Recent Results from WIMP-search analysis of CDMS-2 data

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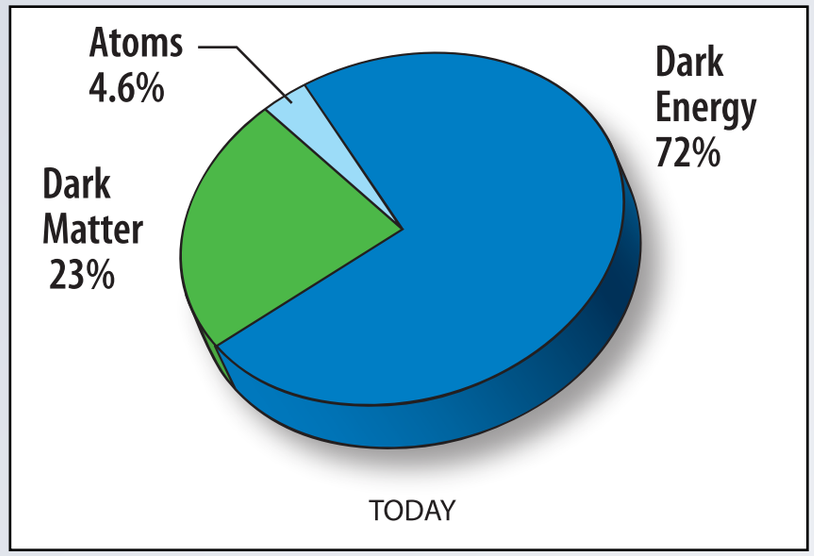
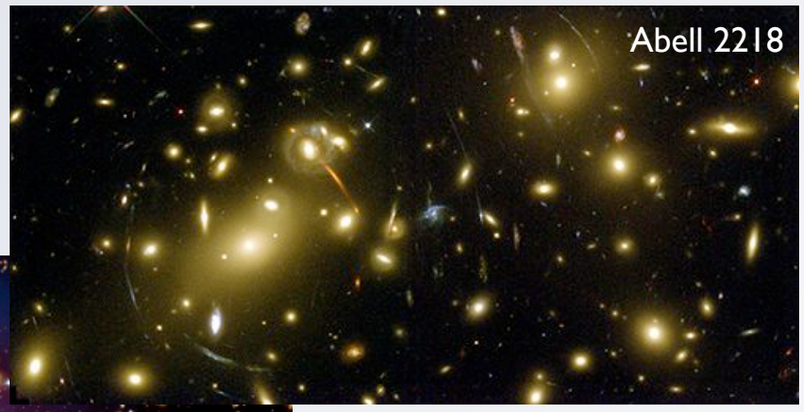
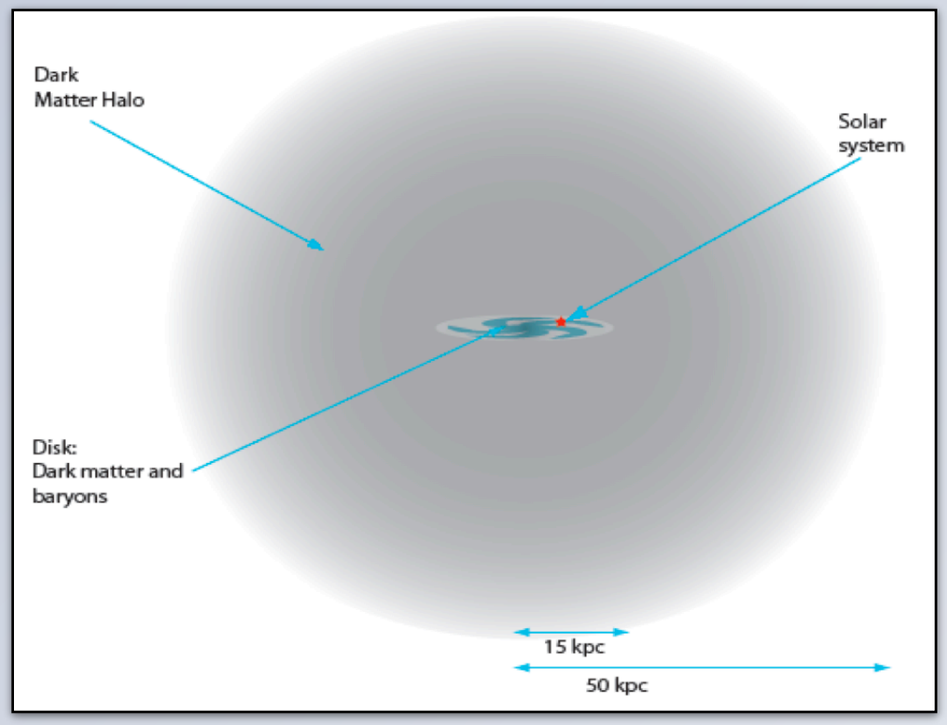
Motivating Dark Matter & WIMPs

- Evidence for dark matter on various scales
  - Galaxies
  - Galaxy clusters
  - Large scale
- WIMPs (among other models) are particularly well motivated

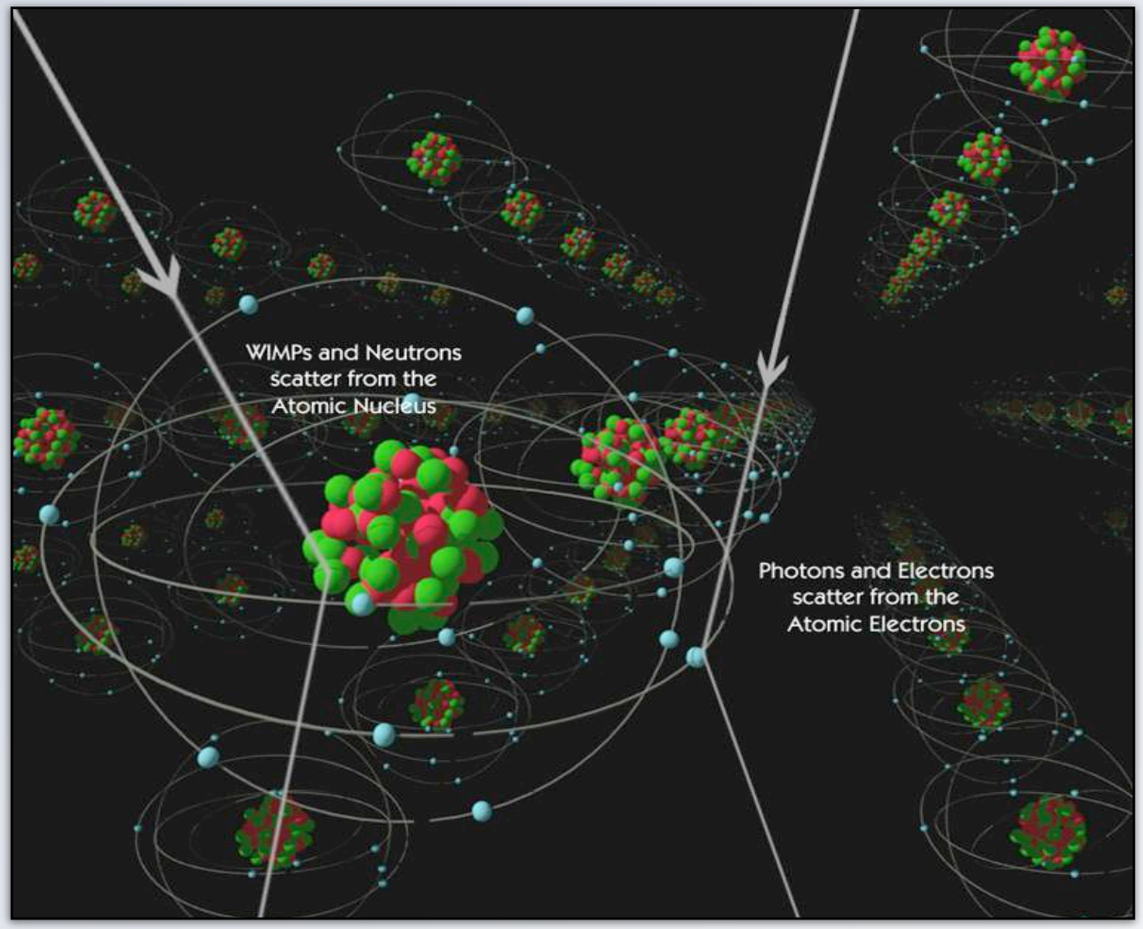




Direct Detection of WIMPs



Spherical Isothermal Halo
Max. Boltz. *v* distribution,
<v>~230km/s



Build a good mousetrap!

