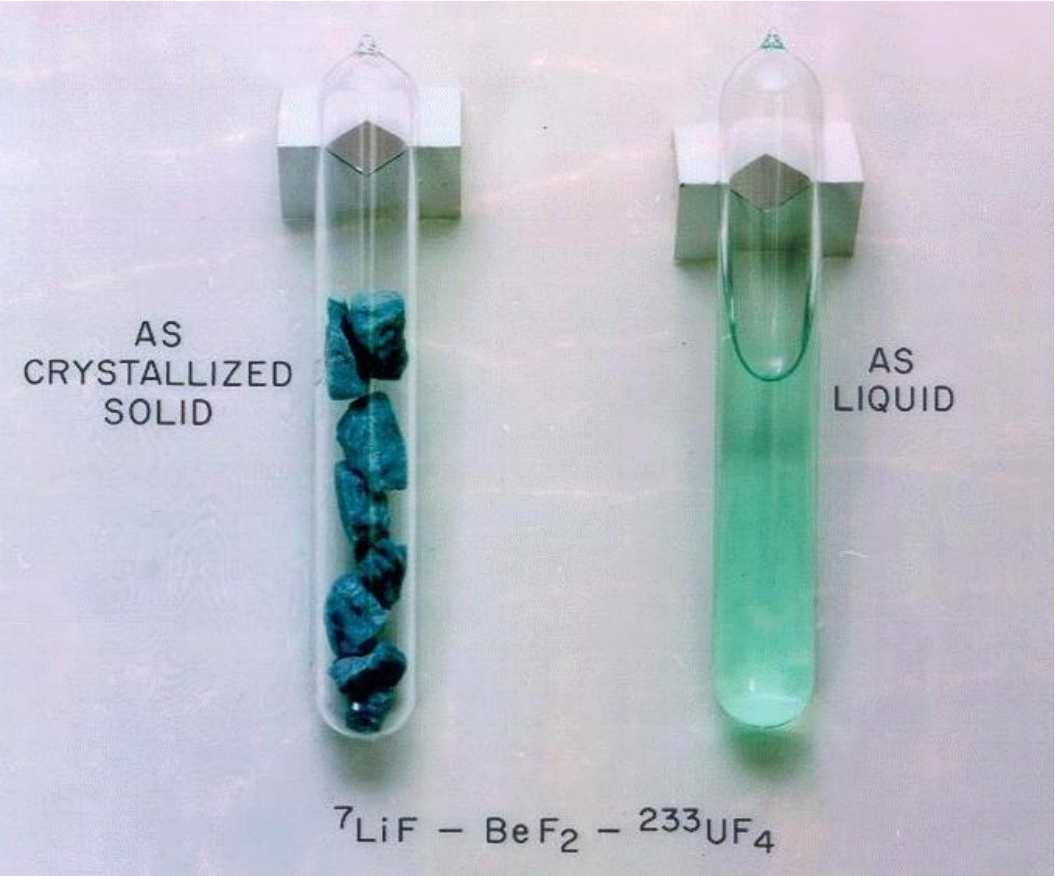
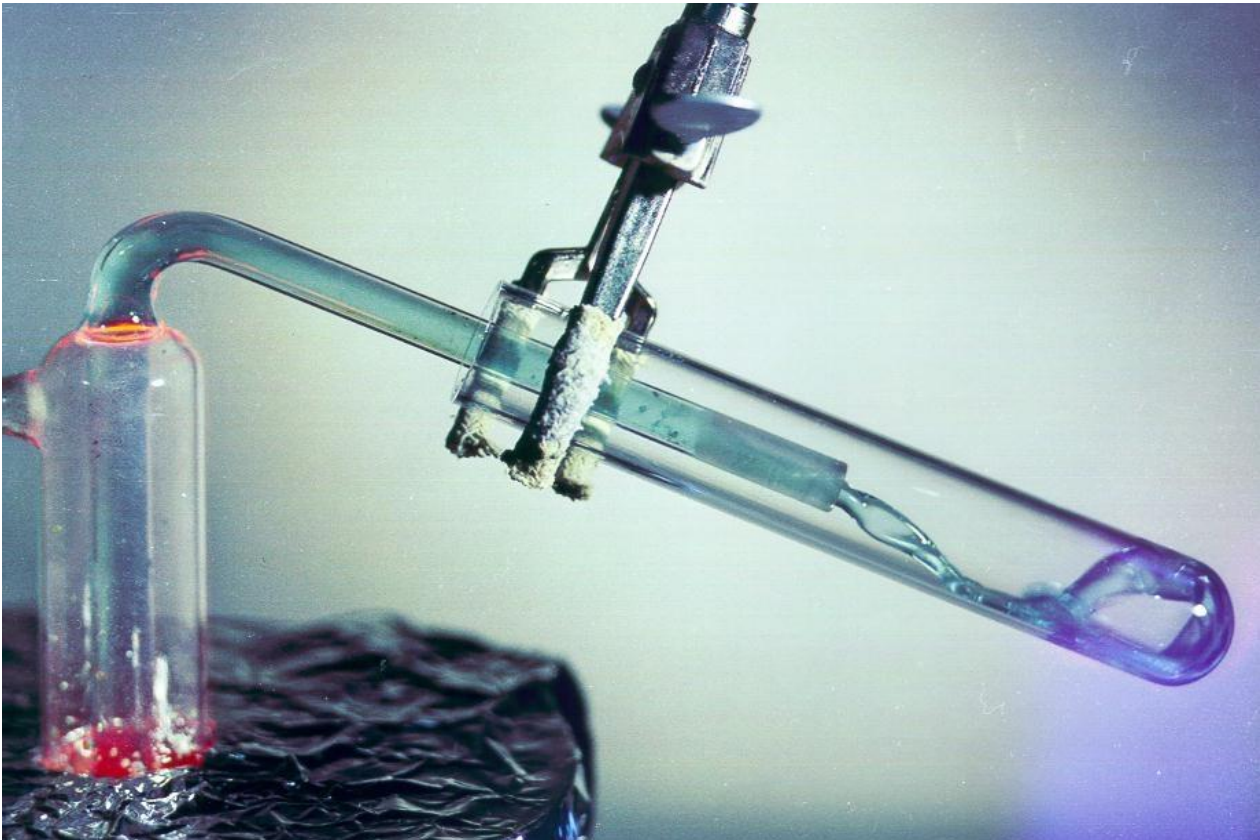


