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CDMS: The low mass WIMP region

CDMS II Si

- Blind analysis presented at APS
- Compatibility with existing limits

Zero charge events

- CDMS challenge at low mass!
- ≠ Collar and Fields

What next?

- CDMSII, SuperCDMS Soudan
- SNOLAB
- Possibility of combining with Eureca

The SuperCDMS Collaboration

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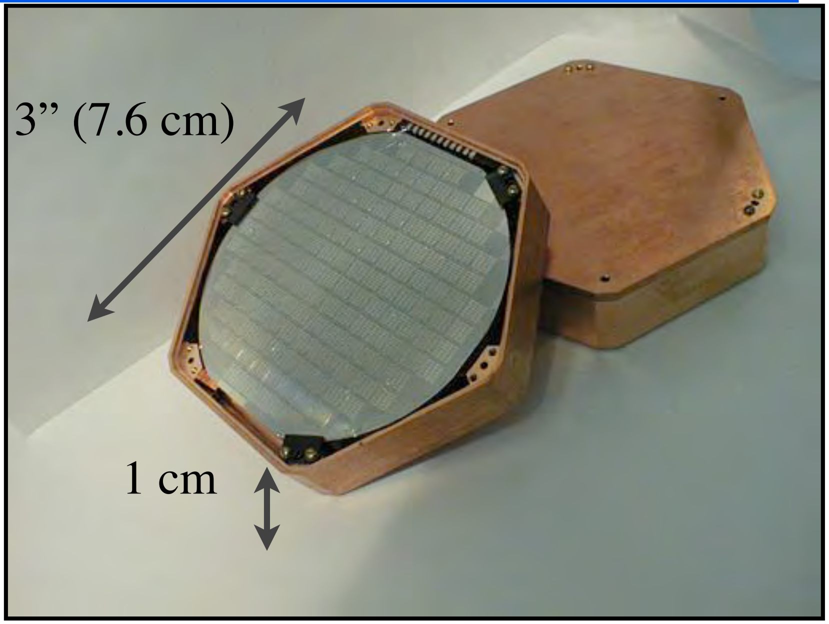
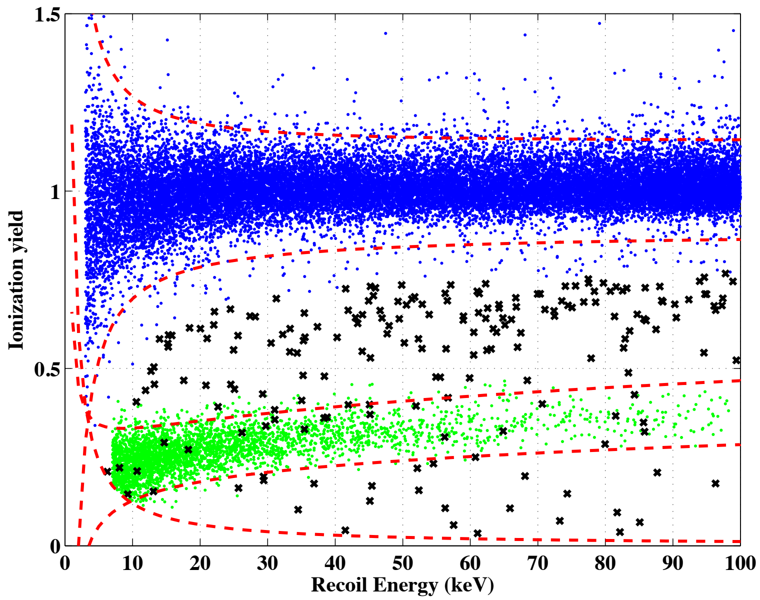
http://cdms.berkeley.edu

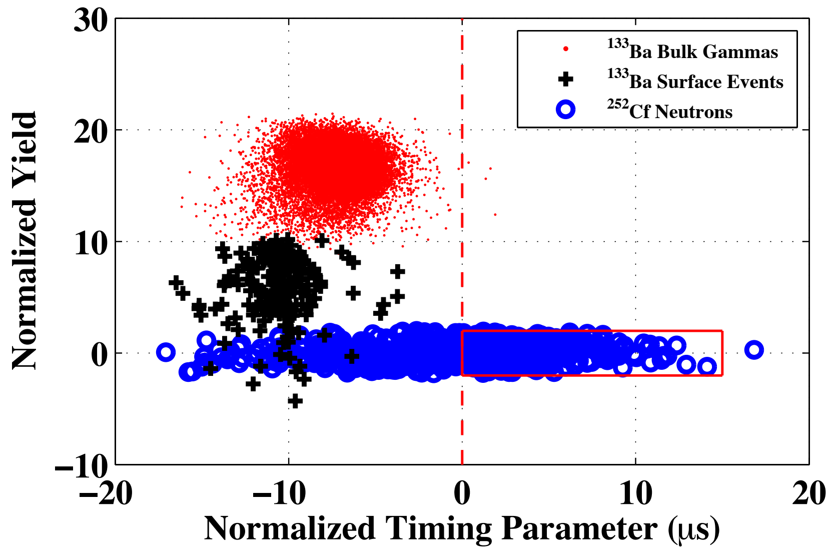
The CDMS-II Experiment

ZIP Detectors

Z-sensitive Ionization and Phonon mediated
230 g Ge or 106 g Si crystals
(1 cm thick, 7.5 cm diameter)
Photolithographically patterned to collect athermal phonons and ionization signals
Direct xy-position imaging
Surface (z) event rejection from pulse shapes and timing (athermal phonons)
30 detectors stacked into
5 towers of 6 detectors



