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Title: Neutron storage time for the neutron EDM experiment

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Abstract Submitted
for the DNP10 Meeting of
The American Physical Society

Sorting Category: (Experimental)

Neutron storage time measurement for the neutron EDM experiment W. CLARK GRIFFITH, TAKEYASU ITO, JOHN RAMSEY, MARK MAKELA, STEVEN CLAYTON, RAUL HENNINGS-YEOMANS, M. SAIDUR RAHAMAN, SCOTT CURRIE, TODD WOMACK, WALTER SONDHEIM, MARTIN D. COOPER, Los Alamos National Laboratory, NEDM COLLABORATION — A new experiment to search for the neutron electric dipole moment (nEDM) is under development for installation at the Spallation Neutron Source (SNS) at Oakridge National Laboratory. The experiment will use ultracold neutrons (UCN) stored in superfluid helium, along with ^{3}He atoms acting as a neutron spin analyzer and comagnetometer. One crucial factor affecting the ultimate sensitivity of the experiment is the neutron storage time that can be obtained in the acrylic measurement cell. The acrylic cell walls will be coated with deuterated polystyrene (dPS), which is expected to give a wall loss factor of $\sim< 10^{-5}$ per bounce when cooled below the point where upscattering by hydrogen impurities contribute to UCN losses. We are currently preparing a measurement at Los Alamos to verify that a 10^{-5} wall loss factor can be achieved in a dPS coated acrylic test cell. The planned measurement will investigate the temperature dependence of the UCN storage time in the dPS coated test cell between room temperature and below 20 K.

[X] Prefer Oral Session
[ ] Prefer Poster Session

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Neutron storage time for the neutron EDM experiment

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Los Alamos National Laboratory

nEDM Collaboration

2010 DNP meeting, Santa Fe

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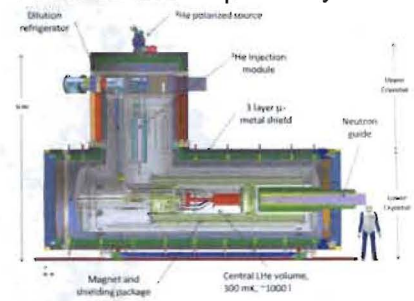
Neutron EDM search

- a finite permanent electric dipole moment of the neutron = new physics (SUSY?)
- current limit: $|d_n| < 3.0 \times 10^{-26}$ e cm C.A. Baker et al. PRL 97, 131801 (2006)
  - stored UCNs + ^{199}Hg cogmagnetometer
- SNS neutron EDM experiment: improve limit by 1-2 orders of magnitude
  - generate UCNs in superfluid ^{4}He
  - polarized ^{3}He acts as comagnetometer and n spin analyzer



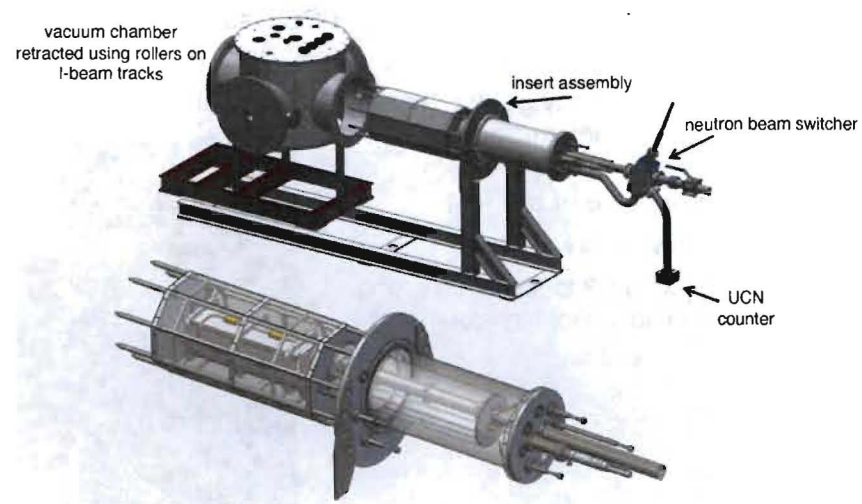
nEDM wall coating

- UCNs will be contained in a rectangular acrylic (PMMA) cell coated with deuterated polystyrene (dPS)
- UCN storage time in the cell directly affects ultimate sensitivity of the EDM measurement
- Goal: verify that a ~ 500 sec. neutron storage time can be achieved in the EDM

