

First COUPP-4 Run at SNOLAB

<http://arxiv.org/abs/1204.3094>

May 8, 2012

Fermilab

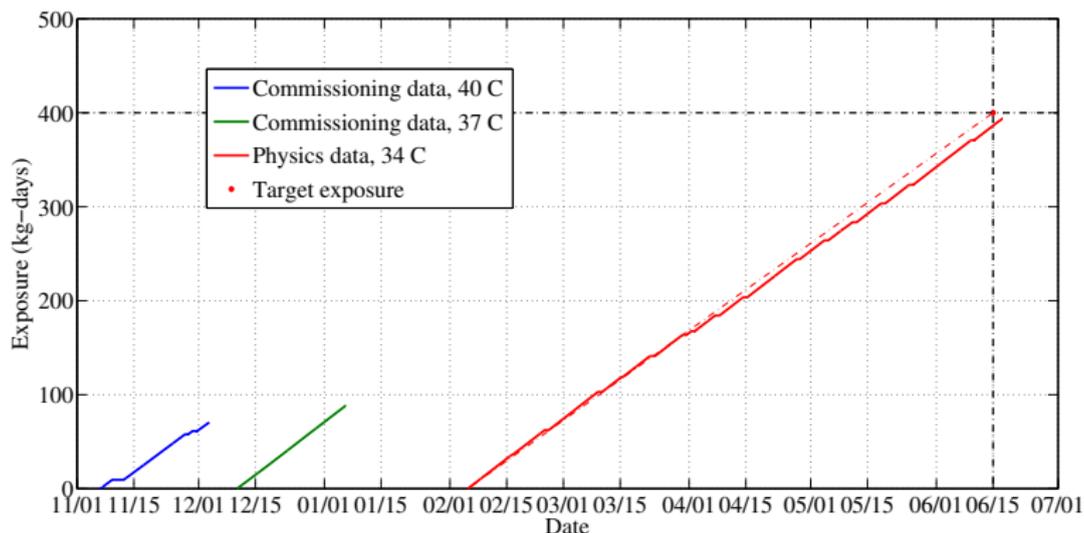
COUPP-4 at SNOLAB



- ▶ Installed August-September 2010

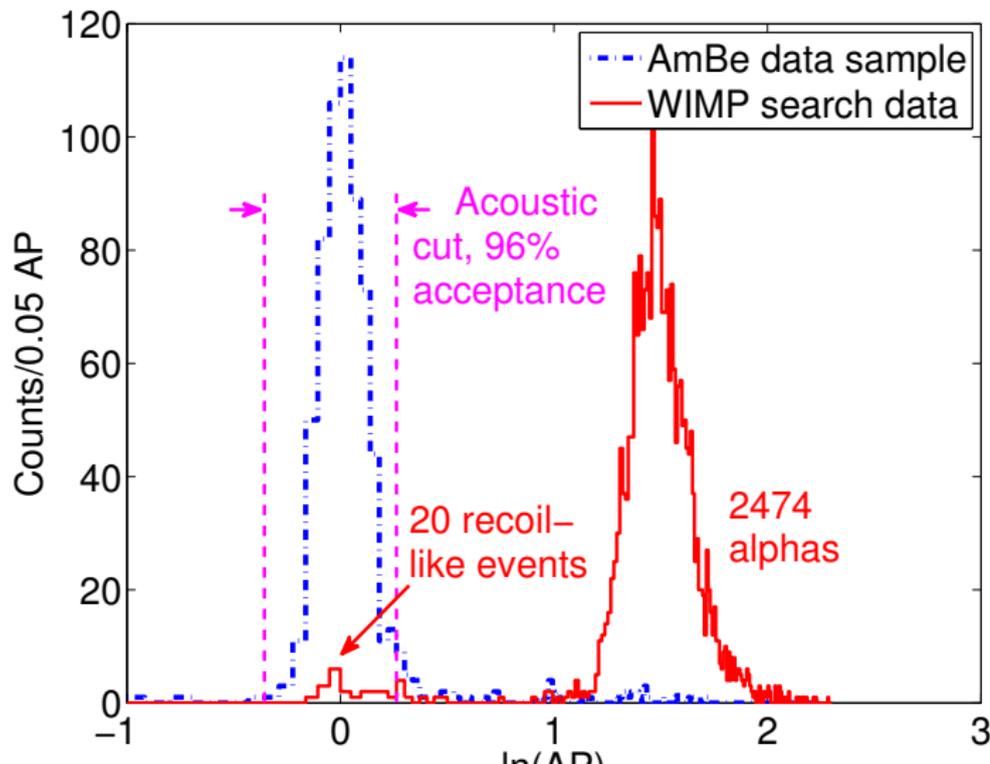
COUPP-4 at SNOLAB

- ▶ 70.6 kg-days at 7.8 keV threshold
- ▶ 88.5 kg-days at 11 keV threshold
- ▶ 394 kg-days at 15.5 keV threshold ended June 16
- ▶ 79% acceptance for nuclear recoils after all cuts (including fiducial and acoustic)



Acoustic discrimination

