The Los Alamos UCN Source

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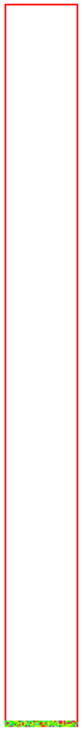
P-25 Nuclear and Particle Physics
LOS ALAMOS NATIONAL LABORATORY

UCN for beta decay measurements

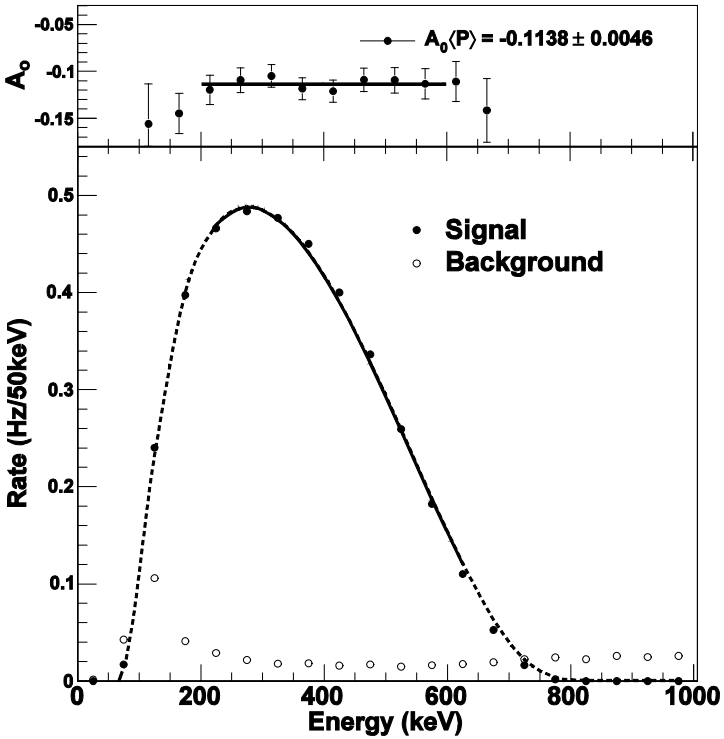


$$V_{^{58}Ni} = \frac{2\pi\hbar^2 \rho_n a}{m} = 335\,nV \rightarrow v = 8\,m/\sec$$

$$V = \; mgh \; = 102\,nV/m$$

$$V = \; \vec{\mu} \bullet \vec{B} \; = 60 \; nV/T$$

UCN for beta decay measurements



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Beta decay measurements with UCN

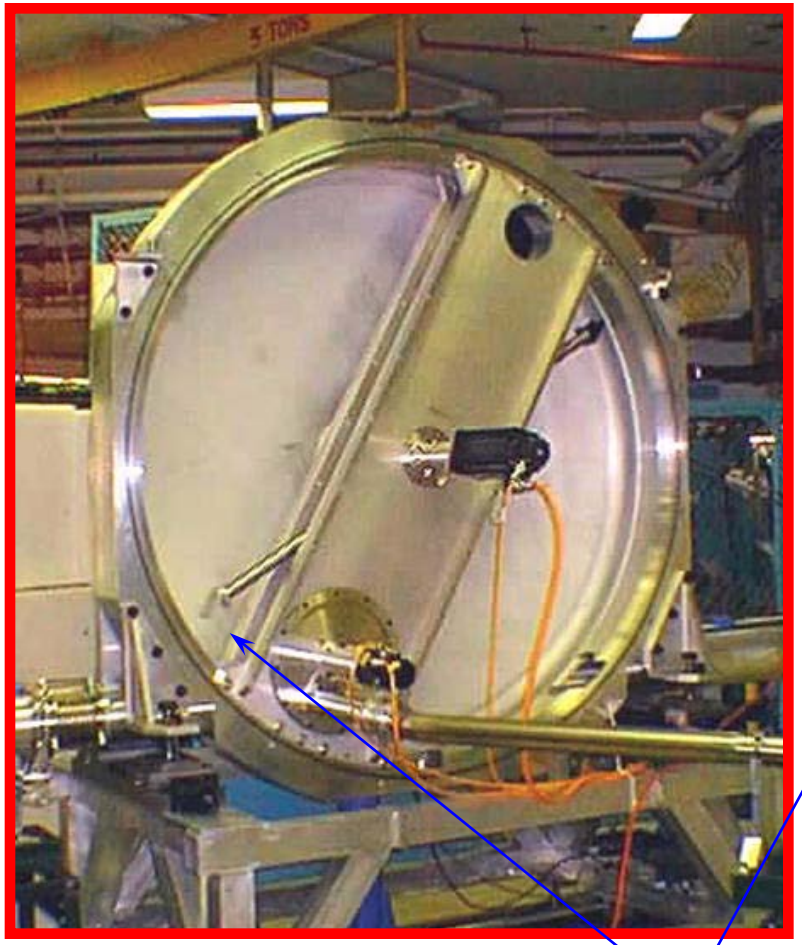
- Reduced background
  - Higher ratio of decays to neutrons
  - No production source background
  - Negligible UCN induced backgrounds

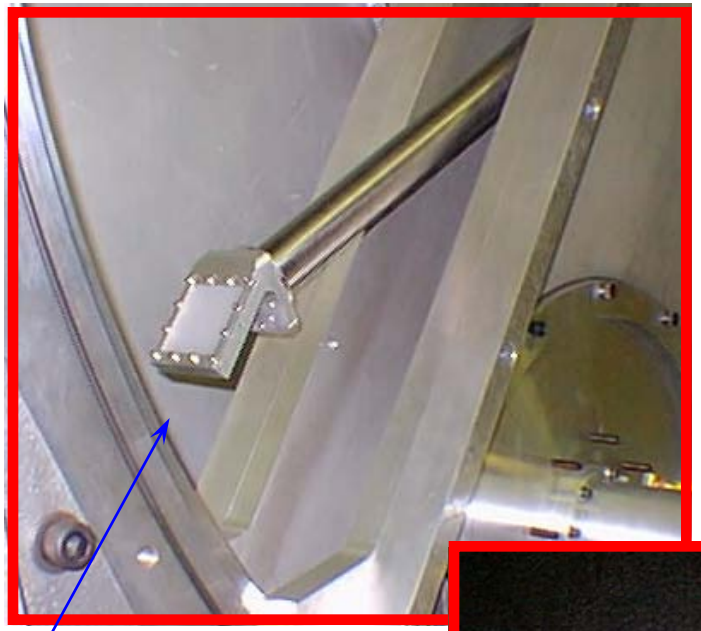
Our first attempt

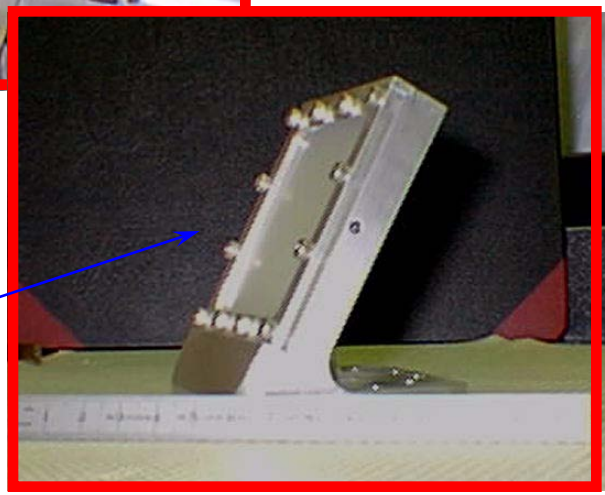
- FP11 6 cm x 6cm cold beam
- Moderator-crystal distance 8m
- Rotor diameter 181 cm
- Frequency 40 Hz
- Mica crystal converter
- 9.96 A neutrons converted

