

# Testing a new thermal scattering law for $C_5H_8O_2$

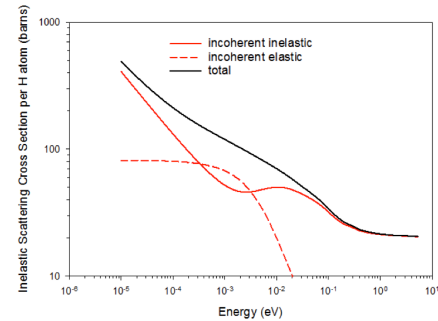
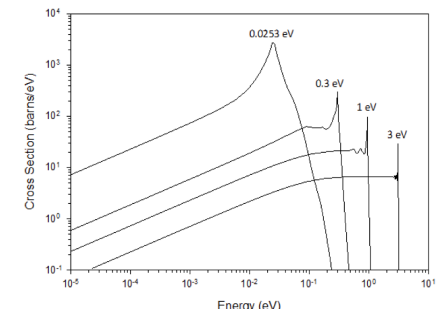
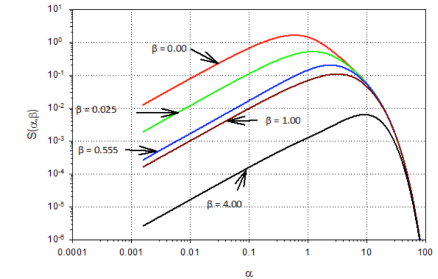
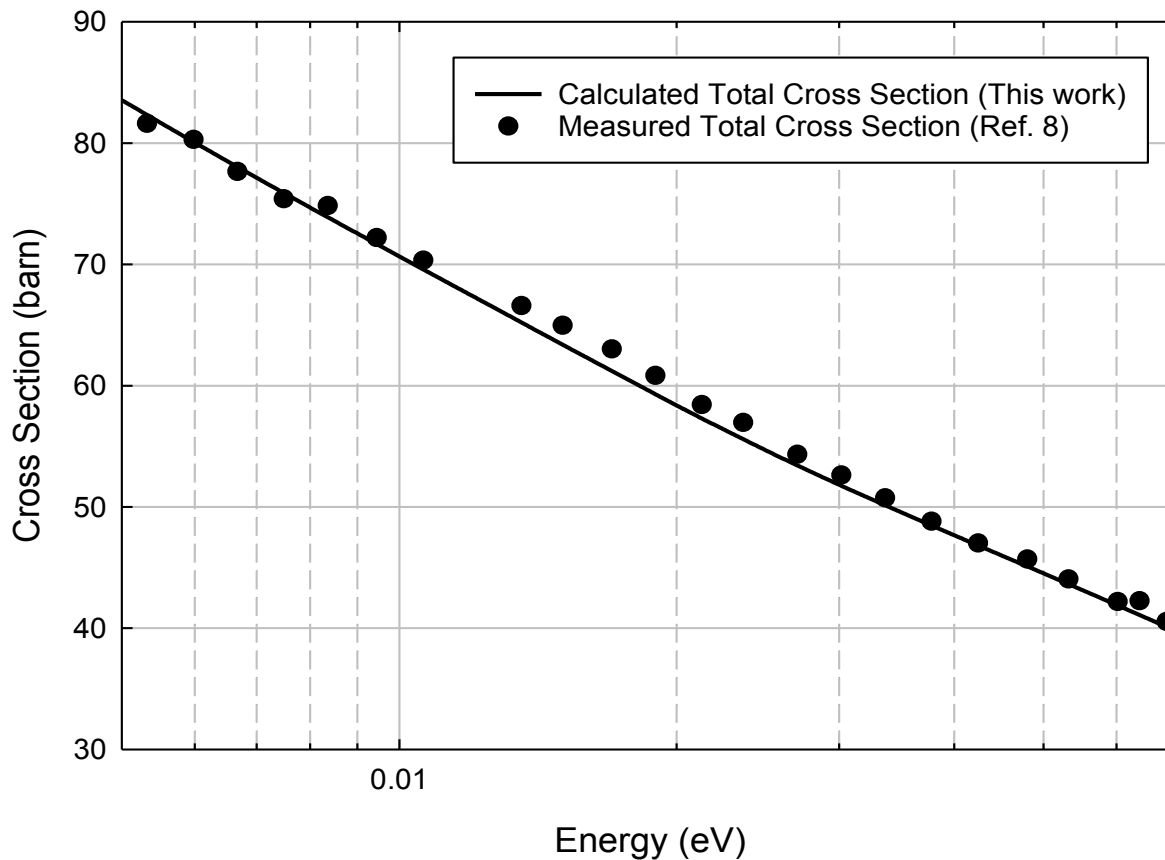
## (Tradenames: Lucite, Plexiglas, Perspex)