- ▶ Better than 98.9% rejection against alphas with all data sets
 - ▶ Better than 99.3% rejection at 15 keV threshold



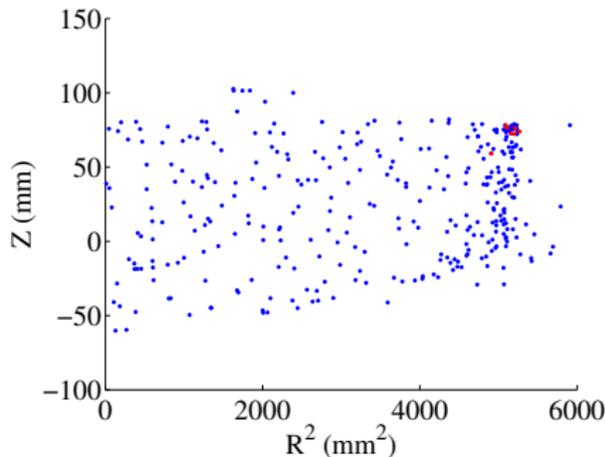
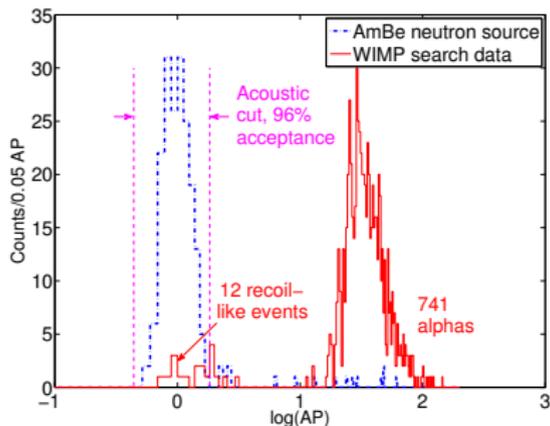
WIMP search results

Nucleation Threshold (keV)	Total Exposure (kg-days)	Observed (Predicted) Event Counts		
		$N_b = 1$	$N_b = 2$	$N_b = 3$
7.8 ± 1.1	70.6	6 (0.7)	0 (0.3)	0 (0.1)
11.0 ± 1.6	88.5	6 (0.8)	0 (0.3)	2 (0.1)
15.5 ± 2.3	394.0	8 (3.5)	1 (1.0)	0 (0.3)