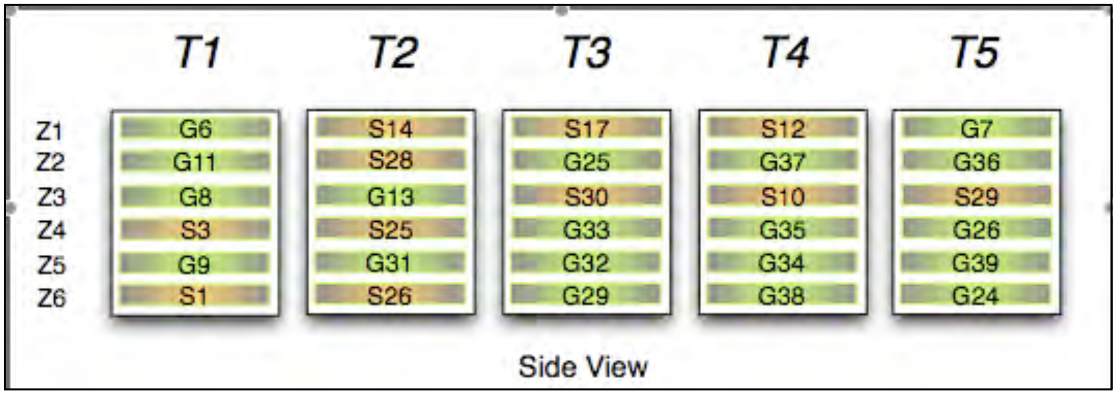




CDMS II Si

Si CDMS-II Exposure

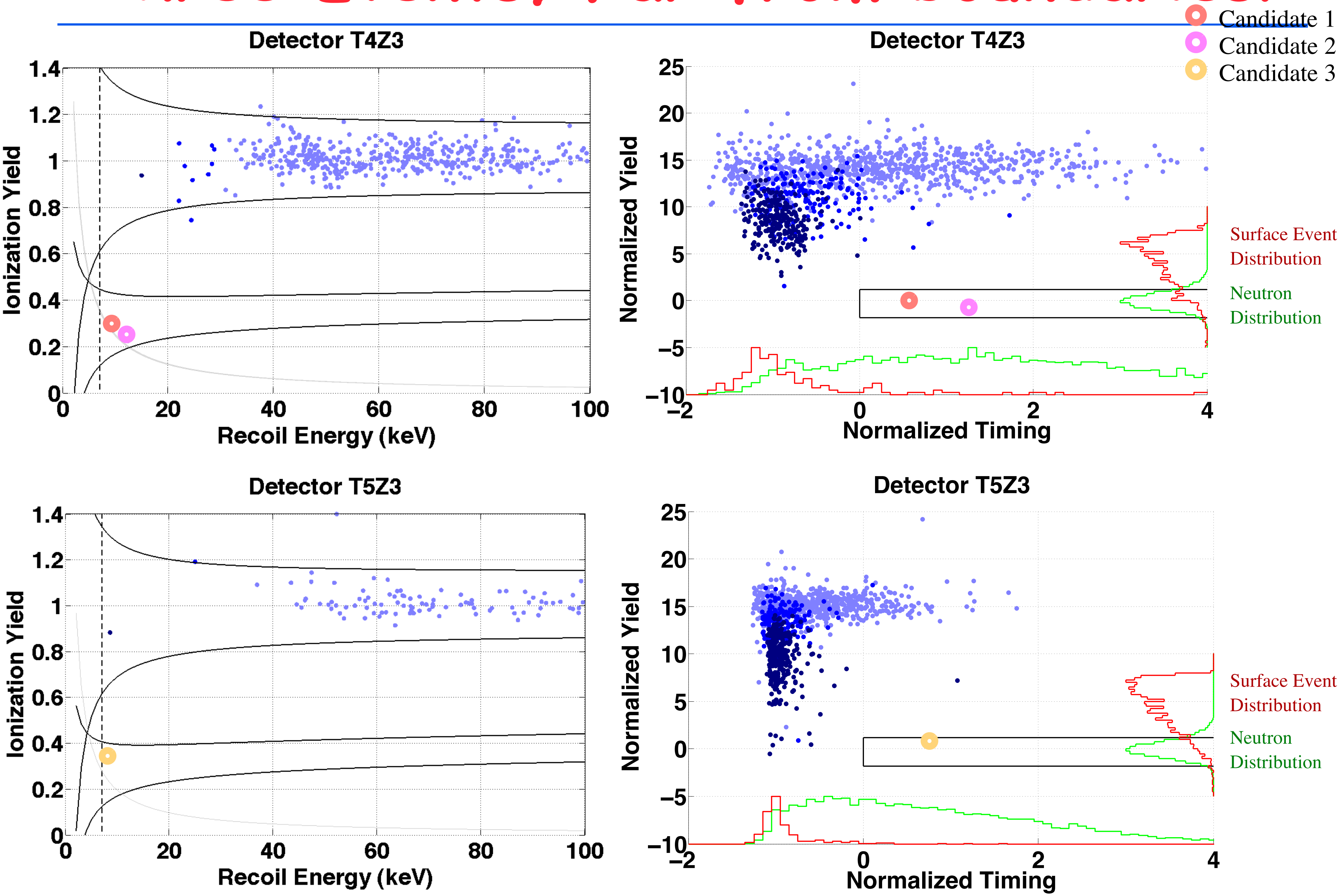
- Oct. 2003 - Aug. 2004
  - 42.7 kg-days in 4 Si detectors
- Oct. 2006 - July 2007
  - 55.9 kg-days in 6 Si detectors
- July 2007 - Sep. 2008
  - 140.23 kg-days in 8 Si detectors



Blind analysis

Mask signal region
Define cuts on calibration events
Determine background beforehand
Make commitment to publish result
Unmask region ("Open the Box")
Validate result
Publish: necessarily limited

Three Events; Far from boundaries!



