Thermal Neutron Simulation From Different Geometries

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Monte Carlo Simulation:

- Computation technique to estimate possible outcomes of a process, using repeated random sampling.

Cross Section and Mean Free Path data for thermal neutrons (E ~ 25.3 meV):

Table 1. JANIS cross section data for thermal neutrons.

	Absorption	Scattering
	σ (cross section, barns)	
^{1}H	0.332	20.491
^{2}D	0.000506	3.390
^{8}O	0.000190	3.761

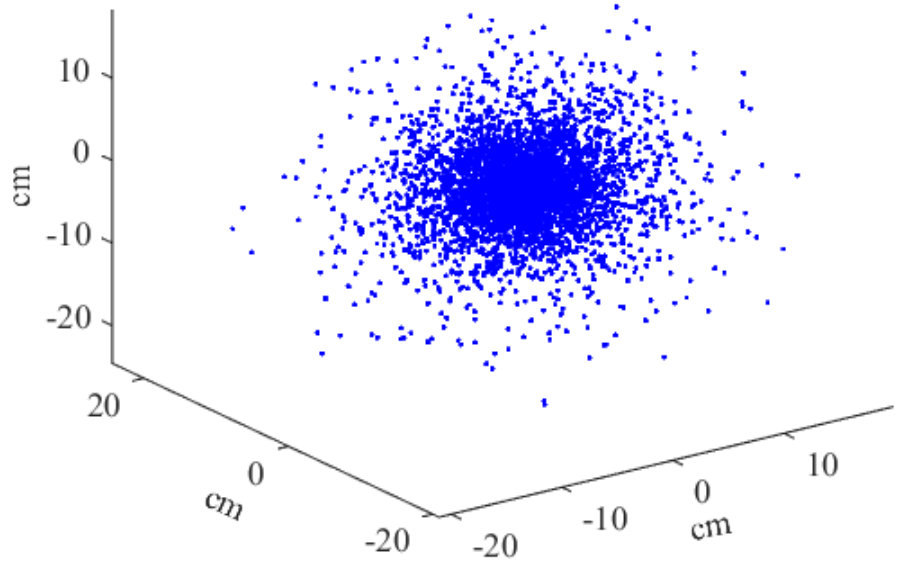
Table 2. Calculated mean free path for thermal neutrons.

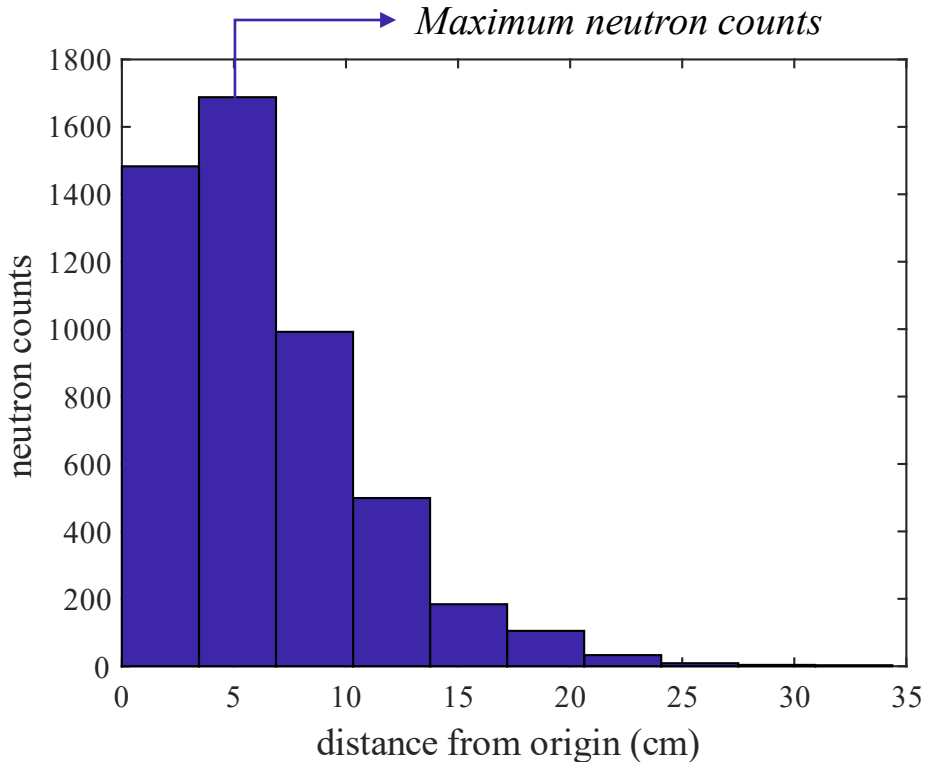
	Absorption	Scattering
	λ (mean free path, cm)	
H_2O	45.1766	0.6706
D_2O	24994.0175	2.8501

