DE LA RECHERCHE À L'INDUSTRIE

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Measurements of light water double differential cross sections in cold operating conditions: P=1 bar, 300 K < T < 350 K

Juan Pablo Scotta[1], Gilles Noguere[1], Emmanuel Farhi[2],

Yoann Calzavara[2] , Stephane Rols[2], Jacques Ollivier [2],

Vaibhav Jaiswal[3], Luiz Leal[3]

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[1] CEA Cadarache, France
[2] Institute Laue-Langevin, France
[3] Institut de Radioprotection et de Sûreté Nucléaire, France

OUTLINE OF THE PRESENTATION

- Context and motivation of the work
- ILL time-of-flight spectrometers IN4 and IN6
- Experimental conditions set-up
- Results
- Conclusions and future work

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CONTEXT AND MOTIVATION OF WORK

- Light water differential cross section data is important to validate new models to improve the physical description of this material.

- The data available for open consultancy is old and accurately poor (in EXFOR database there is no existing data).

- Measures at cold reactor conditions (room temperature and pressure) were done in EOLE reactor at CEA Cadarache (Mistral benchmark). Therefore the need to have experimental data at same thermodynamic conditions.

CONTEXT AND MOTIVATION OF WORK

Summary of published data of double differential cross section of light water

• **Bischoff et al. (RPI, 1967)**	T=300K	E_0 = 154meV (θ = 14°, 25°, 40°, 60°, 90°, 120°) E_0 = 231meV (θ = 14°, 25°, 40°, 60°, 90°, 120°) E_0 = 332meV (θ = 14°, 25°, 40°, 60°, 90°, 120°) E_0 = 499meV (θ = 14°, 25°, 40°, 60°, 90°, 120°) E_0 = 631meV (θ = 14°, 25°, 40°, 60°, 90°, 120°)
• **Esch et al. (RPI, 1971)**	T=300K	E_0 = 40meV (θ = 10°, 14°, 25°, 40°, 60°, 90°) E_0 = 154meV (θ = 14°, 25°, 40°, 60°, 90°, 120°) E_0 = 233meV (θ = 14°, 25°, 40°, 60°, 90°, 120°) E_0 = 333meV (θ = 10°, 14°, 25°, 40°, 60°, 90°) E_0 = 500meV (θ = 14°, 25°, 40°, 60°, 90°, 120°) E_0 = 632meV (θ = 10°, 14°, 25°, 40°, 60°, 150°)
	T=443K	E_0 = 40meV (θ = 10°, 14°, 25°, 40°, 60°, 90°) E_0 = 233meV (θ = 14°, 25°, 40°, 60°, 90°, 120°) E_0 = 333meV (θ = 10°, 14°, 25°, 40°, 60°, 90°) E_0 = 500meV (θ = 14°, 25°, 40°, 60°, 90°, 120°)
	T=543K	E_0 = 154meV (θ = 10°, 14°, 25°, 40°, 60°, 90°) E_0 = 333meV (θ = 10°, 14°, 25°, 40°, 60°, 90°) E_0 = 632meV (θ = 10°, 25°, 40°, 60°, 90°, 150°)
• **Novikov et al. (IBR, 1986)**	T=300K	E_0 = 8meV (θ = 12°, 37°)
• **Bellisent-Funel (ILL, 1984)**	T=300K	E_0 = 2.3meV (θ = 64°)

