4-14-2019

Status of the Los Alamos Room Temperature Neutorn Electric Dipole Moment Search

Robert W. Pattie Jr.
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Status of the Los Alamos Room Temperature Neutorn Electric Dipole Moment Search

The Los Alamos nEDM Search

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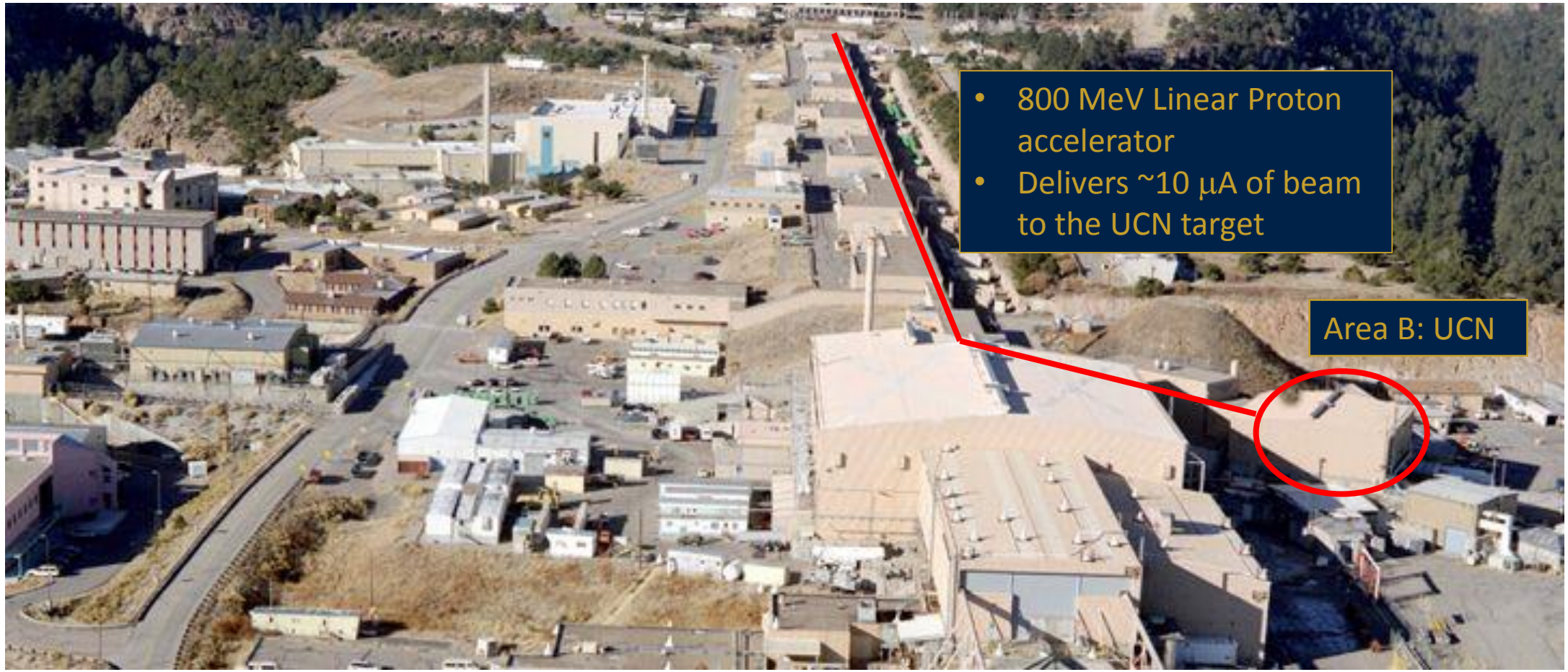
East Tennessee State University

