

Latest Dark Matter Limits from COUPP



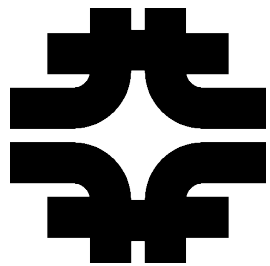
Kavli Institute
for Cosmological Physics
AT THE UNIVERSITY OF CHICAGO

University of Chicago

**J. Collar, C.E. Dahl, D. Fustin,
M. Szydagis, A. Robinson**

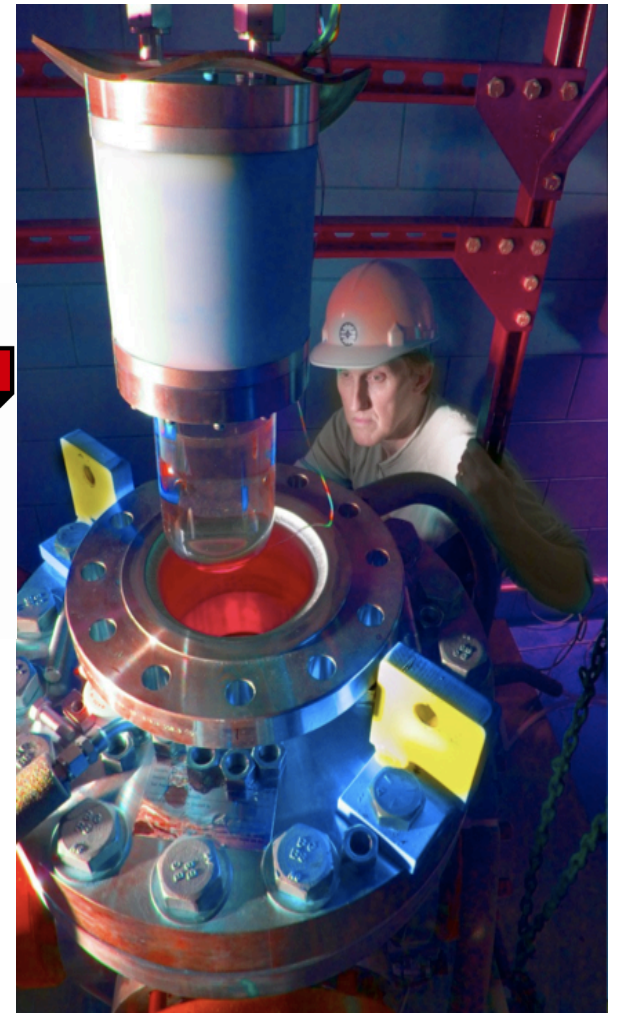
Indiana University South Bend

**E. Behnke, J. Behnke, J.H. Hinnefeld, I.
Levine, A. Palenchar, T. Shepard, B.
Sweeney**



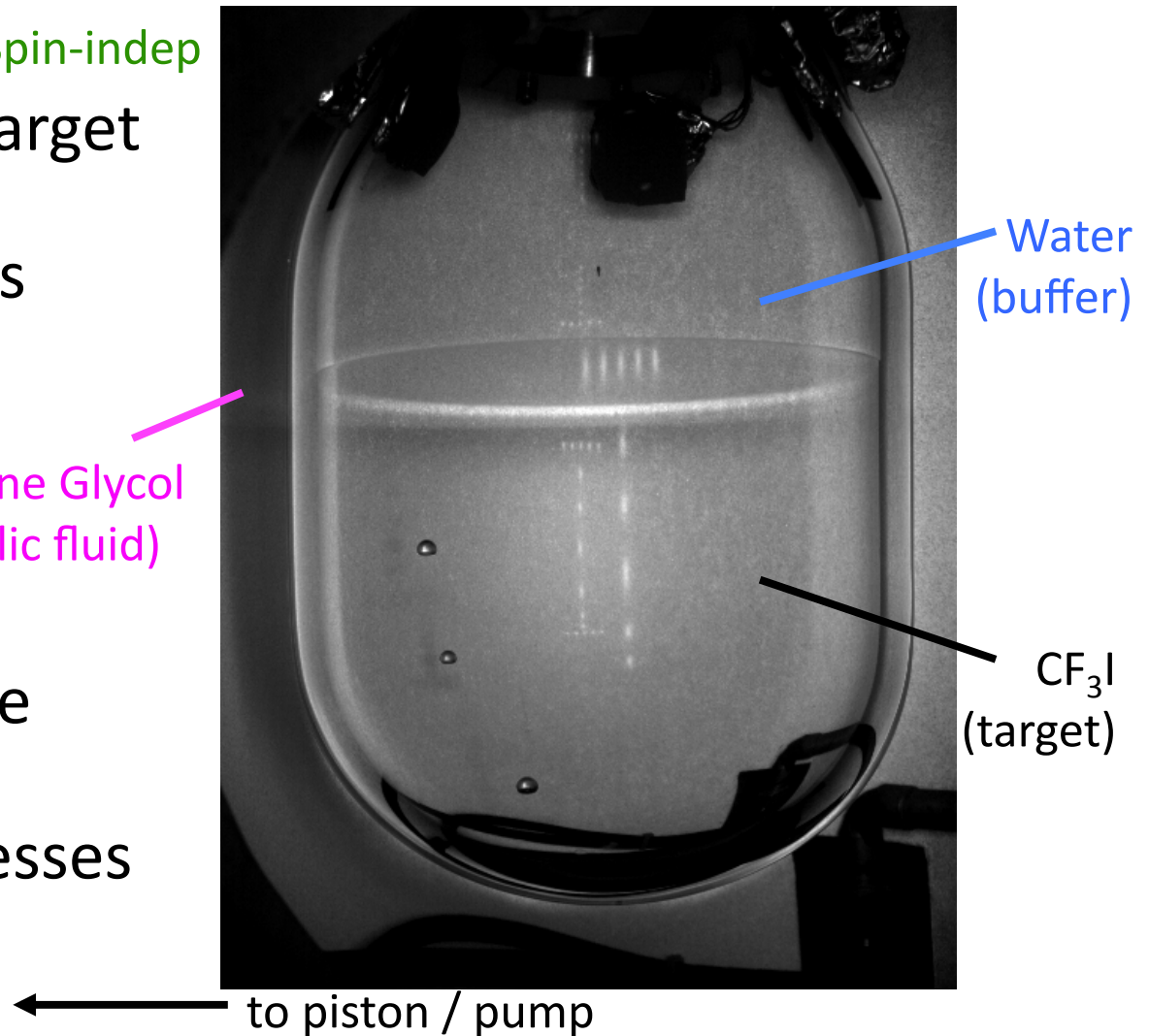
**Fermi National Accelerator
Laboratory**