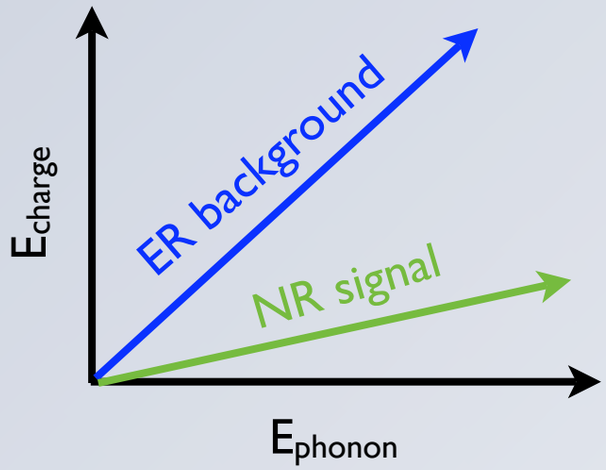
- Choose target material to "see" recoils
- Discriminate NRs from ERs
- Reduce background

RARE EVENT SEARCH

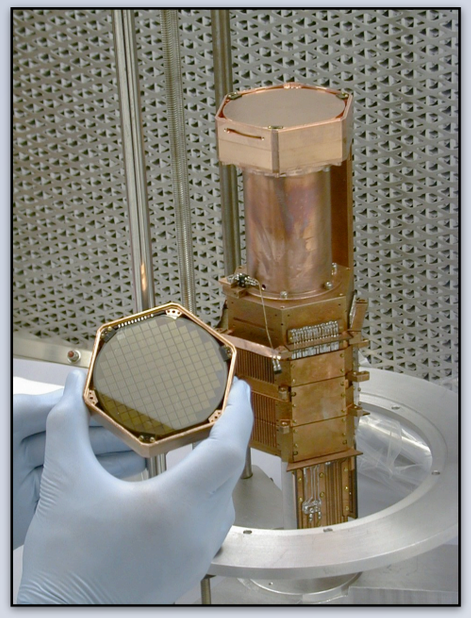
"See" Nuclear Recoils
<E_r>~30 keV, < ~1event/kg/100days

CDMS-2 in a nutshell

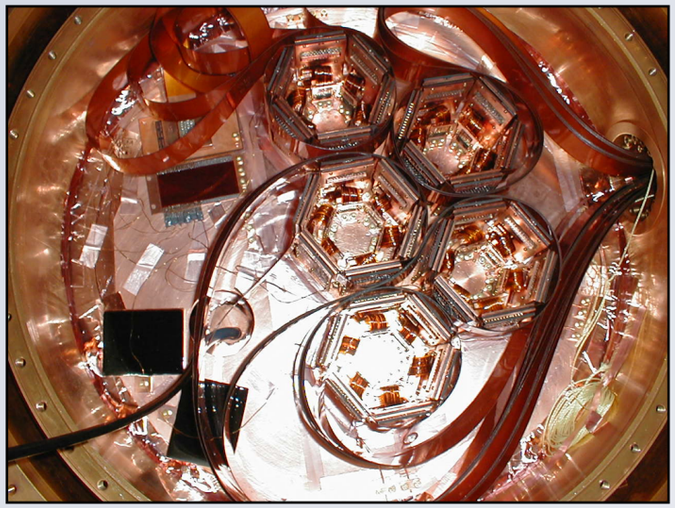
Ge & **Si** target masses



Allow <1 background event to maximize discovery potential



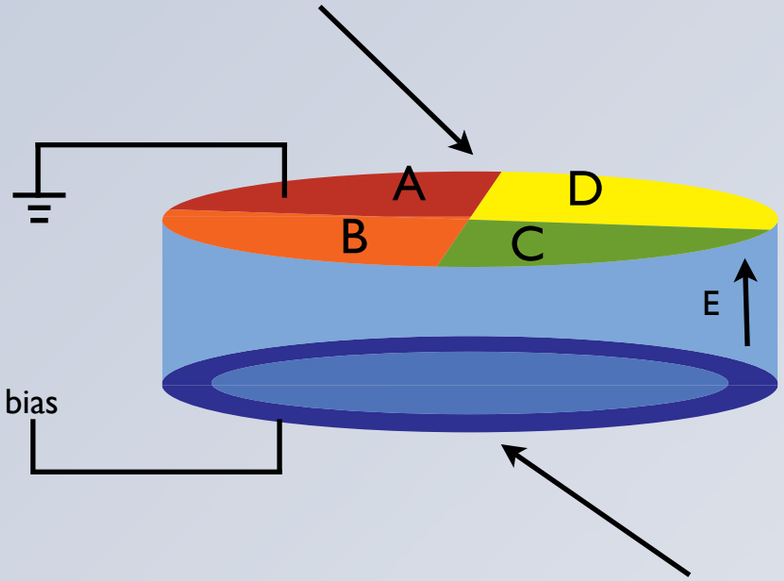
Event by event **discrimination** of nuclear and electron recoils using **ionization** and **phonon** signals



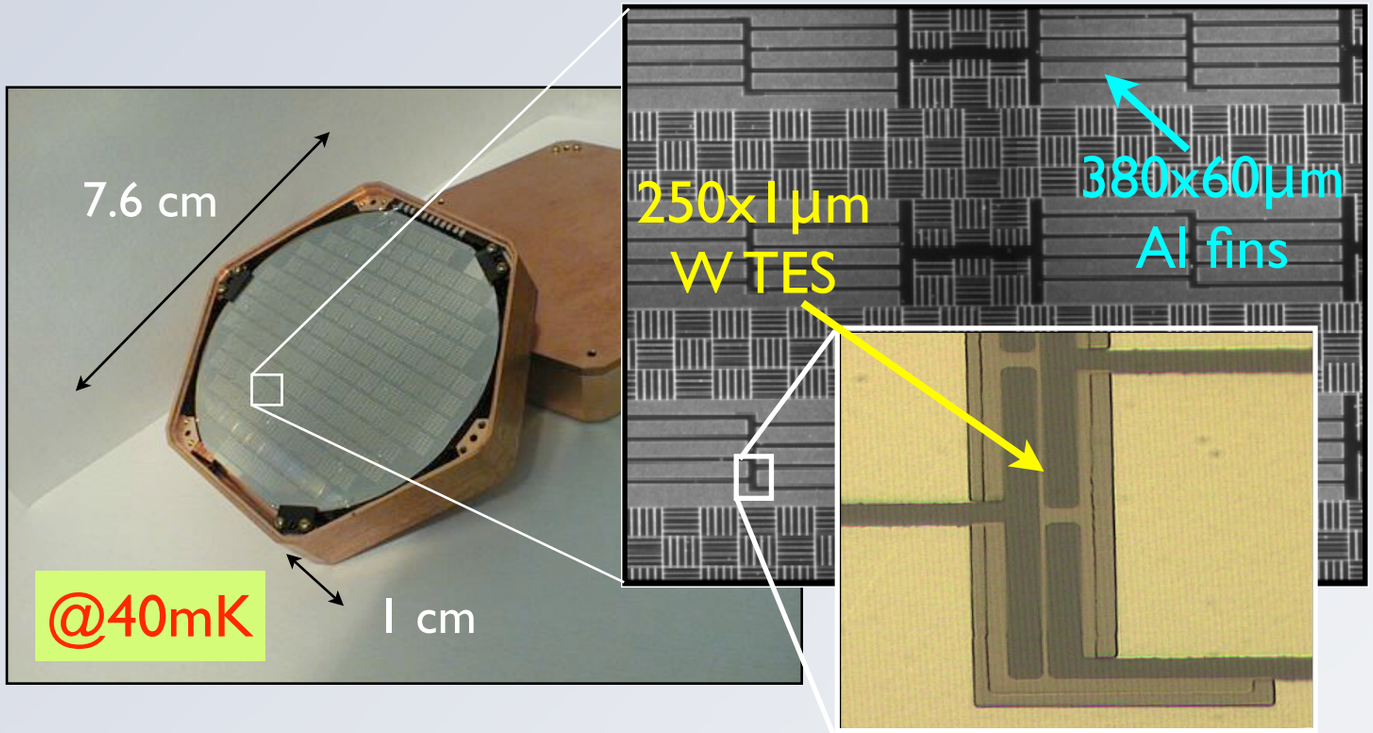
Control Backgrounds by going underground, using clean materials and shielding

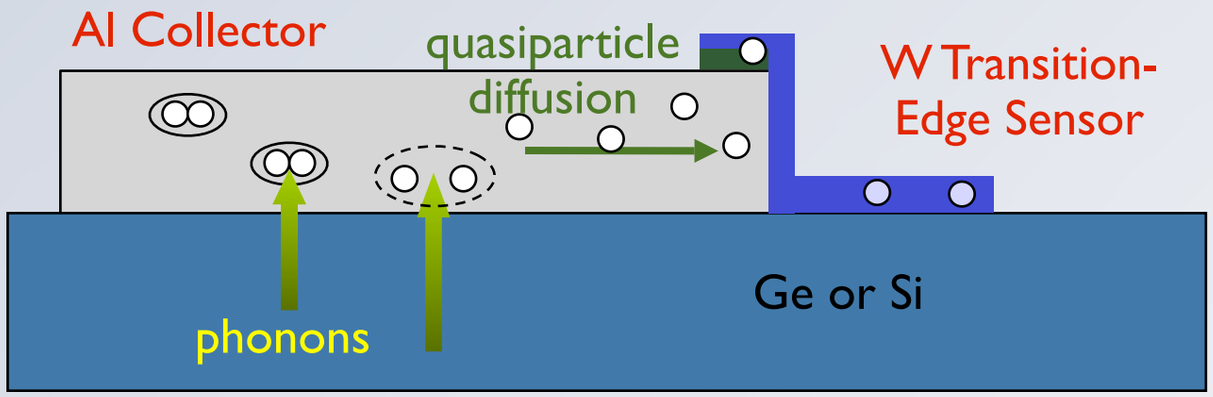
ZIP: Z-sensitive Ionization & Phonon Detectors