Expect 10 UCN/cm^3

Our first attempt

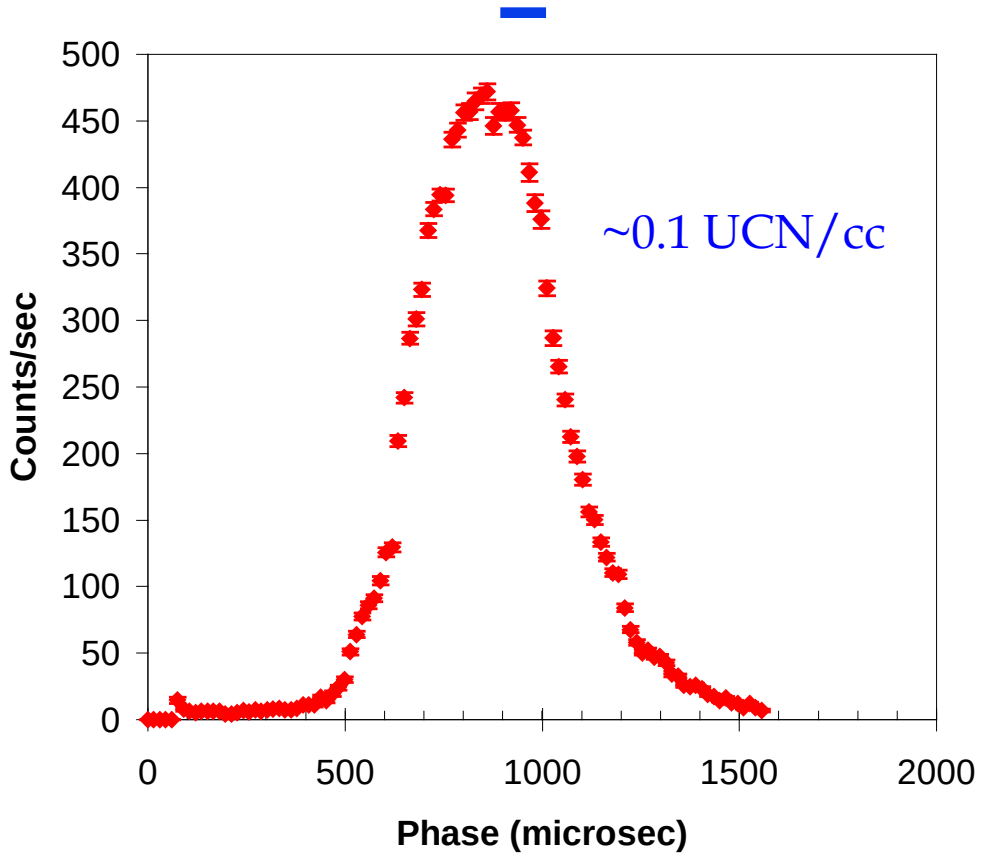




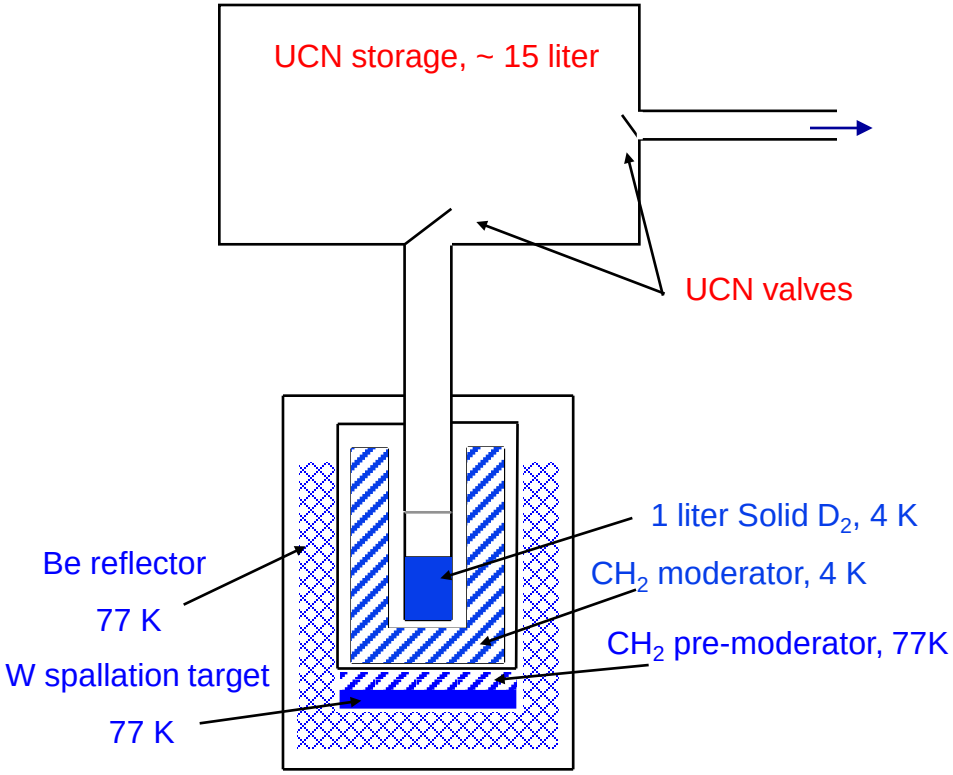


Mica Crystal Package

Our first attempt



Solid D_2 Spallation UCN Source Concept



$$\tau \approx \frac{V}{V_{SD2}} \tau_{SD2}$$

$$\rho(t > \tau) \approx \rho(SD_2)$$

$$\tau_{SD2} = 160 \text{ msec (absorption)}$$

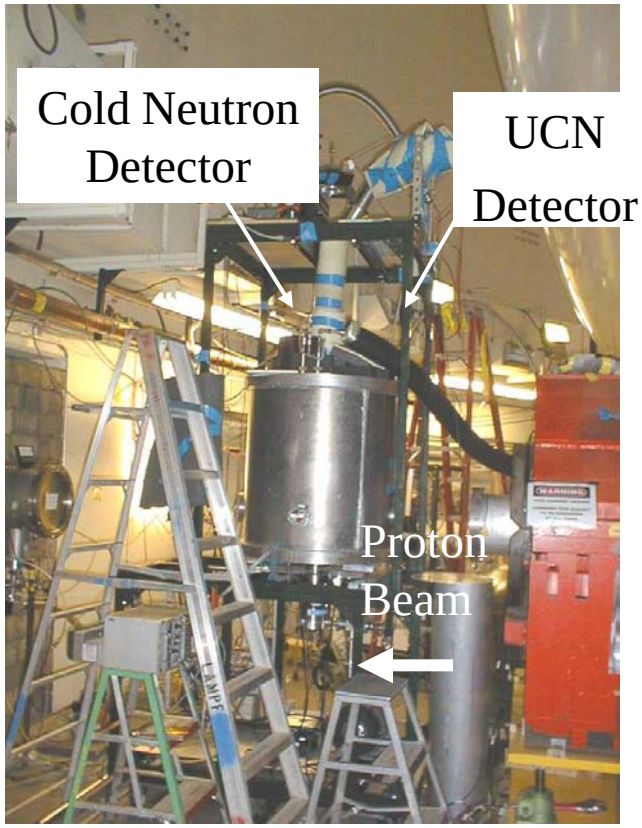
$$V_{SD2} = 102\, nV$$

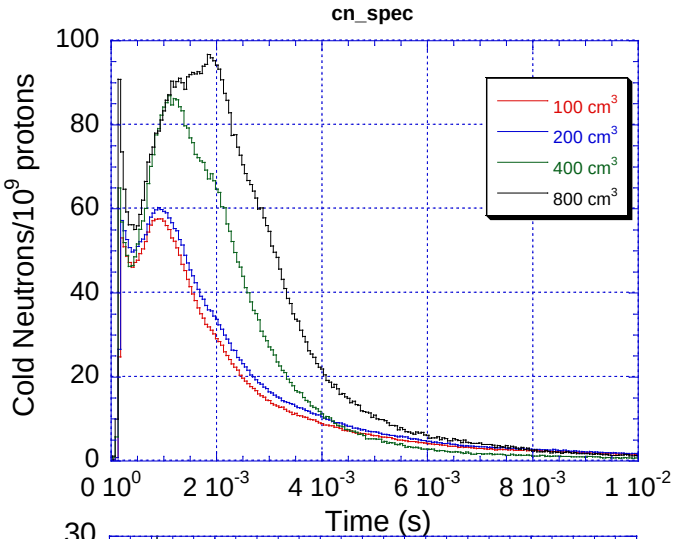
- SD2 source †
  - SD_2 has a large down scattering rate R
  - Cold SD_2 is predicted to have small absorption and up scattering cross sections-> long UCN lifetime τ
  - UCN density, Rτ, is predicted to be large.
- Spallation driver‡
  - High cold neutron density
  - Shutter source

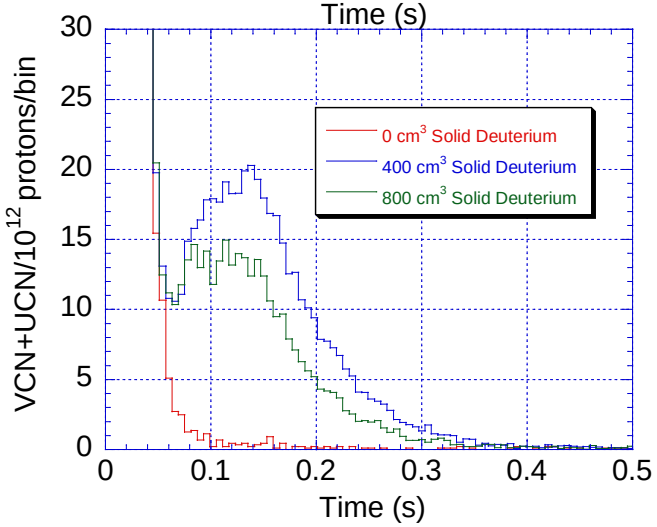
†R. Golub and K Boning, Z. Phys. B **51,** 187 (1993).

‡A. Serebrov, "First UCN Factory Workshop'" Jan 18-22, 1988, Puskin, Russia.