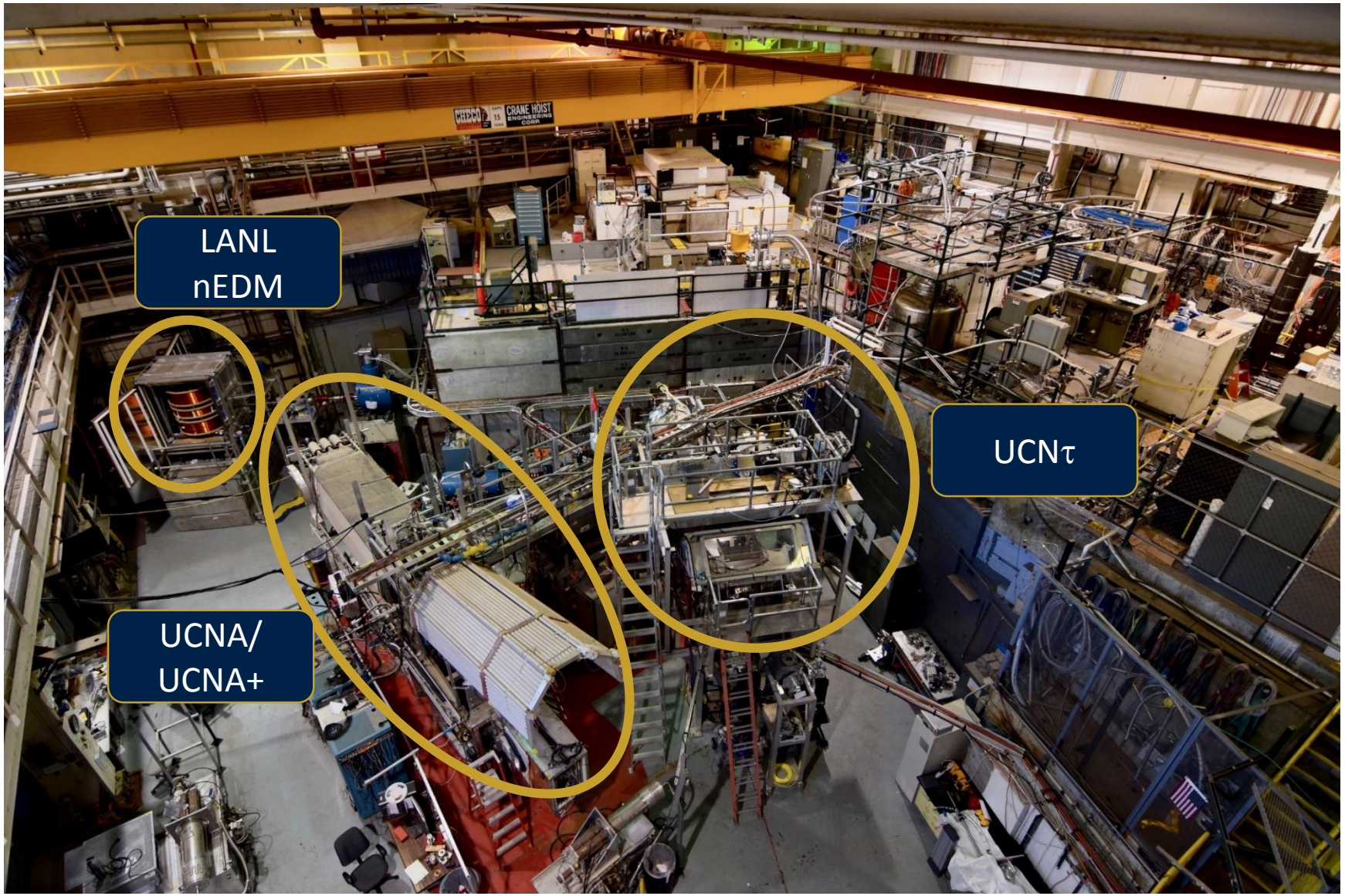
For the LANL nEDM Collaboration

Apr. 14, 2019 APS

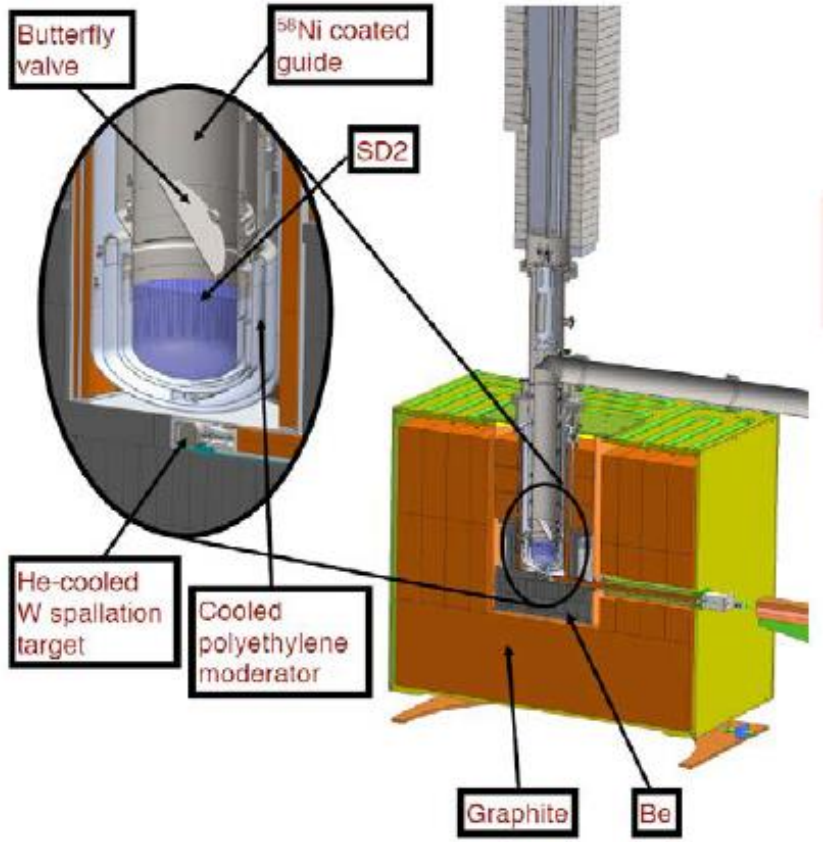
Ultracold Neutrons at the Los Alamos Neutron Science Center



