Transmission experiments

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CIEMAT

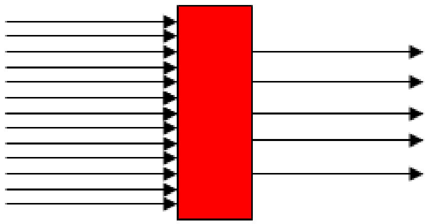
Transmission

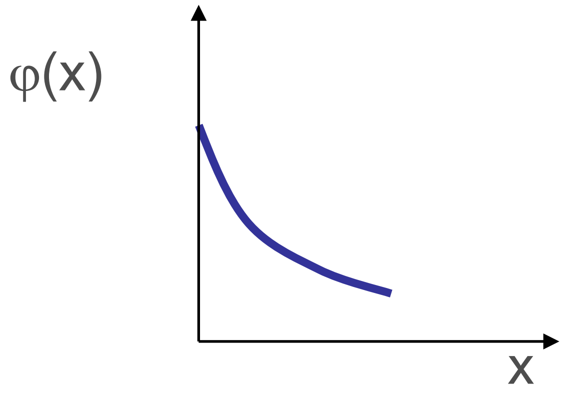
Fraction of the incident neutron beam traversing a sample without any interaction

Parallel neutron beam, perpendicular to a slab of material :

Transmission
Lambert-Beer law

$$T = \frac{\varphi(d)}{\varphi(0)} = e^{-n\,\sigma_{tot}}$$





$$n_j = \frac{1}{A} N_A \frac{m}{m_x}$$

m	:	target mass	(g)
m_X	:	atomic mass nuclide	(g)
N_A	:	Avogadro number	
A	:	target area	(cm^2)