Line C Measurements



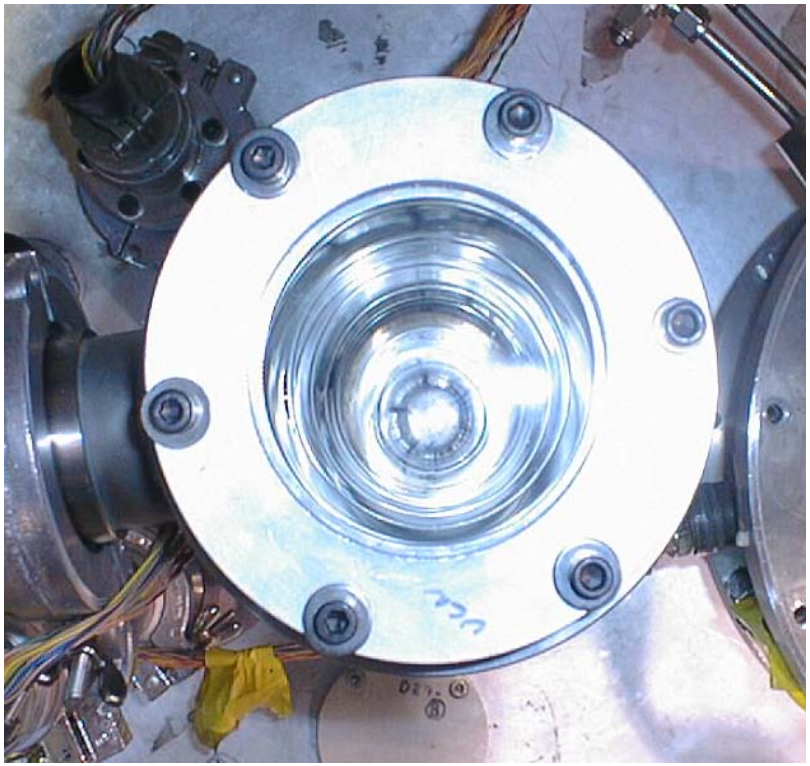




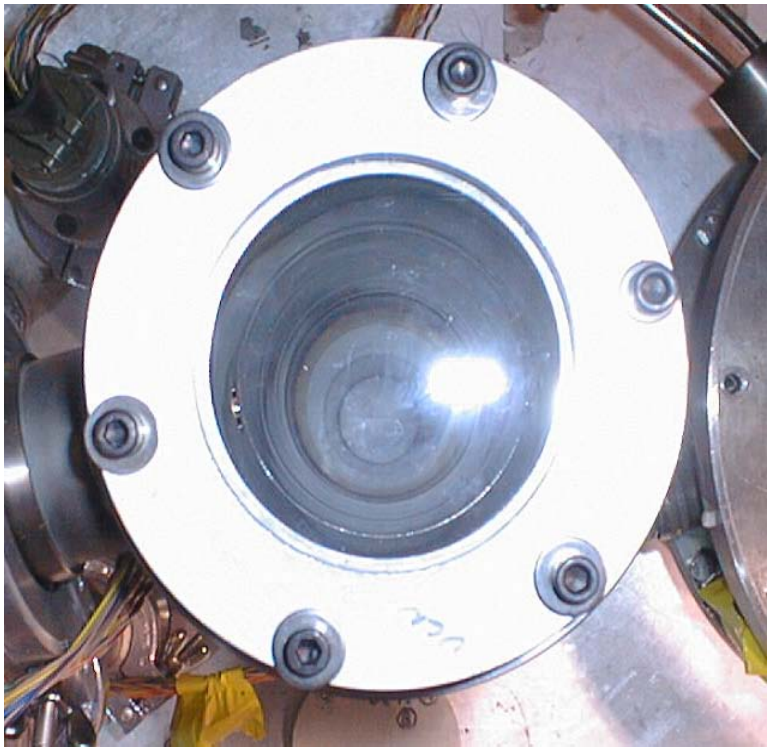
- Line C results show reduced (÷100) UCN production.
  - D_2 frost on guide windows and walls.
  - Gravity+Aluminum detector window

