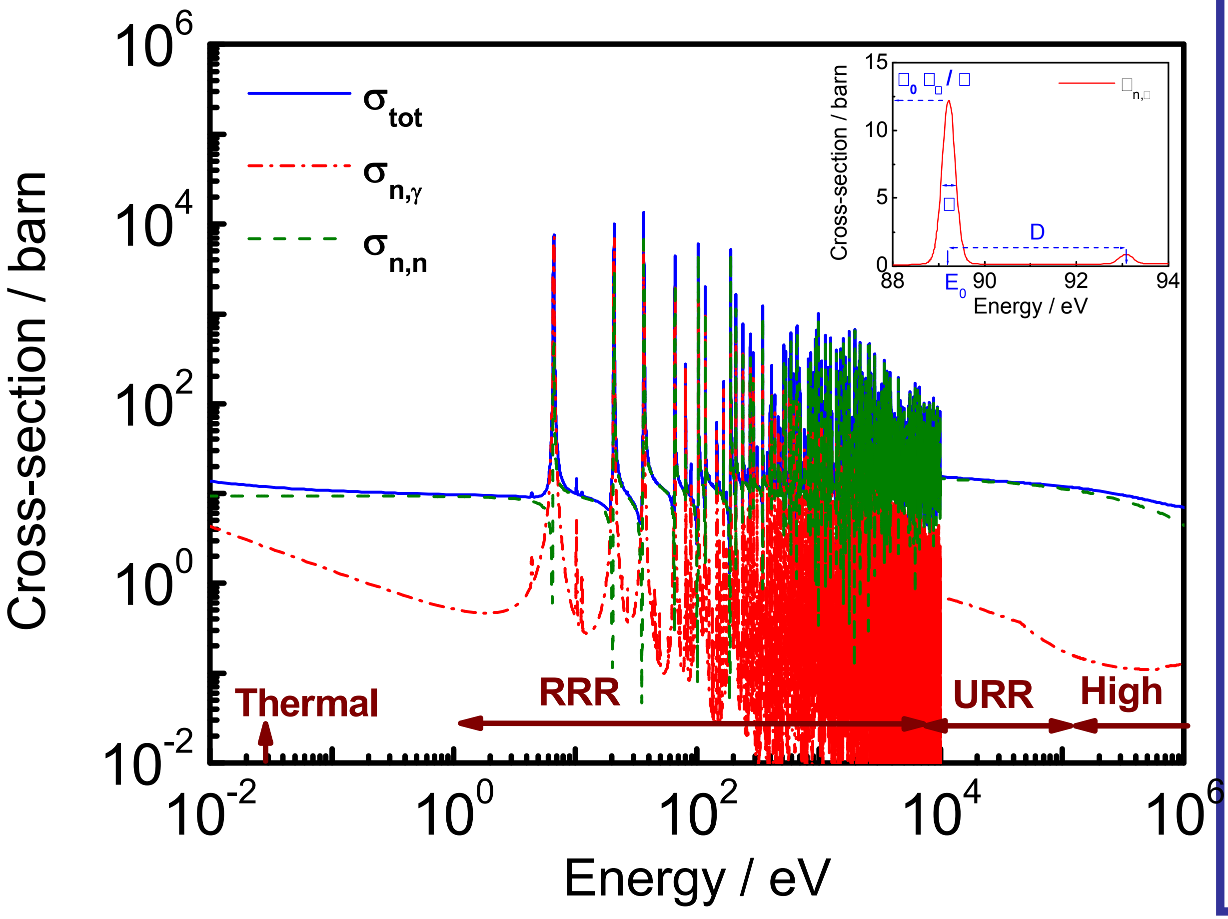
Content

Neutron Induced Reaction



$^{238}U(n,tot) = {}^{238}U(n,n) + {}^{238}U(n,\gamma)$

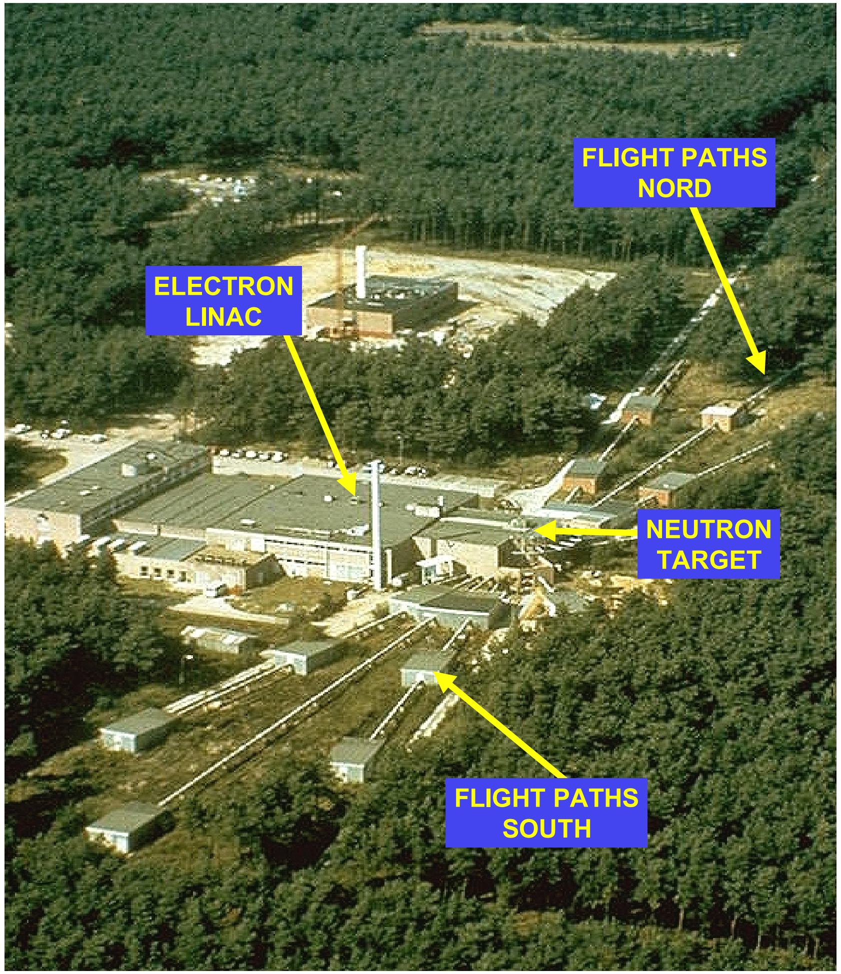
$\sigma_{tot} = \sigma_n + \sigma_\gamma$

- **Thermal**
- **Resonance Region : D > Γ**

  Resolved Resonance Region : $\Delta_R < D$

  Unresolved Resonance Region : $\Delta_R > D$
- **High Energy Region : D < Γ**

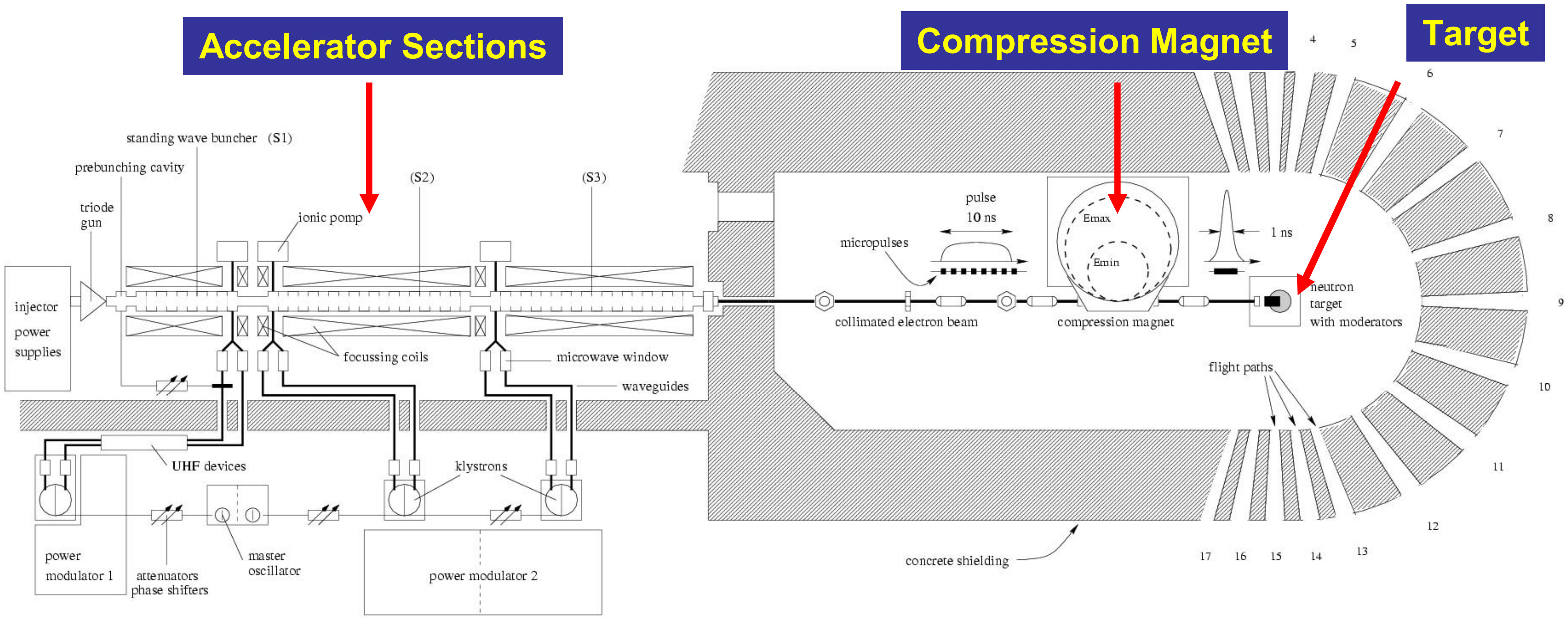
GELINA



- **Time-of-flight facility**
- **Pulsed white neutron source**
  (1 meV < E_n < 20 MeV)
- **Multi-user facility with 10 flight paths (10 m - 400 m)**
- **The measurement stations have special equipment to perform:**
  - Total cross section measurements
  - Partial cross section measurements

Pulse Width	**: 1ns**		
Frequency	**: 50**	**–**	**800 Hz**
Average Current	**: 4.7**	**–**	**75 μA**
Neutron intensity	**: 1.6 10^{12}**	**–**	**2.5 10^{13} n/s**

GELINA

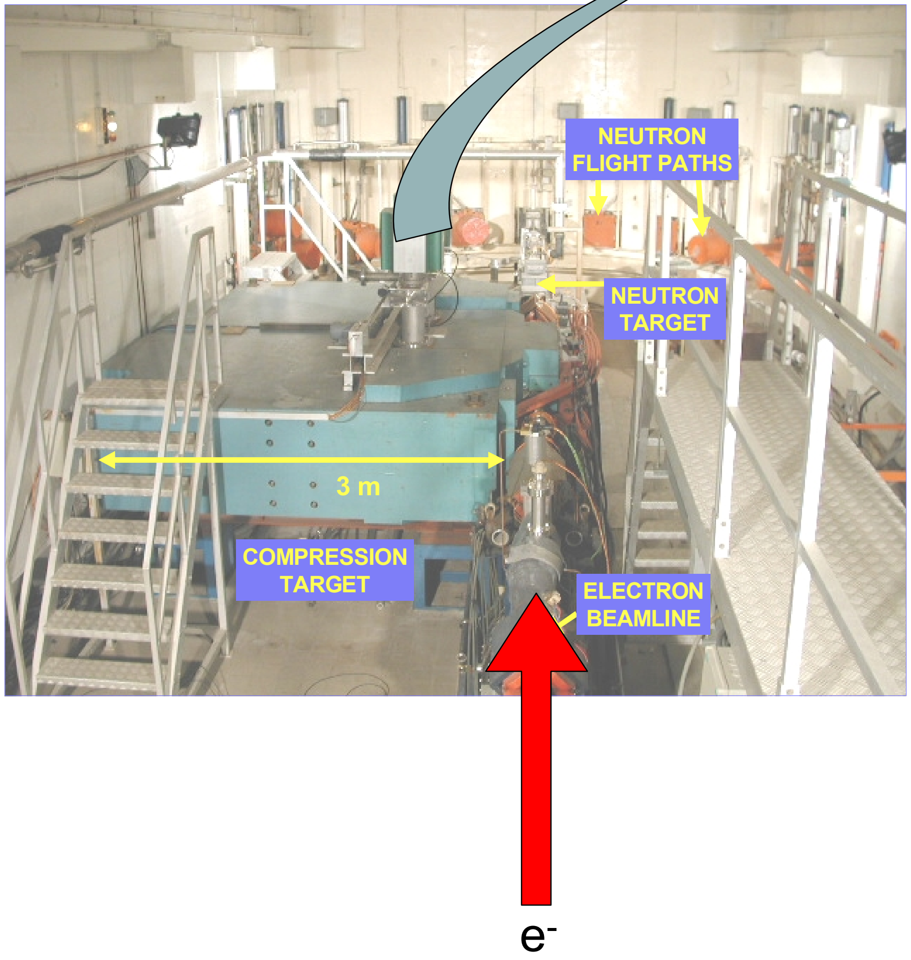


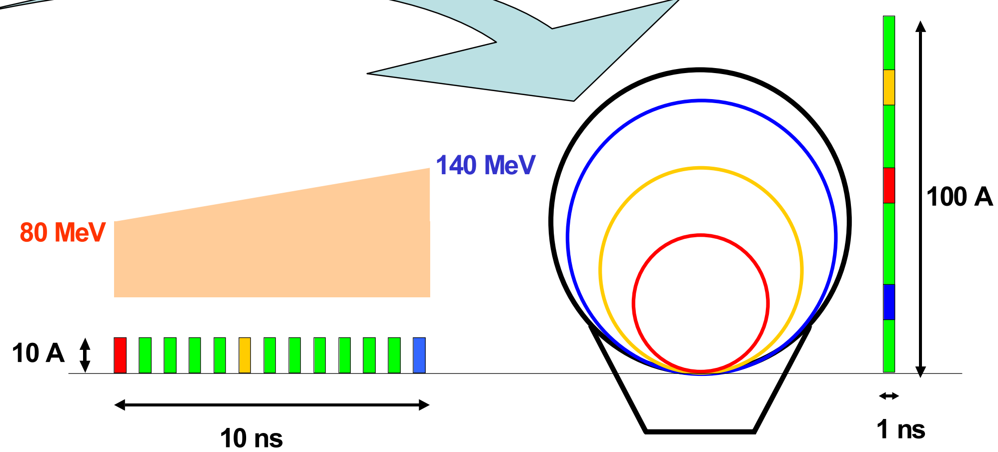
Normal Operation Parameters

Average Current : 75 µA
Average Electron Energy : 100 MeV
Mean Power : 7.5 kW

Frequency : 800 Hz
Pulse Width : 1 ns
Neutron Intensity : 2.5×10^{13} n/s

Compression Magnet





$$B\rho = \frac{p}{q};\ E \cong pc;\ q = e$$

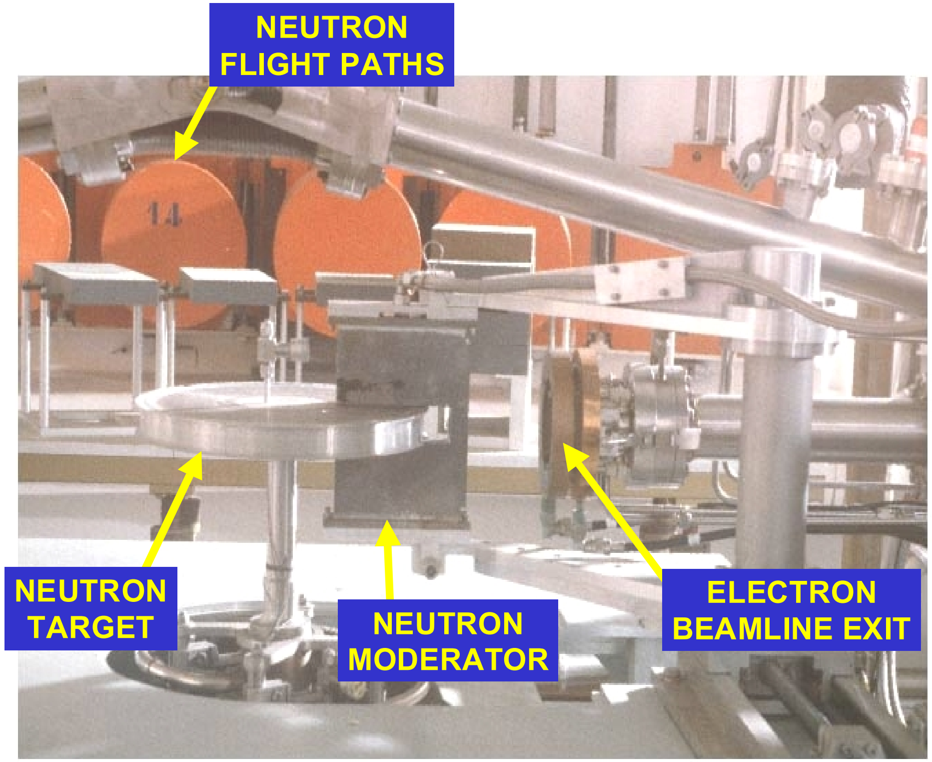
$$\Rightarrow \quad \rho = \frac{1}{B}\frac{E}{qc}$$

$$\Rightarrow \quad B = \frac{2\pi}{qc^2}\frac{\Delta E}{\Delta\tau}$$

ΔE = 60 MeV
$\Delta\tau$ = 10 ns

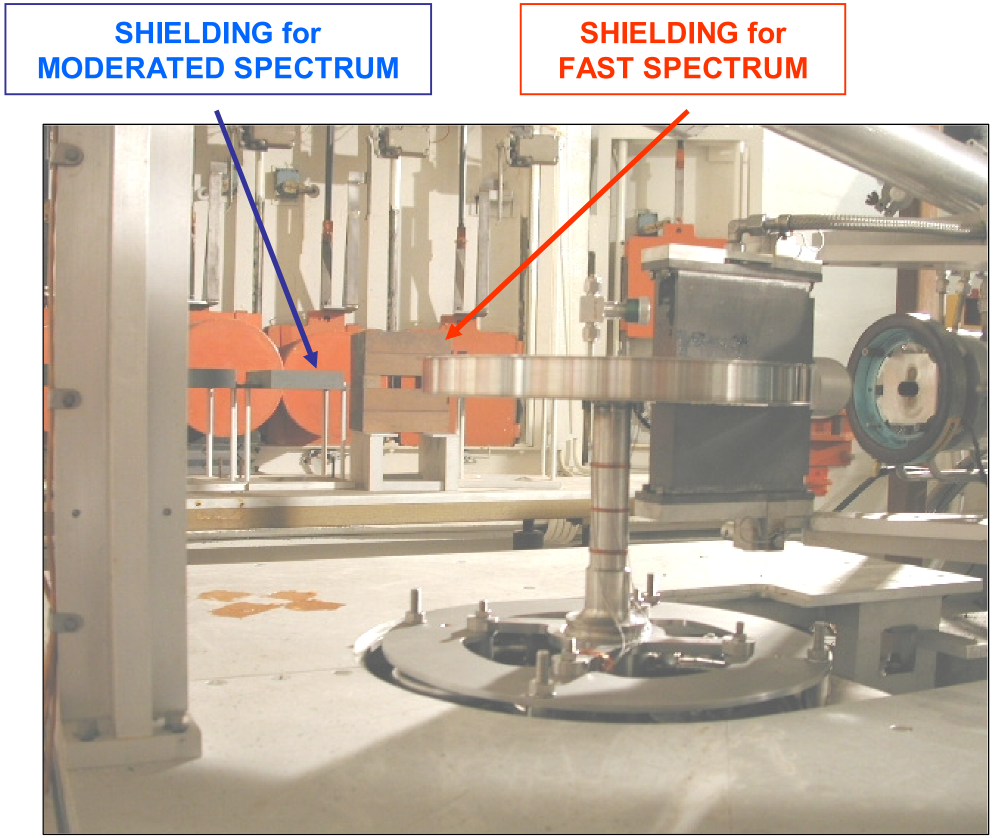
➔ **compressed pulse length ← 1 ns**

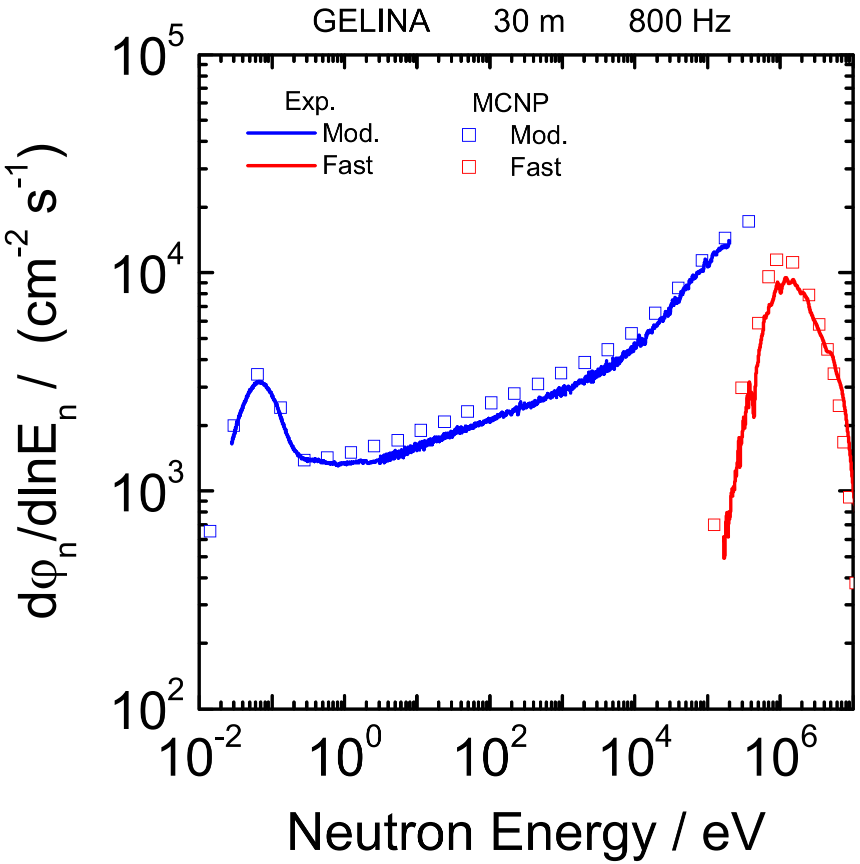
Neutron Production



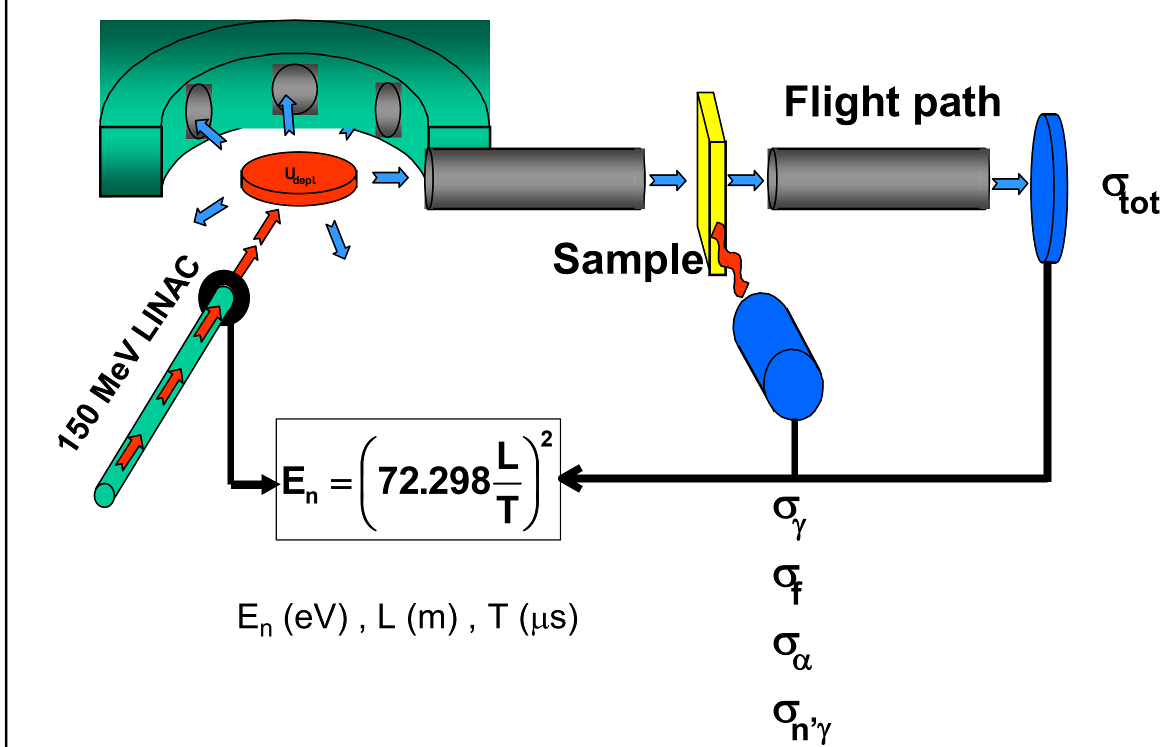
- **e^- accelerated to $E_{e-,max}$ ≈ 140 MeV**
- **(e^-, γ) Bremsstrahlung in U-target (rotating & cooled with liquied Hg)**
- **(γ , n) , (γ , f) in U-target**
- **Low energy neutrons by water moderator in Be-canning**