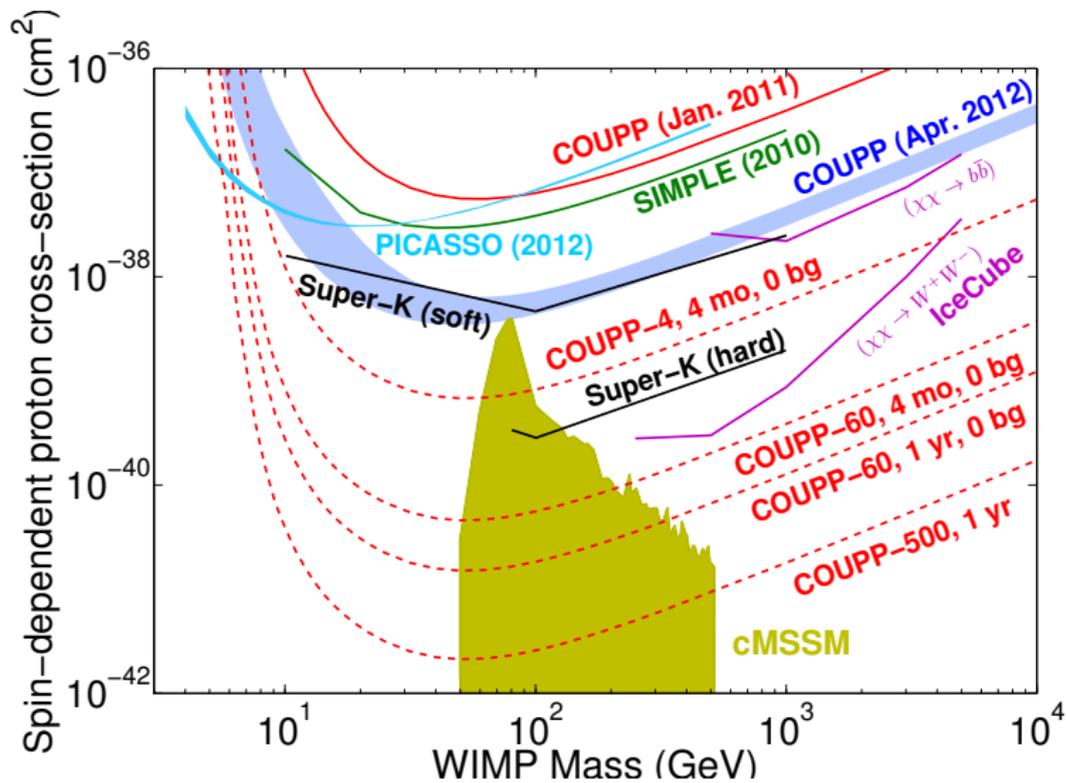
- ▶ Predicted neutron background from piezos and viewport window does not account for the observed rates at lower thresholds

Spurious events at low thresholds

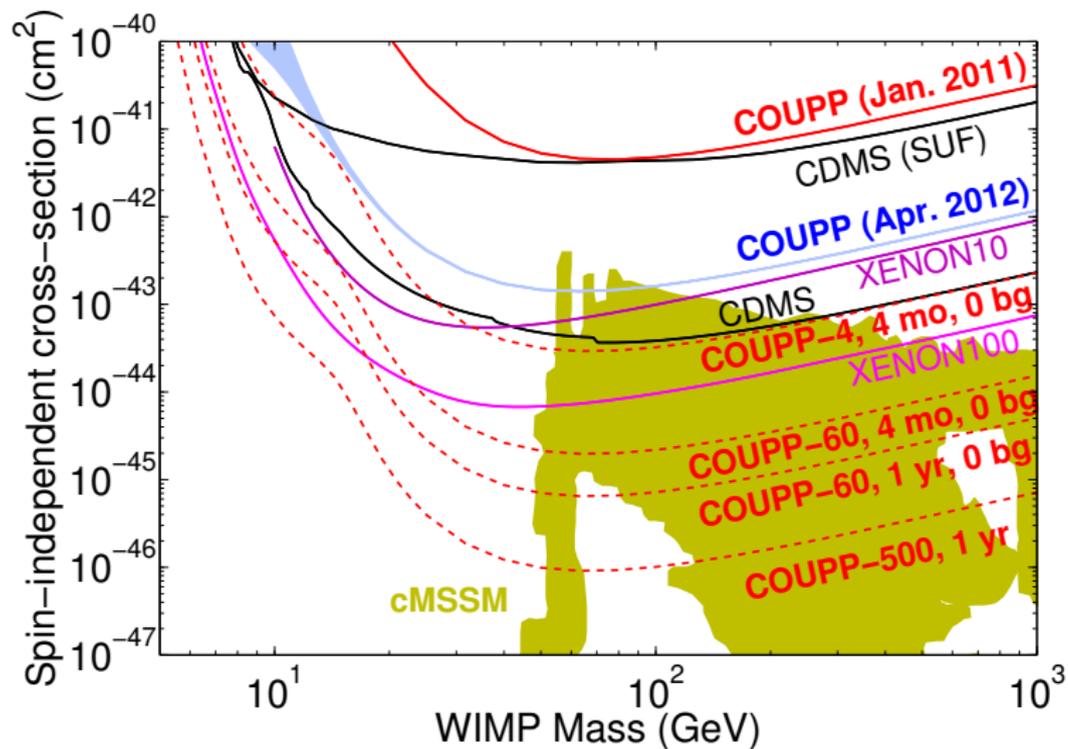
- ▶ Different AP distribution compared to neutron calibration
- ▶ Time clustering
 - ▶ 3 events in 12 hours (2 within 8 minutes)
 - ▶ 5 events in 8 hours (3 within 10 minutes)
 - ▶ 2 events in 3 minutes
- ▶ Correlation with previous bubble at the interface