Solid D_2 in a "windowless" container

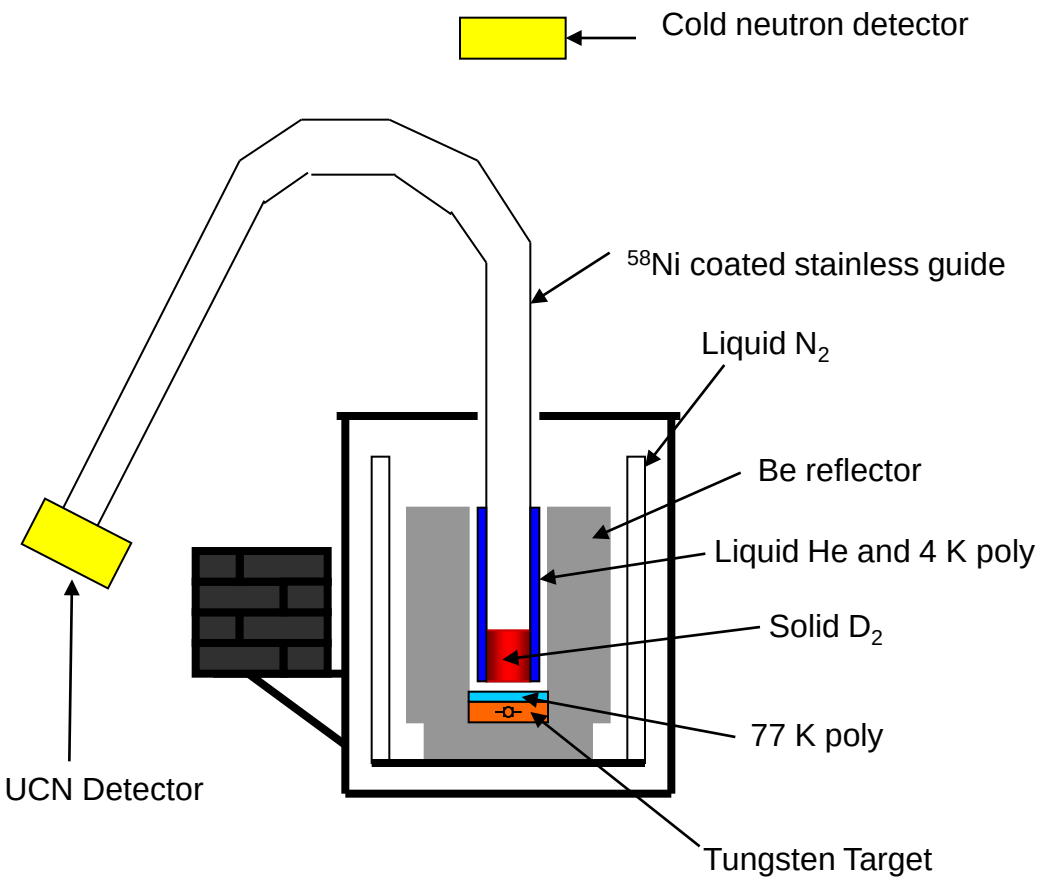
Grown from a gas phase at 50 mbar



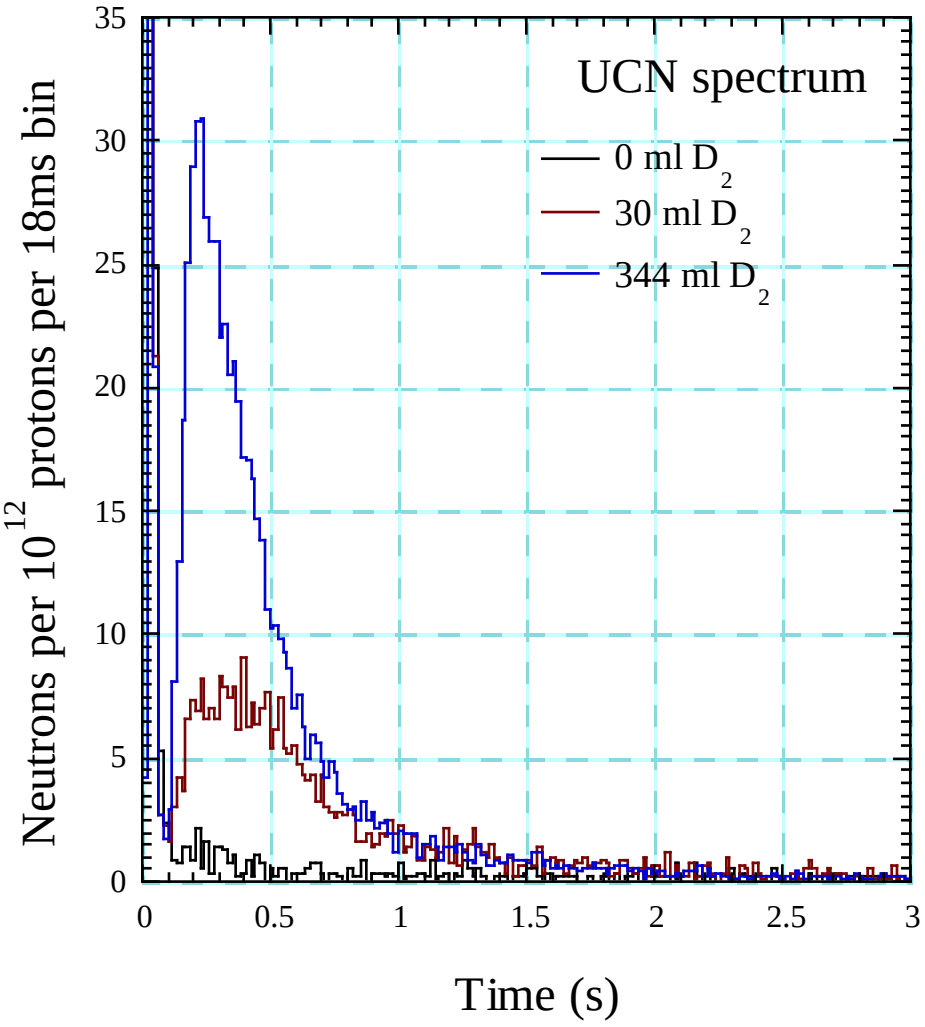
Cooled through the triple point



UCN Measurements in Blue Room



UCN Measurements in Blue Room



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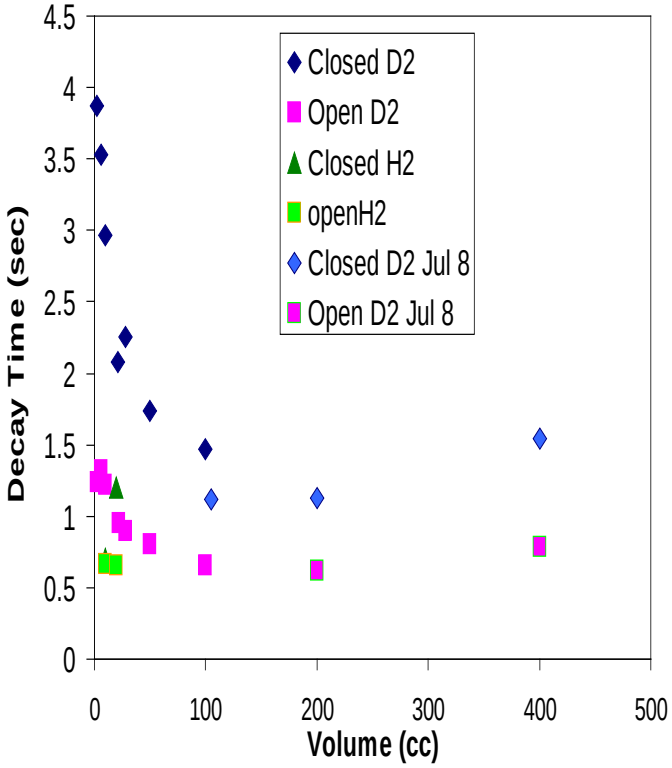
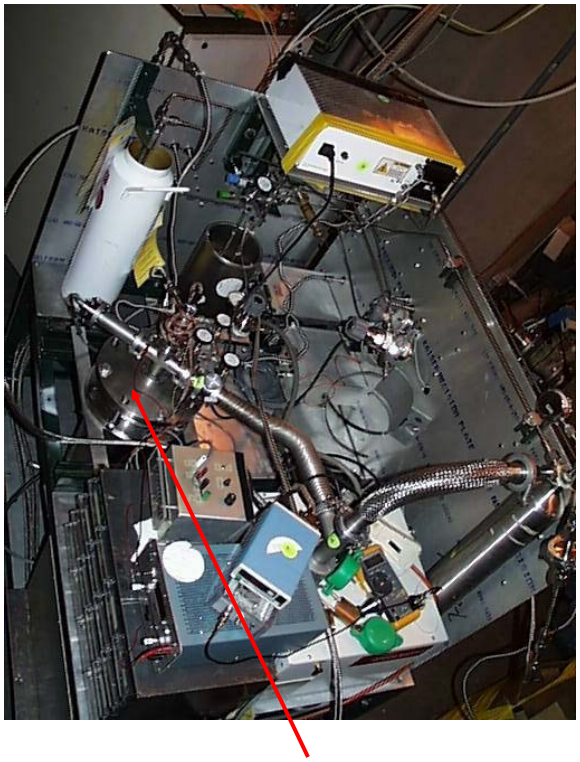


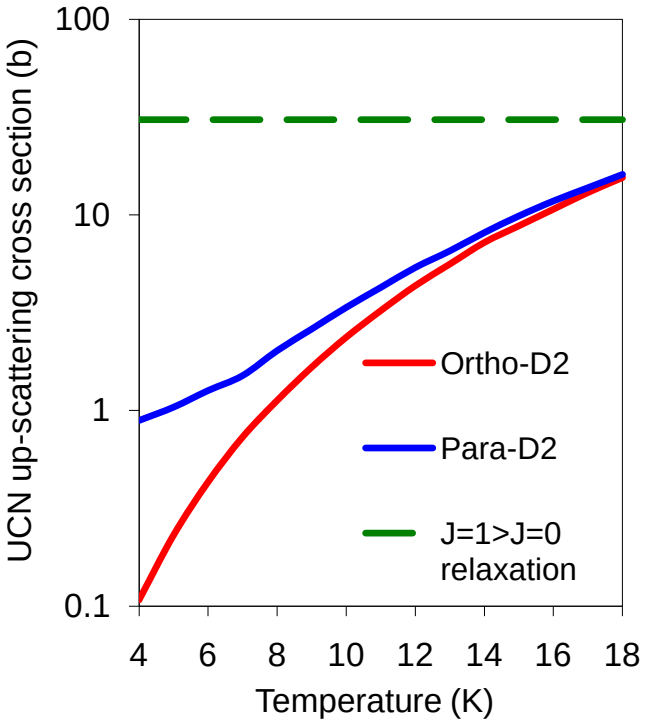
- Significant UCN fluxes are produced from 50 cm^2 SD_2.
- SD_2 lifetime looks shorter than expected even for 10 k up-scatter cross section..
  - Temperature?
  - Other up-scatter mechanisms?

Solid Model† (solution to the lifetime puzzle)



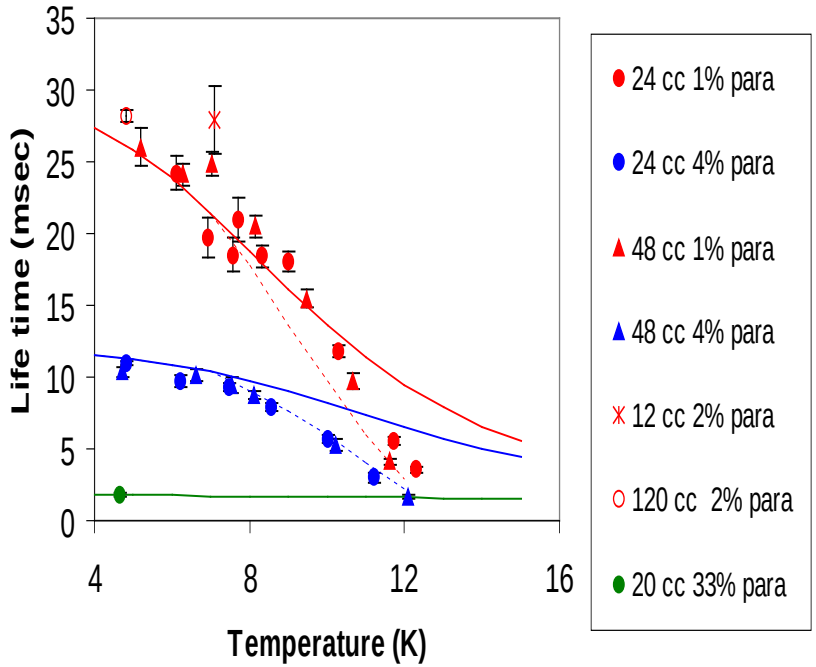
Para to ortho converter
17 K ferric hydroxide

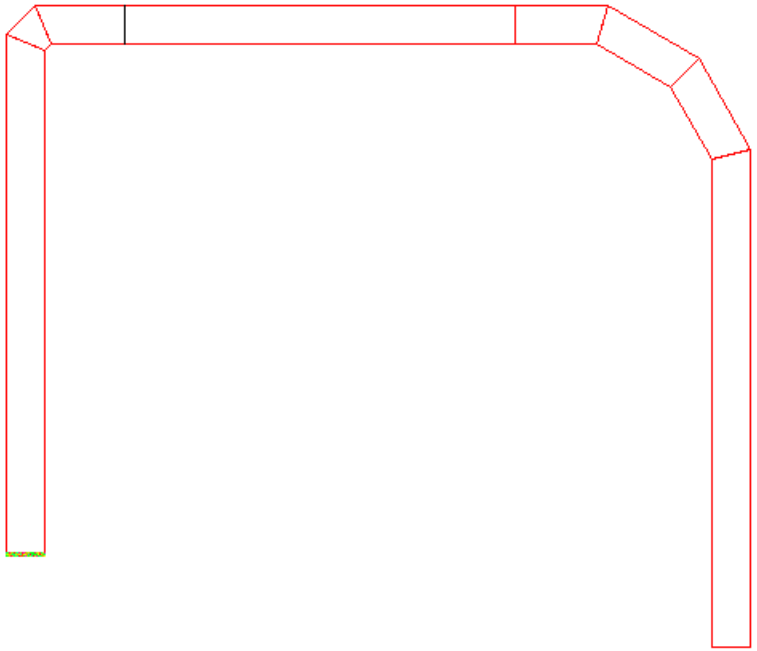
- 150 msec
  - n+D→γ+t
  - 0.2 %HD
  - 2% Para
  - 5 K temperature



