

Helium UCN source at the extracted beam of thermal neutrons

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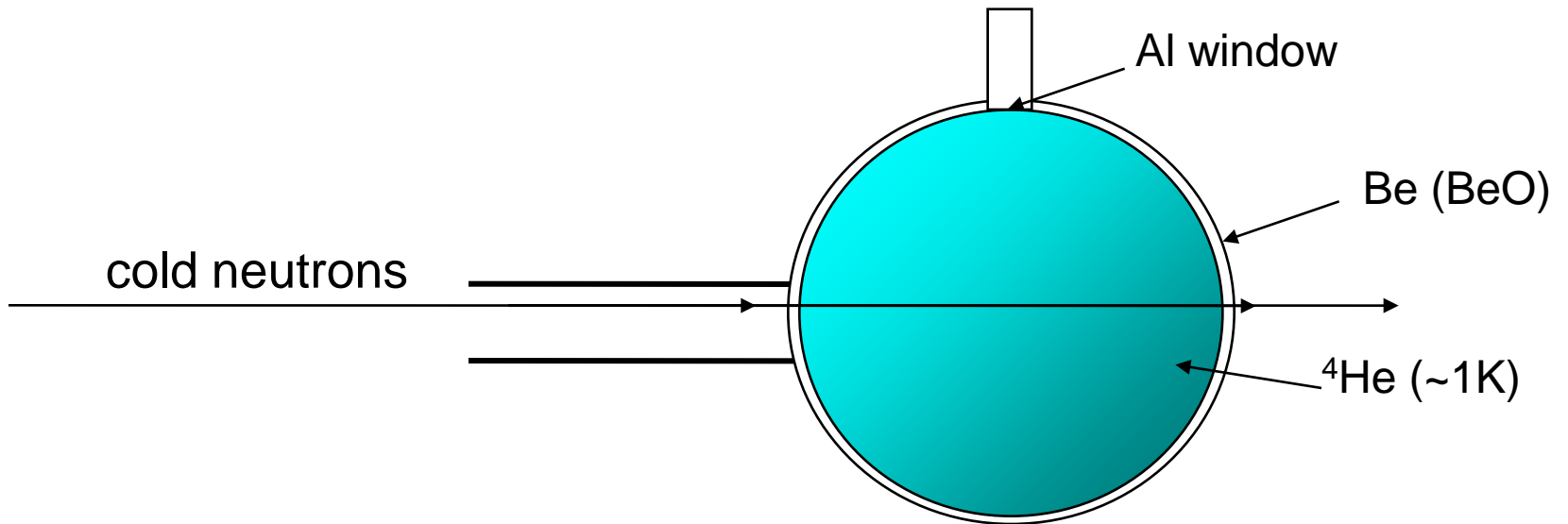
Plan:

1. Source idea
2. Evaluation of parameters of the source
3. Experimental results
4. Conclusion

The source idea

1. SUPER-TERMAL SOURCES OF ULTRACOLD NEUTRONS

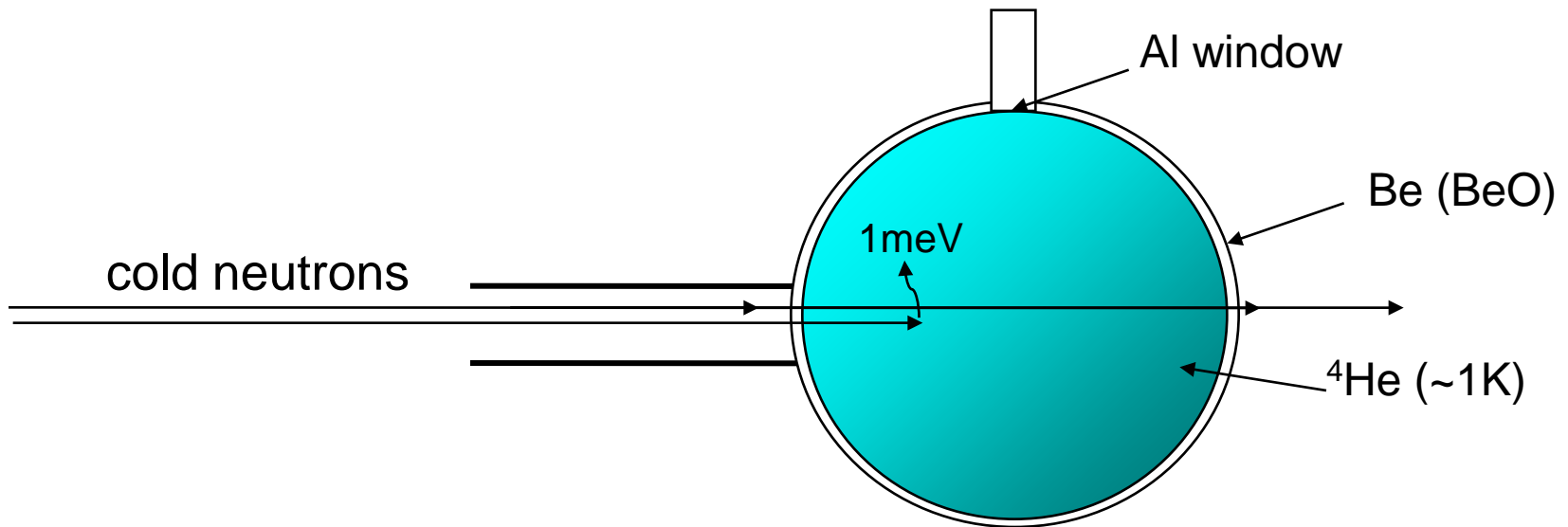
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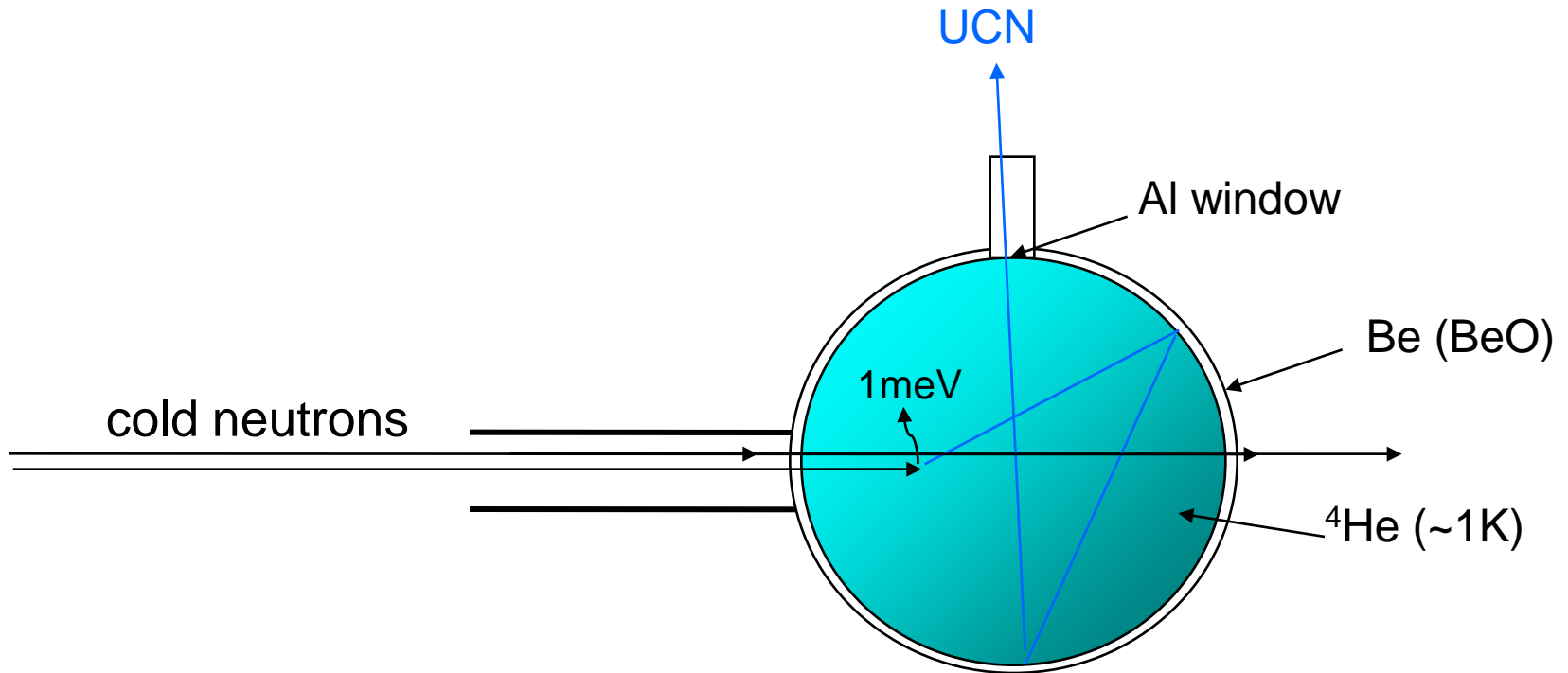
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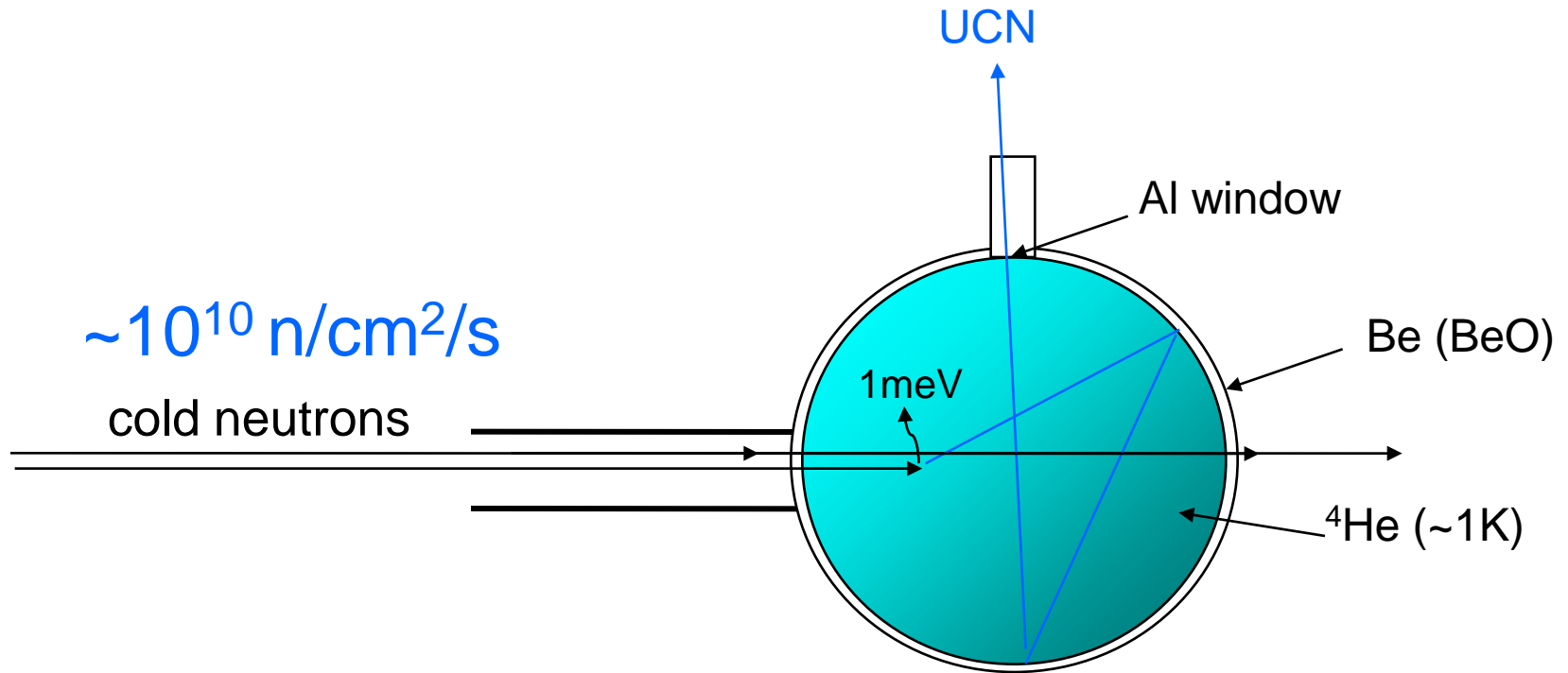
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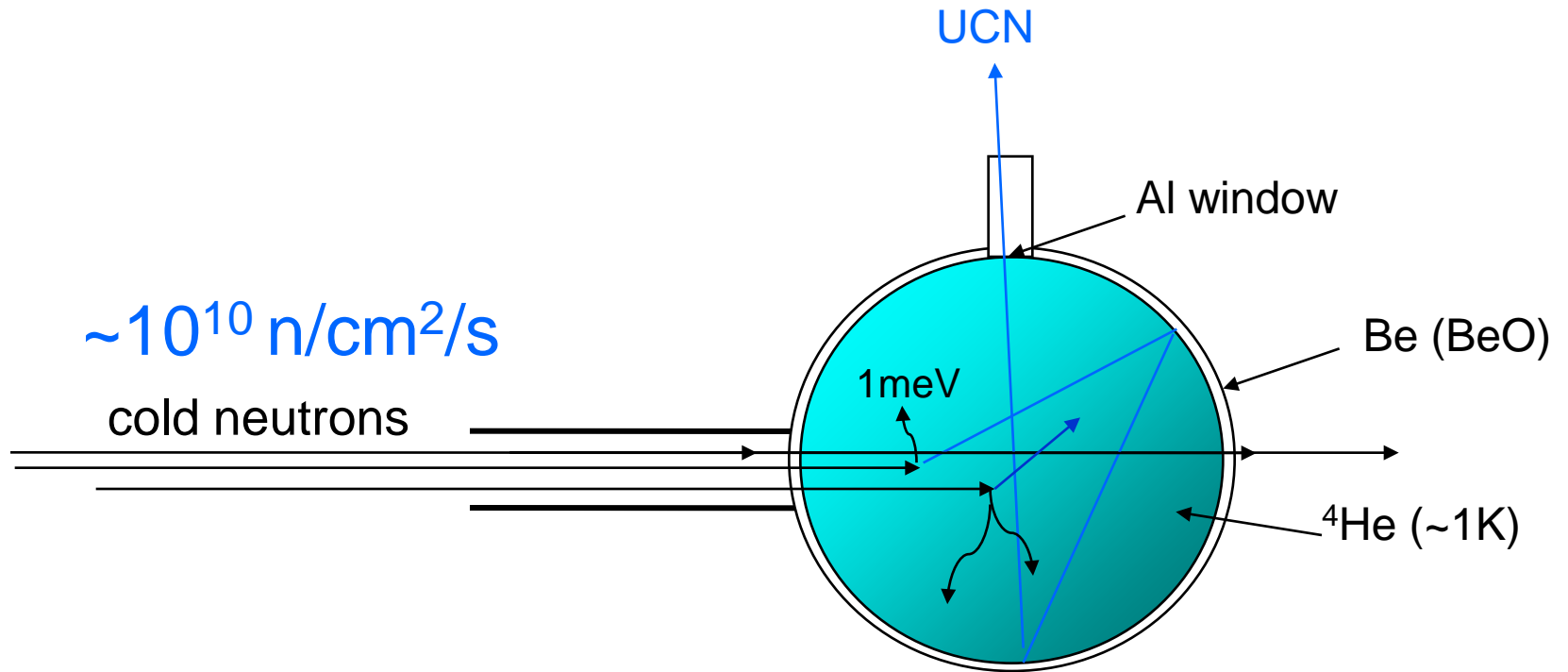
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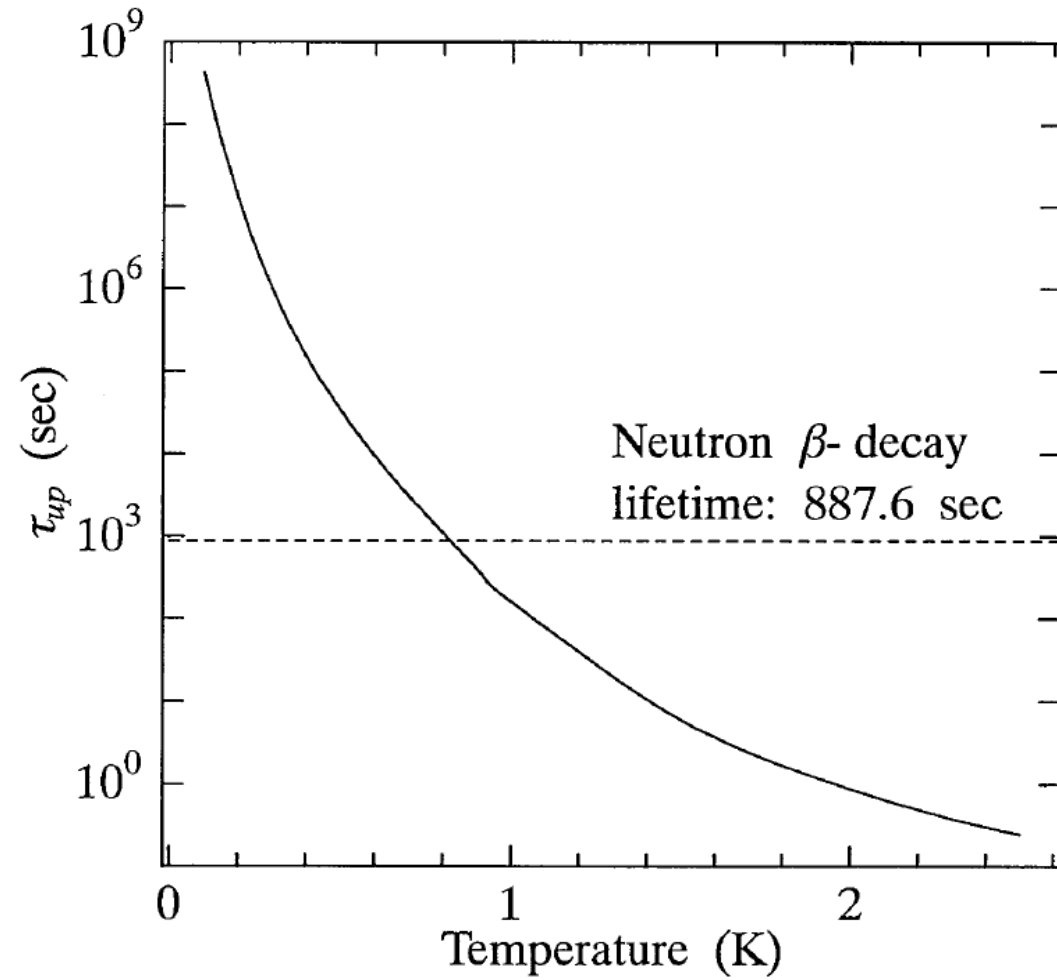
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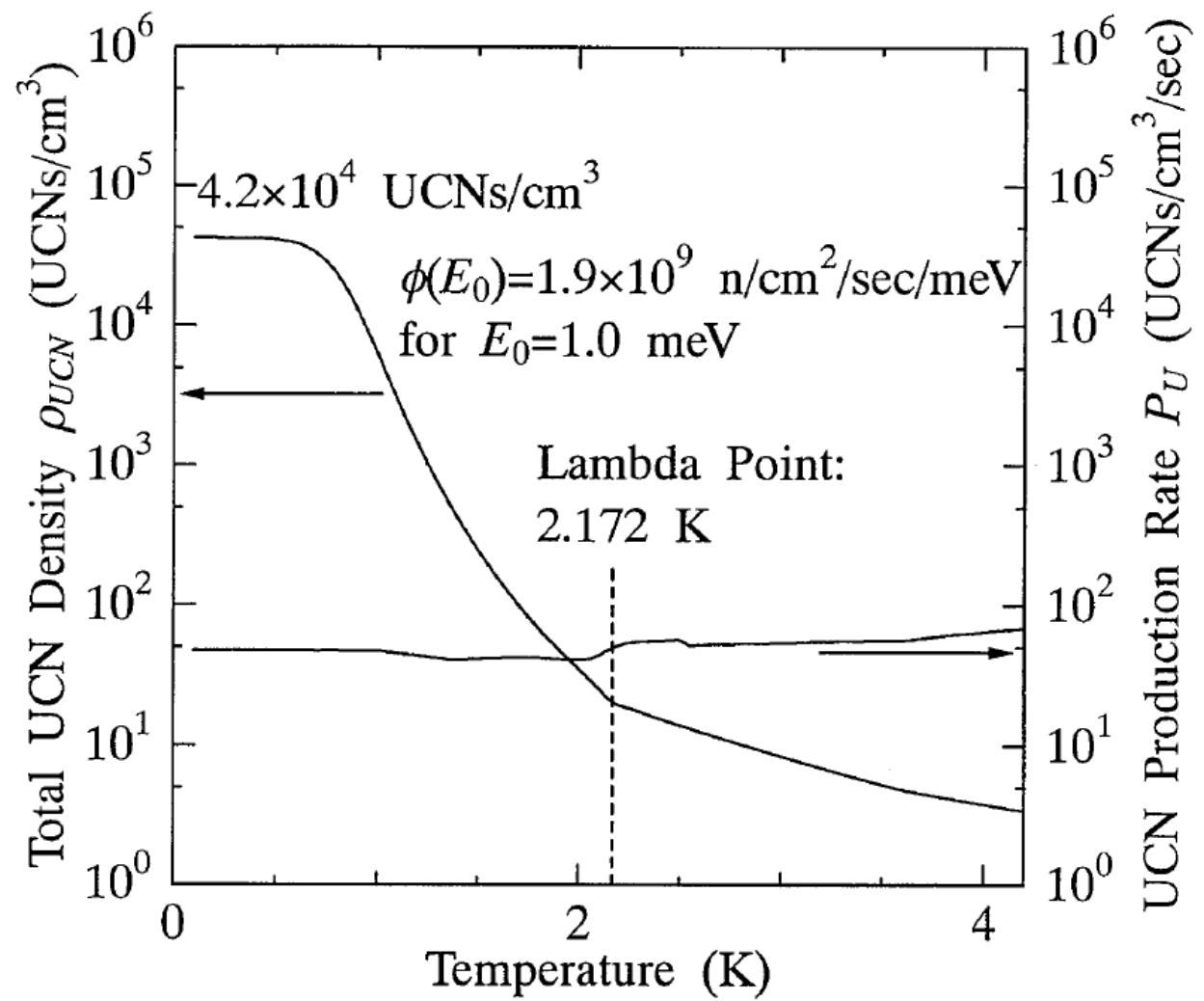