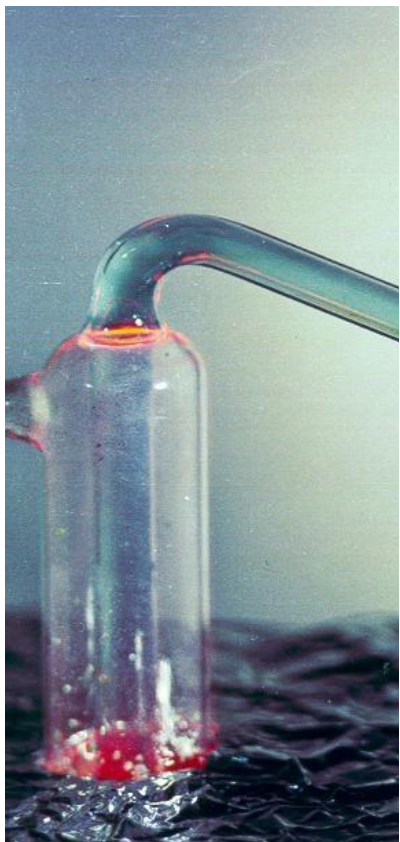
# Novel Experimental Approach to Vapor Pressure Measurements of Actinides in FLiBe

S. Scott Parker, **Hannah K. Patenaude**, Moiz I. Butt, Michael Hahn,  
J. Matt Jackson, Marisa J. Monreal

5 Nov 2024

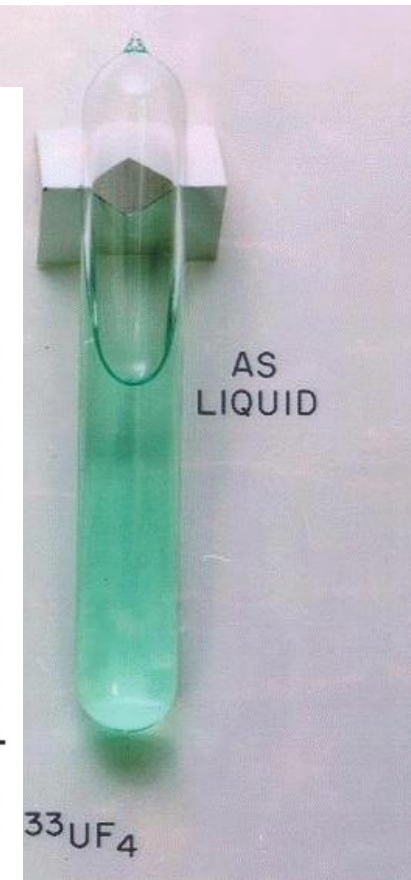
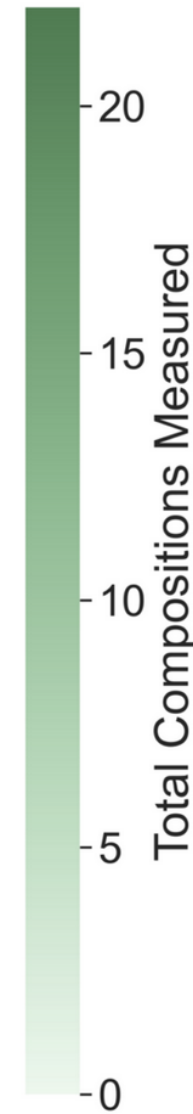
LA-UR-24-31560





### Molten Salt Thermal Properties Database (TP)

	KF	LiF	BeF <sub>2</sub>	RbF	ThF <sub>4</sub>	UF <sub>4</sub>	ZrF <sub>4</sub>
LiF		$\rho:5 \ \mu:5$ $\kappa:0 \ C_p:0$					
BeF <sub>2</sub>		$\rho:4 \ \mu:20$ $\kappa:1 \ C_p:1$					
RbF		$\rho:1 \ \mu:1$ $\kappa:0 \ C_p:1$					
ThF <sub>4</sub>		$\rho:5 \ \mu:0$ $\kappa:0 \ C_p:0$					
UF <sub>4</sub>		$\rho:5 \ \mu:3$ $\kappa:0 \ C_p:0$					
ZrF <sub>4</sub>	$\rho:11 \ \mu:0$ $\kappa:0 \ C_p:0$	$\rho:20 \ \mu:0$ $\kappa:0 \ C_p:0$					
NaF	$\rho:5 \ \mu:3$ $\kappa:0 \ C_p:0$	$\rho:9 \ \mu:1$ $\kappa:0 \ C_p:1$	$\rho:10 \ \mu:11$ $\kappa:0 \ C_p:0$		$\rho:8 \ \mu:9$ $\kappa:0 \ C_p:0$	$\rho:5 \ \mu:7$ $\kappa:0 \ C_p:0$	$\rho:7 \ \mu:2$ $\kappa:0 \ C_p:0$



# “What are your capabilities?”

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✓ Molten salt? Sure!