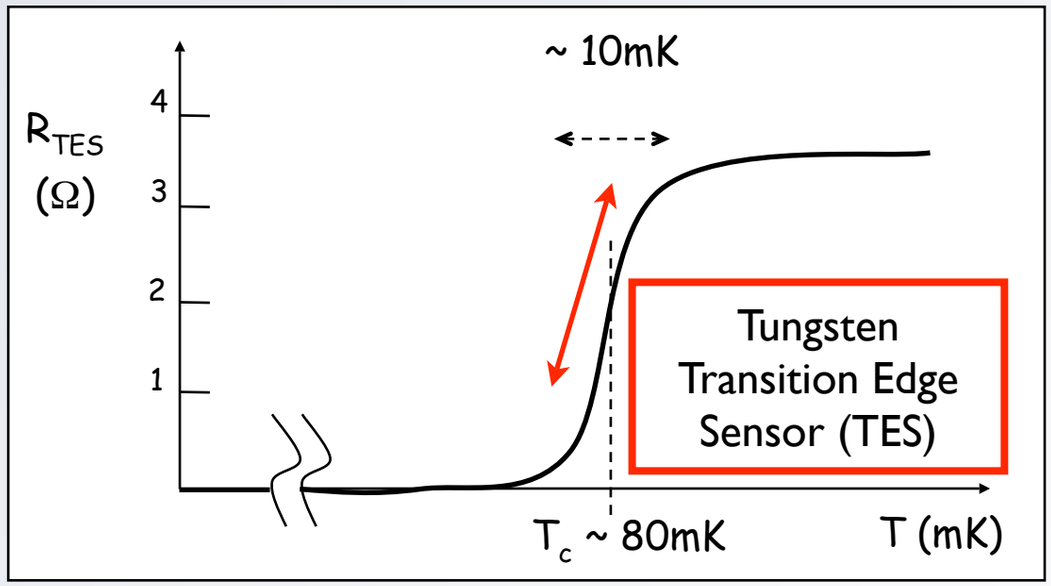
Phonon readout: 4 quadrants of superconducting *Al phonon absorbers* and *W Transition-Edge Sensors*



Charge readout: 2 concentric electrodes for measurement and fiducial volume

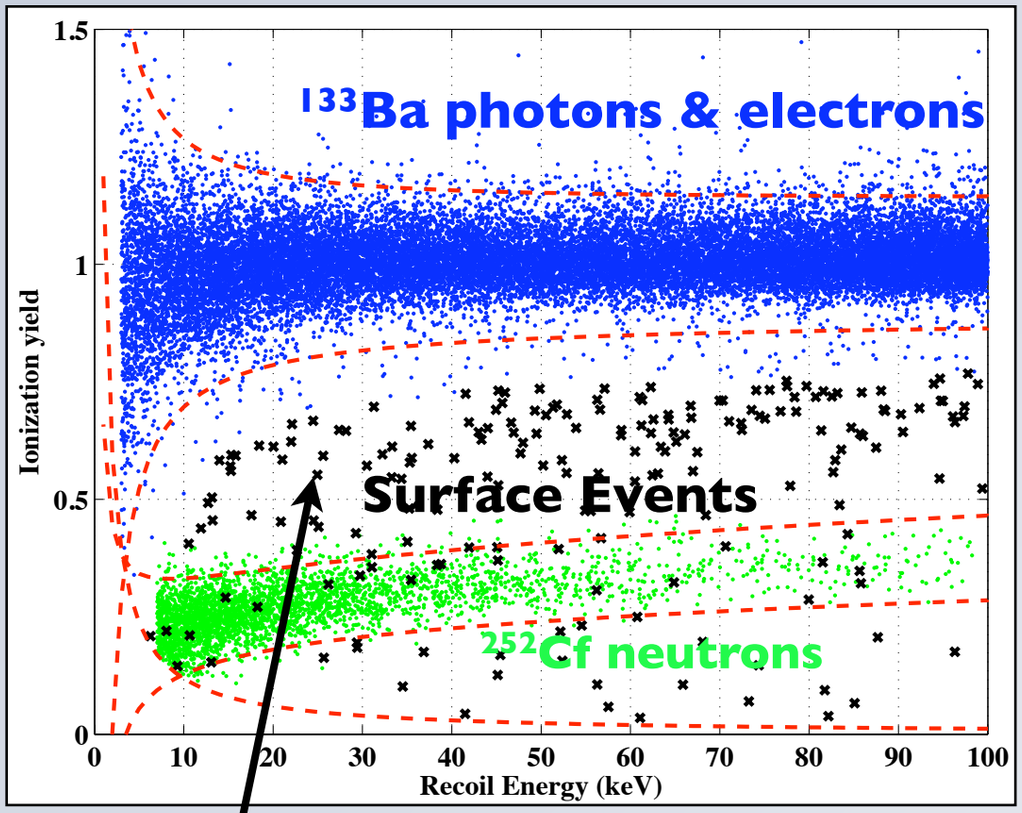




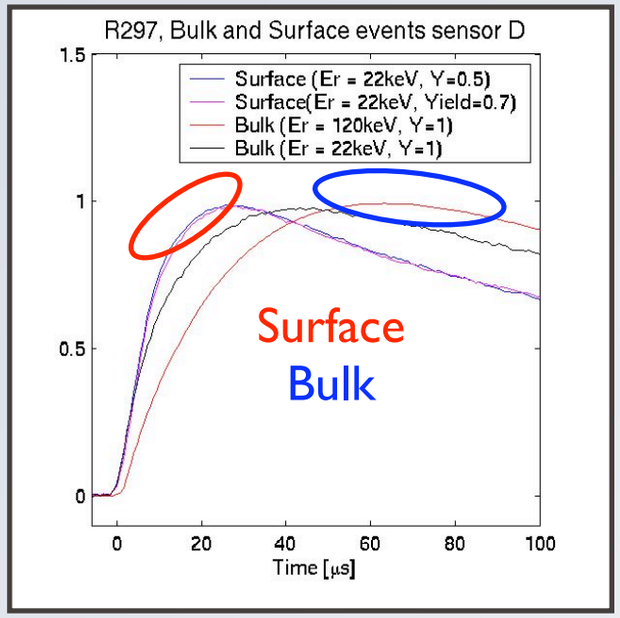


Basic Discrimination principles

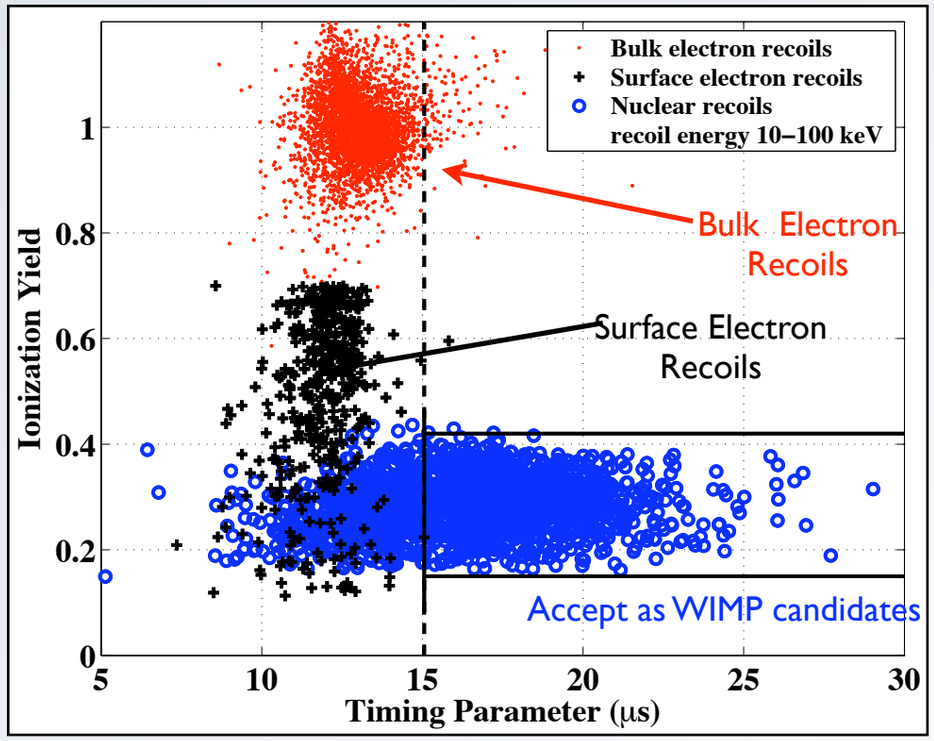
Reject bulk electron recoils using $y=Q/E_{recoil}$