**S.J. Brice, D. Broemmelsiek, P. Cooper,
M. Crisler, J. Hall, M. Hu, E. Ramberg, A.
Sonnenschein**



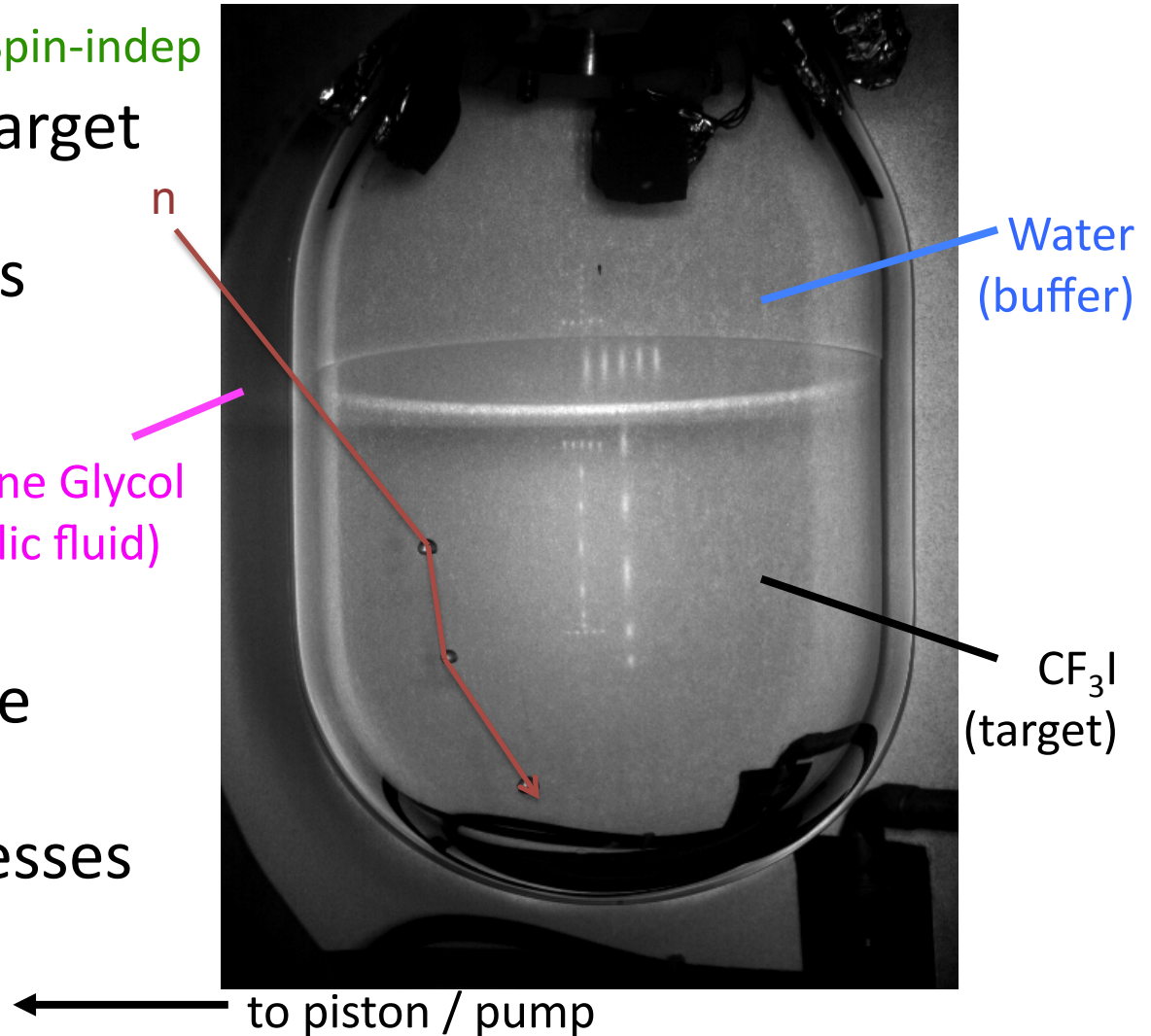
Direct Detection of Dark Matter

- Superheated CF_3I target
 - Spin-dep
 - Spin-indep
- Particle interactions nucleate bubbles
 - WIMPs
 - Neutrons Propylene Glycol (hydraulic fluid)
 - Alphas
- Cameras capture stereoscopic bubble images
- Chamber recompresses after each event