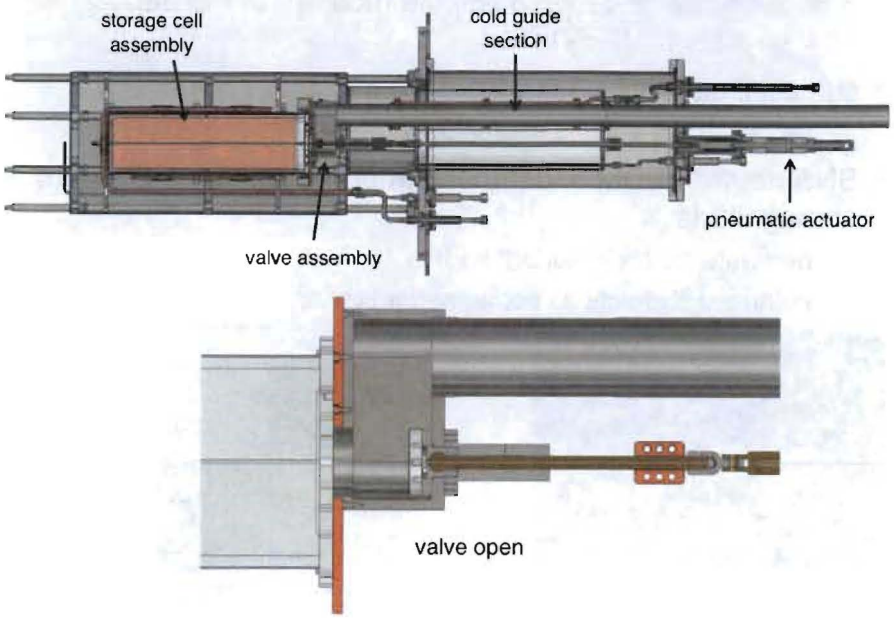
$$\frac{1}{\tau} = \frac{1}{\tau_n} + \frac{1}{\tau_{wall}}$$

  - $\tau_n \approx 900$ sec $\rightarrow$ $\tau_{wall} > 1000$ sec,
  - need dPS loss per bounce, $\mu < 2 \times 10^{-5}$
- room temperature μ typically ~ 10^{-4} due to H contaminant upscattering, should go away by cooling below 20 K

