

# Low Energy WIMP Search Results from CDMS

Lauren Hsu

Fermilab

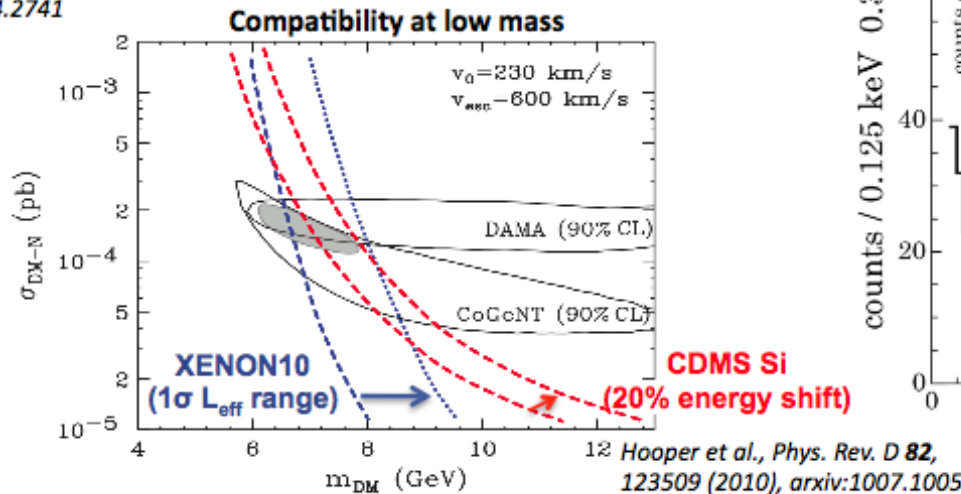
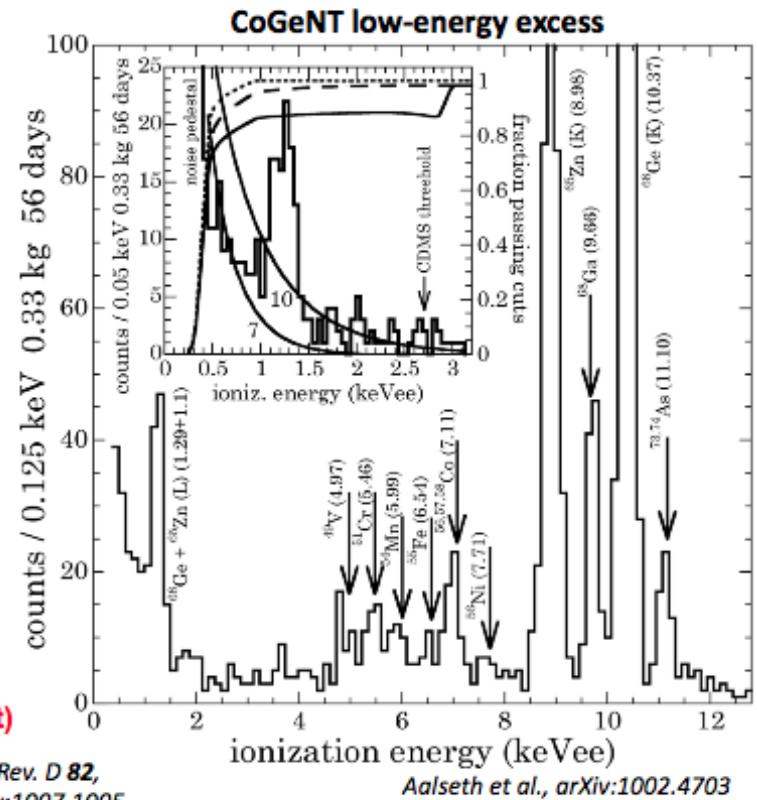
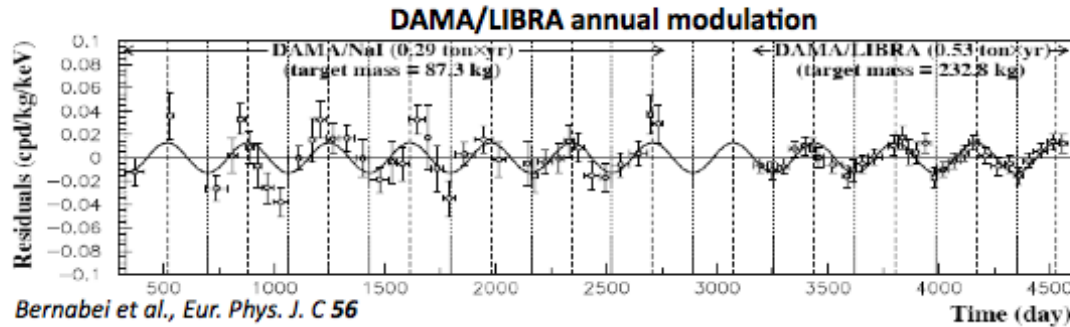
for

the CDMS Collaboration

*Slide material contributed by David Moore*

# Low Mass WIMPs

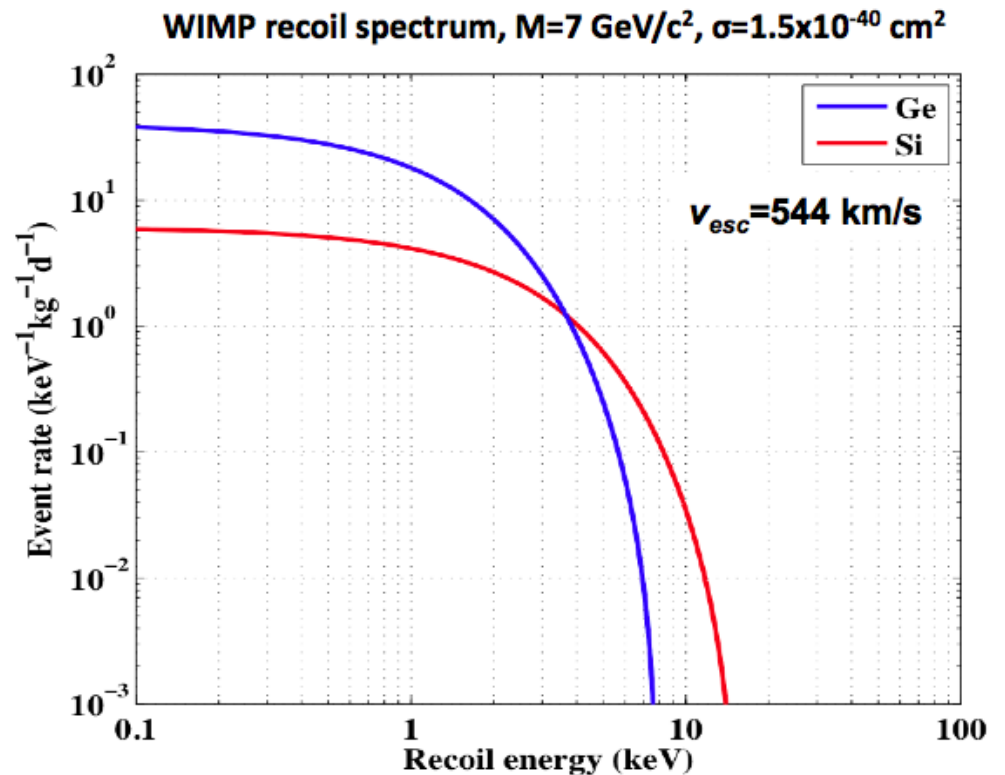
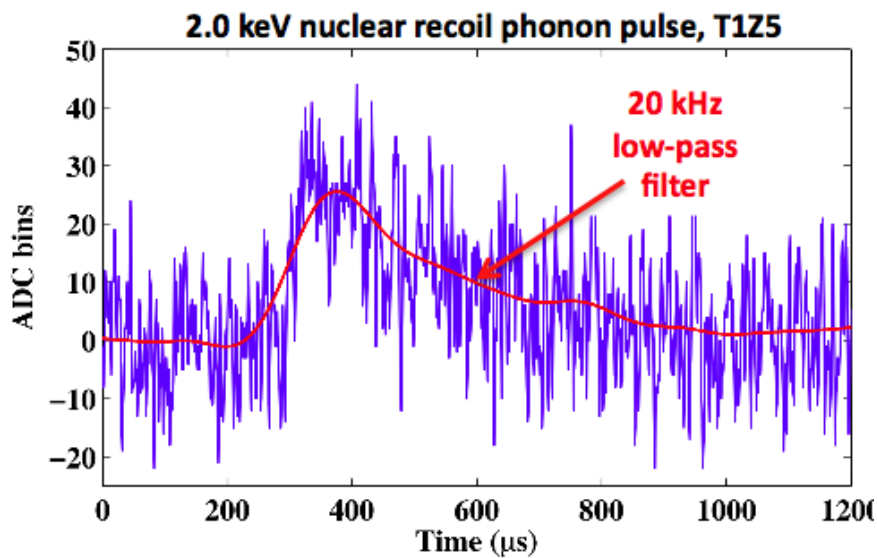
- Results from DAMA/LIBRA, CoGeNT, and others have been interpreted as evidence for elastic scatters from light WIMPs