Presented to the Nuclear Data Advisory Committee  
November 4, 2015 at Brookhaven National Laboratory

Dave Heinrichs  
Chuck Lee  
Ed Lent

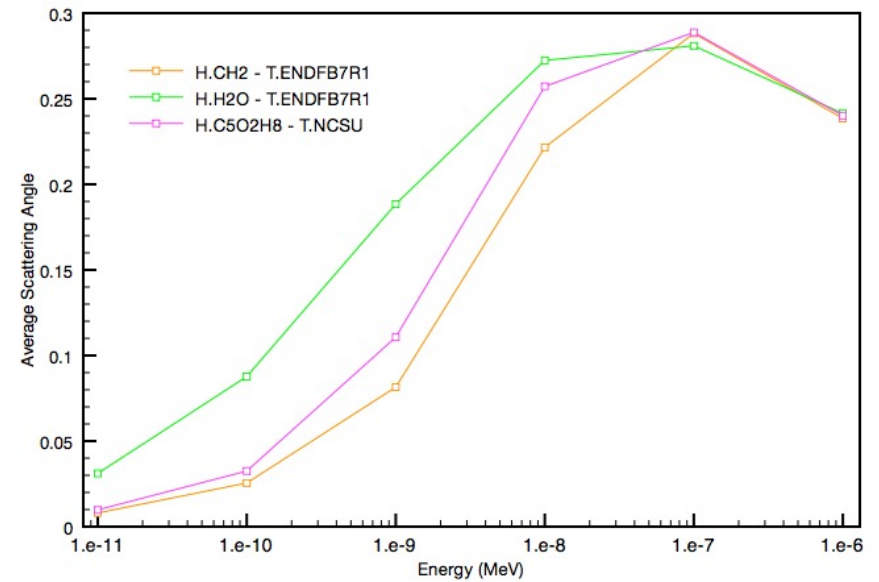
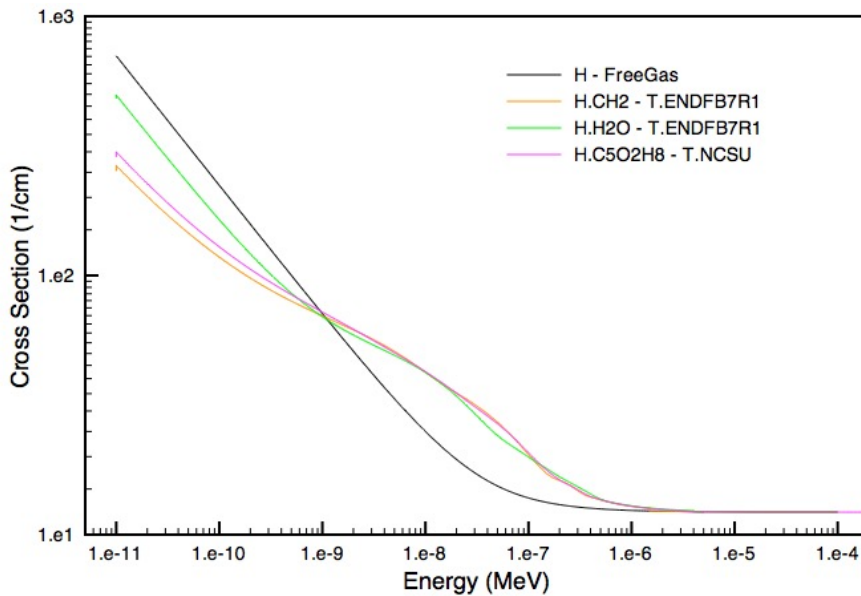


# The total cross-section for Lucite ... A. Hawari



A. Hawari et al., *Analysis of Thermal Neutron Scattering in Polymethyl Methacrylate (Lucite)*, TANSO (Nov. 2015)

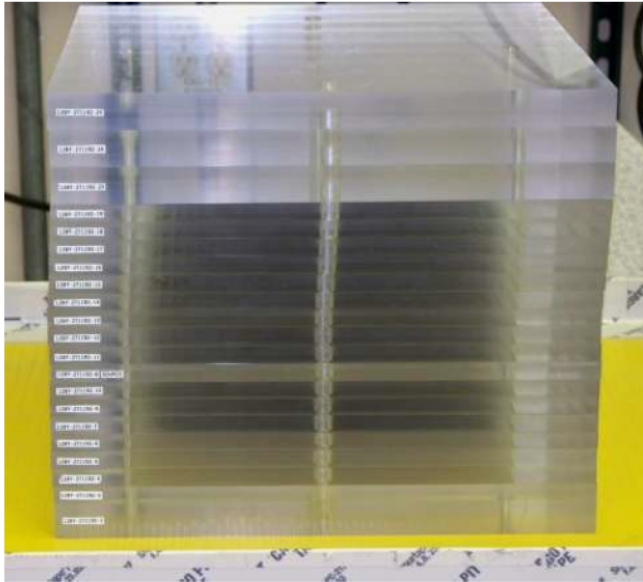
# Lucite - Polyethylene - Water



Lucite and polyethylene total cross sections are nearly identical where it matters – differences in the angular distributions