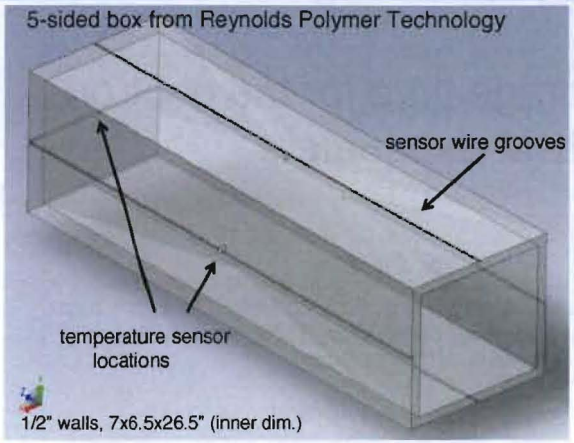
Neutron storage time apparatus

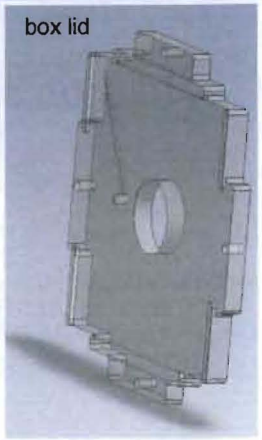


Insert assembly



The test cell



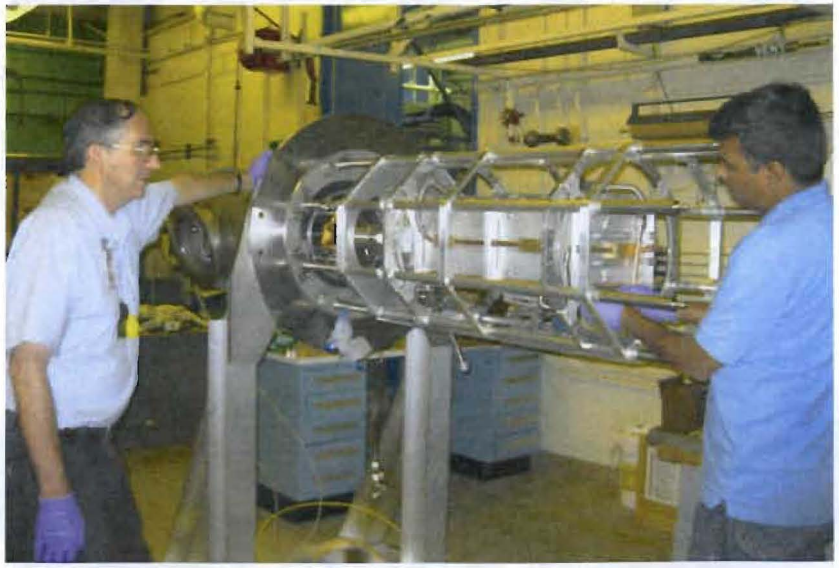


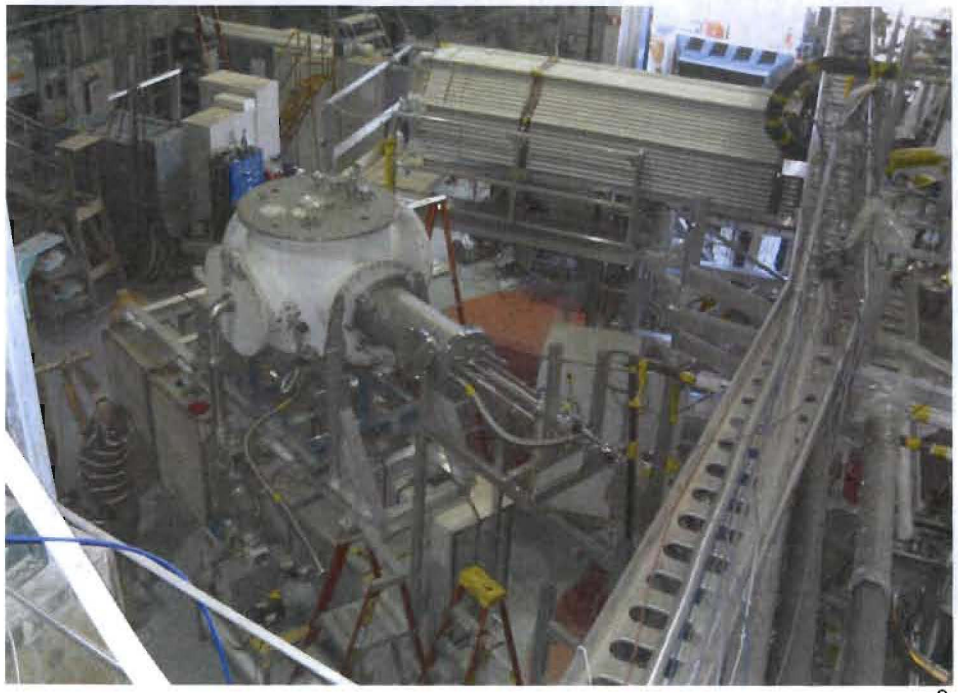
- 5-sided box used to minimize our need to make good glue joints for this measurement
- lid attached with MC-Bond acrylic cement
  - 81% methylene chloride, 14% methyl methacrylate, 5% acetic acid

dPS "pool" coating

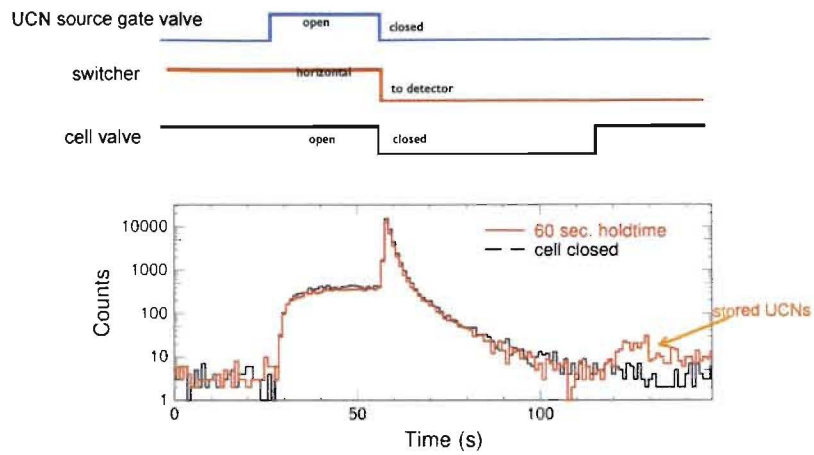
- dPS dissolved in deuterated tolulene is poured onto a surface in the assembled cell and left to evaporate while leaving that side level.
- 1 mm high pool of d-Toluene, enough dPS dissolved for a 10 micron coating
- test coatings generally gave a mostly clear, uniform coating when left to dry undisturbed
- coated bottom side of cell first
  - took > 3 days to dry
  - started flowing N2 to speed up drying, resulting in nonuniformity/cloudiness