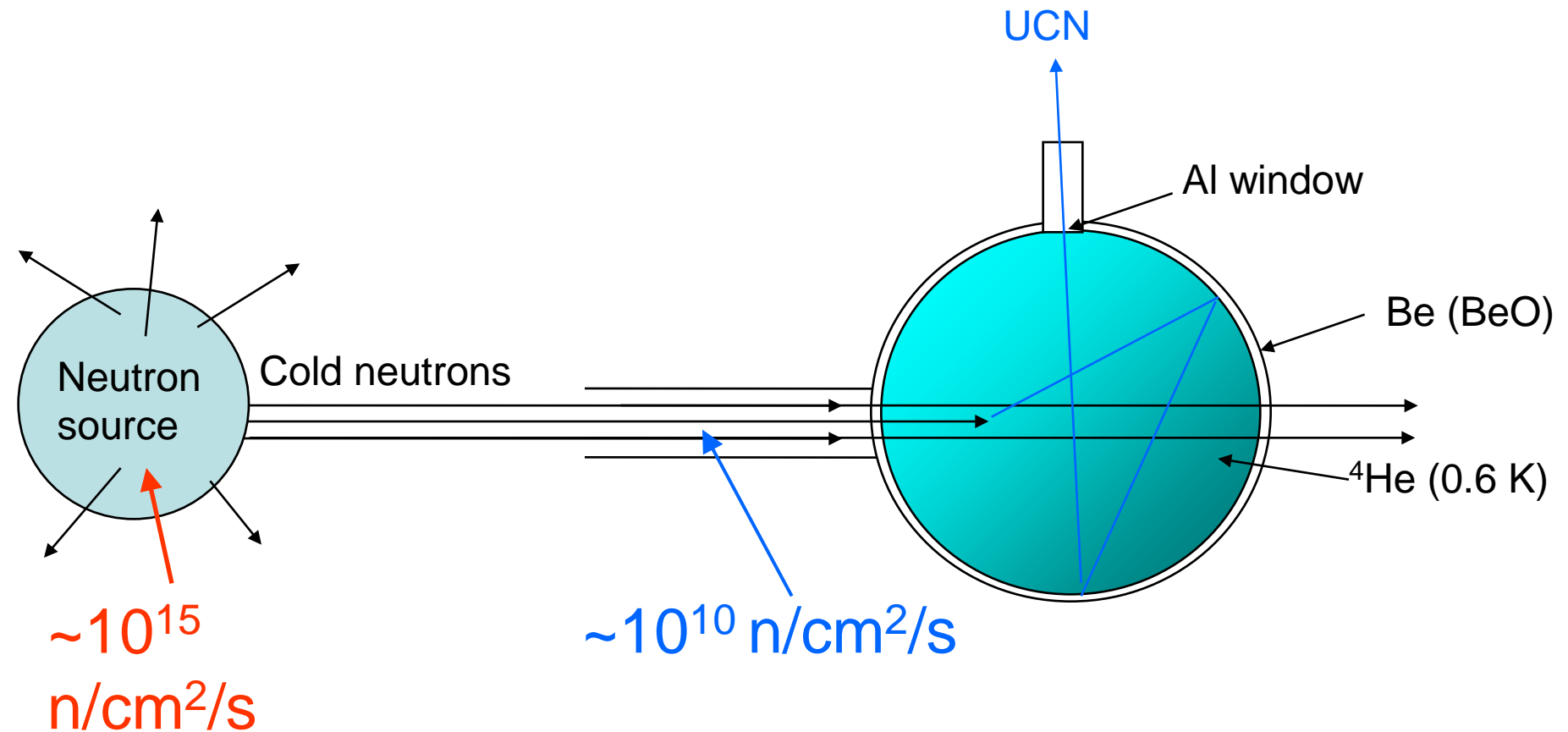
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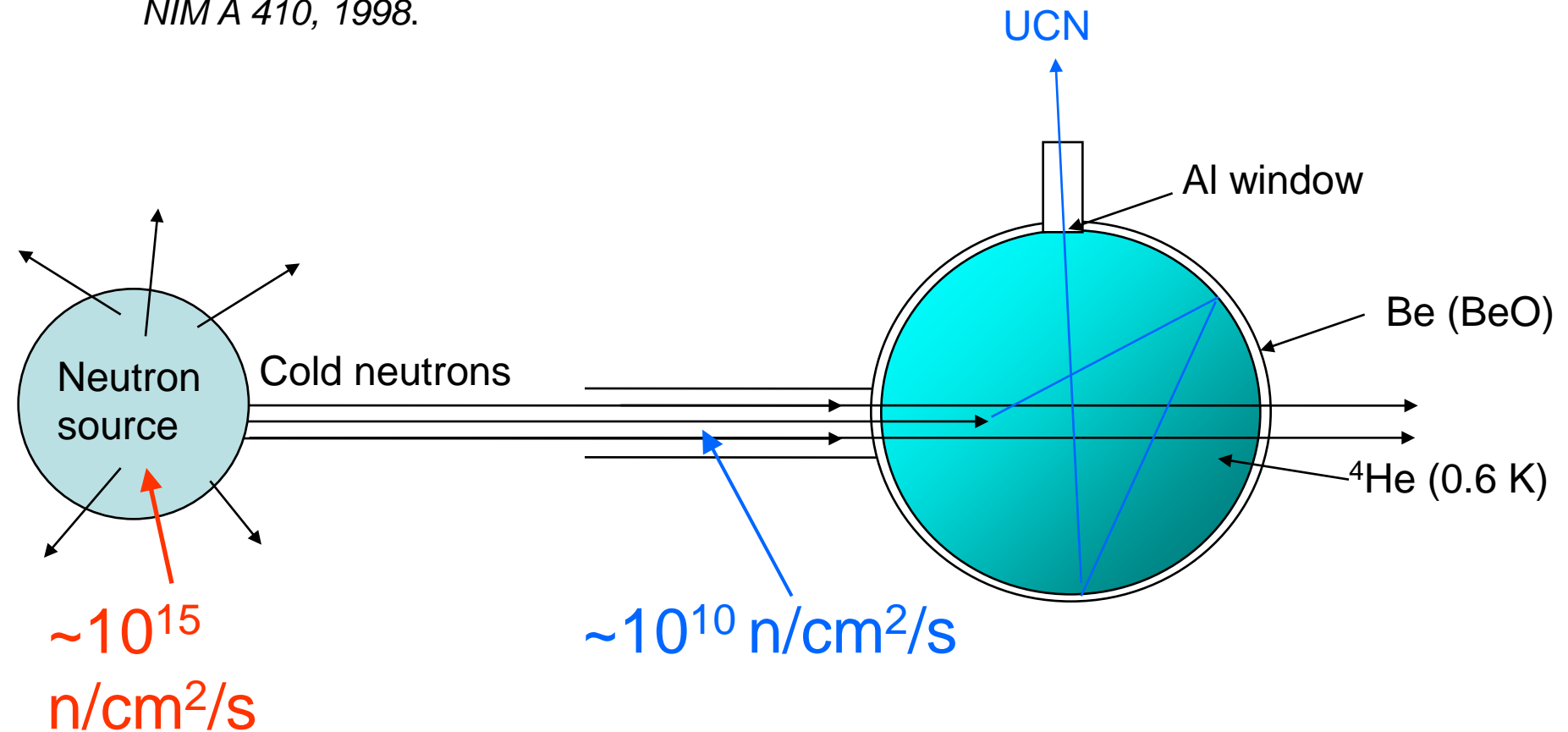


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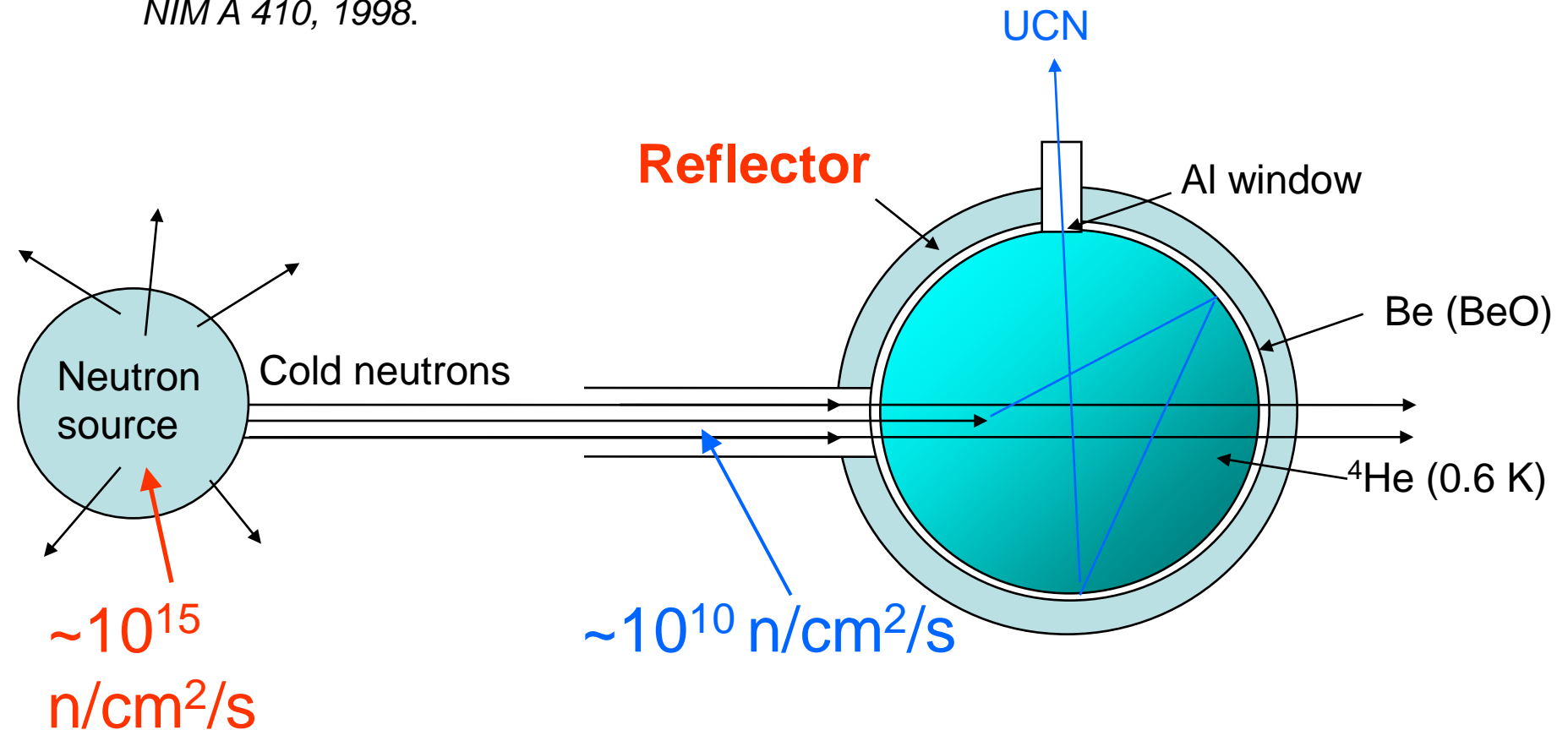


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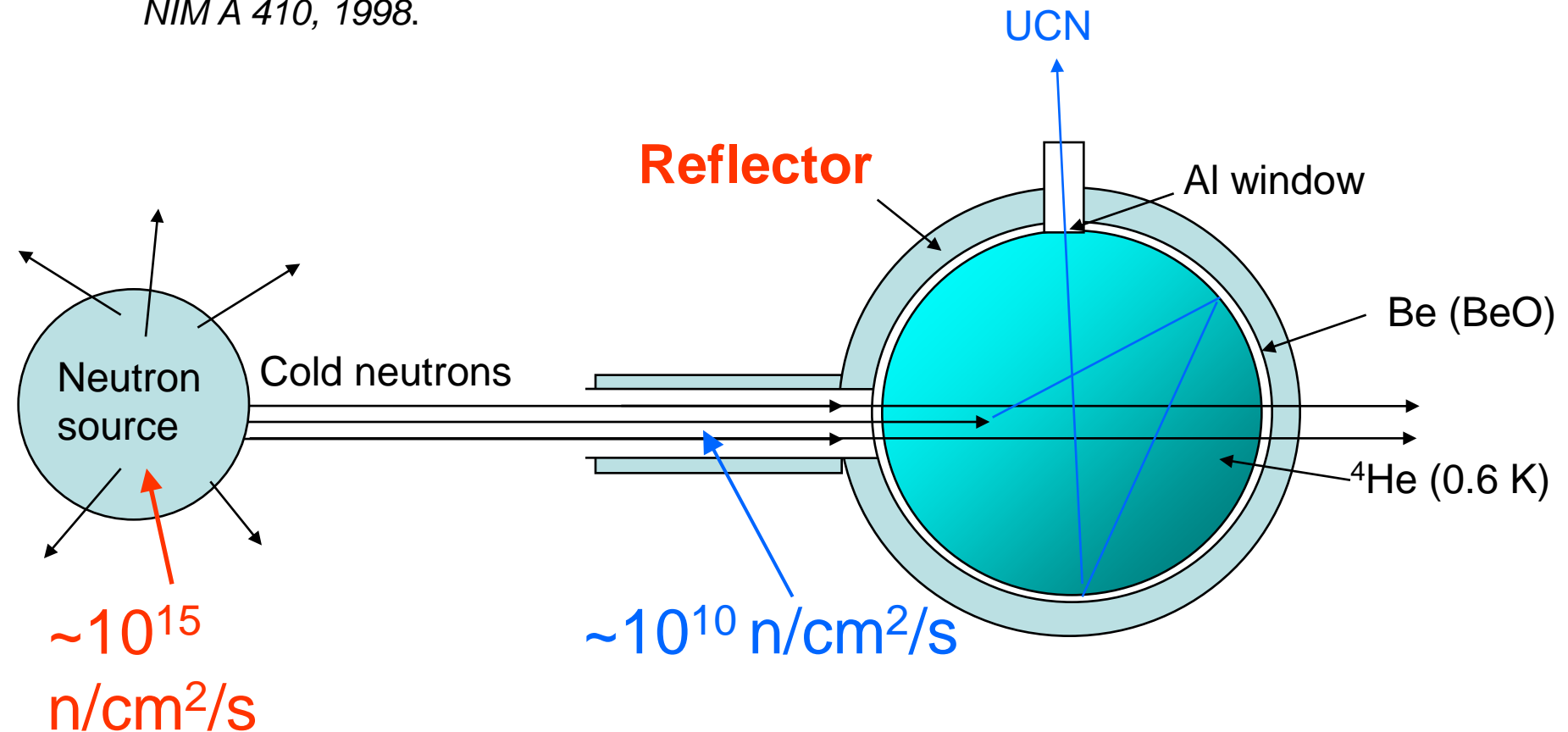