• Point Source @ (0,0,0): H_2O

MC simulation for 5K neutrons, *for 25 such data*:

- Scattering counts before absorption (aka n history): 68.2748 ± 0.7224
- Mean of neutron distance: 6.2716 ± 0.0512 cm
- Maximum neutron distance: 38.2243 ± 5.7061 cm

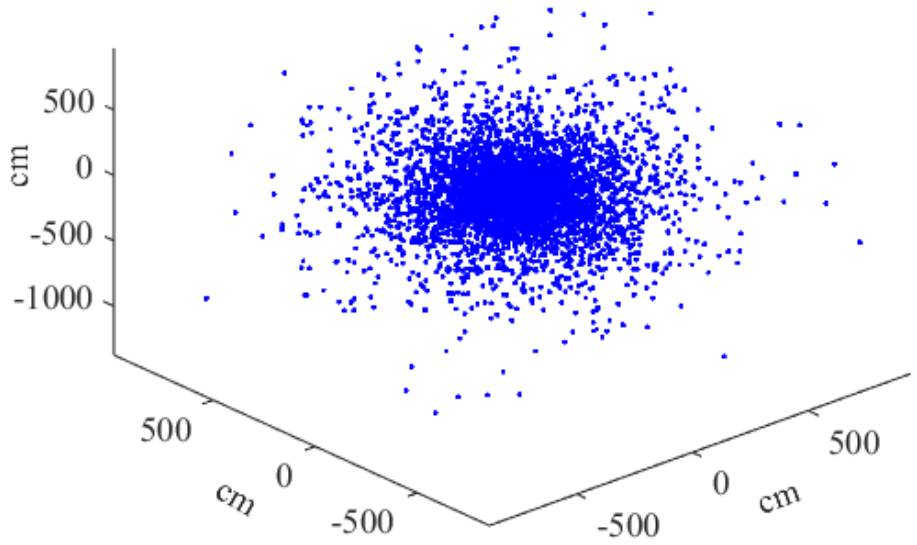


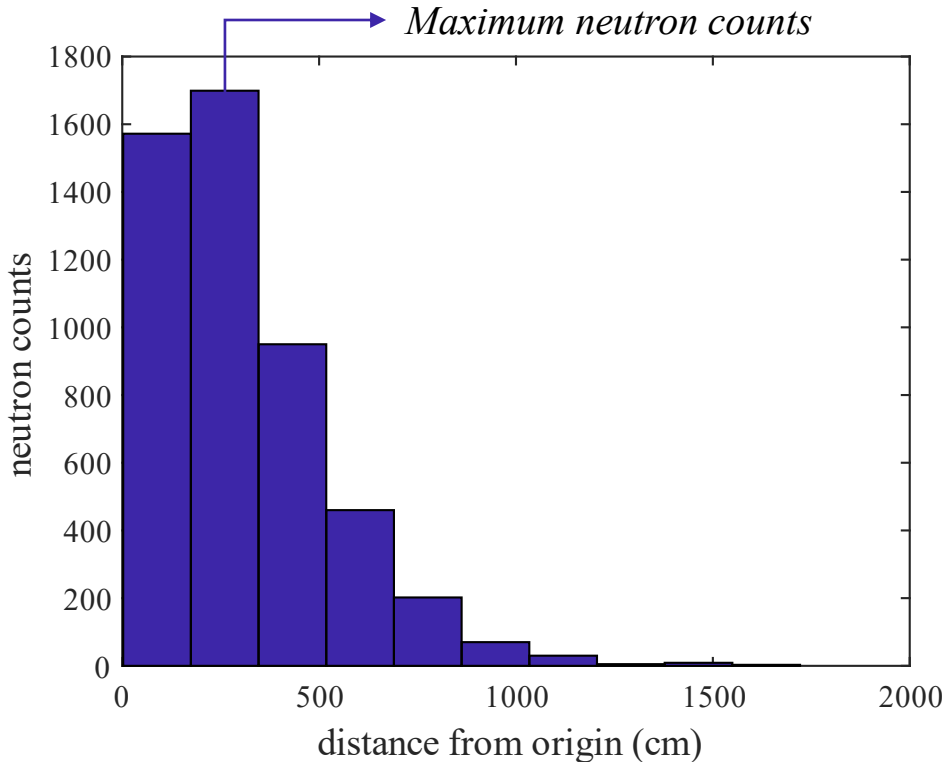


• Point Source @ (0,0,0): D_2O

MC simulation for 5K neutrons, *for 25 such data*:

- Scattering counts before absorption (aka n history): 8795.1912 ± 138.0917
- Mean of neutron distance: 308.5265 ± 2.8019 cm
- Maximum neutron distance: 1793.4059 ± 218.9170 cm