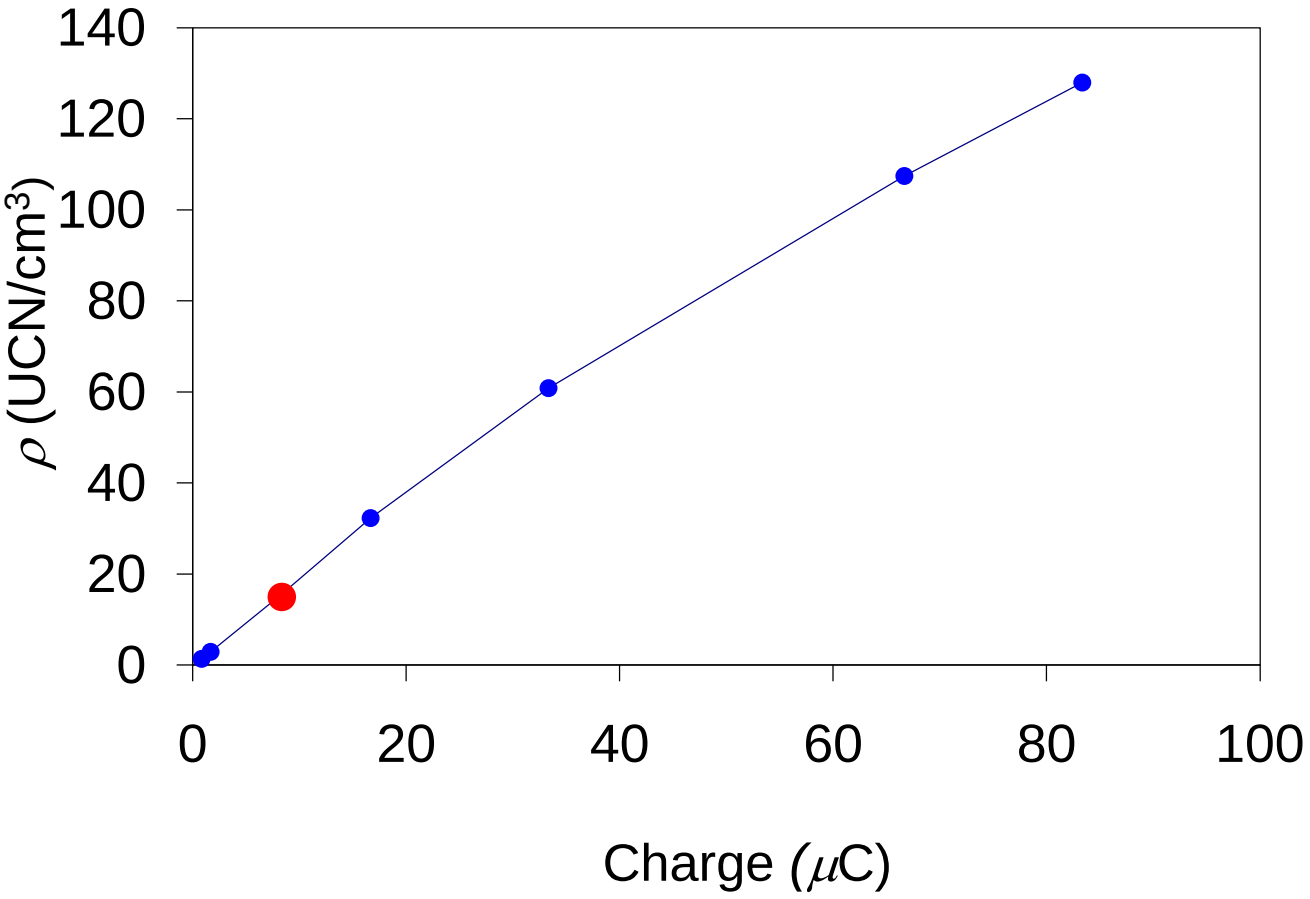
†C.-Y. Liu, A. R. Young, and S. Lamoreaux, Phys. Rev. C, to be published.