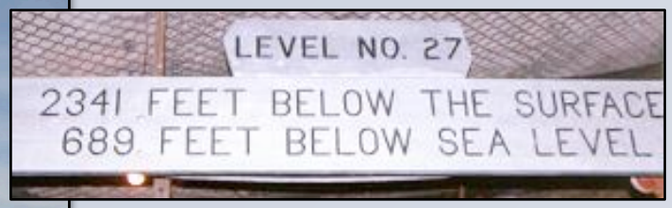
- Events within 10 micron "dead layer" have poor charge collection
- Electrons, x-rays low energy gammas from contamination of surfaces surrounding detectors



Reject surface events using promptness of phonon pulse

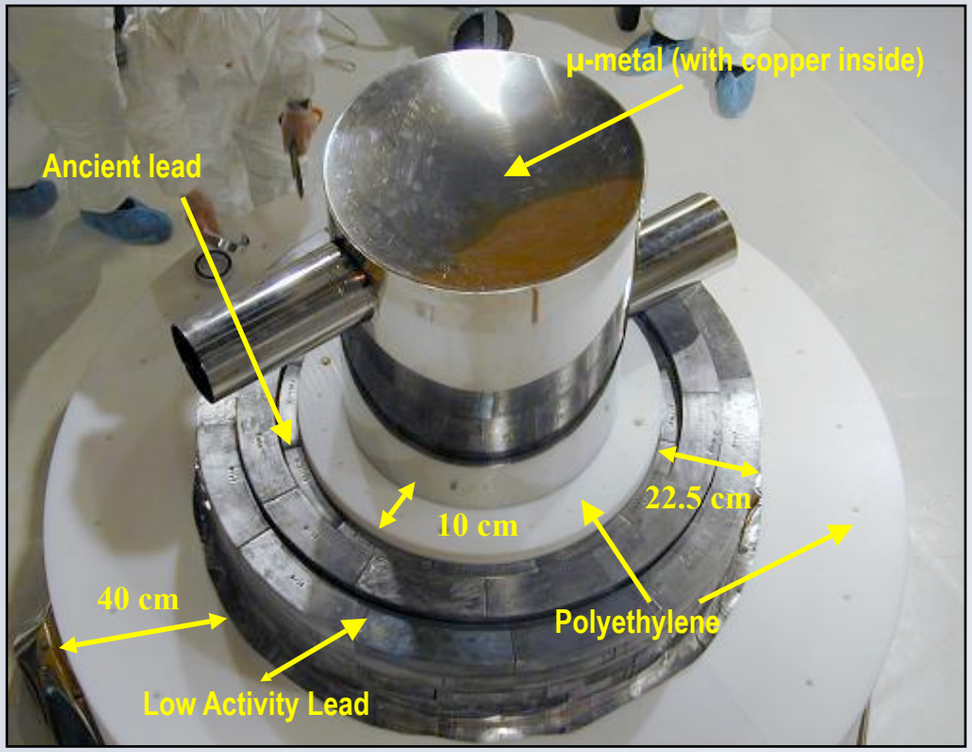


Background Control in CDMS-2

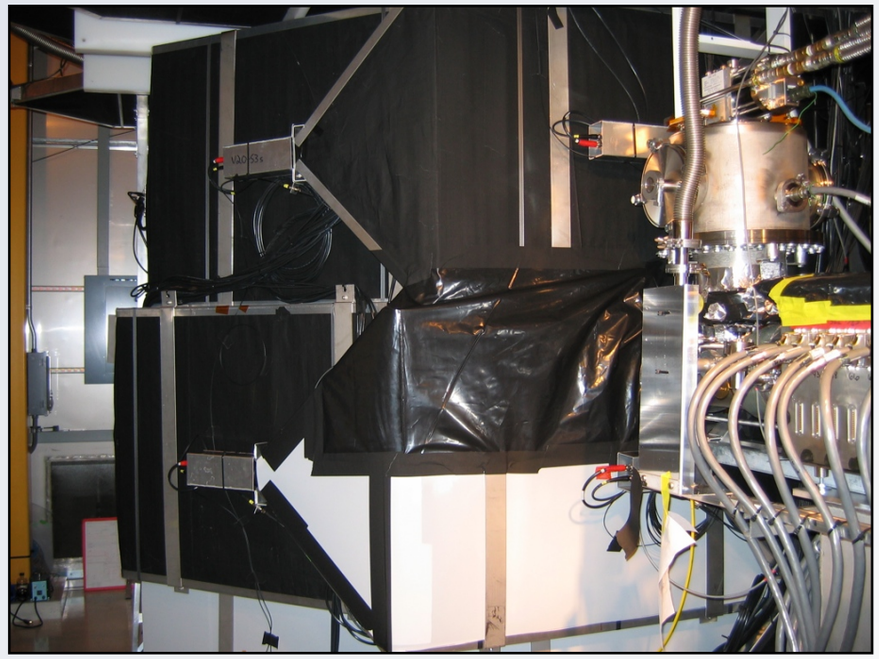


Soudan Underground Lab

RF shielded class
10,000 clean room

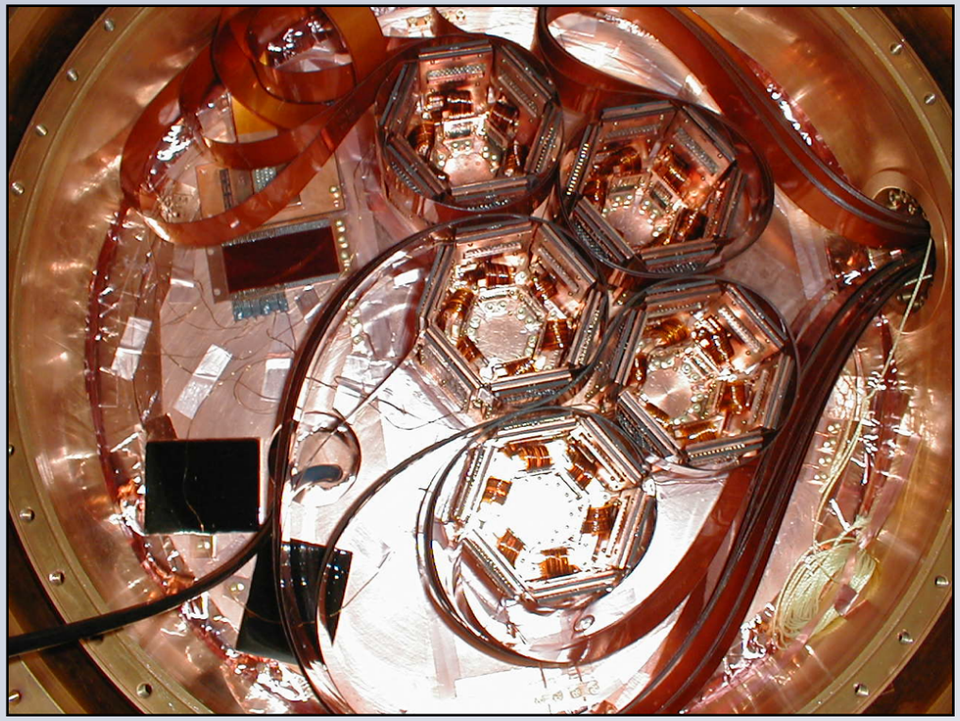


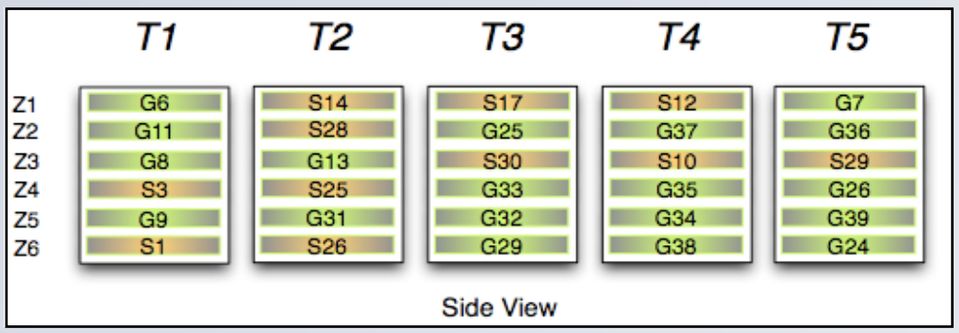
Passive shielding



Plastic scintillator muon veto

CDMS-2 @ Soudan





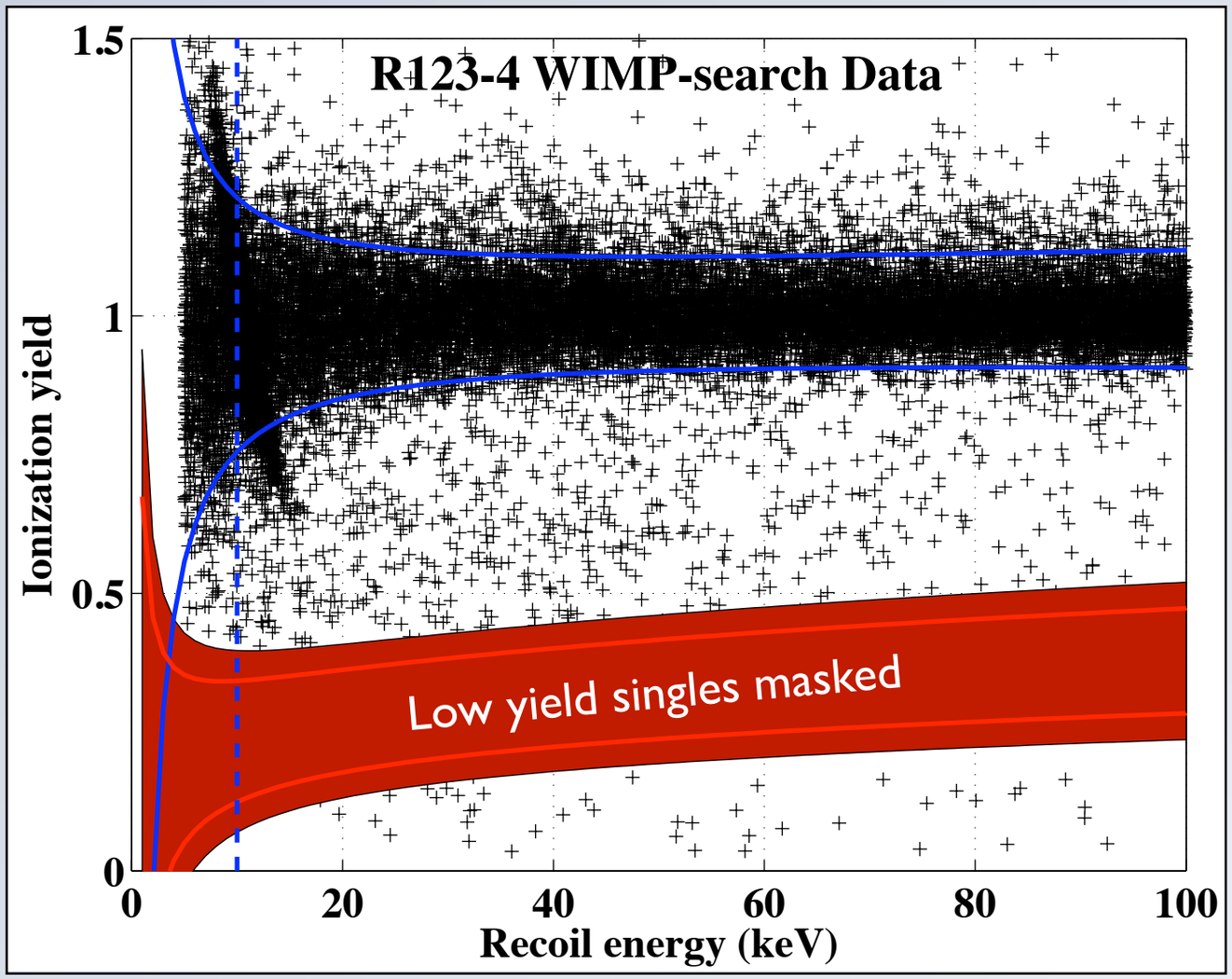
- **30 detectors installed and operating in Soudan since June 2006.**
  - **4.75 kg of Ge, 1.1 kg of Si**
- **Seven Total Data Runs:**
  - **R123 - R124:**
    - **taken: (10/06 - 3/07) (4/07 - 7/07)**
    - **exposure: ~400 kg-d (Ge "raw")**
    - **PRL 102, 011301 (2009)**
  - **R125 - R128**