# Critical benchmarks

- LANL class foils in Lucite



**Inensitive**

- TEX

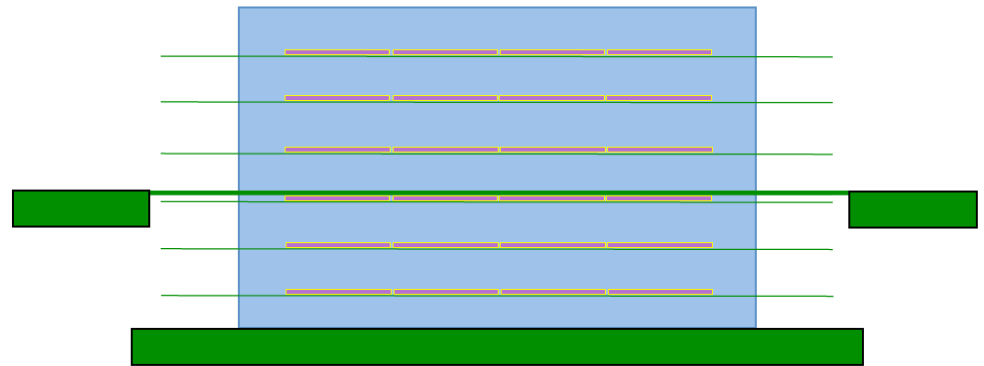


Figure 3.16. Experimental Configuration for Experiment 5: ZPPR Plate Layers with 1" Interspersed Polyethylene. This experiment consists of 6 layers of Pu.

**Sensitive**

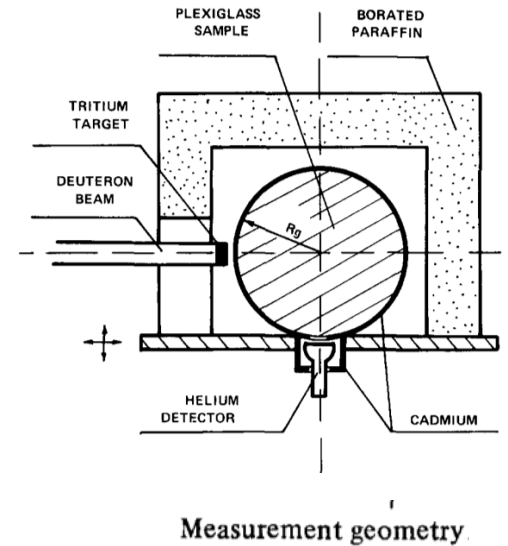
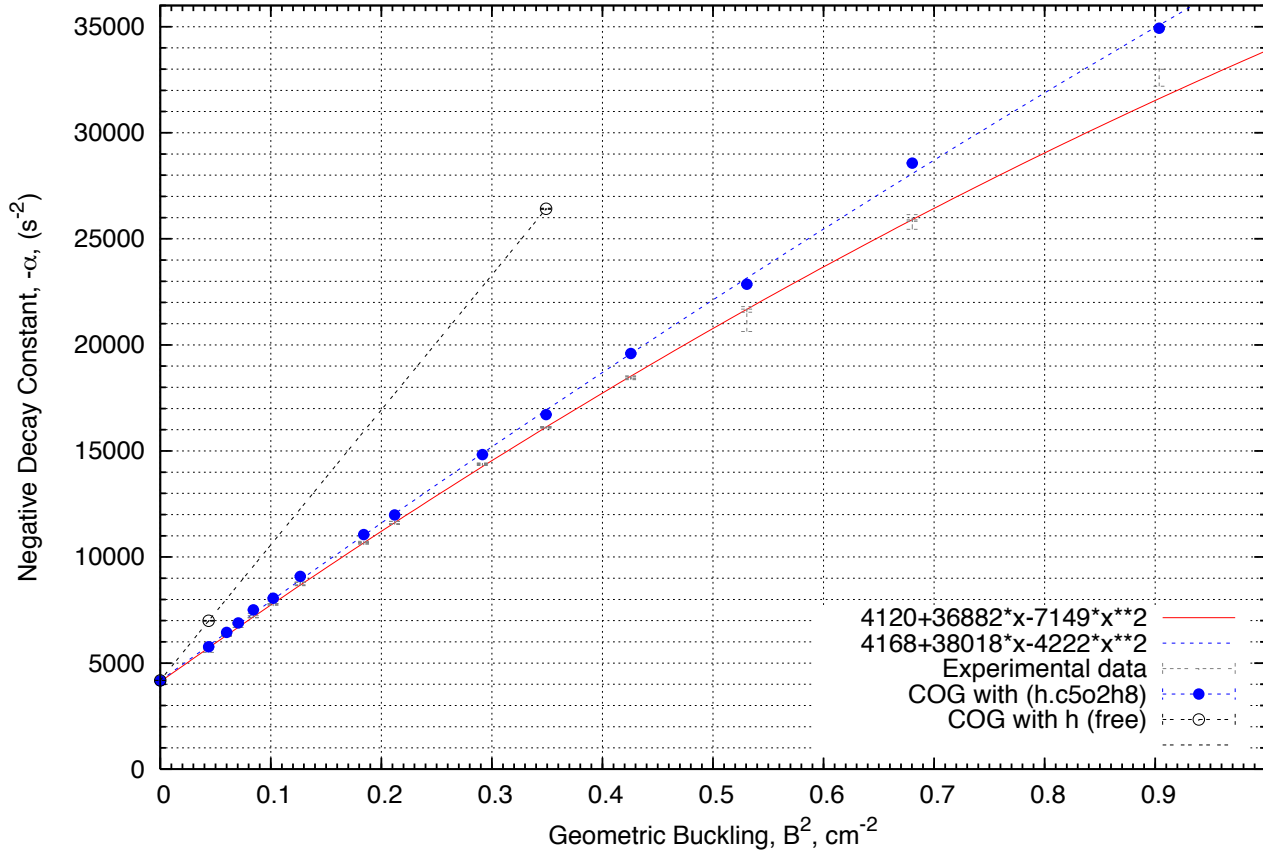
No current ICSBEP benchmarks are sensitive to Lucite thermal scattering.