Profile Likelihood Analysis

Expected background (pre-unblinding)

Neutrons: <0.13

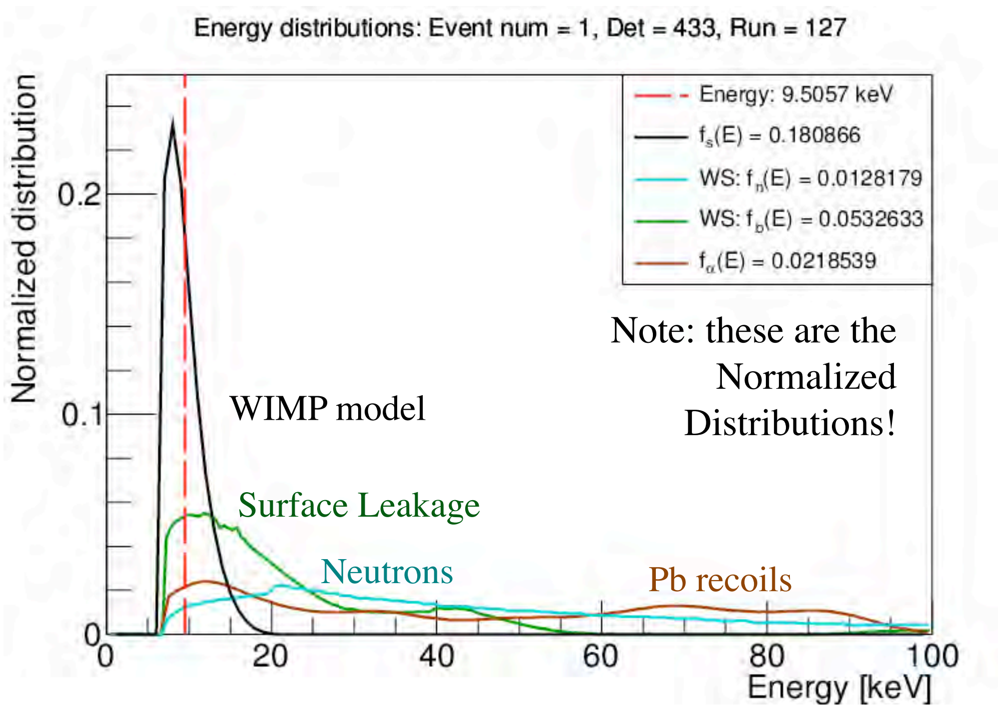
Surface events; $0.41^{+0.20}_{-0.08}(stat.)^{+0.28}_{-0.24}(syst.)$

^{206}Pb from ^{210}Pb:0.08 (post unblining)

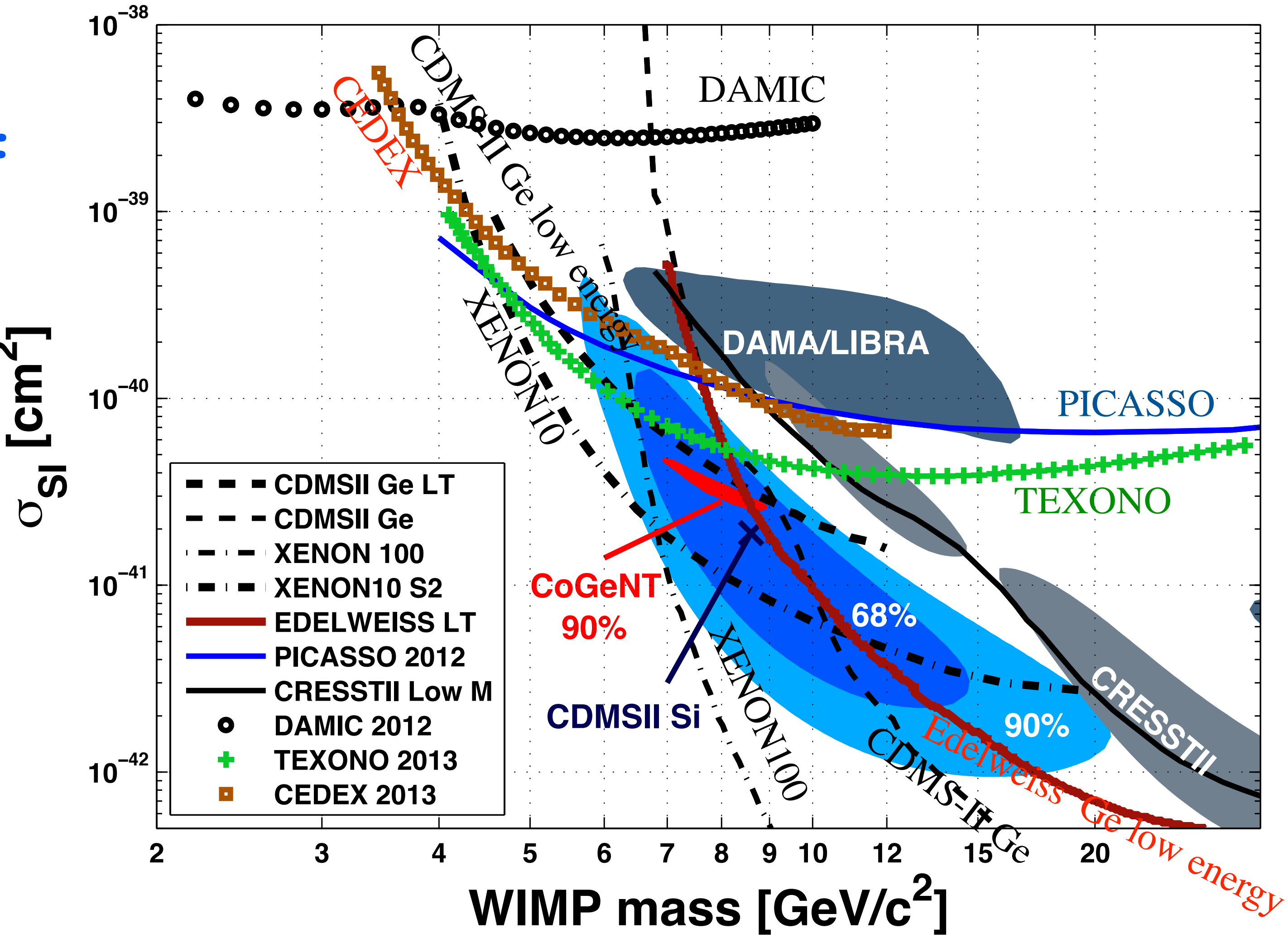
Monte Carlo simulations of the background-only model indicate the probability of a statistical fluctuation producing three or more events anywhere in our signal region is 5.4%.