Transmission measurements

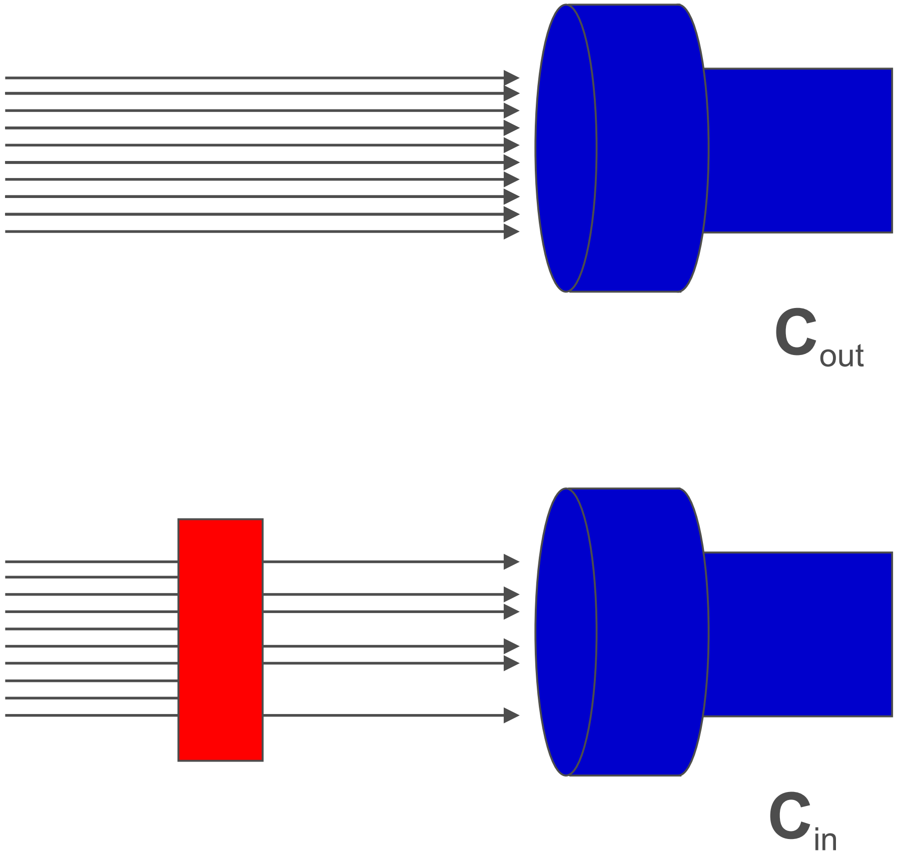
Transmission

$$T_{exp} = \frac{C_{in}}{C_{out}} \propto e^{-n\sigma_{tot}}$$

- Incoming neutron fluence rate cancels
- Detection efficiency cancels

$\Rightarrow$ Absolute measurement

$\Rightarrow$ Direct relation between T_{exp} and σ_{tot}



Transmission : principle

$$T_{exp} = \frac{C_{in}}{C_{out}} \propto e^{-n\sigma_{tot}}$$

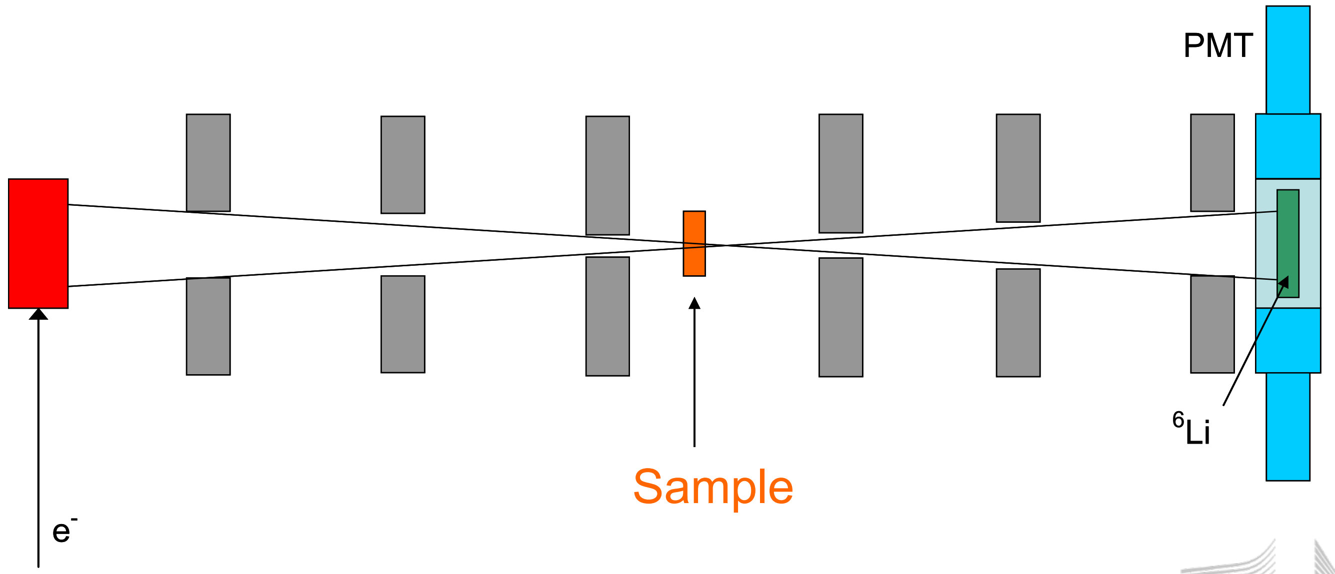
(1) All detected neutrons passed through the sample