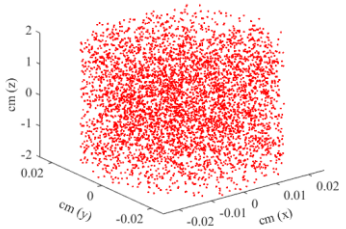


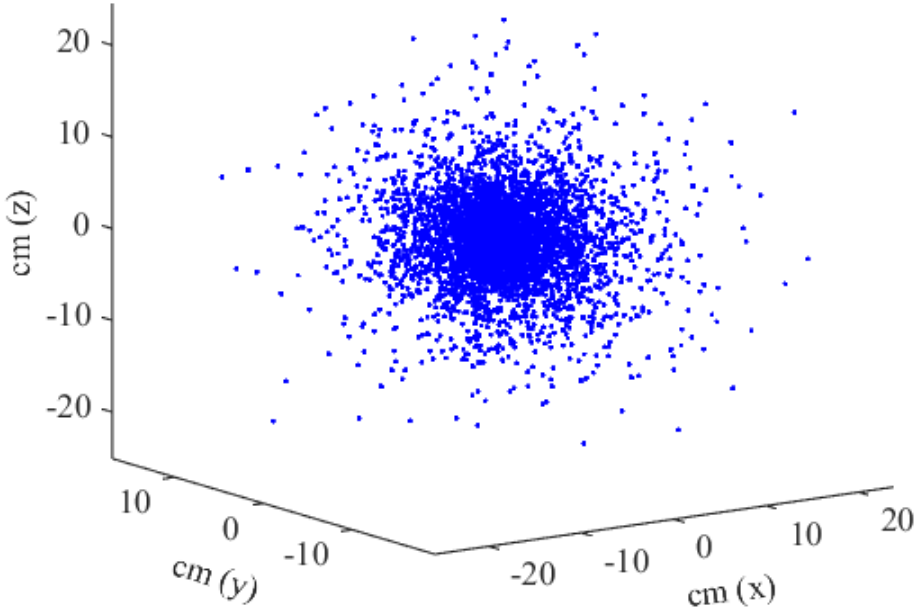


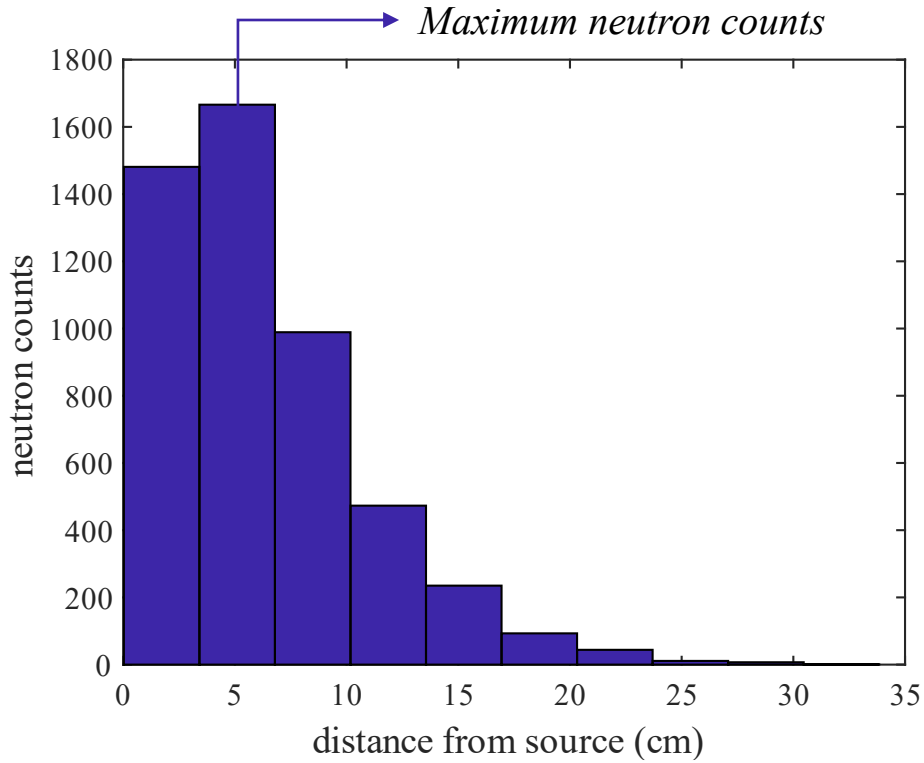
• Cylinder Source @ (h = 4cm z:[-2,2], d = 0.5 mm): H_2O

MC simulation for 5K neutrons, *for 25 such data*:

- Scattering counts before absorption (aka n history): 68.3475 ± 1.0078
- Mean of neutron distance: 6.2818 ± 0.0613 cm
- Maximum neutron distance: 37.5690 ± 3.9512 cm