    - **taken: (7/07 - 1/08) (1/08 - 4/08) (5/08 - 8/08) (8/08 - 9/08)**
    - **exposure: ~ 750 kg-d (Ge "raw")**
    - **Under Analysis**
  - **R129:**
    - **taken: (11/08 - 3/09)**

CDMS-2 : First Five Tower Result

PRL 102, 011301 (2009)

Blind Analysis:

Event selection and efficiencies were calculated without looking at the signal region of the WIMP-search data.



Event Selection:

- Energy threshold (*10-100 keV*)
- Veto-anticoincident
- Single-scatter
- Inside fiducial volume
- 2-sigma Nuclear Recoil
- Phonon timing

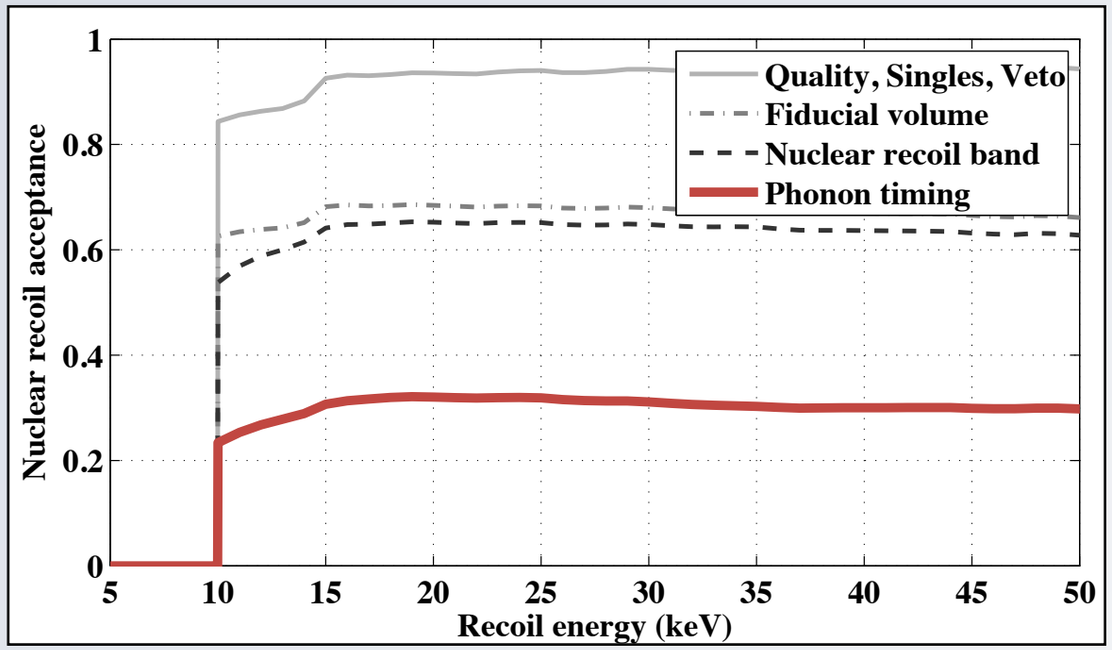
CDMS-2 : First Five Tower Result

PRL 102, 011301 (2009)

Surface Background

Estimated number of background events to pass surface cut in Ge

$$0.6^{+0.5}_{-0.3}(stat.)^{+0.3}_{-0.2}(syst.)$$



Neutron Backround

Poly Cu (α,n): < 0.03
Pb (fission): < 0.1
Cosmogenic: < 0.1 (MC 0.03-0.05)

398 raw kg-d
121 kg-d WIMP equiv. @ 60 GeV/c^2 (10 - 100 keV analysis energy range)