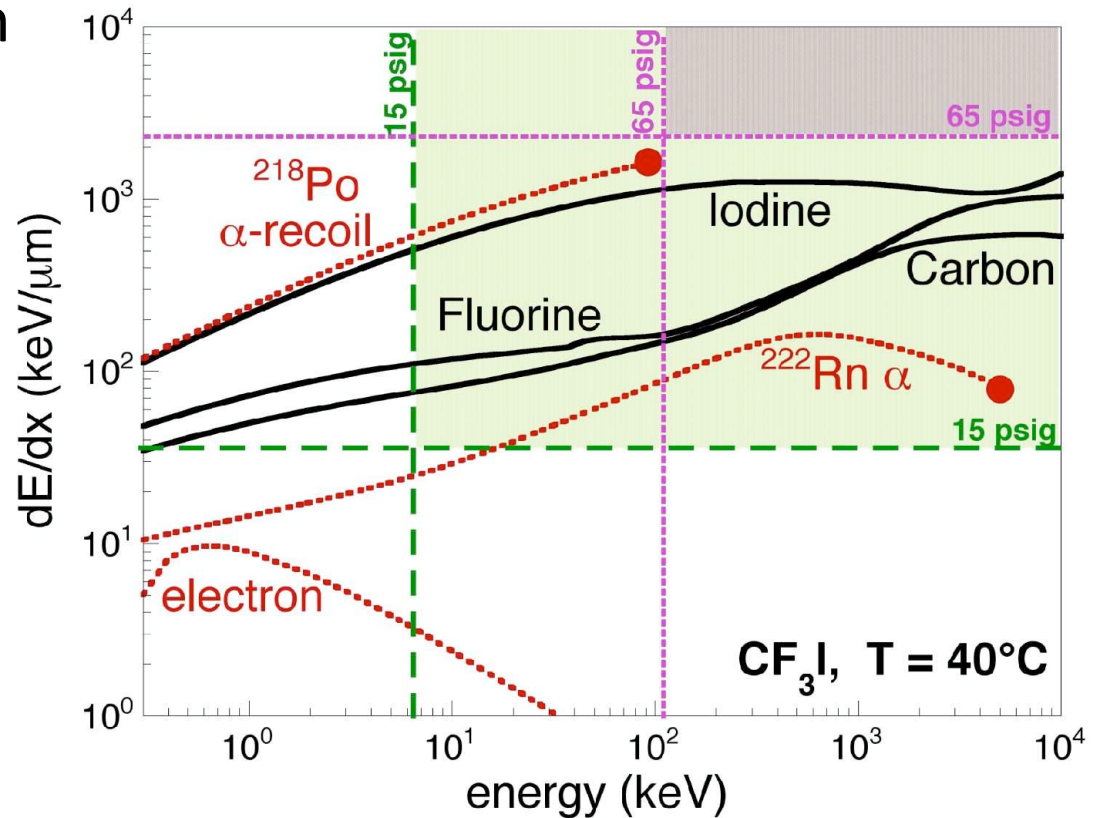
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Backgrounds

- Only proto-bubbles with $r > r_{\text{crit}}$ grow to be macroscopic
- Minimum Energy
- Minimum dE/dx
- Backgrounds:
 - Alpha decays
 - Neutron-nucleus elastic scattering
 - Natural or sAmBe radioactivity
 - Cosmic radiation (muon veto)
 - NuMI beam (tagged)