COUPP-4 at SNOLAB



COUPP-4 at SNOLAB

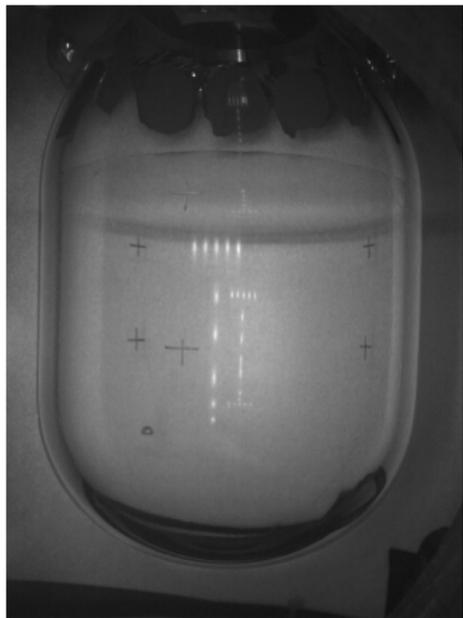
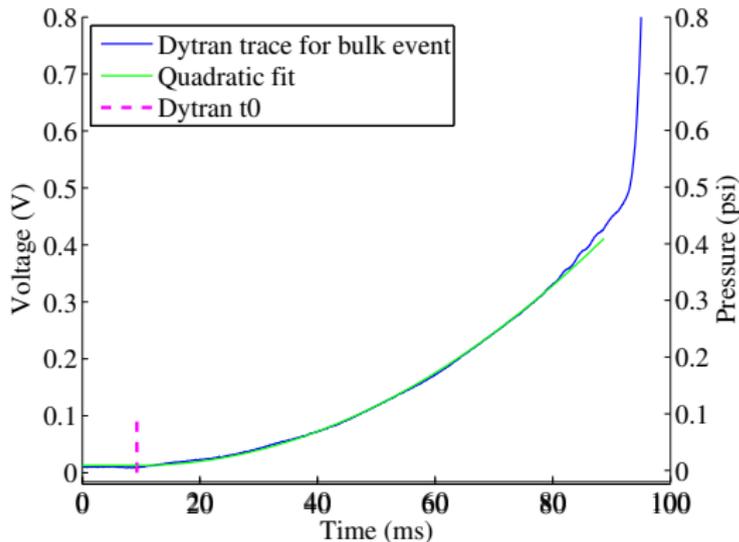


End

Backup

Improvements: the "dytran"

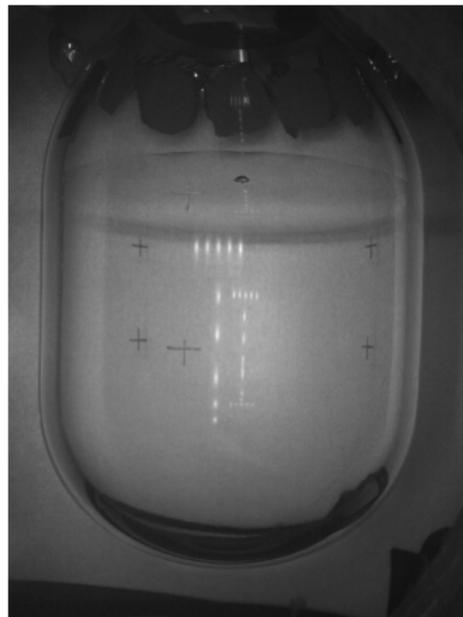
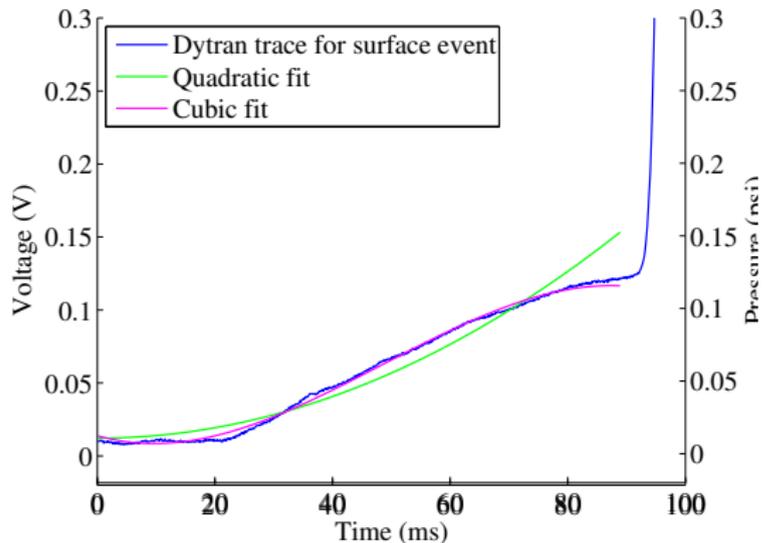
- ▶ A fast pressure transducer measures the pressure rise during bubble expansion
- ▶ The shape gives position information



