

Target Analysis for Spin-Duality

Vincent Sulkosky

Pol. ^3He Collaboration Meeting

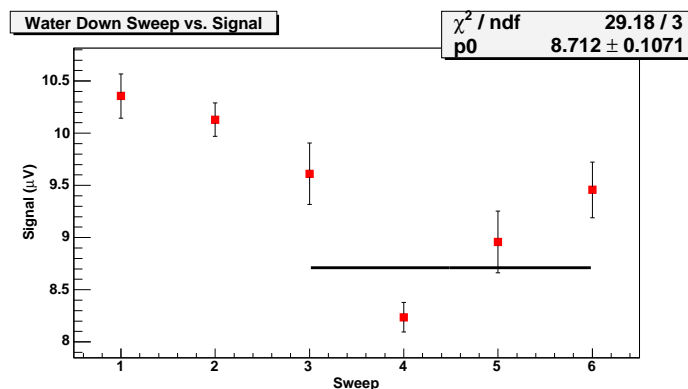
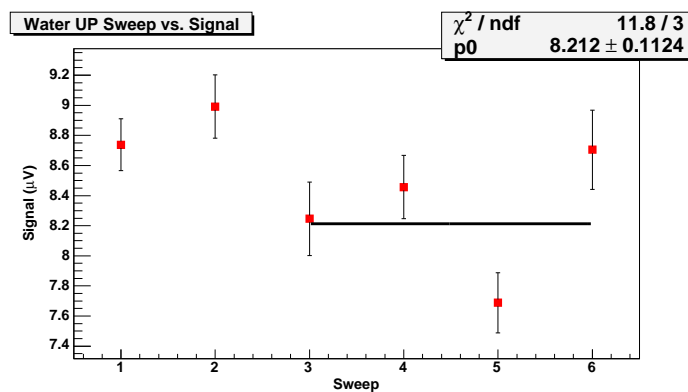
April 08th, 2005

A- ϕ Box ^3He Tests

- Tests conducted in June 2004.
- Checked pick-up signal and arbitrary signal from RF function generator with and without circuit
- $\langle \text{Ratio} \rangle = -1.02343$ (ratio of pure signal to circuit signal)
- Compare with results from Feb. 17, 2003, $-1.02666 \pm 1.5\%$
- Took NMR with and without A- ϕ box.
- These studies showed the correction factor was ~ -1.08
- Used a correction factor of -1.053 with 2.7% Sys. Uncertainty.
- Decided to test A- ϕ box with a water signal. (Hai Zhang)

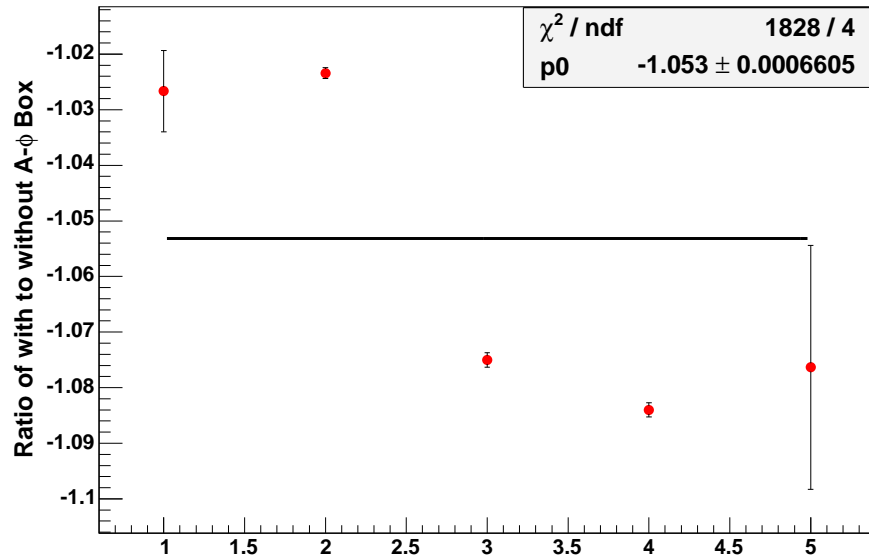
Water Signal Tests

- Water signals analyzed by Hai Zhang.
- Unfortunately the results from the tests were not conclusive.
- Possible problem with the RF field at the time of the test.