Have unexpected energy distribution!

A likelihood ratio test with energy only favors a WIMP+background hypothesis over the known background estimate as the source of our signal at the 99.81% confidence level (~3σ).



New result for CDMS on Si APS April 13, 2013



Analysis favors a WIMP region of interest ≈3σ

- Most likely value at 8.6 GeV WIMP mass with 1.9×10^{-41} cm^2 cross section
- Consistent with earlier CDMS Ge and Si limits

Data are insufficient to claim discovery of a WIMP signal, but does warrant further investigation

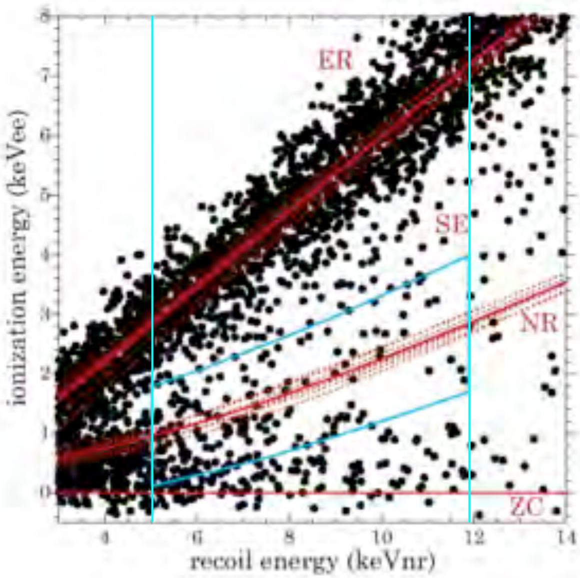
Compatibility with CoGeNT

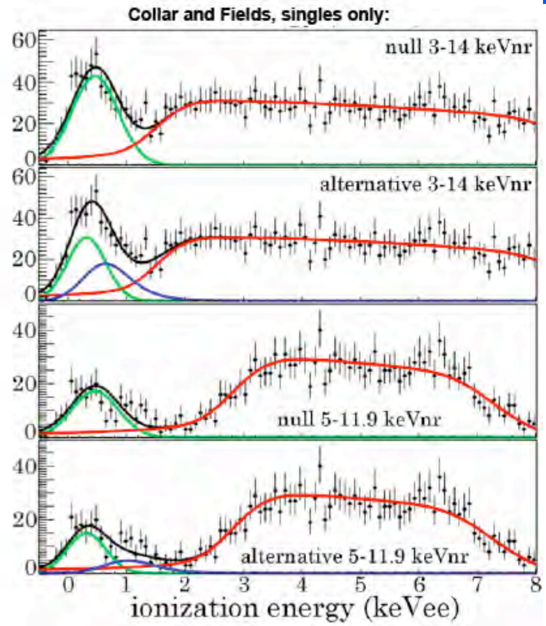
- But how reliable is surface identification?