- ▶ A bulk event is quadratic

Improvements: the "dytran"

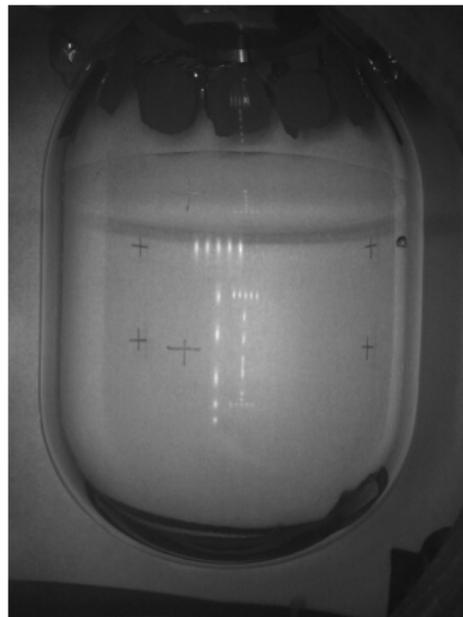
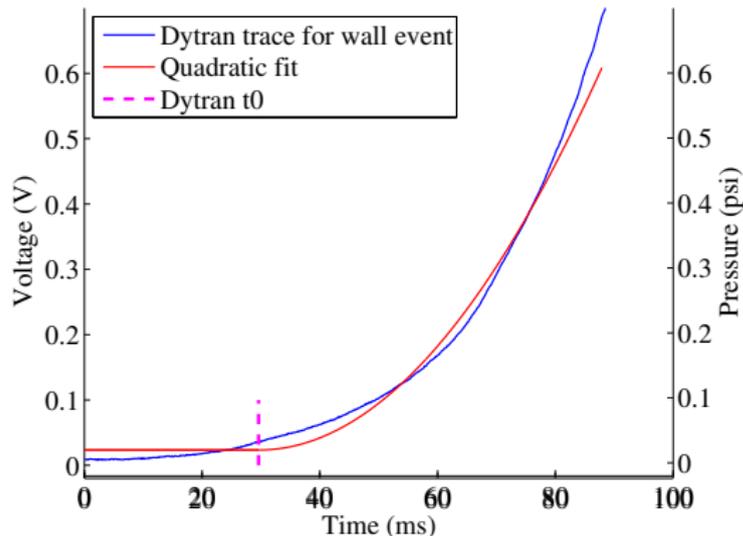
- ▶ A fast pressure transducer measures the pressure rise during bubble expansion
- ▶ The shape gives position information



- ▶ A surface event turns over

Improvements: the "dytran"