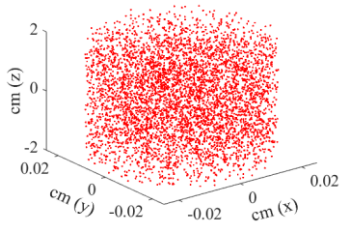


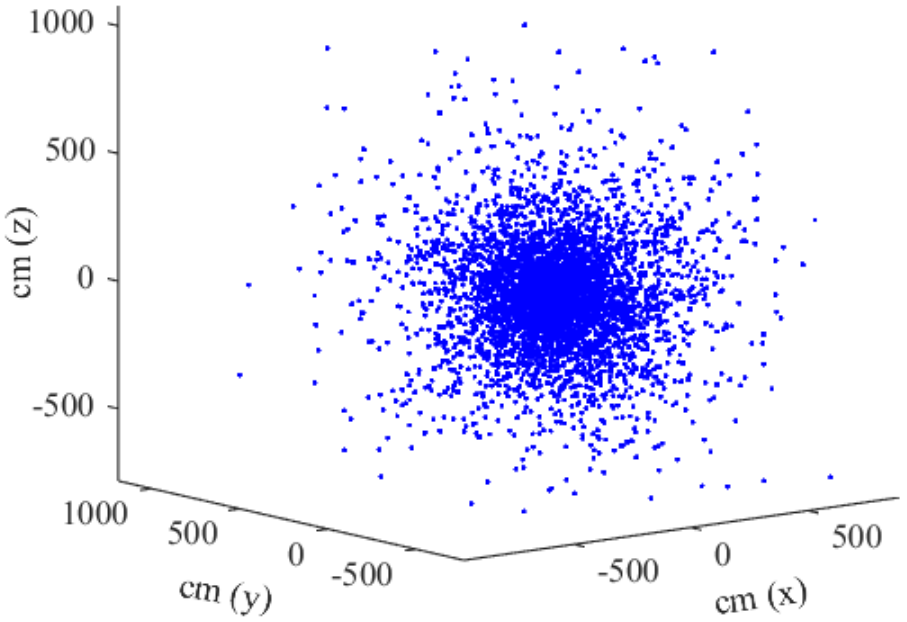


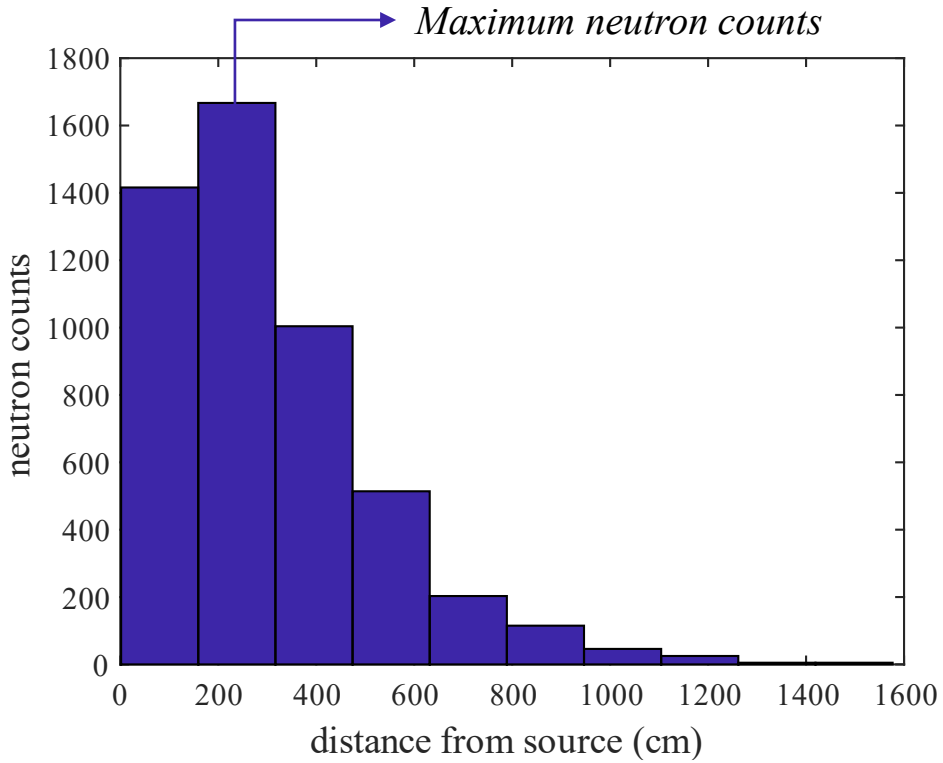
• Cylinder Source @ (h = 4cm z:[-2,2], d = 0.5 mm): D_2O

MC simulation for 5K neutrons, *for 25 such data*:

- Scattering counts before absorption (aka n history): 8771.1276 ± 117.2476
- Mean of neutron distance: 308.1507 ± 3.1943 cm
- Maximum neutron distance: 1819.5574 ± 241.4102 cm