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- ✓ Fluorides? No problem

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# “What are your capabilities?”

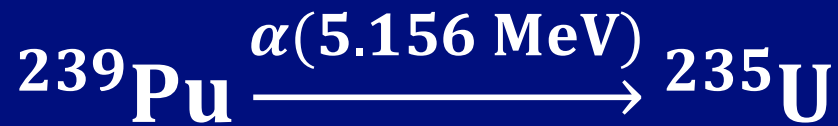
- ✓ Molten salt? Sure!
- ✓ Fluorides? No problem
- ✓ Actinides? Obviously...
- ? Beryllium? If we have to
- ✗ Boil it...?

**What is a chemist to do?**

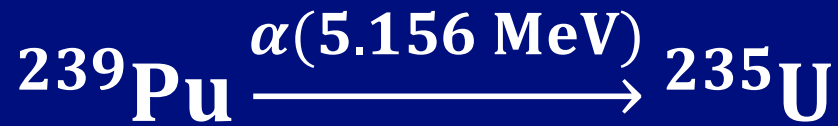


Let's Use Nuclear Physics!

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# Let's Use Nuclear Physics!

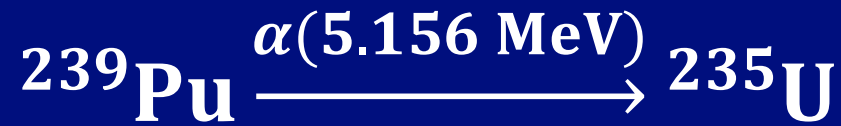


60%

40%

Odeblad & Nati, *Acta Radiol.*, 43(3), 1955.

# Let's Use Nuclear Physics!

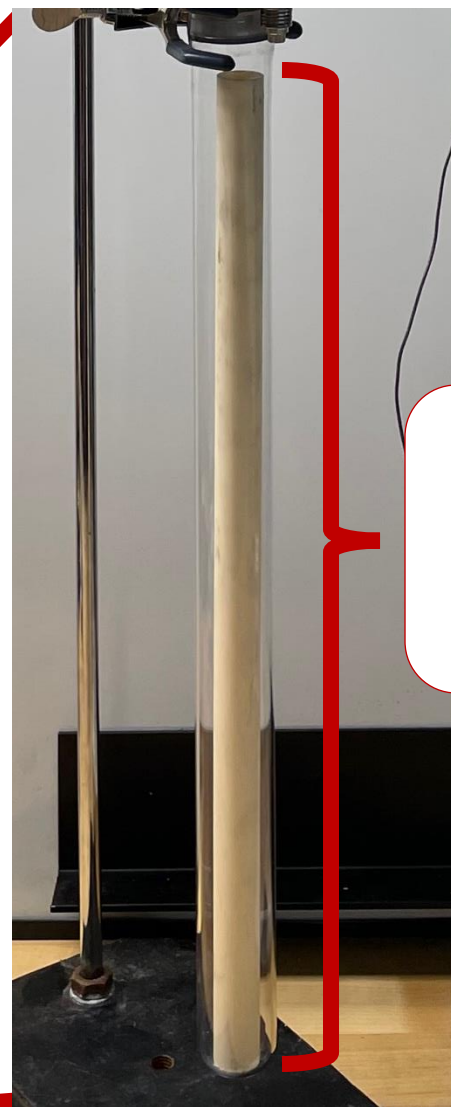
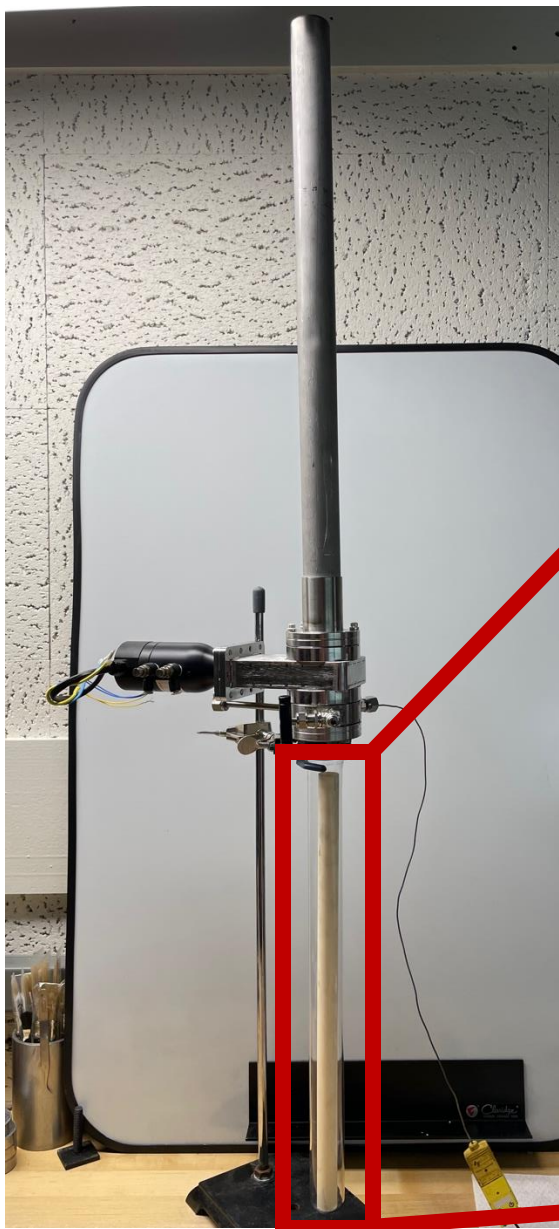