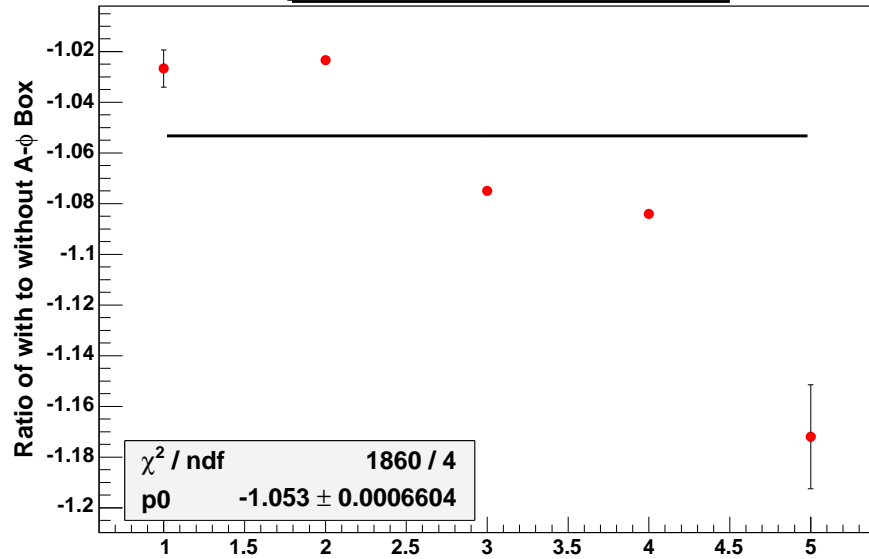


- $\text{Ratio}_{\text{up}} = -1.076 \pm 0.022$
- $\text{Ratio}_{\text{down}} = -1.172 \pm 0.021$