Cell mounted

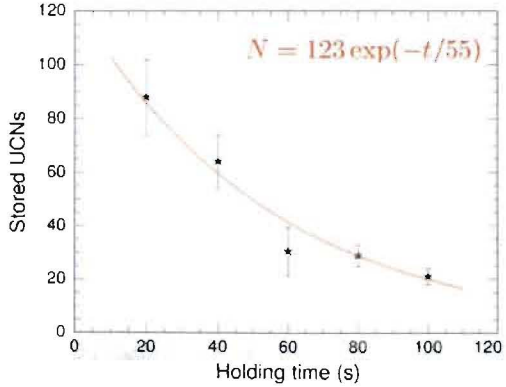




Room temperature storage time



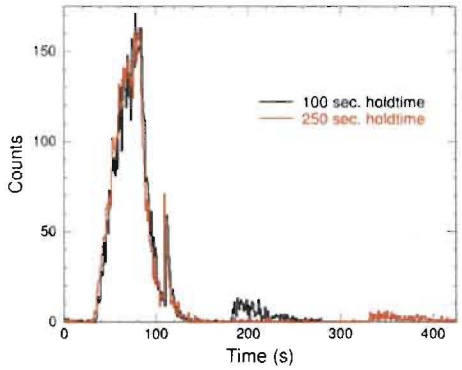
Room temperature storage time

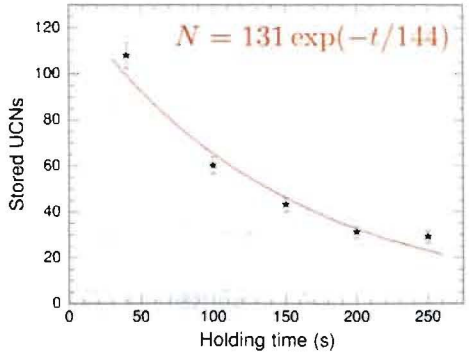


- expected ~ x100 more stored UCNs
- storage time from previous room temperature LANL measurement was ~100 s (with 30% larger cell)

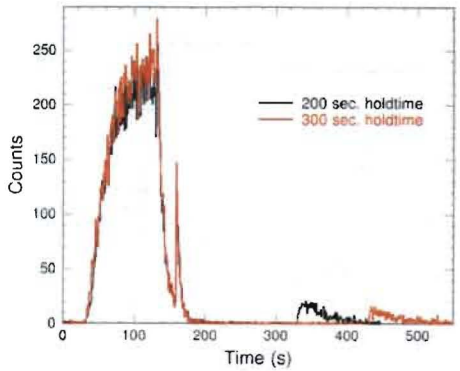
Cold data

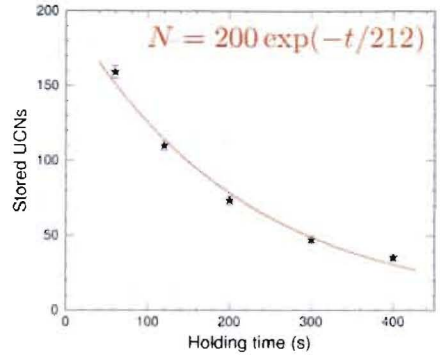
- Better beam quality (production vs. accelerator development)
- had control over beam delivery: lower background (4x)
- 105 K storage time:





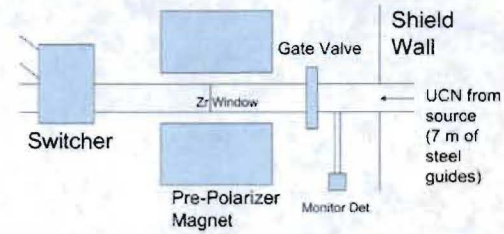
40 K storage time





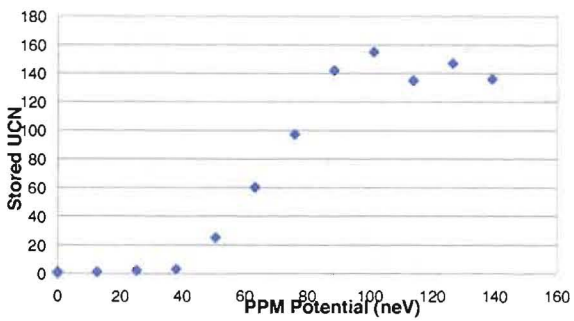
Wall potential evaluation with PPM scan

- a Zr foil window separates the UCN source from the detector region
- varying the field in the Pre-Polarizing Magnet (PPM) gives a variable low energy cutoff for UCNs transmitted through the window



A. Saunders

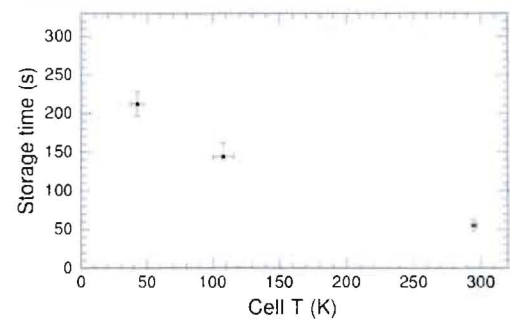
Bottle potential



indicates wall potential of 45–50 neV

dPS: 165 neV, PMMA: 22 neV

Next steps



- believe dPS coating includes PMMA dissolved by the long (~3 day) exposure to toluene
- plan to recoat cell restricting toluene exposure to ~minutes
- reinstall for another measurement in December