60%

40%

Odeblad & Nati, *Acta Radiol.*, 43(3), 1955.





**Salt Loading  
&  
Hot Region**

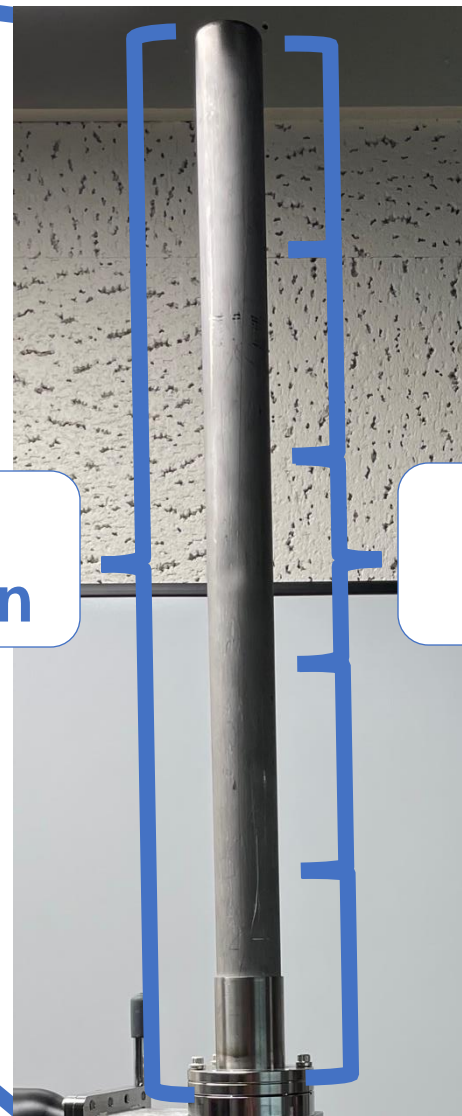
- FLiBe
  - 67.2-32.8 mol% BeF<sub>2</sub>-LiF
- <100 ppm An
  - <sup>239</sup>Pu
  - 20% Enriched <sup>235</sup>U

- Quartz tube
- Al<sub>2</sub>O<sub>3</sub> crucible
- 1000 °C furnace





Cold  
Region



Detection  
Zones

- 316 SS
- 10 °C Water-circulating jacket
- Concentric radiation detection
  - HPGe  $\gamma$  spectroscopy
    - Segmented Pb shielding
  - $n$  counting
    - Paraffin wax shielding

# Monte Carlo N-Particle Transport Code

*MCNP to Guide Vessel Design*



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*MCNP to Guide Vessel Design*

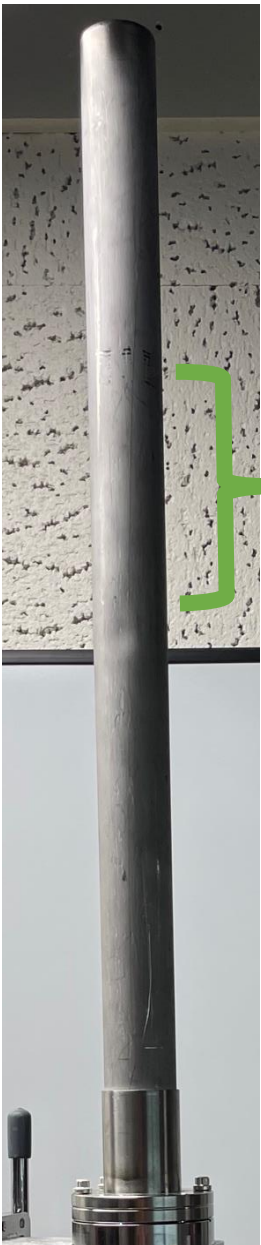
- 2 MeV  $n$  source &  $10^7$  particles