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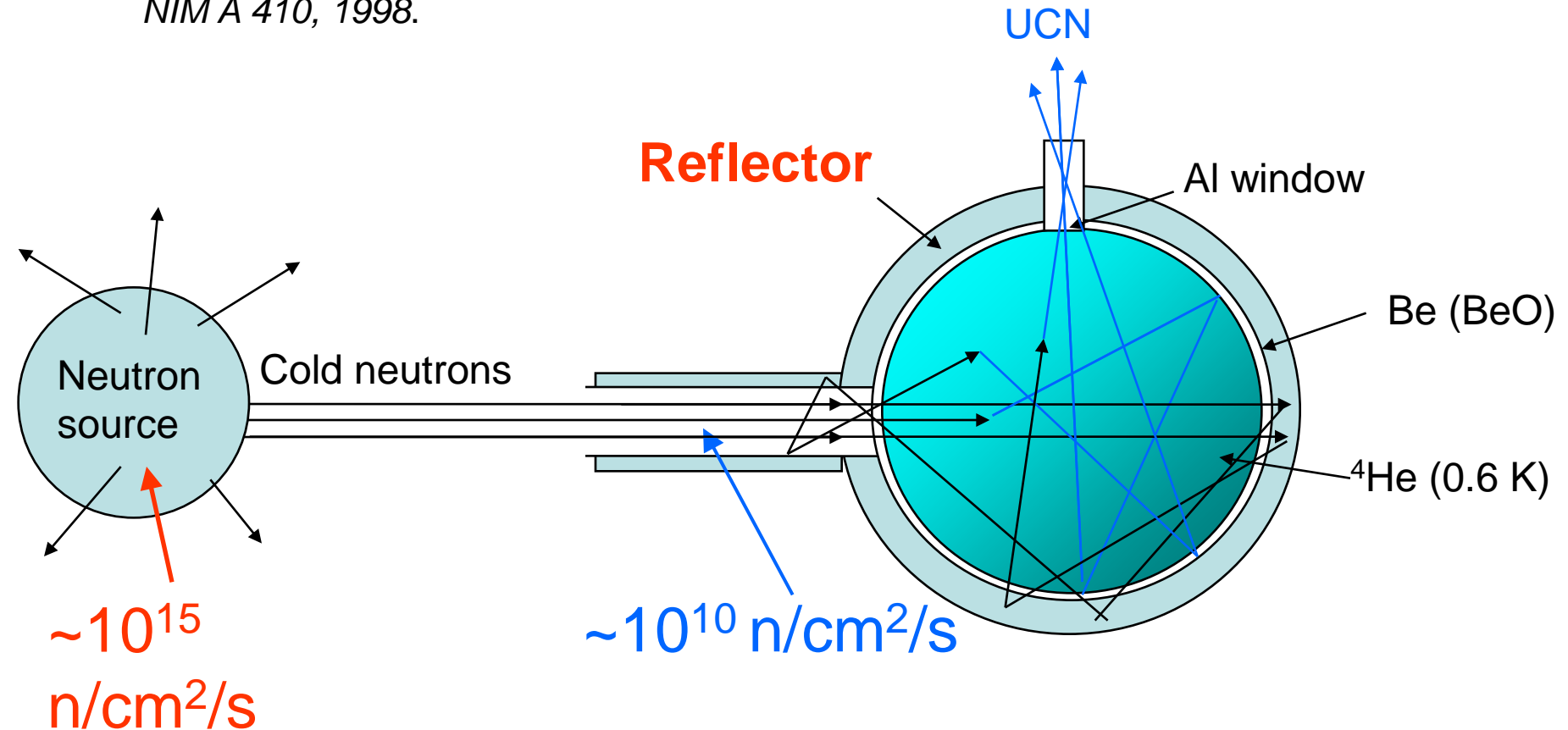


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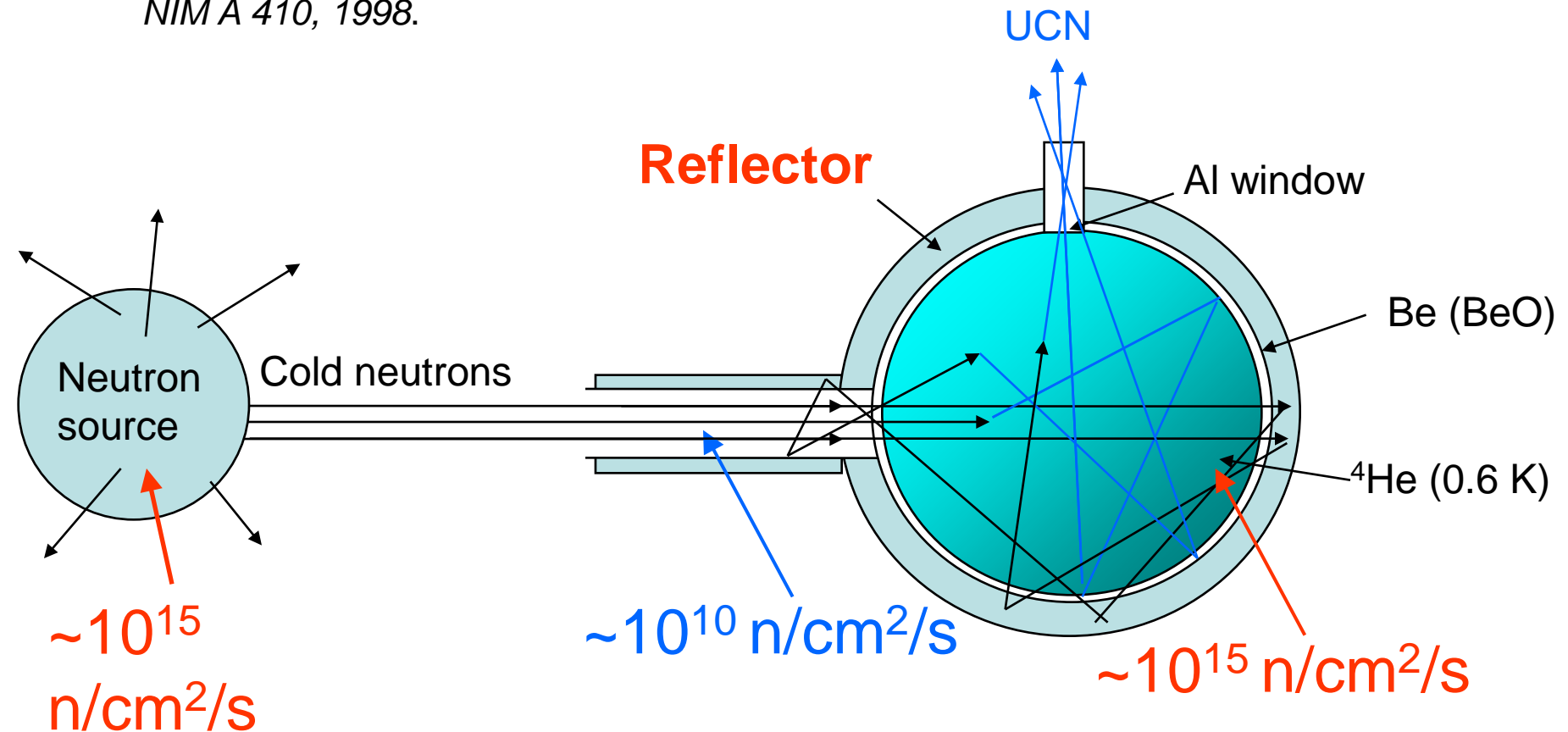


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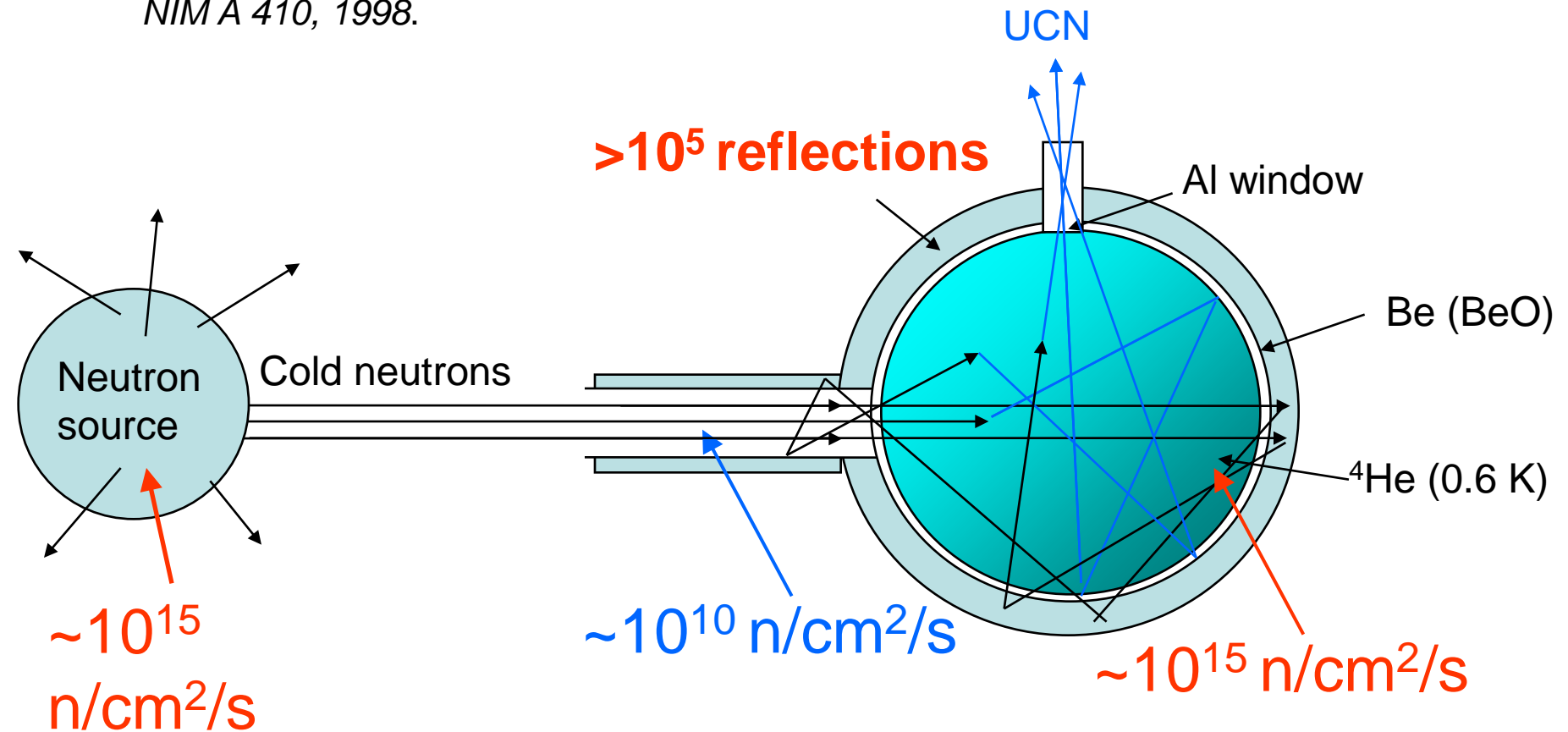