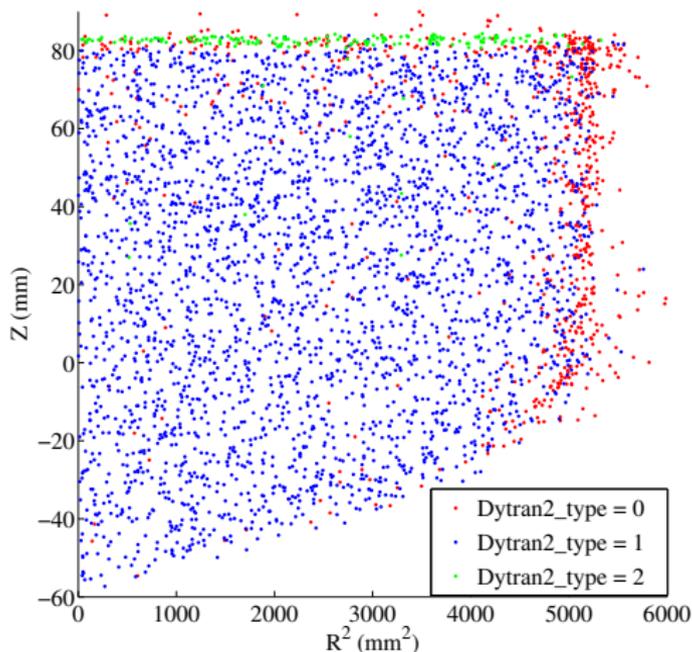
- ▶ A fast pressure transducer measures the pressure rise during bubble expansion
- ▶ The shape gives position information



- ▶ A wall event blows up

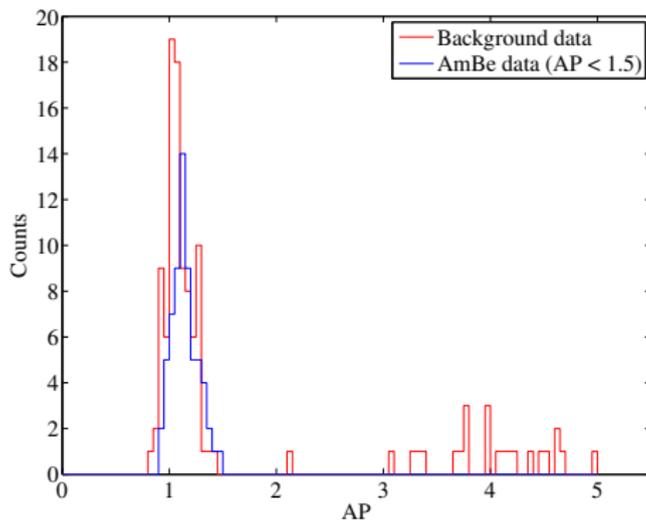
Improvements: the "dytran"

- ▶ A fast pressure transducer measures the pressure rise during bubble expansion
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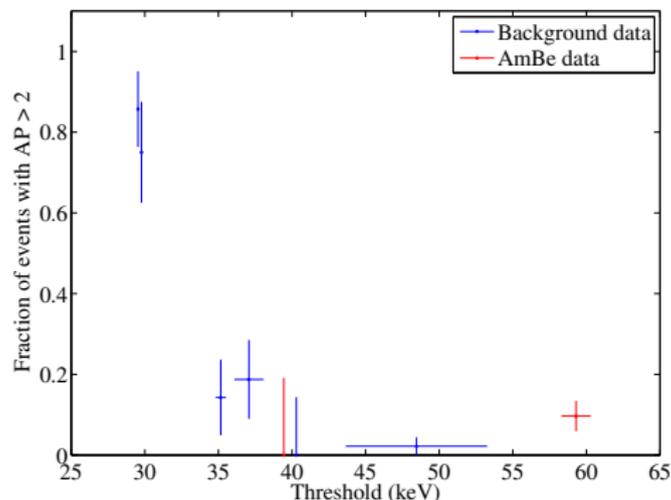
More on acoustic discrimination

- ▶ Acoustic discrimination appears to be discrete
 - ▶ Temperature scan shows that alphas form a bi-modal distribution around a threshold of 30-40 keV