(2) Neutrons scattered in the sample do not reach detector

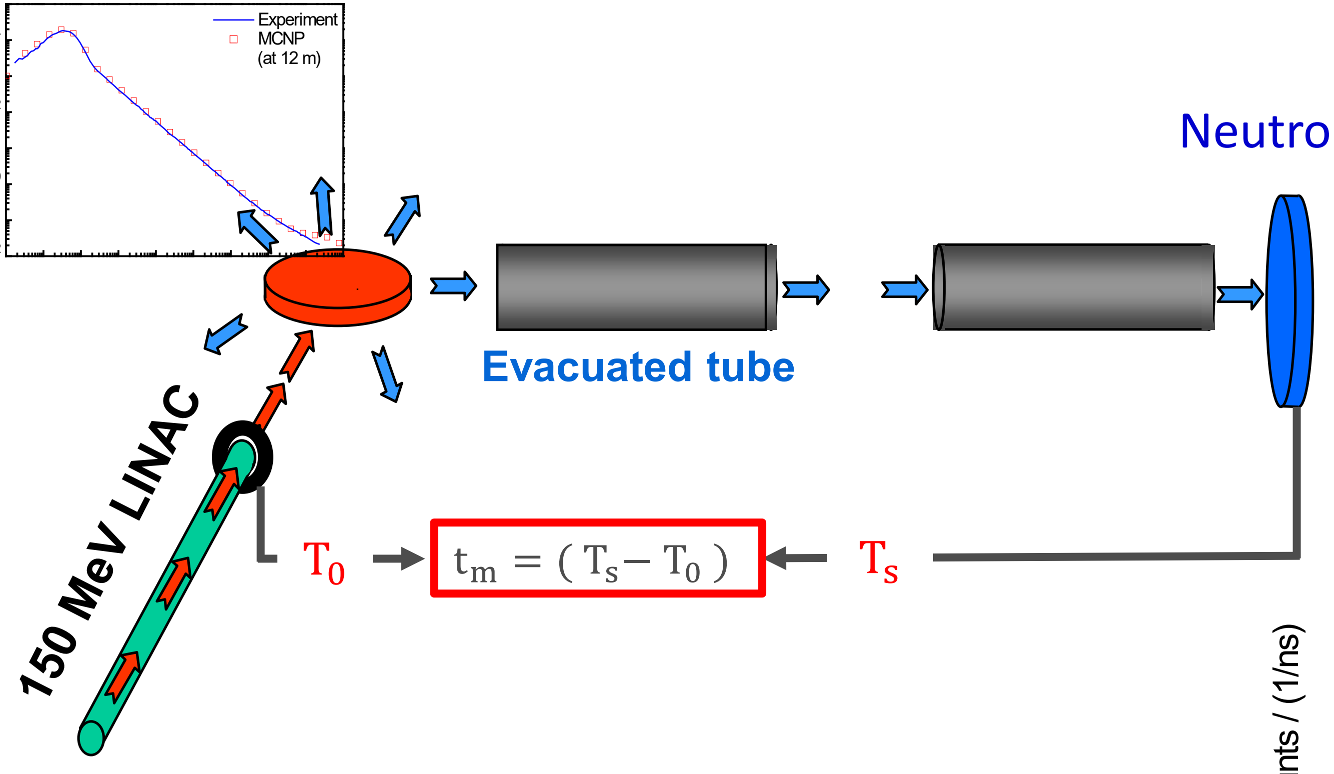
(3) Sample perpendicular to parallel neutron beam

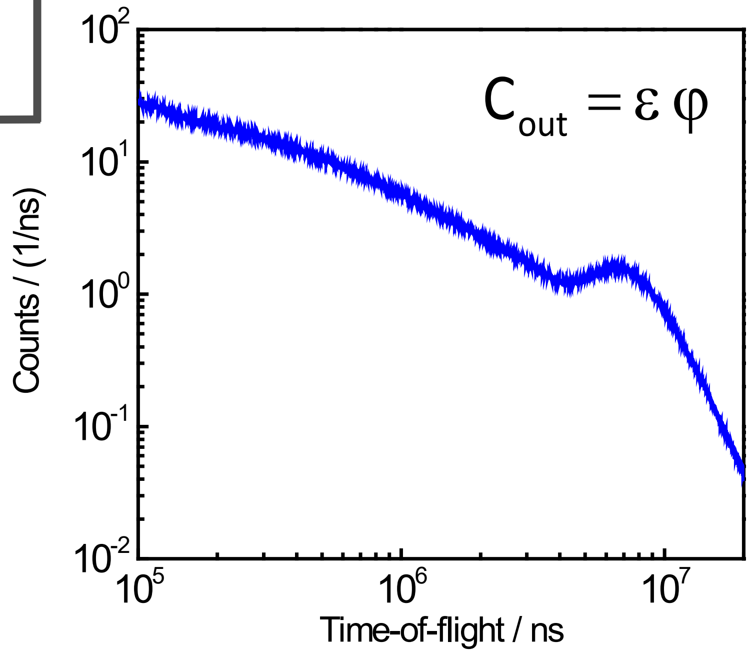
$\Rightarrow$ Good transmission geometry (collimation)