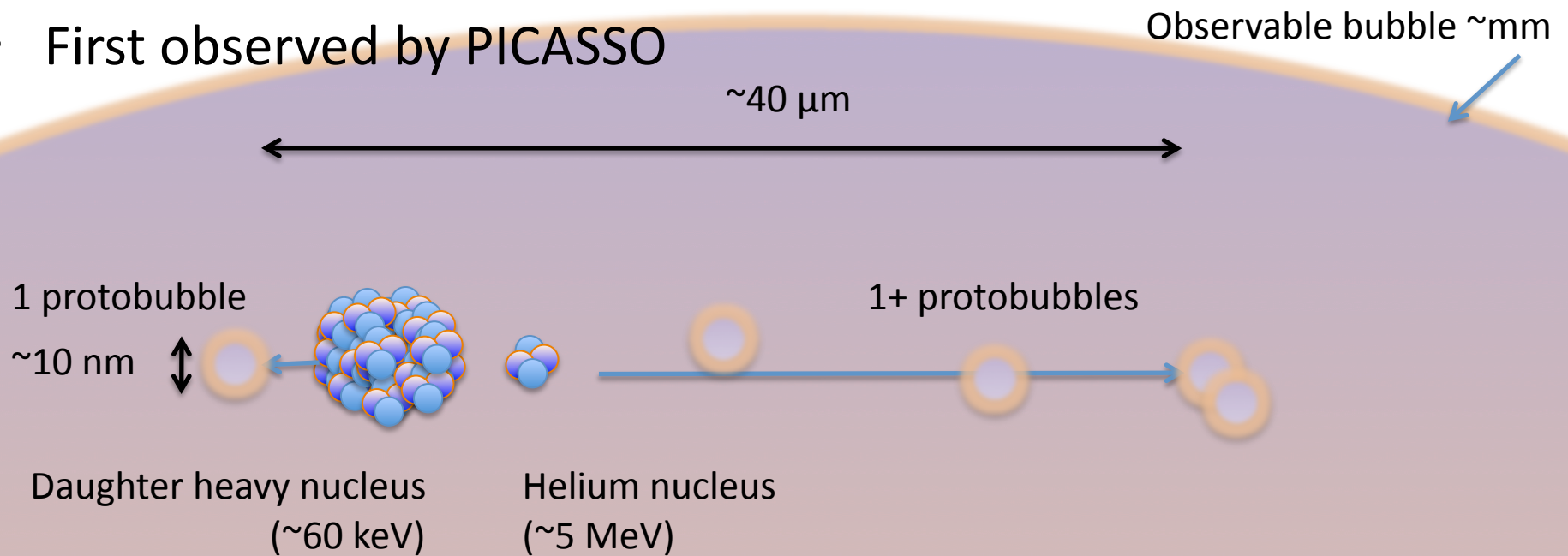


No sensitivity to γ 's or β 's!

n 's and α 's do make bubbles

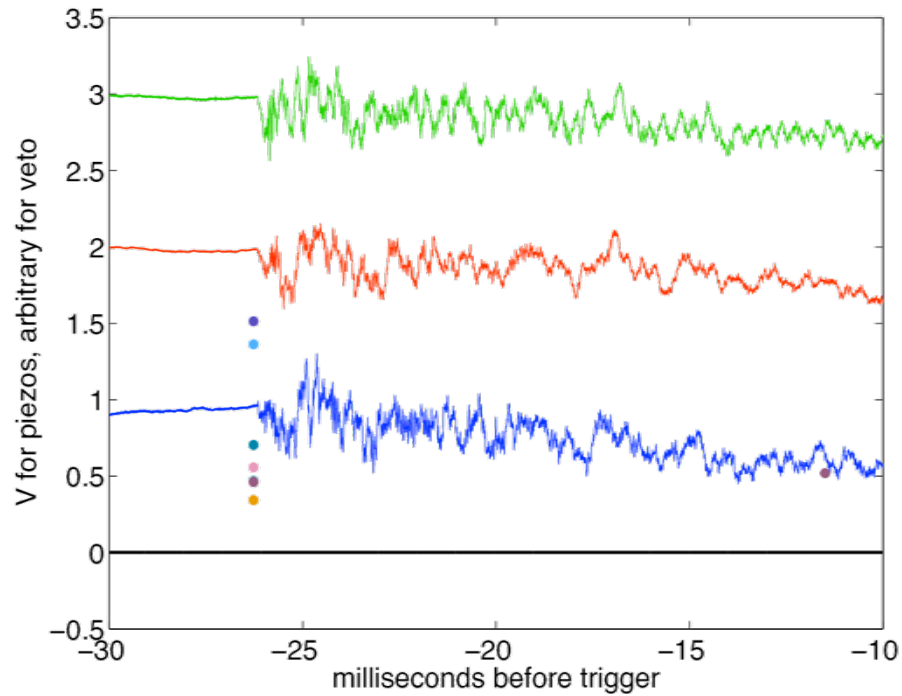
Acoustic Discrimination

- Nuclear recoil: 1 protobubble // Bulk α -decay: 1+ protobubble
- High frequency acoustic information probes smaller scales
- Alpha decays produce more than one protobubble, so they should produce more sound at high frequencies
- First observed by PICASSO