# Monte Carlo N-Particle Transport Code

*MCNP to Guide Vessel Design*

- 2 MeV  $n$  source &  $10^7$  particles



Top View Cross-Section



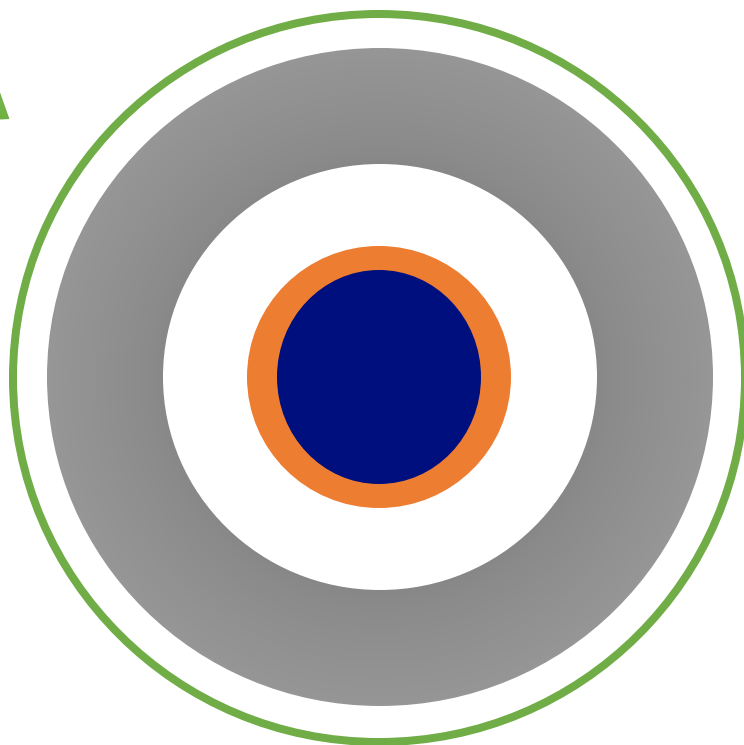
# Monte Carlo N-Particle Transport Code

*MCNP to Guide Vessel Design*

- 2 MeV  $n$  source &  $10^7$  particles

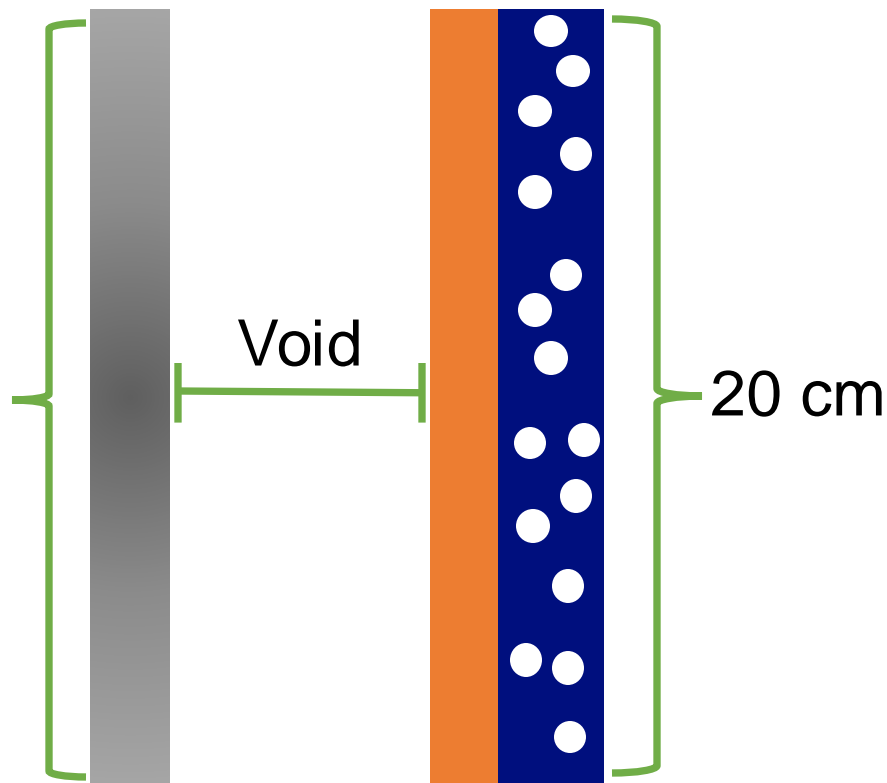


### Top View Cross-Section



$\gamma$  &  $n$   