(4) Homogeneous sample (no spatial distribution of n)



TOF-cross section measurements: transmission

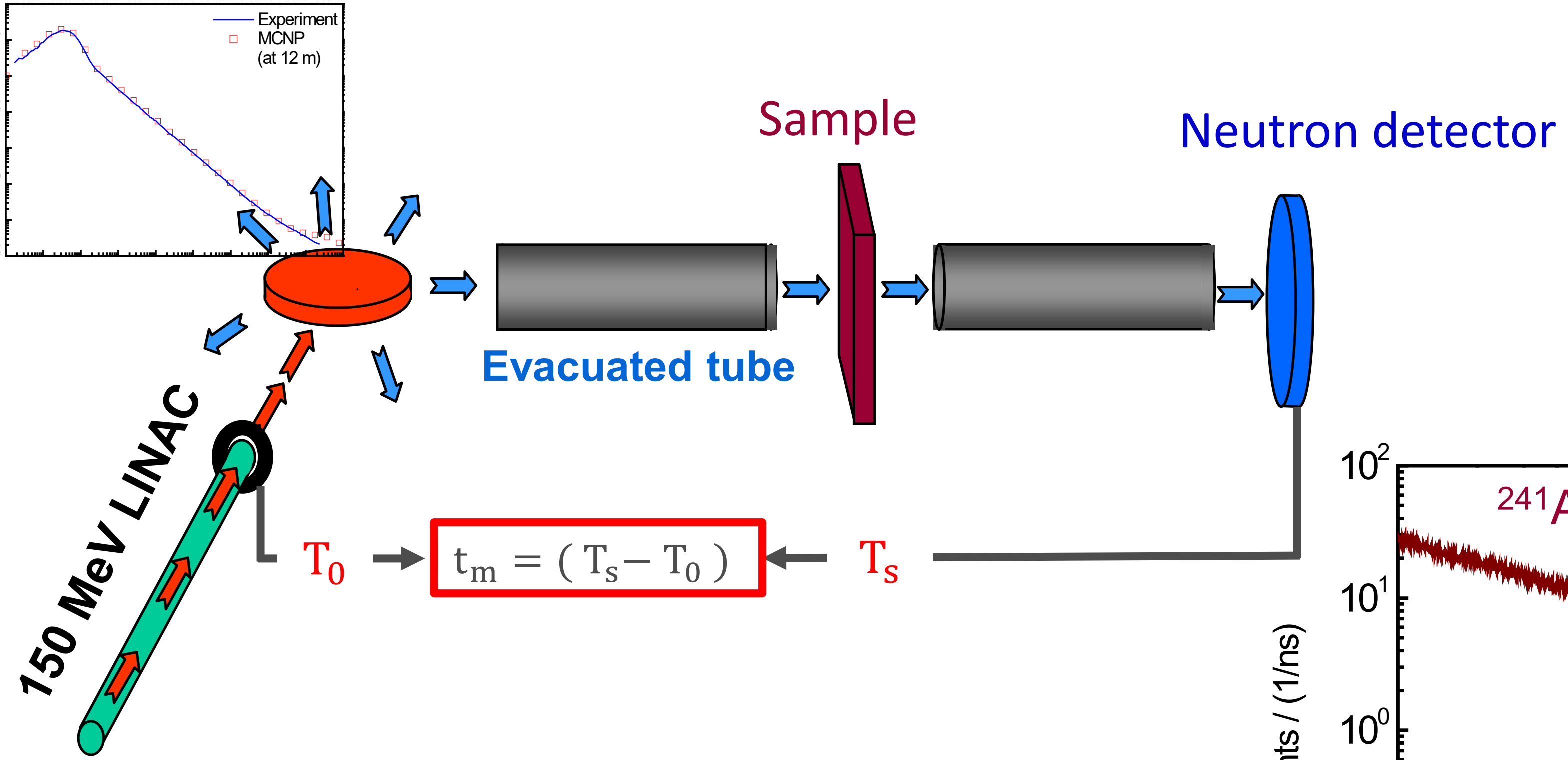


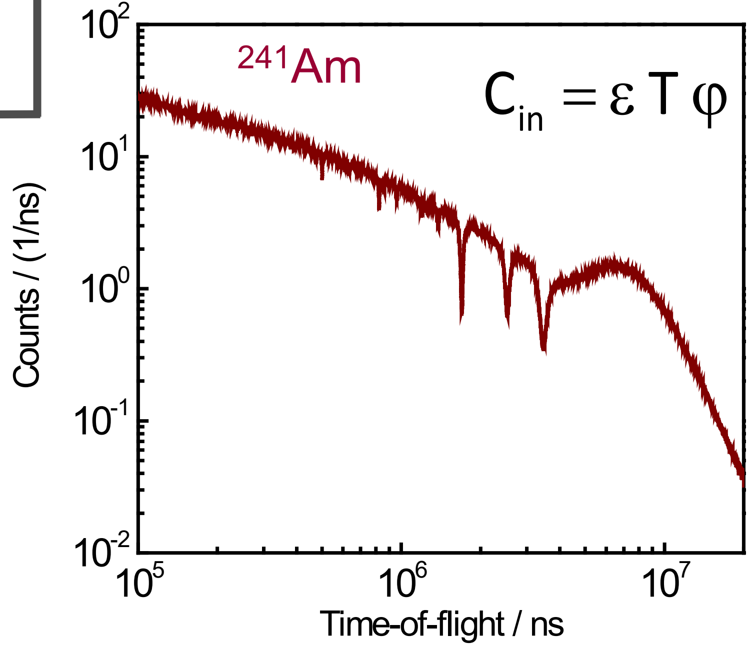