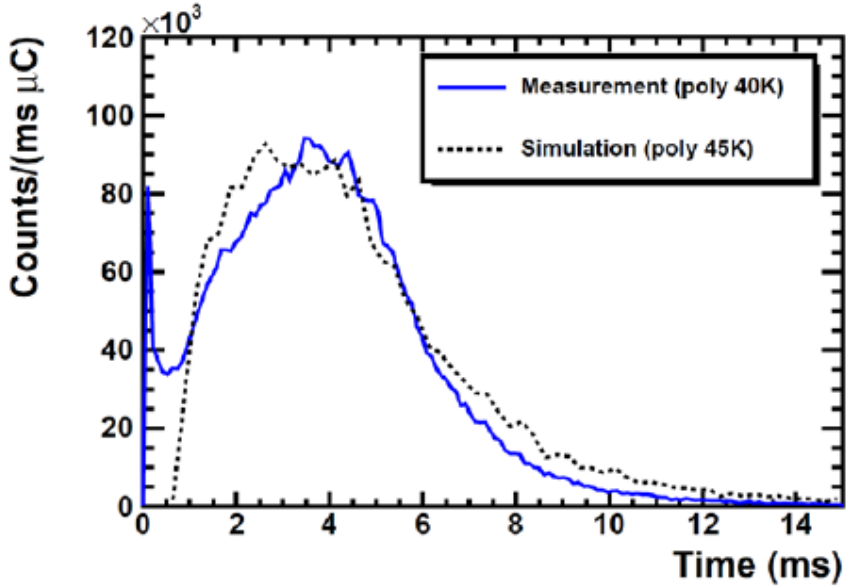
Area B

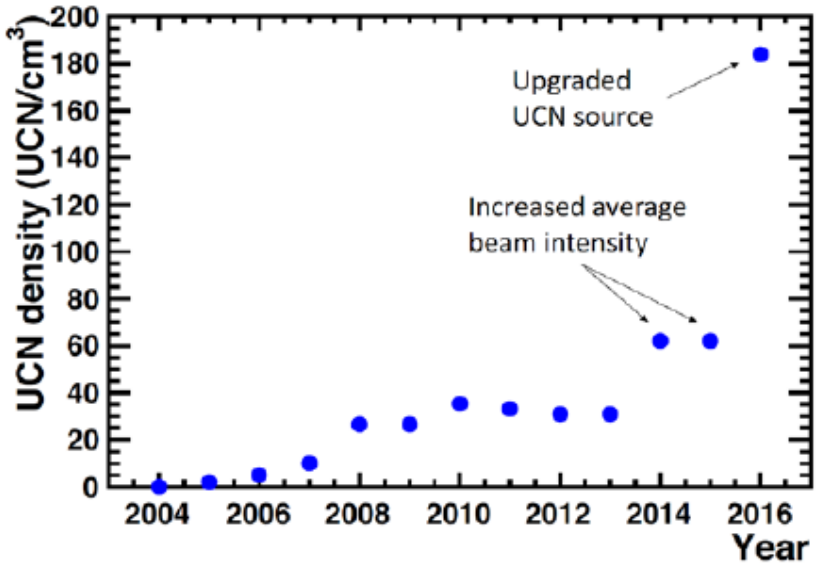


UCN Production



$$P_{UCN} = \rho_{SD2} \int \Phi_{cn}(E)\sigma_{UCN}(E)\, dE$$

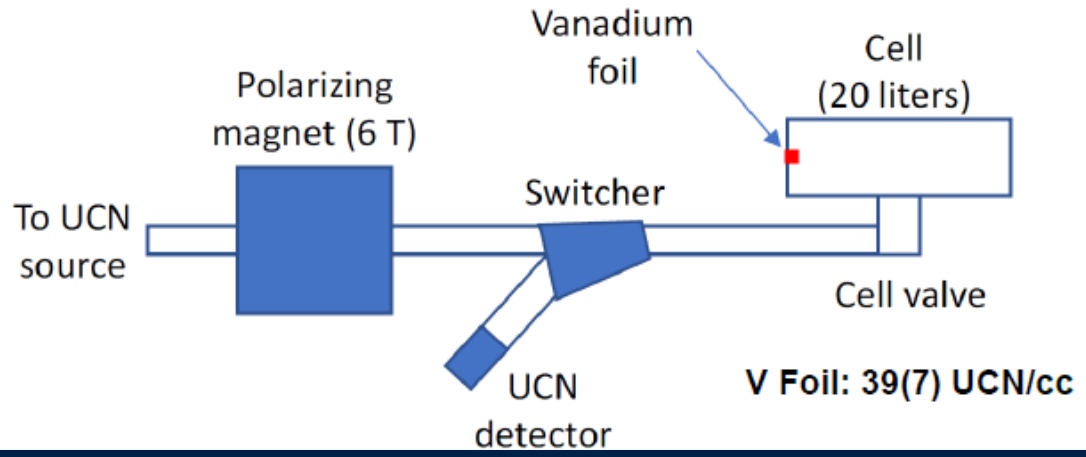


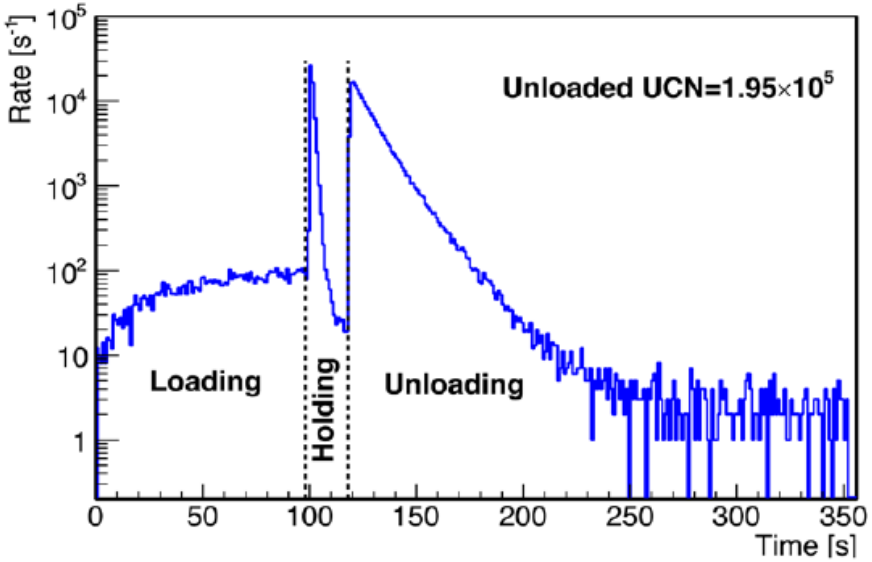


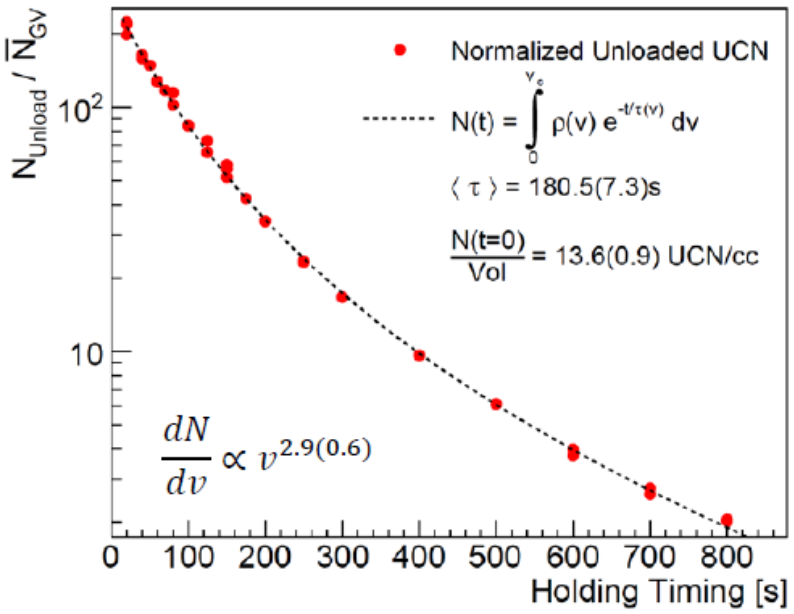
T.M. Ito et al., PRC 97, 012501 (2018)

Storable UCN Density

- UCN density measured by V activation $\rho_{ucn} = 39(7) UCN/cc$
- Fill and dump density was ρ_{ucn} =14(1) UCN/cc