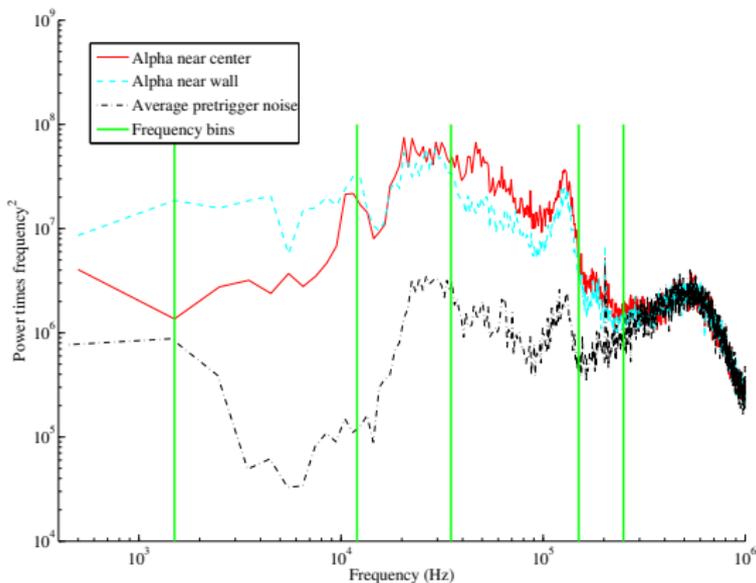
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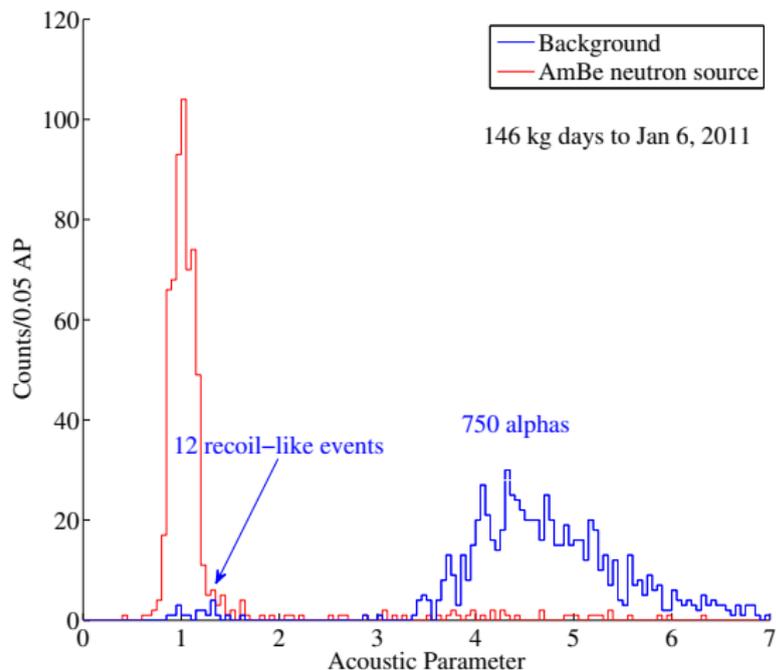
More on acoustic discrimination

- ▶ Events near the center → more power at high frequencies
- ▶ Events near the walls → more power at low frequencies



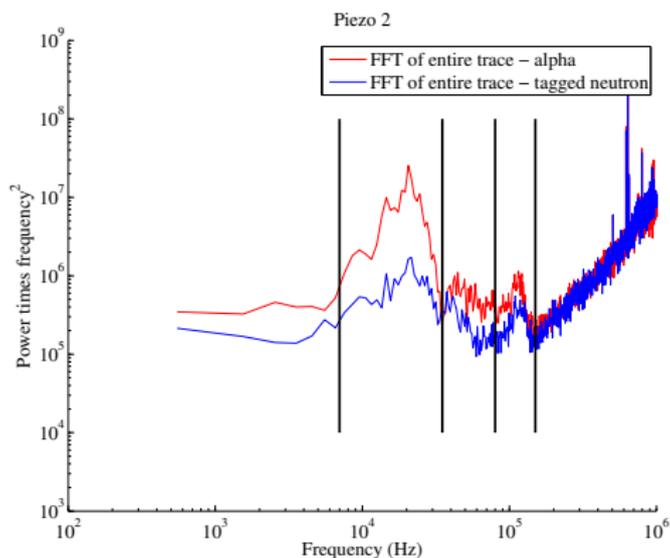
Status through Jan 6, 2011

- ▶ Evidence for 2nd source?
 - ▶ Clusters of 3 and 5 events in 3 and 9 hours respectively
 - ▶ Weighted to high end of AP distribution