Neutron Production





GELINA TOF-Measurements
Total and Partial Cross-Section



$$E_n = \left(72.298 \frac{L}{T}\right)^2$$

E_n (eV) , L (m) , T (μs)

- **Neutron Flux** ⇒ L ↘

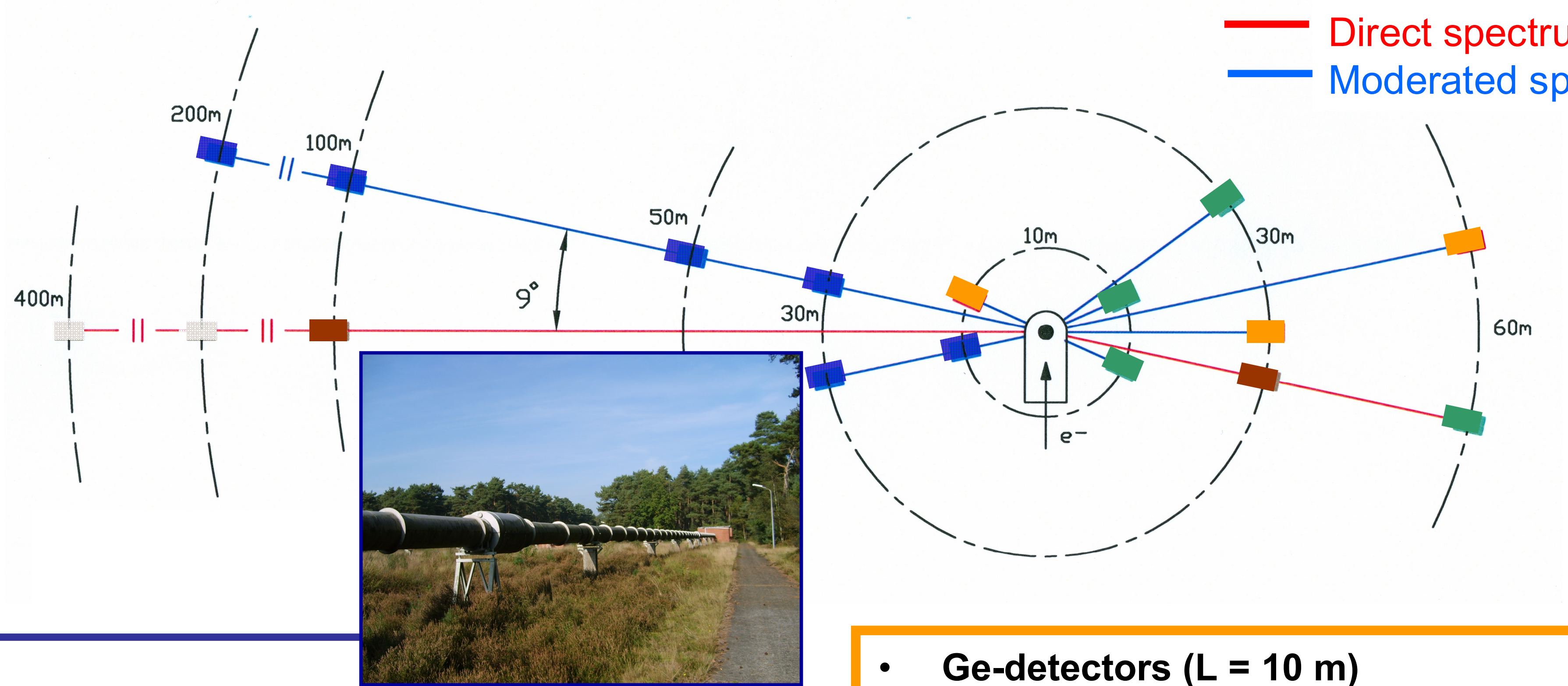
$$\varphi_n(L) \propto \frac{1}{L^2}$$

- **Resolution** ⇒ L ↗

$$\frac{\Delta E_n}{E_n} = \frac{1}{L}\sqrt{\frac{E_n \Delta T^2}{\alpha} + \Delta L^2}$$

Optimization of flight path length in view of <u>neutron flux</u> and <u>resolution</u> !

Measurement Stations



orange	(n,γ)	NIM A, 577, 626 (2007)
	(n,tot)	NP A 773, 173 (2006)
green	(n,f) and (n,cp)	NSE 156, 211 (2007)
brown	(n,n'γ)	NP A 786, 1 (2007)

- Ge-detectors (L = 10 m)
- C_6D_6 detectors (L = 10, 30 and 60 m)

- ^{6}Li glass -detectors (L = 25 and 50m)

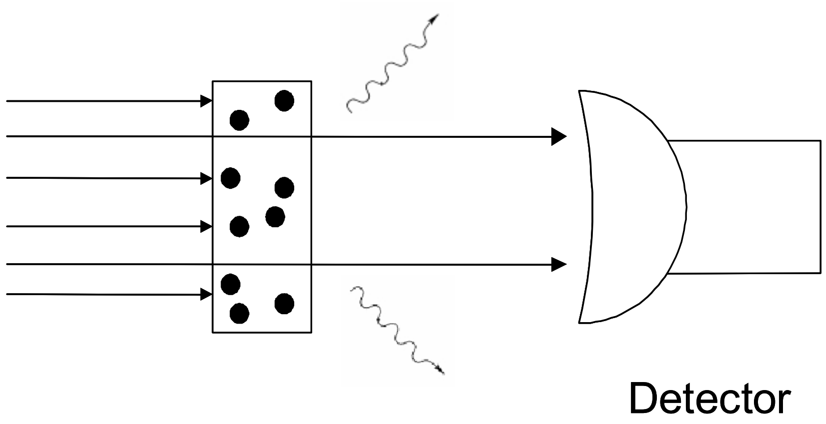
Basic principles of cross section measurements

Transmission : σ_{tot}

$$T = \frac{C_{in}}{C_{out}} \cong e^{-n\sigma_{tot}}$$

C_{in} = sample in

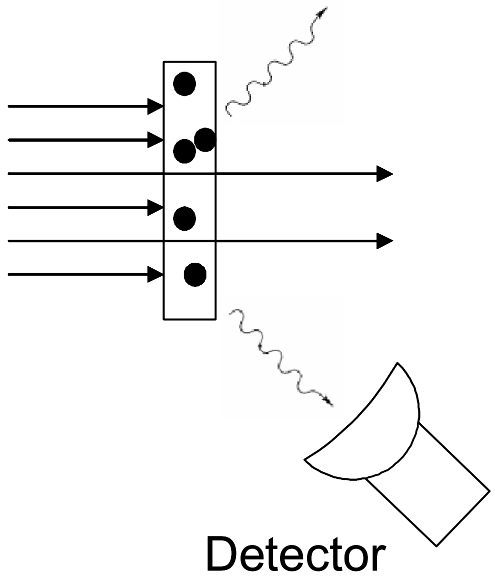
C_{out} = sample out



Partial cross section: $\sigma_{(n,\gamma)}$, $\sigma_{(n,f)}$, $\sigma_{(n,n')}$

$$C_r \propto \varepsilon_r \, n \, \sigma_r \, \varphi$$

(thin sample)



Basic Principles

Transmission

$$T = \frac{C_{in}}{C_{out}} \cong e^{-n\sigma_{tot}}$$

- Incoming flux cancels
- Detection efficiency cancels
- Good geometry

$\Rightarrow$ Direct relation between T and σ_{tot}

Partial

$$C_r = \varepsilon_r Y_r A_r \varphi_r$$

- φ_r Neutron Fluence Rate
- ε_r Detection Efficiency
- A_r Effective area
- Y_r Reaction Yield

  (Beam Fraction Undergoing the partial Reaction)

$\Rightarrow$ Complex relation between C_r and Y_r
Y_r related to σ_r and σ_{tot}

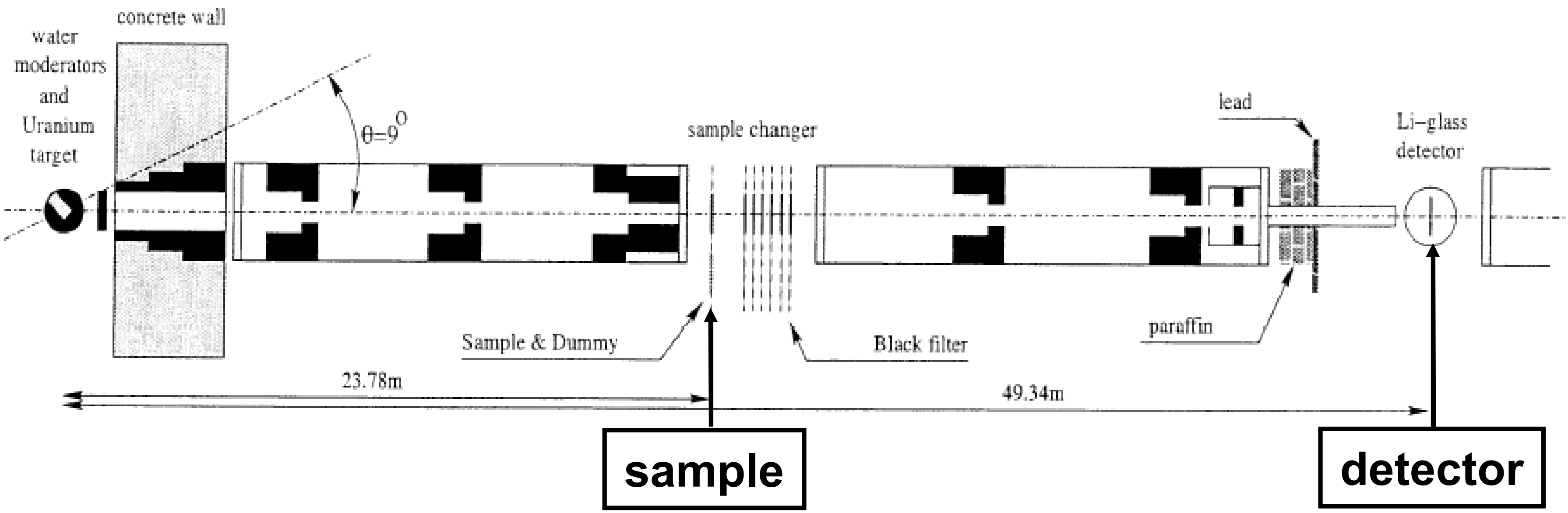
Transmission measurements

$$T \cong e^{-n\sigma_t}$$

Good Geometry

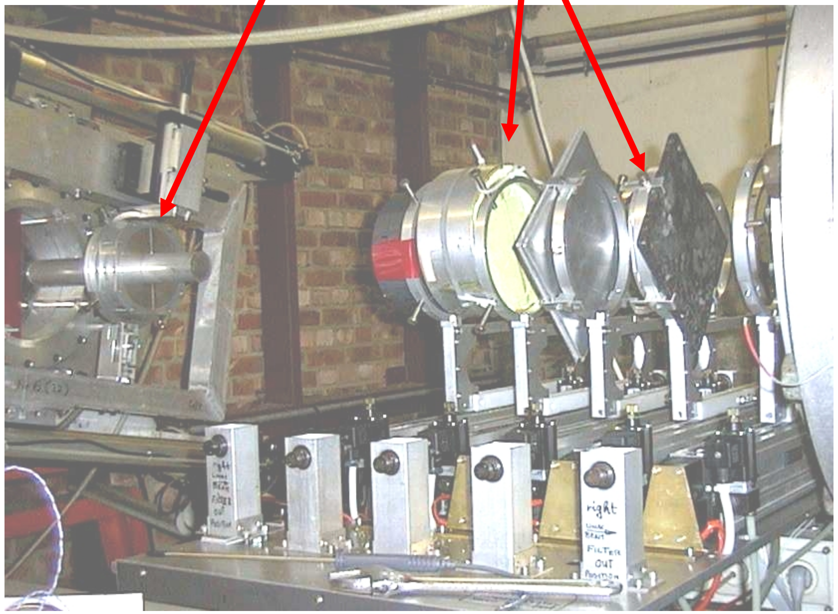
- All detected neutrons have traversed the sample
- Neutrons scattered in the target do not reach the detector

Importance of collimation

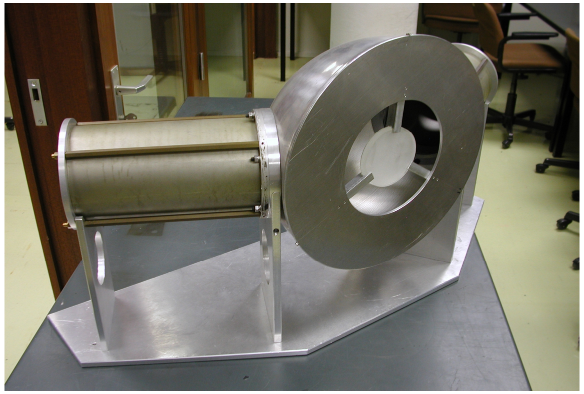


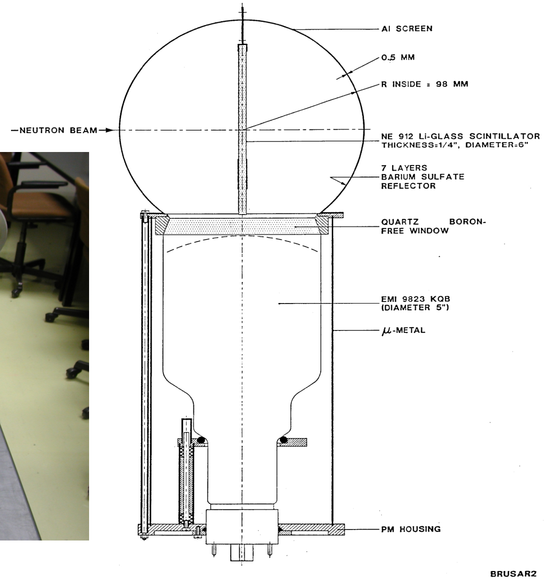
Transmission Measurements

Sample & Background Filters



Detector





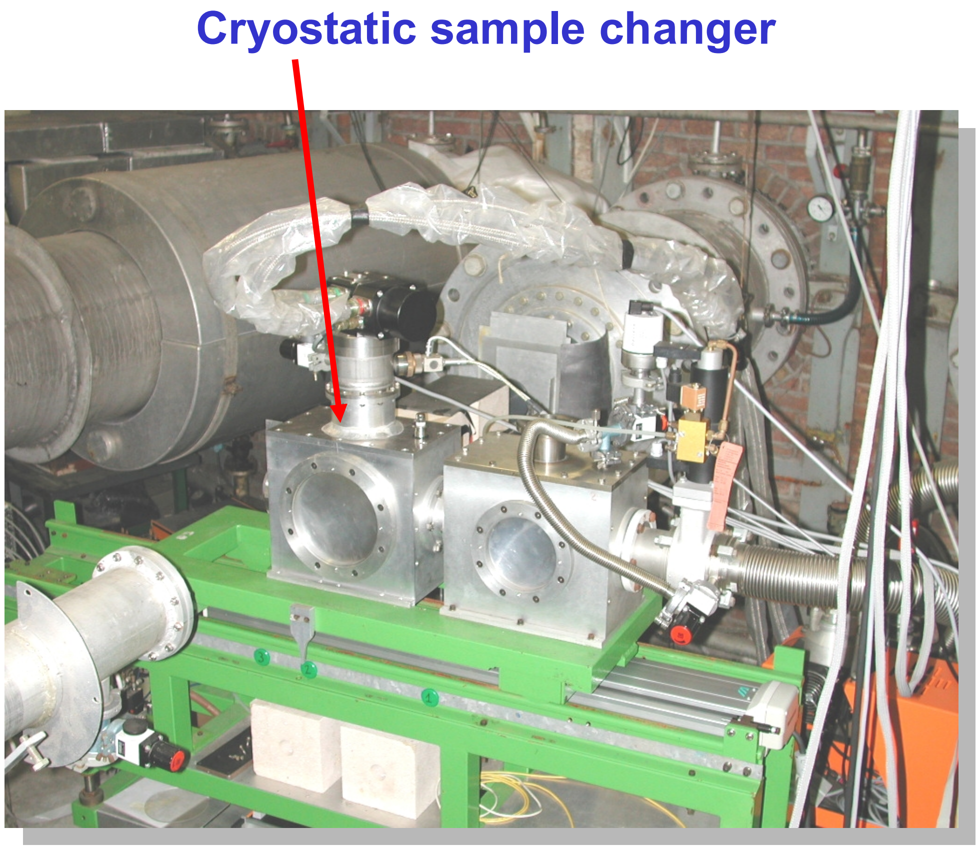
Detector stations
Moderated : L = 30 m, 50 m, (100 m, 200 m)
Fast : L = 400 m

Low energy : $^{6}Li(n,t)\alpha$ Li-glass

High energy : H(n,n)H Plastic scintillator

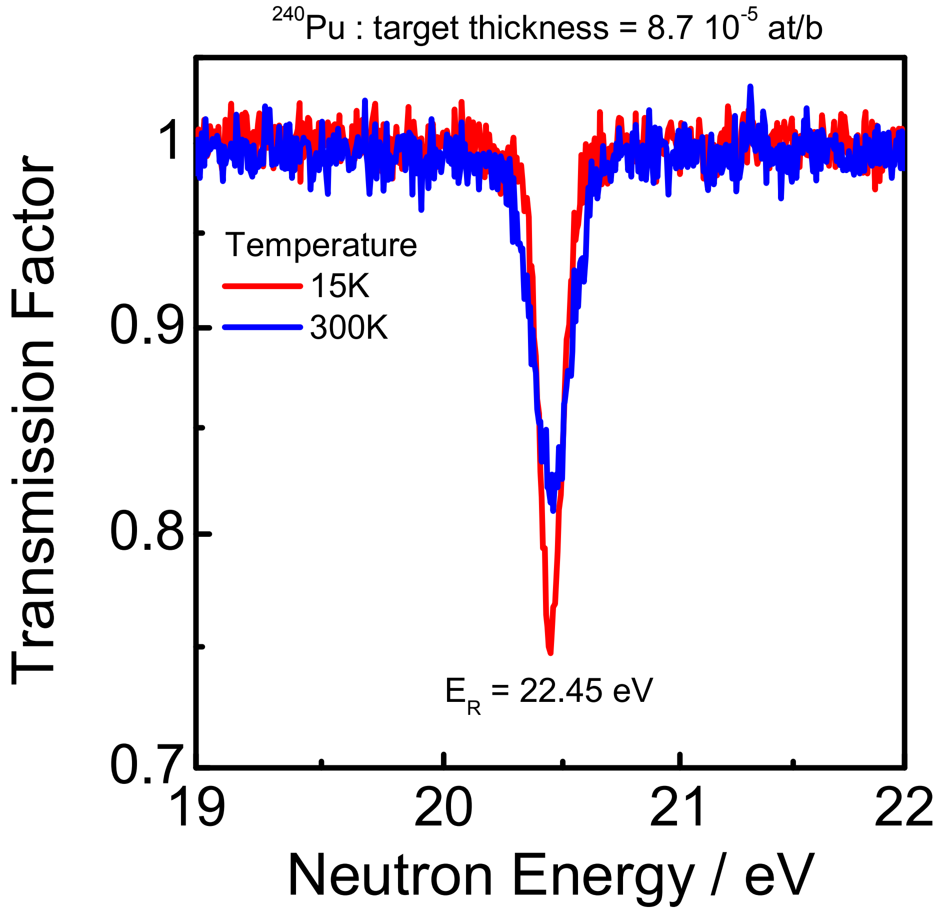
Kopecky and Brusegan, NP A 773, 173 (2006)
Borella et al., PR C 76, 014605 (2007)