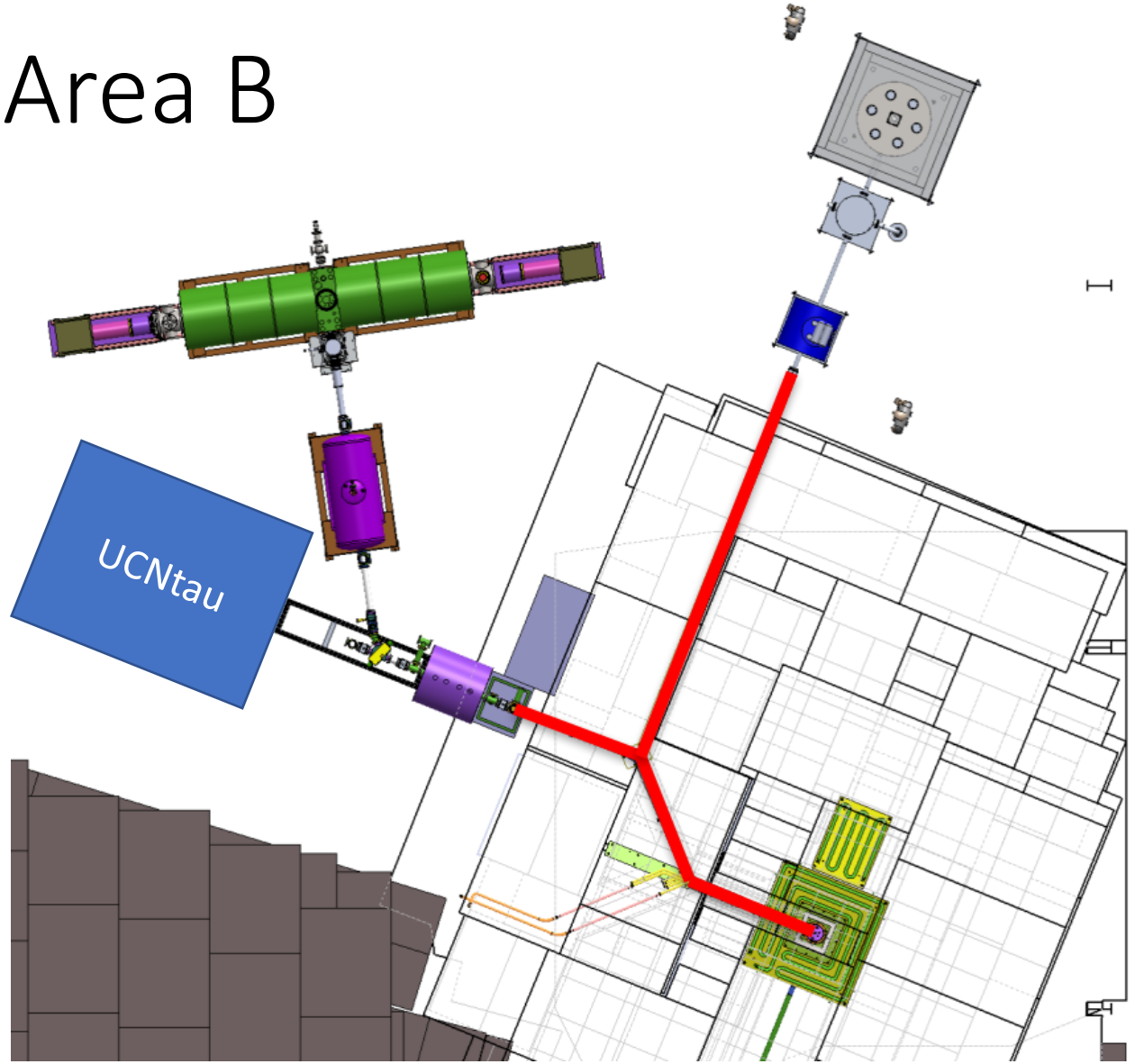






UCN Transport in Area B

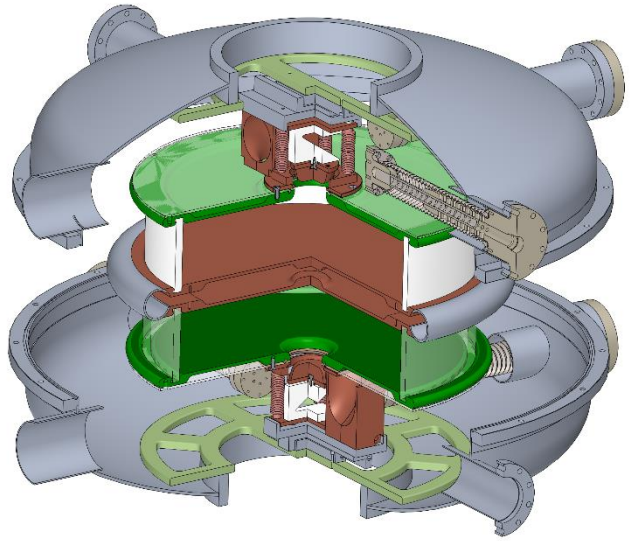
- Addition of a 2nd UCN "beamline"
- Upgraded 4-port switcher with >95% transmission.
- Allow for integrated running with UCNtau



Projected Sensitivity

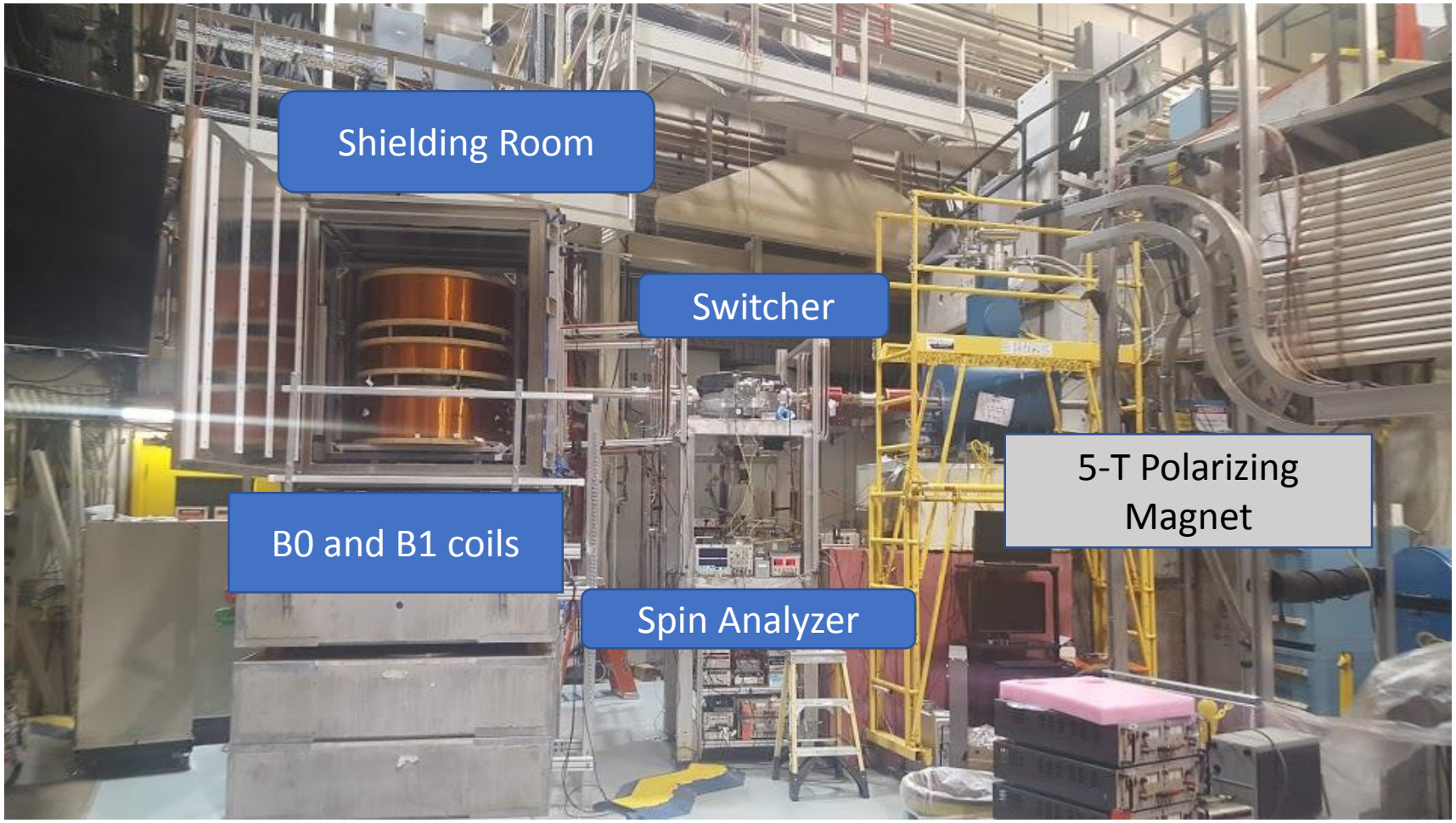
Parameters	Values
Electric Field (kV/cm)	12.0
Neutrons per cell	39,100
$T_{free}(s)$	180
$T_{duty}(s)$	300
α	0.8
$\sigma_{dn}/day/cell\ (10^{-26}\ e \cdot cm)$	5.7
$\sigma_{dn}/day\ (10^{-26}\ e \cdot cm)$	4.0
$\sigma_{dn}/year\ (10^{-27}\ e \cdot cm)$	2.1
90% C.L. /year $(10^{-27}\ e \cdot cm)$	3.4