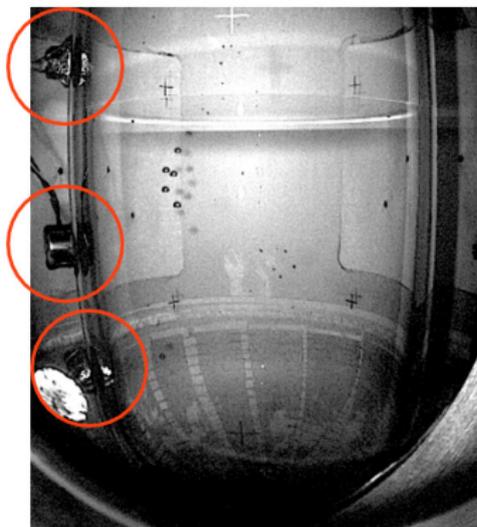
COUPP-60 Update

- ▶ Commissioning at shallow site last summer and fall
- ▶ Achieved background goals
 - ▶ 2.2 alphas/kg/day, identified by acoustic signature



COUPP-60 Update

- ▶ Commissioning at shallow site last summer and fall
- ▶ Achieved background goals
 - ▶ 2.2 alphas/kg/day, identified by acoustic signature
- ▶ ~ 1 recoil-like event/kg/day - piezos are closer to the fluid



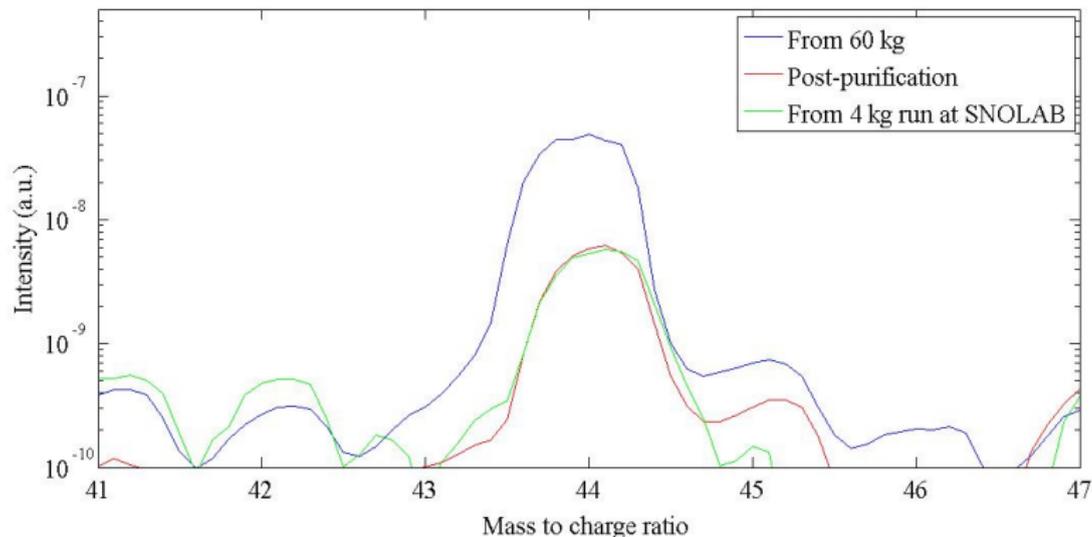
COUPP-60 Update - Chemistry issues

- ▶ Fluid turned red due to the release of iodine
 - ▶ Photodissociation
 - ▶ Impurities
- ▶ Recreated on test stand
- ▶ Solution to be tested on new commissioning run "in progress"
 - ▶ Sodium sulfite in water to draw out iodine



COUPP-60 Update - Chemistry issues

- ▶ Surface boiling
 - ▶ Carbon dioxide discovered in post-run fluid analysis
 - ▶ New purification step using molecular sieve and SAES getter produces levels comparable to current, stable COUPP-4 run at SNOLAB



COUPP-60 Plans

- ▶ Second commissioning run "in progress"



- ▶ Pack up and move to SNOLAB

COUPP-60 Plans

- ▶ Second commissioning run in progress
 - ▶ Demonstrate stability of optics
 - ▶ Absence of surface boiling?
 - ▶ If not, still work to do on understanding chemistry
- ▶ Begin move to SNOLAB
 - ▶ Study of safety requirements
 - ▶ Replace high radioactivity components
 - ▶ Pack up and move

Other considerations

- ▶ Calibrations - we need a better understanding of our threshold and efficiency
- ▶ Comparing rate of single and multiple bubble events from a calibrated neutron source with MC simulation
 - ▶ Agreement with theory at high temperatures (44 C)
 - ▶ $\sim 50\%$ efficiency between 30 and 40 C
 - ▶ Can fit data with wide range of efficiency curves
 - ▶ What other calibrations can we do?