Doppler Measurements

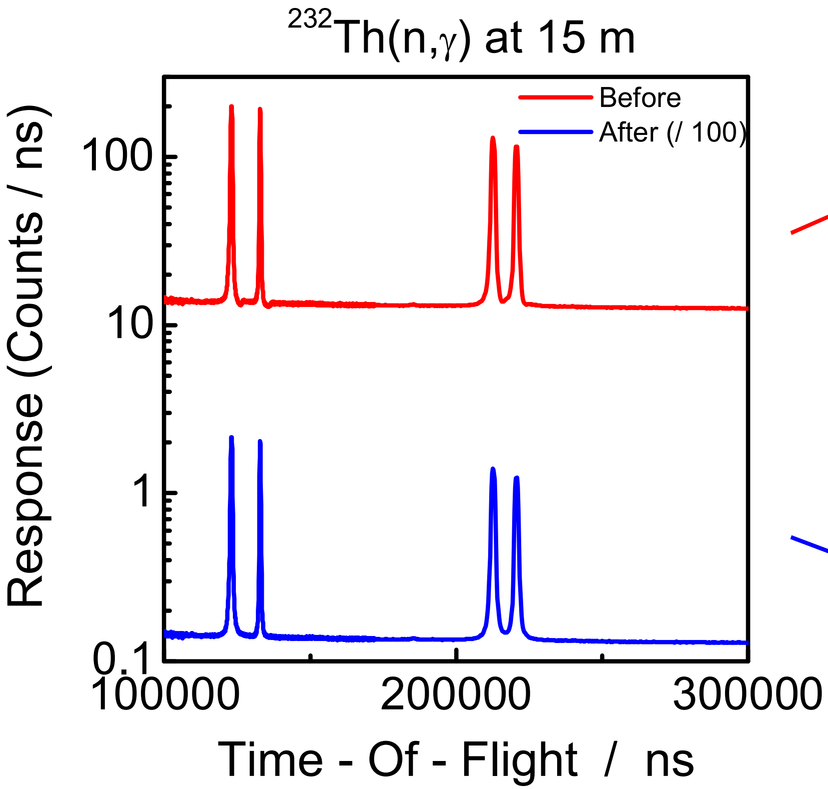


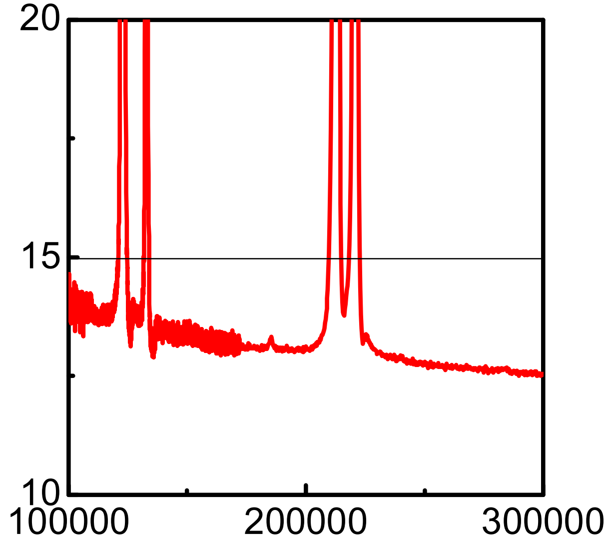
Detector station at : L = 30m

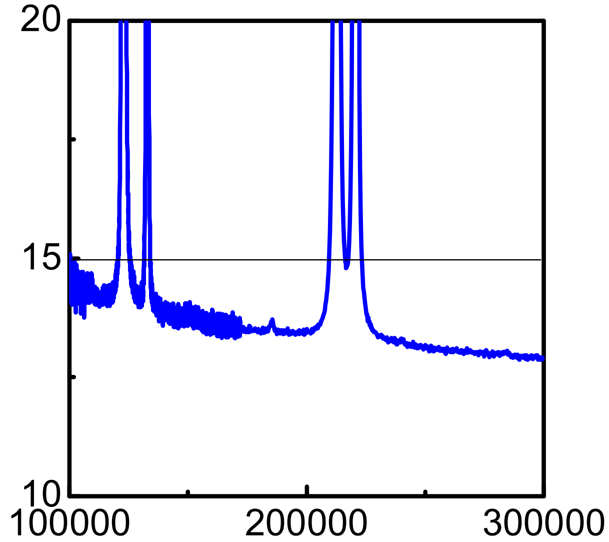
Temperatures from 10 K - 300 K



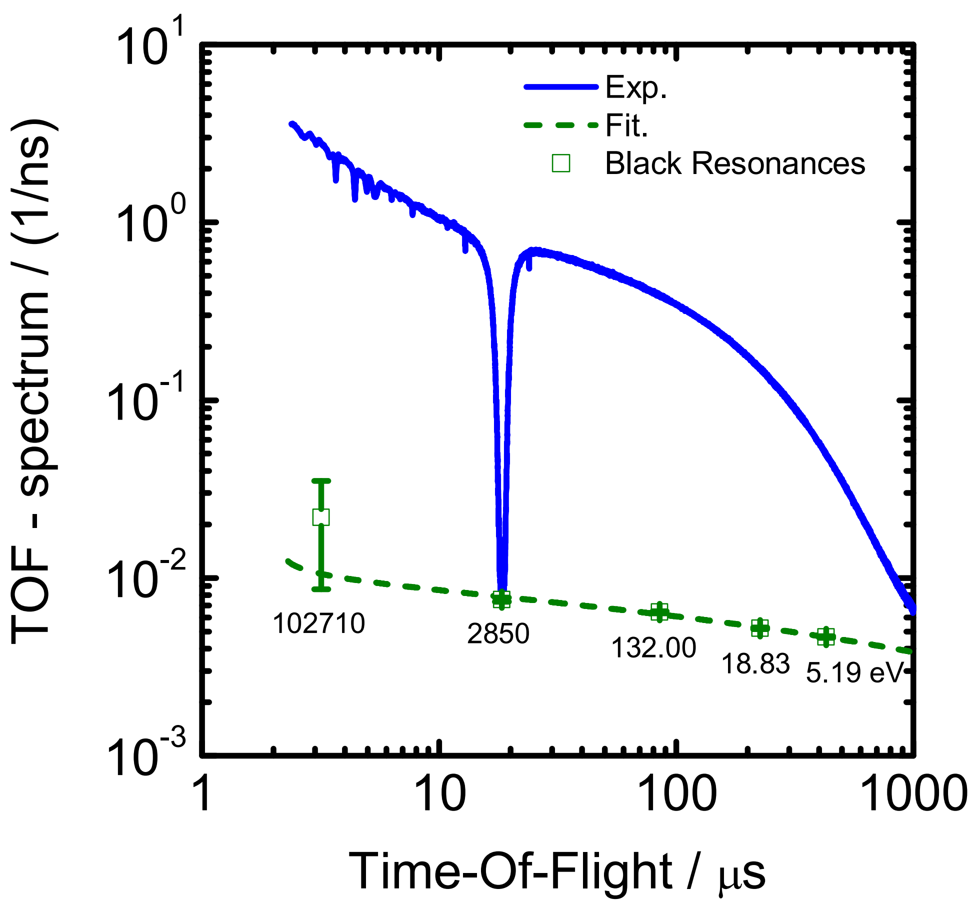
Dead time correction







Background correction

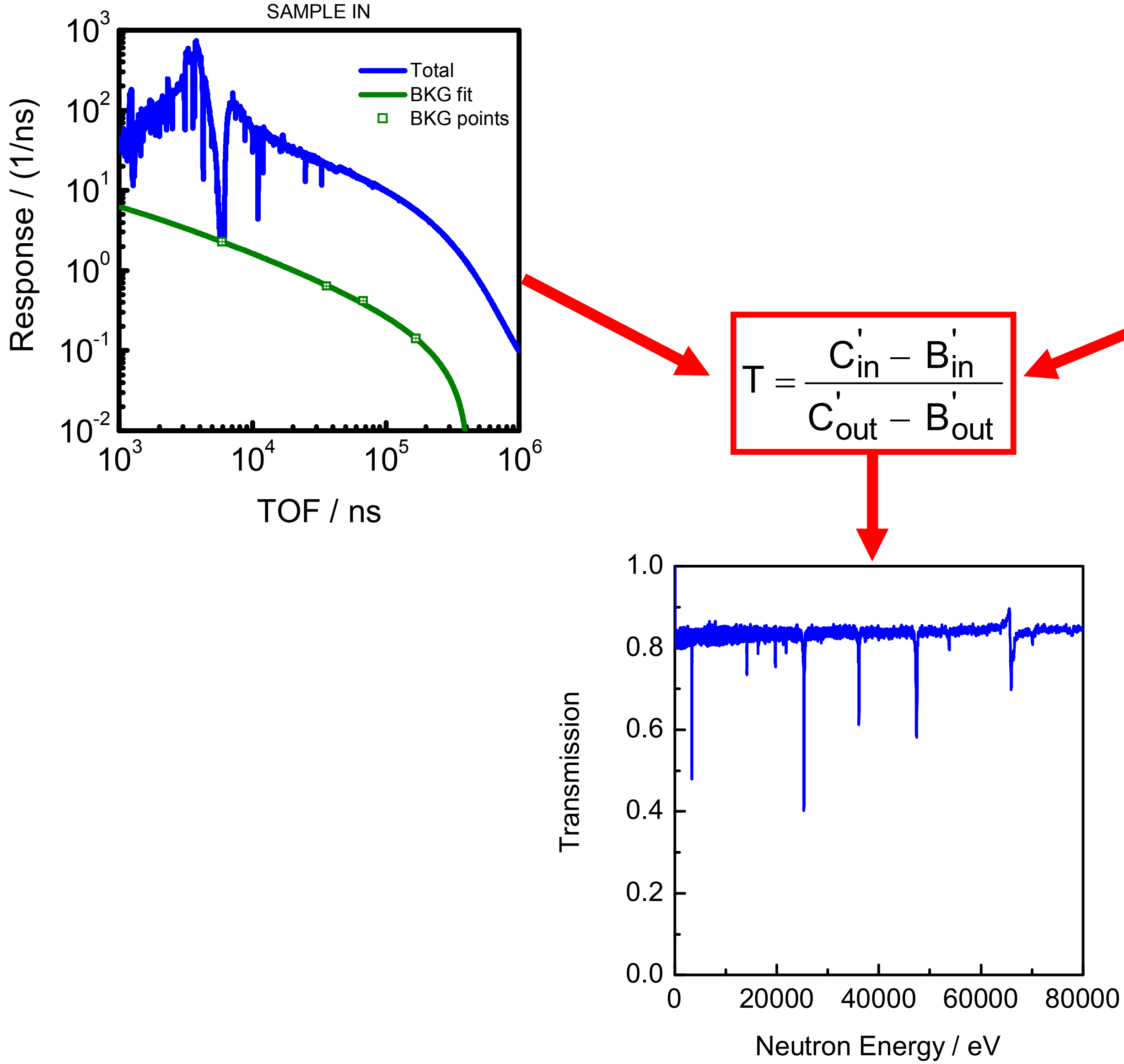


Black Resonance Filters

Element	Energy / eV
Ag	5.19
W	18.83
Co	132.00
Na	2850.00
S	102710.00

A constant and low background during the whole measurement campaign is mandatory !

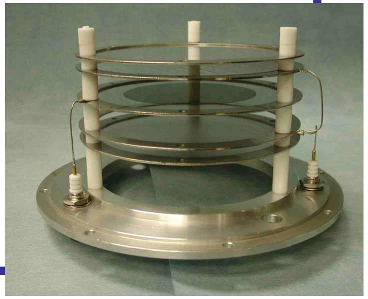
Transmission

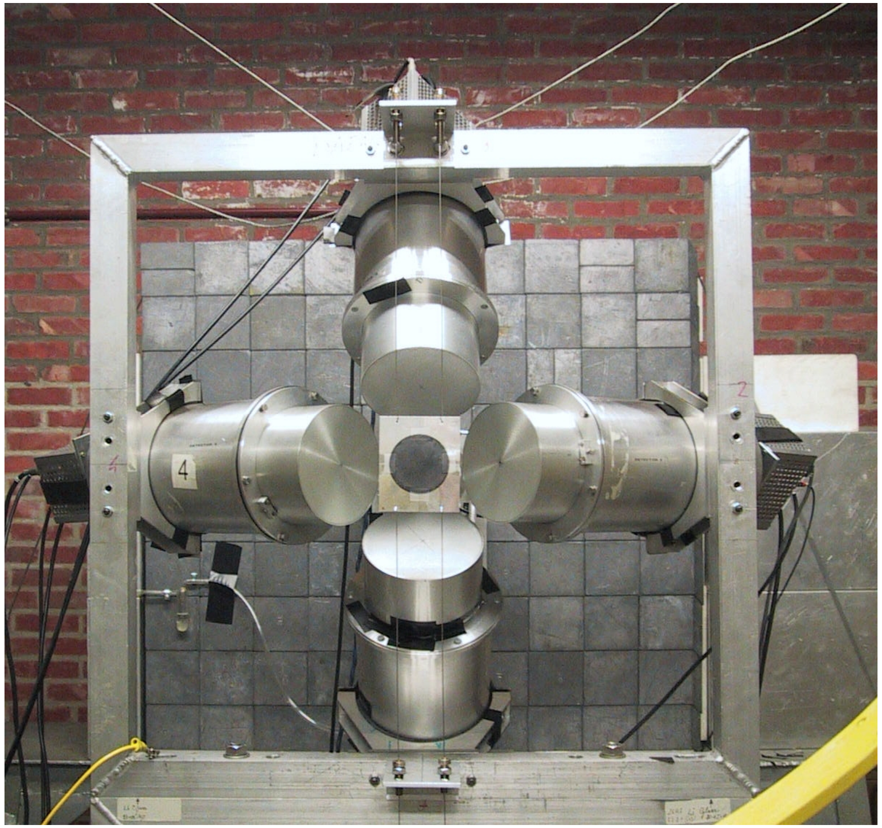


Capture cross section measurements

Total energy detection

- **C_6D_6 liquid scintillators**
  - 125^o
  - PHWT $\int R(E_d,E_\gamma)\,WF(E_d)\,dE_d = kE_\gamma$
- **Flux measurements (IC)**
  - $^{10}B(n,\alpha)$
  - $^{235}U(n,f)$



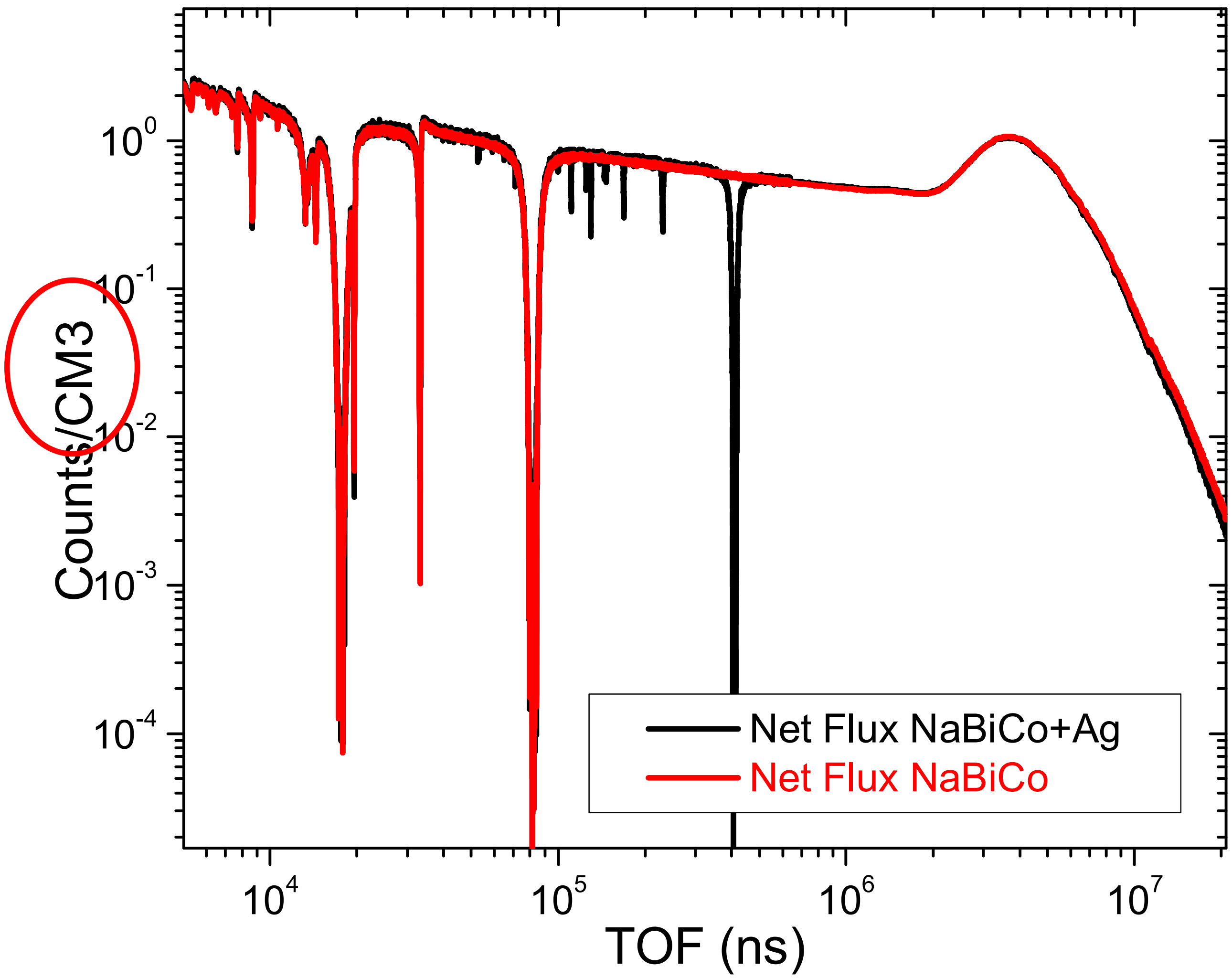


$$Y_{n,\gamma} = \sigma_\varphi \frac{C_w - B_w}{C_\varphi - B_\varphi}$$

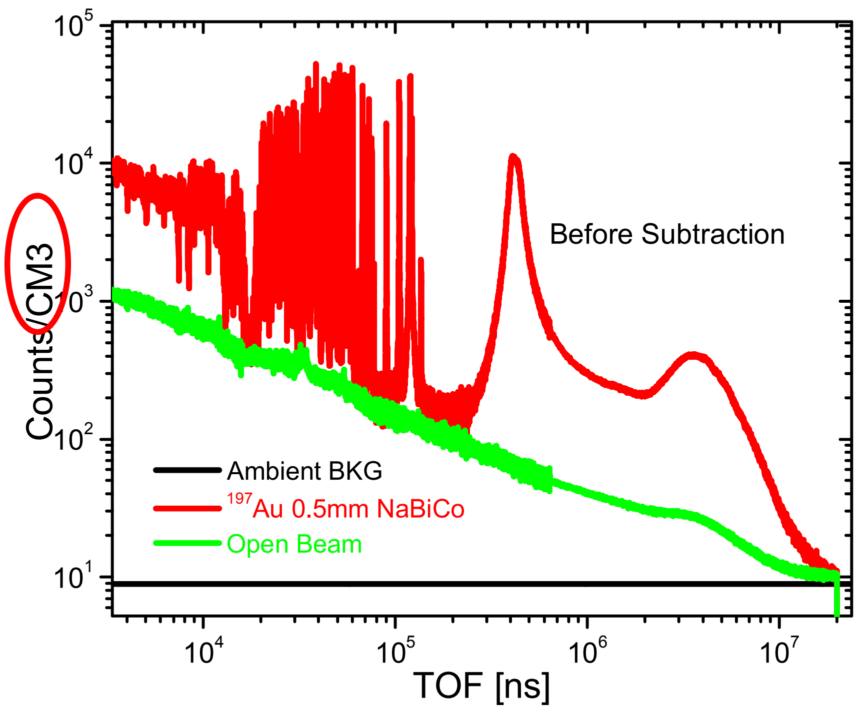
L = 10 m, 30 m and 60 m

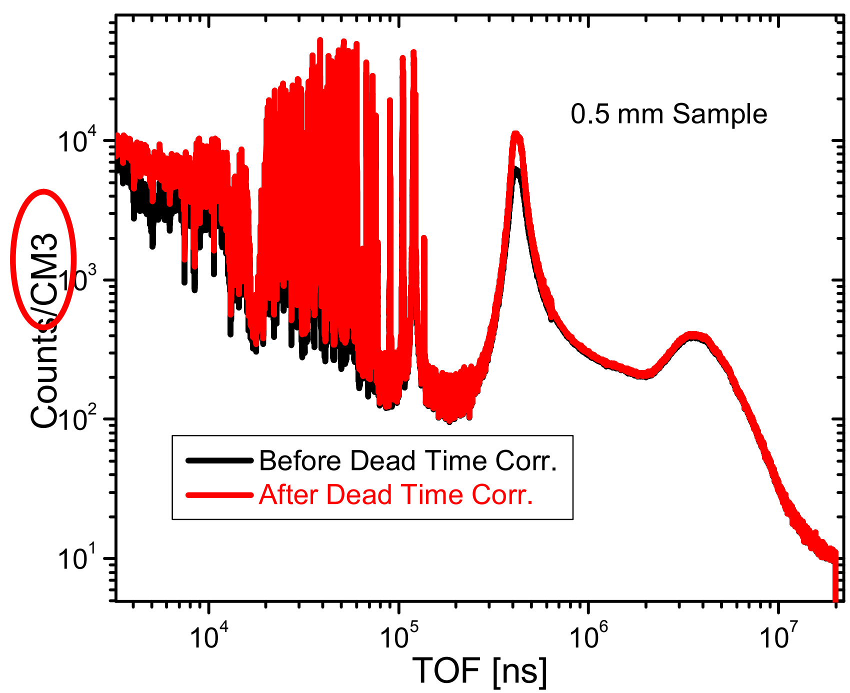
Borella et al., NIM A, 577, 626 (2007)
Borella et al., PR C 76, 014605 (2007)

Neutron flux



Capture raw data



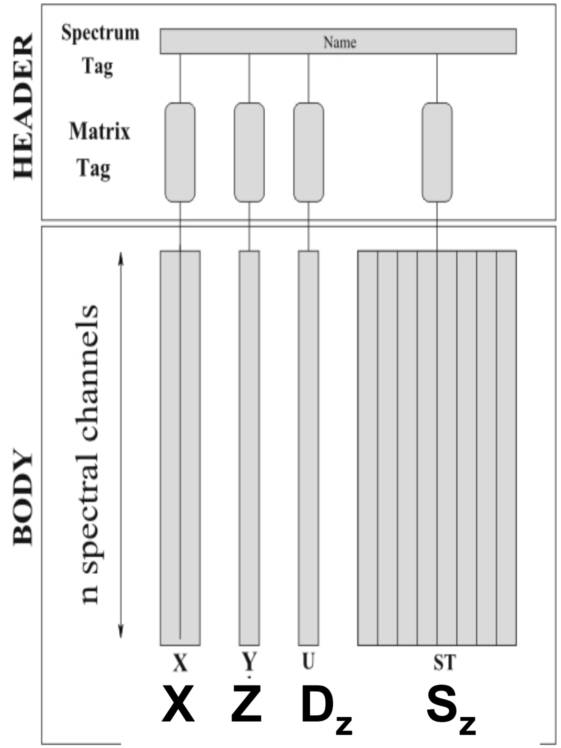


Analysis of Generic tof Spectra (AGS)

- Transform count rate spectra into observables (transmission factors, partial reaction yields)
- Full propagation of uncertainties starting from counting statistics
- Output: complete covariance matrix
- Due to the special format used in AGS:
  - **We reduce space for data storage (EXFOR)**
  - **We can verify and document the various sources of uncertainties in each step of the reduction process**

Observable Z (dimension n) with
k sources of correlated uncertainties

$$C_Z = D_Z + S_Z\,S_Z^{\,T}$$



D_Z : uncorrelated part
n values

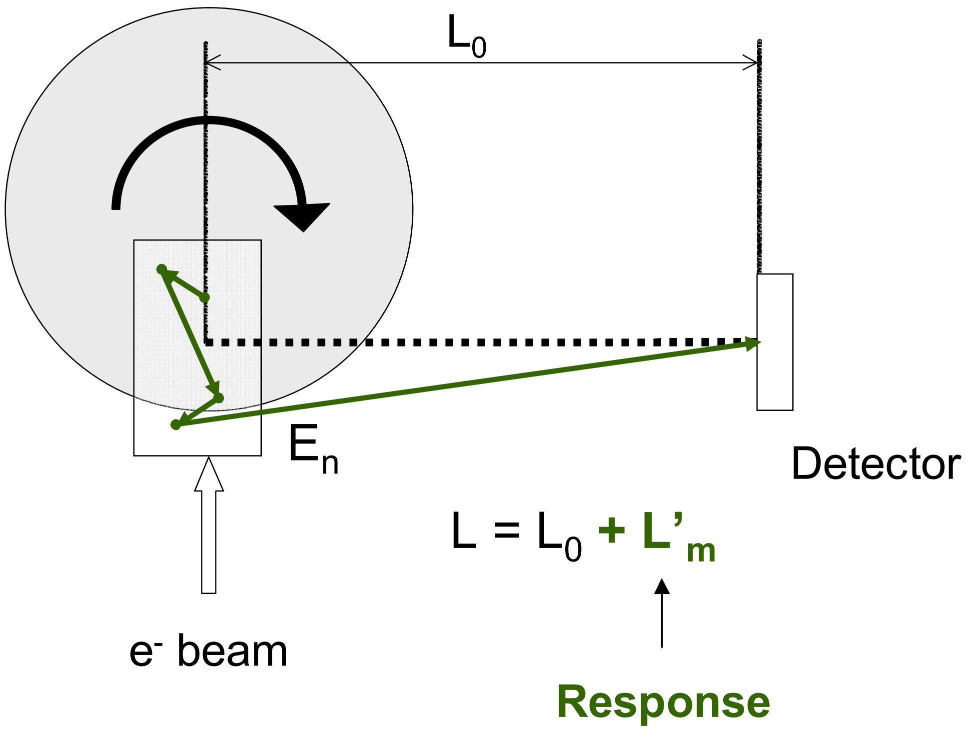
S_Z : correlated part
dim. (n x k)