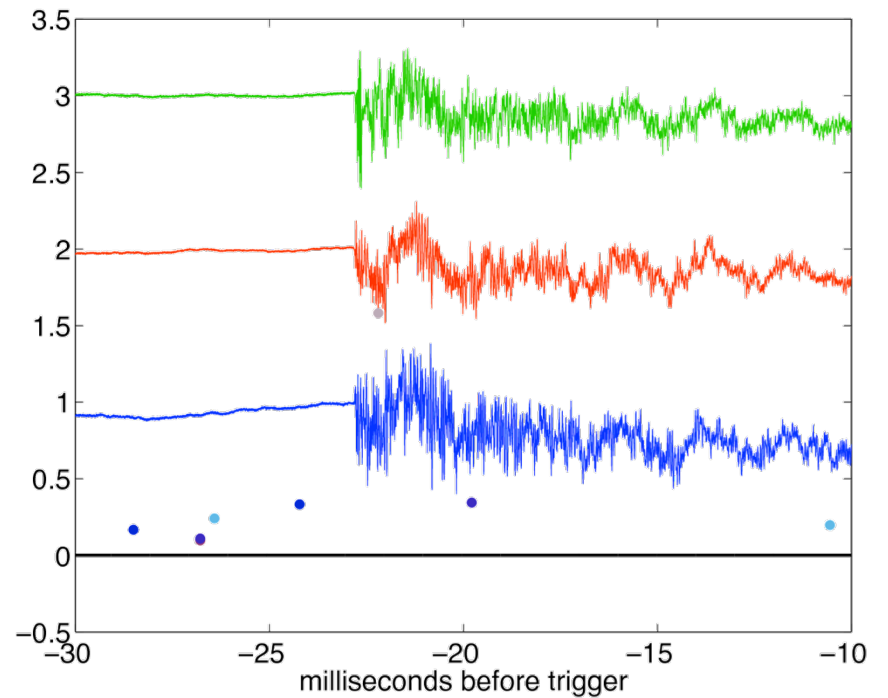


Acoustic Discrimination

Neutron

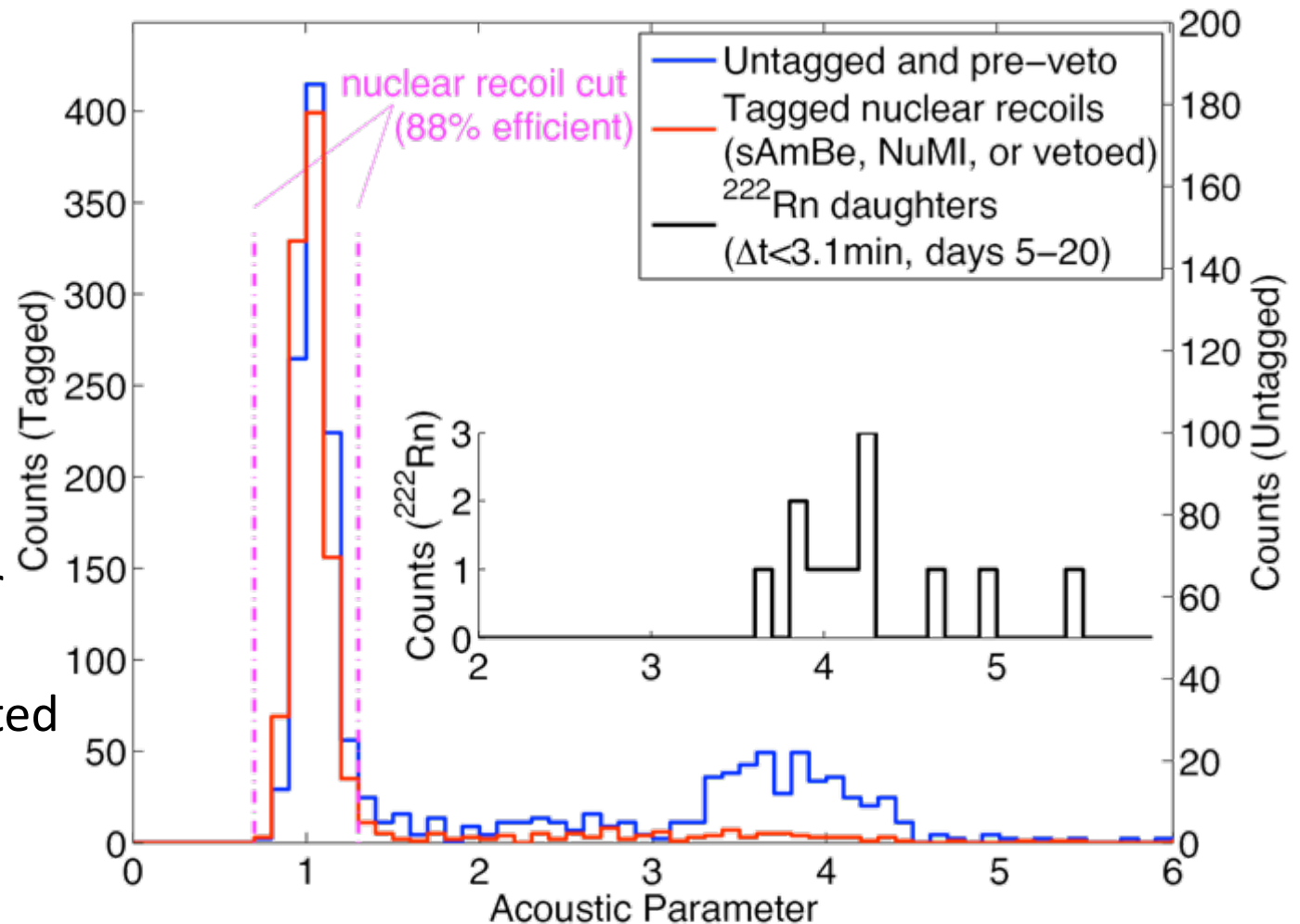


Alpha

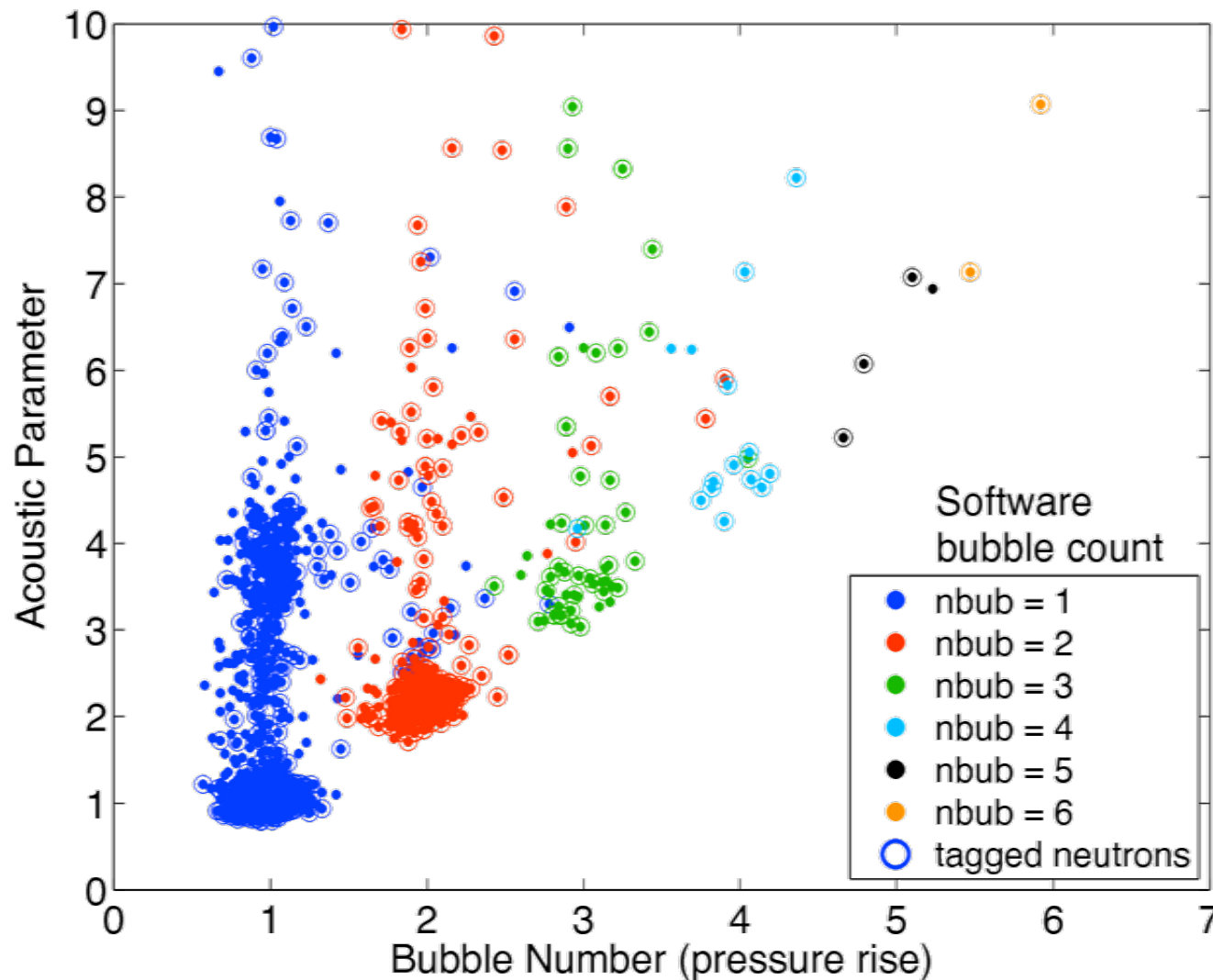


Acoustic Parameter

- $(\text{Amp} \cdot \omega)^2$
(Normalized and position-corrected for each freq-bin)
- Measure of acoustic energy deposited in chamber
- Alphas are louder than neutrons
- ~200 well separated alpha events