A- ϕ box Ratio, Up Sweeps

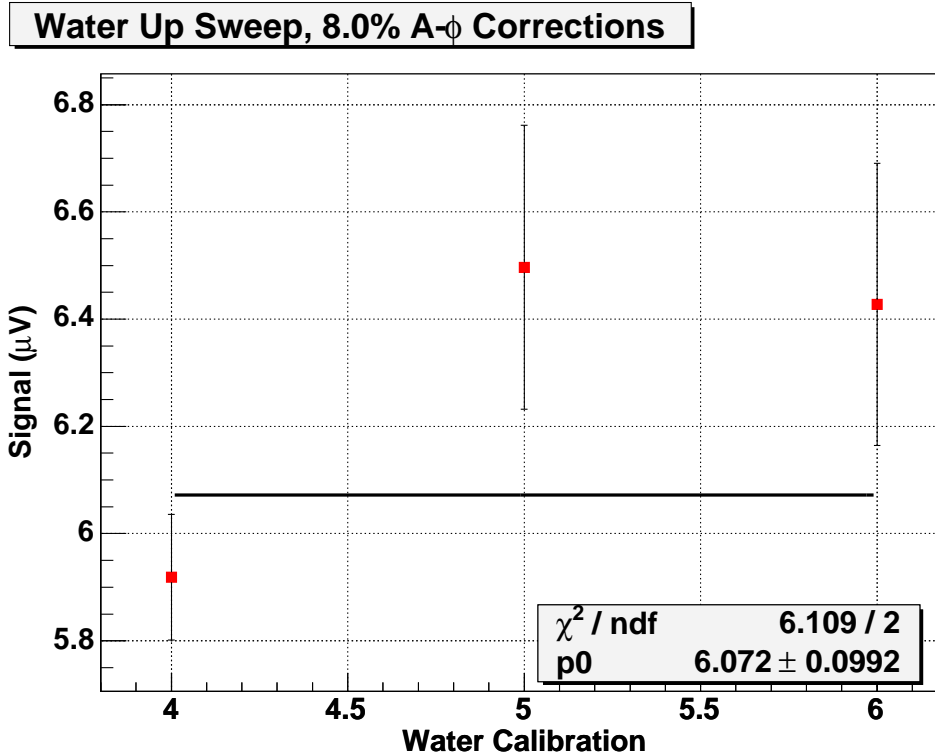


A- ϕ box Ratio, Down Sweeps

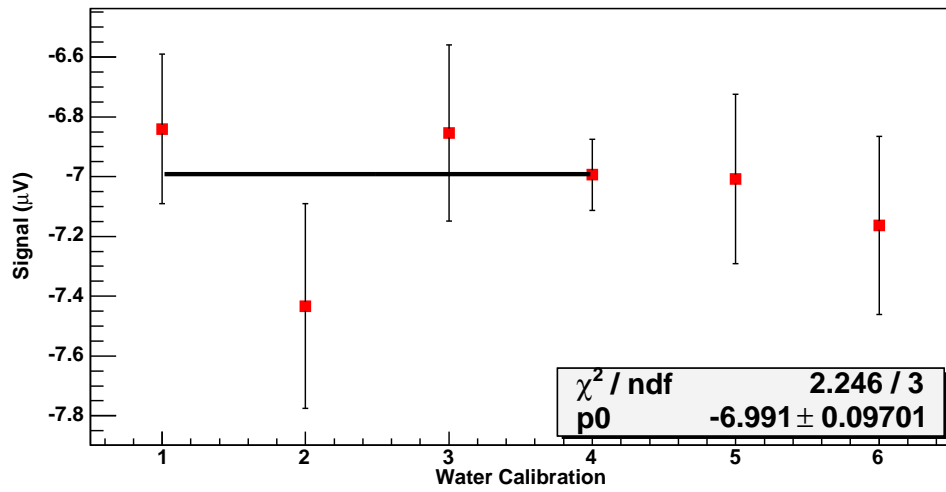


Water Signal Results

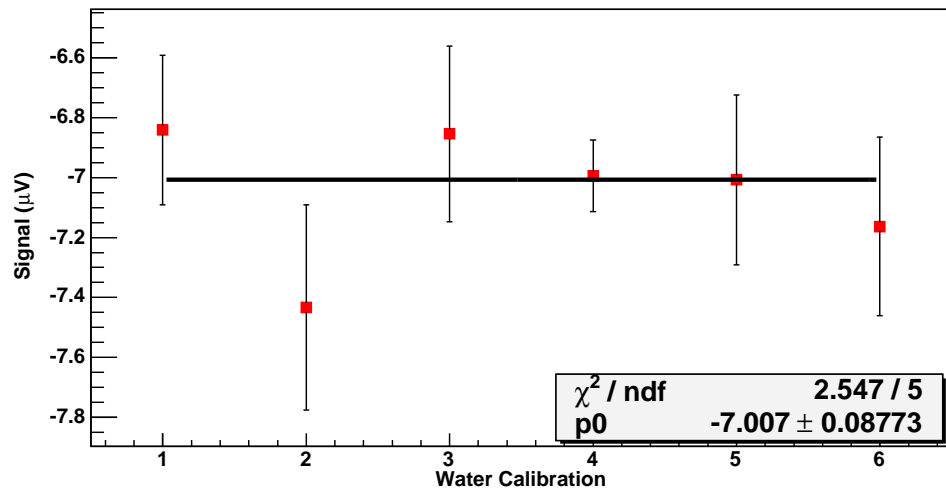
- Decided to use **8% correction** on the $A-\phi$ signals.
- **50% systematic error** on the correction.