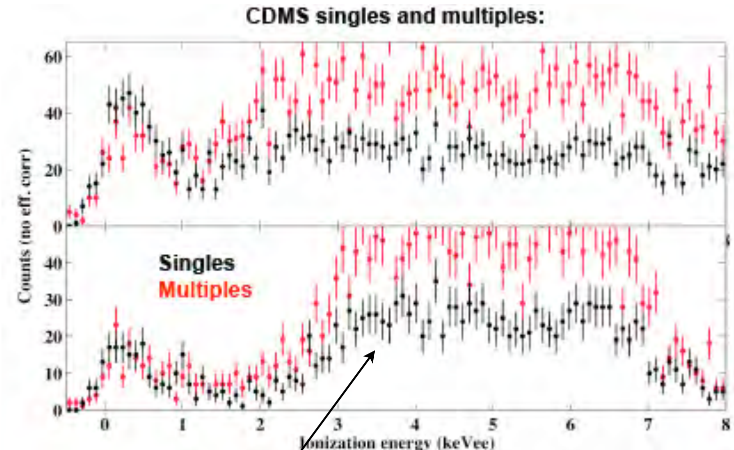
Tension with Xenon

- Xenon 10 erratum
- Xenon 100: Are the two events seen compatible(Hooper)
  - + uncertainty in calibration
- Sensitivity to halo velocity

The CDMSII “Signal” (Collar and Fields)



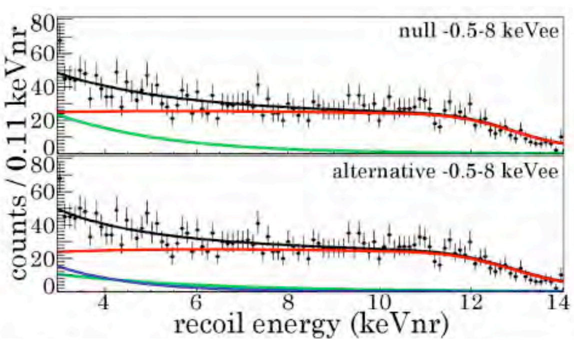


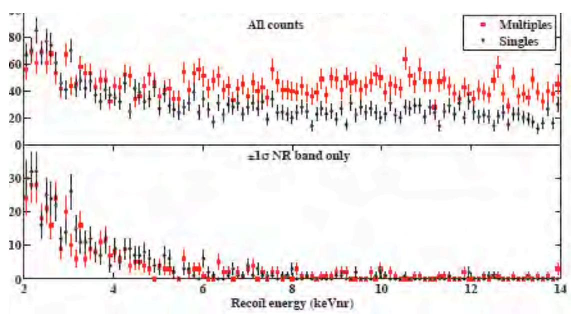


— Zero charge

— e recoils

— Putative signal





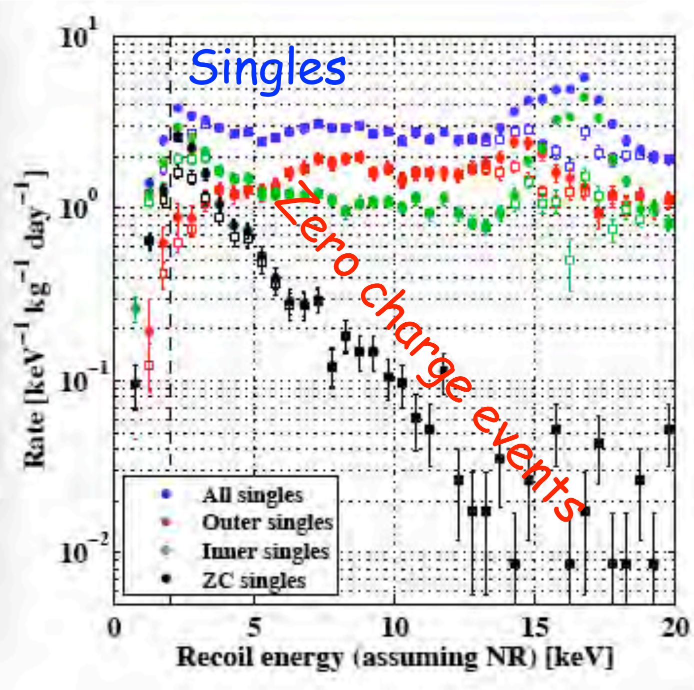
No significant difference between singles and multiples

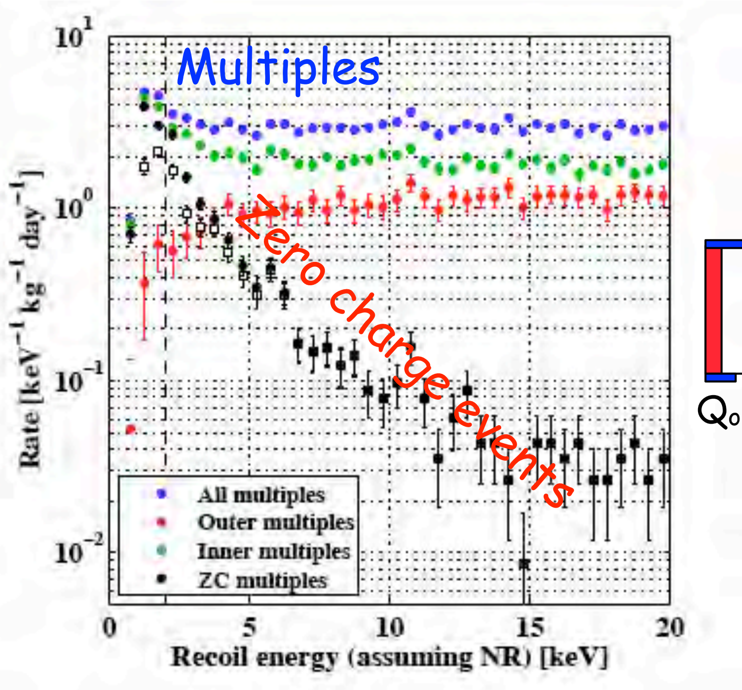
We are doing our own analysis

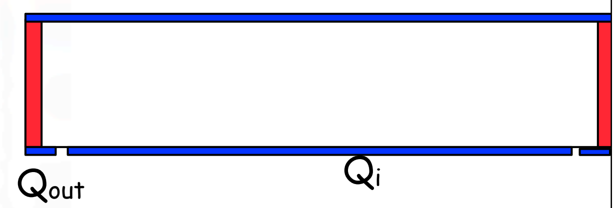
With Collar’s and Fields’ background model we get a signal in both singles and multiples