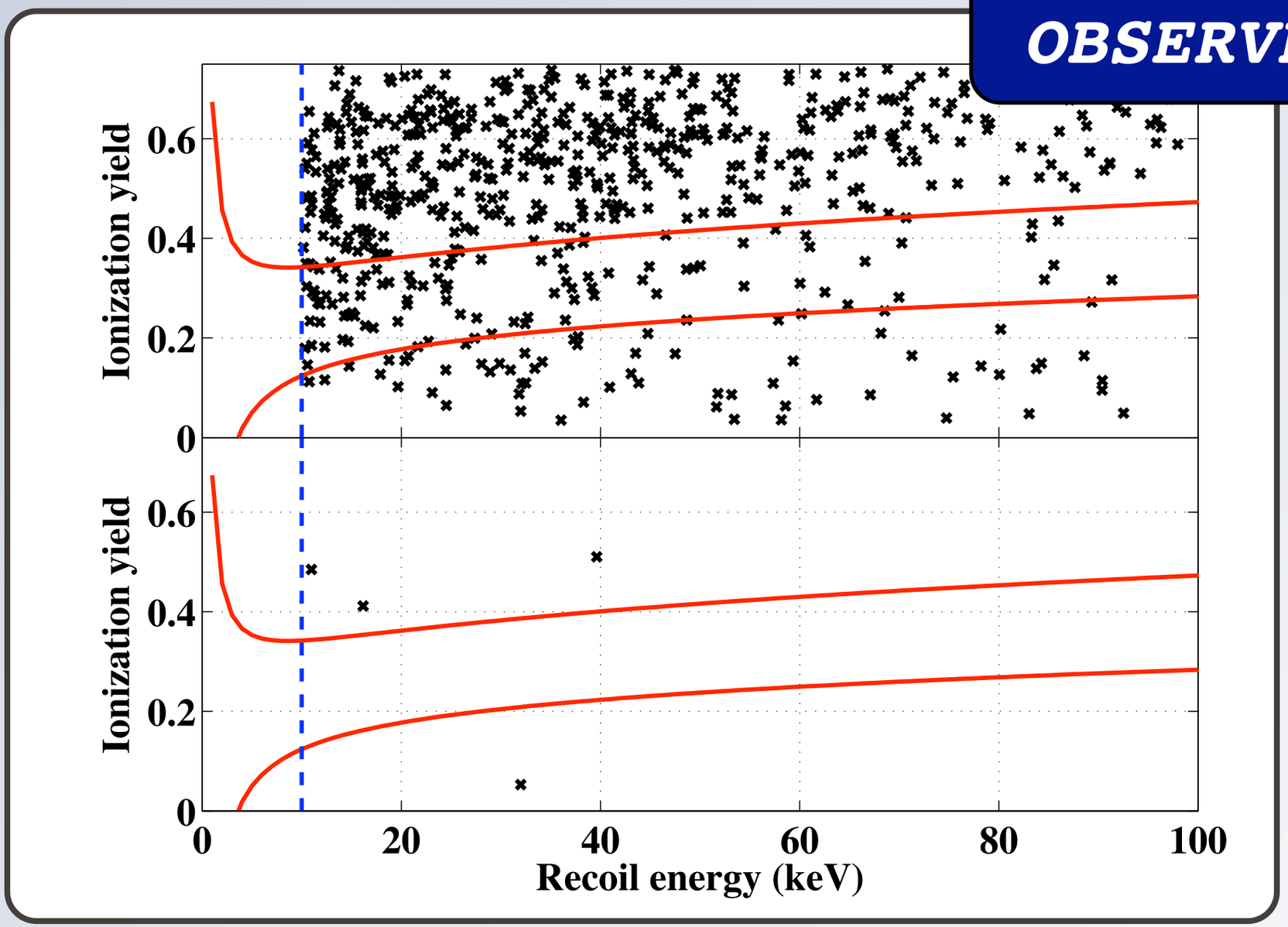
CDMS-2 : First Five Tower Result

PRL 102, 011301 (2009)

NO EVENTS OBSERVED !