Water Down Sweep

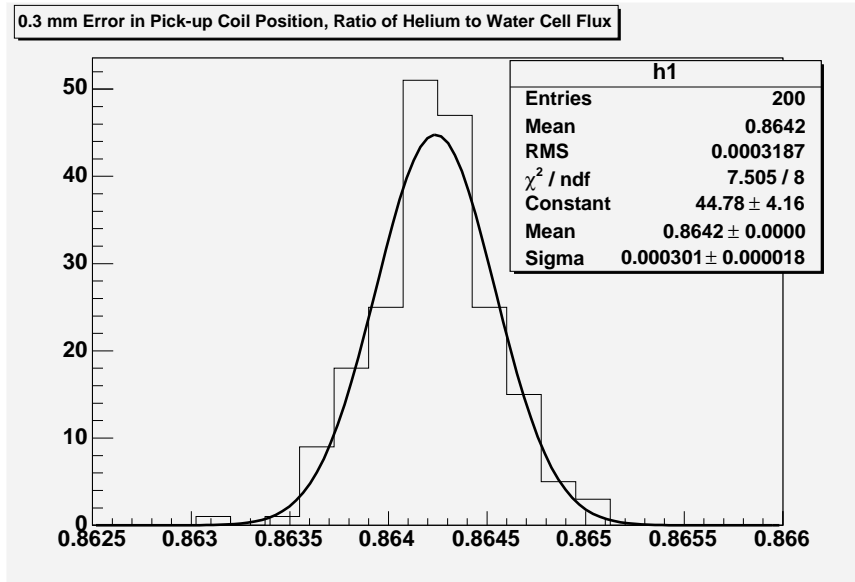
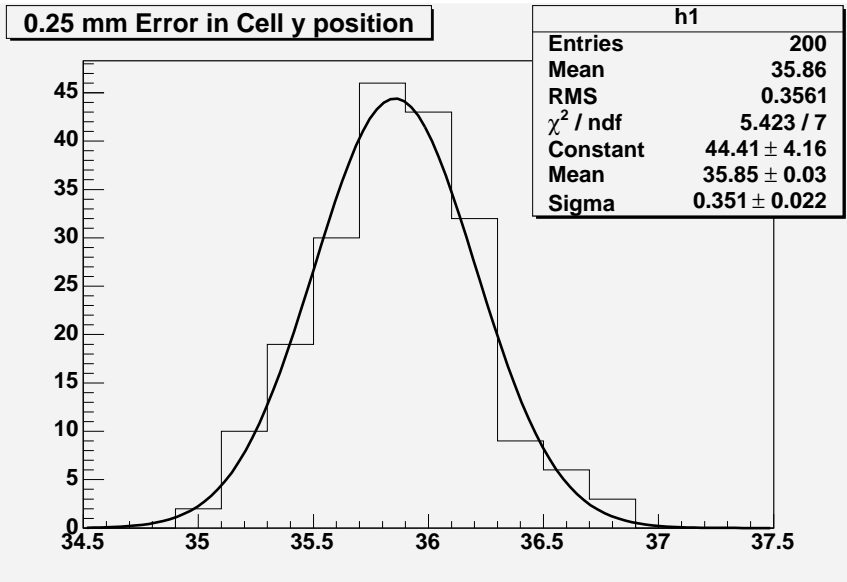


Water Down Sweep, 8.0% A- ϕ Corrections



Flux Uncertainty

- Determined uncertainties in position measurements:
 - Uncertainty in pick-up coil positions: 0.25 mm
 - Uncertainty in target chamber radius: 0.05 - 0.12 mm (varies with cell)
 - Uncertainty in cell position in y: 4.3%
 - Ran flux code 200x, varying input parameters randomly within error bars of the position measurements.
- Looked at the ratio of the flux distribution for Duke and the water cell, while varying the inter-coil distances.
 - The uncertainty in the flux ratio due to the coil distances is $\ll 1\%$.
 - In the final flux error, this uncertainty will not be included.