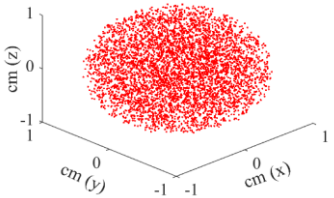


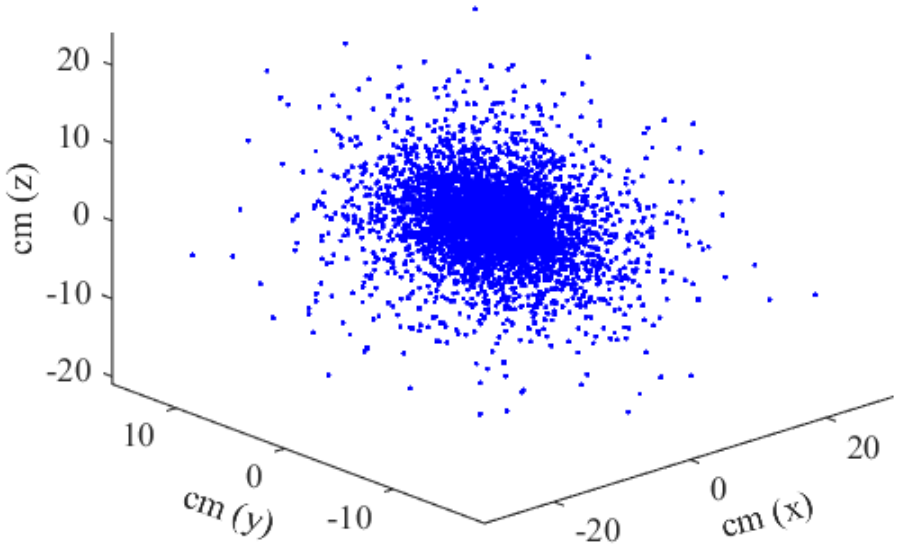


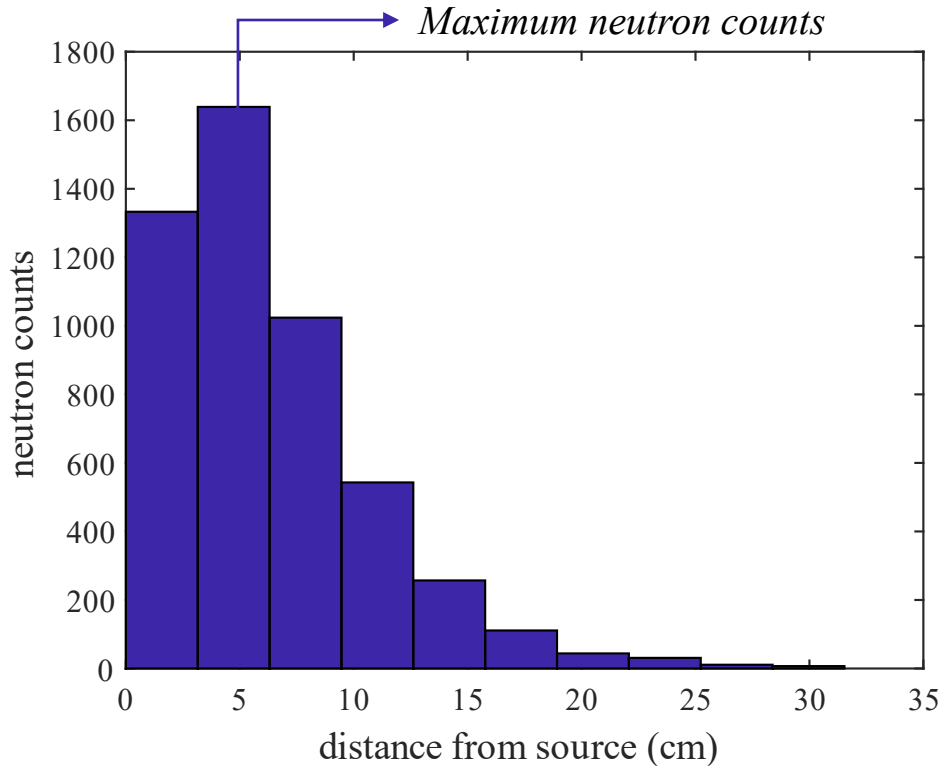
• Spherical Source @ (r = 1cm & c:[0,0,0]): H_2O

MC simulation for 5K neutrons, *for 25 such data*:

- Scattering counts before absorption (aka n history): 68.4373 ± 0.9366
- Mean of neutron distance: 6.2874 ± 0.0555 cm
- Maximum neutron distance: 37.5249 ± 5.0371 cm