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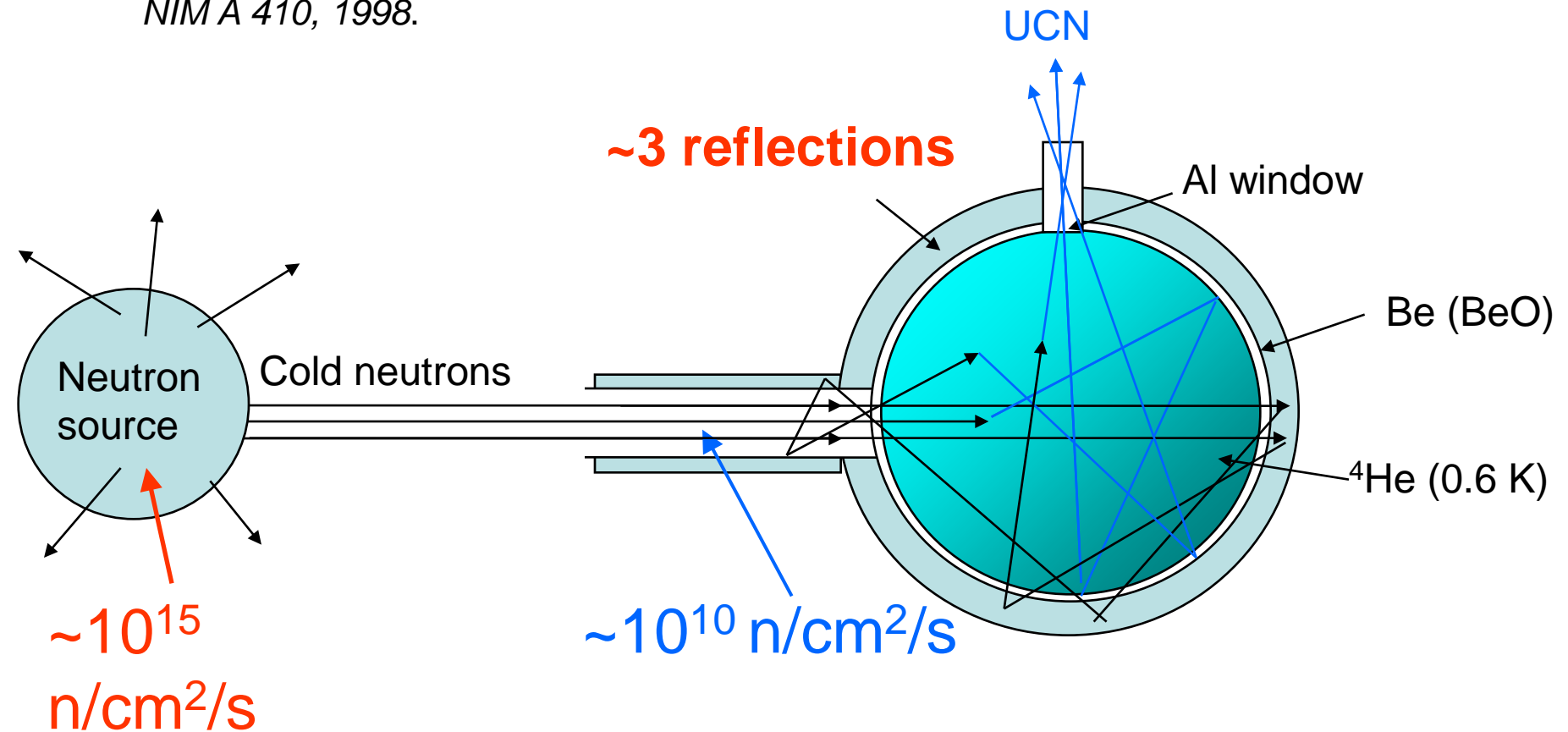
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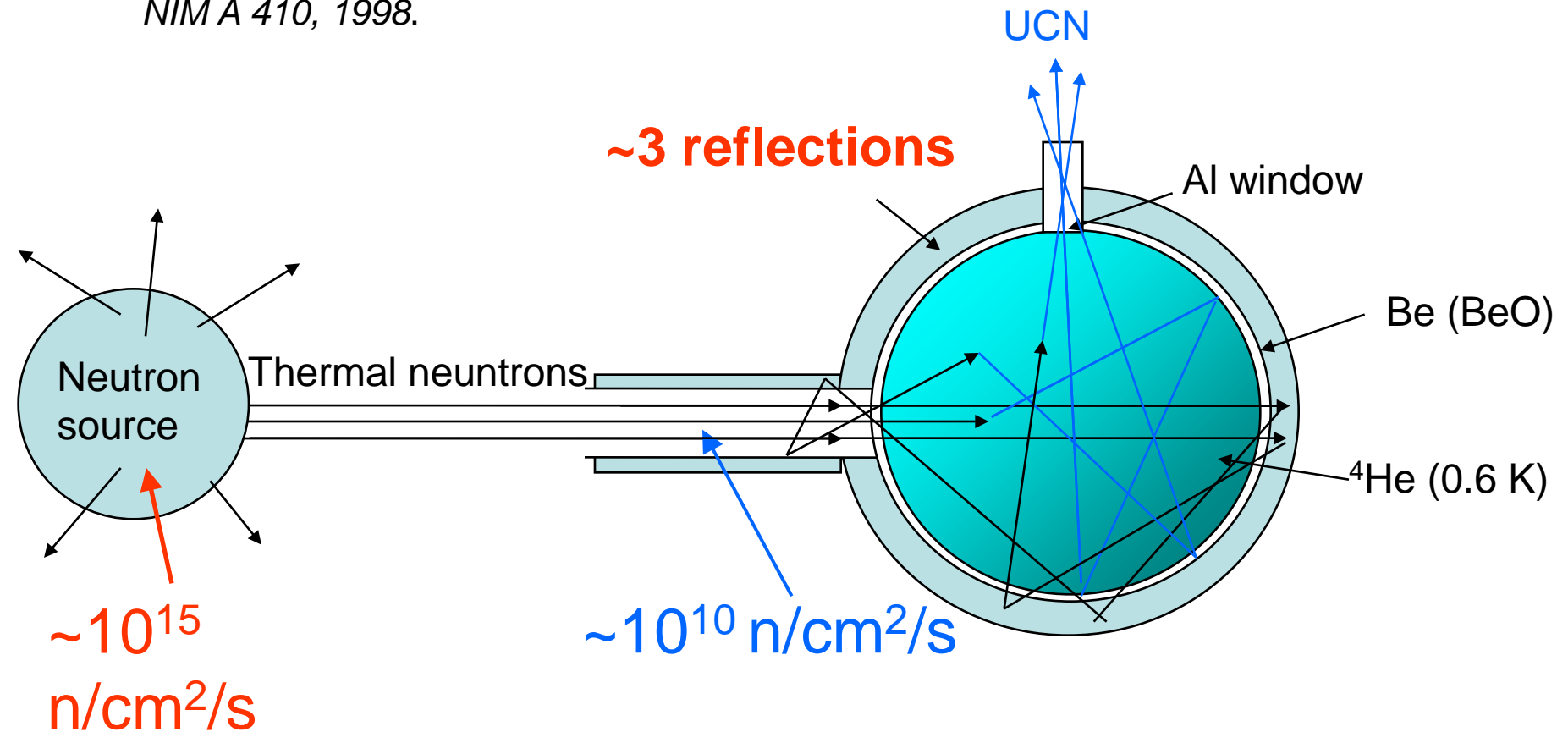
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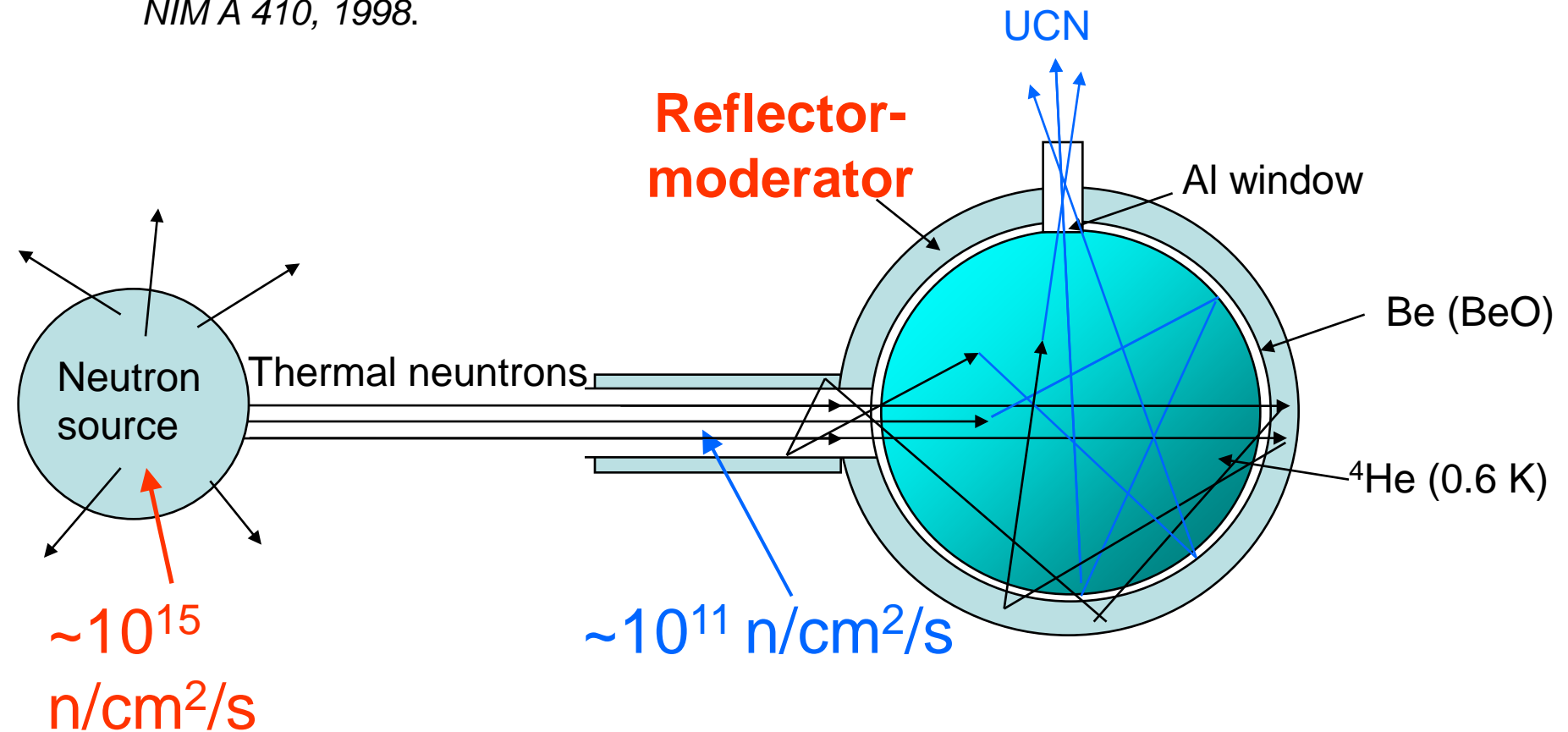
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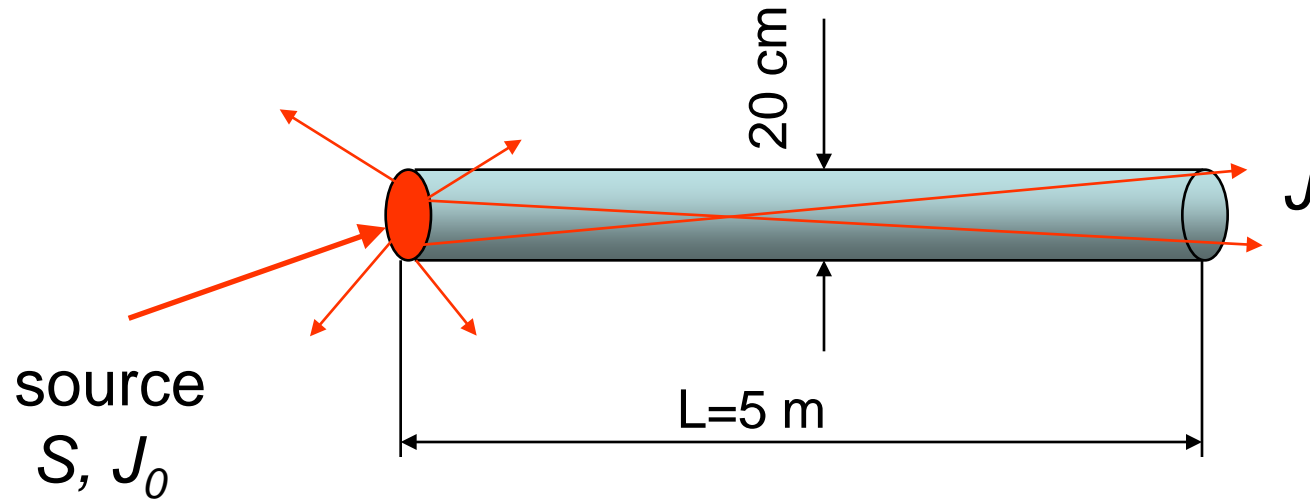
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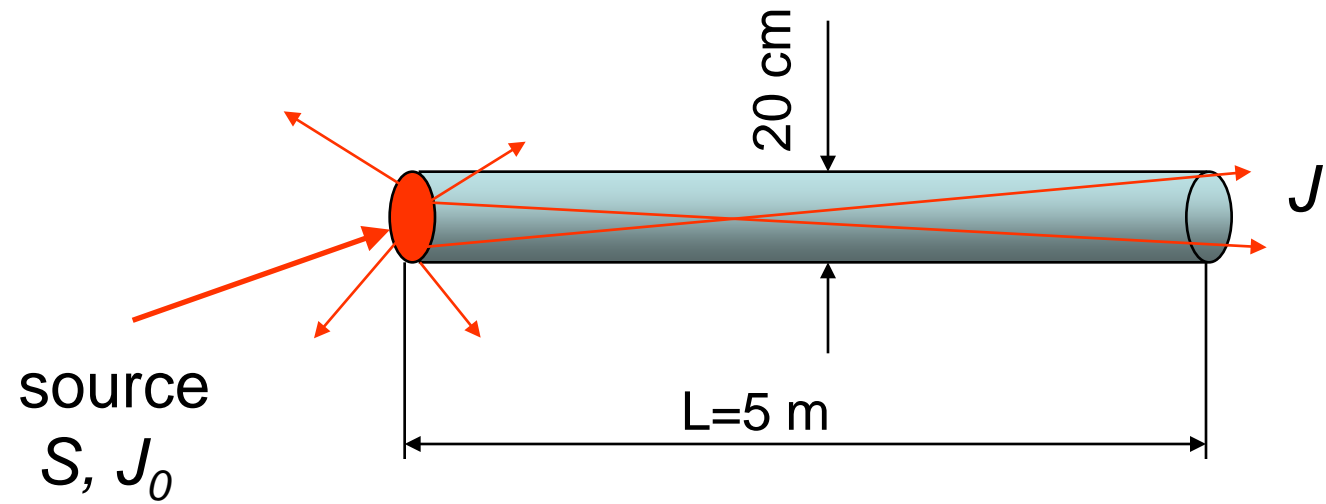
Evaluation of parameters of the source

10^{11} n/cm²/s ?

Evaluation of parameters of the source

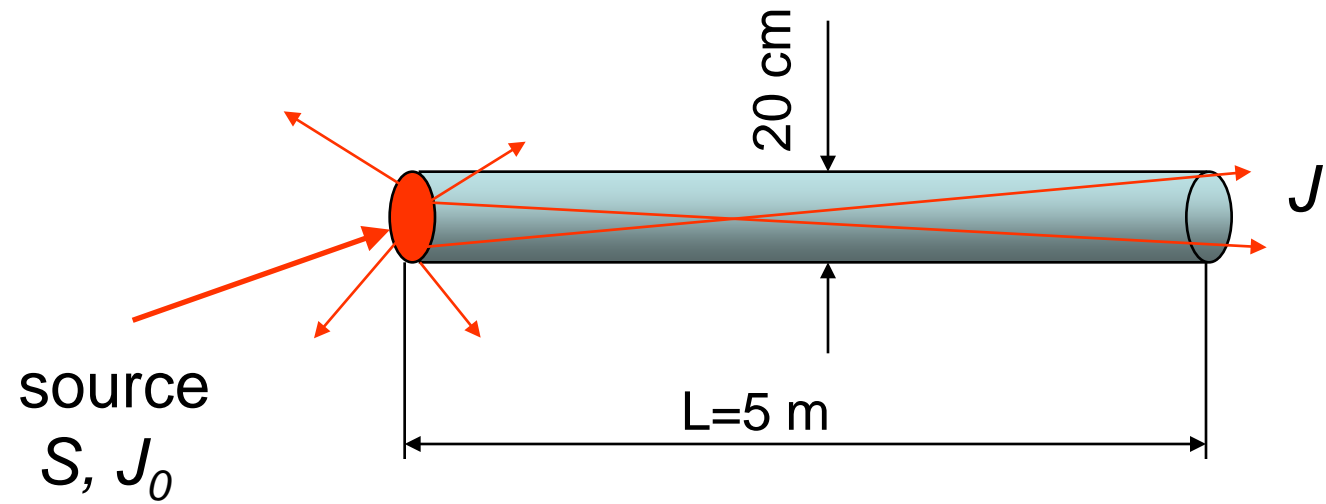


Evaluation of parameters of the source



$$J = J_0 \frac{S}{4\pi L^2} = J_0 \cdot 10^{-4}$$

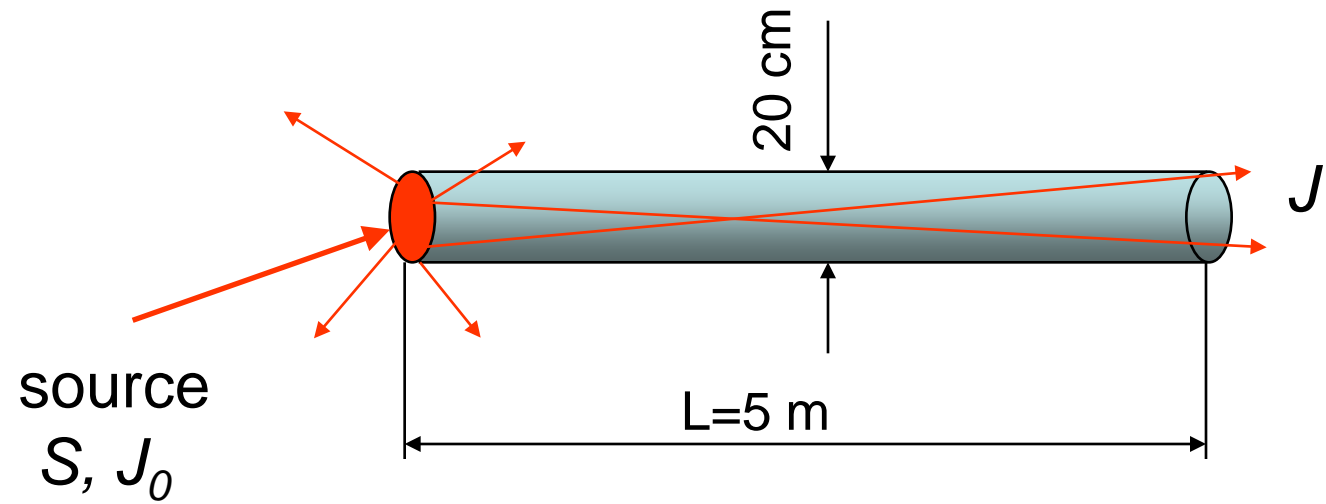
Evaluation of parameters of the source



$$J = J_0 \frac{S}{4\pi L^2} = J_0 \cdot 10^{-4}$$

$$V_{\perp} \sim 90 \text{ m/s}$$

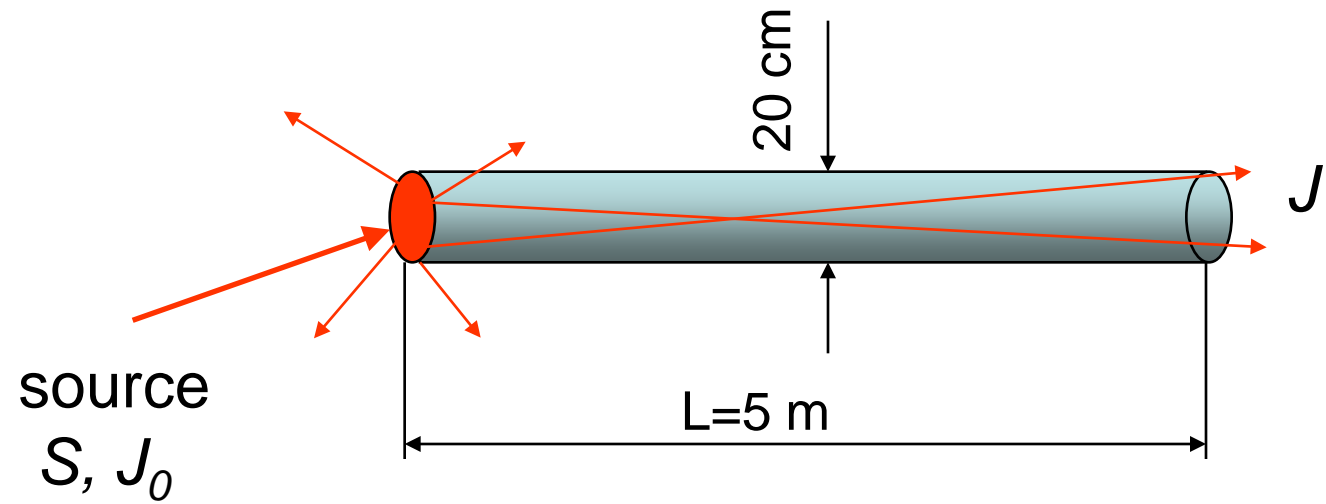
Evaluation of parameters of the source



$$J = J_0 \frac{S}{4\pi L^2} = J_0 \cdot 10^{-4}$$

$$J_0 = 1.2 \cdot 10^{15} \text{ n} \cdot \text{cm}^{-2} \text{ s}^{-1} \quad J = 1.2 \cdot 10^{11} \text{ n} \cdot \text{cm}^{-2} \text{ s}^{-1}$$

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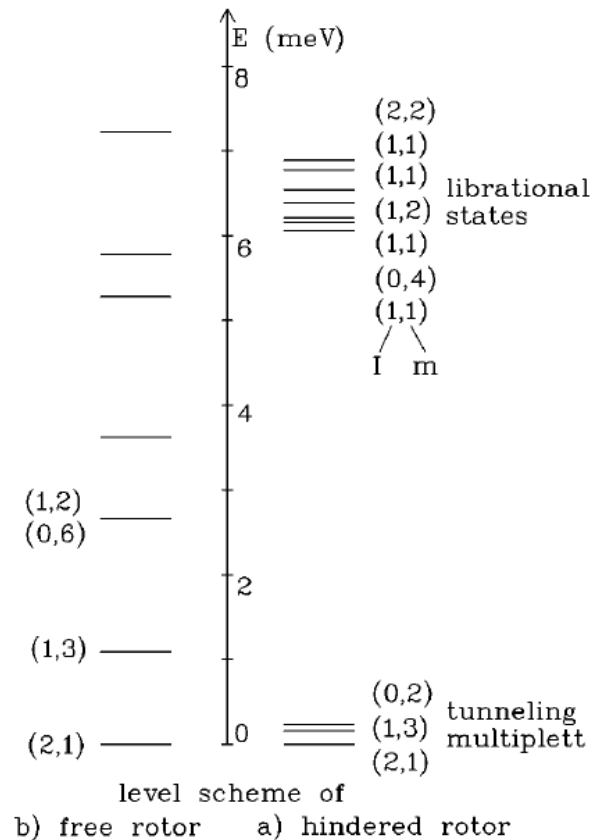
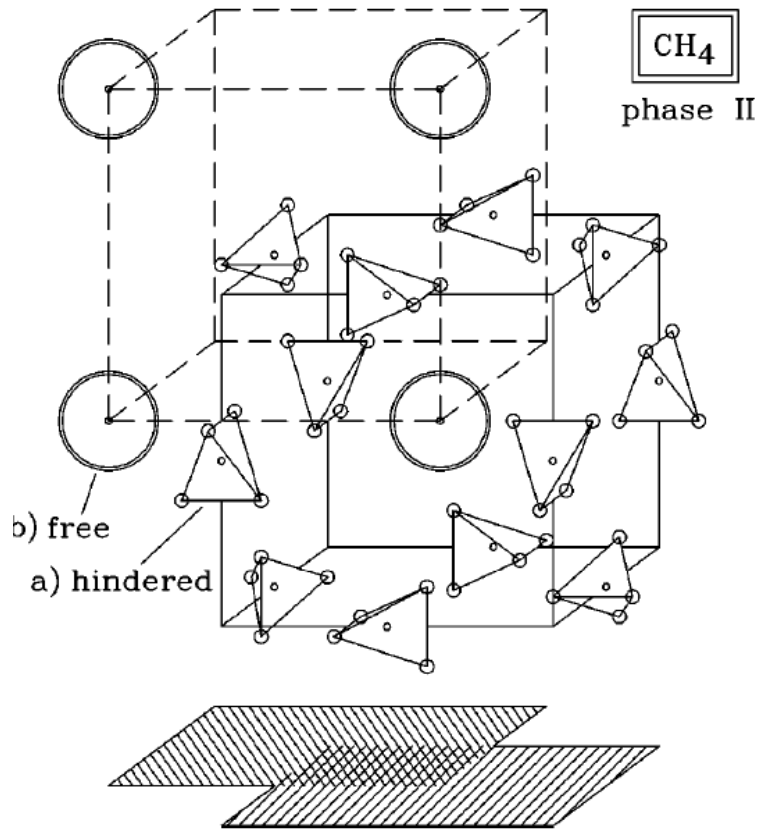