$$\sigma_{dn} \propto \frac{\hbar}{2\ \alpha\ E\ T\ \sqrt{N}}$$

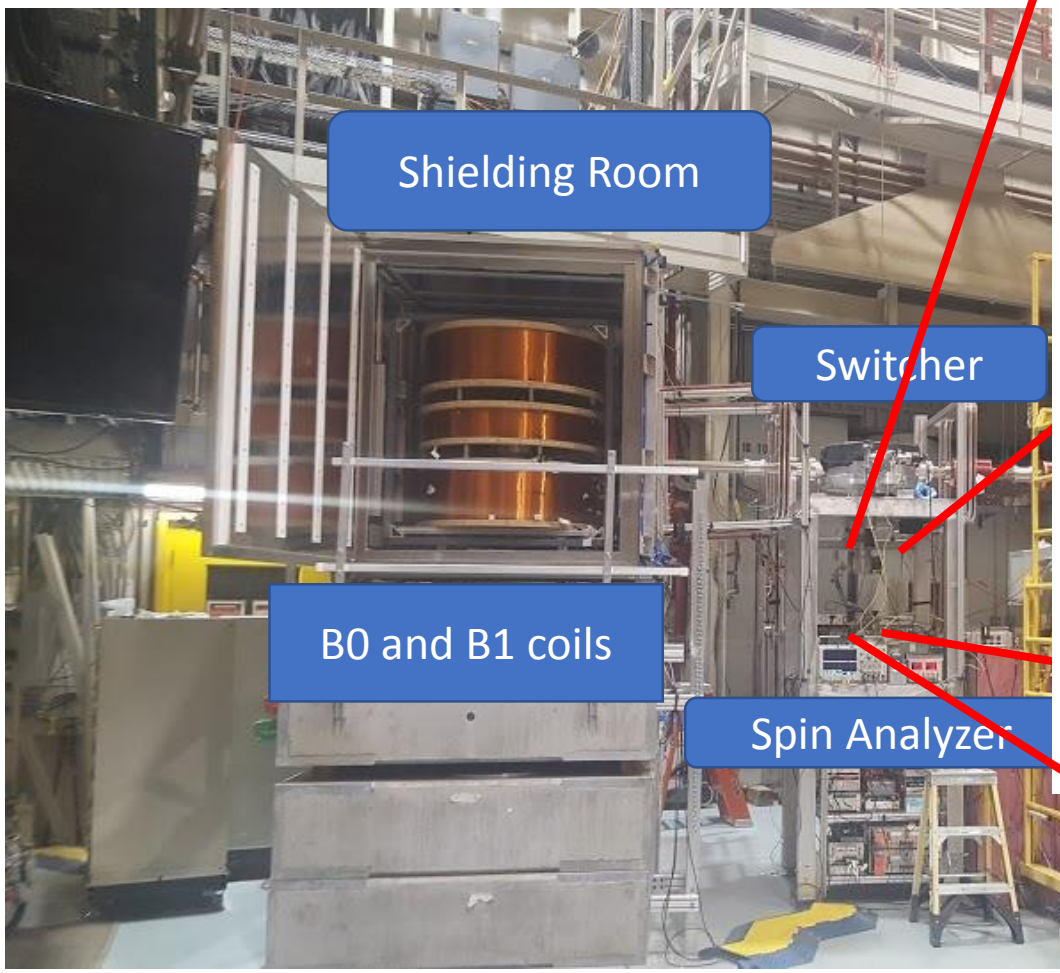


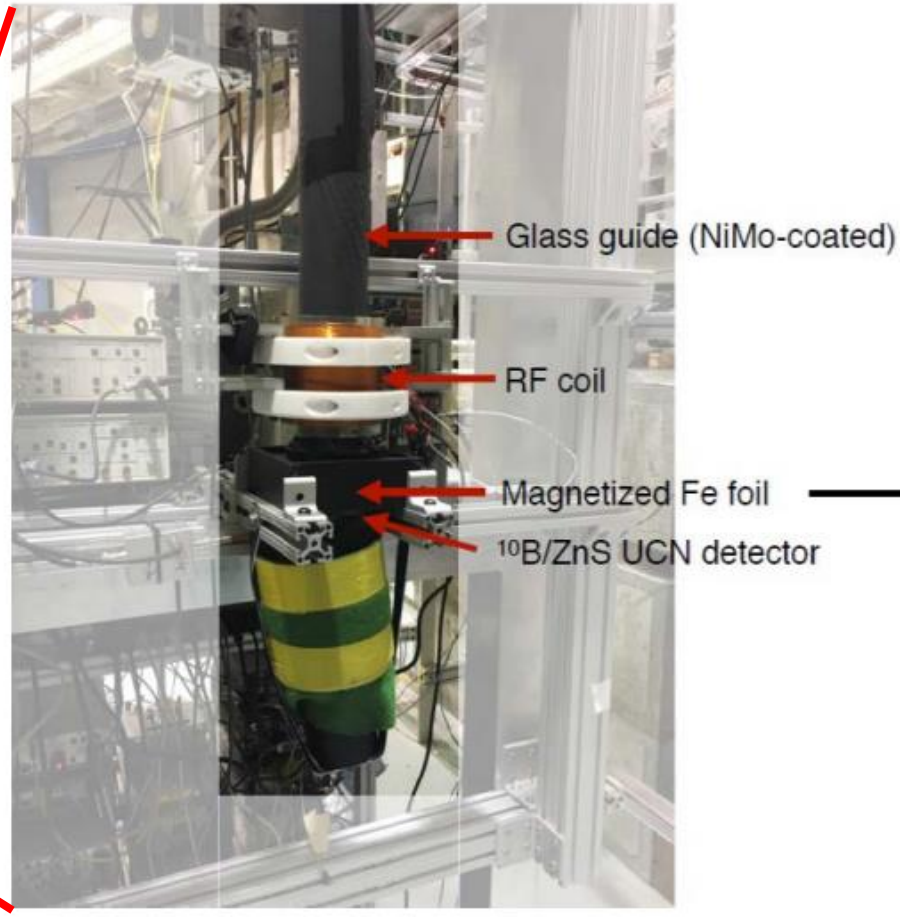
- Electric field, spin contrast, cycle and precession time based other experiments
- Neutrons per field based on storage measurements at LANL
- 5 Years of total run time required