Necessity of new measurements with more accurate data

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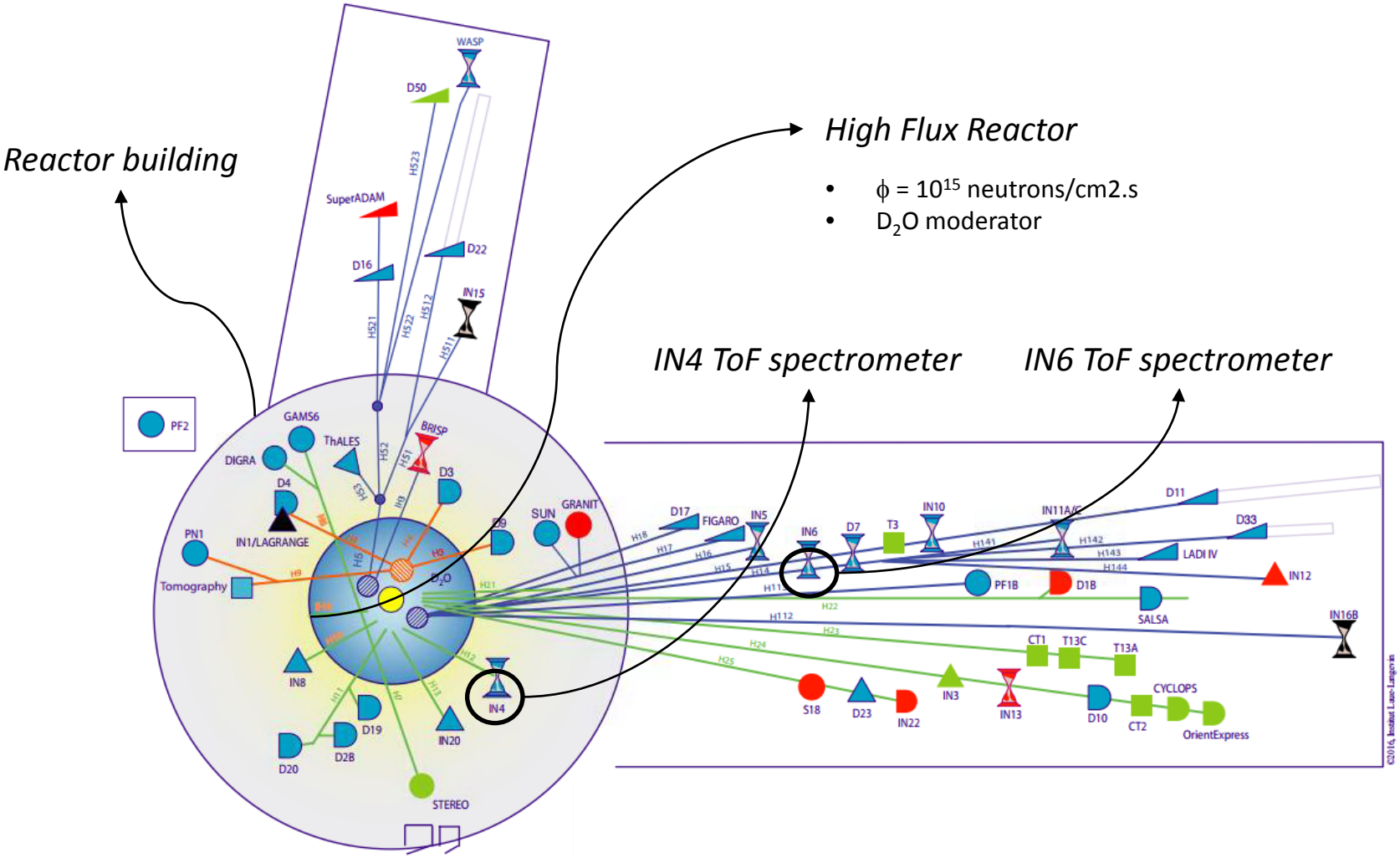
ILL TIME OF FLIGHT SPECTROMETERS

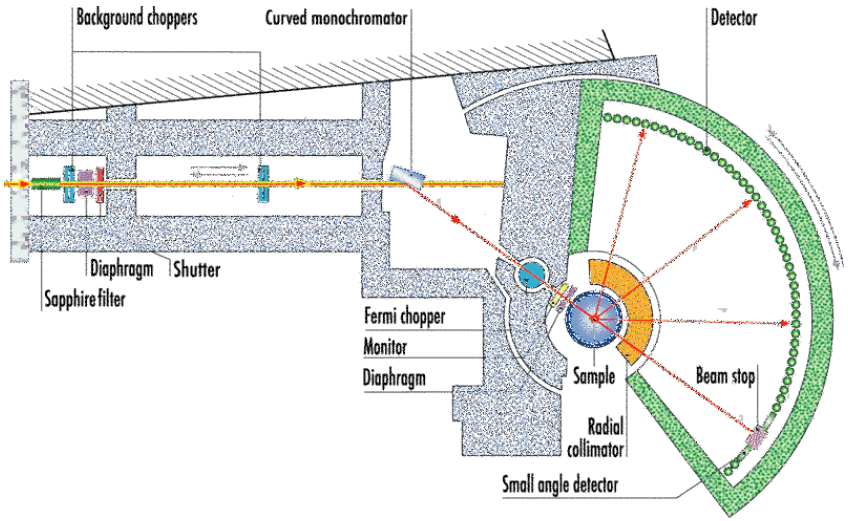
Institute Laue-Langevin (Grenoble, France)