Bastian et al., PHYSOR 2006

Characterisation of GELINA TOF-Facility Collaboration Univ. Delft

$$R_n = \frac{\Delta E_n}{E_n} = 2\sqrt{\frac{\Delta T^2}{T^2} + \frac{\Delta L^2}{L^2}}$$

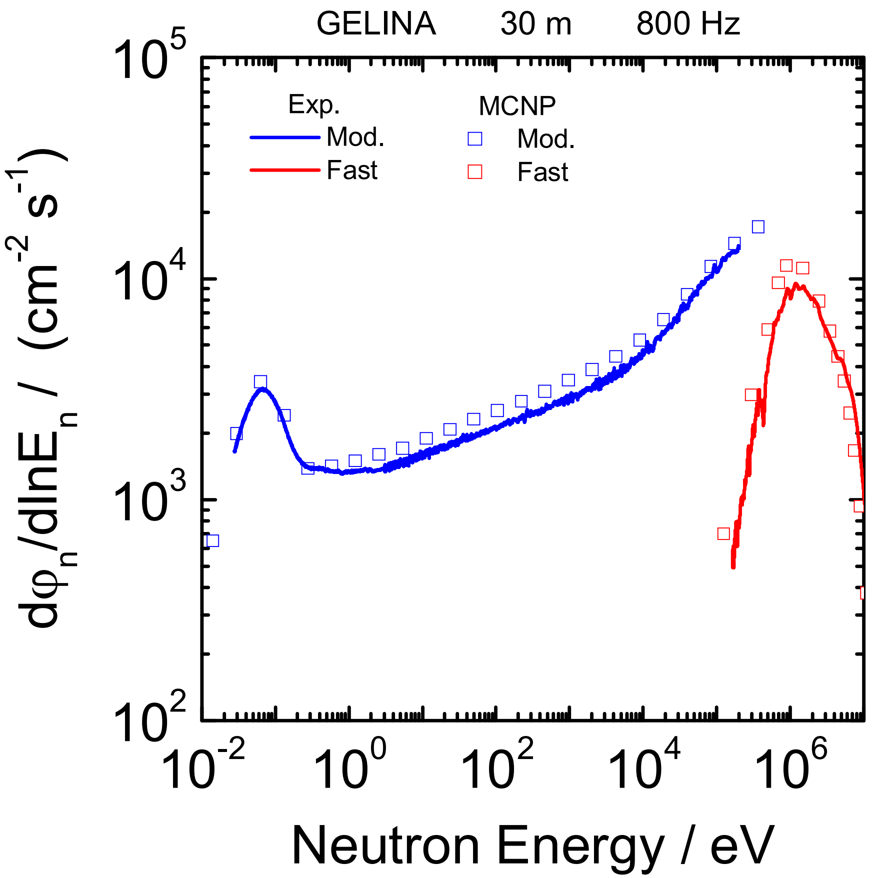
- ΔT
  - Initial burst width (~ 1 ns)
  - Time jitter of detector (~ 1 – 40 ns)
  - Electronics (~ 0.5 ns)
- ΔL
  - **Neutron transport in Moderator and U-target**
  - Neutron transport in the detector or sample

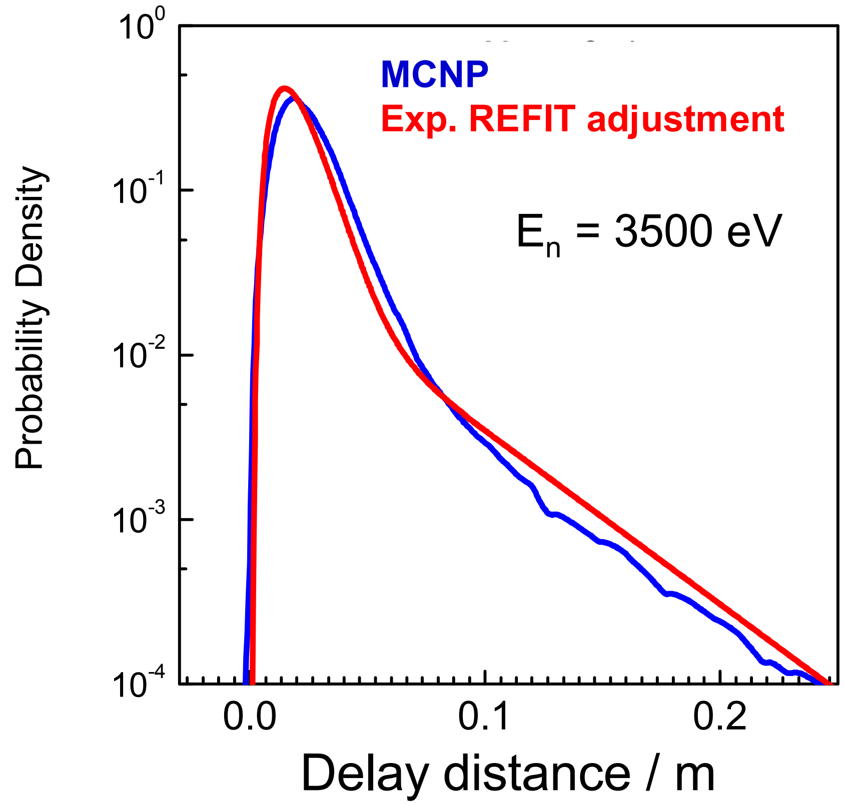


Flaska et al., NIM A 531, 394 (2004)
Flaska et al., NIM A 555, 329 (2005)

Neutron Flux

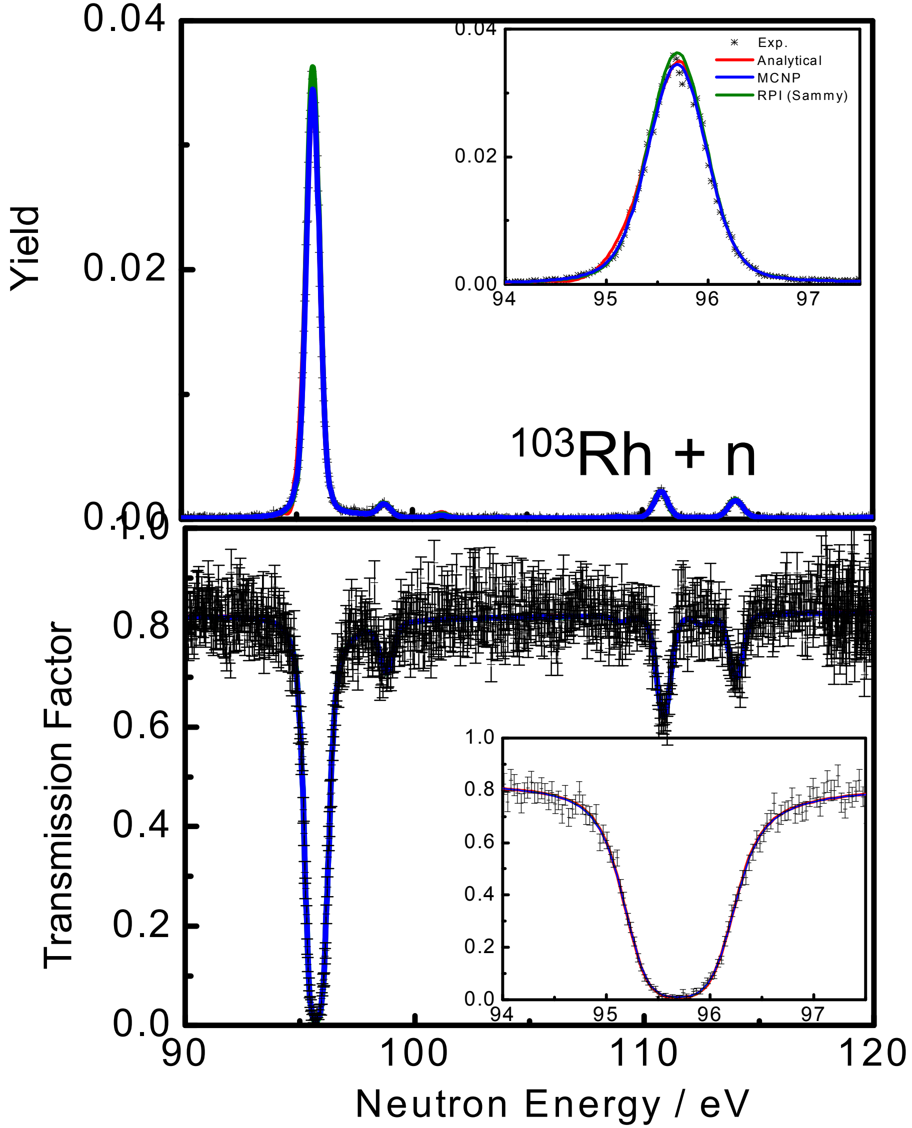
Resolution Function





Flaska et al.,NIM A , 531, 394 (2004)

Impact of the resolution function



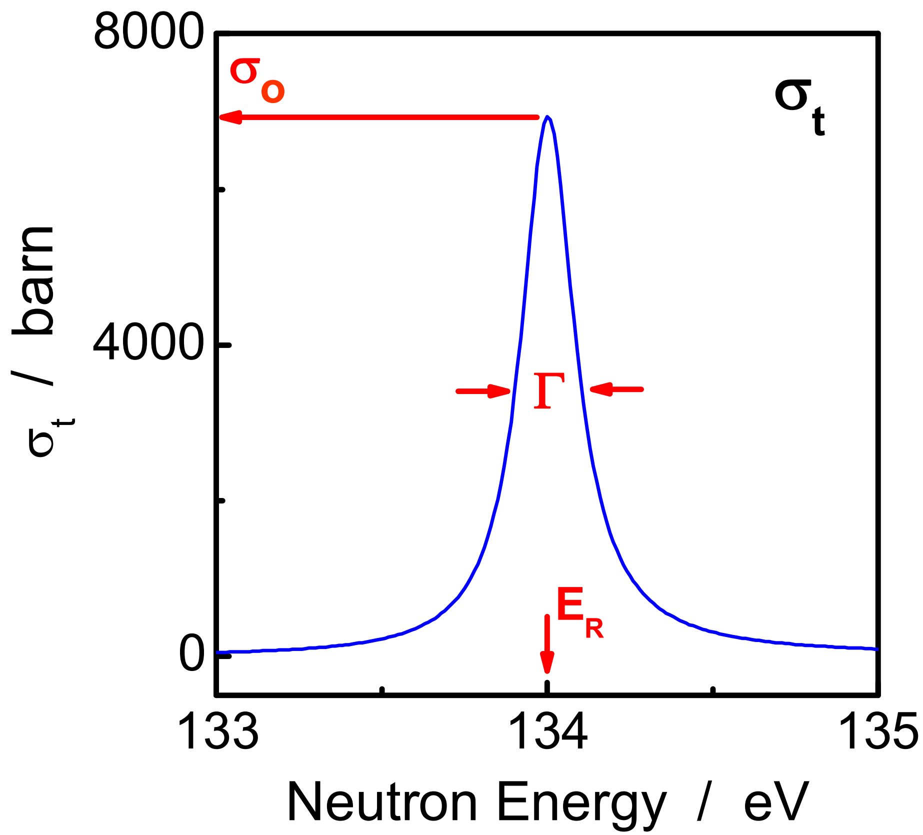
Resolution Function (RF)	E_0 = 95.7 eV Γ_n / meV
Capture	
Analytical (REFIT)	2.47 (5)
MCNP	2.42 (5)
RPI (fit MCNP RF)	2.50 (5)
Transmission	
Analytical (REFIT)	2.40 (5)
MCNP	2.42 (5)
RPI (fit MCNP RF)	2.40 (5)

⇒ RF has an impact on RP deduced from RSA

⇒ Transmission less sensitive to RF than capture

Kopecky et al., WONDER 2006

Resonance structure



A cross section as a function of E_n shows a resonant structure, which can be described by a Breit-Wigner shape :

$$\sigma_t \sim \frac{1}{(E_n - E_R)^2 + (\Gamma/2)^2}$$

with

Γ **natural line width (FWHM)**

E_R **resonance energy**

Breit – Wigner formula
Resonance part of the cross section

- **Total Cross Section (n,tot)**

$$\sigma_t(E_n) = g_J \frac{\pi}{k_n^2} \frac{\Gamma_n \Gamma}{(E_n - E_R)^2 + (\Gamma/2)^2} \qquad g_J = \frac{2J+1}{2(2I+1)};\ k_n = \text{wavenumber}$$

- **Elastic Cross Section (n,n)**

$$\sigma_n(E_n) = \sigma_t(E_n)\frac{\Gamma_n}{\Gamma}$$

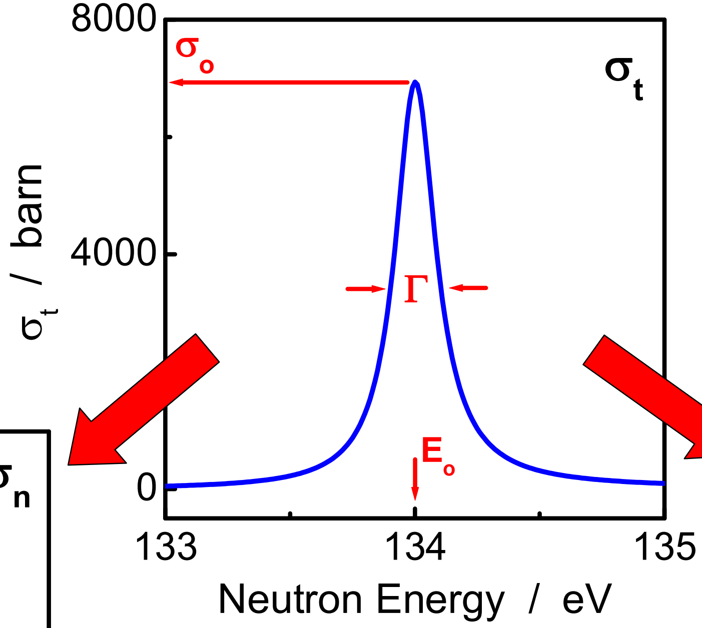
- **Capture Cross Section (n,γ)**

$$\sigma_\gamma(E_n) = \sigma_t(E_n)\frac{\Gamma_\gamma}{\Gamma}$$

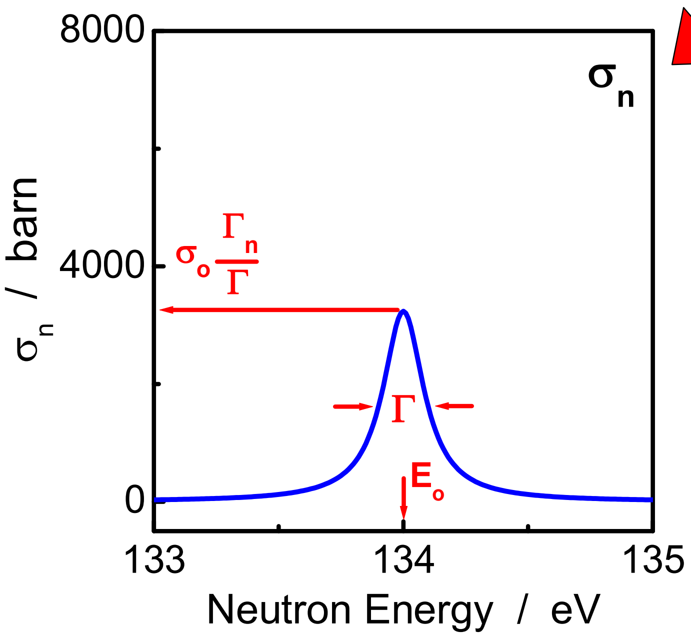
e.g. ^{109}Ag s-wave at E_o = 134 eV

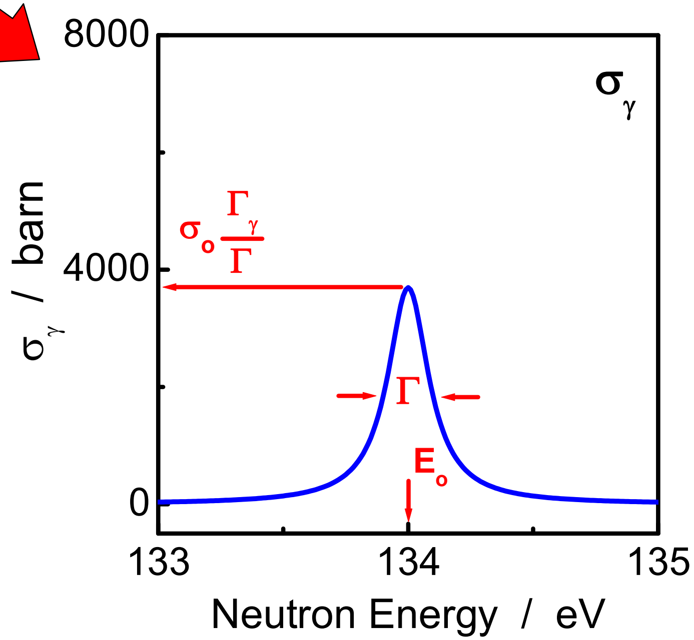
(E_R, Γ_n, Γ_γ , $J^{(\pi)}$, l)

$$\sigma_o = \frac{4\pi}{k_R^2} g_J \frac{\Gamma_n}{\Gamma}$$



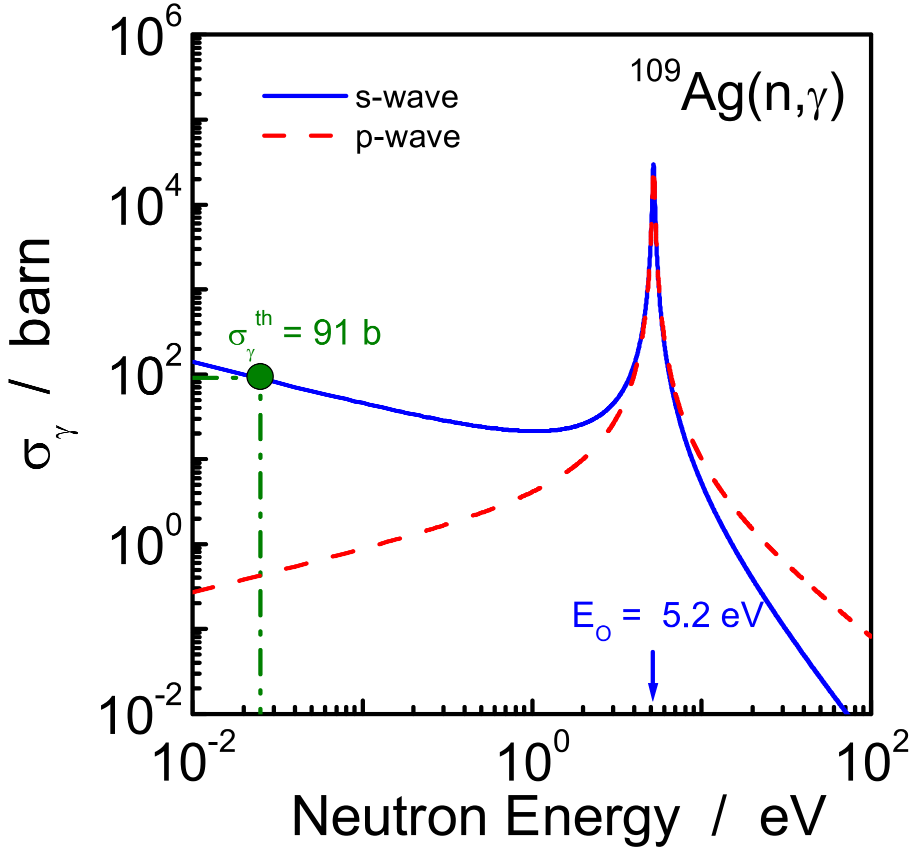
E_R = 134 eV
Γ_n = 0.093 eV
Γ_γ = 0.106 eV
J^π = 1^-
ℓ = 0
g_J = 3/4





Neutron width
s-wave <---> p-wave (l > 0)

$$\sigma_\gamma(E_n) = g_J \frac{\pi}{k_n^2} \frac{\Gamma_n \Gamma_\gamma}{(E_n - E_R)^2 + (\Gamma/2)^2}$$



Γ_n depends on E_n : due to the centrifugal-barrier penetrability, which depends on the angular momentum of the incoming neutron ℓ and E_n

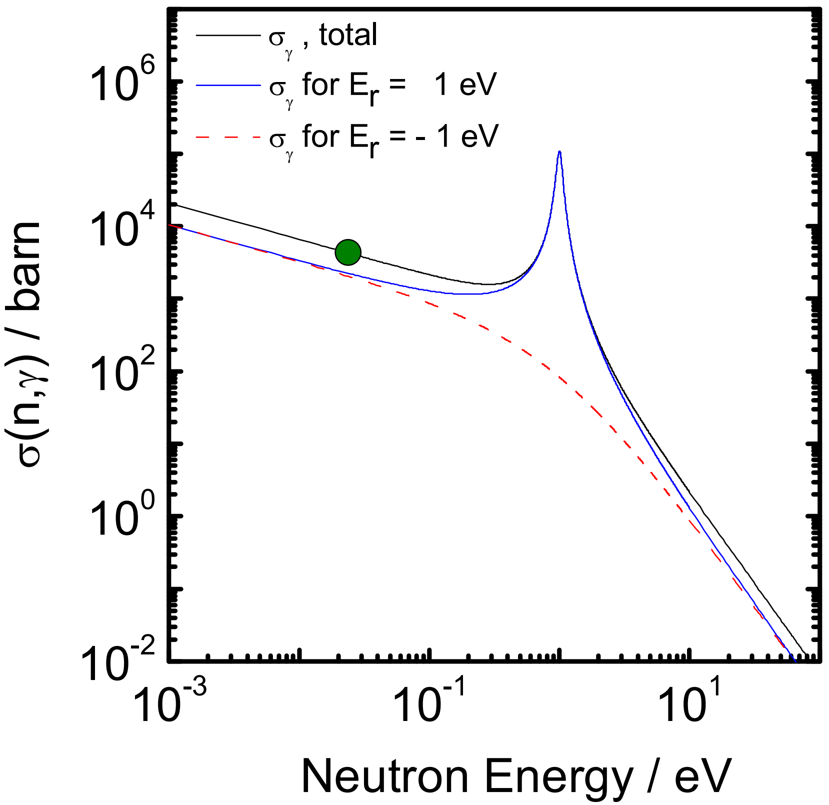
(penetration probability depends on ℓ)

- **s-wave** $\Gamma_n(E_n) = \Gamma_n^0 \sqrt{\frac{E_n}{1\text{eV}}}$
- **p-wave** $\Gamma_n(E_n) = \Gamma_n^1 \sqrt{\frac{E_n}{1\text{eV}}} \frac{k_n^2 a^2}{1 + k_n^2 a^2}$

$\Rightarrow$ **cross section at 0.025 eV (Thermal)**

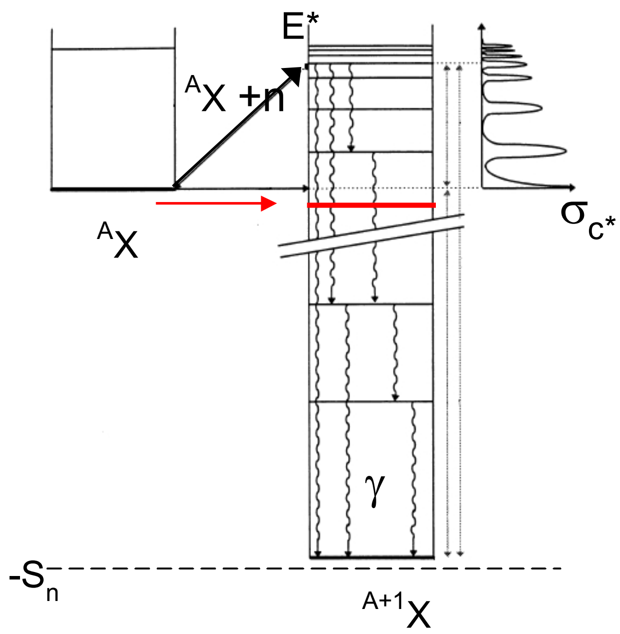
$$\sigma_r^{th} \approx 4.099.10^6 \left(\frac{A+1}{A}\right)^2 \sum_{j=1}^{N} \frac{g_J \Gamma_{nj}^o \Gamma_{rj}}{E_{Rj}^2}$$