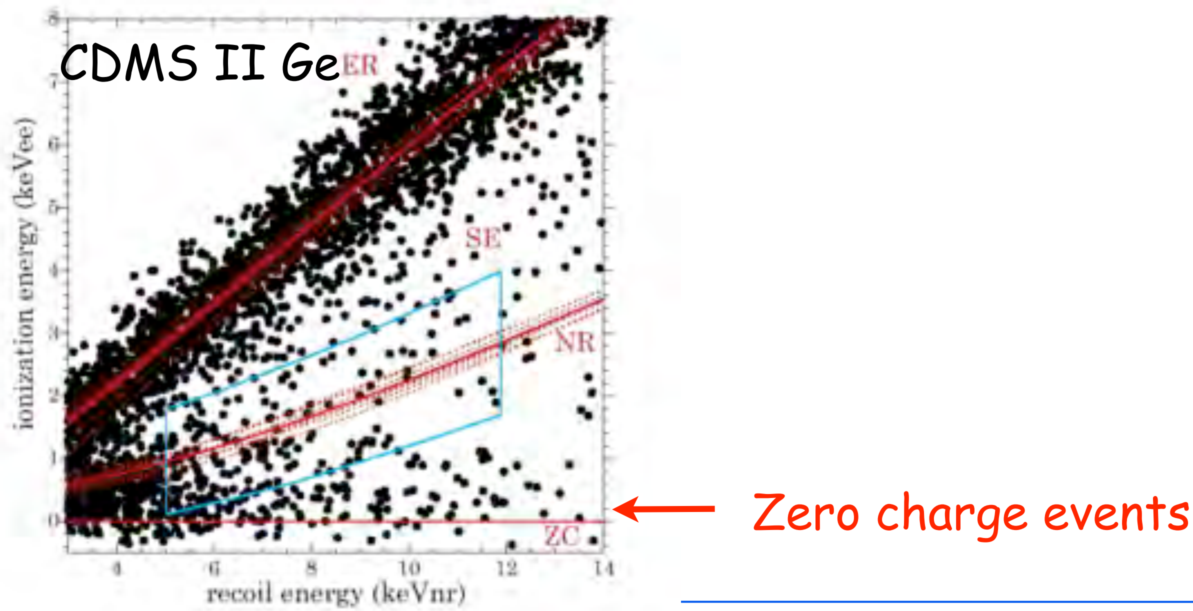
Zero charge events!