ILL TIME OF FLIGHT SPECTROMETERS

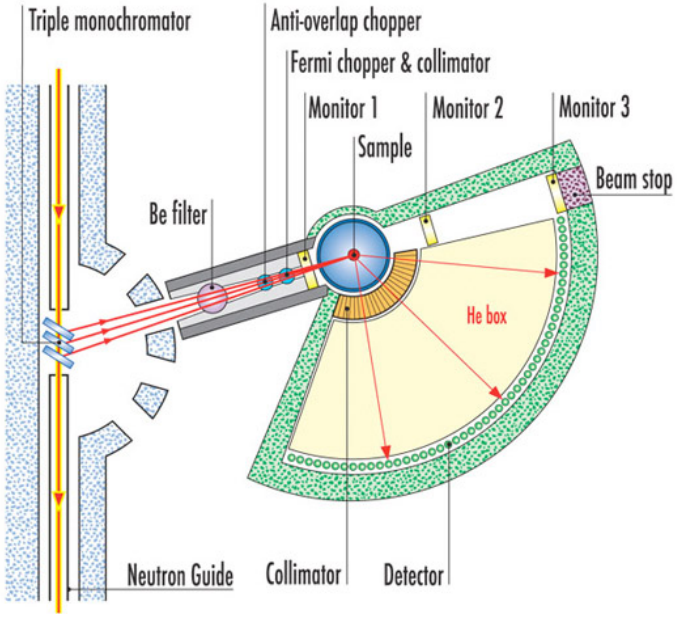
Institute Laue-Langevin (Grenoble, France)

IN4 ToF spectrometer



- Selected incident neutron energy E_0 = 14.5meV
- Scattering angle θ = [15 ; 120]

IN6 ToF spectrometer



- Selected incident neutron energy E_0 = 3.1meV
- Scattering angle θ = [15 ; 110]

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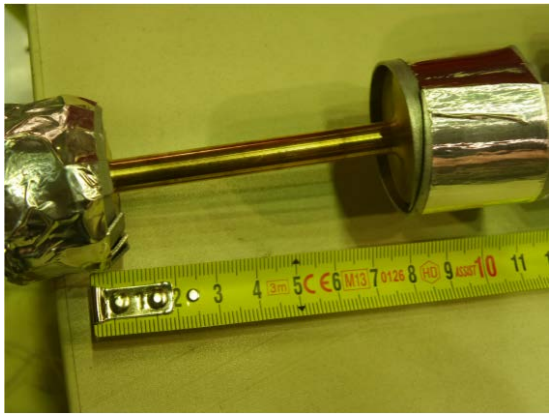
EXPERIMENTAL CONDITIONS SET-UP

Characteristics of the sample holder



Cu(Be)
ϕ_{int} = 6 mm
ϕ_{ext} = 8 mm
h = 70 mm

Summary of the measurement conditions

E_0 = 14.5 (meV) – IN4			
	T	**P**	**$T_{measure}$**
H_2O	300K	1 b	2.5 h
Empty Cell	~320K	1 b	7 h
Vanadium	300K	1 b	4.5 h

E_0 = 3.1 (meV) – IN6			
	T	**P**	**$T_{measure}$**
H_2O	350K	1 b	4 h
Empty Cell	500K	1 b	14.5 h
Vanadium	290K	1 b	1.5 h

- ✓ The **H_2O**, **Vanadium** and **Empty Cell** counts were normalized to the monitor counts (located before the sample) and corrected to the detector's efficiency.
- ✓ Background is subtracted to the sample and renormalized to Vanadium: $H_2O^* = \frac{H_2O - EC}{V}$