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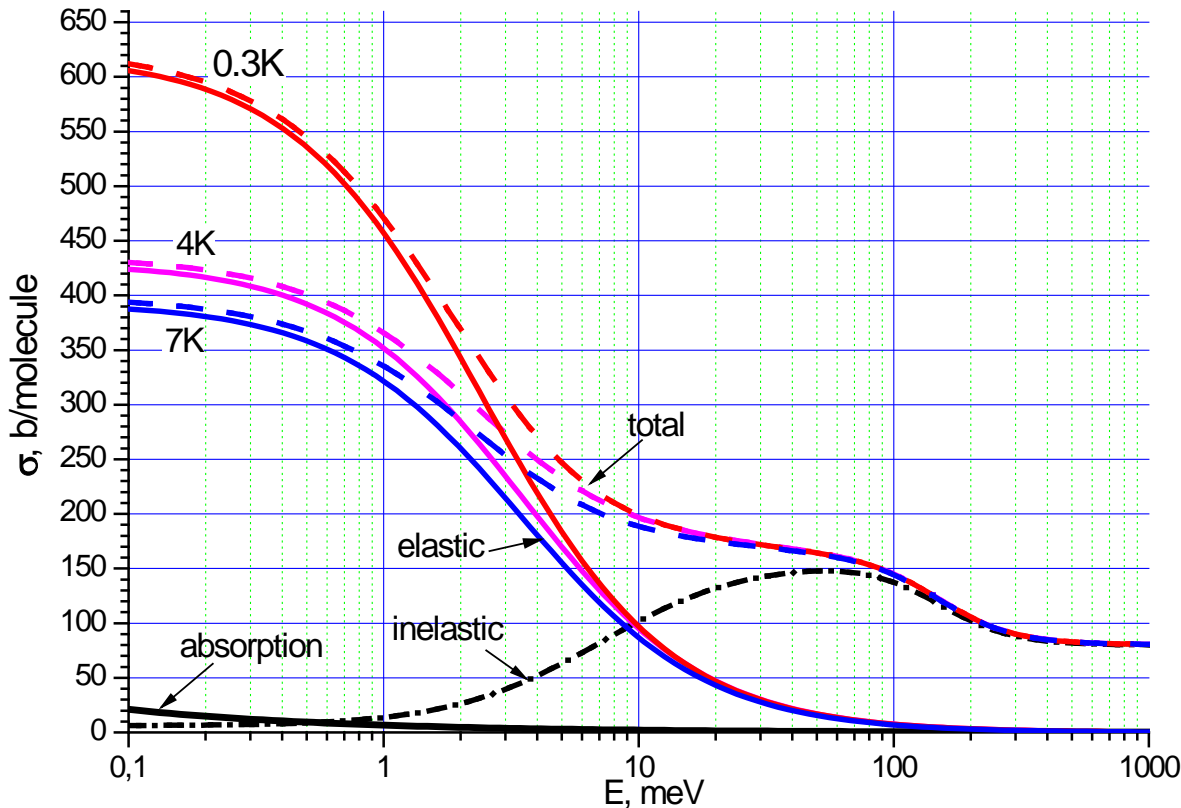
$F = 3.8 \cdot 10^{13} \text{ n/s}$

Methane



molecular crystal with a very round molecule

Methane

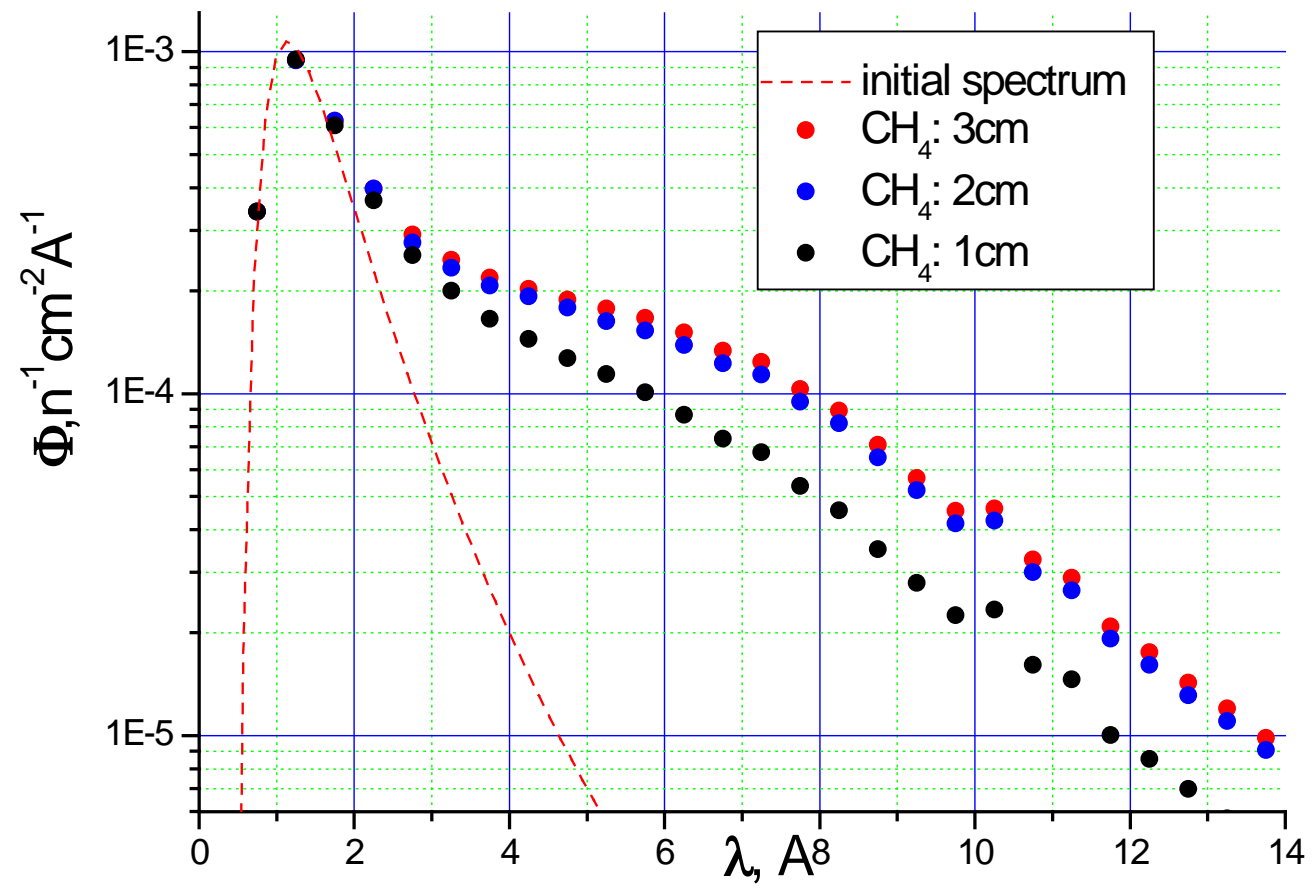


Solid CH_4 : Coherent scattering in one molecule and incoherent scattering on different molecules.

Simulations

MCNP 4c with special kernel (solid CH₄)

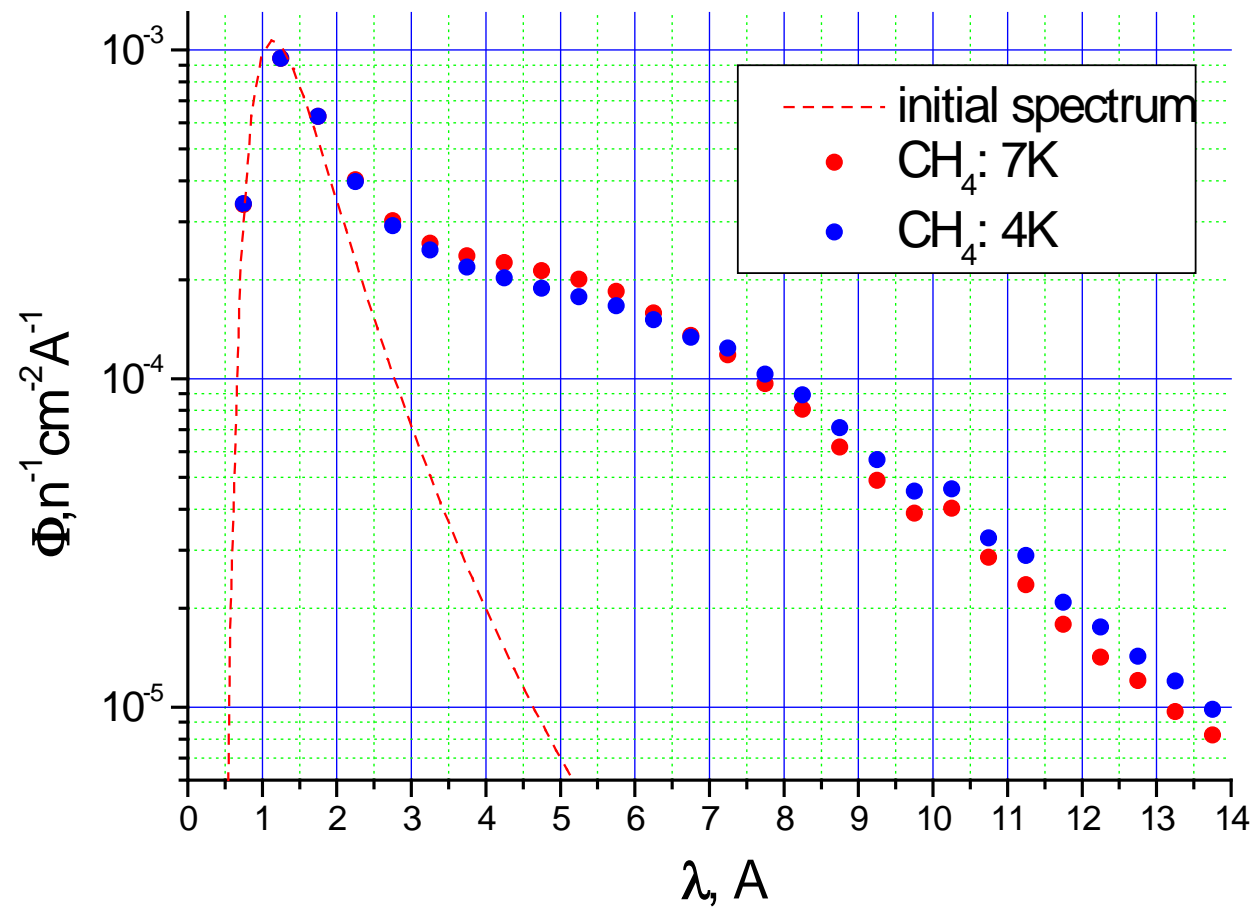
CH₄: 4K, φ40 cm. Entrance hole φ20 cm



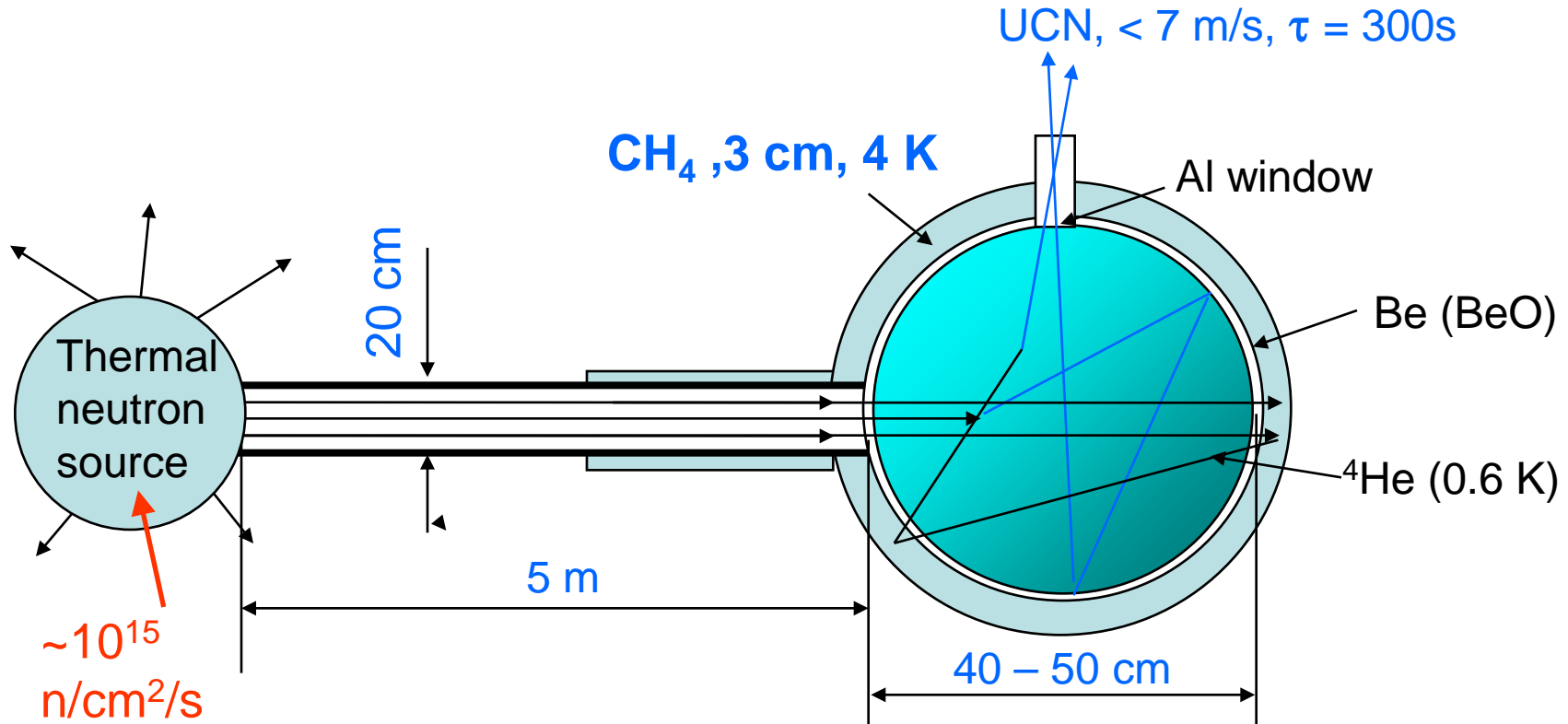
Simulations

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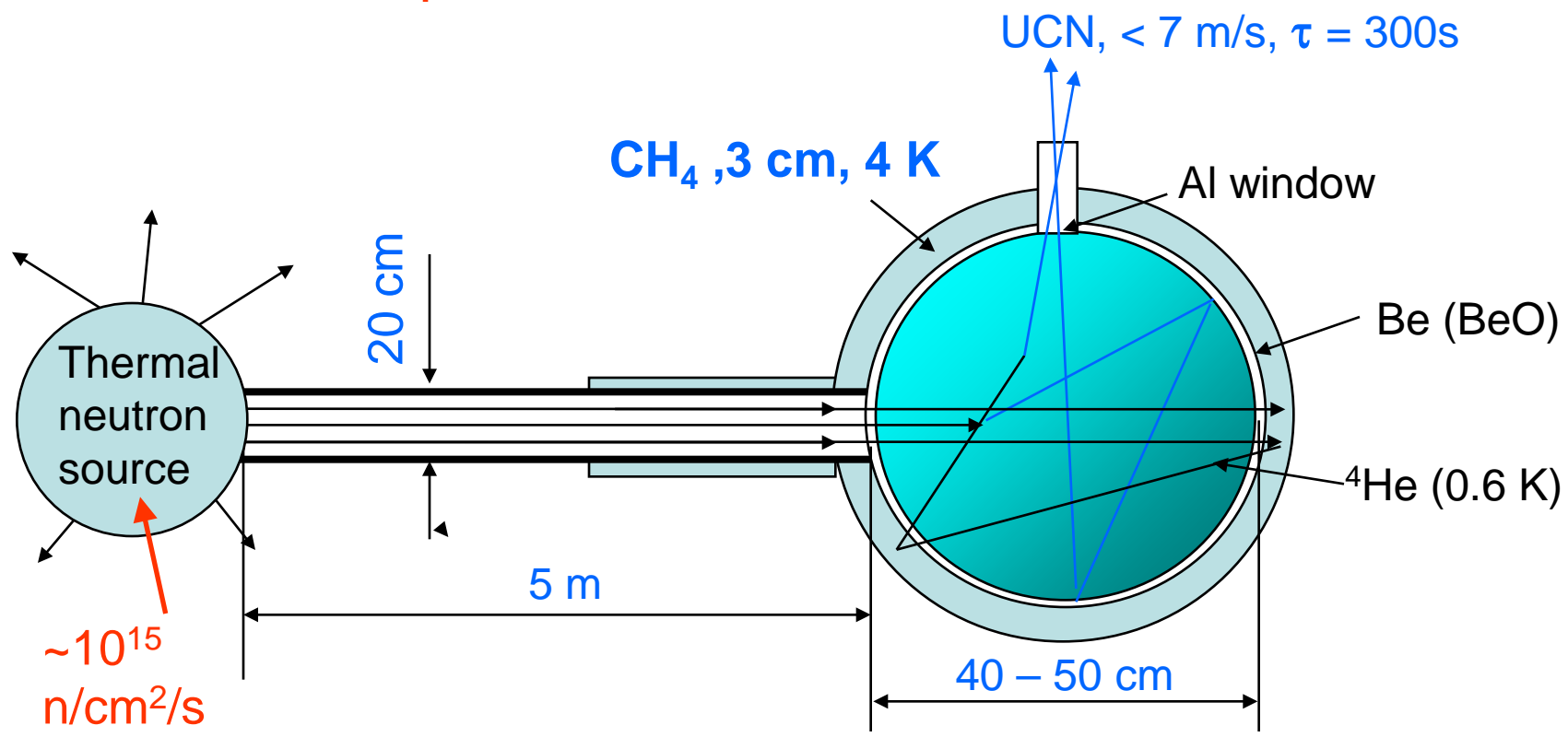
CH₄: 3cm. ϕ 40 cm. Entrance hole ϕ 20 cm