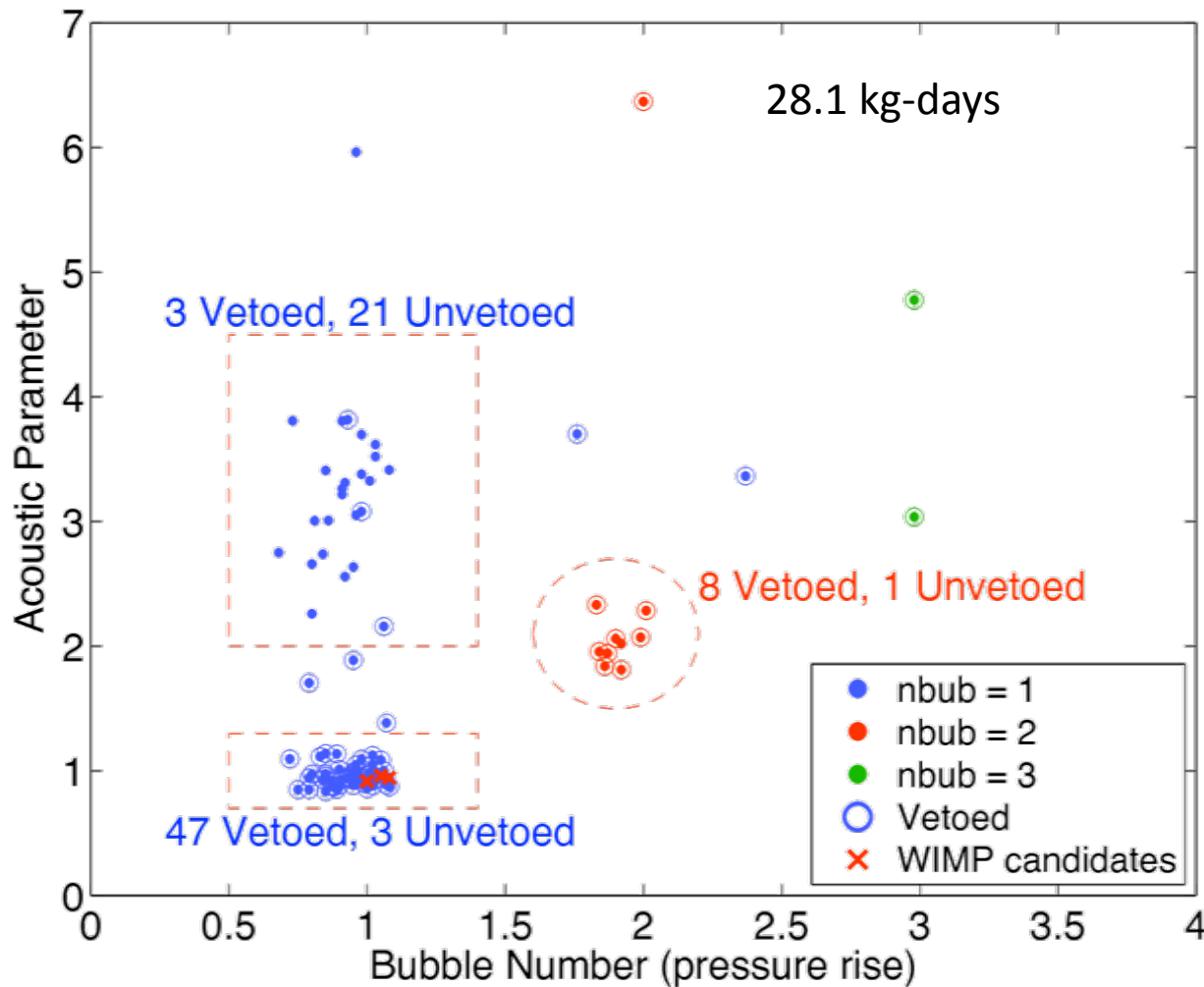


Counting Bubbles



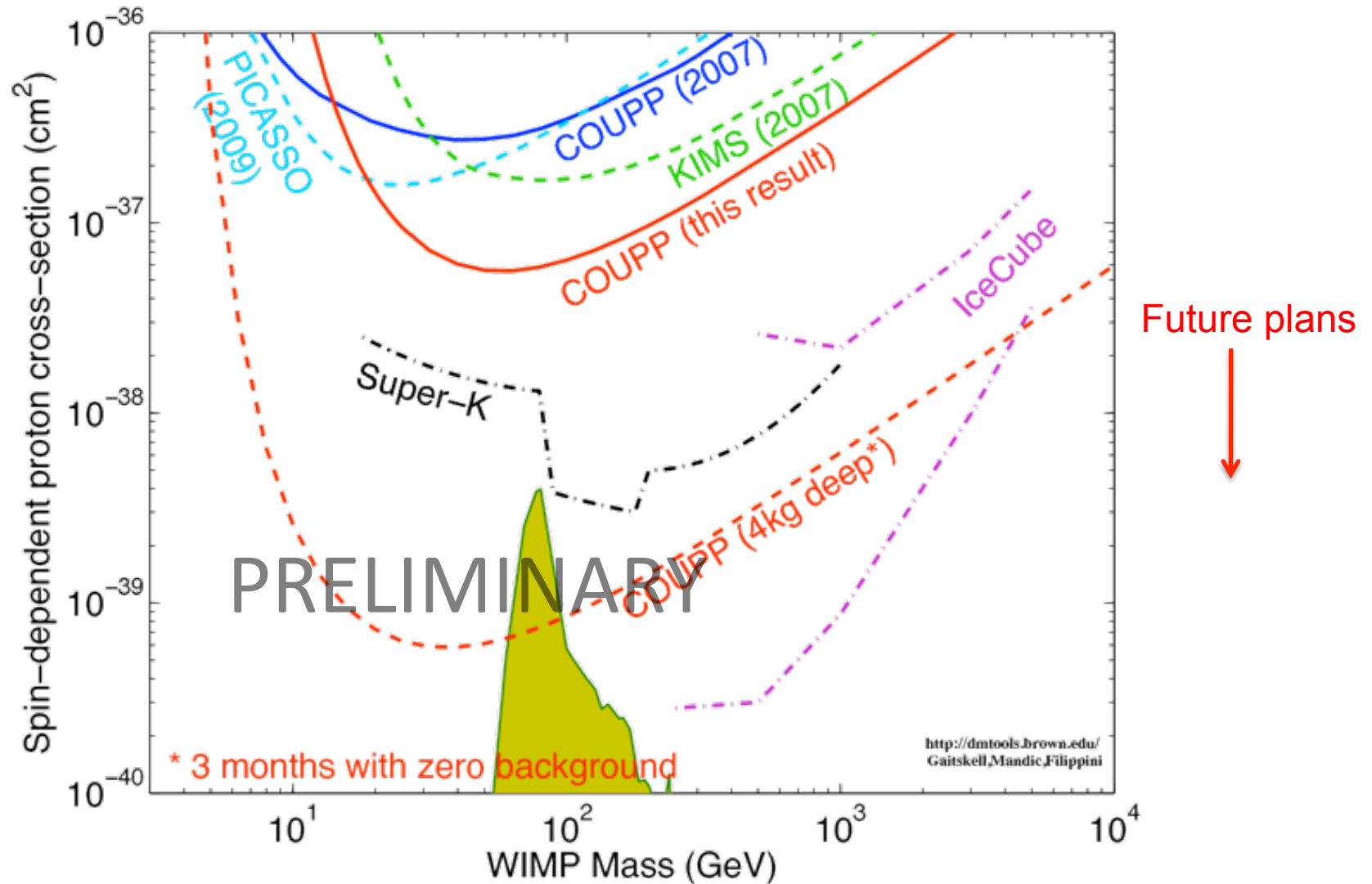
- 3 Methods of counting bubbles
 - Camera Images
 - Pressure Rise
 - Acoustic Parameter
- Acoustic Parameter scales with # of bubbles
- No tails at low Acoustic Parameter
- 291 kg-days, mostly before veto installation