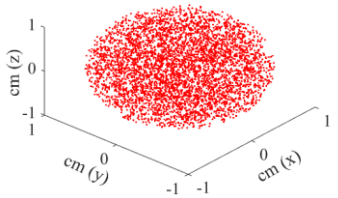


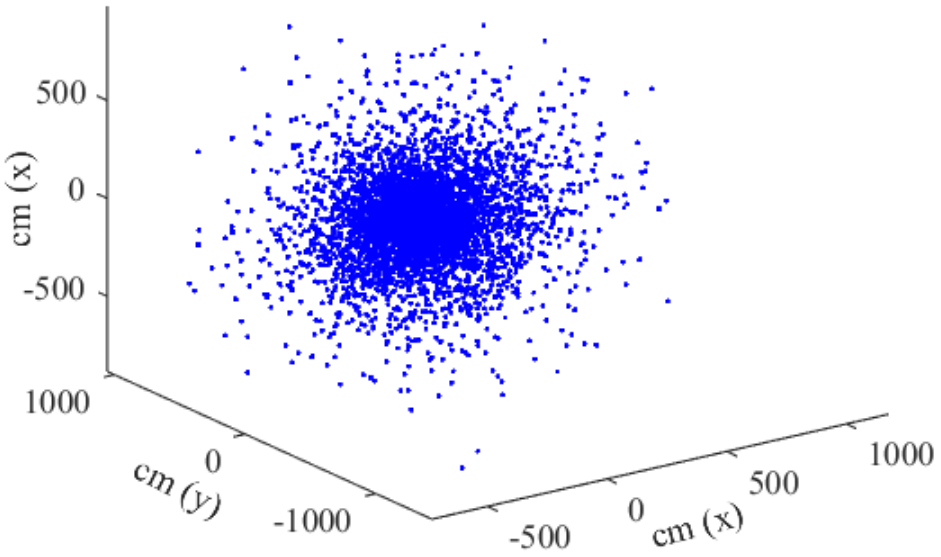


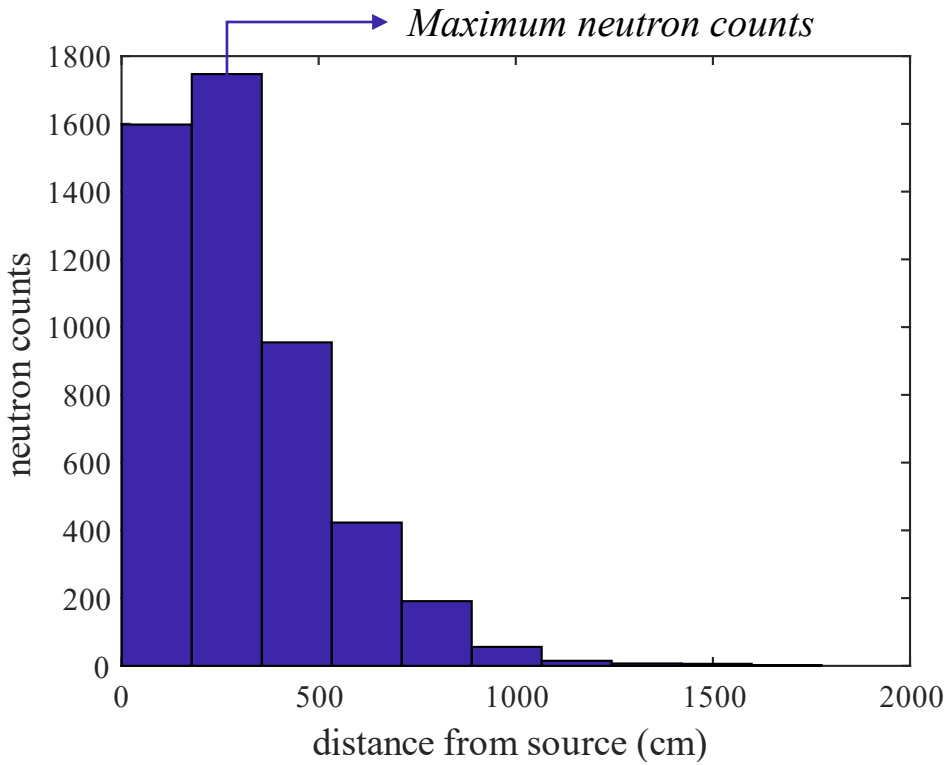
• Spherical Source @ (r = 1cm & c:[0,0,0]): D_2O

MC simulation for 5K neutrons, *for 25 such data*:

- Scattering counts before absorption (aka n history): 8771.5681 ± 146.0955
- Mean of neutron distance: 308.1092 ± 3.6943 cm
- Maximum neutron distance: 1925.7930 ± 313.9405 cm







• Results & Discussions:

	N History	Mean N Distance	N History	Mean N Distance
Source ↓	H_2O		D_2O	
Point	68.27 ± 0.72	6.27 ± 0.05 cm	8795.19 ± 138.09	308.53 ± 2.80 cm
Cylinder	68.35 ± 1.01	6.28 ± 0.06 cm	8771.13 ± 117.25	308.15 ± 3.19 cm
Spherical	68.44 ± 0.94	6.29 ± 0.05 cm	8771.57 ± 146.09	308.11 ± 3.69 cm

Inferences:

- Moderator plays a dominant role in neutron transport. D_2O enables over 100x more scatterings and 50x longer travel than H_2O.
- The geometry of the neutron source has minimal effect on the overall scattering statistics and mean travel distances in a homogeneous medium.
- The results align with theoretical expectations from cross-section and mean free path data derived from JANIS.