Evaluation parameters of the source

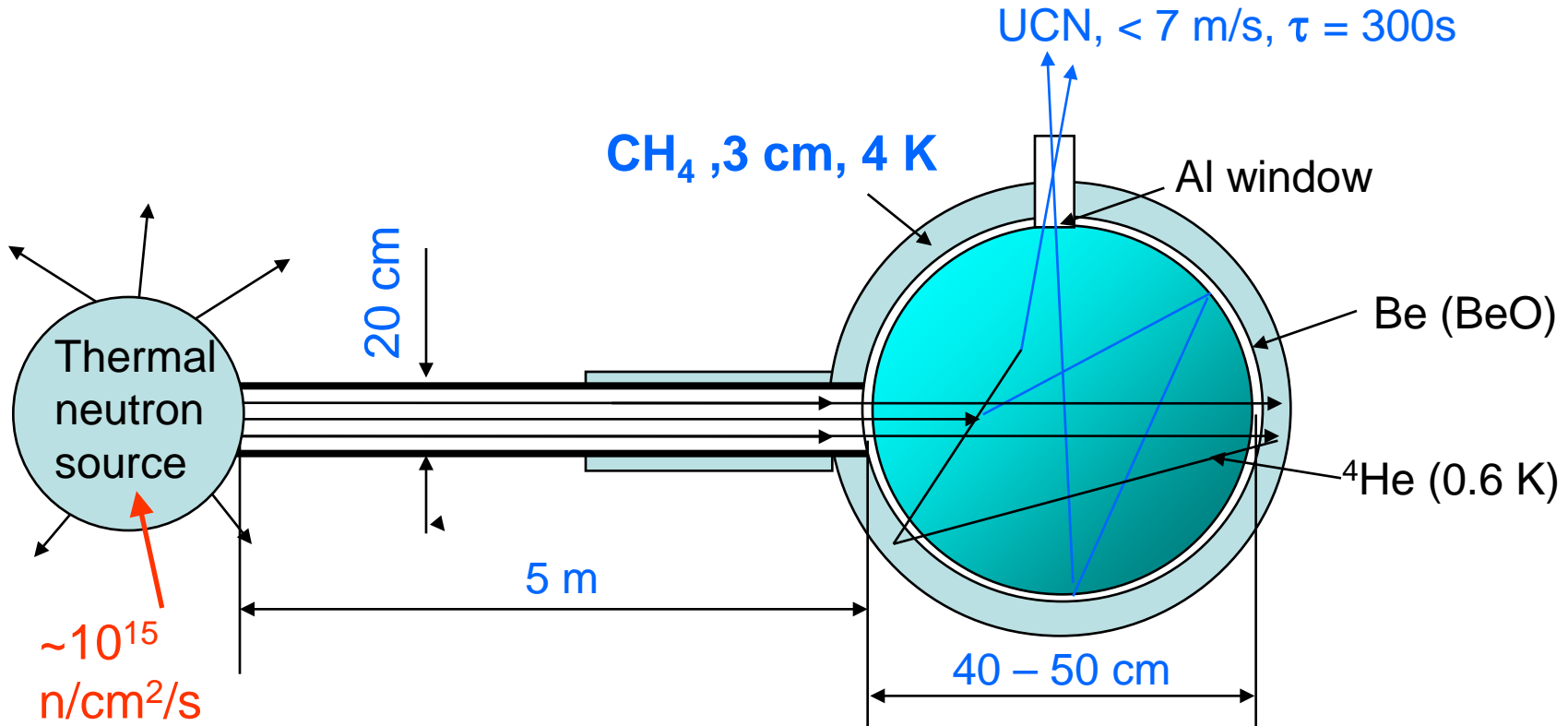


Evaluation parameters of the source



Power $\sim 10^7$ UCN/s

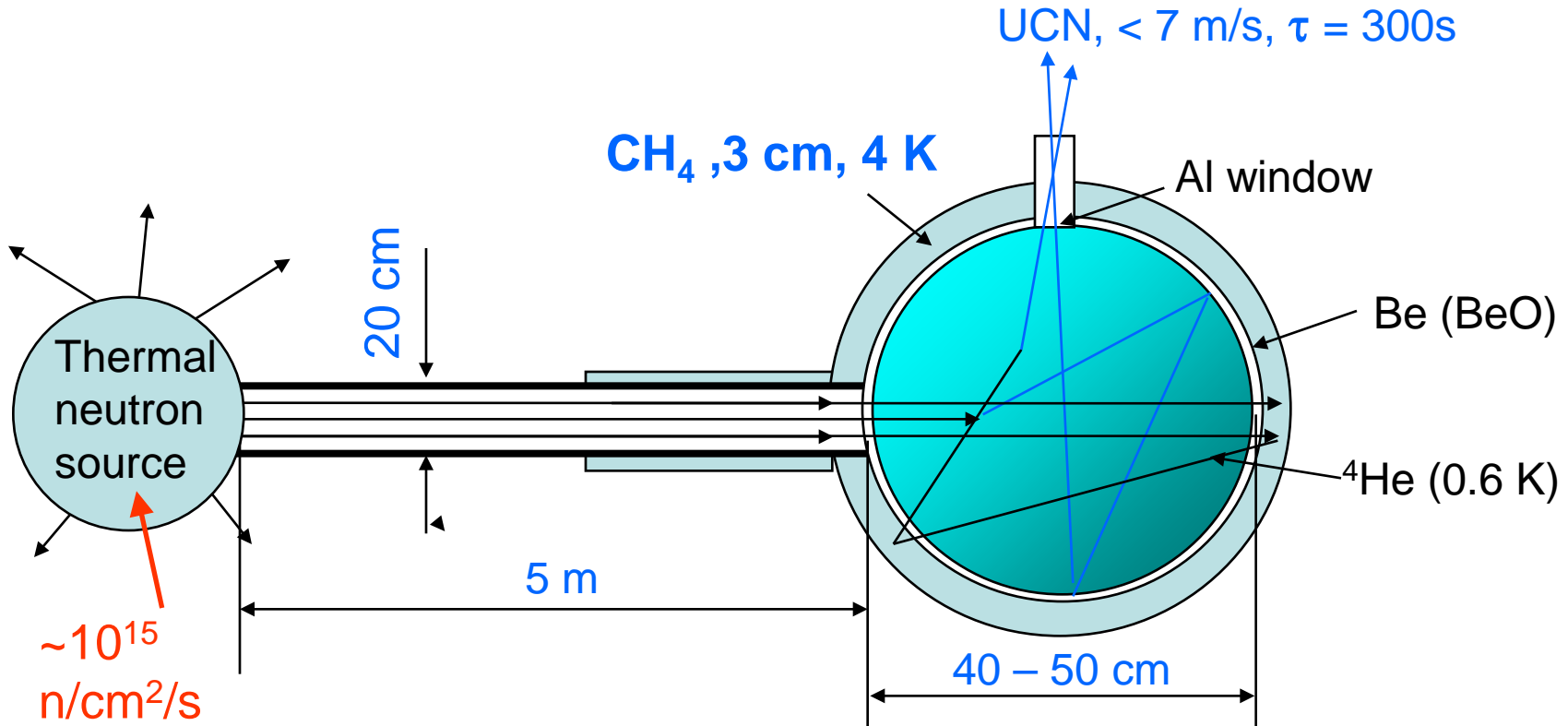
Evaluation parameters of the source



Power $\sim 10^7$ UCN/s

Density $\sim 10^5$ cm⁻³

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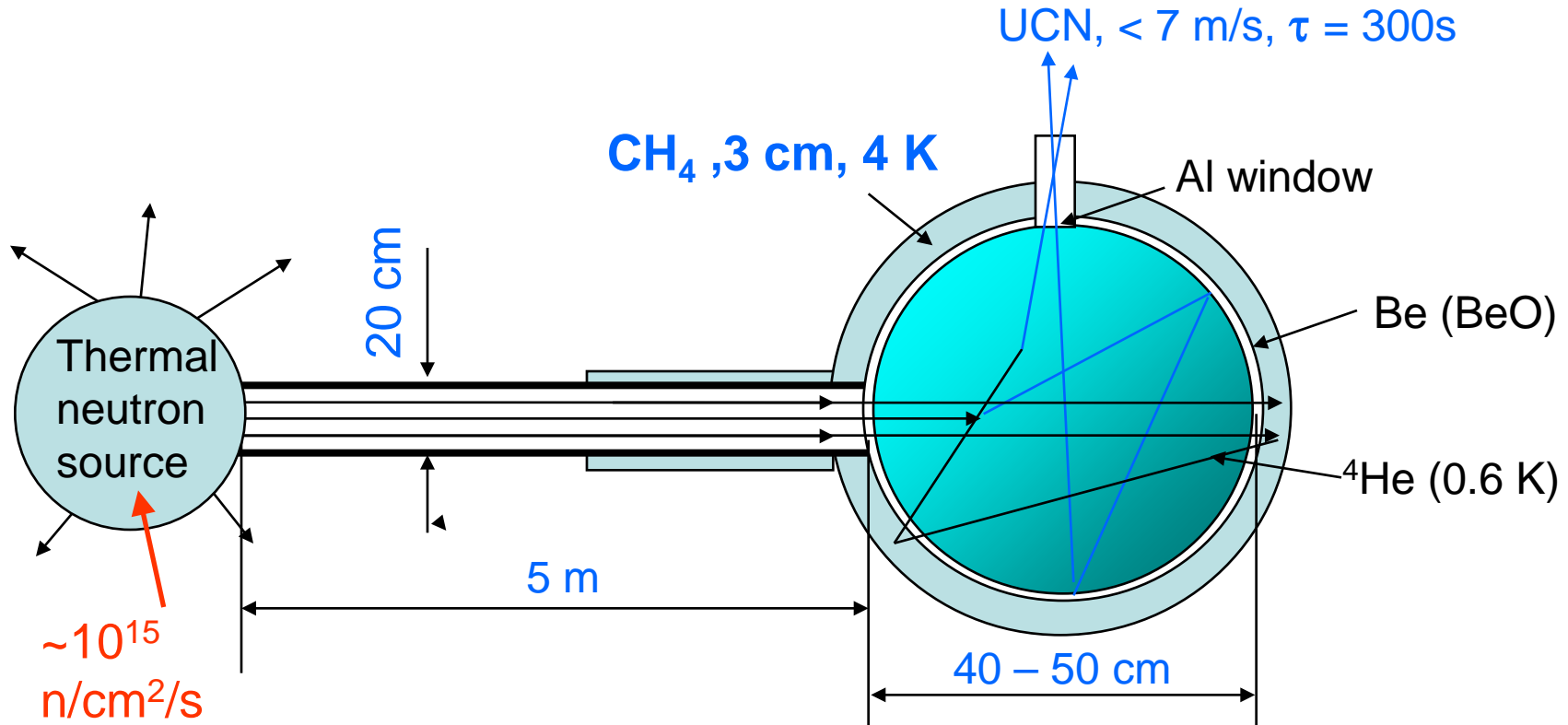


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Size is very important !

Evaluation parameters of the source



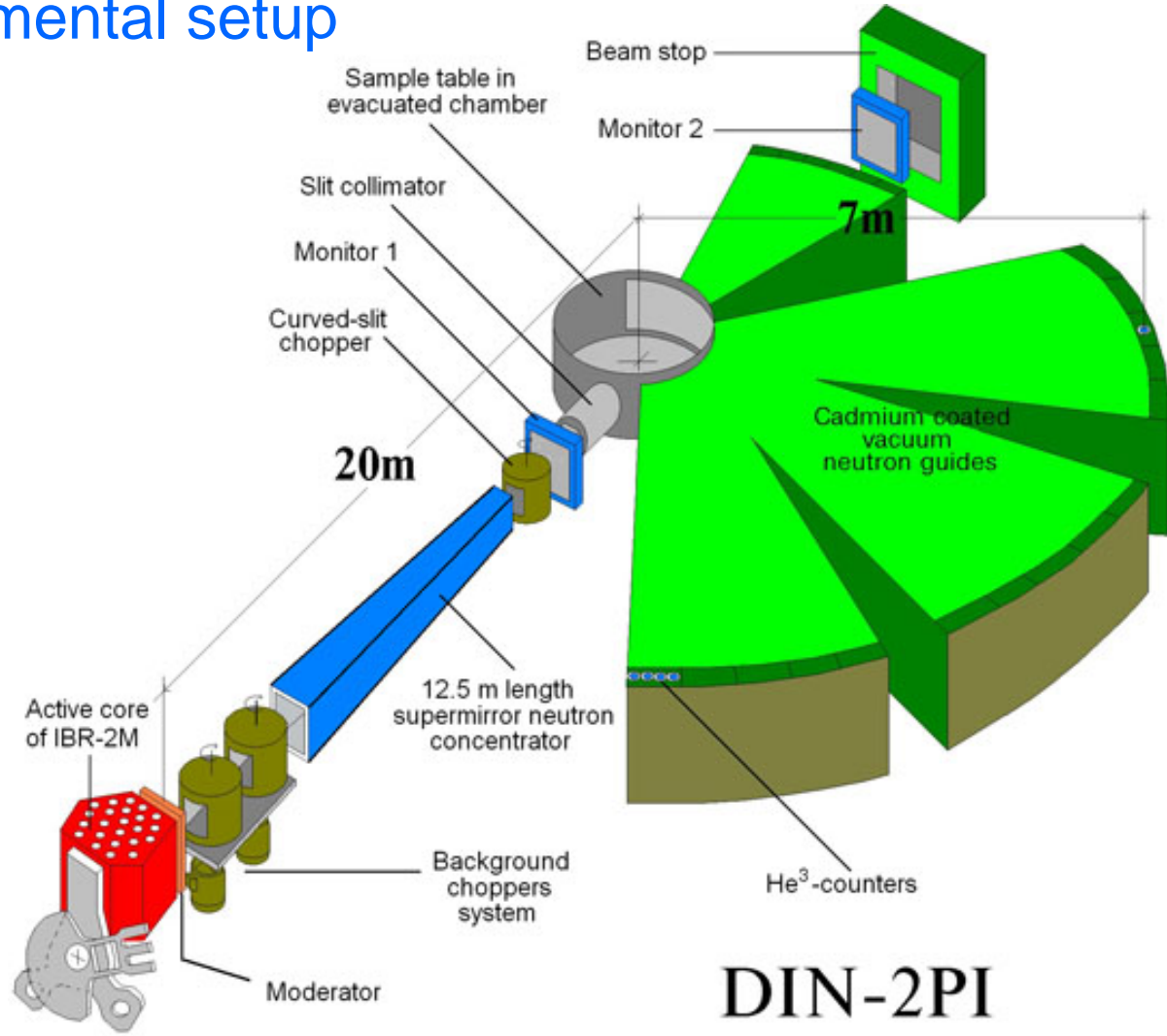
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Up to d⁵