Detection

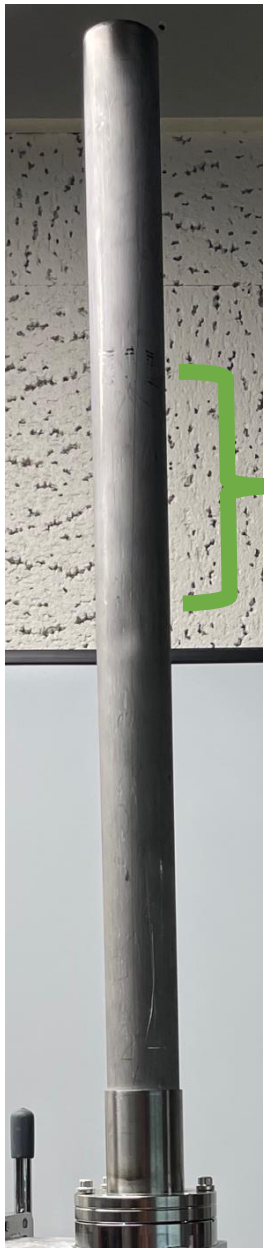
### Side View Cross-Section



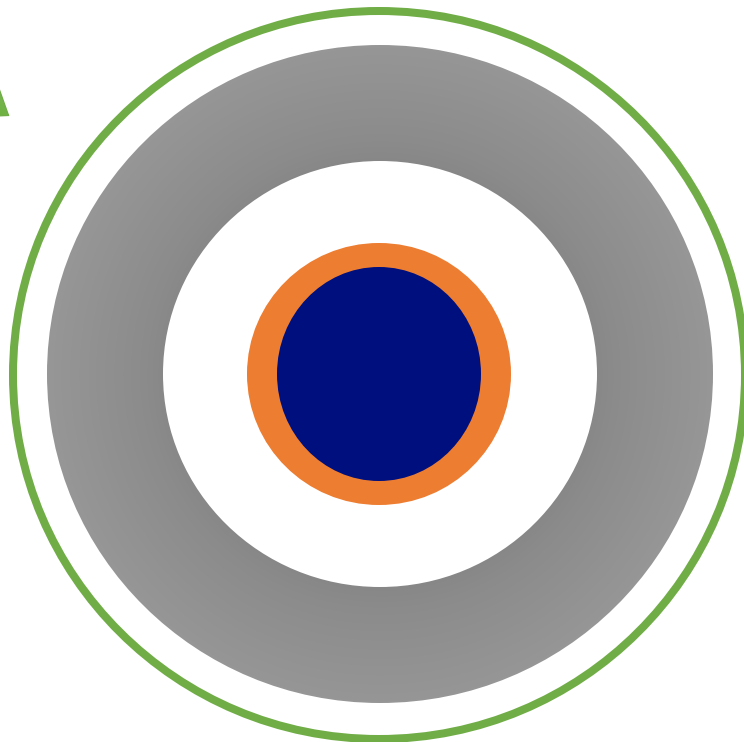
# Monte Carlo N-Particle Transport Code

*MCNP to Guide Vessel Design*

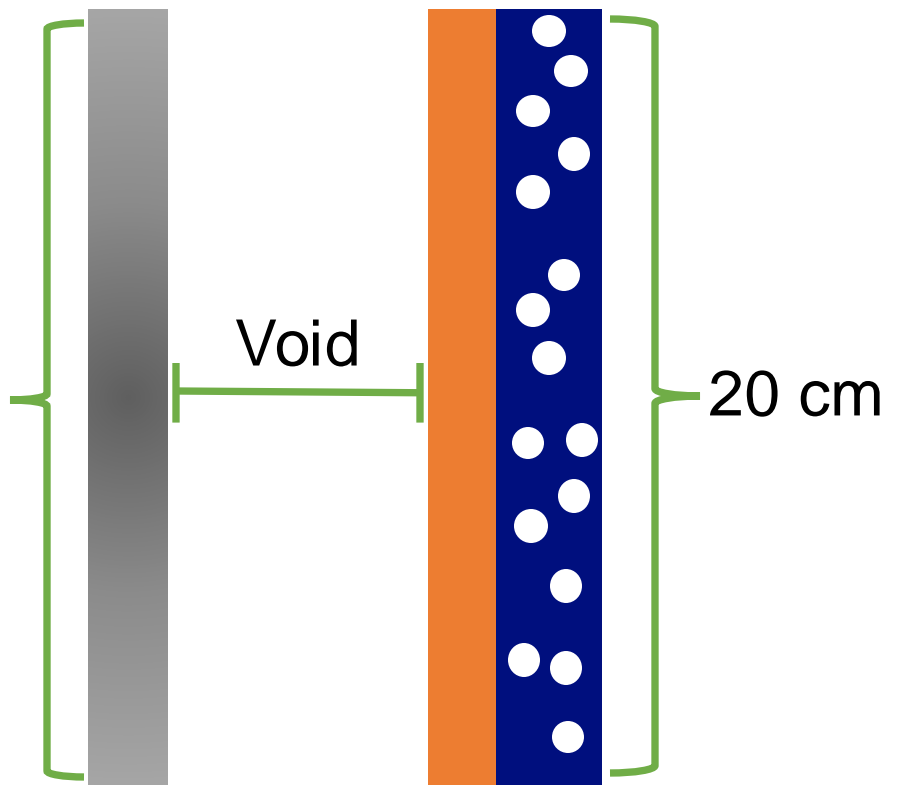
- 2 MeV  $n$  source &  $10^7$  particles
- $E_\gamma$  & count  $\uparrow$  as SS wall thickness  $\uparrow$ 
  - Increased collisions