σ_{th} and contribution of s-wave resonances



- $\sigma^{th} > \sigma^{th}_{E>0} \cong 4.099.10^{6}\left(\frac{m_A+1}{m_A}\right)^{2}\sum_{j=1}^{N}\frac{g_J\Gamma^{o}_{nj}\Gamma_{\gamma j}}{E_{Rj}^{2}}$

- **Additional contribution from bound states (negative resonances)**



SLBW for low energy s-wave (n,n) and (n,γ)

$$\Gamma = \Gamma_n + \Gamma_\gamma$$

$$g_J = \frac{2J+1}{2(2I+1)}$$

$$R = (0.80 + 1.23A^{1/3})\mathrm{fm}$$

- **(n,γ)**

$$\sigma_\gamma(E_n) = g_J \frac{\pi}{k_n^2} \frac{\Gamma_n \Gamma_\gamma}{(E_n - E_R)^2 + (\Gamma/2)^2}$$

- **(n,n)**

$$\sigma_n(E_n) = g_J \frac{\pi}{k_n^2} \frac{\Gamma_n \Gamma_n}{(E_n - E_R)^2 + (\Gamma/2)^2} + g_J \frac{4\pi}{k_n} \frac{\Gamma_n (E - E_R) R}{(E_n - E_R)^2 + (\Gamma/2)^2} + g_J 4\pi R^2$$

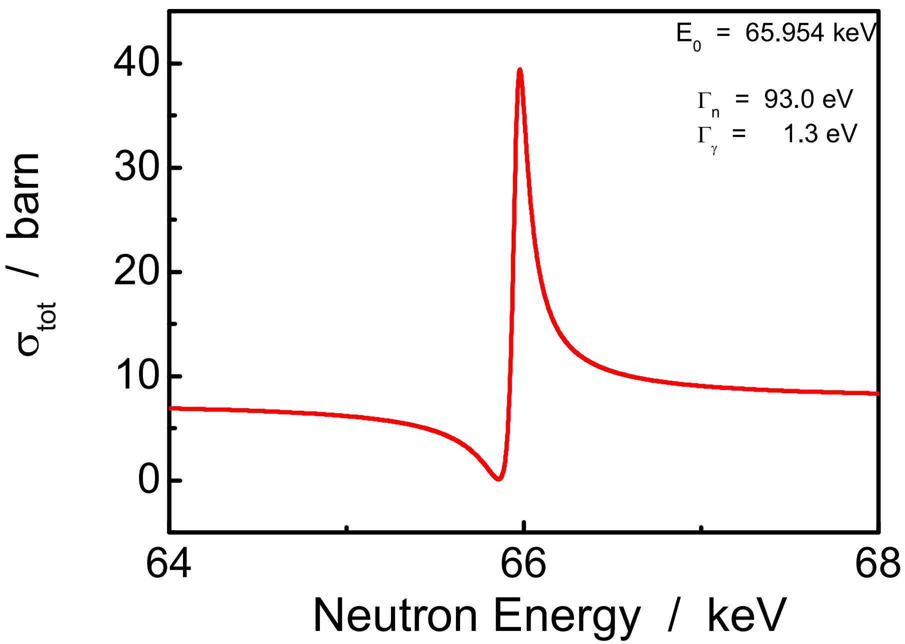
- **Total**

$$\sigma_{tot}(E_n) = g_J \frac{\pi}{k_n^2} \frac{\Gamma_n \Gamma}{(E_n - E_R)^2 + (\Gamma/2)^2} + g_J \frac{4\pi}{k_n} \frac{\Gamma_n (E - E_o) R}{(E_n - E_R)^2 + (\Gamma/2)^2} + g_J 4\pi R^2$$

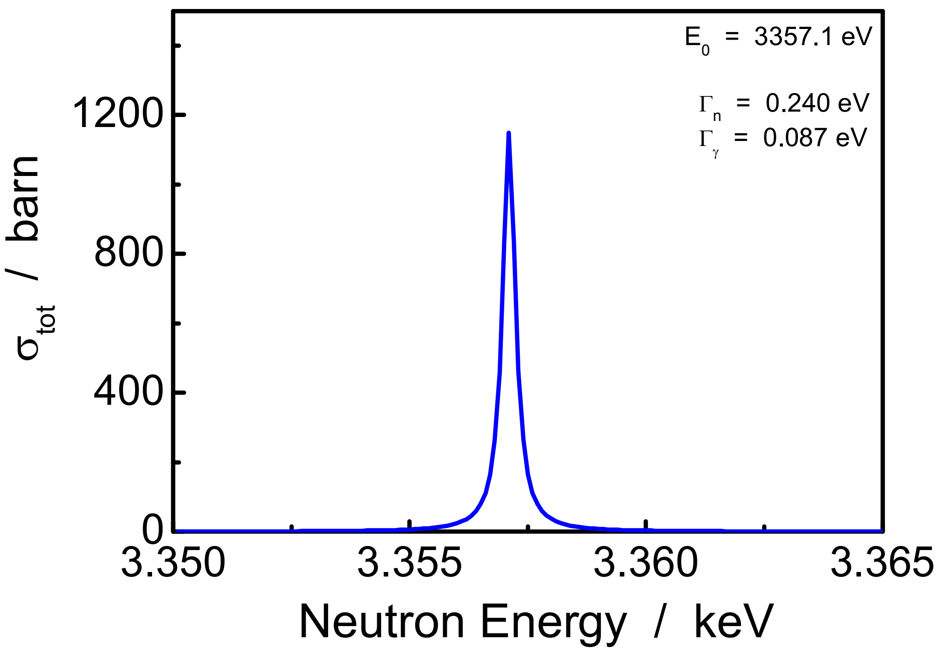
Interference term
s-wave <----> p-wave (l > 0)

$$\sigma_{tot}(E_n) = g_J \frac{\pi}{k_n^2} \frac{\Gamma_n \Gamma}{(E_n - E_R)^2 + (\Gamma/2)^2} + g_J \frac{4\pi}{k_n} \frac{\Gamma_n (E - E_o) R}{(E_n - E_R)^2 + (\Gamma/2)^2} + g_J 4\pi a^2$$

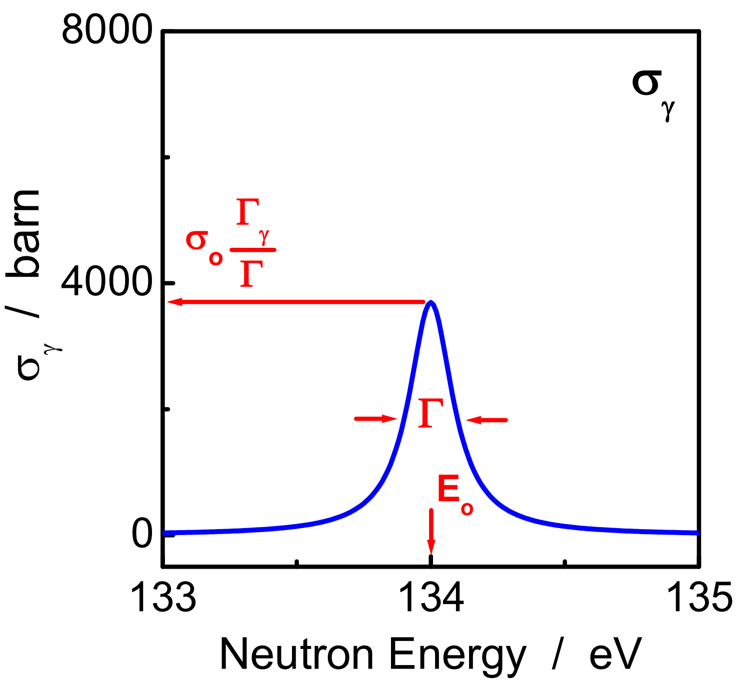
s-wave



p-wave



Ideal experiment



- **In ideal conditions, without any instrumental resolution broadening, we can determine $\sigma_o\Gamma_\gamma/\Gamma$ and Γ from one experiment.**

$\Rightarrow$ Γ_γ and Γ_n **$\sigma_o = f(g_J, \Gamma_n, \Gamma)$**

However,

- **Due to instrumental limitations it is mostly impossible to determine Γ and $\sigma_o\Gamma_\gamma/\Gamma$**
- **Due to the instrumental limitations the effective experimental observable is mostly:**

  the area of a resonance

Experimental observables

- **Transmission**

$$A_{t,thin} \propto n g_J \Gamma_n$$

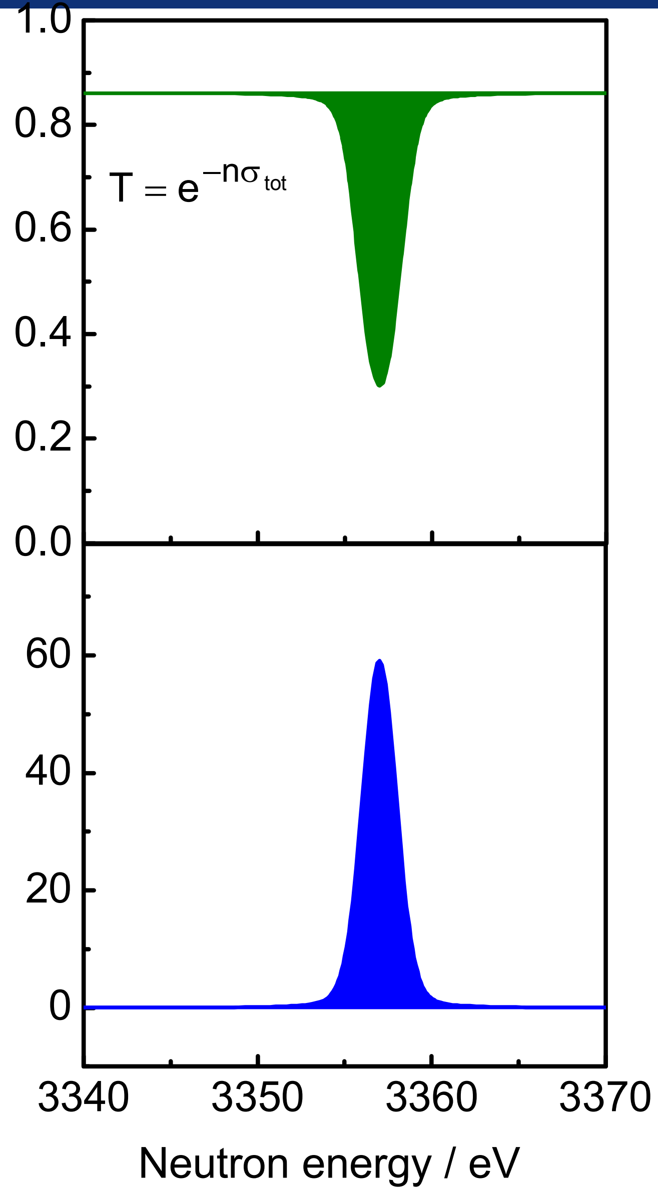
$$A_{t,thick} \propto \sqrt{n g_J \Gamma_n \Gamma}$$

- **Capture**

$$A_{\gamma,thin} \propto n g_J \frac{\Gamma_n \Gamma_\gamma}{\Gamma}$$

n is the target thickness in atoms/barn

Rae et al., Nucl. Phys. 5 (1958) 89
F. Fröhner et al., ND1966, p. 55



Capture + Transmission

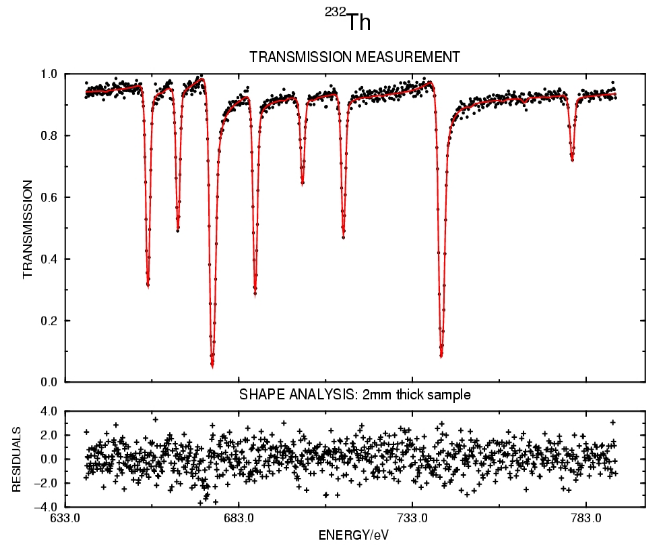
Rae et al., Nucl. Phys. 5 (1958) 89
F. Fröhner et al., ND1966, p. 55

		$\Gamma_\gamma << \Gamma_n$	$\Gamma_\gamma >> \Gamma_n$
• **Capture**	$A_\gamma \propto n g_J \frac{\Gamma_n \Gamma_\gamma}{\Gamma}$	$n\, g_J\, \underline{\Gamma_\gamma}$	$n\, g_J\, \underline{\Gamma_n}$
• **Transmission**	$A_{t,thin}$	$n\, g_J\, \underline{\Gamma_n}$	$n\, g_J\, \underline{\Gamma_n}$
	$A_{t,thick}$	$\sqrt{n\, g_J \Gamma_n}$	$\sqrt{n\, g_J\, \Gamma_n\, \Gamma_\gamma}$

$\Rightarrow$ **Ideally : combine thin capture measurements with transmission measurements on samples with different thicknesses**

Determination of resonance parameters

- **SLBW and Resonance Area Analysis**
  - Instructive
- **<u>R</u>esonance <u>S</u>hape <u>A</u>nalysis (RSA)**



(Reich-Moore (or better) Recommended)

  - Extension of RRR
  - Direct treatment of broadening effects (Resolution & Doppler)
  - Direct treatment of multiple scattering effects (capture data)
  - Reduction of uncertainties
    - » **SAMMY (N. Larson)**
    - » **REFIT (M. Moxon)**

- **Cadmium**

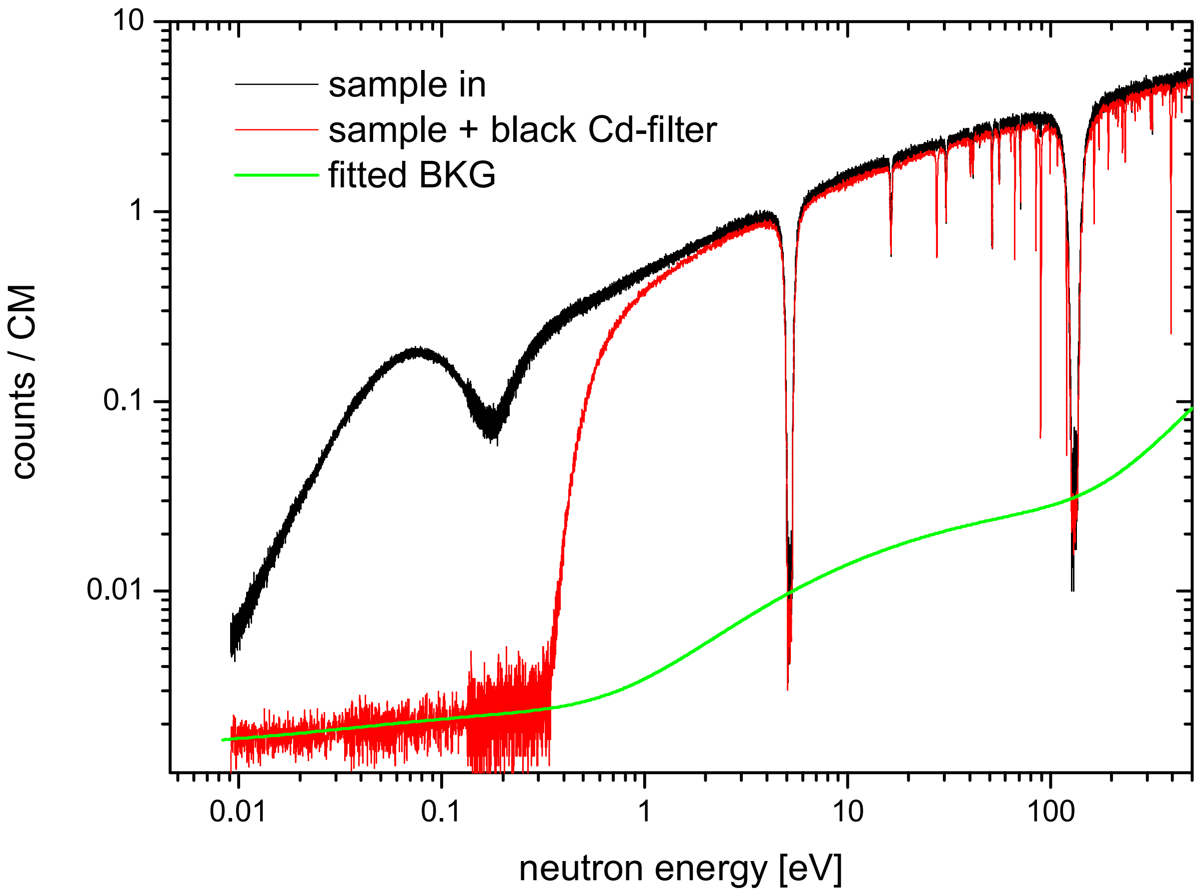
Cd - Previous Experiments

	sample	energy	Γγ [meV]	Γn [mev]
Rainwater	metal	0.176+/-0.002	115 +/- 2	0.620 +/- 0.020
Brockhouse	metal	0.180 +/- 0.003	113 +/- 2	0.680 +/- 0.020
Akyuz	metal	0.181 +/- 0.003	109 +/- 3	0.645 +/- 0.025
Widder	powder	0.1776 +/- 0.0006	114.3 +/- 0.6	0.618 +/- 0.003
Harz	various	0.1783 +/- 0.0002	113.5 +/- 0.5	0.650 +/- 0.005

^{nat}Cd - measurements

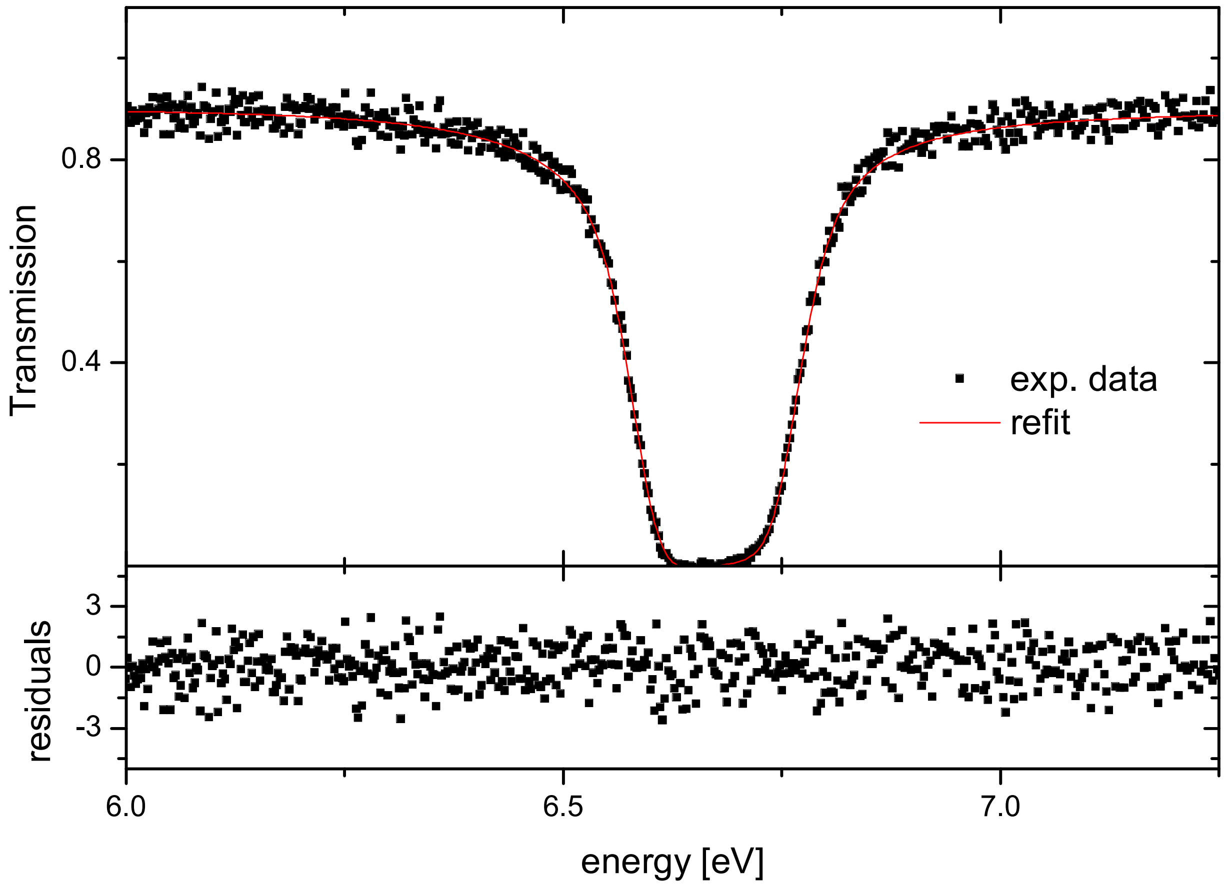
thickness (atoms/barn)	type	flight path length
$1.38\ 10^{-4}$	capture	10 m
$3.40\ 10^{-4}$	capture	10 m
$5.40\ 10^{-4}$	transmission	50 m
$1.10\ 10^{-3}$	capture	30 m
$2.36\ 10^{-3}$	capture	30 m
$4.67\ 10^{-3}$	capture	30 m
$9.34\ 10^{-3}$	capture transmission	10 m 25 m, 50 m
$2.34\ 10^{-2}$	transmission	50 m
$1.20\ 10^{-1}$	transmission	25m, 50m

Background



sample in
sample + black Cd-filter
fitted BKG
counts / CM
10
1
0.1
0.01
0.01
0.1
1
10
100
neutron energy [eV]