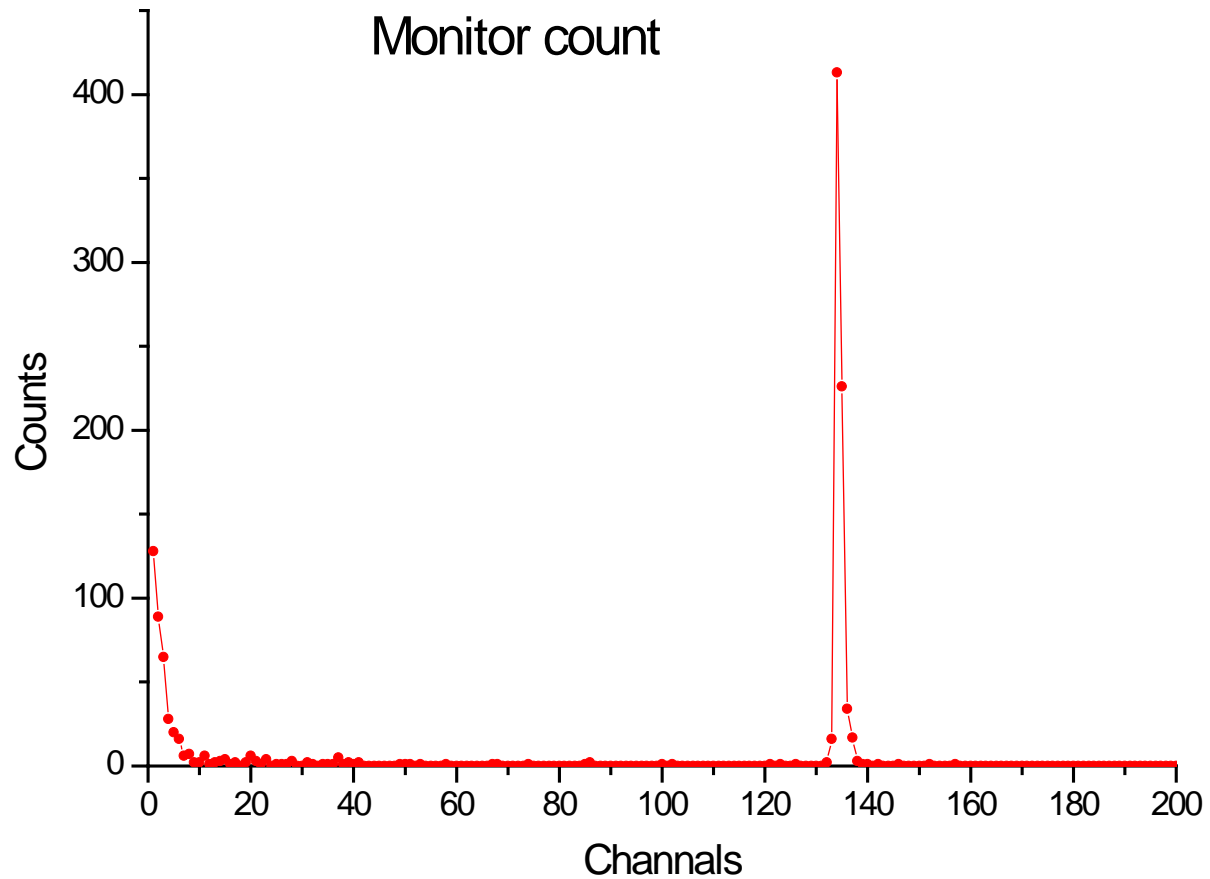
Experimental setup



DIN-2PI

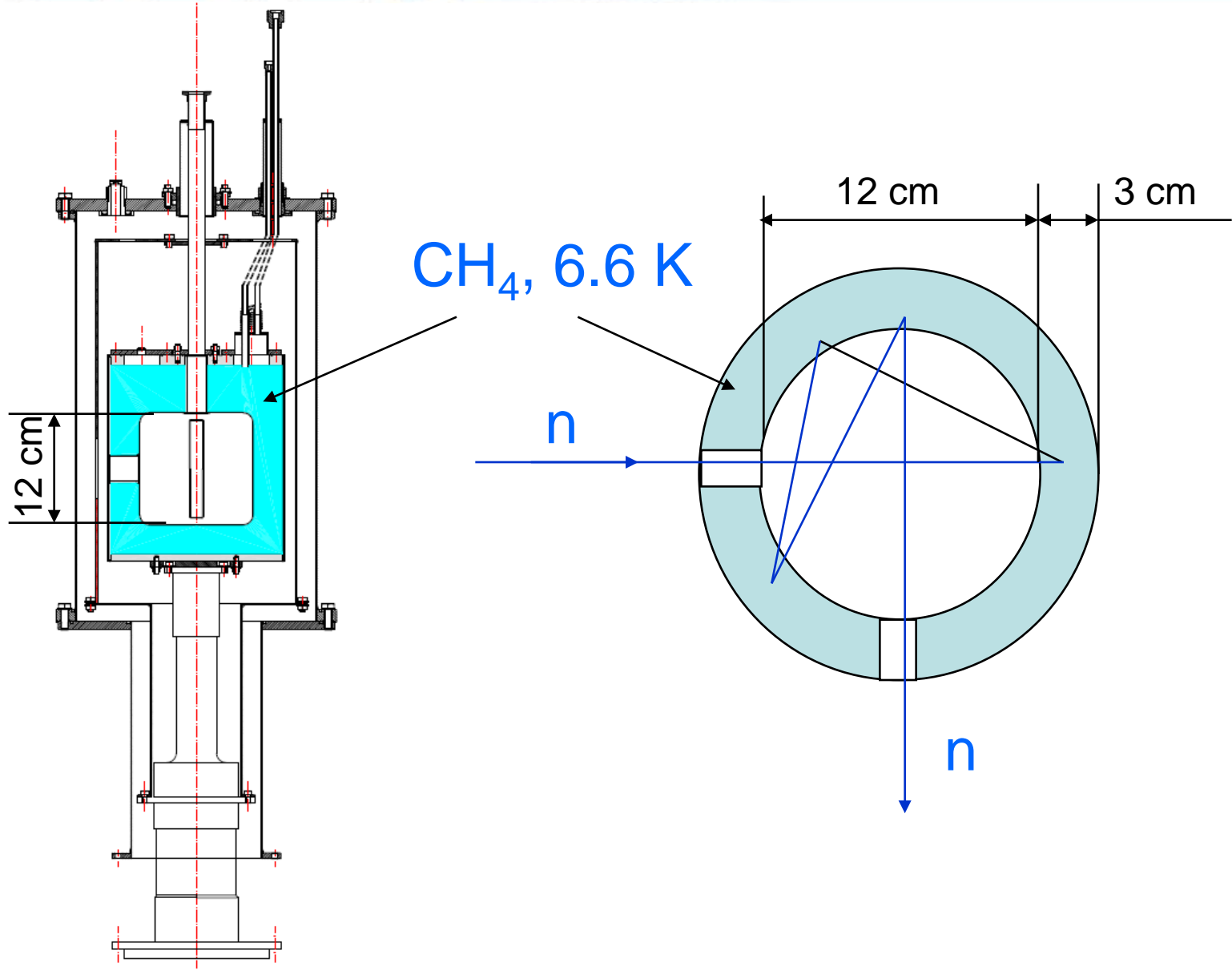


DIN-2PI. TOF spectrum of the beam



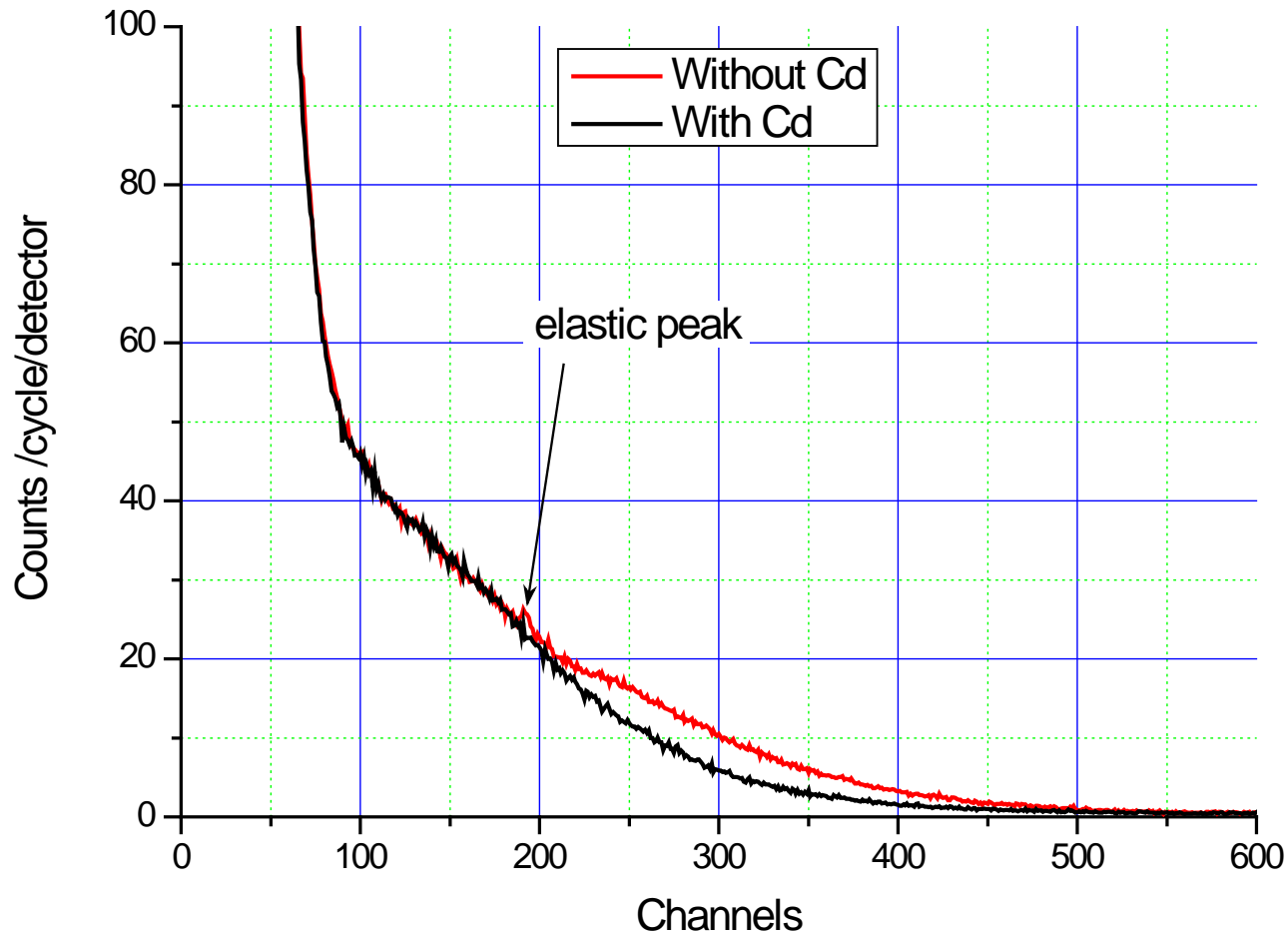
$V = 2200 \pm 15 \text{ m/s}$

$J \sim 10^5 \text{ n}\cdot\text{cm}^{-2}\text{s}^{-1}$



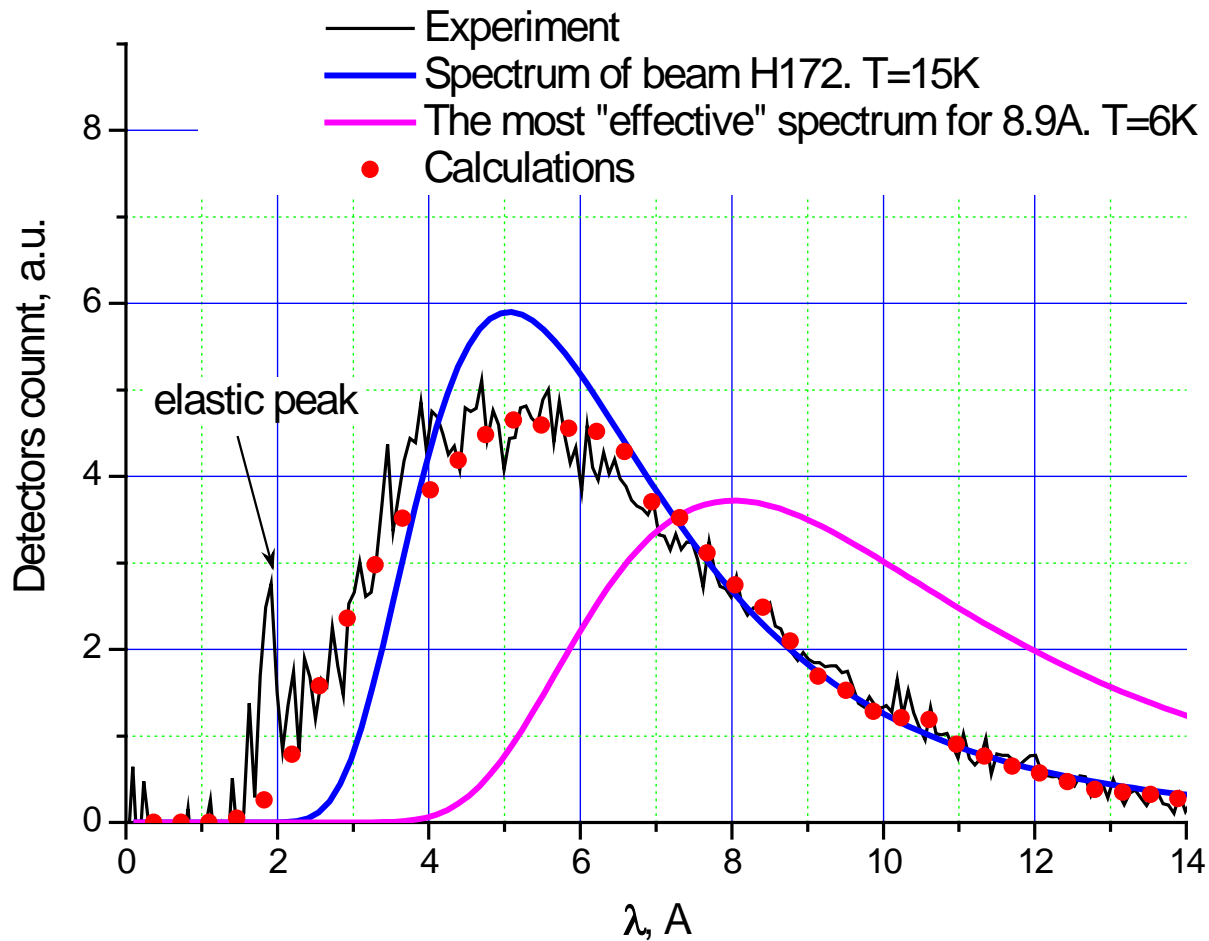
Experimental results

TOF spectrum
Solid methane. $T=6.6\text{K}$



Experimental results

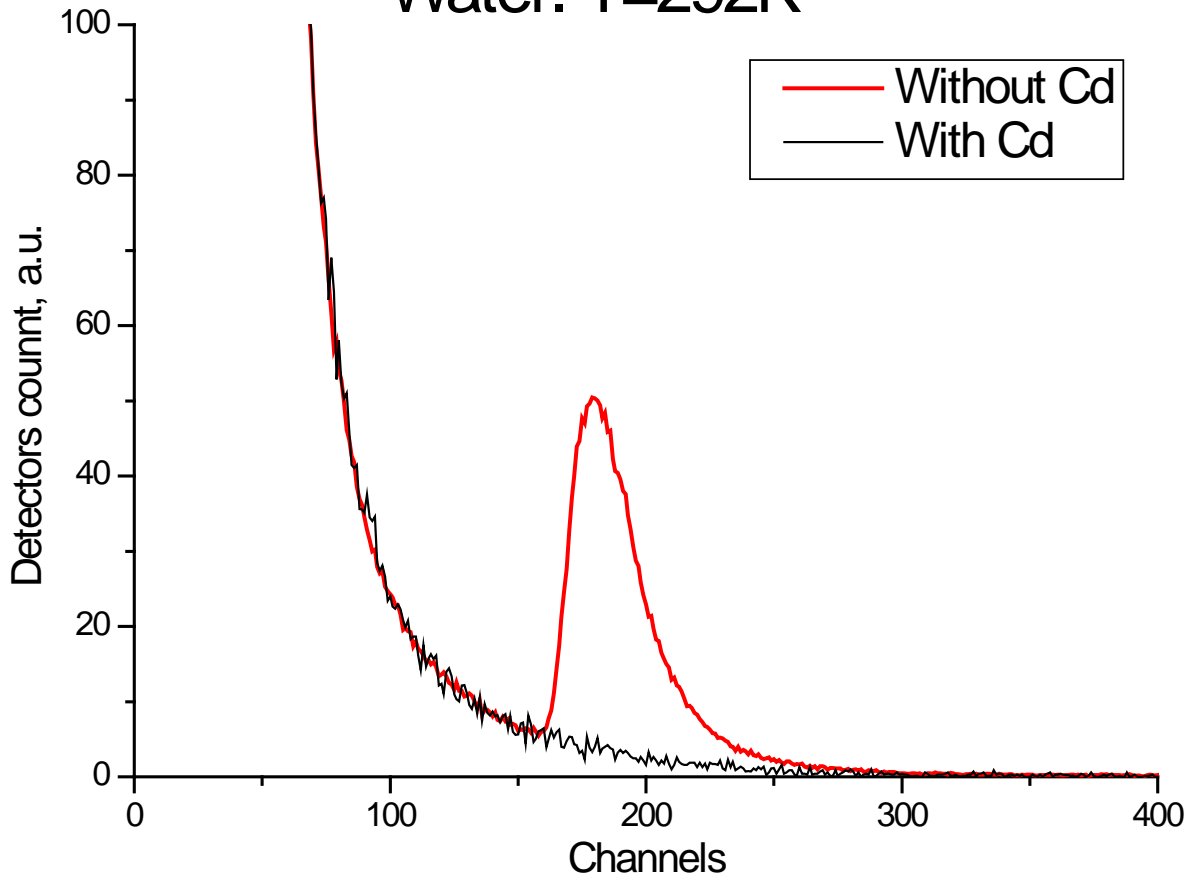
Solid methane. $T=6.6\text{K}$



Experimental results

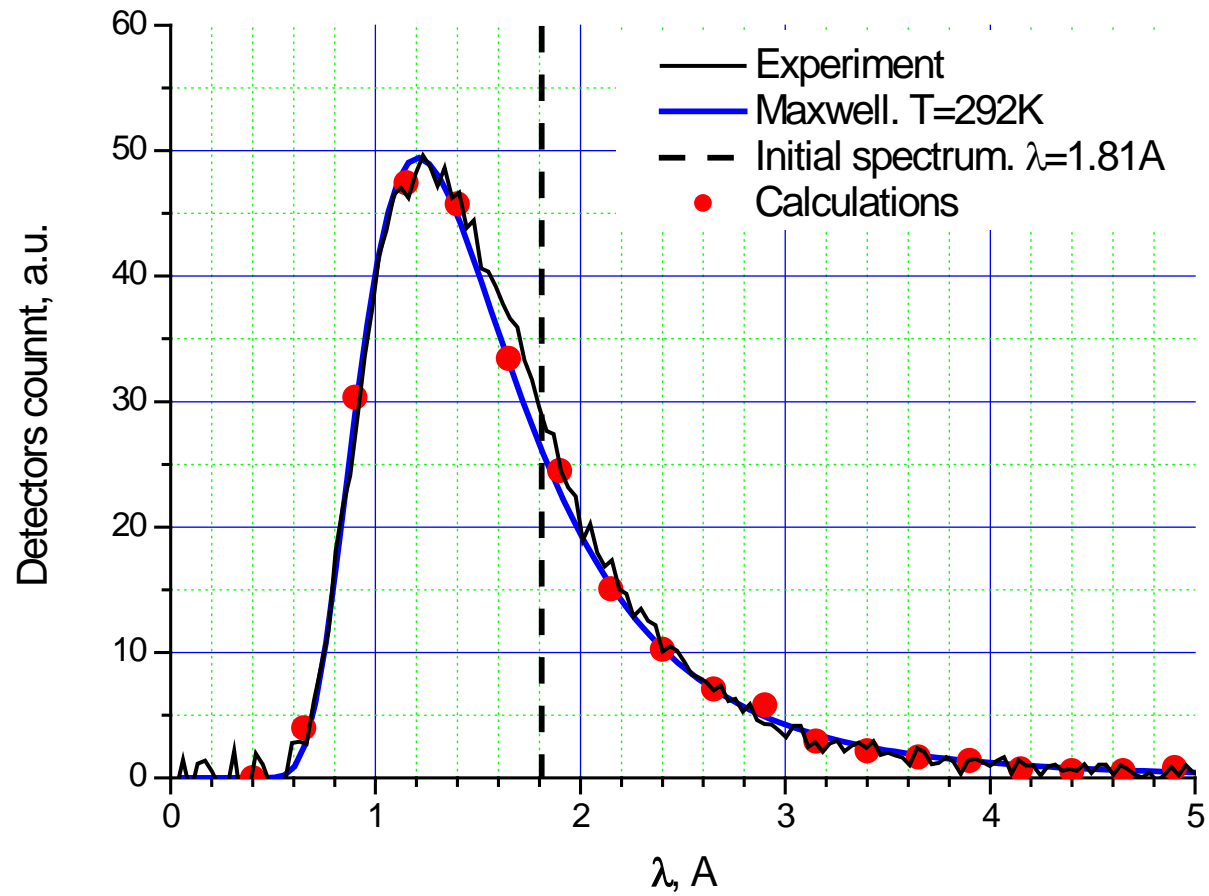
TOF spectrum

Water. $T=292\text{K}$



Experimental results

Water. T=292K



Experimental results

Experiment

$$\frac{\text{NH}_2\text{O} (292\text{K})}{\text{NCH}_4 (6.6\text{K})} = 2.01 \pm 0.02$$