### Top View Cross-Section



### Side View Cross-Section

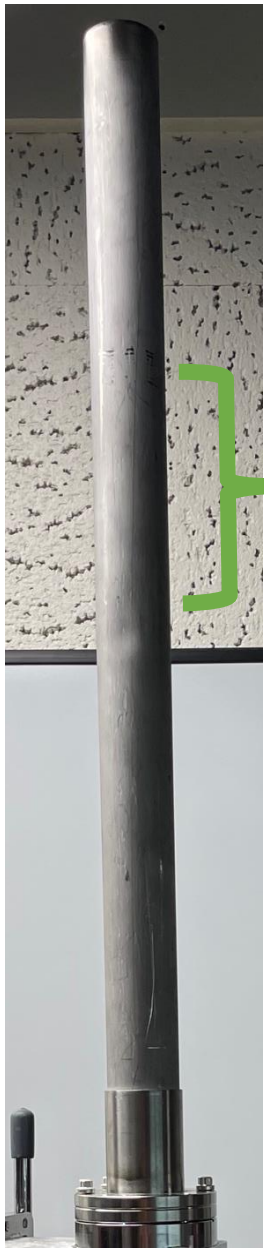


$\gamma$  &  $n$   
Detection

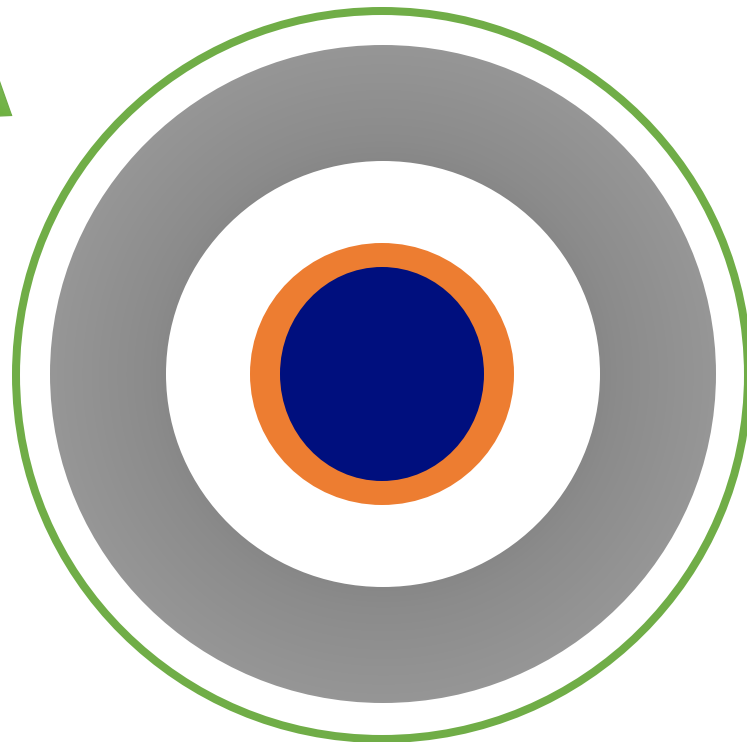
# Monte Carlo N-Particle Transport Code

*MCNP to Guide Vessel Design*

- 2 MeV  $n$  source &  $10^7$  particles
- $E_\gamma$  & count  $\uparrow$  as SS wall thickness  $\uparrow$ 
  - Increased collisions
- $E_n$  & count  $\downarrow$  as SS wall thickness  $\uparrow$ 
  - Absorption & attenuation