Prototype Configuration

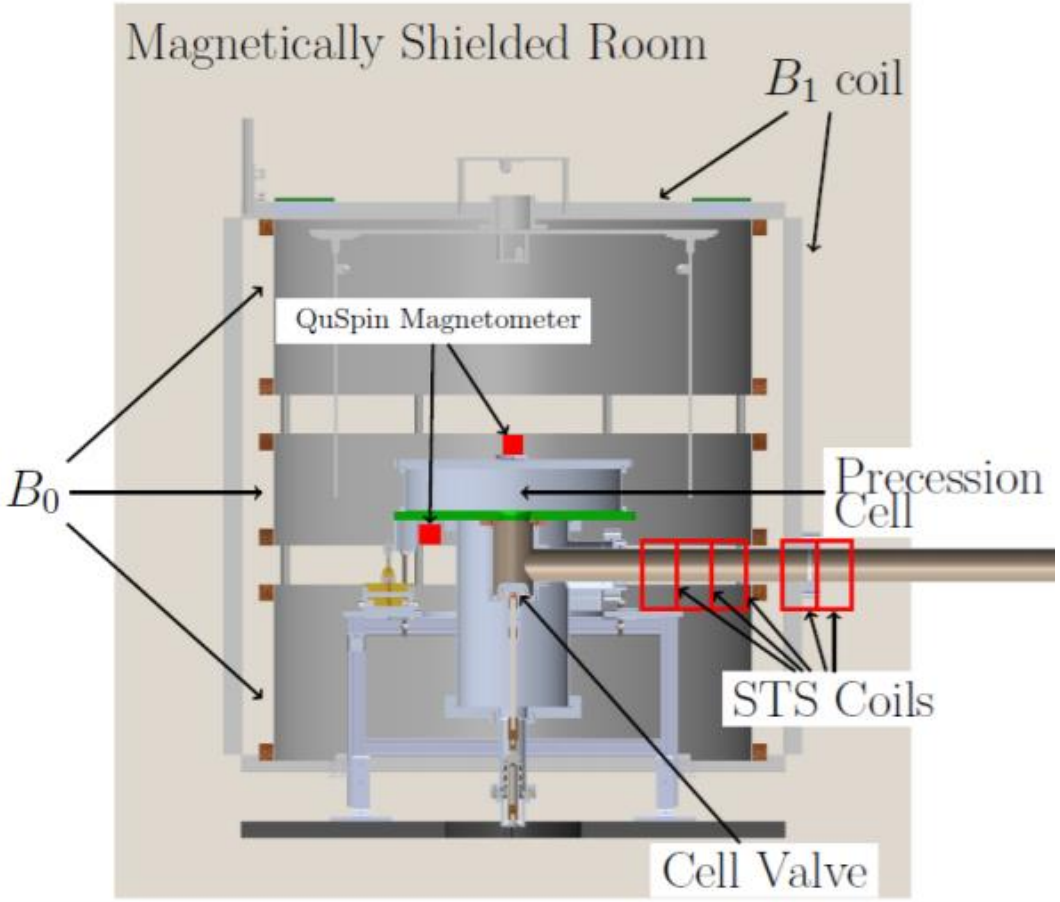


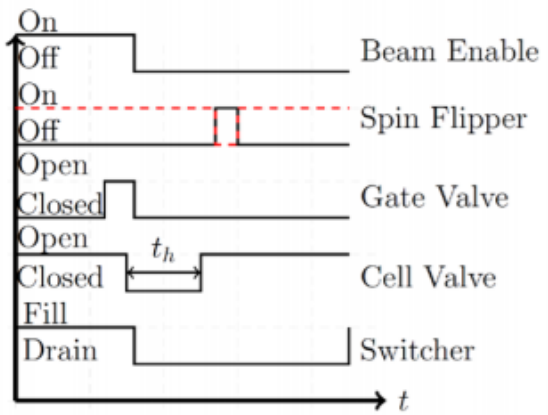
Prototype Configuration

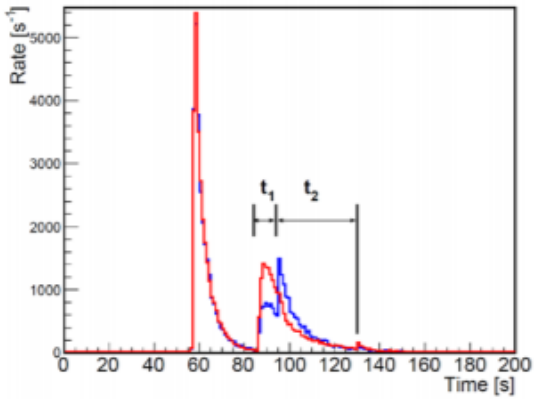


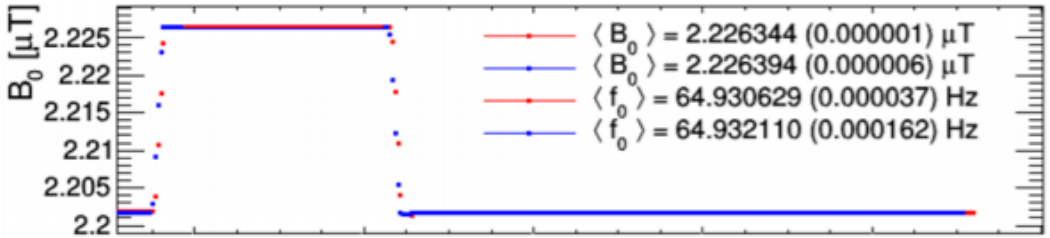


Prototype Apparatus for Spin Transport Testing

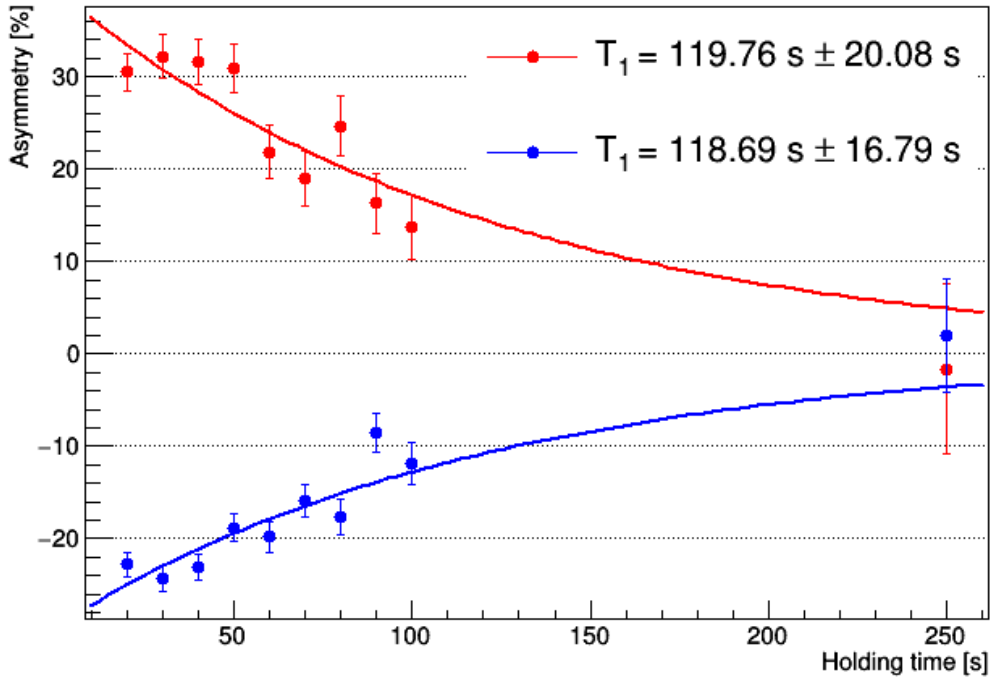


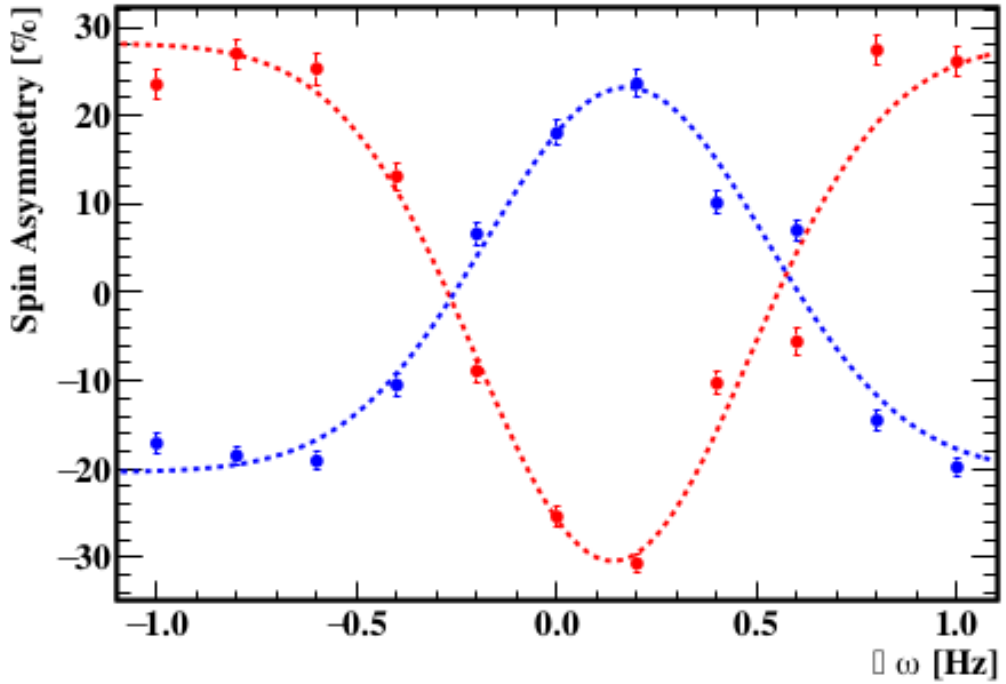






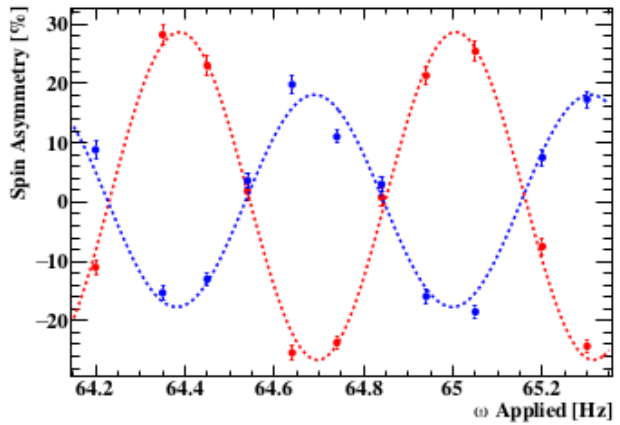