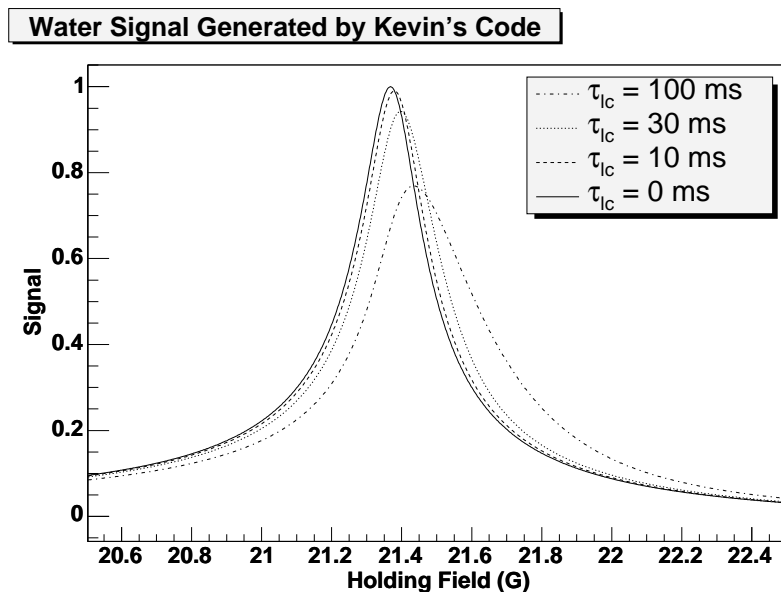
- Water cell flux uncertainty from the first period of Exodus
 - Pick-up coils moved during reference cell replacement.
 - No flux measurement for the water cell from Exodus's first period.
 - Calculated the water cell flux based off the measurements for the first period of Exodus.
- How do you estimate the error in this calculated value?
 - Know the inter-coil distance for Exodus's first period and the water cell at the end of the experiment.
 - Coil B did not move, when the ref. cell was replaced.
 - Difference between inter-coil distance from Exodus and the water cell has to be the distance Coil A was moved.
 - Only additional uncertainty in the water cell flux from this period is in the position of Coil A.
 - Looked at the water cell flux distribution with additional error on the cell to coil distance for Coil A.

Cell	σ_{cell} (mm)	σ_{tot} (%)
Water	0.25	1.487
Water	0.50	1.923
Water	0.75	2.651

Cell	Φ (cm ²)	σ_{tot} (%)	Time Period
Water	38.67	1.459	Jan-Feb, 2003
Water	39.06	1.459	Feb. 14-17, 2003
Water	39.15	1.459	Feb. 14-17, 2003
Water*	42.07	1.923	(Feb. 7-10, 2003)*
Duke	35.90	1.811	Jan-Feb, 2003
Exodus	40.39	1.917	Feb. 7-10, 2003
Exodus	37.85	1.917	Feb. 10-14, 2003

Signal Shape Analysis

- Used Kevin's watershape generator code to determine signal shape corrections for Duality.
- Duality H1(2.5 Vrms) = 83.1 mG
- Longitudinal Gradients: Duke (7.6 mG/cm), Exodus (7.8 mG/cm)
- Lock-in Time Constant: $\tau = 30$ ms
- Effect of the time constant and gradient widen NMR signal to 91 mG and reduce the height by 5%.