Candidate Events

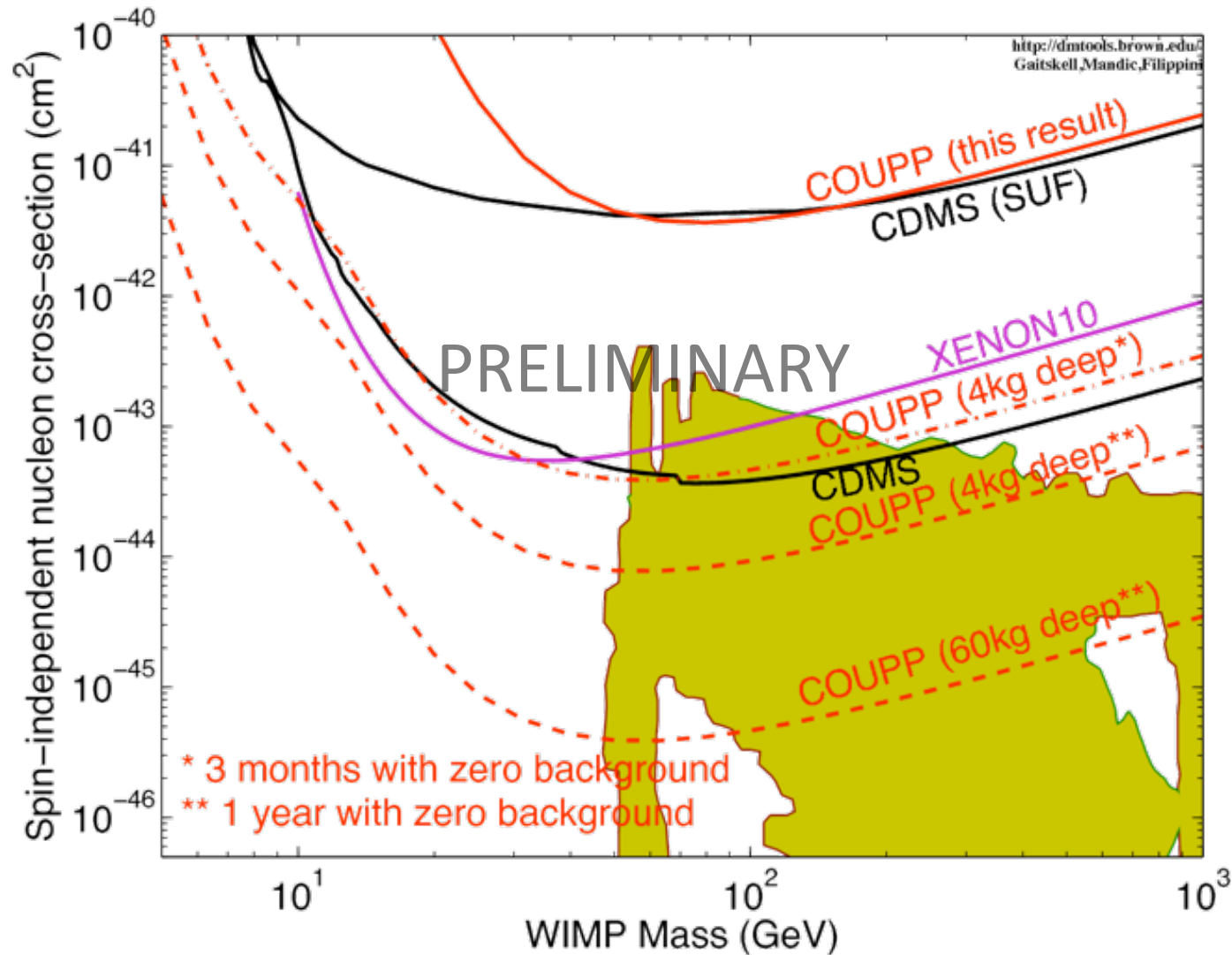


- 3 Events Pass All Cuts
 - Alphas?
 - Neutrons?
 - WIMPs?
- Taking the 3 unvetoed events as alphas
 - Alpha rejection >80% at 90% confidence level
 - Consistent with >99% alpha rejection

New Dark Matter Limits



New Dark Matter Limits



Onward and Downward

- Competitive to world-leading SD limits with 4kg chamber at shallow site at Fermilab
- Successful alpha discrimination has potential to yield zero background experiment
- Moving 4kg chamber to deep site at Snolab this summer
- Beginning engineering run of 60kg chamber Fermilab shallow site (to be followed by a run at the Snolab deep site)