UCN setup in line B at LANSCE

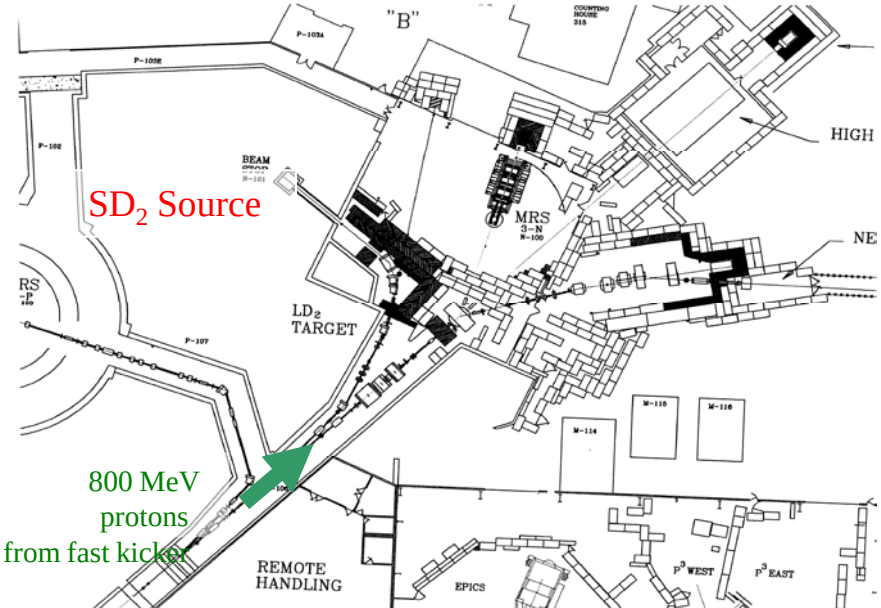


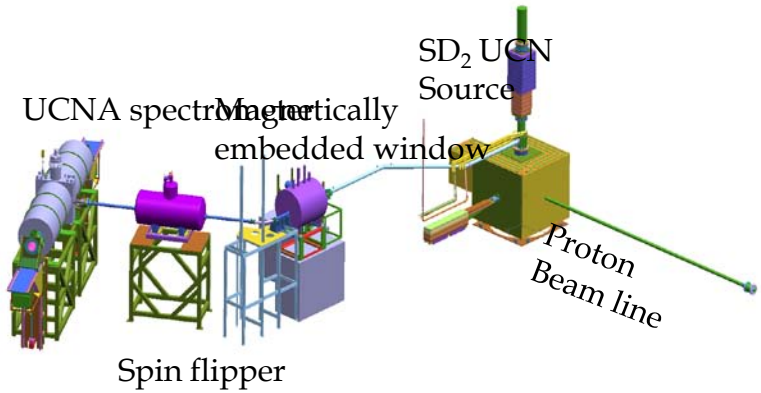


Line B Bottle measurements

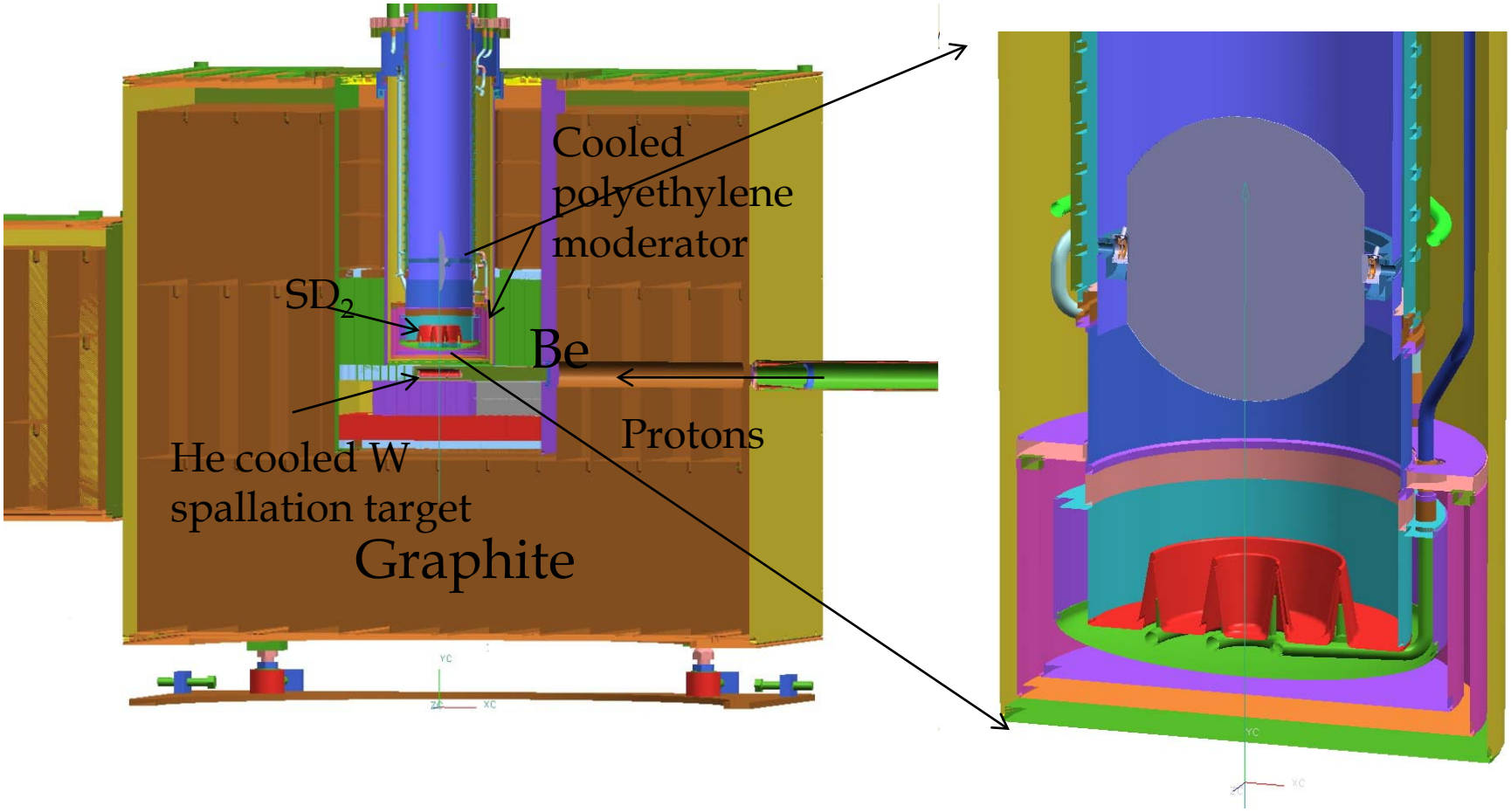


Area B then and now



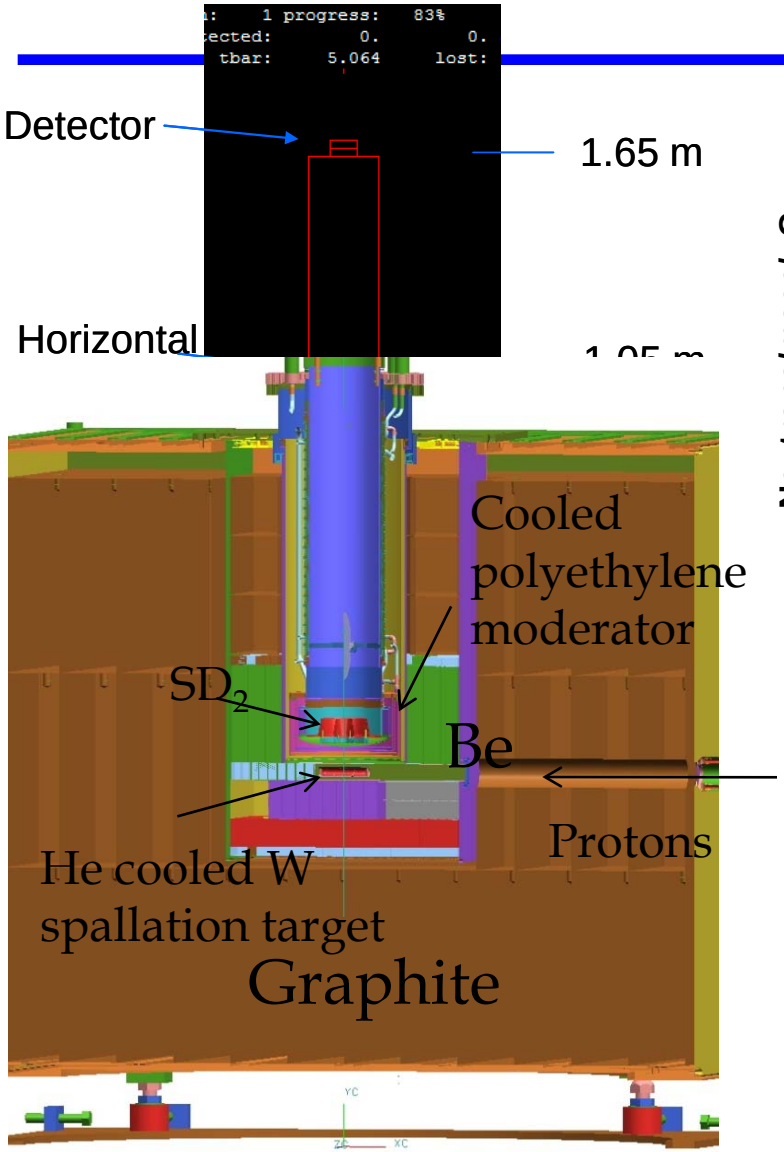


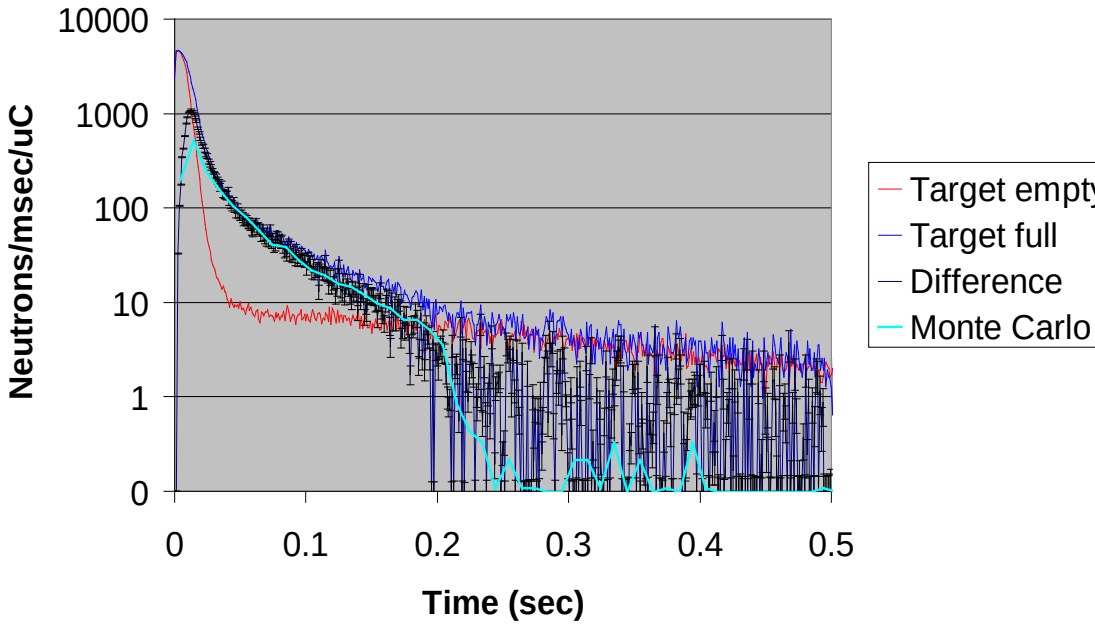
Schematic representation of the source *