Energy Calibration -> ^{238}U



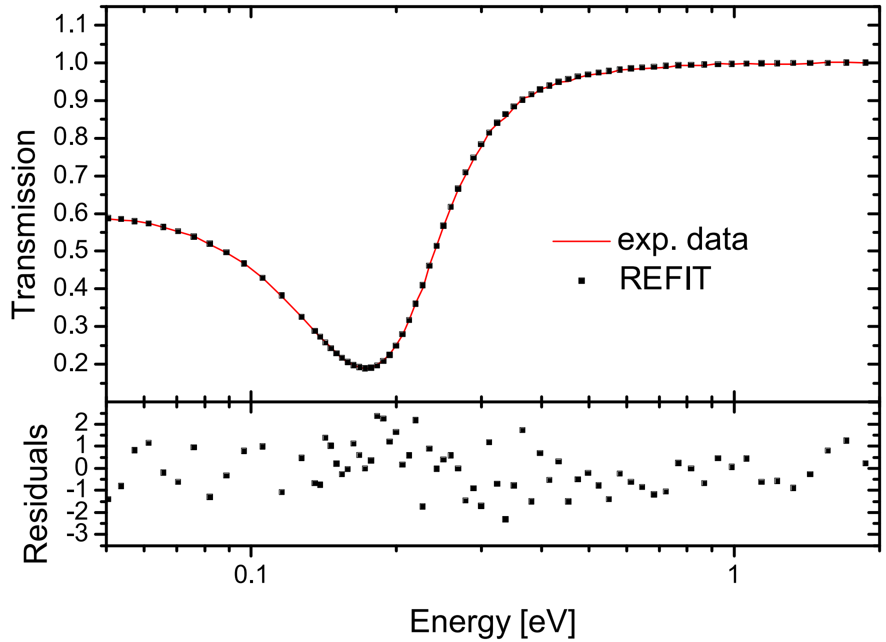
E_{res}=6.6735+/-0.002

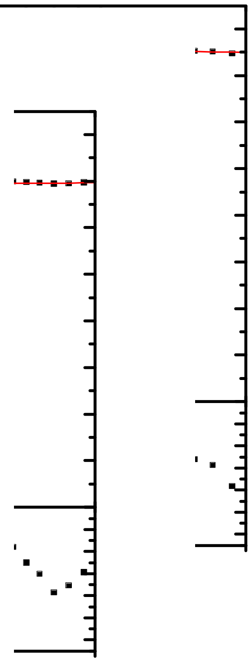
Fp=26.4440+/-0.005

Checked consistency with energies above 1 keV (Oak Ridge , 200 m, data by J.Harvey)

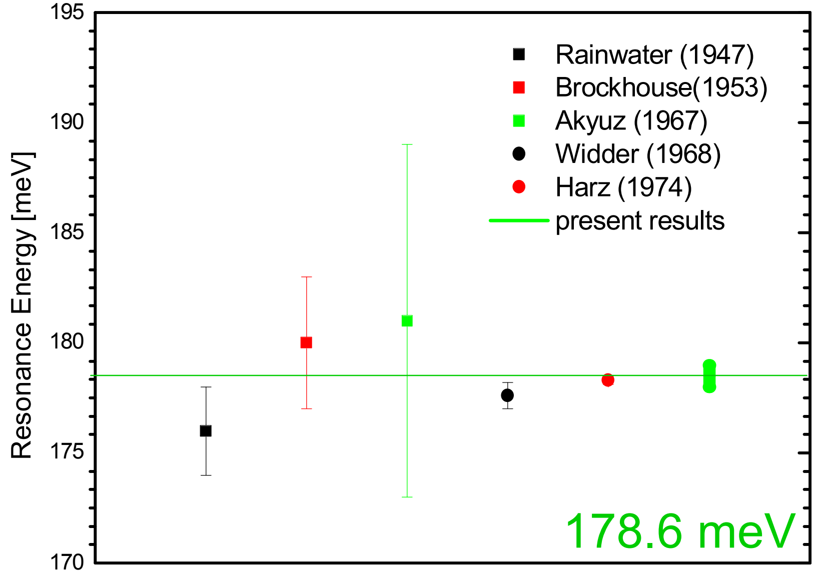
Experimental Results

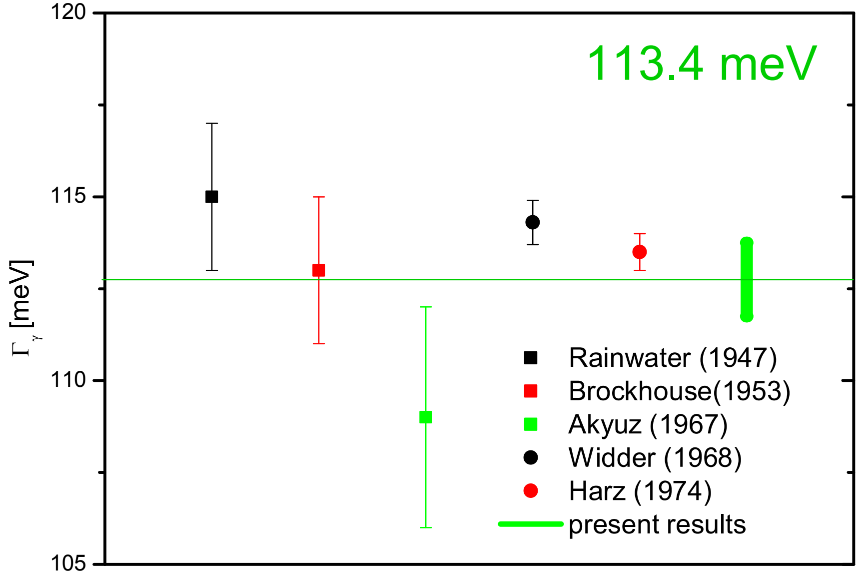
thickness (atoms/barn)	sam
1.40 10^{-4}	
1.36 10^{-4}	
2.24 10^{-4}	
2.80 10^{-4}	

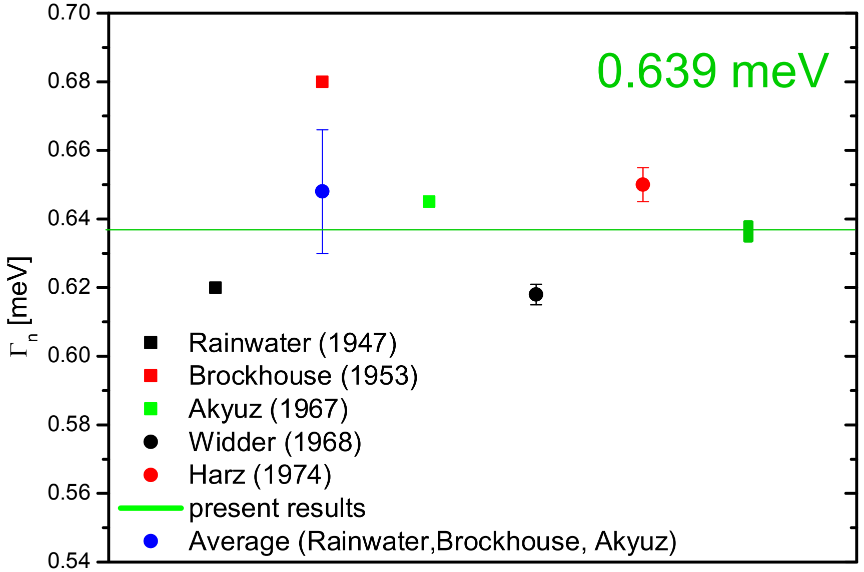




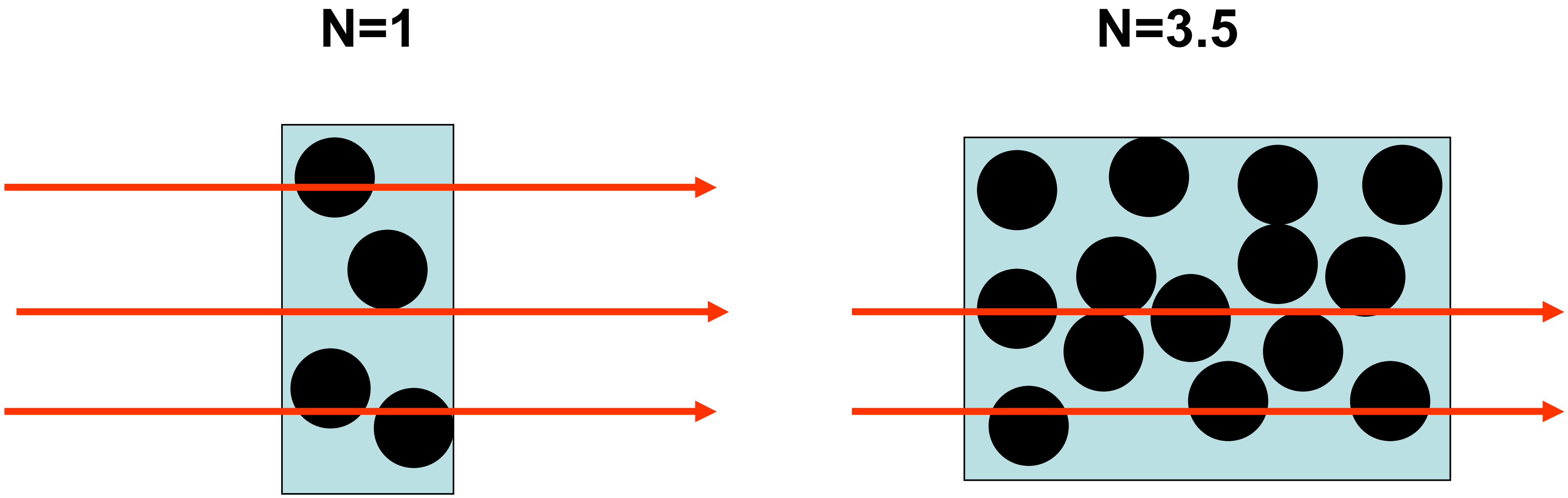
Resonance Parameters – first resonance





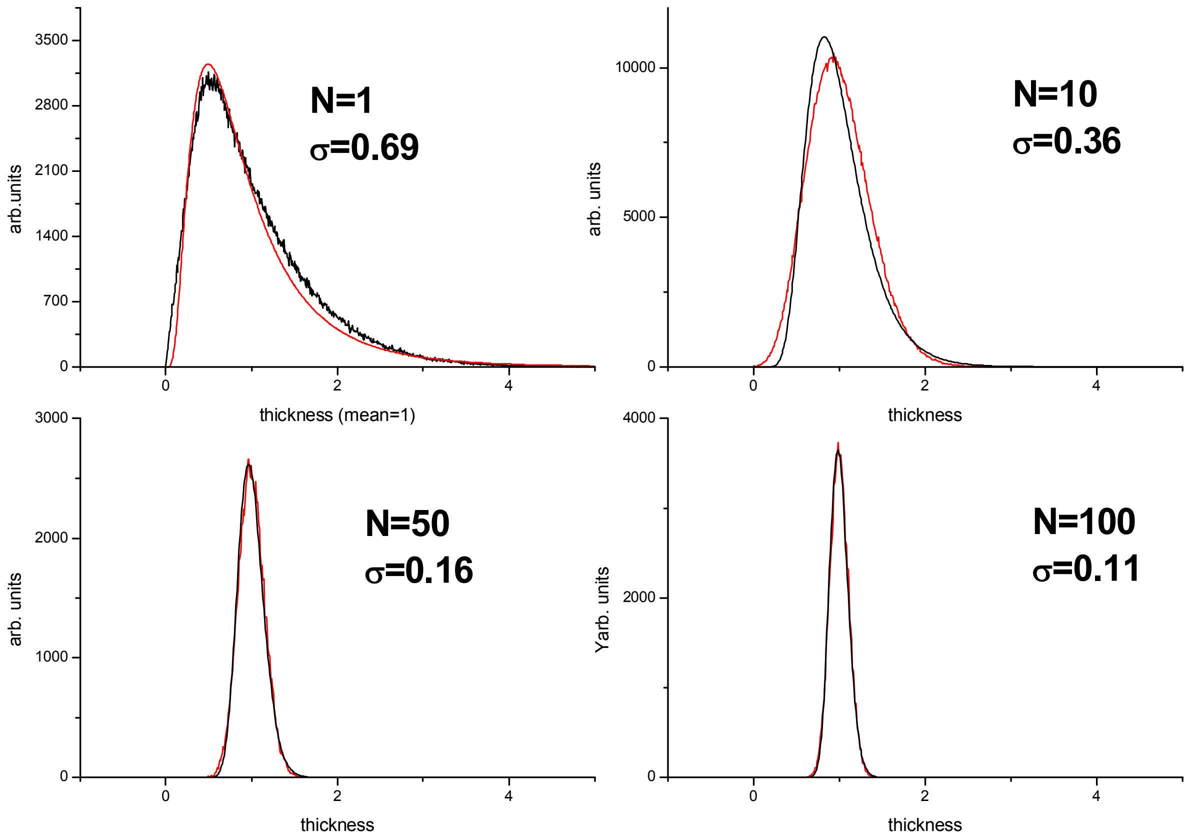


Powder Sample



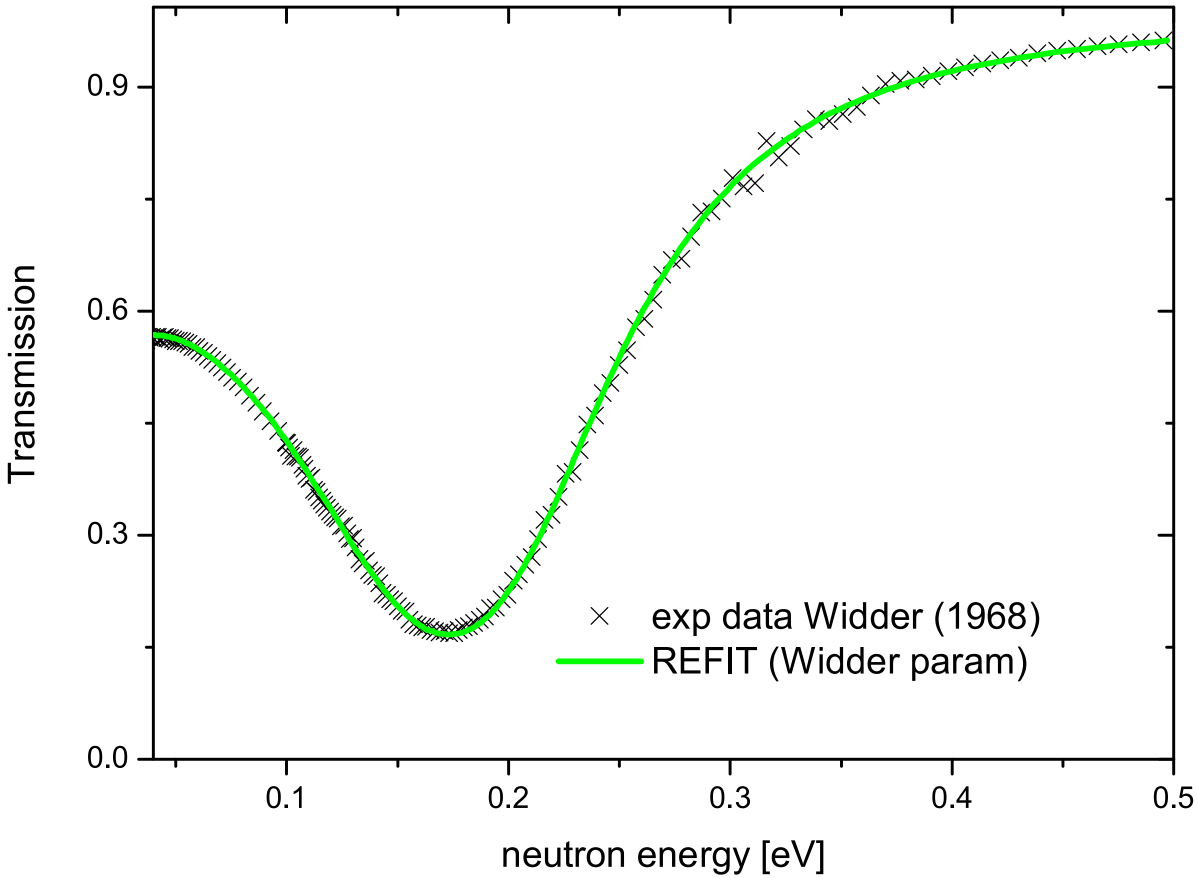
Probability that a neutron “sees” n particle, given by Poisson-statistics

Powder Sample



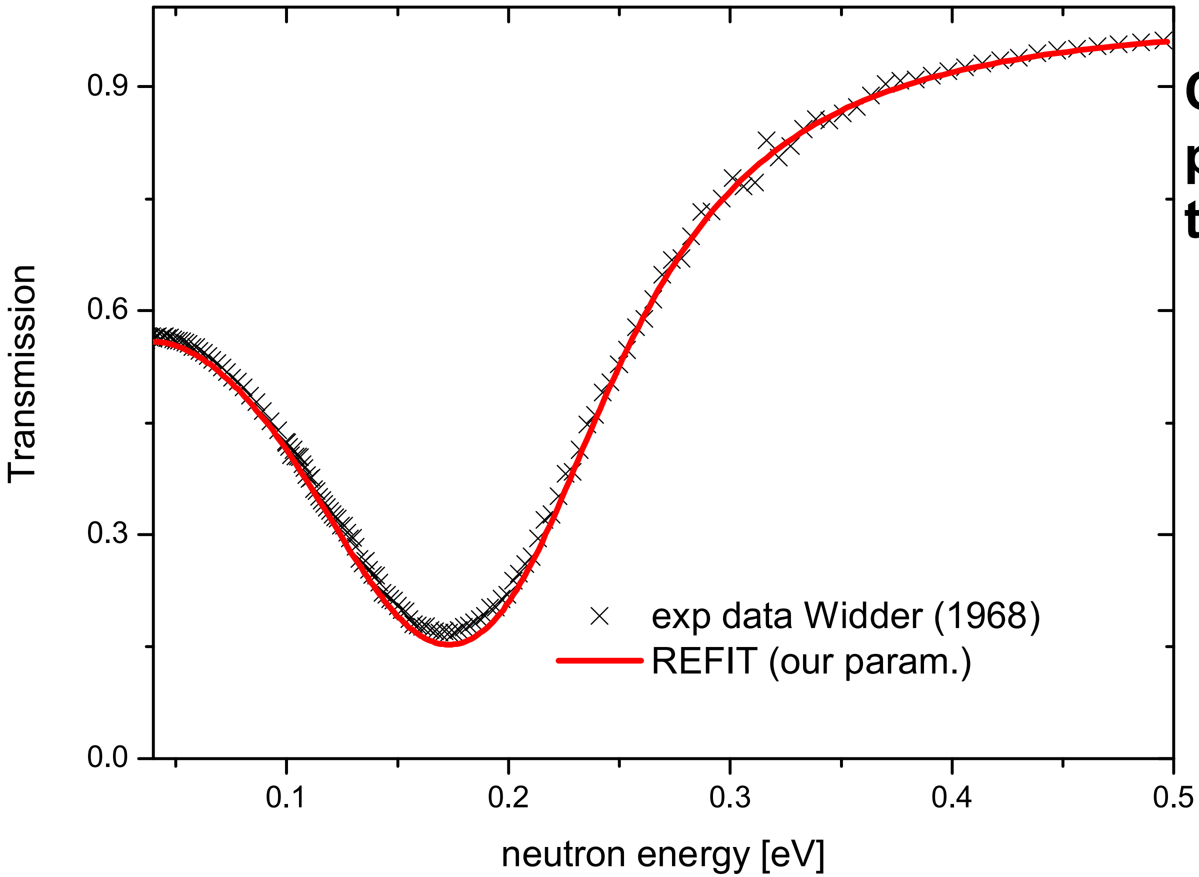
- Poisson distribution
- Spheres
- Radius lognormal
- Black line MC
- Red line lognormal fit

Fit to Widder et al. (1/3)



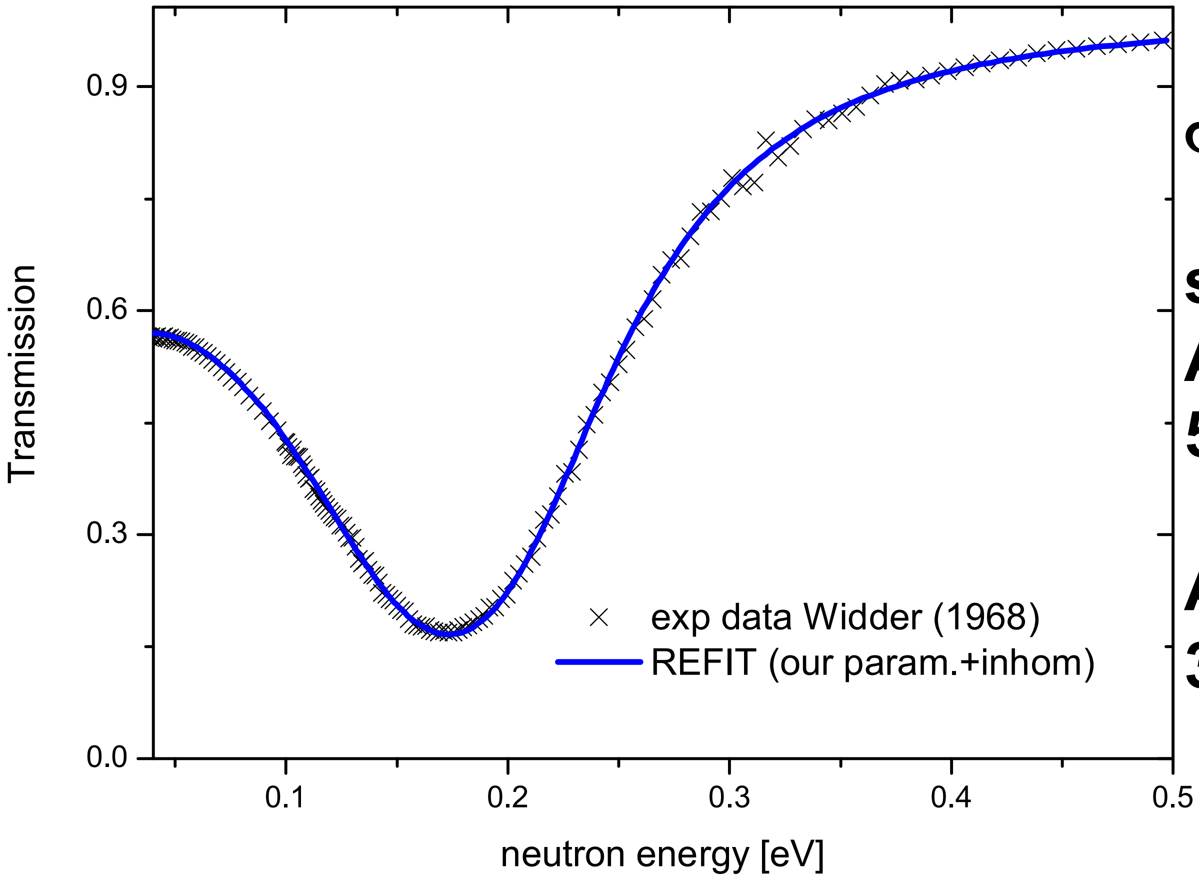
Calculation using parameters given by Widder et al.