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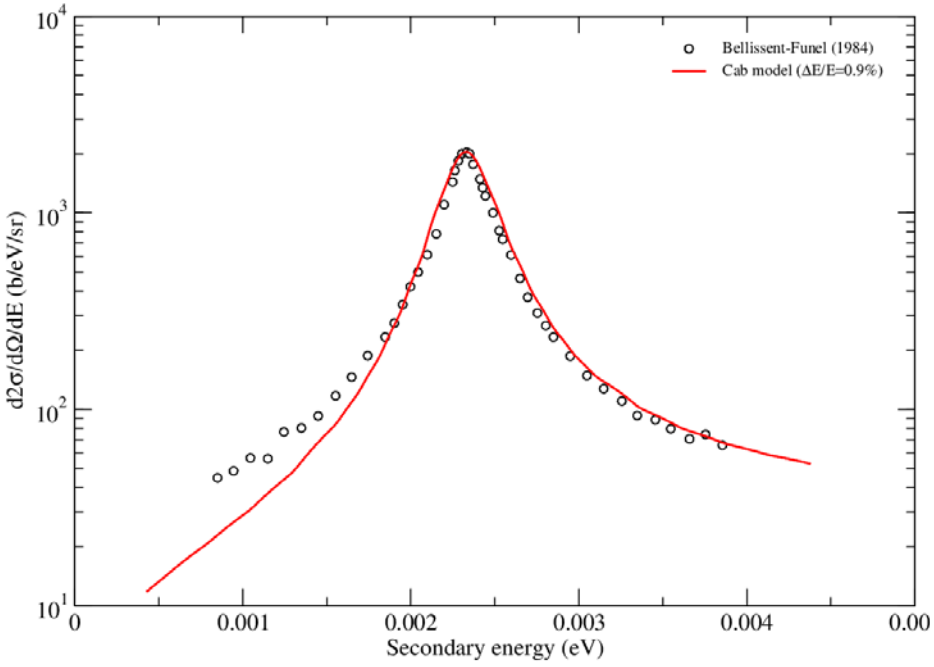
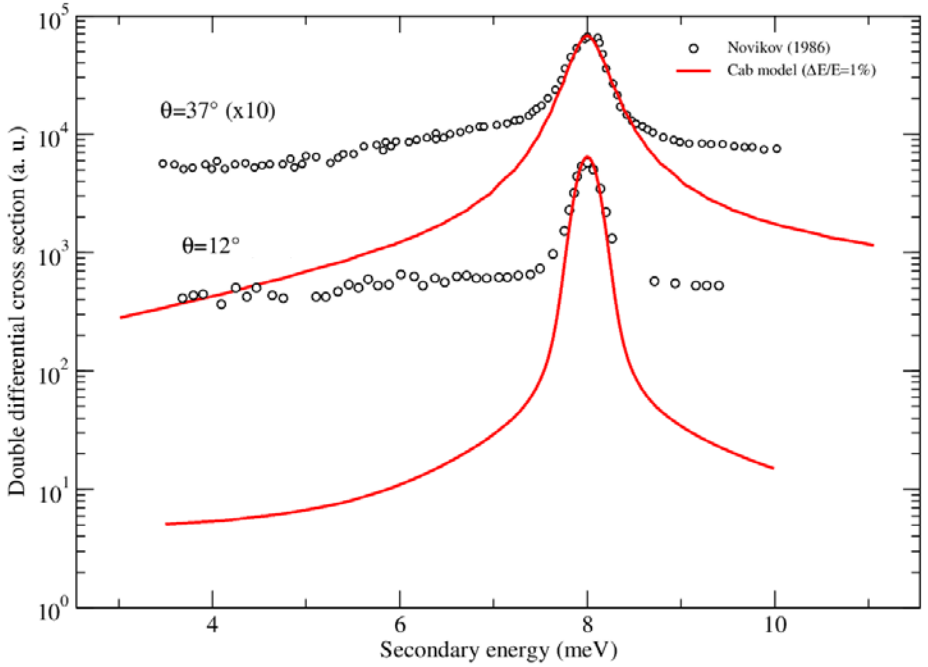
RESULTS