* idea from Yu. N. Pokotilovski

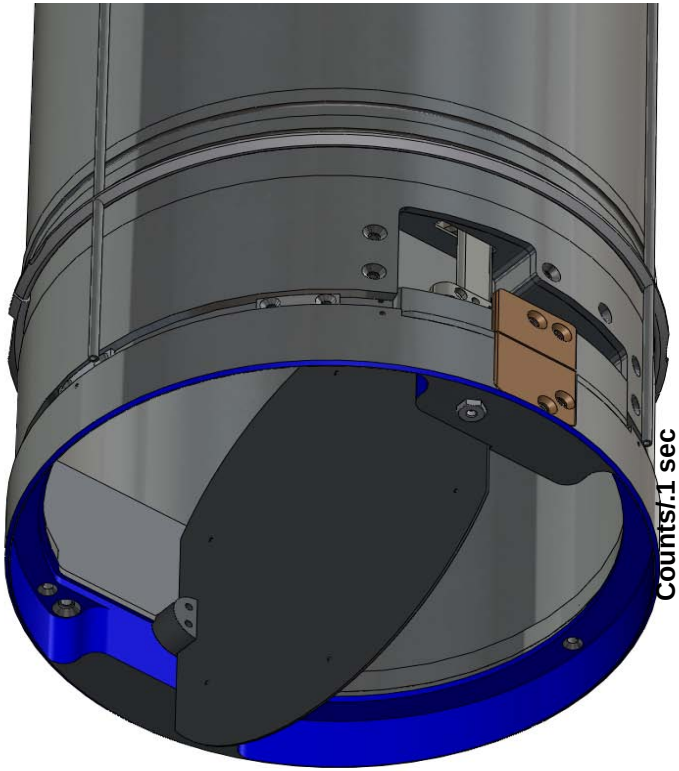
Internal detector



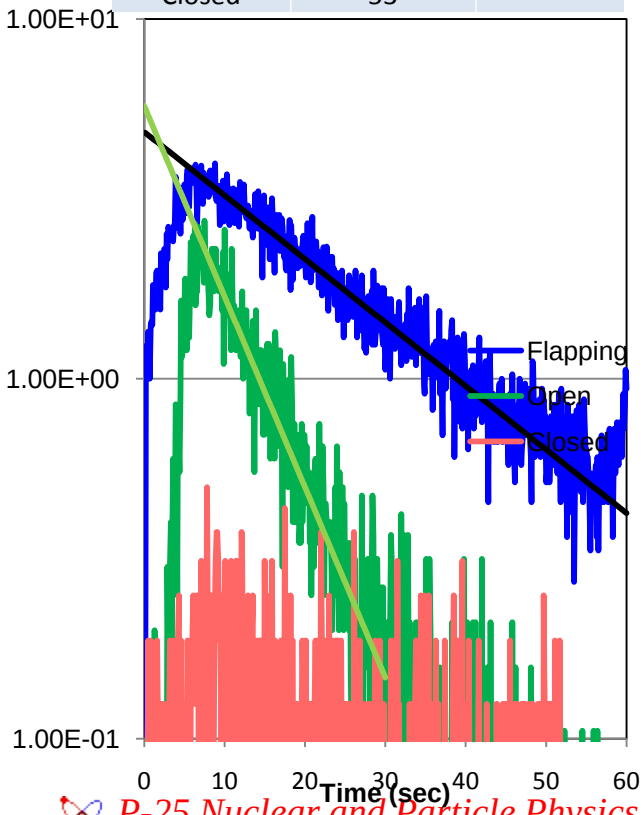


- UCN output <~50
- Measured UCN/proton
- Discover transport problem with DLC quartz guide system
- Replaced with welded SS

UCN Shutter (version 3)

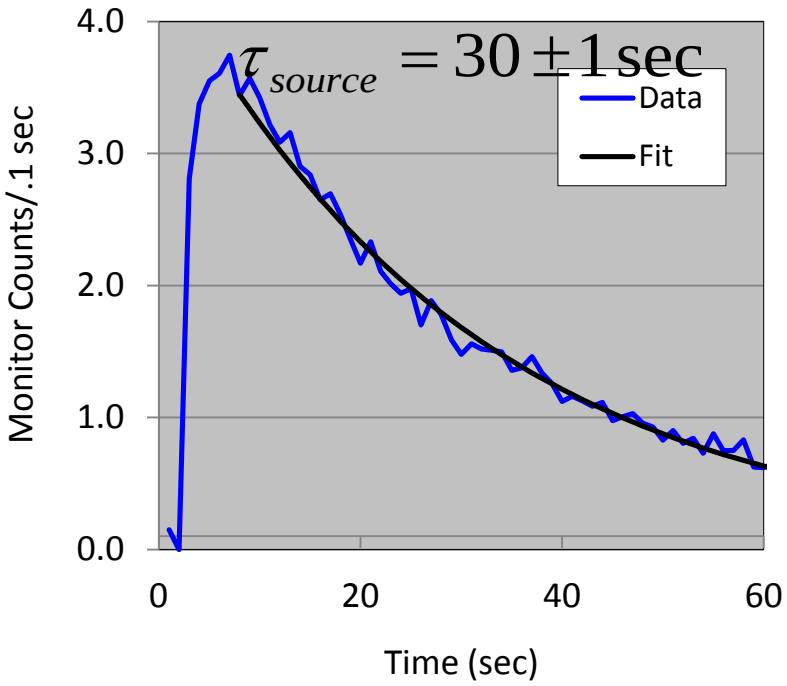


Column1	Counts	Tau
	/5 pulses	sec
Flapping	992	26+/-.2
Open	269	8.1+/-.1
Closed	53	