Fit to Widder et al. (2/3)



Calculation using parameters derived by fit to "our data"

Fit to Widder et al. (3/3)

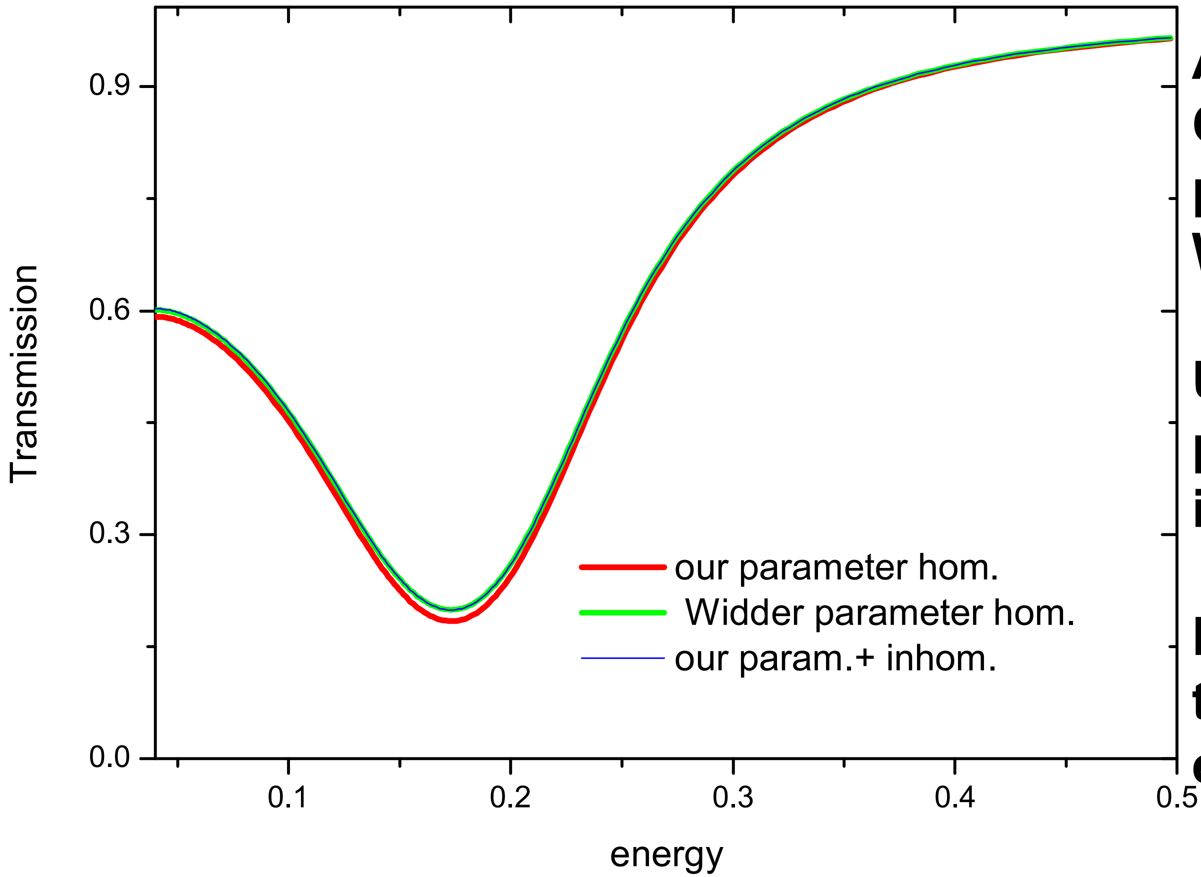


σ_{inhom}=0.096

sample thickness:
Approx. 50 μm
50-200 layers (estim)

Average particle size
300nm – 1μm (estim)

Comparison



Agreement between: Calculation using parameters given by Widder et al.

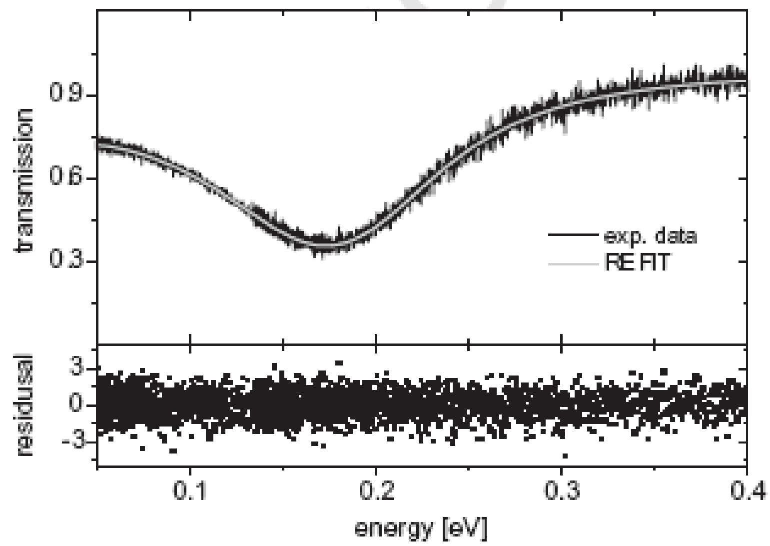
Using *our* resonance parameters+ sample inhogeniety

Relative deviation less than 0.001 over whole energy range

Conclusion: Widder et al. did a good experiment but their sample was not homogenius.

Cd Resonance Parameters

thickness (at/b)	sample type	flight path length
$1.40\ 10^{-4}$	solution	25 m
$1.36\ 10^{-4}$	foil	25m
$2.24\ 10^{-4}$	foil	25 m



Only uncorrelated uncertainties

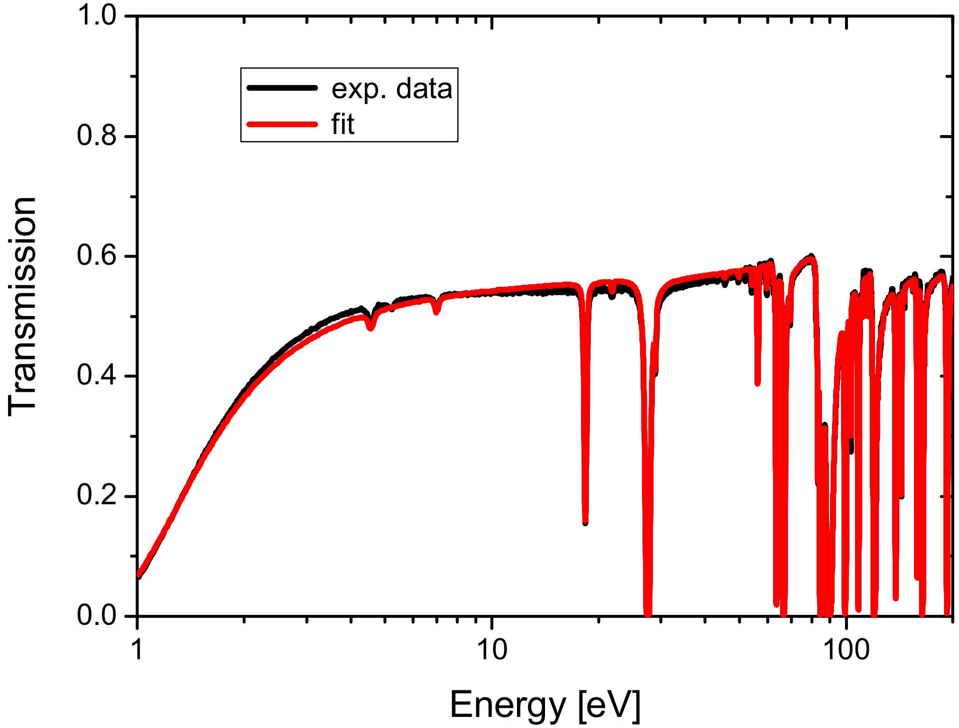
Parameter	p / meV			ρ(pi,pj)		
E_R	178.7	±	0.1	1.00	0.43	0.79
Γ_n	0.640	±	0.001		1.00	0.43
Γ_γ	113.5	±	0.2			1.00

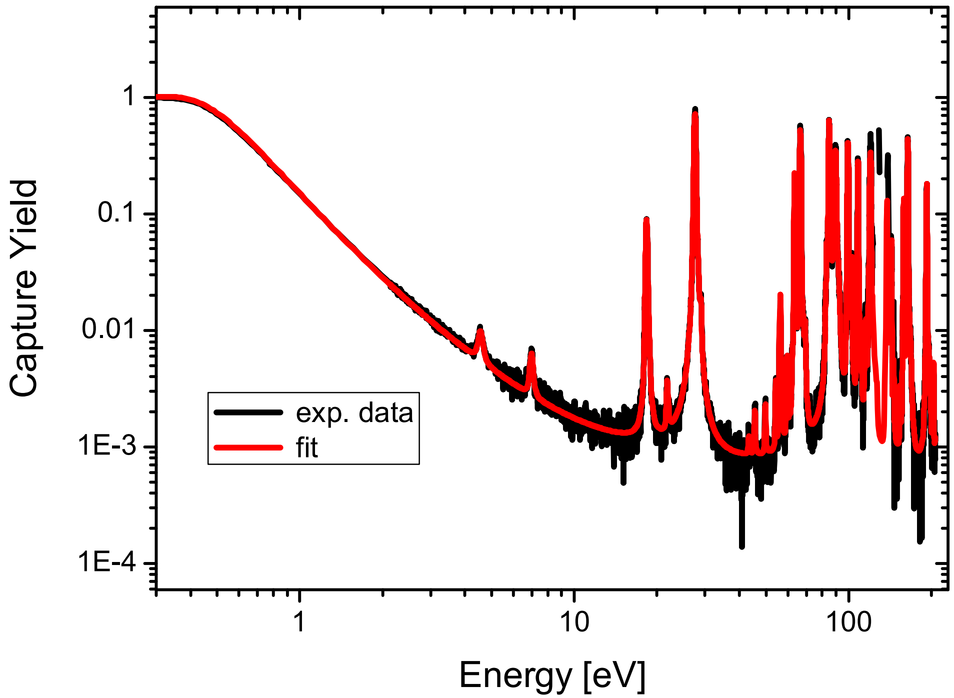
Full Covariance Matrix

Parameter	p / meV			ρ(pi,pj)		
E_R	178.7	±	0.1	1.00	0.53	0.28
Γ_n	0.640	±	0.004		1.00	0.25
Γ_γ	113.5	±	0.2			1.00

Kopecky et al., NIMB 267 (2009), 2345

^{nat}Cd - conclusion

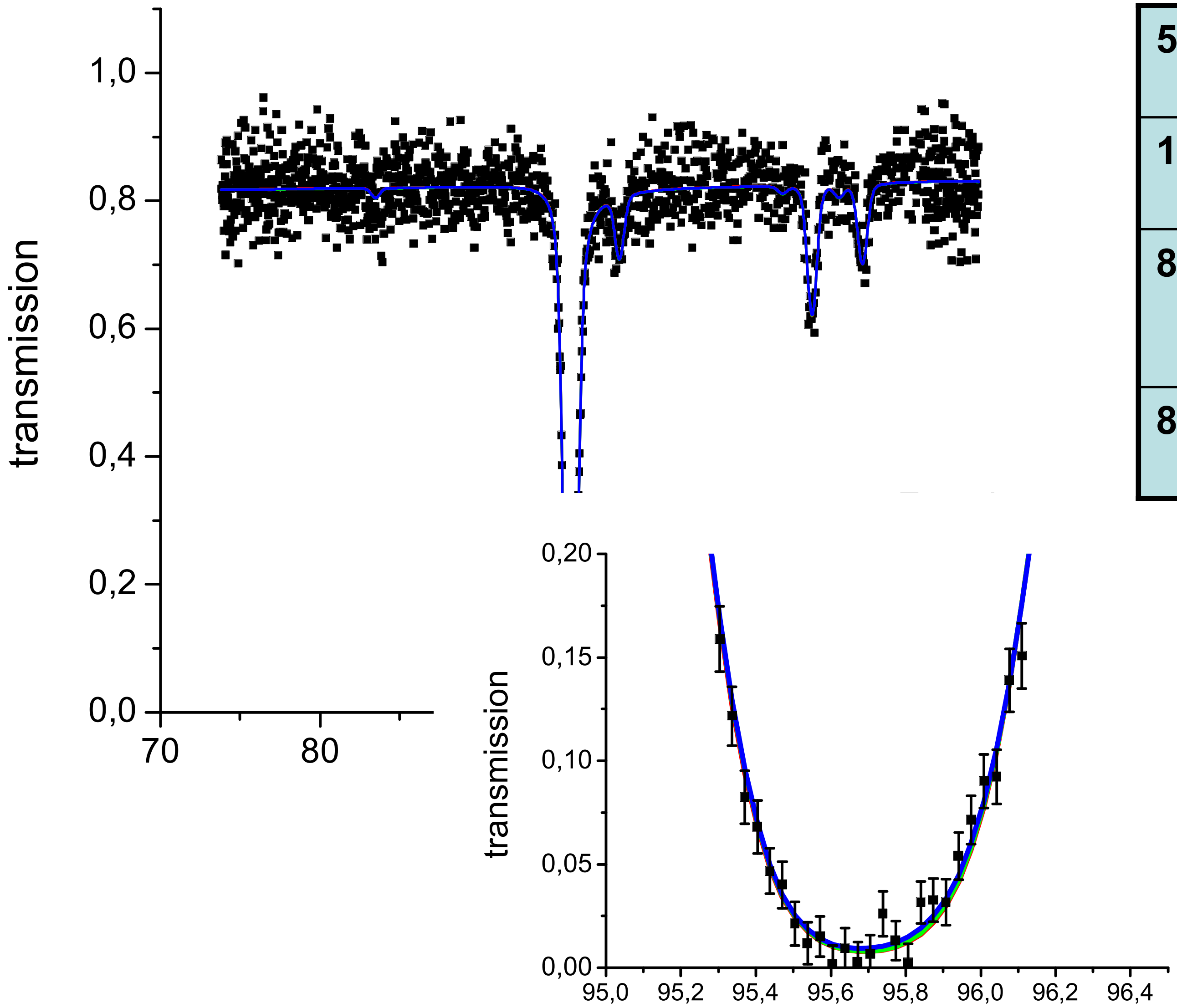




- capture/transmission RSA analysis finalized up to 1.5 keV
- input to the IRDF 2009 (IAEA) up to 1 keV
- consistency check including comparisons with results on enriched samples
- Thermal point difficult since Cd is not monoisotopic (but dominated by ^{113}Cd)
- comparisons with integral experiments (impact of first resonance parameters) (see NIMB 267)

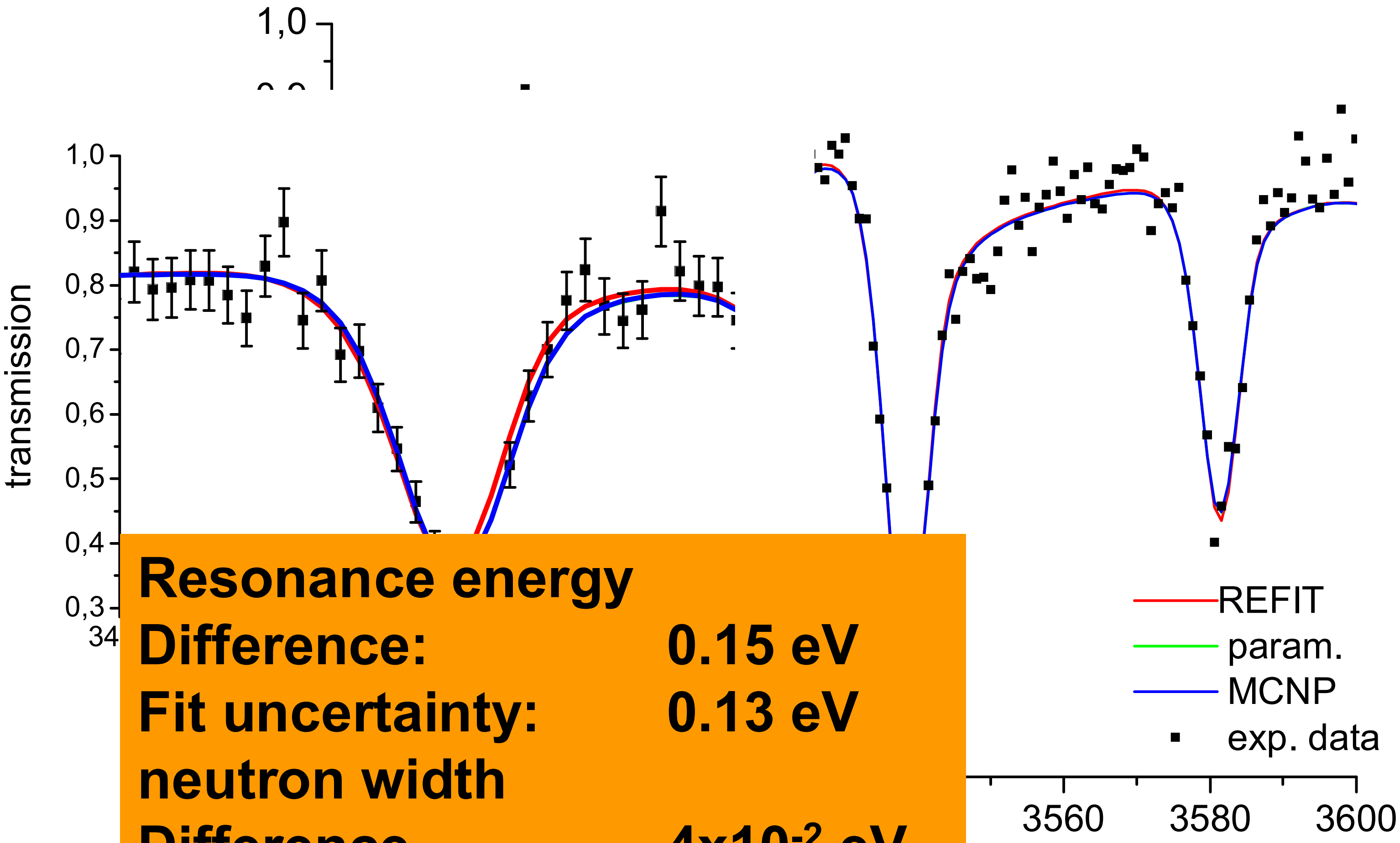
- **Rhodium**

Transmission ^{103}Rh



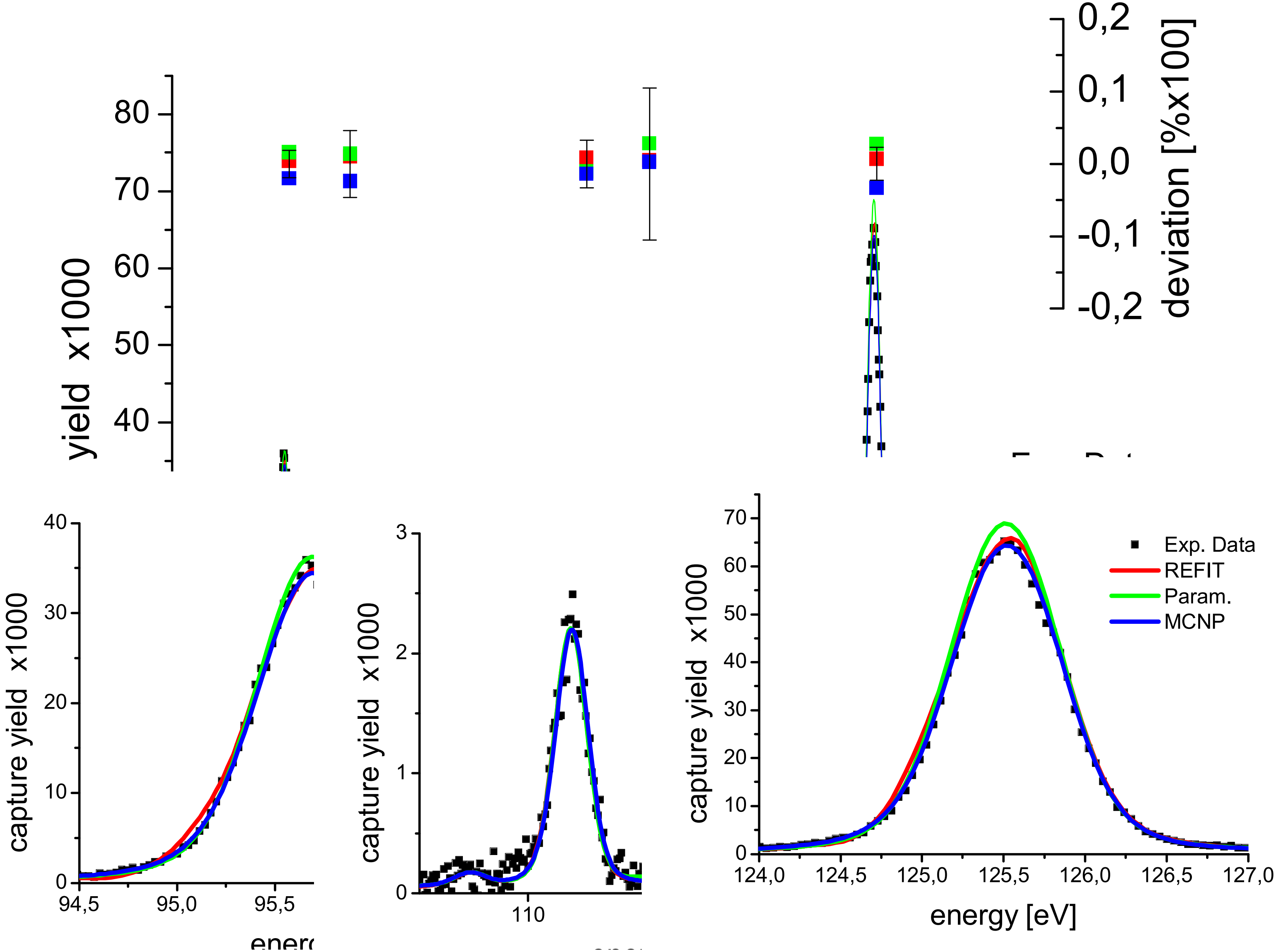
50 Hz	10 m	thick	capture
100 Hz	50 m	thin	transm.
800 Hz	30 m 60 m	thin/ thick	capture
800 Hz	50 m	very thick	transm.