- Possibly compatible with null results from CDMS Si and XENON due to calibration uncertainties at low energy

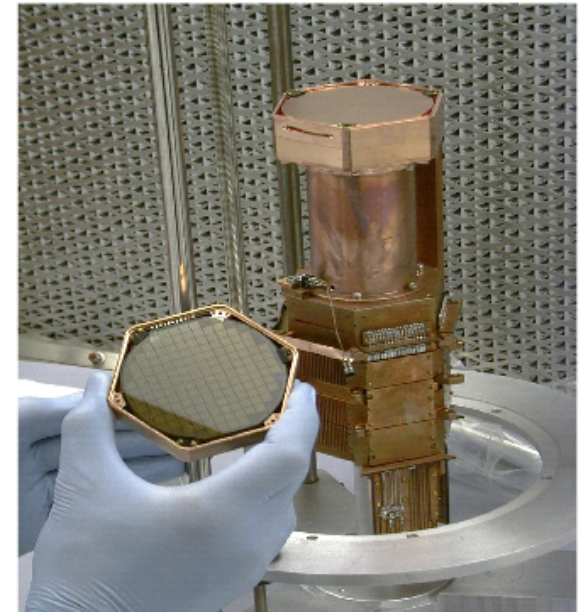
# Lowering the CDMS Threshold

- Lowering analysis threshold below 10 keV yields sensitivity to low mass WIMPs in region of contention.
- The cost = sacrifice some background rejection due to worsening timing resolution. Accept  $> 1$  event background.



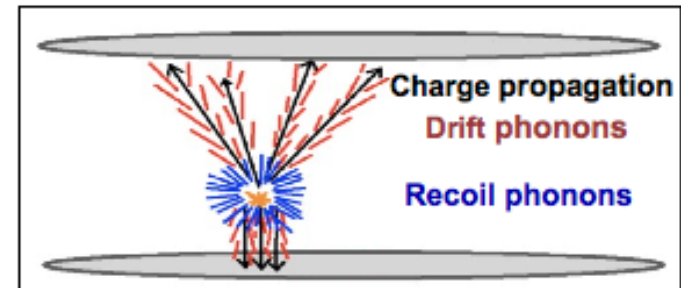
# Low Threshold Dataset

- Soudan data from Oct. 2006-Sept. 2008 reanalyzed with 2 keV recoil energy threshold
- Used 8 Ge detectors with lowest trigger thresholds (1.5-2.5 keV)
- Small subset (1/4 of the data) used to study backgrounds at low energy
  - Limits calculated from remaining 241 kg-day raw exposure
  - Results driven by detector with best resolution (T1Z5)
- Measure both ionization and phonons to discriminate against low-energy electron recoil backgrounds

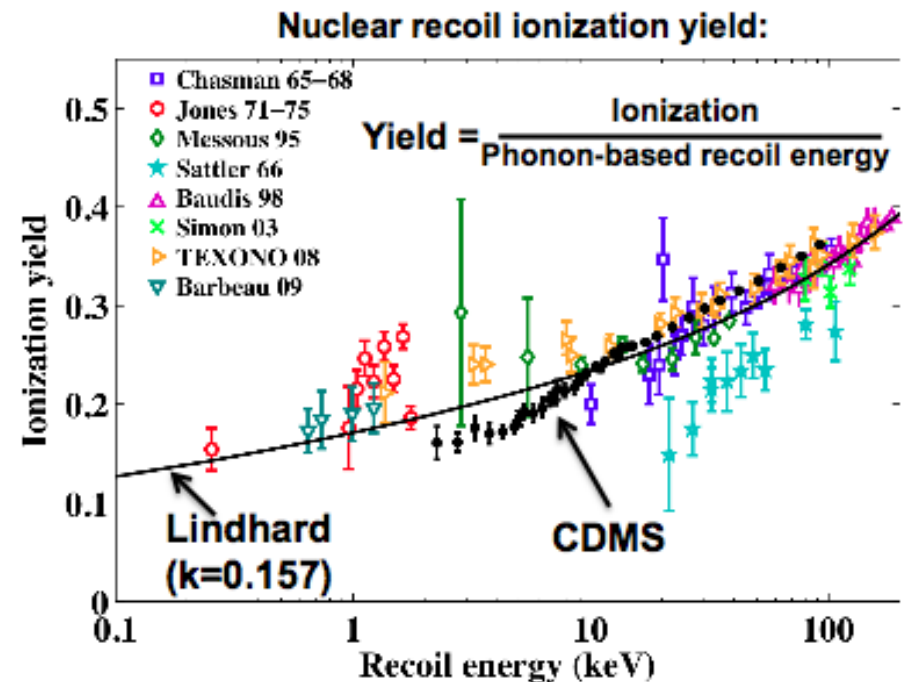
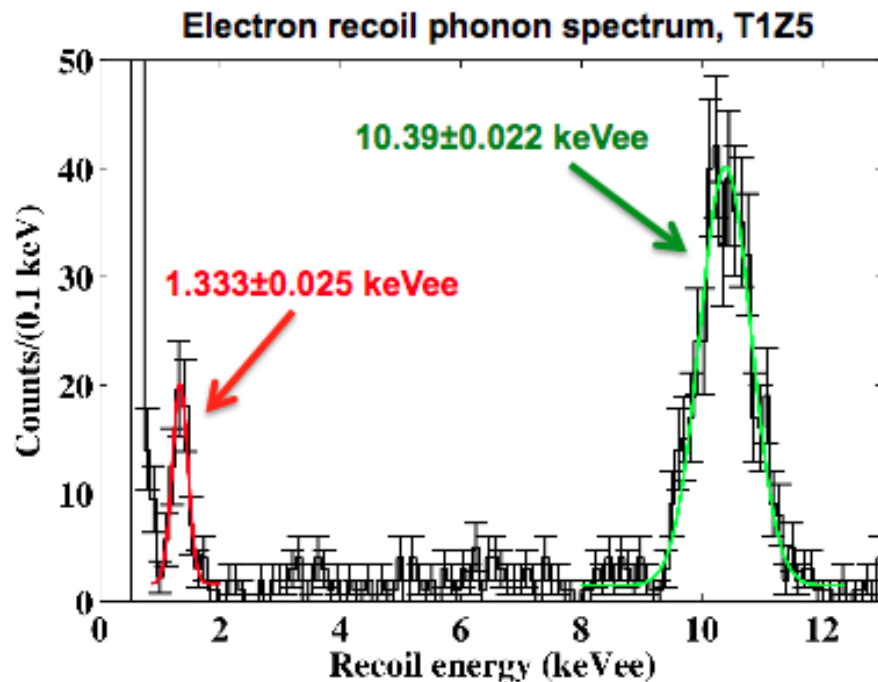