Our problem: Zero charge events

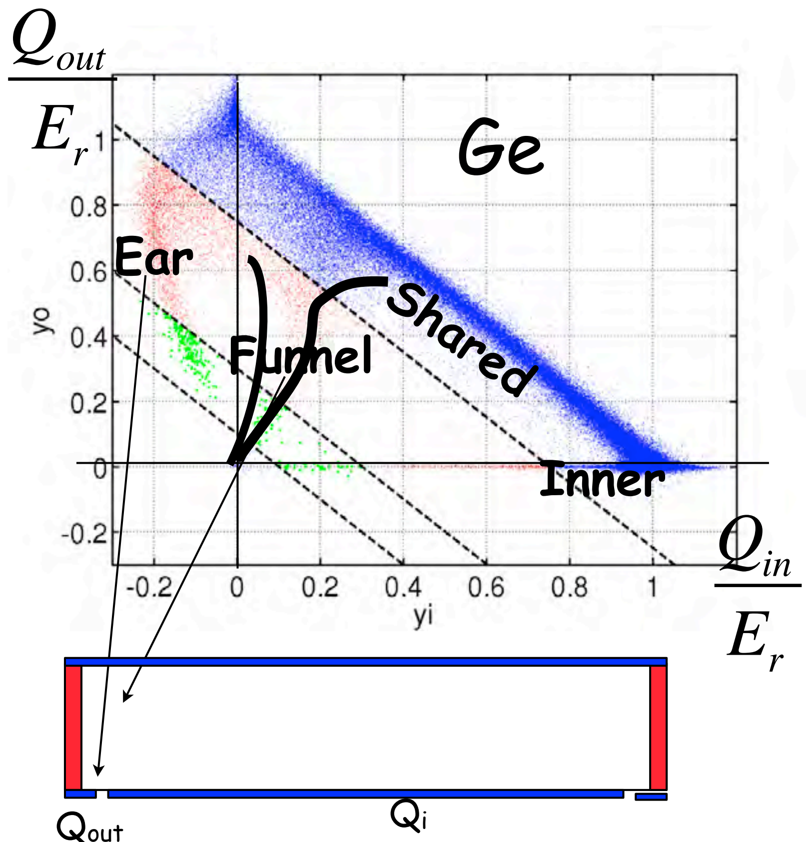


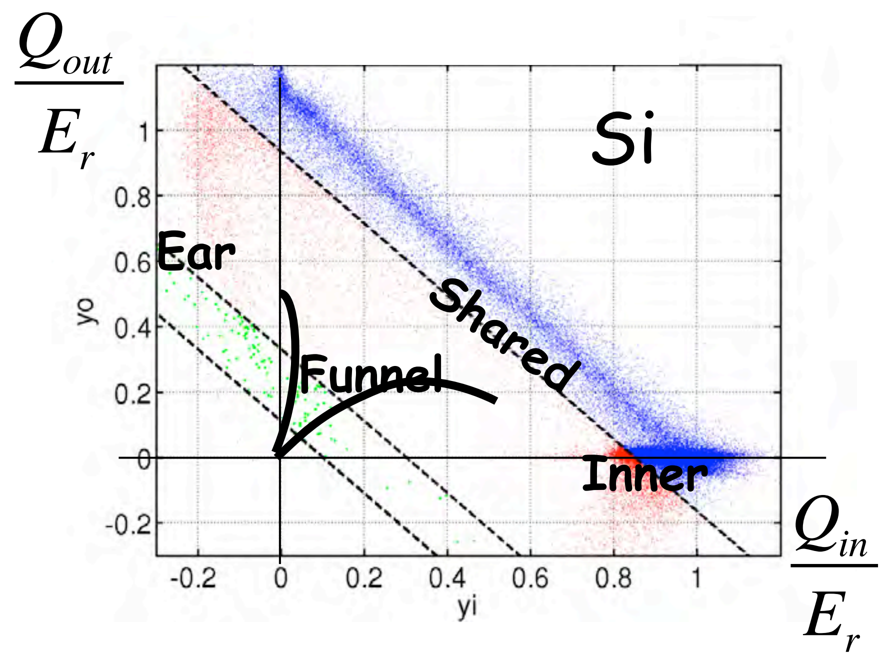






A Possible Origin: Funnels and Ears





Origin of the zero charge events

Bad collection in outer part of detector near cylindrical surface

Oblique propagation + charging of surfaces

Our inner cut (Qout>2σ) carves out zero charge events by admitting more ear/funnel at low Er

Compounded by ^{210}Pb from detector enclosure

Electrons from ^{210}Pb	Reduced Yield
^{206}Pb recoil	

What next?

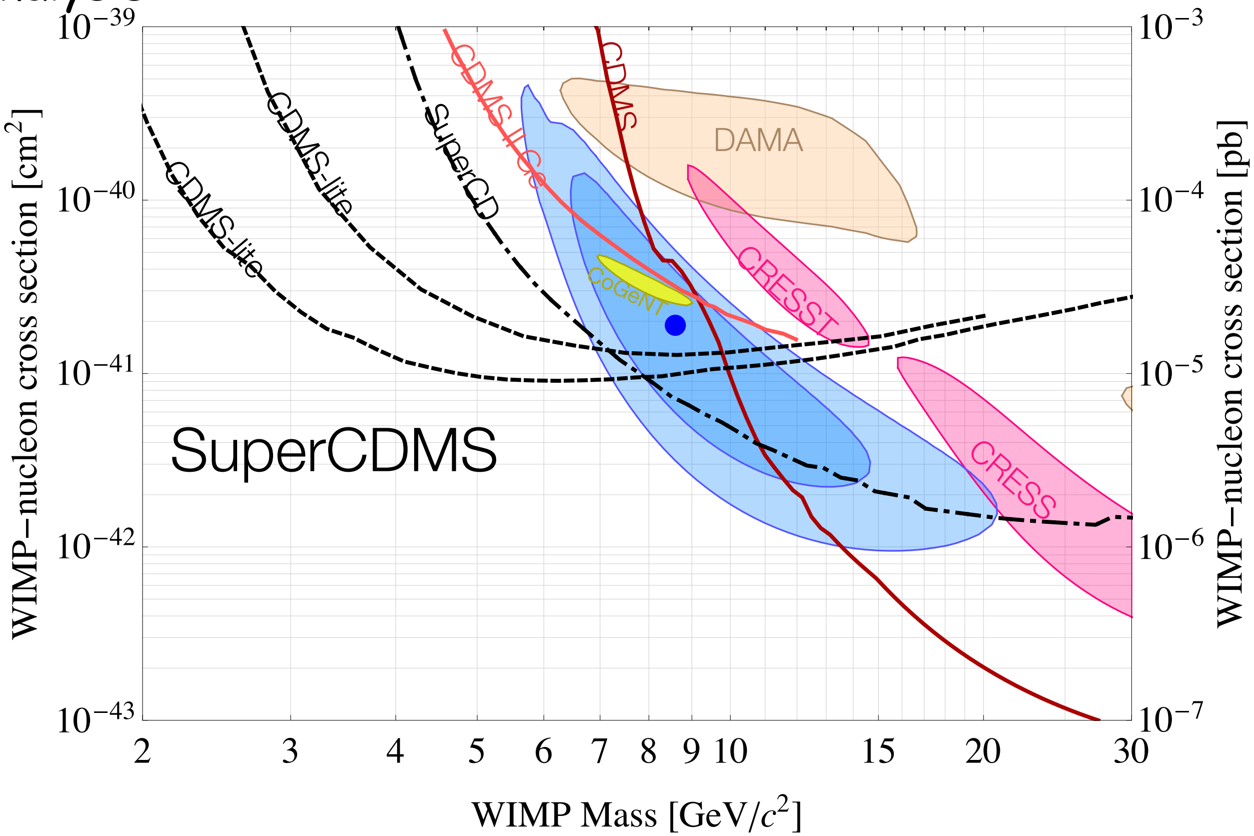
Still to be done with CDMS II

Investigation of possible systematics, unsuspected background
Zero charge events are key!
Low energy Si analysis in same style as Ge
Ge+Si consistent likelihood analysis