L : distance between target and detector

t_m : observed time-of-flight

TOF-cross section measurements: transmission





L : distance between target and detector

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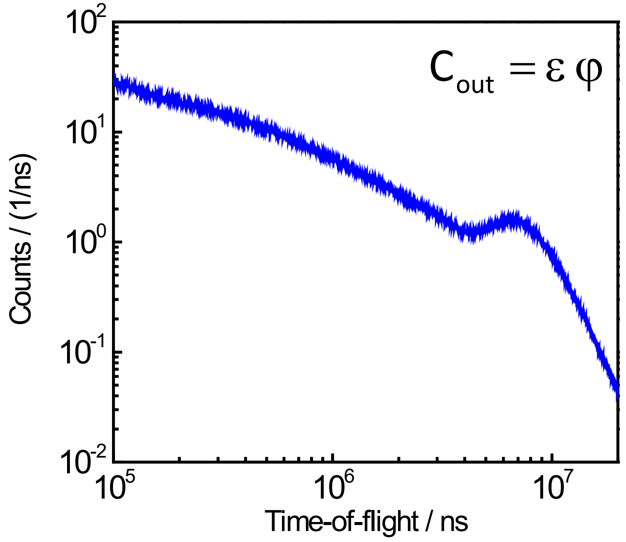
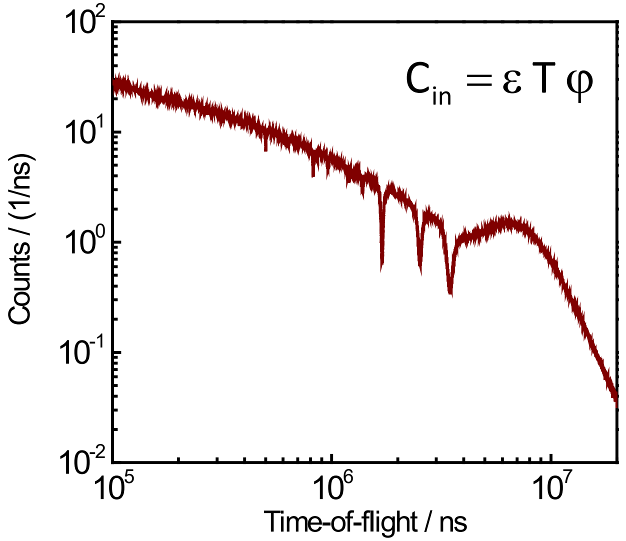
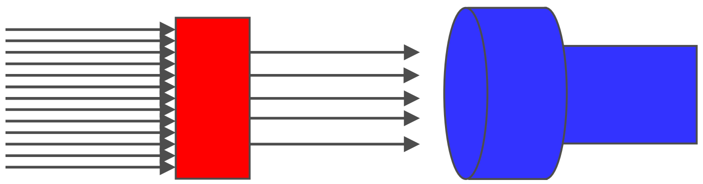
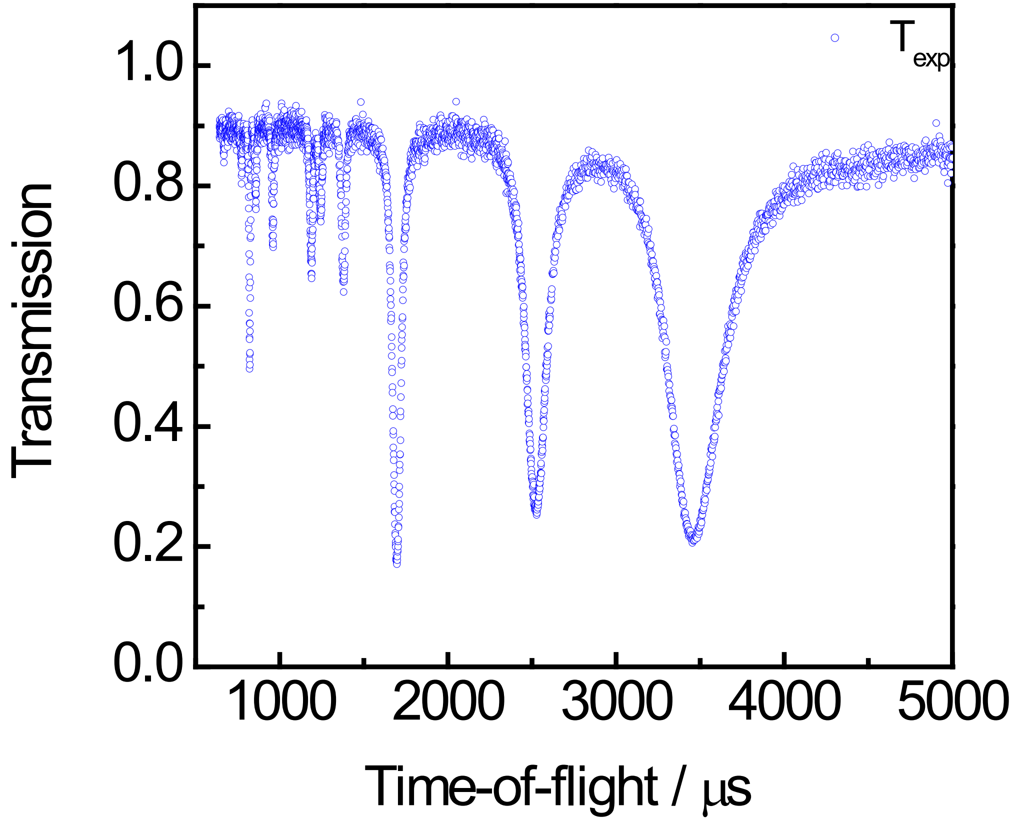
Transmission experiment