# Energy Calibration

- Phonon energy scale calibrated with electron recoil lines at 1.3 keV and 10.37 keV
- Nuclear recoil energy reconstructed from phonon signal alone after subtracting Neganov-Luke phonons (~15% of signal)

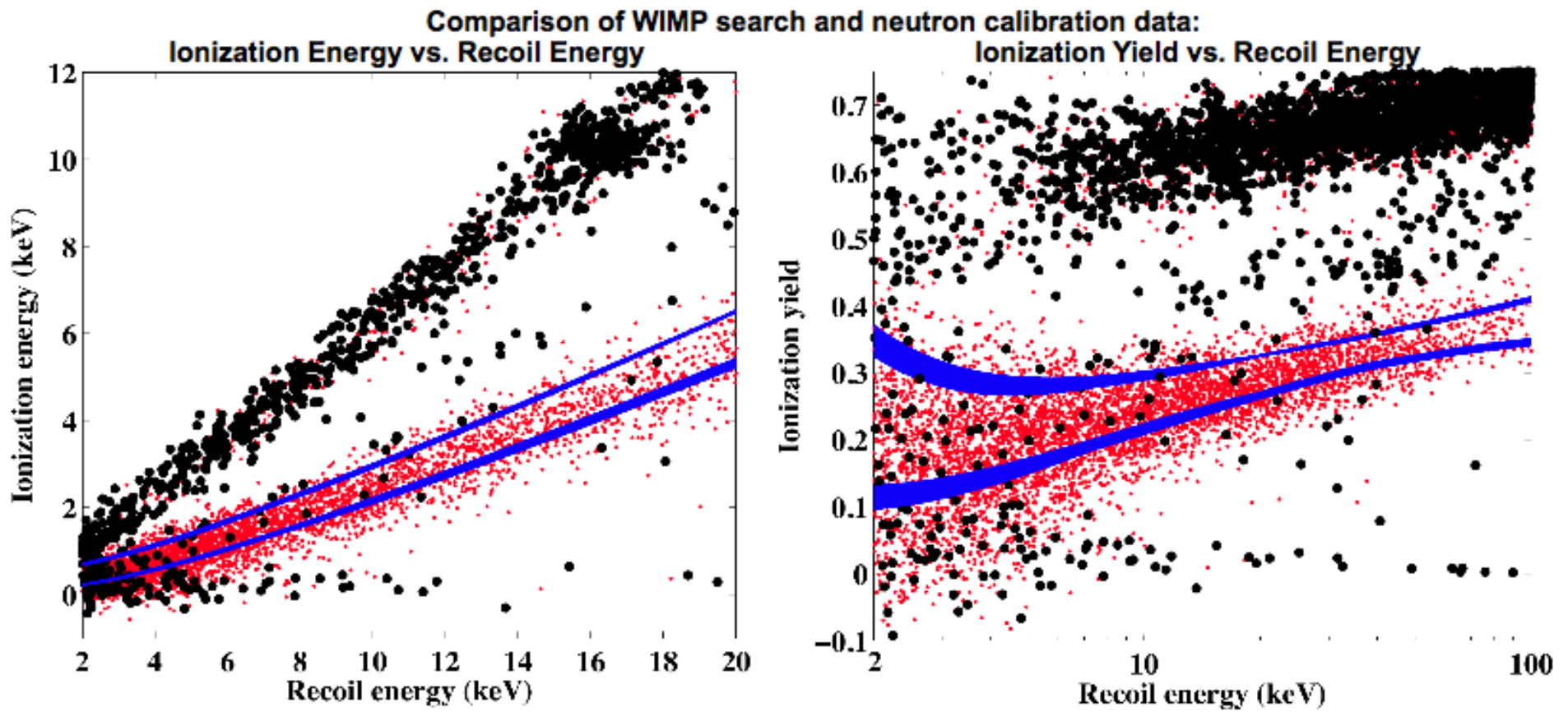


Neganov and Trofimov, *Otkryt. Izobret.*, **146**, 215 (1985)  
Luke, *J. Appl. Phys.*, **64**, 6858 (1988)



# Candidate Events

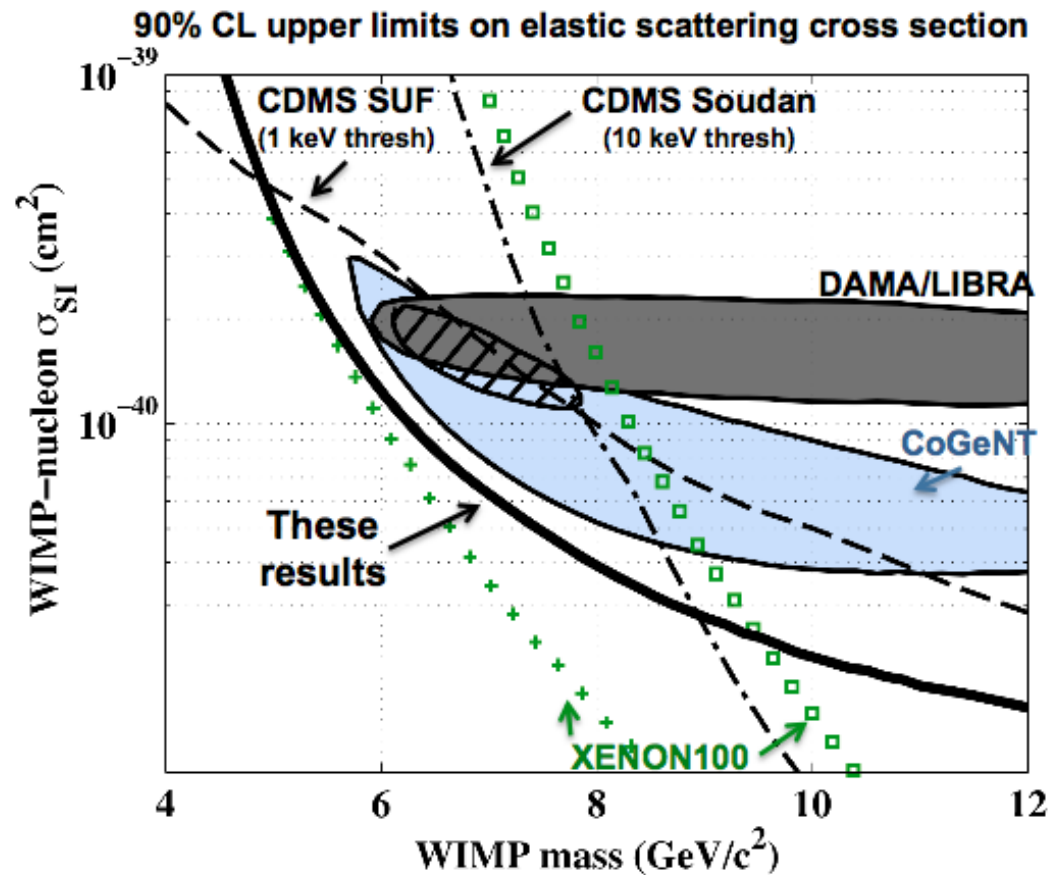
- Nuclear recoil acceptance region defined as  $(+1.25, -0.5)\sigma$  band in ionization energy
  - Maximizes sensitivity to nuclear recoils while minimizing expected backgrounds