Transmission ^{103}Rh



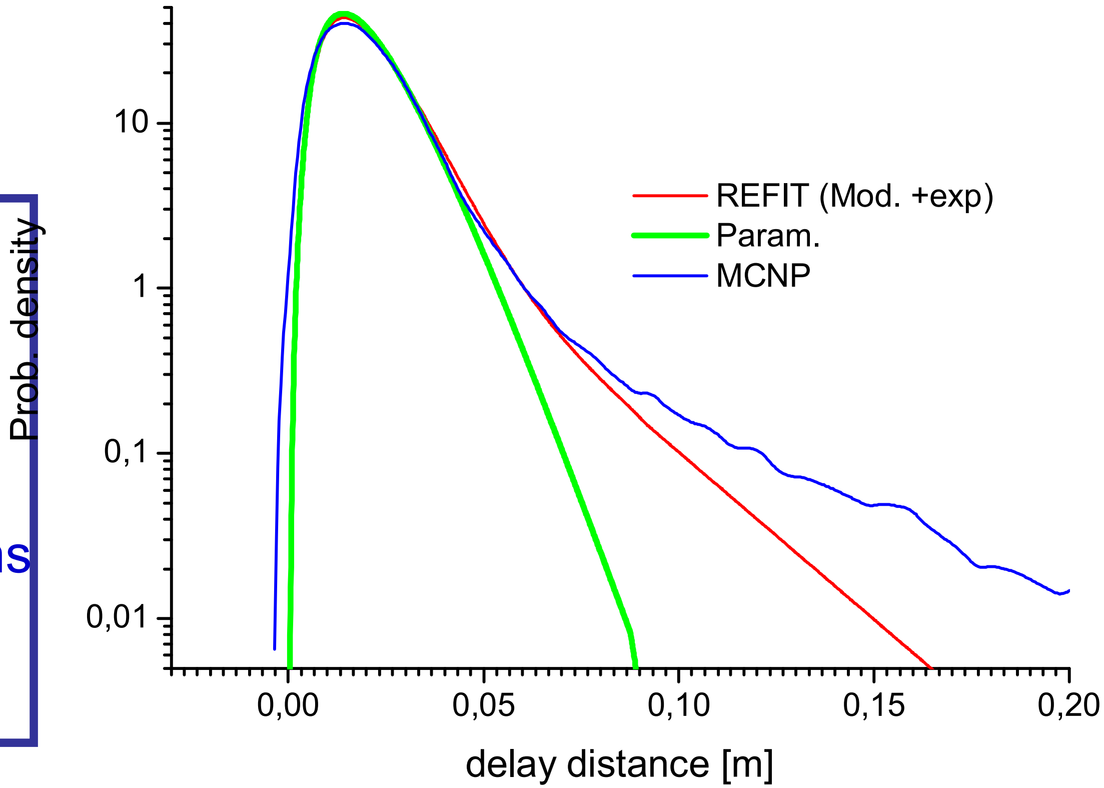
Resonance energy	
Difference:	**0.15 eV**
Fit uncertainty:	**0.13 eV**
neutron width	
Difference	**$4x10^{-2}$ eV**
Fit uncertainty:	**$2.5x10^{-2}$ eV**

^{103}Rh Capture 80-150 eV

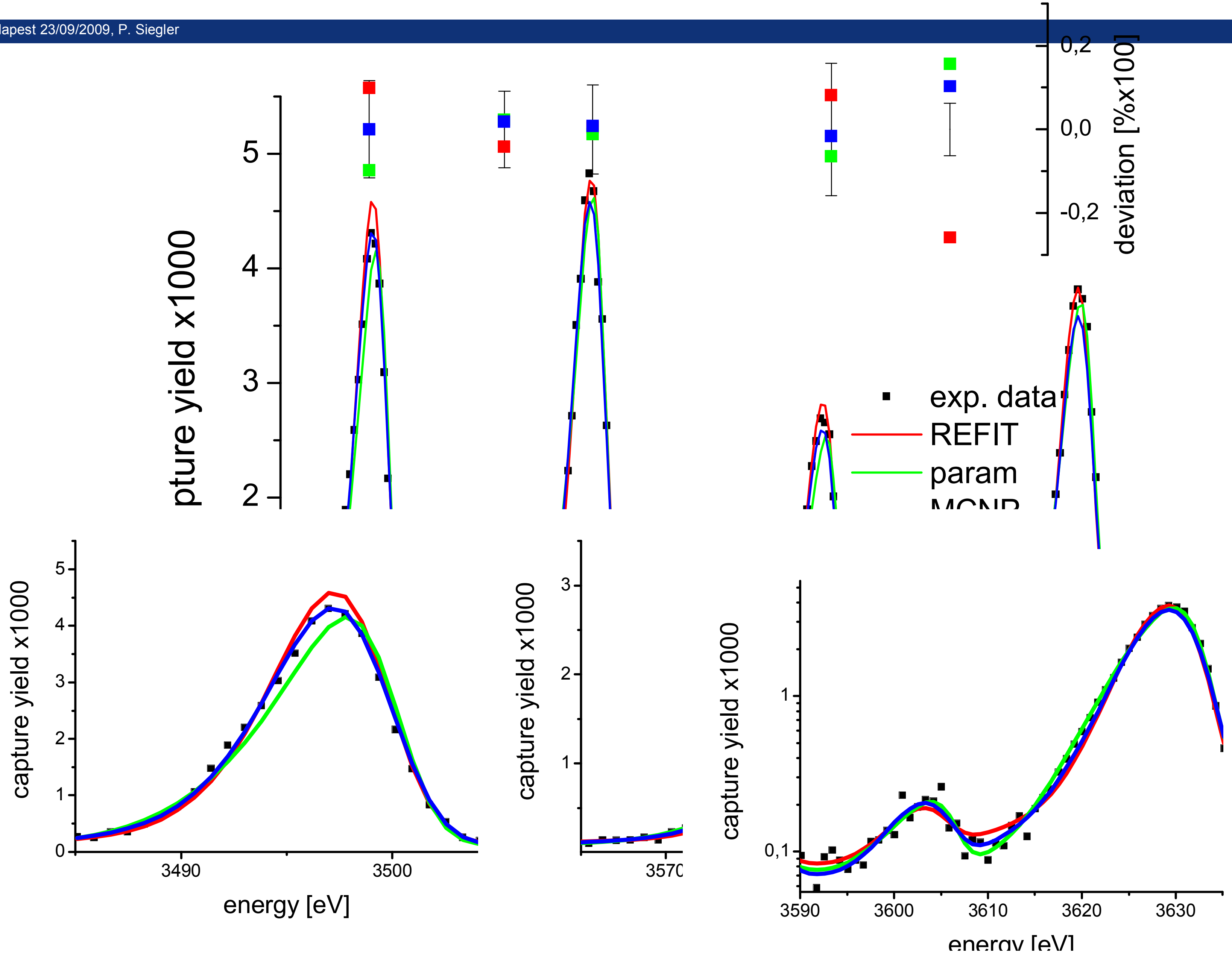


Resolution function 80-150 eV

- **REFIT**
- **Exponential Decay**
  - Amplitude 8.5 %
  - Decay constant 110 ns

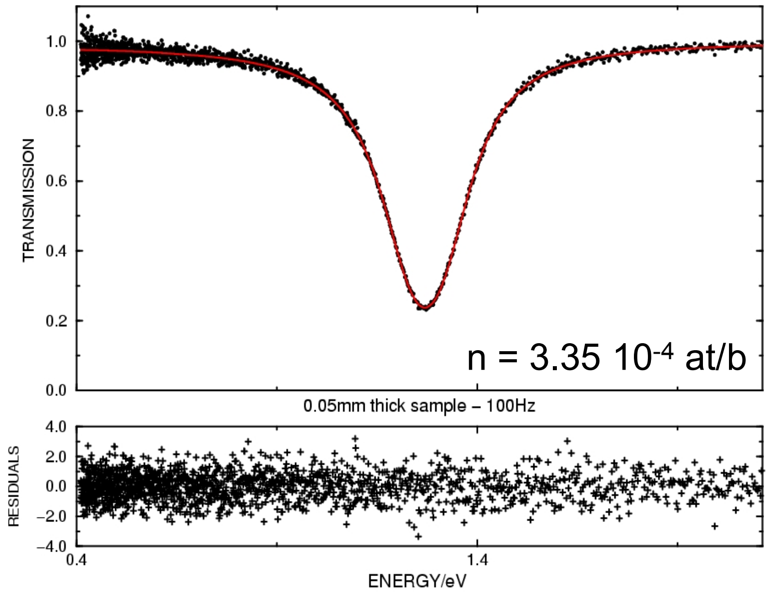


Capture ^{103}Rh 3.5 keV



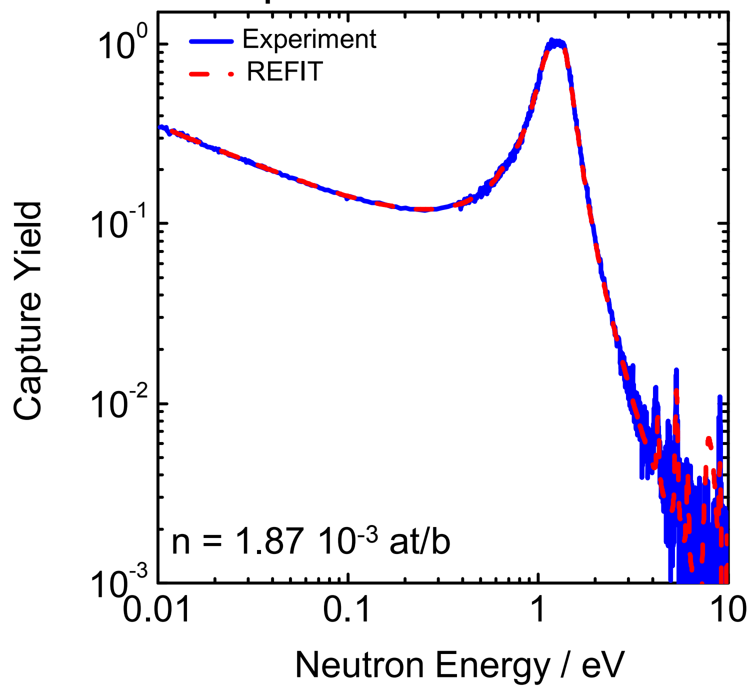
Thermal region : $^{103}Rh(n,\gamma)$

Transmission: 50 m 100 Hz



REFIT
RP + N
⇔

Capture : 15 m   40 Hz



E_r	=	1.260 eV
Γ_n	=	0.464 meV
Γ_γ	=	156.0 meV
g	=	3/4

$\sigma(n,\gamma)$ at 25.3 meV

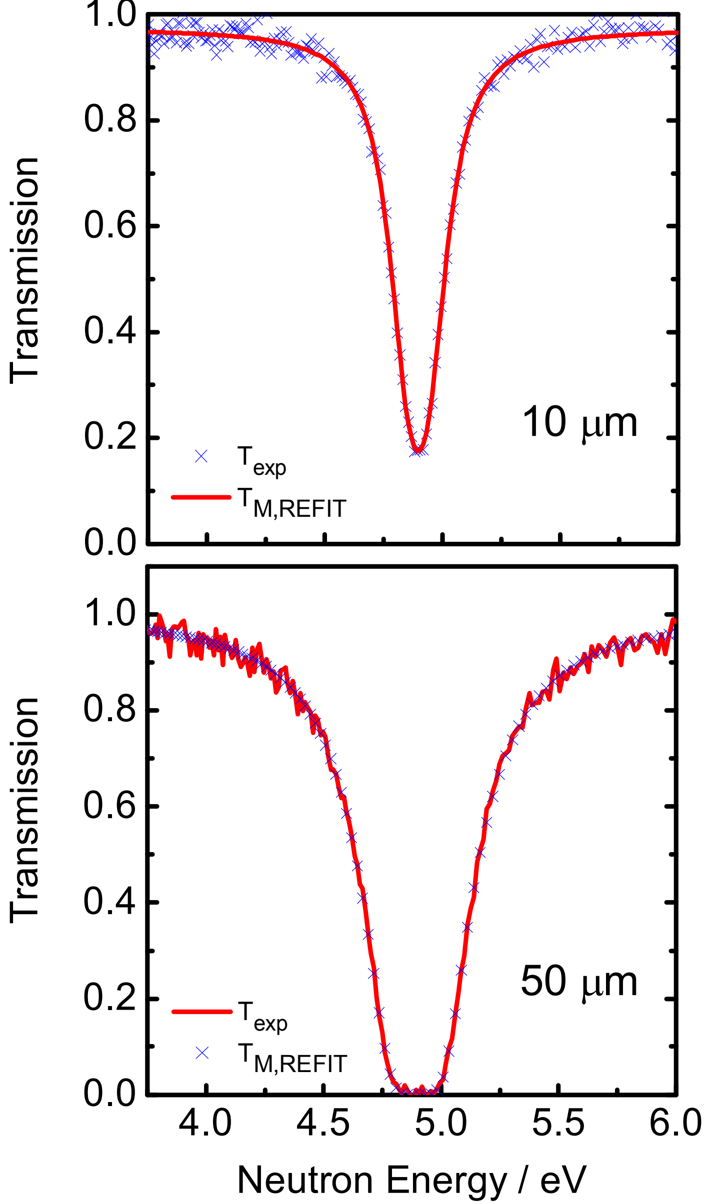
WF : 142.0 (1.5) b
1.0 % normalization
0.5 % uncorrelated

Counts : 143.3 b

Mughabghab:
145.0 (2.0) b

- **Gold**

4.9 eV resonance for $^{197}Au+n$



$C_{T,exp}$: only uncorrelated uncertainties due to counting statistics

$\Rightarrow$

Γ_n = (15.06 ± 0.08) meV

Γ_γ = (121.7 ± 1.3) meV

$\rho(\Gamma_n, \Gamma_\gamma)$ = 0.55

$\Rightarrow$

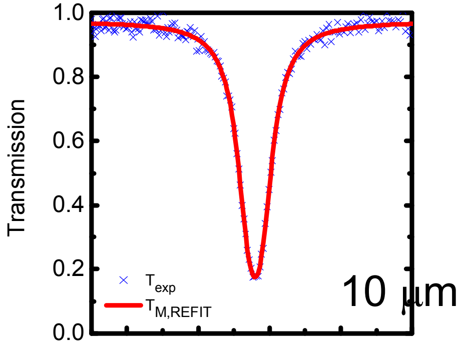
Γ_n = (14.66 ± 0.30) meV

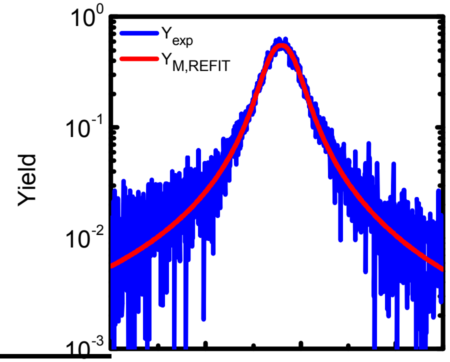
Γ_γ = (124.8 ± 3.7) meV

$\rho(\Gamma_n, \Gamma_\gamma)$ = - 0.96

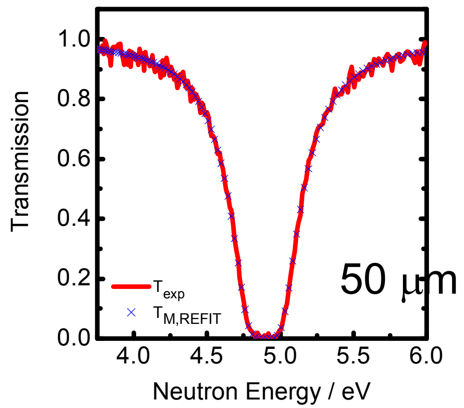
RSA by REFIT

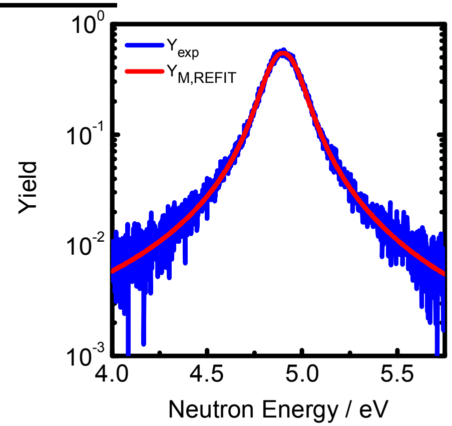
4.9 eV resonance for ^{197}Au+n



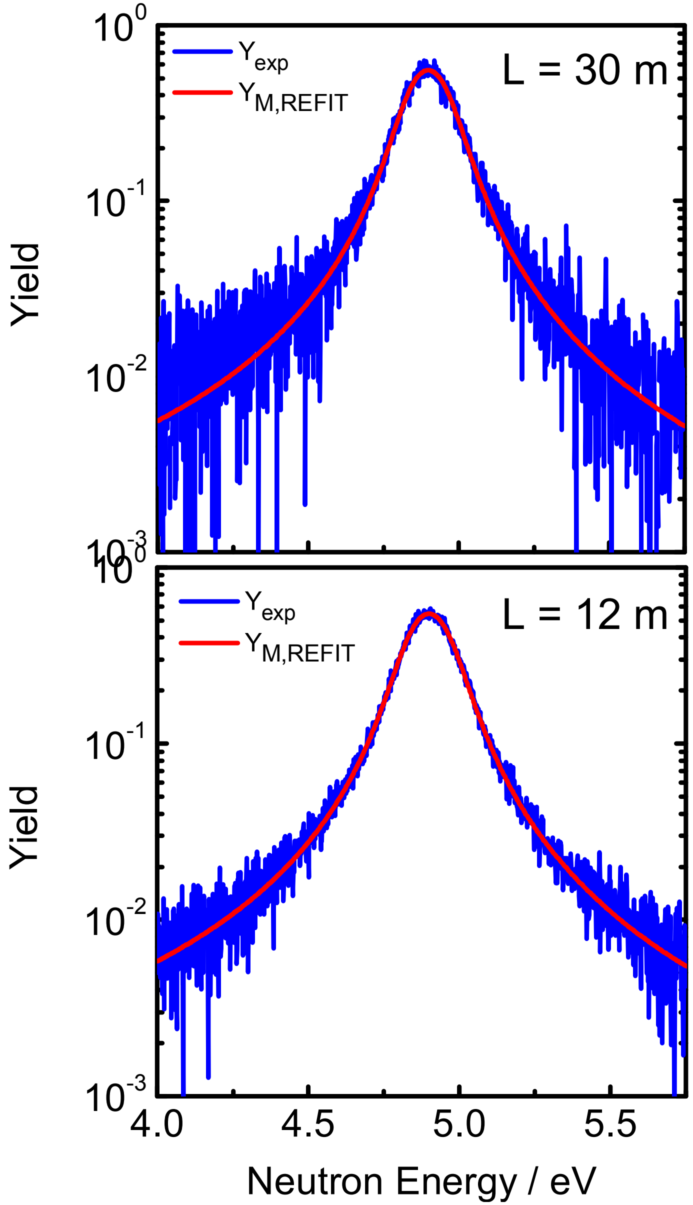


Id-number	Measurement	Distance	Angle (flight path – moderator)	Target thickness
T1	Transmission	50 m	9°	10 μm
T2	Transmission	50 m	9°	50 μm
C1	Capture	30 m	0°	5 μm
C2	Capture	12 m	18°	5 μm





4.9 eV resonance for ^{197}Au+n



$C_{Y,exp}$: only uncorrelated uncertainties due to counting statistics

$\Rightarrow$

Γ_n = (15.31 ± 0.12) meV

Γ_γ = (118.0 ± 1.4) meV

$\rho(\Gamma_n, \Gamma_\gamma)$ = - 0.50

$\Rightarrow$

Γ_n = (15.26 ± 0.15) meV

Γ_γ = (118.9 ± 1.2) meV

$\rho(\Gamma_n, \Gamma_\gamma)$ = - 0.63

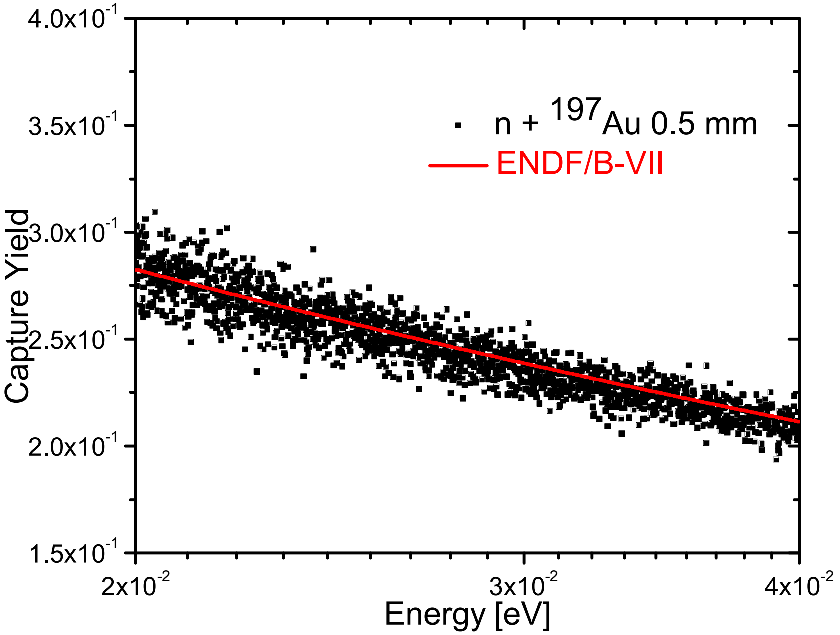
RSA by REFIT

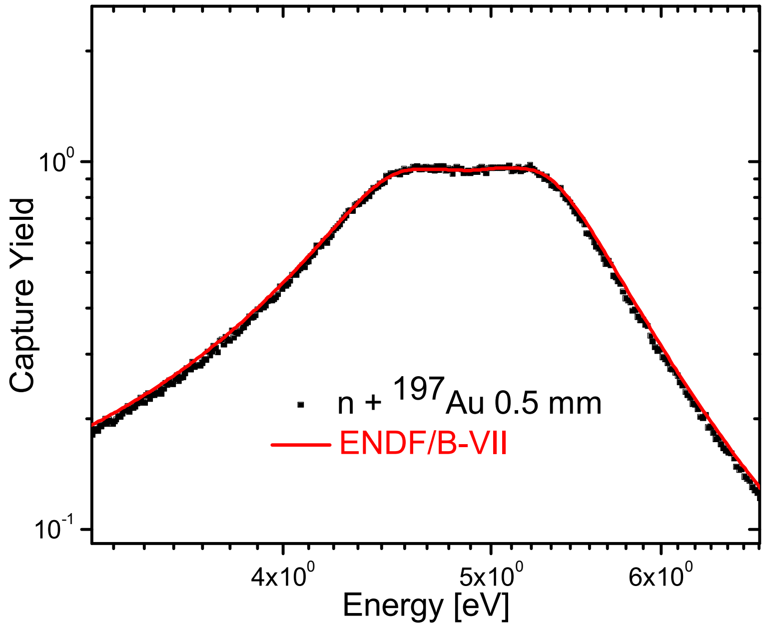
4.9 eV resonance for $^{197}Au+n$

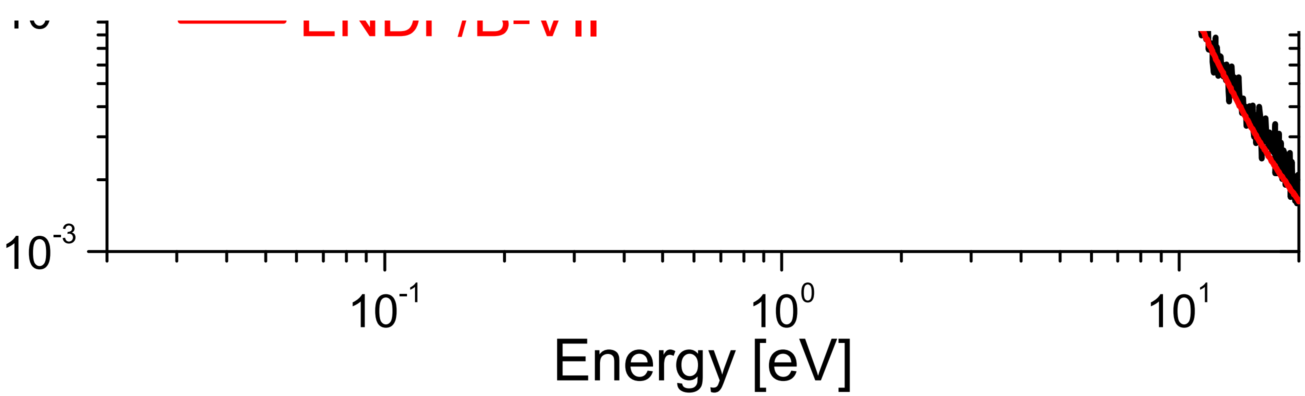
Measurements	Γ_n / meV	Γ_γ / meV	$\rho(\Gamma_n, \Gamma_\gamma)$
T1	15.06 ± 0.08	121.7 ± 1.3	0.55
T2	14.66 ± 0.30	124.8 ± 3.7	- 0.96
C1	15.31 ± 0.12	118.0 ± 1.4	- 0.50
C2	15.26 ± 0.15	118.9 ± 1.2	- 0.63
T1 + C1	15.14 ± 0.07	120.0 ± 1.0	0.06
T1 + C2	15.10 ± 0.07	120.2 ± 0.9	- 0.29
T1 + T2 + C1 + C2	15.14 ± 0.06	119.8 ± 0.7	- 0.47

Id-number	Measurement	Distance	Angle (flight path – moderator)	Target thickness
T1	Transmission	50 m	9°	10 μm
T2	Transmission	50 m	9°	50 μm
C1	Capture	30 m	0°	5 μm
C2	Capture	12 m	18°	5 μm

^{197}Au


Capture Yield
4.0x10-1
3.5x10-1
3.0x10-1
2.5x10-1
2.0x10-1
1.5x10-1
n + 197Au 0.5 mm
ENDF/B-VII
2x10-2
3x10-2
4x10-2
Energy [eV]


Capture Yield
10^0
10^-1
n + 197Au 0.5 mm
ENDF/B-VII
4x10^0
5x10^0
6x10^0
Energy [eV]


10-3
10-1
10^0
10^1
Energy [eV]

Please have a look at:

- **14:30-15:00 Cristian Massimi et al.: The neutron resonance parameters of ^{197}Au from transmission, capture and self-indication measurements at GELINA.**

Conclusion

- Design and control of experimental parameters is of paramount interest for precise cross section measurements.
- Combination of transmission and capture measurements
- Dedicated measurements in thermal flux are useful
- Cd: capture and transmission final up to 1.5 keV
- Rh: measurements finished; analysis: „fine-tuning“
- Au: completed; see C. Massimi et al.