SuperCDMS Soudan

CDMS Lite 23eV rms
Low threshold

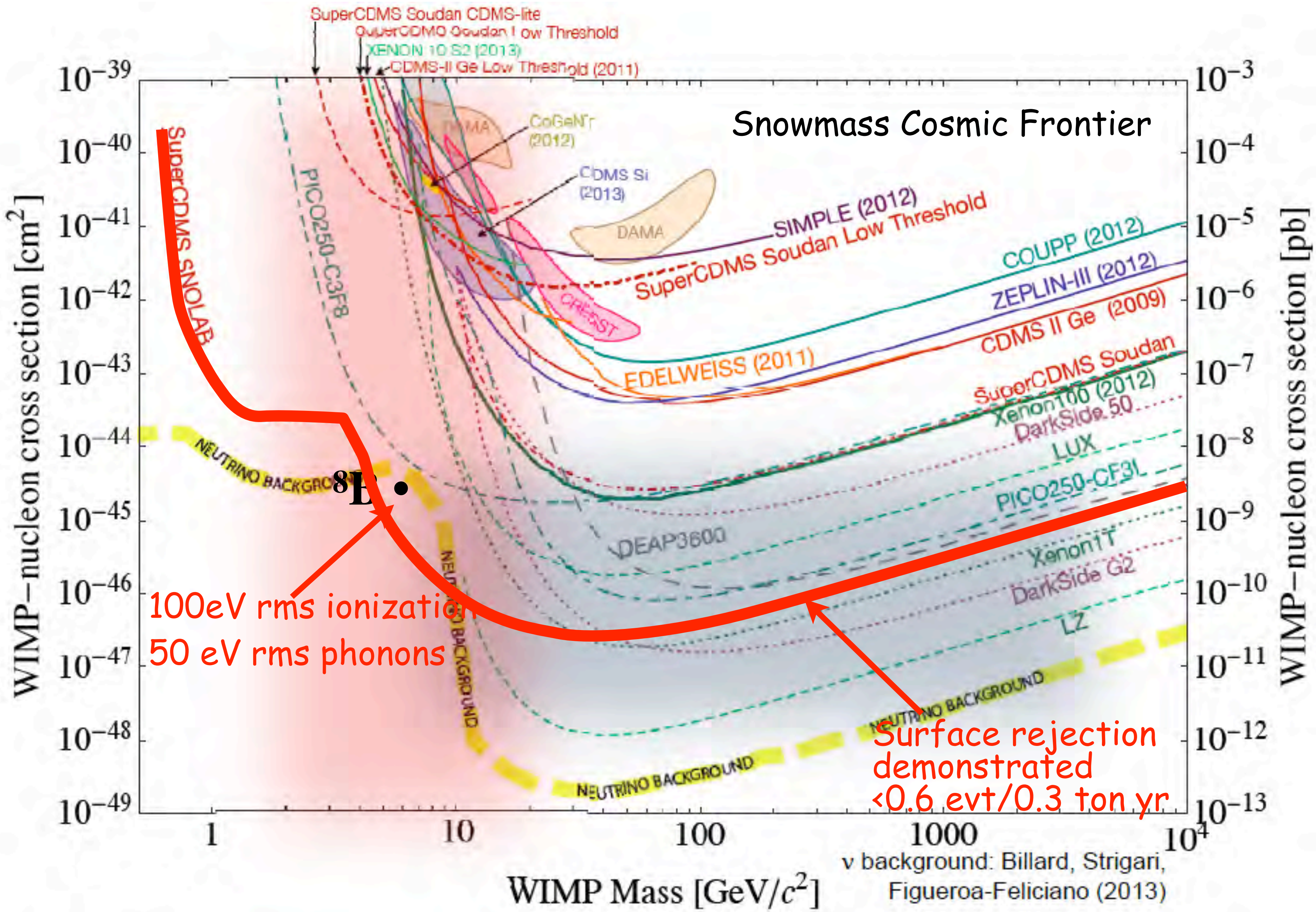
Si towers?



SuperCDMS SNOLAB

Lower noise in phonons and Ionization <-R&D
Si towers?

Next Step: SuperCDMS SNOLAB



Combining with Eureca at SNOLAB

Eureca= European effort after

EDELWEISS III 35kg
CRESST II new run

Serious discussion between SuperCDMS and Eureca

Unification of the low temperature WIMP search community to maximize the use of the versatile tools at our disposal:

- Low mass sensitivity
- Different targets
- Control of backgrounds

1) Combine at SNOLAB

Possibility for the French to take charge of the SNOLAB Cryostat
->15mK to allow EDELWEISS and CRESST detector technologies
Interesting possibilities: e.g. Mix of targets

- 100kg Ge, 40kg of Si, SuperCDMS technology, low threshold
- 85 kg Ge from Edelweiss
- 50 kg $CaWO_4$

or apply Edelweiss technology to CDMS=> reduce Zero Charge events

Depends on technical feasibility,
Need to present a simple story in the G2 US competition (October 2013)

2) => Ton scale at SNOLAB or in Modane

Depends, of course, on what is seen or not seen in the coming years

Low mass WIMP best with low T Detectors