$$T_{exp} = \frac{C_{in}}{C_{out}}$$





Transmission data : ^{241}Am + n

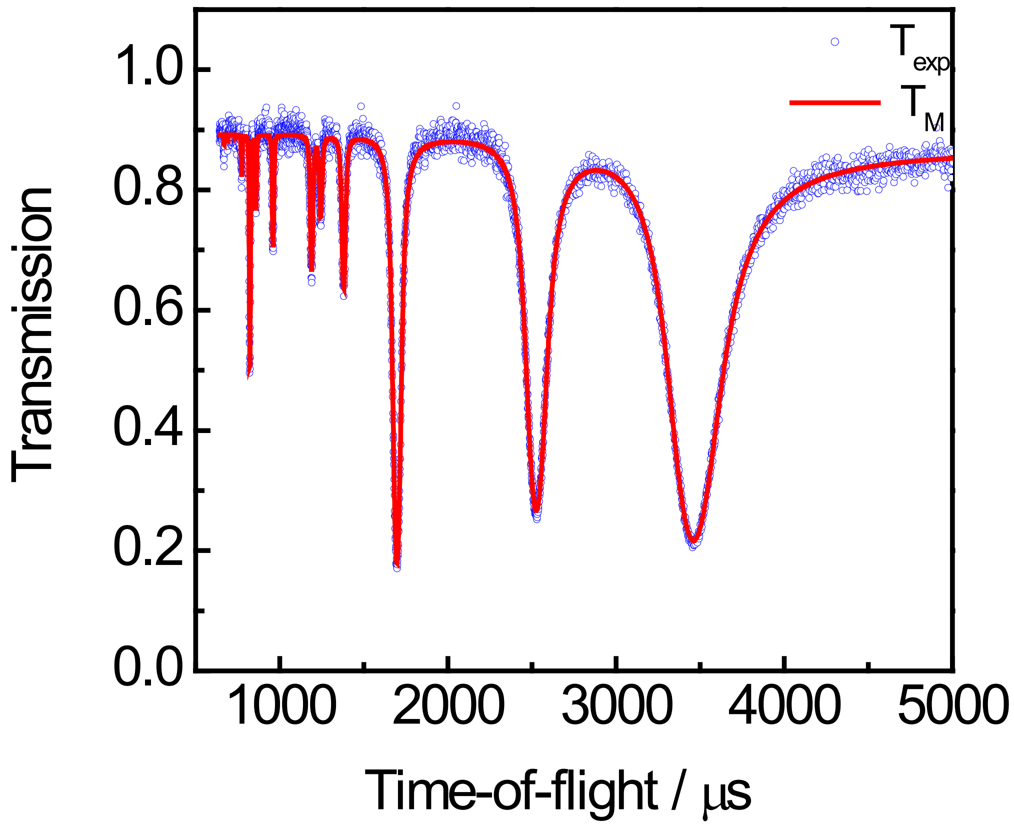
Determine resonance parameters from a LSQ fit to the data (REFIT)

$$T_{exp} = N\frac{C_{in} - B_{in}}{C_{out} - B_{out}} \qquad \frac{u_{T_{exp}}}{T_{exp}} \leq 0.25\%$$

$\Rightarrow$absolute measurement

$\Rightarrow$no calibration measurement required

$$\chi^2(\mathbf{RP}) = (T_{exp} - T_M)^T\, V_{T_{exp}}^{-1}\, (T_{exp} - T_M)$$



$$T_M(t_m) = \int R(t_m, E)\, e^{-n\, \bar{\sigma}_{tot}(E_n)}\, dE_n$$

$R(t_m, E)$	:	response of TOF-spectrometer
$\bar{\sigma}_{tot}$	:	Doppler broadened total cross section
n	:	areal number density
		total number of atoms per unit area

Literature

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