# Pulse die-away benchmarks

$$-\alpha = \lambda_0 = \overline{\nu\Sigma_a} + D_0 B^2 - CB^4 + O(B^6),$$

$$B^2 = \left(\frac{\pi}{R+d}\right)^2, \quad d = \frac{2.28 D}{1 + 2.28 D/R}, \quad D = D_0(\overline{1/\nu}).$$

$-\alpha$  versus  $B^2$  for Lucite Spheres



K. Drozdowicz et al., *Thermal Neutron Diffusion Parameters for Plexiglass*, Nuclear Instruments and Methods 178 (1980) 513-516

# Diffusion parameters

Reference	Year	$\nu\Sigma_a$ (s <sup>-1</sup> )	$D_0$ (cm <sup>2</sup> s <sup>-1</sup> )	$C$ (cm <sup>4</sup> s <sup>-1</sup> )	$F$ (cm <sup>6</sup> s <sup>-1</sup> )
Hawari <sup>1</sup>	2015	4,168	38,018 ± 390	-4,222 ± 556	
Hawari <sup>2</sup>	2015	4,216 ± 100	37,758 ± 672	-3,971 ± 773	
Sibona	1991	4,167 ± 10	37,360 ± 20	-4,150 ± 10	
Drozdowicz <sup>2</sup>	1987	4,276 ± 69	35,290 ± 472	-4,785 ± 578	
Drozdowicz	1987	4,120 ± 30	37,048 ± 60	-4,900 ± 137	
Drozdowicz	1980	4,130 ± 30	36,882 ± 314	-7,149 ± 615	
Yurova	1975	4,110 ± 30	35,600 ± 300	-6,100 ± 500	
Graffstein	1966	4,030 ± 150	36,200 ± 1,500	-5,680 ± 1,800	
Graffstein	1966	4,030 ± 150	35,700 ± 1,500	-4,280 ± 1,800	-940 ± 2,000
Čopič	1964	4,015 ± 350	36,500 ± 2,000	-2,800 ± 2,200	

Notes: <sup>1</sup>GNU PLOT fit to  $D_0$  and  $C$  (only). <sup>2</sup>GNU PLOT fit to  $\nu\Sigma_a$ ,  $D_0$  and  $C$ . Other values as published by the referenced authors.



# Conclusions

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- Cross section for Lucite similar to  $\text{CH}_2$  but angular differences
- Possible to design critical benchmarks sensitive to TSL
- Pulse die-away benchmarks are sensitive to TSL if small
- Lucite diffusion parameters consistent with Sibona and Drozdowicz
- Drozdowicz experimental errors appear to be too small
- ACE data working well in COG; File 7 to be tested
- Ice (coming soon)