Rabi Sequence and T1 Measurements in the prototype cell



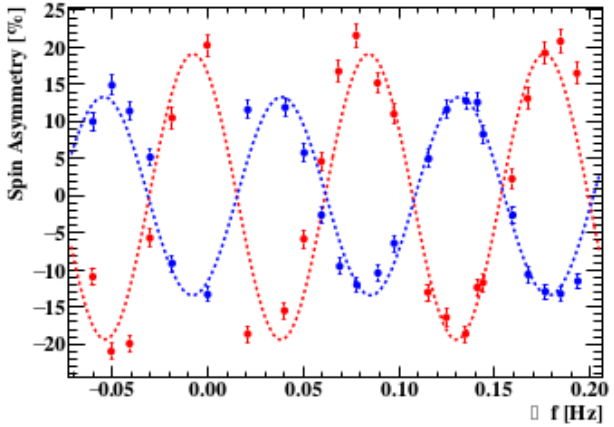


$$T_1^{-1} = \frac{\gamma_n^2 \bar{v}^2 \tau_c}{2\,\omega_0^2(1+\omega_0^2\tau_c^2)} \left(\frac{\partial B_0}{\partial z}\right)^2$$

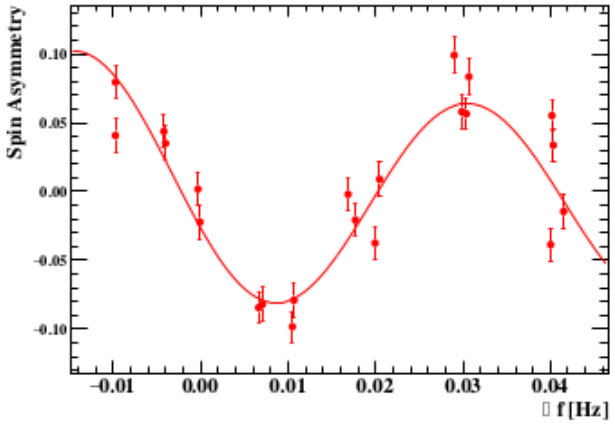
Ramsey Sequence Measurements



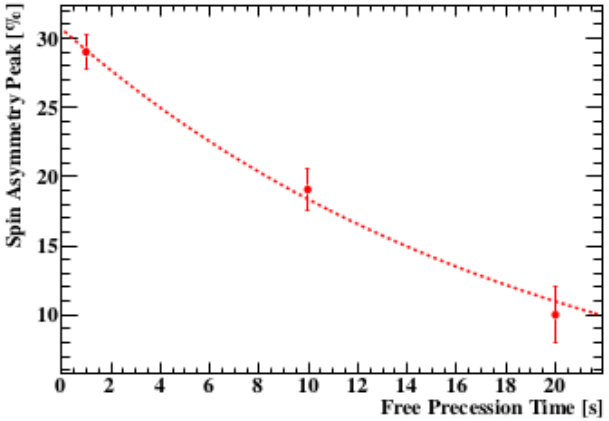
(a)



(b)