# 90% C.L. Limits

- Conservatively assume all candidates could be from WIMPs
  - No background subtraction!
- Limits set using optimum interval method:

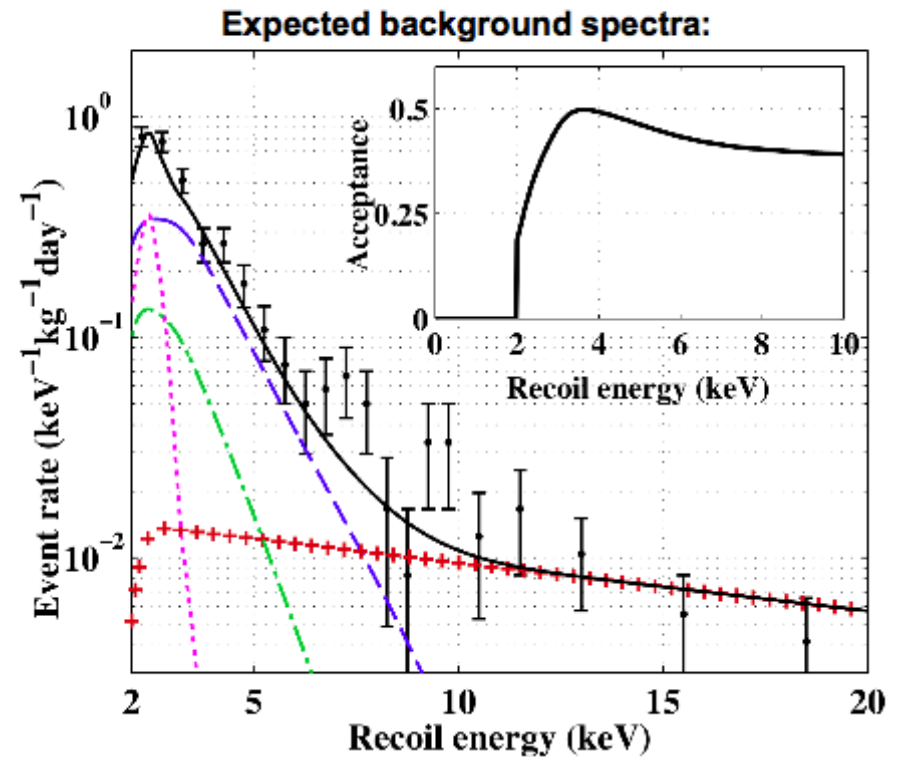
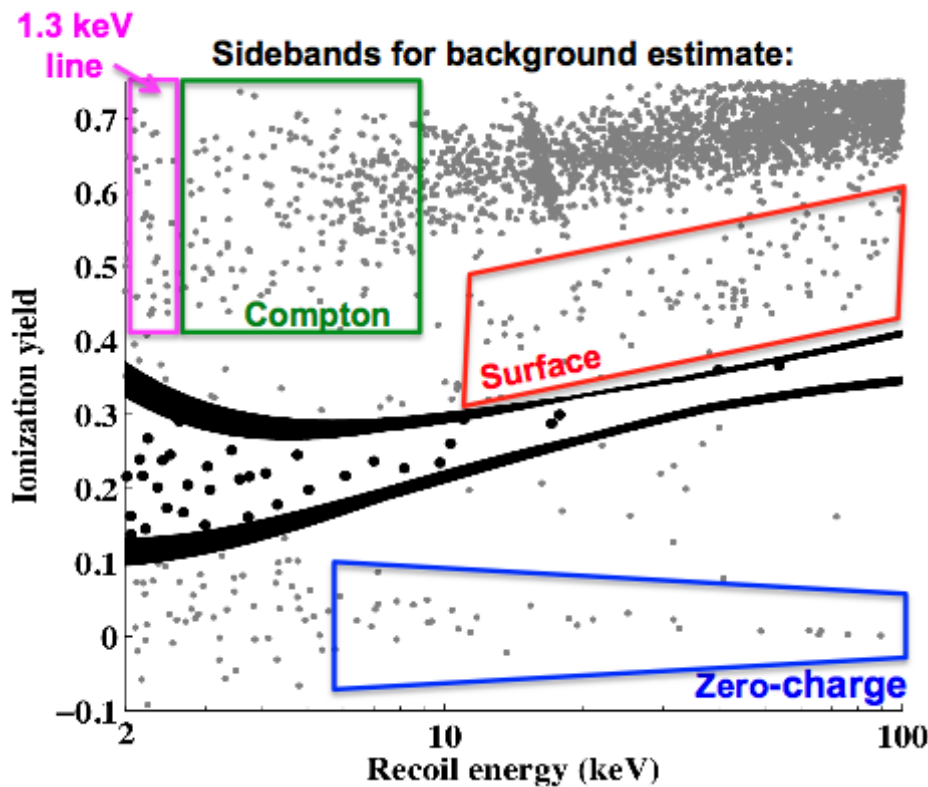
*S. Yellin, PRD, 66, 032005 (2002);  
arXiv:0709.2701v1 (2007)*
- Energy intervals ordered by detector
- For spin-independent, elastic scattering, 90% CL limits incompatible with DAMA/LIBRA and CoGeNT



*Ahmed et al., arXiv:1011.2482 (2010)*  
*Akerib et al., PRD 82, 122004 (2010), arXiv:1010.4290*