Bellissent-Funel (1984)
E_0 = 2.4 meV
θ = 64°
T = 300K

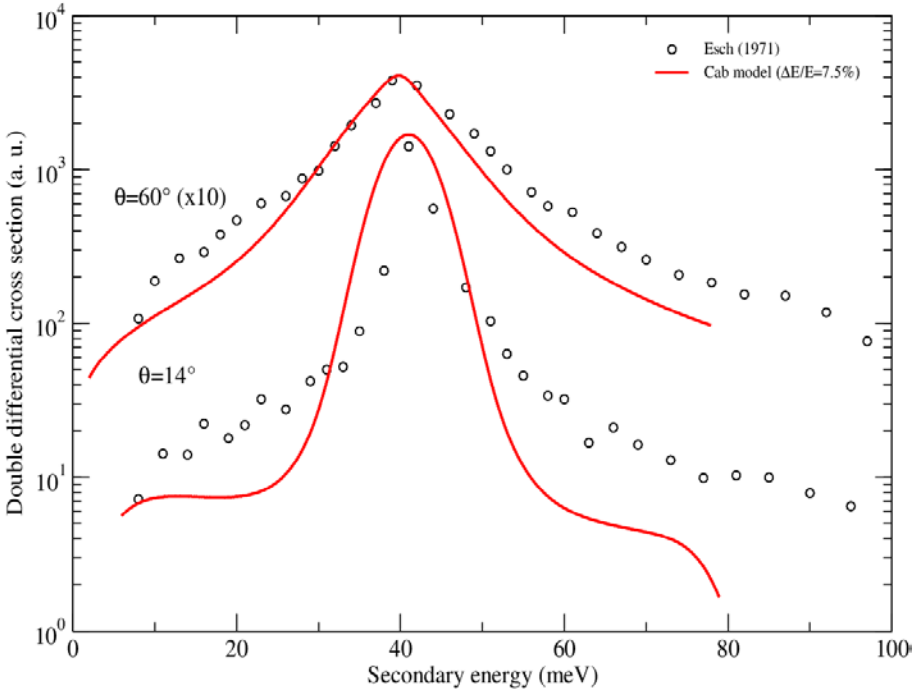


Novikov (1986)
E_0 = 8 meV
θ = 12°, 37°
T = 300K

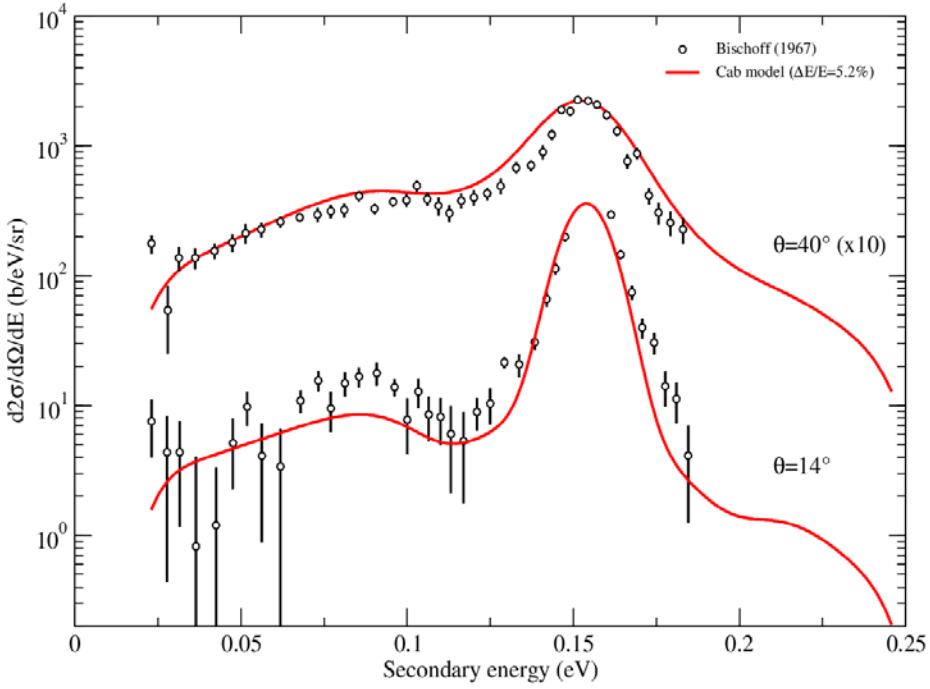


RESULTS

Esch (1971)
E_0 = 40 meV
θ = 14°, 60°
T = 300K

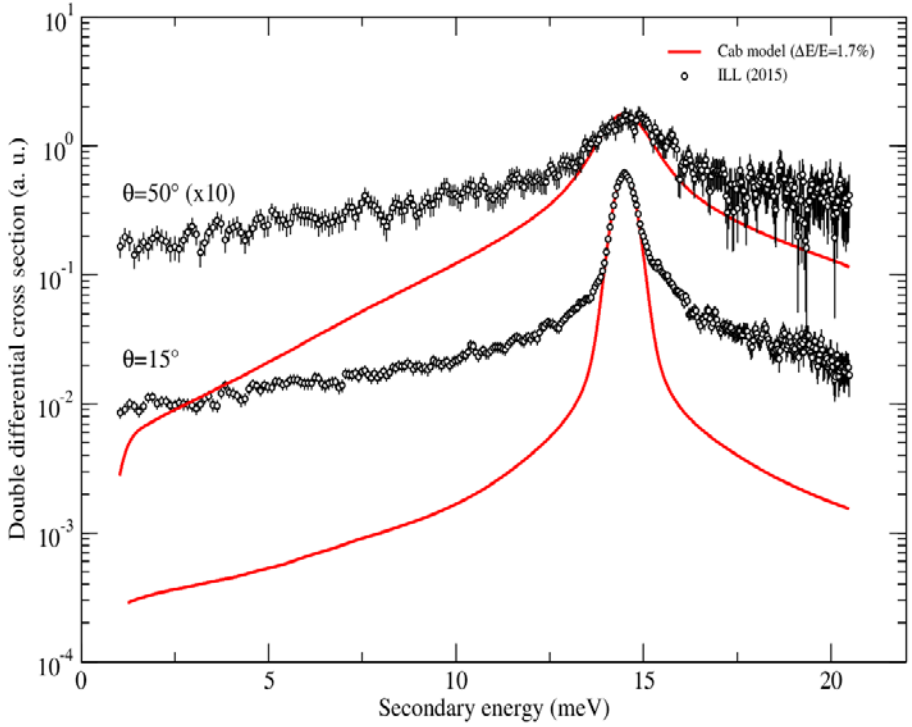


Bischoff (1967)
E_0 = 154 meV
θ = 14°, 40°
T = 300K

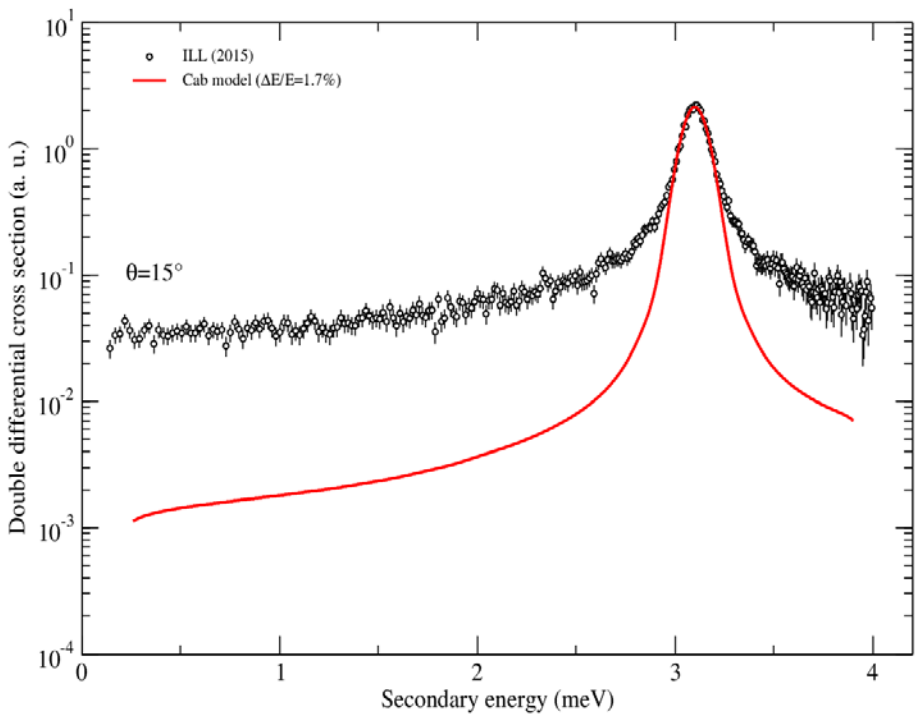


RESULTS – THIS WORK

IN4 ToF Spectrometer
E_0 = 14.5 meV
θ = 15° , 50°
T = 300K



IN6 ToF Spectrometer
E_0 = 3.1 meV
θ = 15°
T = 350K



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CONCLUSIONS AND FUTURE WORK

1. The sample thickness in our experiment is comparable to the neutron mean free path at the measured energy. The multiple scattering contribution might be important(corrections to be done).

2. Background component becomes very important for scattering angles larger than ~40°. An attenuation coefficient of the empty cell “angle dependent” should be applied to improve data reduction process.