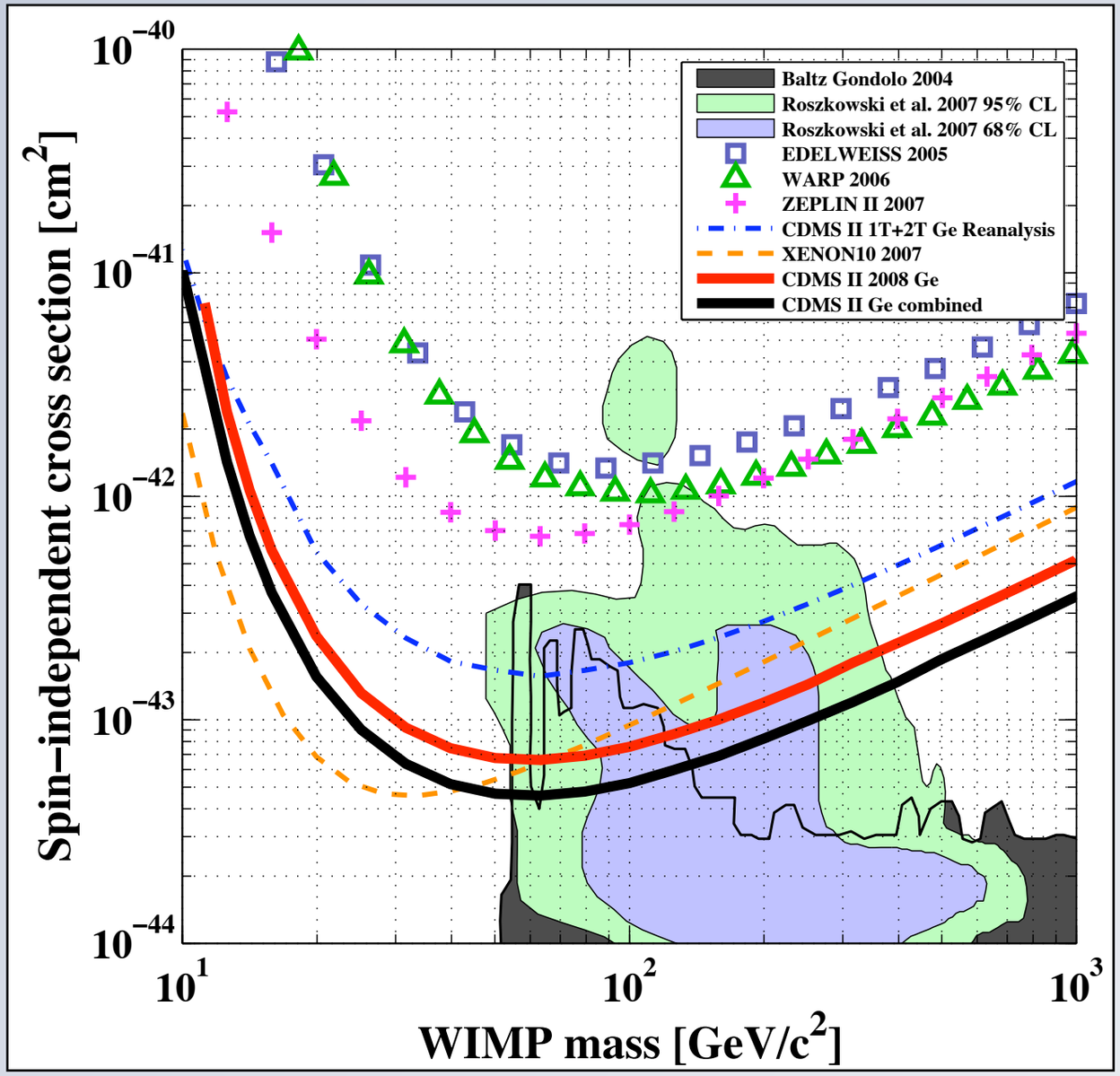
FAIL timing cut

PASS timing cut



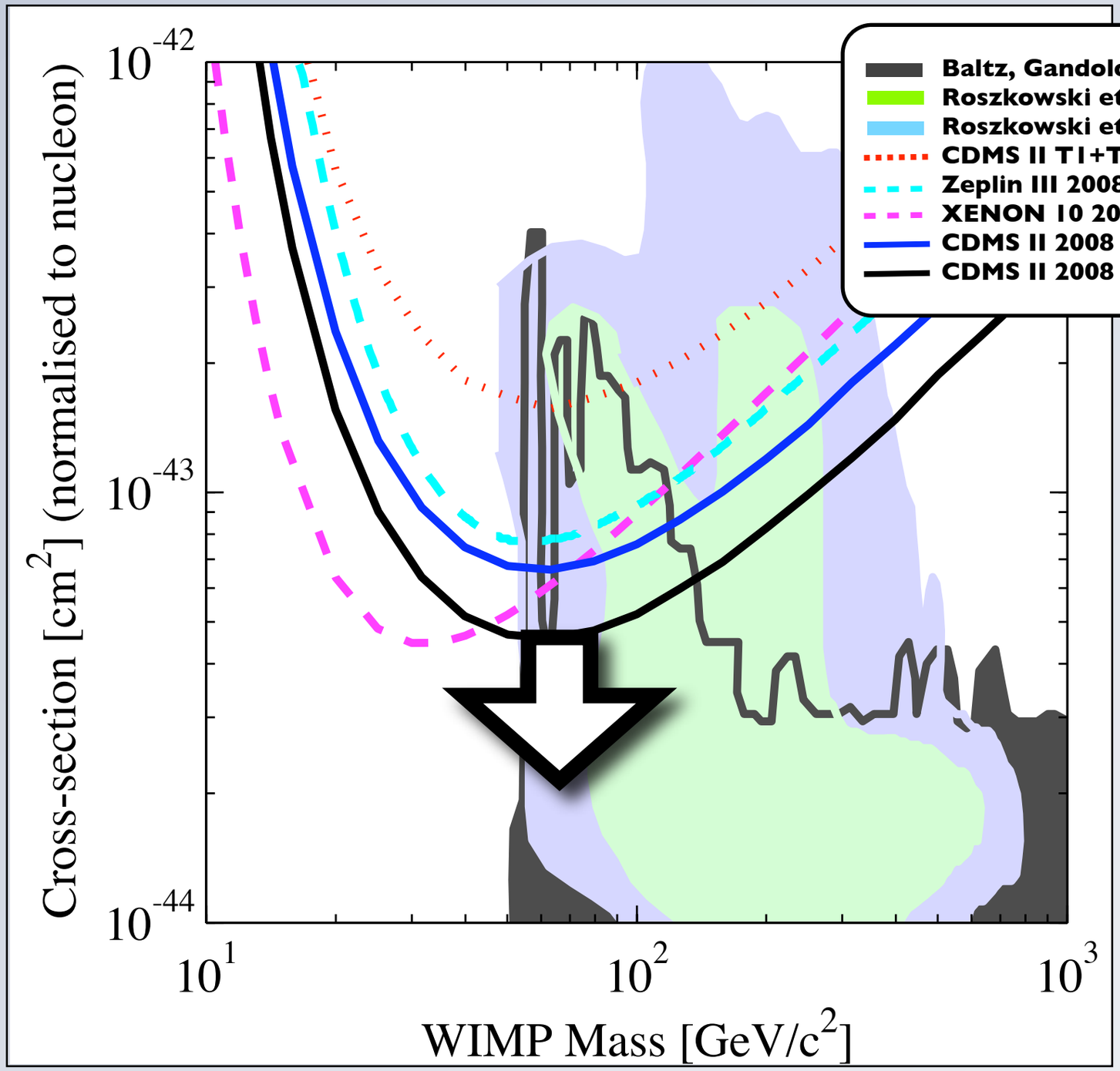
CDMS-2 : First Five Tower Result

PRL 102, 011301 (2009)



Upper limit at the 90% C.L. on the WIMP-nucleon cross-section is **4.6×10^{-44} cm^2** for a WIMP of mass **60 GeV/c^2**

CDMS-2 : Projected Sensitivity (2009)



Raw Exposure

- R118-R119 = ~120 kg-d
- Run 123-124= ~400 kg-d
- Run 125-128 = ~750 kg-d

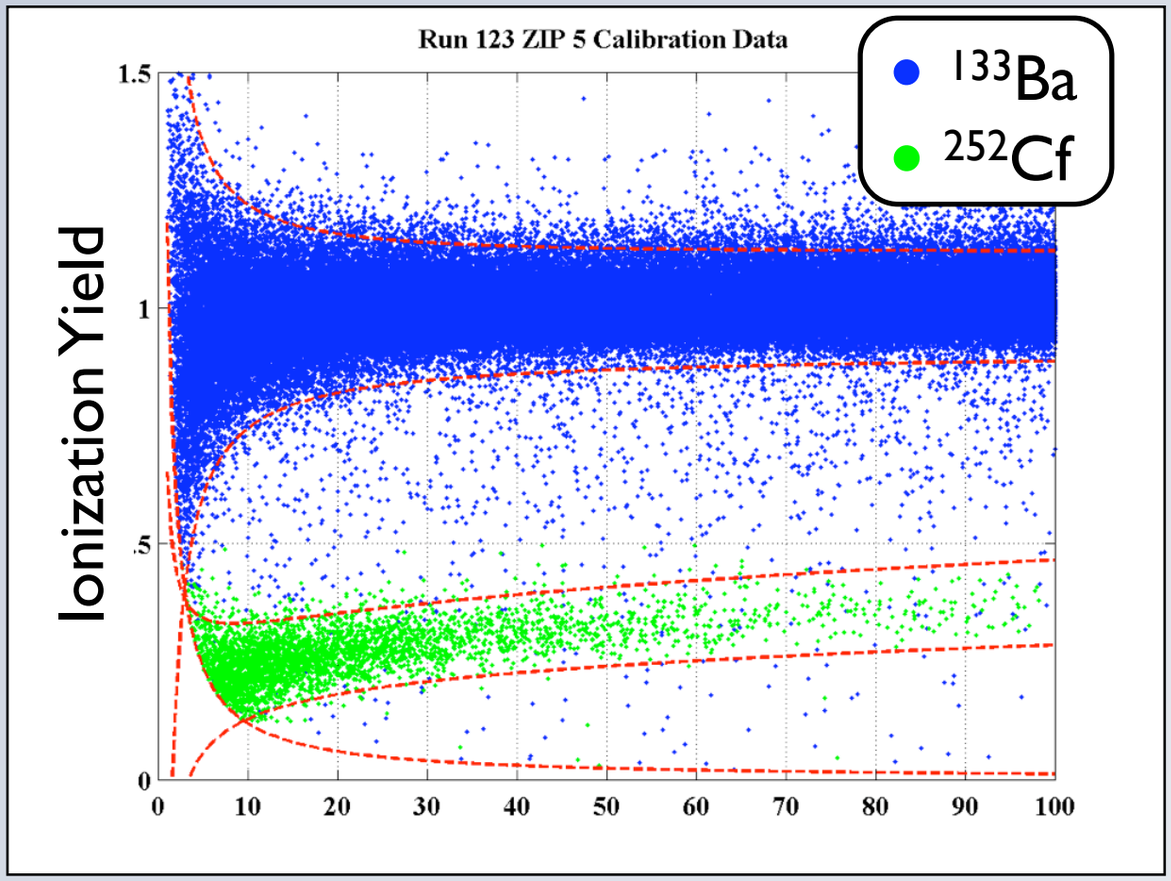
~2.5 times more total exposure

Results expected late Summer 2009

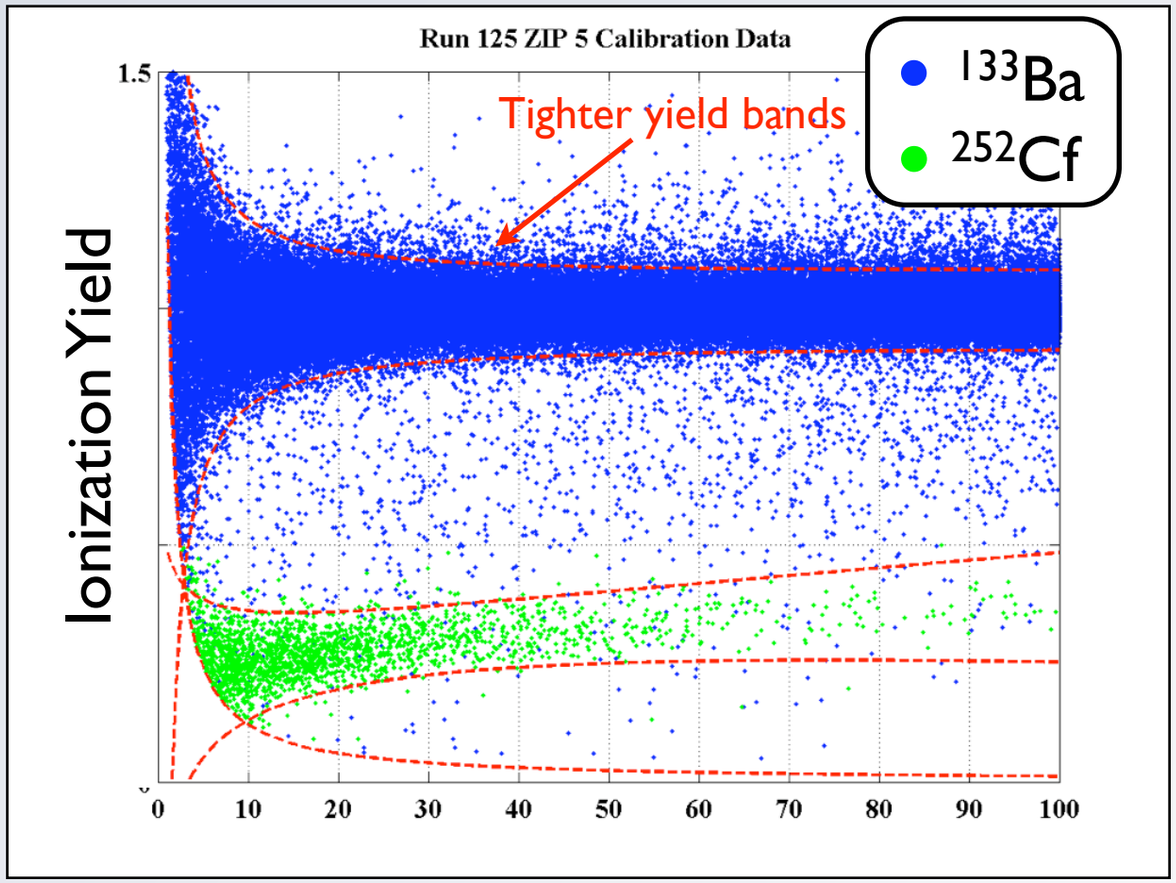
CDMS-2: Calibration Data Preview (2009)

Previous Analysis

PRL 102, 011301 (2009)