# Background Composition

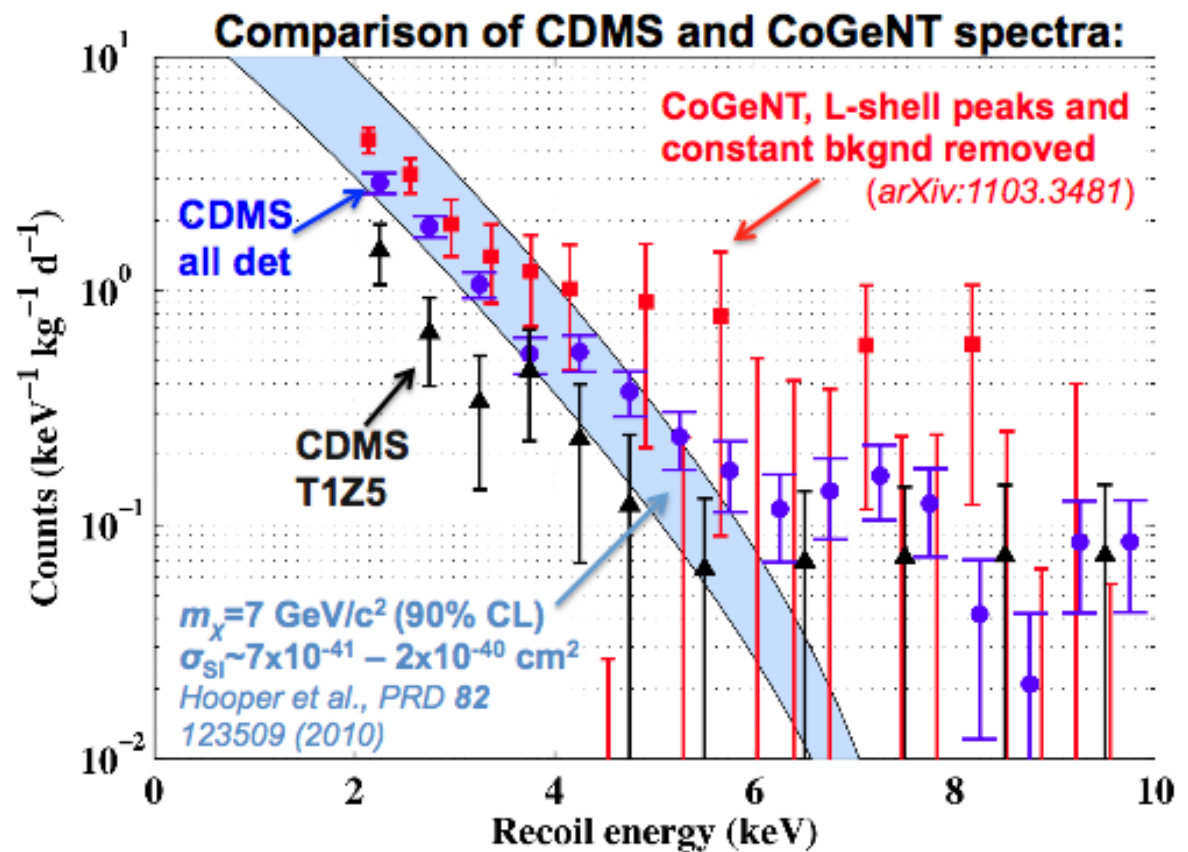
- Observed candidates can plausibly be explained by extrapolations of background estimates from sidebands
  - Possibly significant systematic errors due to extrapolations to low energy
- We do not subtract these backgrounds when setting limits





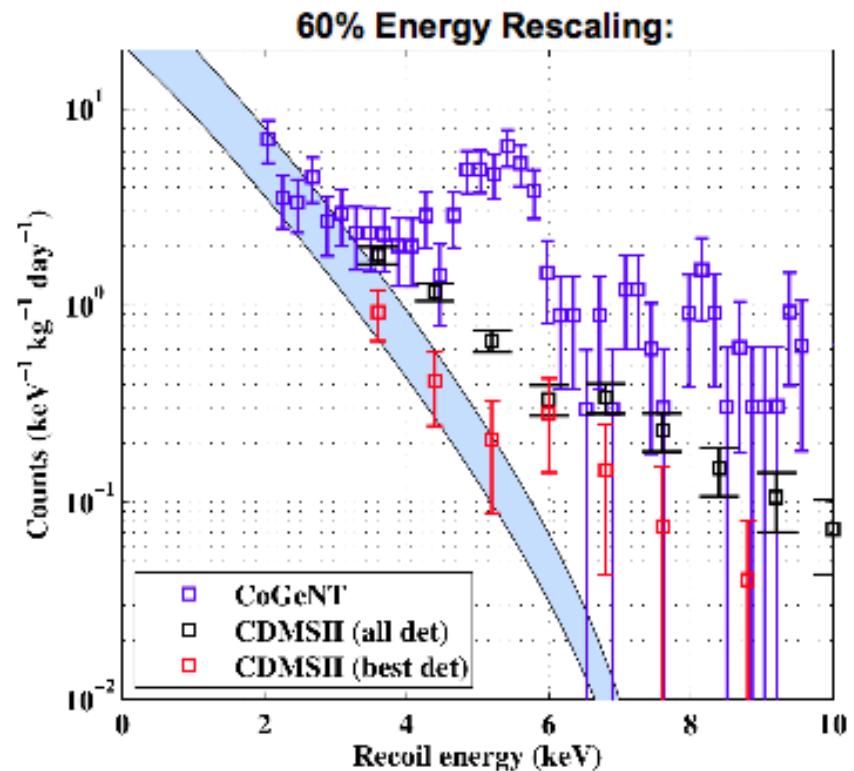
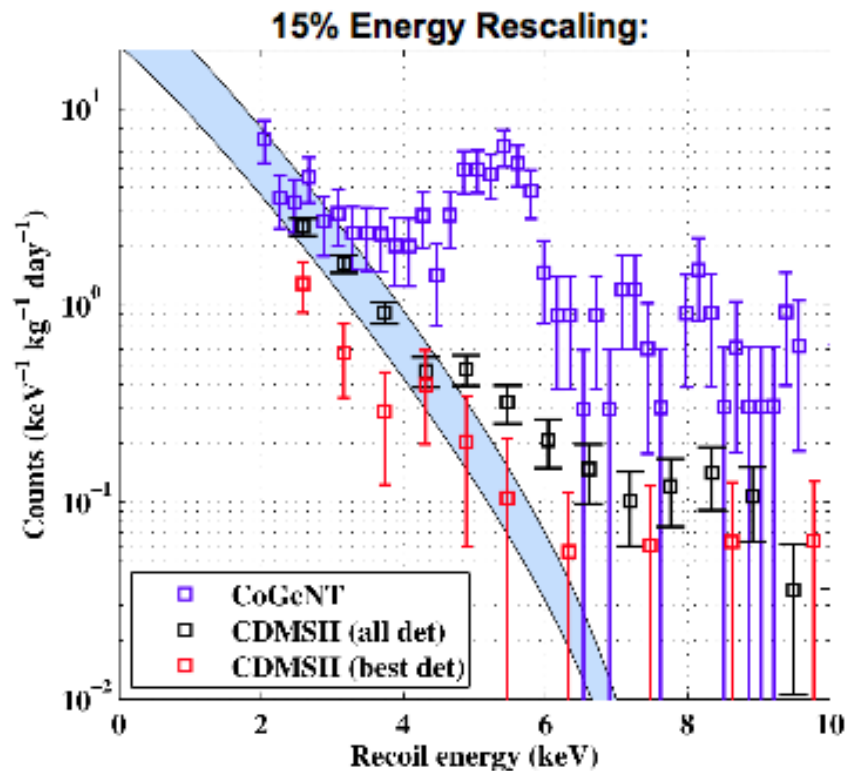
# Comparison to CoGeNT Data

