Paper Evaluation and Summary

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Paper: Pattie et al. (Measurement of neutron lifetime using magnetic trap)

- What is the main finding of this paper and why is it important?
  The mean neutron lifetime was found to be $\tau_n = 877.7 \pm 0.7(\text{stat})+0.4\text{-}0.2(\text{syst})s$.
  The largest uncertainty is dominated by statistics and therefore can be reduced
  through further runs of the experiment. This makes this experiments one of the
  most precise modern measurements of the neutron lifetime using a material trap.
  It still disagrees with the beam method.

- Describe at a high level the basic technique used. Try a series of "steps" here if
  necessary, if there is a sequence to be followed (like a recipe).

  1. Generate ultra cold neutrons, monitor the flux, and then flip the spin-state
     to low-field-seeking. Monitor the flux of neutrons with higher energy than
     the trap can handle.
  2. Fill the trap for $150s$ with neutrons and then close all the valves.
  3. Clean all neutrons with higher energy by using the polyethylene cleaners.
  4. Unload trap by successively lowering the the in situ PMMA detector into
     the fiducial volume and do background measurements afterwards.
  5. Complete two of those measurement cycles in a row (a short and a long run)
     and alter the configuration.

- Choose an interesting technical aspect of the experiment and describe its relation
  and importance to the measurement.
  An interesting fact is that it was chosen to lower the PMMA detector in sev-
  eral steps into the fiducial volume instead of just lowering it completely in the
  first place. According to the paper, this helps to study the uncertainties and
  dependences on neutron energy and momentum.

- Pick one systematic uncertainty issue that you find interesting and describe its
  importance and the author's method of addressing it.
  In order to avoid fluctuations in number and energy of neutrons for loading trap
  the author uses beam monitors to monitor abundances of neutrons with higher
  energy and the spectral variance of the flux of the neutron source. By alternating
  the run times in a cycle of measurements these effects were reduces.

- Fascinating aspect:
  Interestingly the collaboration chose to blind the data from the analysts to reduce
  bias such that the analyses result in a constant offset of $15s$.