Simulations

$$\frac{\text{NH}_2\text{O} (292\text{K})}{\text{NCH}_4 (6.6\text{K})} = 1.93 \pm 0.04$$

Experimental results

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Albedo H₂O (292K) = 0.8

Experimental results

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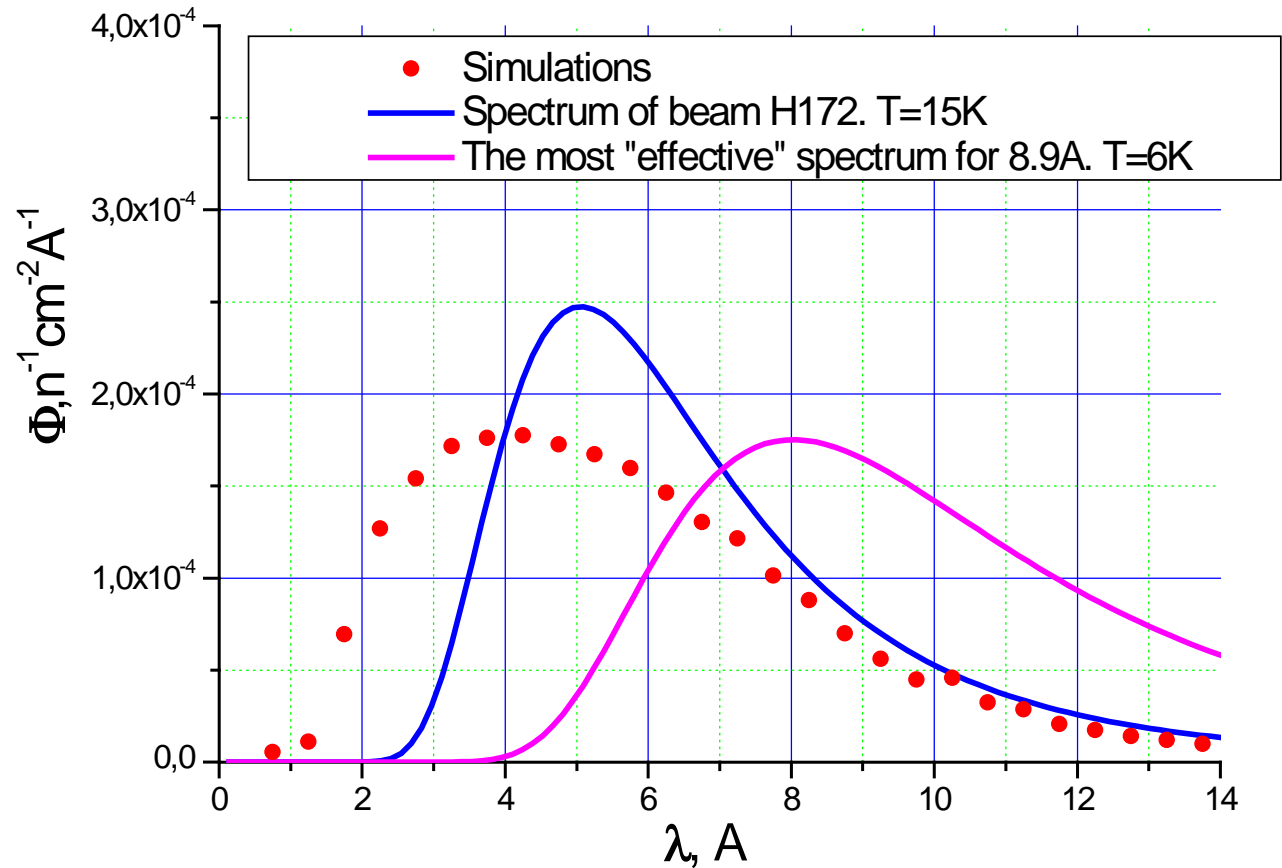
Albedo H₂O (292K) = 0.8

Albedo CH₄ (6.6K) = 0.65



Simulations

CH₄: 3cm, 4K. ϕ 40 cm. Entrance hole ϕ 20 cm



Conclusion

The source parameters if $F = 4 \cdot 10^{13} \text{ n/s}$:

$P \sim 10^7 \text{ UCN/s}$; $\rho_{\text{max}} \sim 10^5 \text{ UCN/cm}^3$

$Q_{\text{He}} \sim 0.2 \text{ W} + ?$

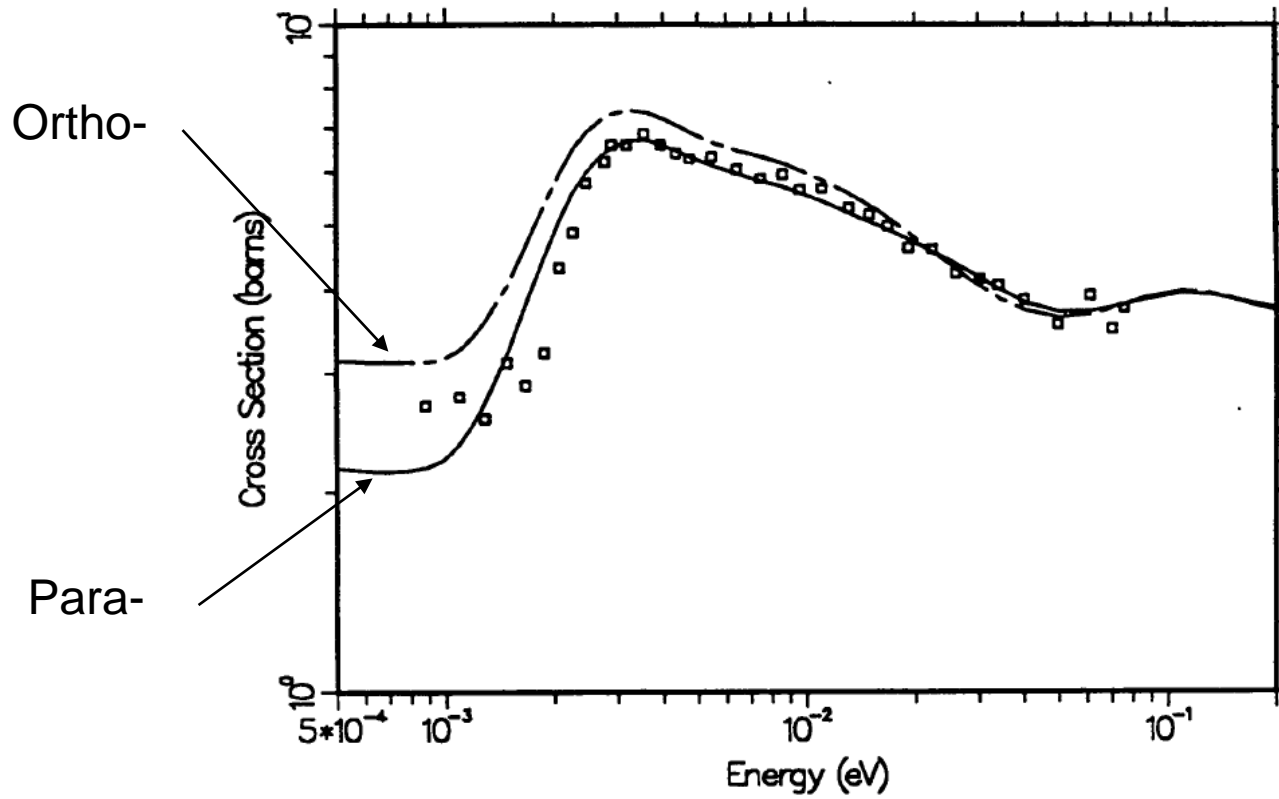
Cost $\sim 1 \text{ M\$}$

Limitations:

1. $Q \sim 1 - 2 \text{ W}$

2. $D(\text{CH}_4) \sim 20 \text{ MGy}$ – accumulation H_2 ?

Liquid deuterium 19K



coherent scattering → optical potential



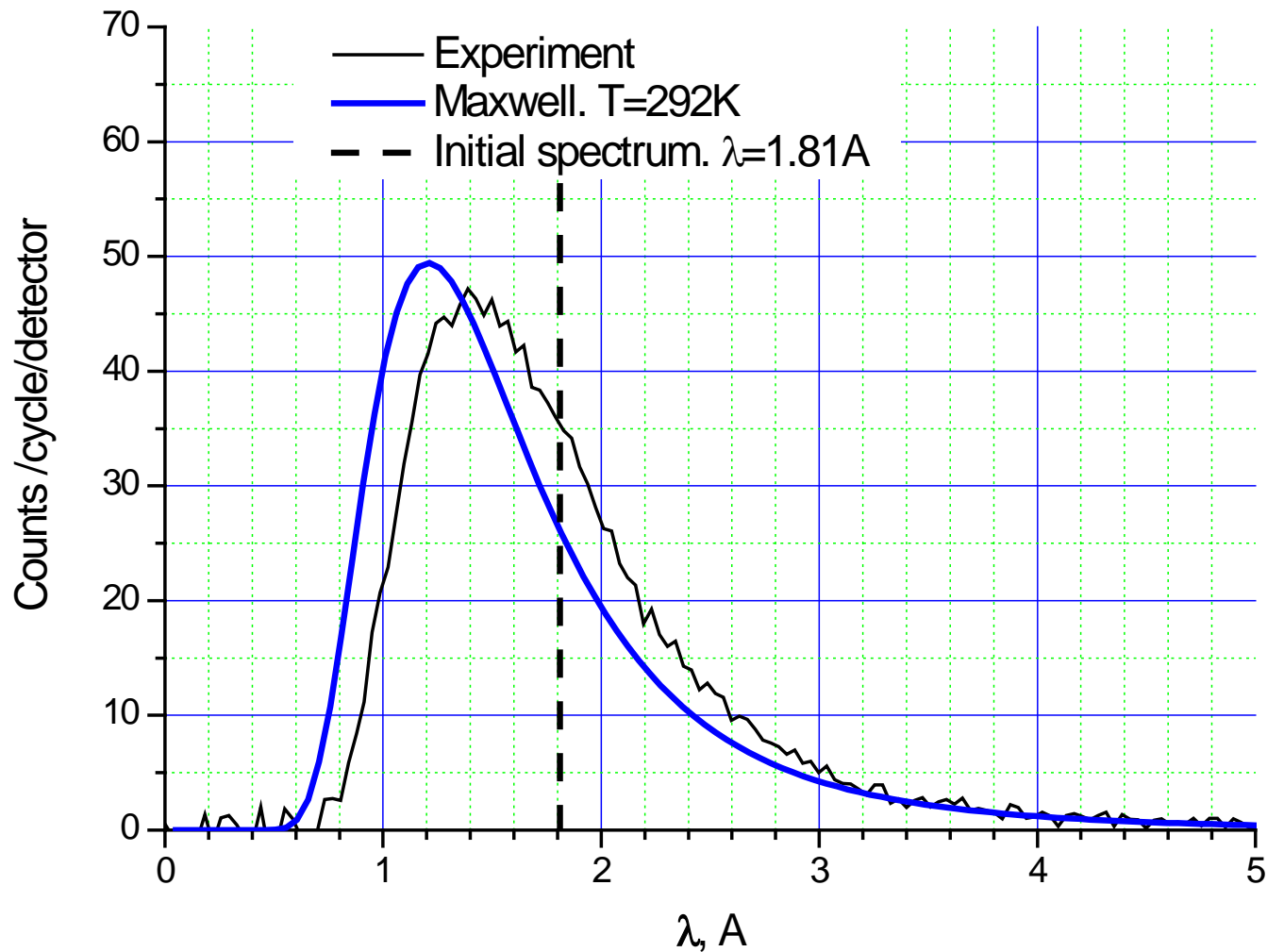
Thank you for attention!

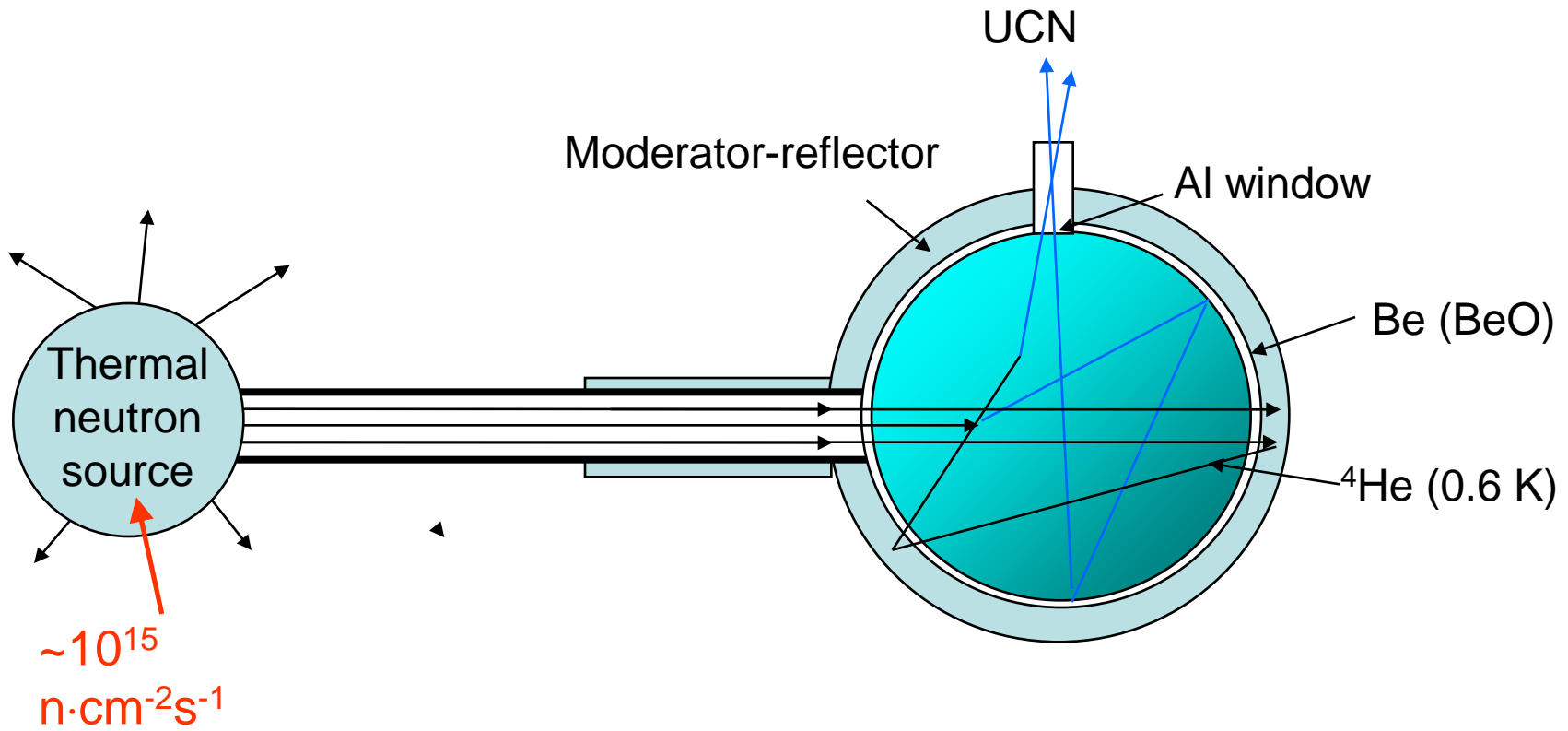




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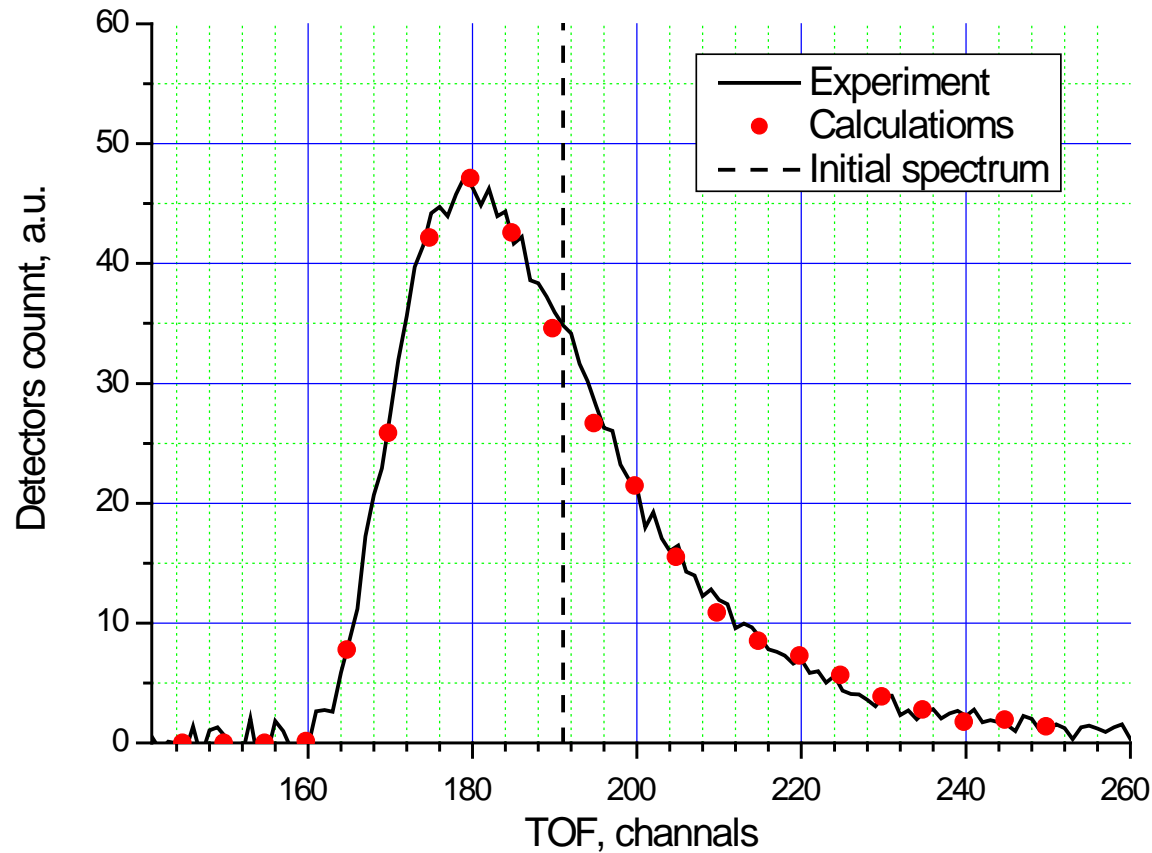
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