- We can directly compare the rates for CDMSII and CoGeNT since they use the same target material
- Both experiments see an exponential spectrum above threshold
- Rate in T1Z5 inconsistent with CoGeNT excess (unless majority of excess not due to WIMPs)
- No background subtraction for CDMS



# Naive Energy Rescaling

- The CDMS energy scale would need to be off by 15% for the coadded data, or 60% for the best detector for good agreement with CoGeNT (7 GeV/c<sup>2</sup> WIMP)
  - Lower bounds since no background subtraction!
- Energy scale already assumes most conservative values consistent with 1.3 keV electron-recoil activation line at 90% CL



# Summary

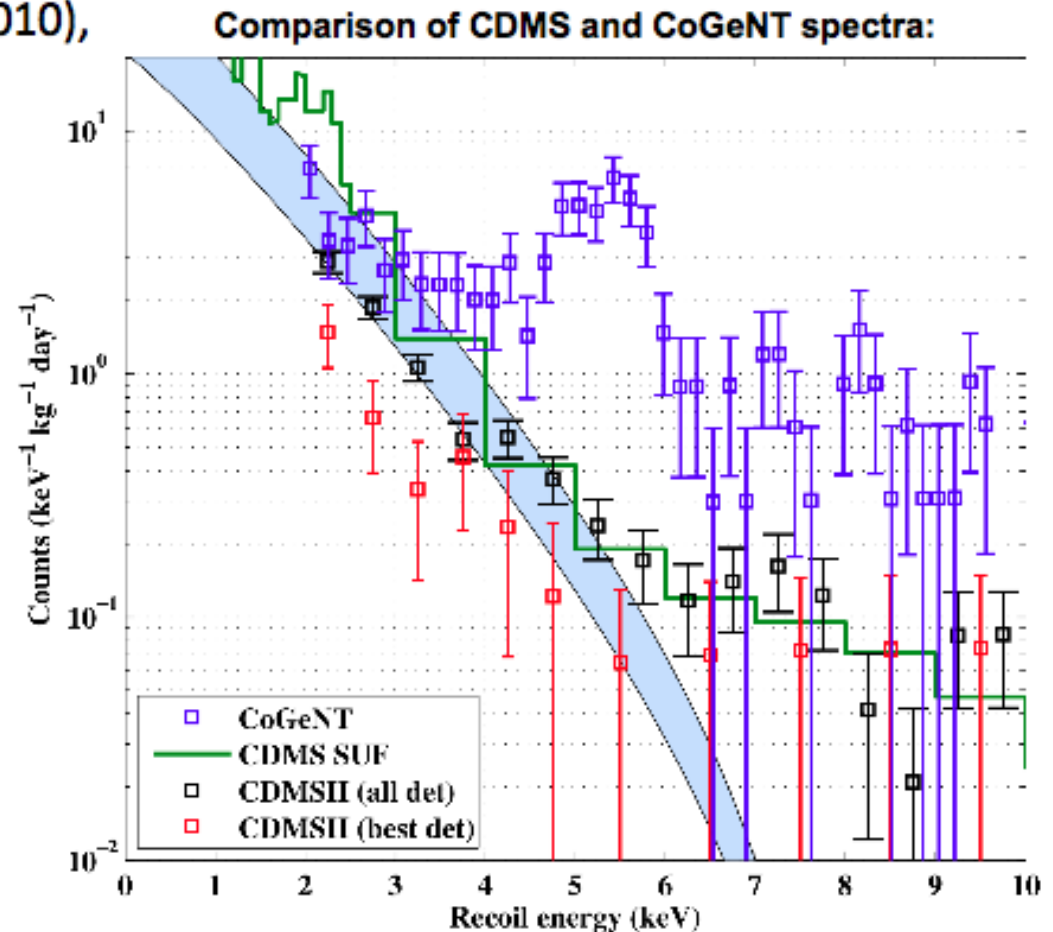
- Presented analysis of CDMSII data with threshold lowered from *10 to 2 keV*
- Backgrounds present in this analysis have been characterized. *No excess events over expected background were observed*
- Despite *no background subtraction*, observed rate of events is incompatible with interpretation of CoGeNT and DAMA data as evidence for spin-independent elastic scattering of WIMPs
- Compatibility between CDMS and CoGeNT data requires majority of CoGeNT excess to be due to background and unexpectedly small CDMS background

# Shallow Site Comparison

- A similar analysis of CDMS SUF (shallow-site) data with a 1 keV threshold has recently been published:

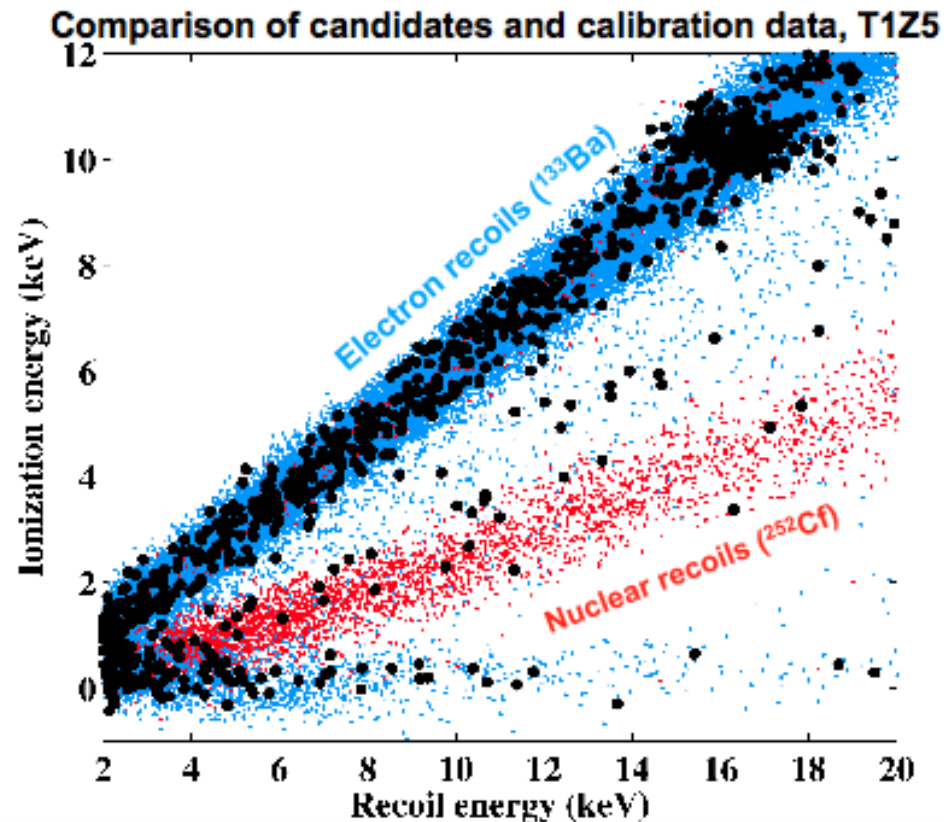
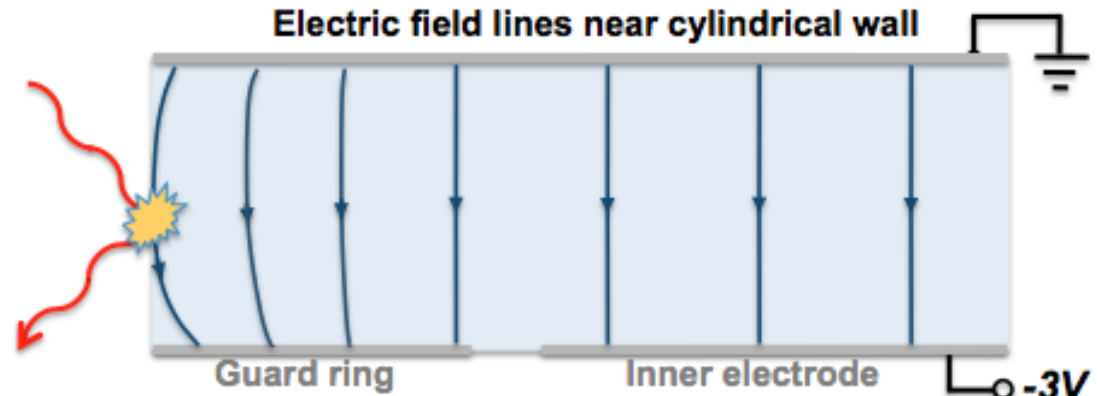
*Akerib et al., PRD 82, 122004 (2010),  
arXiv:1010.4290*