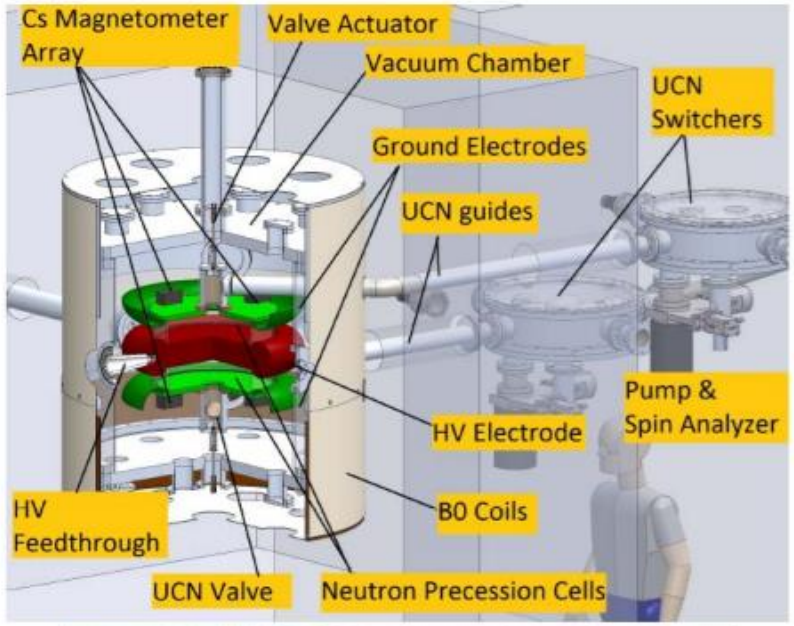
(c)

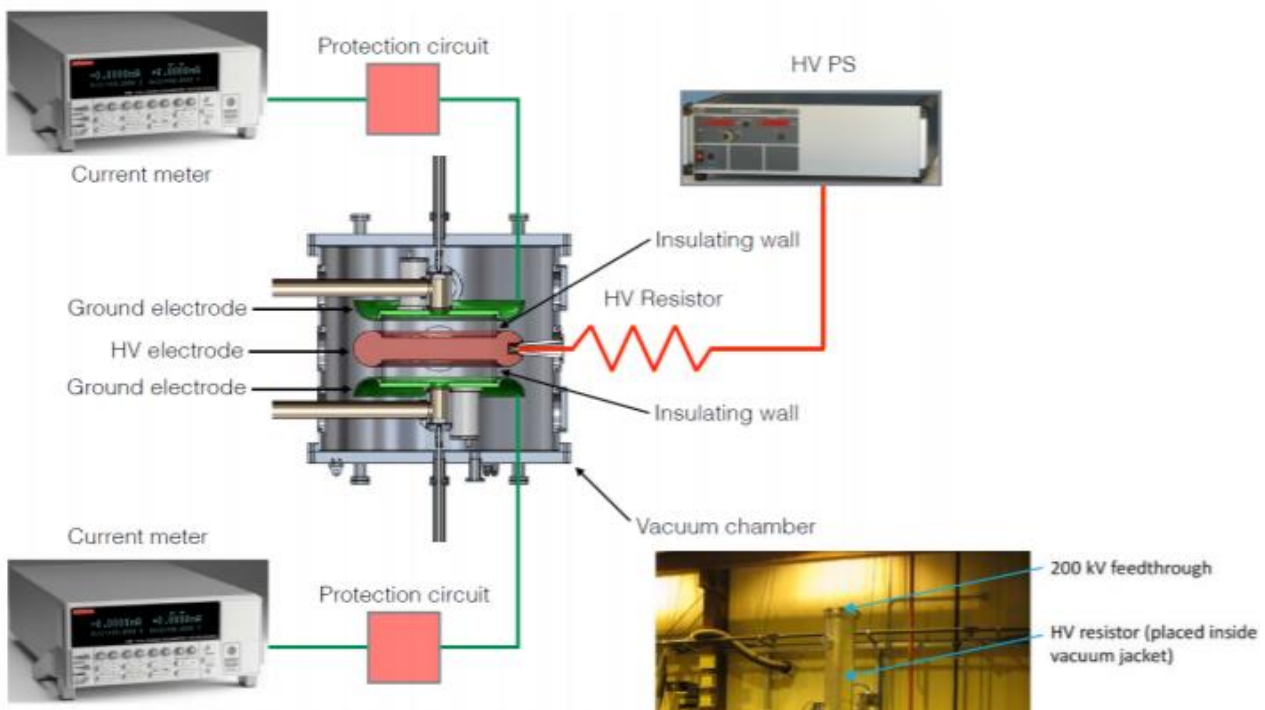


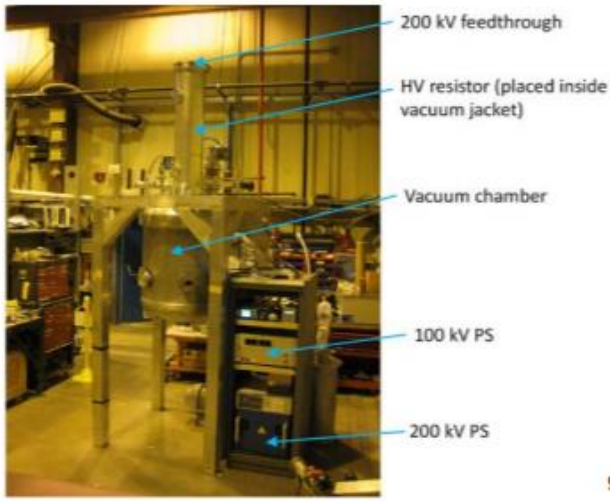
(d)

- T2 ~20s in prototype
- Short T1 and T2 consistent with measured B0 gradients

Apparatus Upgrades and Design







Time Line

Support :

- NSF MRI: 2018-2021
- LANL LDRD-DR : FY19-FY21

		FY19				FY20				FY21			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
LANSCE beam		On			On				On				On
R&D with the current apparatus													
MSR	MSR	Design		Procure				Comission					
Coils	B0 coil	Desing/Procure/test								Install			
	pi/2 coils	Desing/Procure/test								Install			
	Spin transport coils	Desing/Procure/test								Install			
	Earth's field cancallation coils	Desing/Procure/test								Install			
Magnetometers	Cs	Desing/Procure/test								Install			
	3He	Desing/Procure/test								Install			
	Comagnetometer	Desing/Procure/test								Install			
HV, Cells, vacuum chamber	Vacuum chamber	Desing/Procure/test								Install			
	HV system	Desing/Procure/test								Install			
	cell+electrodes	Desing/Procure/test								Install			
UCN transport	PPM guide	Procure/test		Install									
	Switchers	Procure/test		Install									
	UCN guides from switcher to cel	Desing/Procure/test								Install			
	Cell valves	Desing/Procure/test								Install			
UCN detector/spin analyzer	UCN detector	Desing/Procure/test								Install			
	Spin analyzer	Desing/Procure/test								Install			
DAQ	DAQ	Desing/Procure/test								Install			
	Slow control	Desing/Procure/test								Install			
Area B prep	Rad safety calc												
	Shielding block re-config												
	Guide installation												
Comission & Data taking	Commitioning												
	Data taking												

LANL nEDM Collaboration

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ETSU