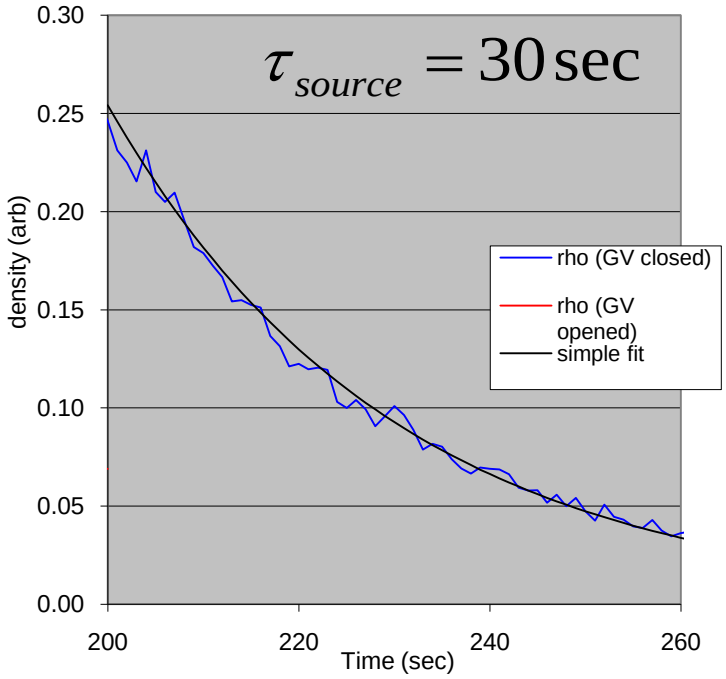


Adjust loss per bounce in MC to reproduce gate valve closed lifetime

Data Flapper running

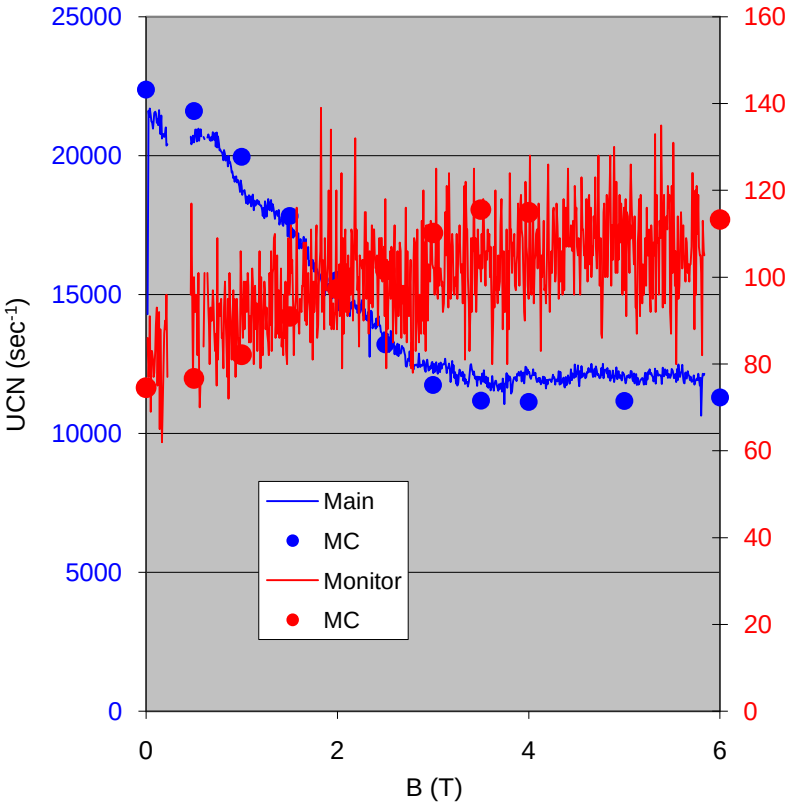


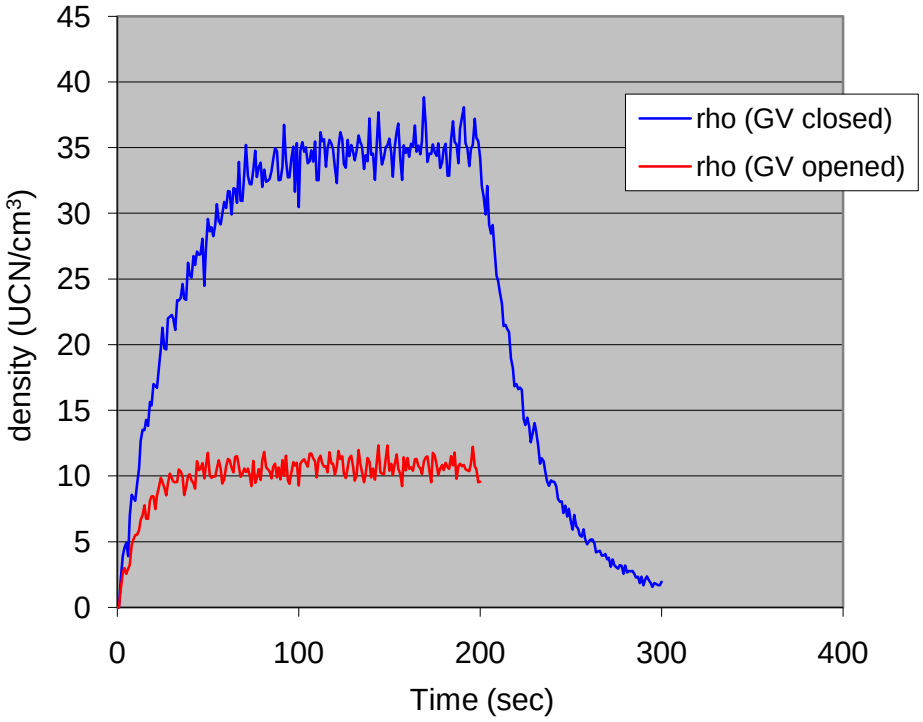
Monte Carlo



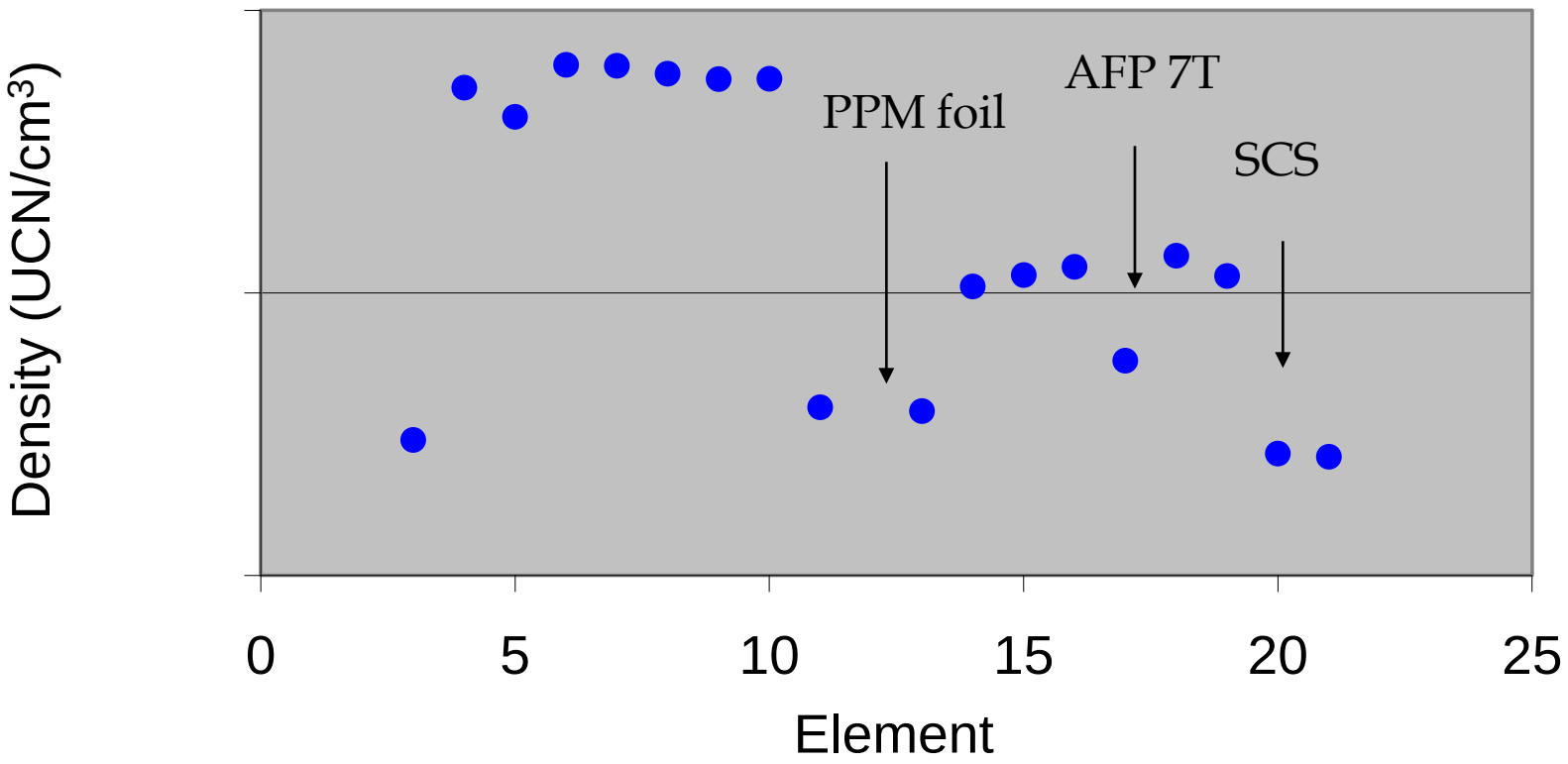
Loss/bounce=4e-4

Normalize the MC to the data and predict the flapper closed density





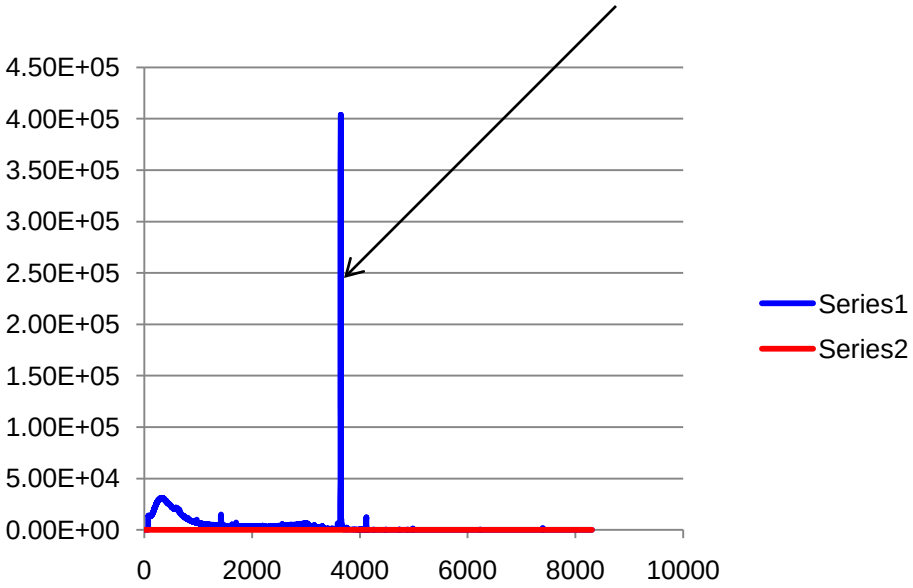
ρ_{UCN}=35 7 UCN/cm^3
At the exit from the shielding package


Density (UCN/cm³)
PPM foil
AFP 7T
SCS
0
5
10
15
20
25
Element

Argon activation

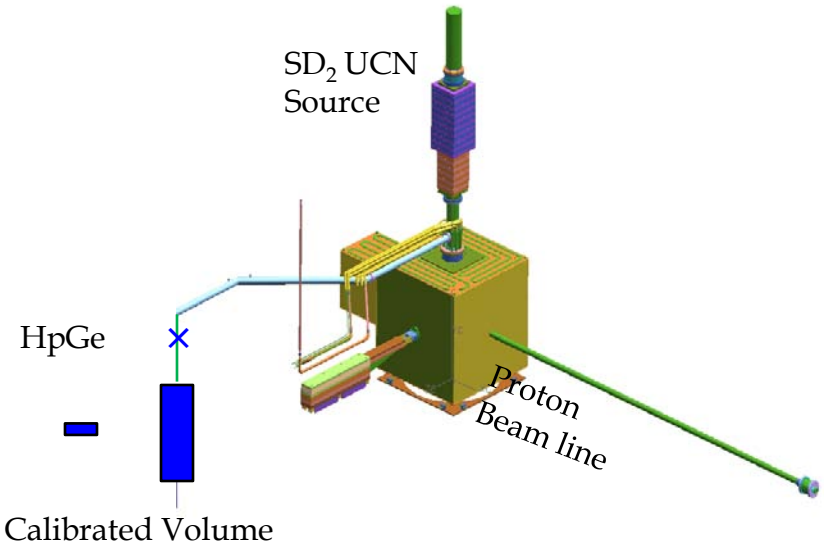
$^{40}Ar+n \rightarrow {}^{41}Ar$

$^{41}Ar \rightarrow e+{}^{41}K^{*}$ (1.2 MeV γ)



neutrons/proton

measured	MCNP
1.45	~3



- Freeze known volume of Argon
- Activate with beam pulse
- Warm
- Count γs
- n/p x1/2
- new target/more diagnostics

Plans

- New Larger Target (In progress)
  - ×1.5 UCN/proton
- Downstream beam monitor (in progress?)
  - Potential for ×2 more protons on target
- New radiation safety system
  - More flexible time structure (40μC/10 sec rather than 20μC/5 sec) 1.5 UCN
  - 10 μA current limit 2.5 UCN
- Shielding Wall between area C and line B
  - 24/7 running! (civilized)