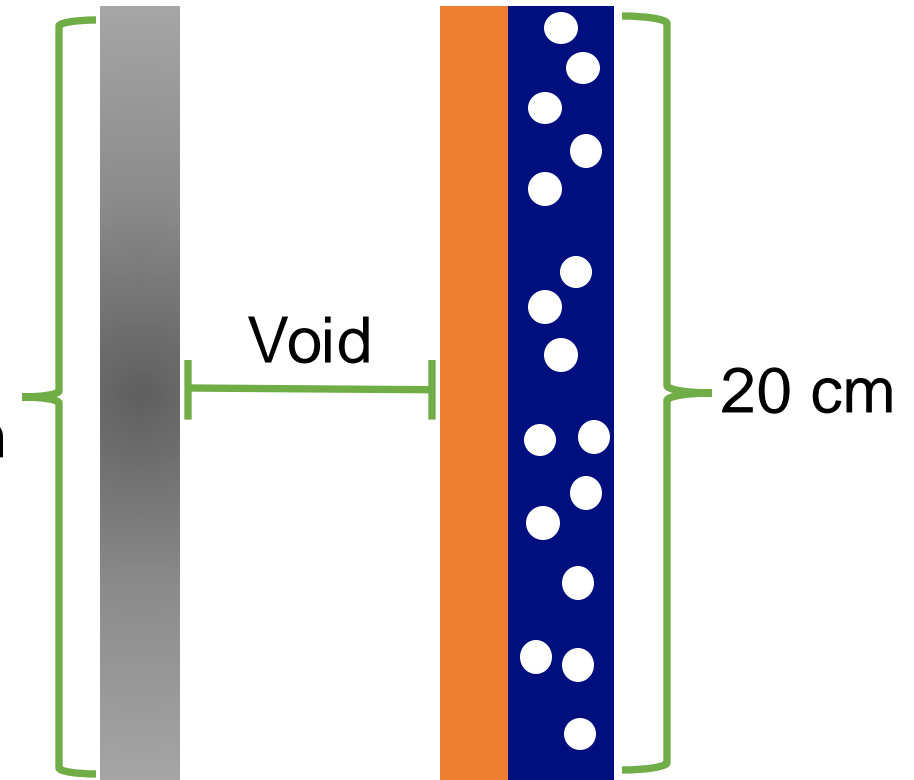


### Top View Cross-Section



$\gamma$  &  $n$   
Detection

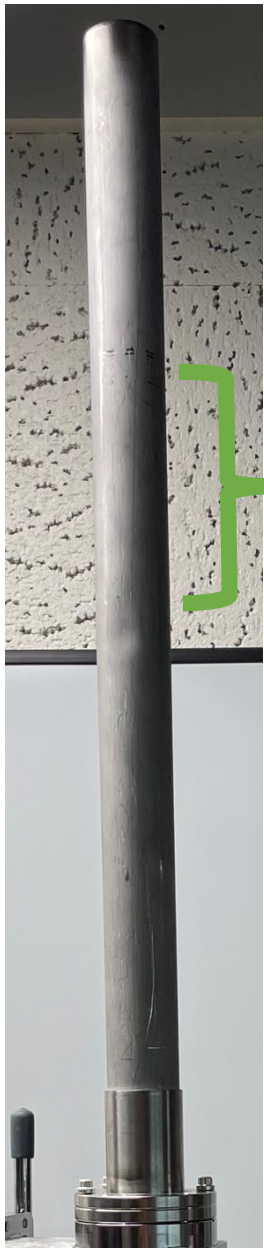
### Side View Cross-Section



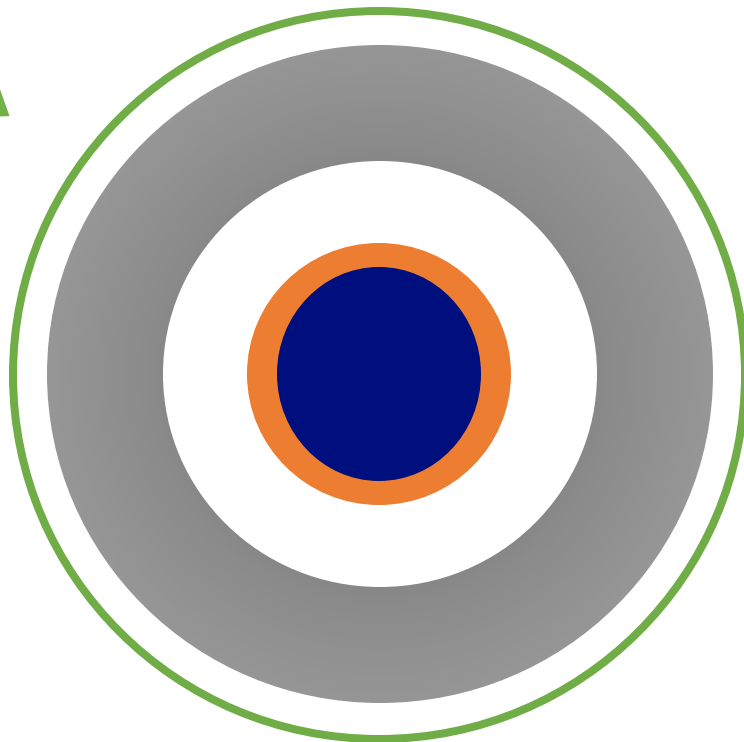
# Monte Carlo N-Particle Transport Code

*MCNP to Guide Vessel Design*

- 2 MeV  $n$  source &  $10^7$  particles
- $E_\gamma$  & count  $\uparrow$  as SS wall thickness  $\uparrow$ 
  - Increased collisions
- $E_n$  & count  $\downarrow$  as SS wall thickness  $\uparrow$ 
  - Absorption & attenuation
- **Overall:**  $\gamma:n$  ratio  $\uparrow$  as SS wall thickness  $\uparrow$

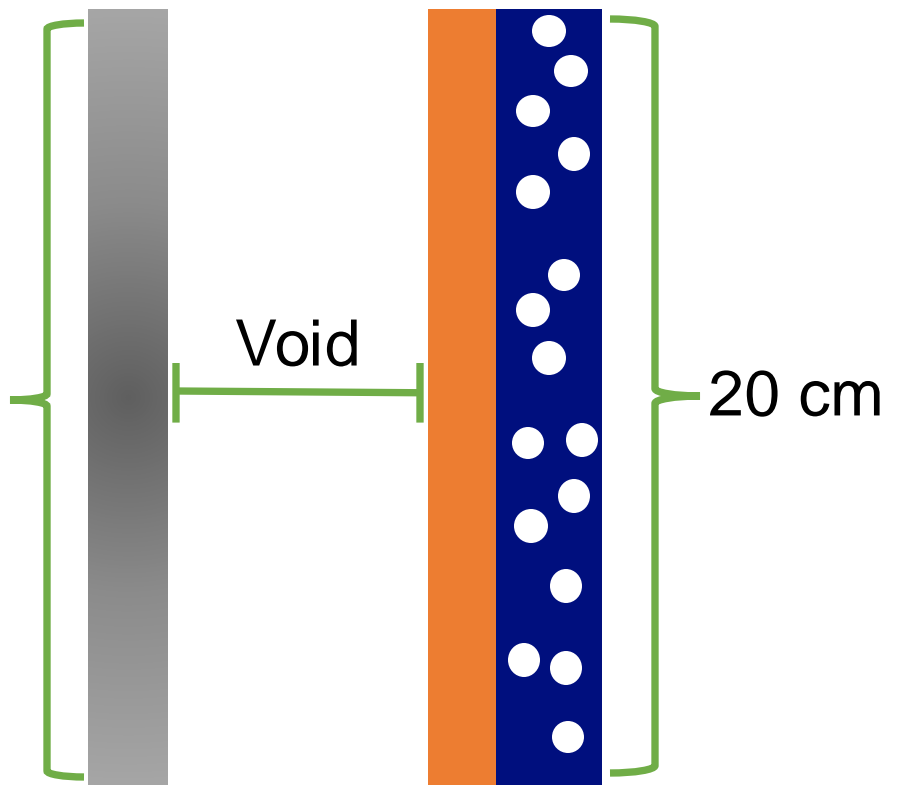


### Top View Cross-Section



$\gamma$  &  $n$   
Detection

### Side View Cross-Section





# Thank You!