- Spectra agree well at high energies
- At low energies, the CDMS Soudan spectrum is a factor of a few lower than CDMS SUF
- Primary differences are nuclear-recoil band cut and less activation of 1.3 keV line



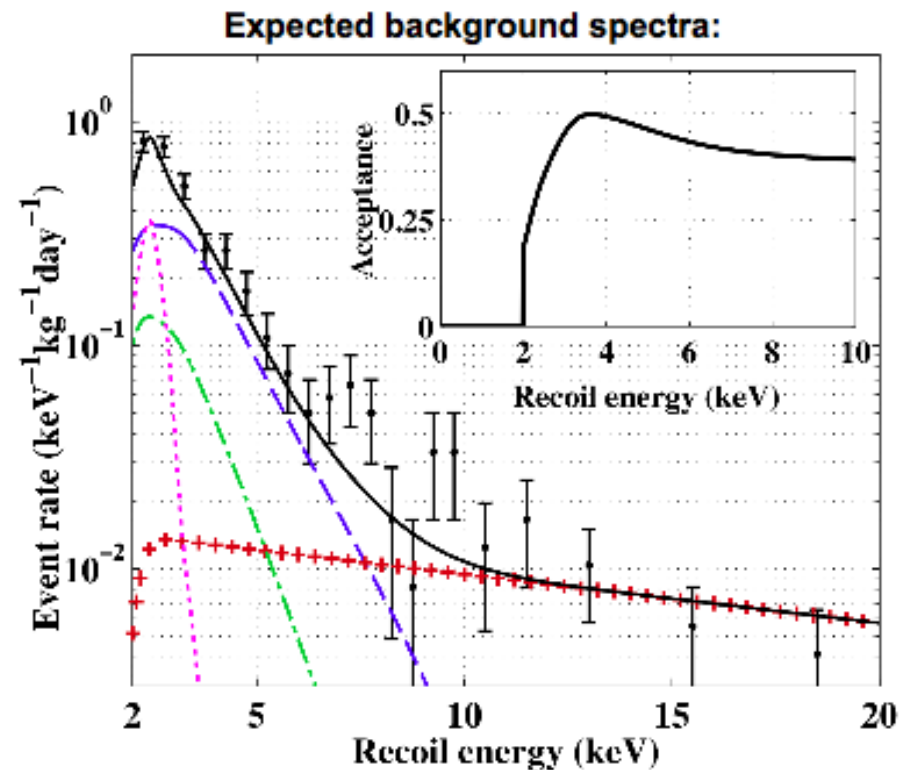
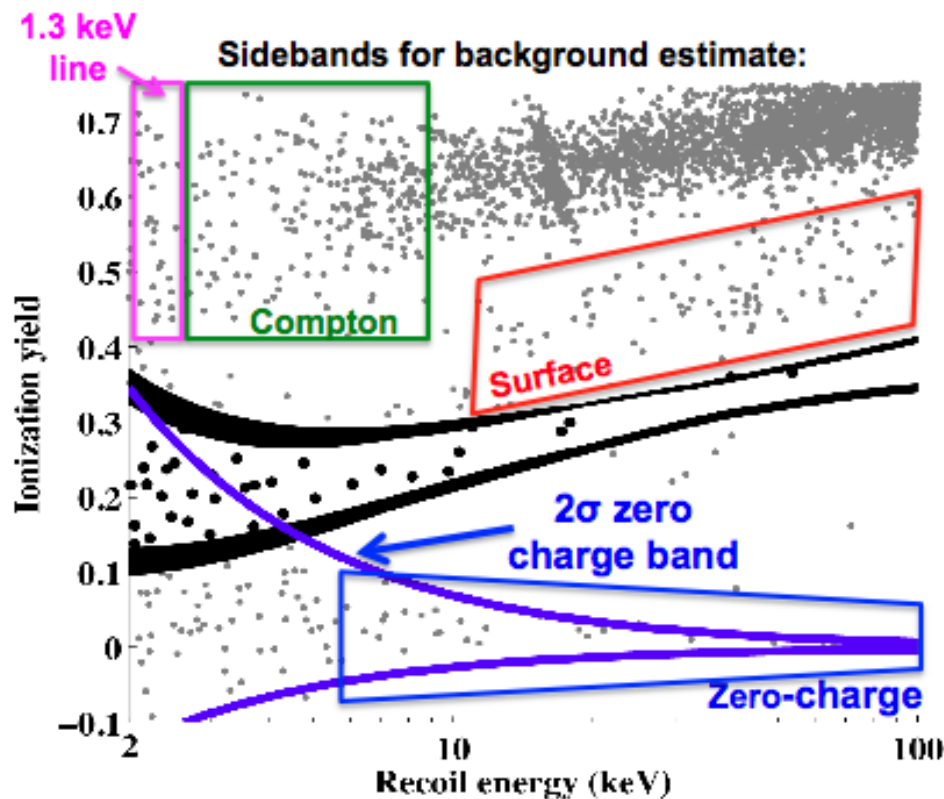
# Zero Charge Events

- Dominant expected background below 10 keV
- Zero-charge events scale with electron-recoil rate, not exposure
- Consistent with electron recoils where charge is collected on cylindrical surfaces
- Pass fiducial volume selection since guard electrode signal consistent with noise
- Exponential spectrum above  $\sim 5$  keV extrapolated to lower energies