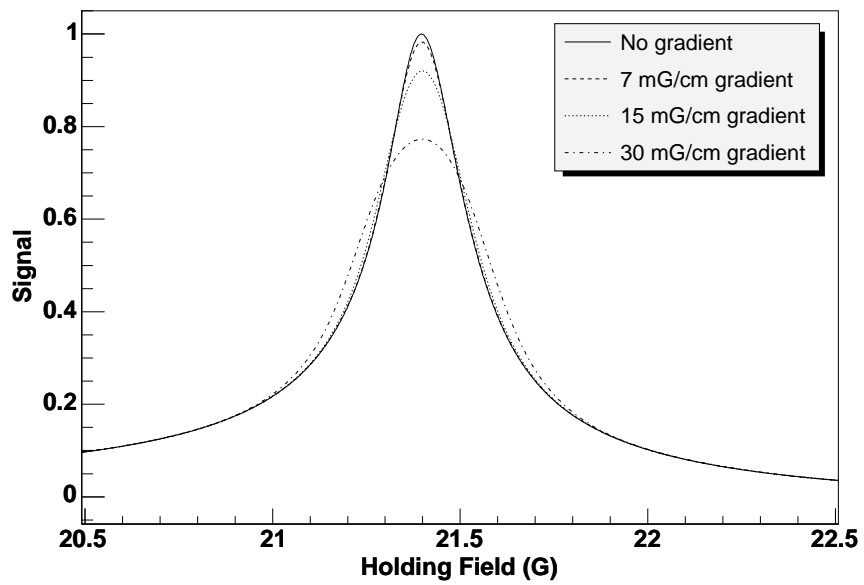


- Signal Shape Analysis

- Replaced the Bloch equations with the square root of a lorentzian to model Helium signal.
- Helium NMR signal widened to 91 mG and height was reduced by 5.6%.
- Corrections comparable between Duke, Exodus and water.

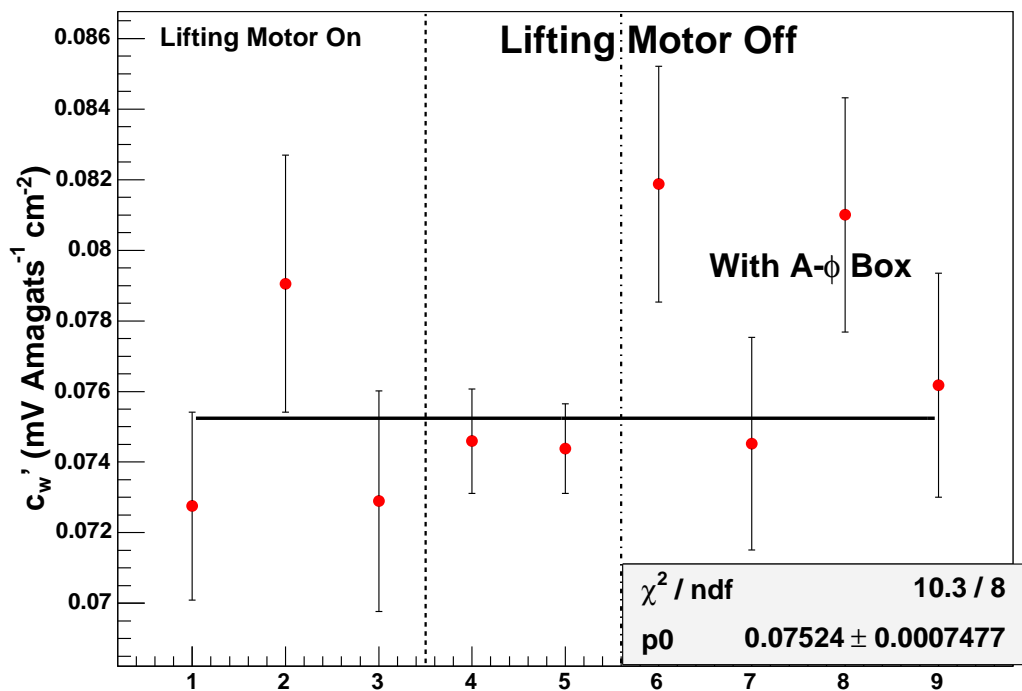
Cell	Ratio (Raw/gradient)	Correction (%)
Water	1.057	5.4
Duke	1.060	5.6
Exodus 1	1.061	5.7
Exodus 2	1.058	5.4

Water Signal Generated by Kevin's Code



Water Calibration Constant

Spin-Duality Water Calibration Constant



Summary

Summary

- A- ϕ tests with water signal were inconclusive.
(H. Zhang)
- Correction factor: $8.0\% \pm 4.0\%$
- Flux uncertainty: $\sim 1.5 - 2.0\%$
- Lock-in time constant and gradient corrections comparable between water, Duke and Exodus.
- No water calibration for Duke and first period of Exodus.
- Know the flux, so can scale water signal by the flux.
- Ratio of flux to water signal should remain constant.

Plan

- Need to finalize systematic errors on calibration constant.
- Write summary report for Spin-Duality NMR analysis.