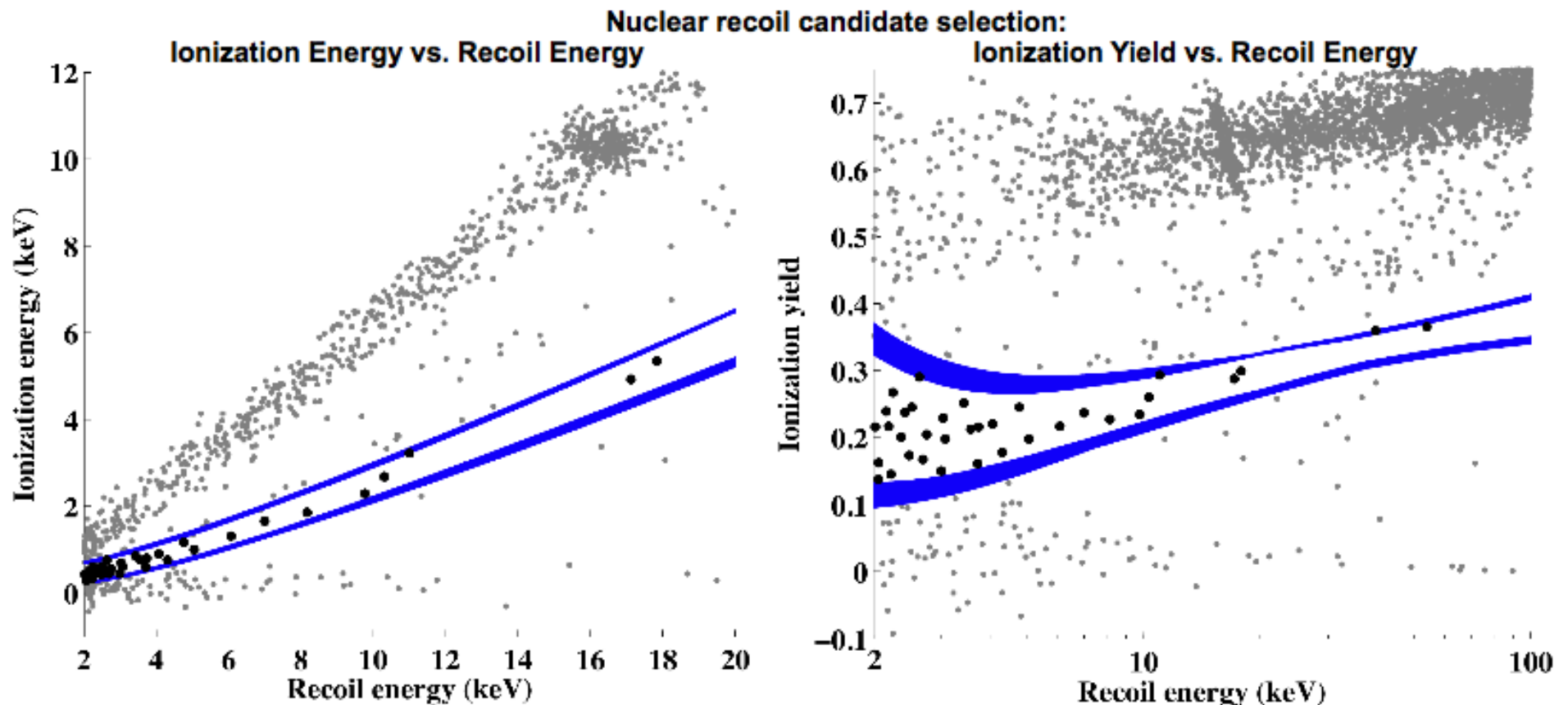
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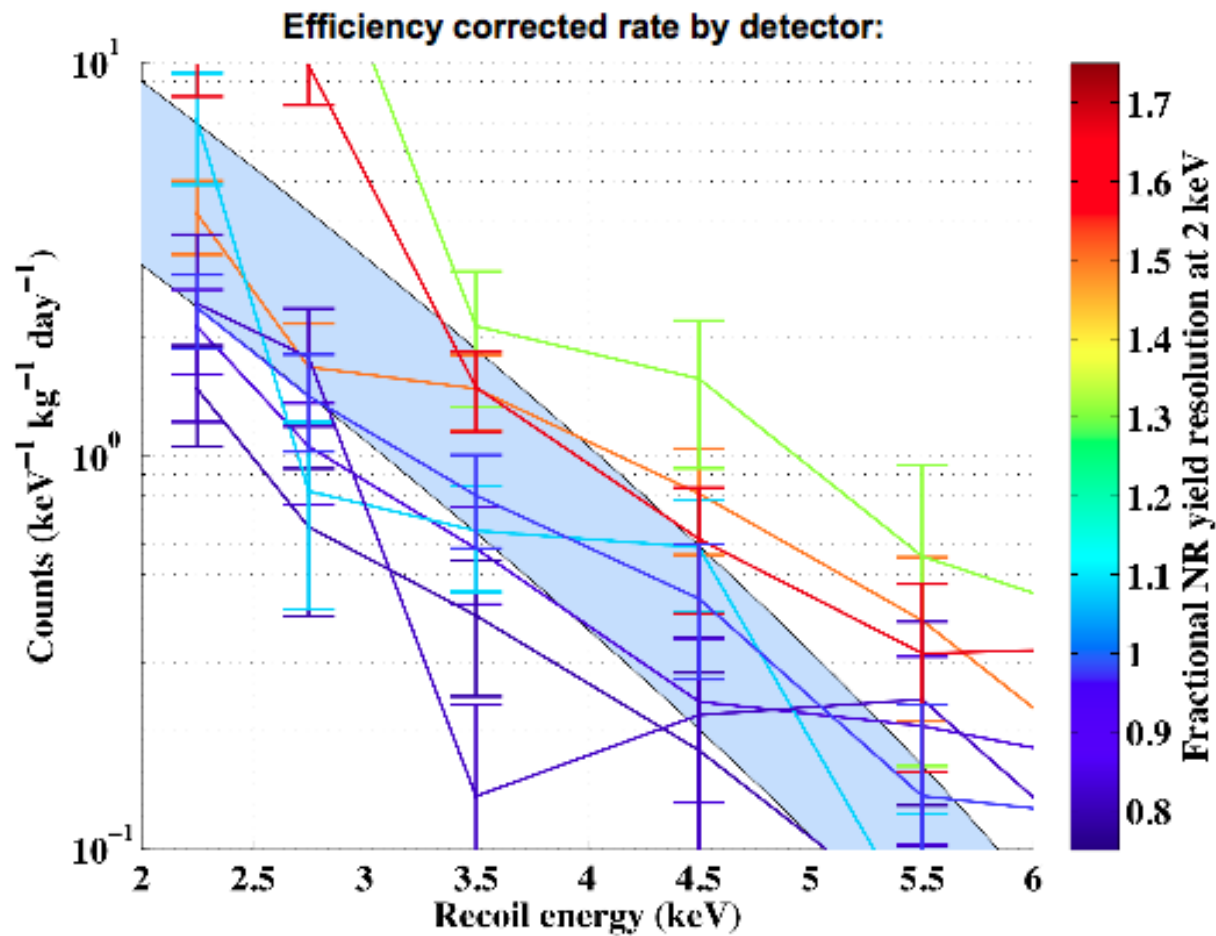
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# Rate by Detector

- Variations in observed rate by detector correlated with yield resolution





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