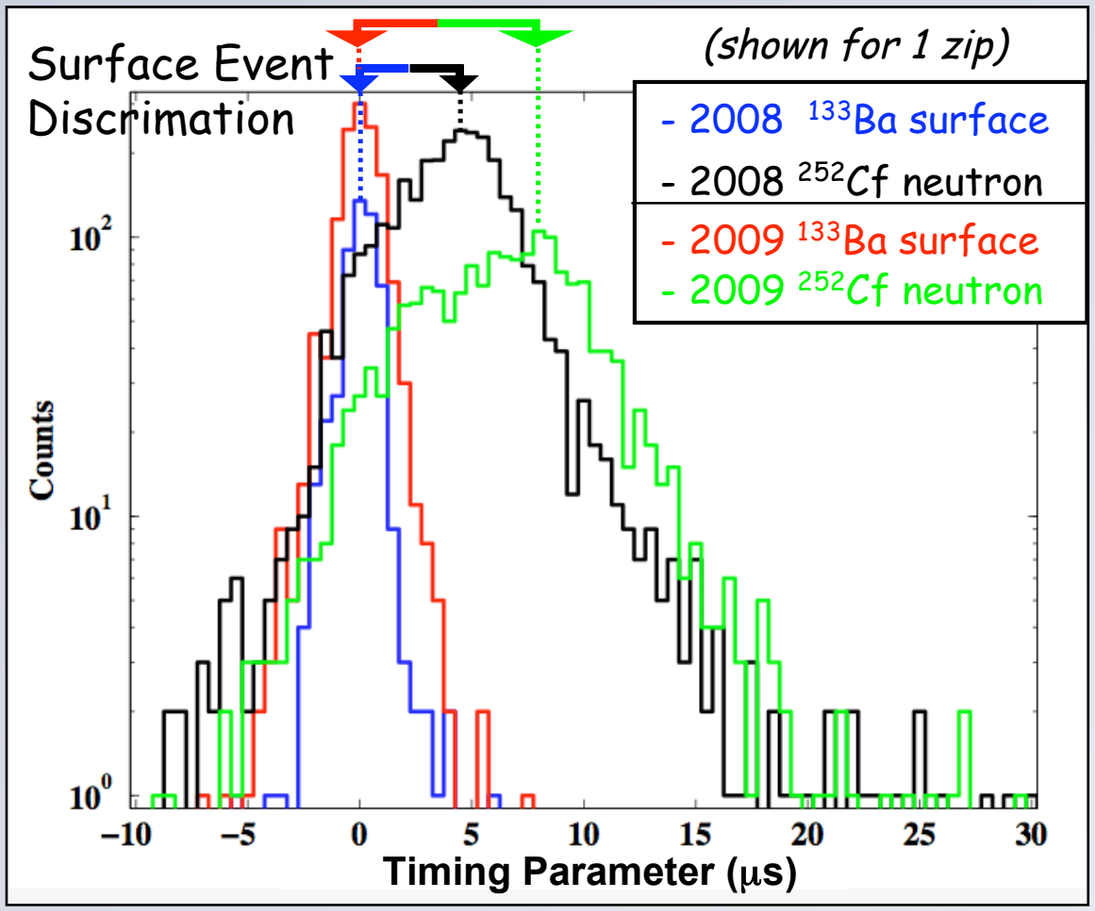
Current Analysis

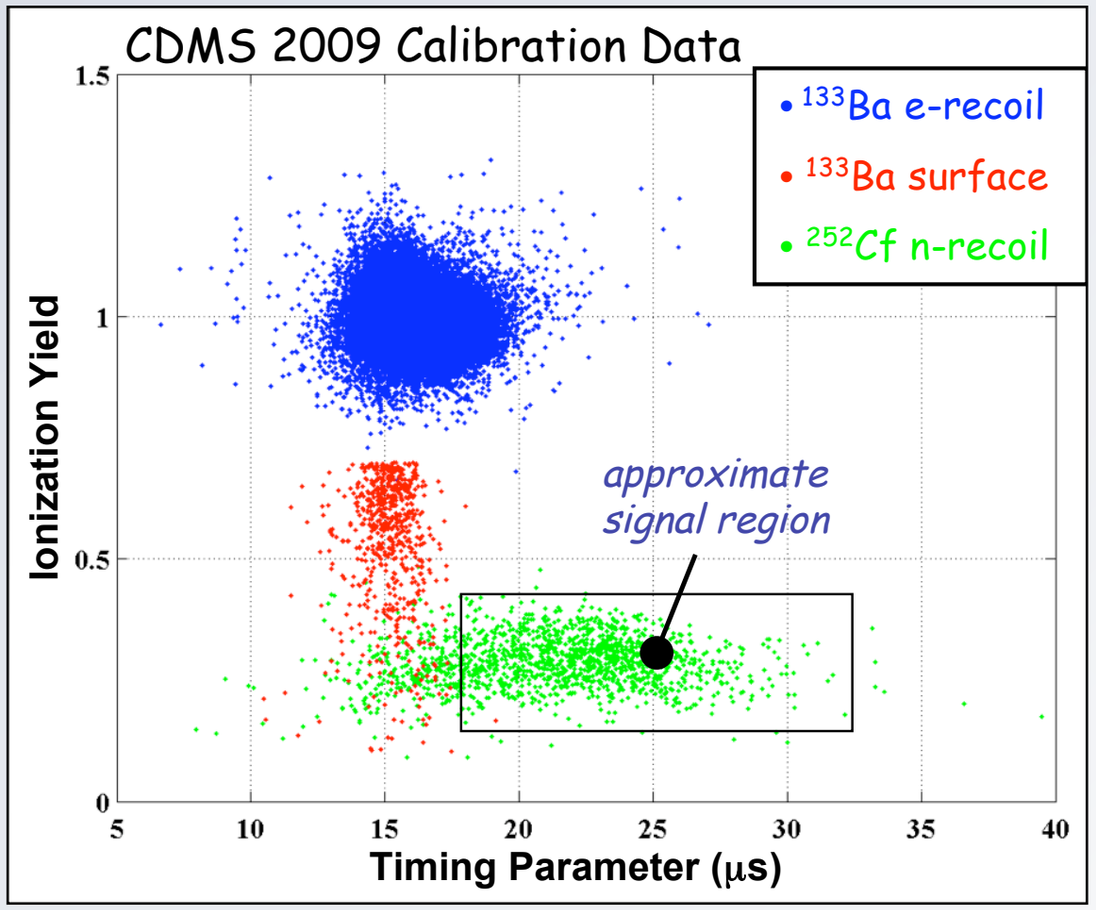


Data Quality and preliminary cuts defined!

CDMS-2: Timing Discrimination Preview (2009)

Aiming for x2-3 better surface event rejection to keep expected background <1 event

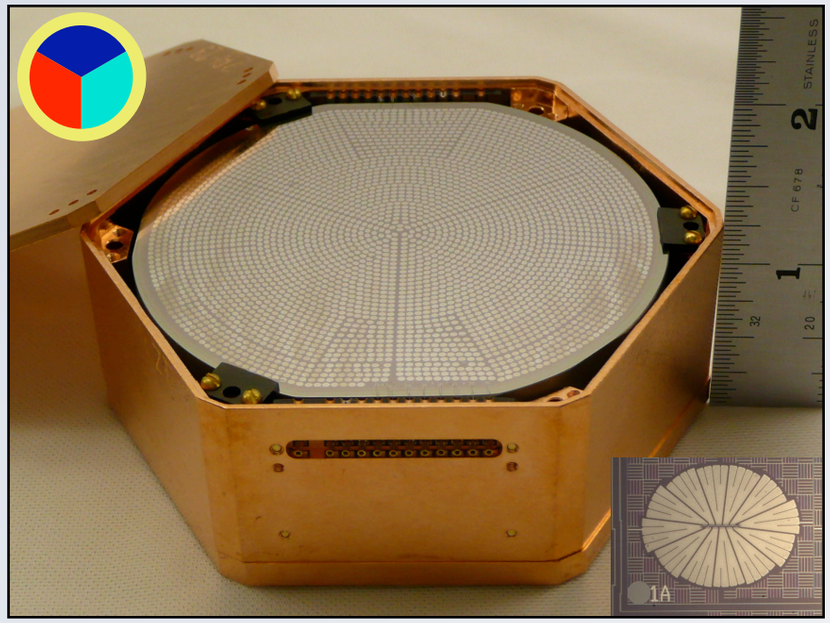


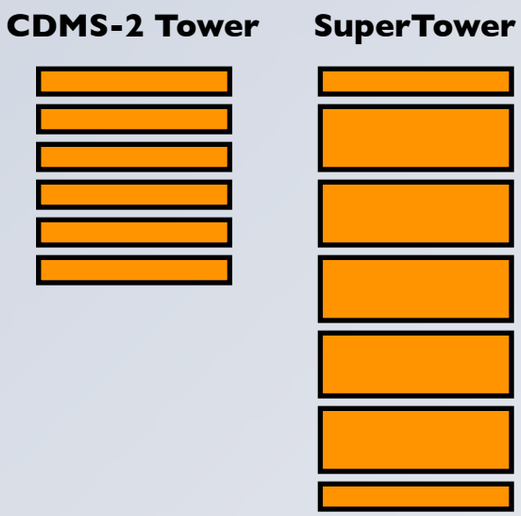


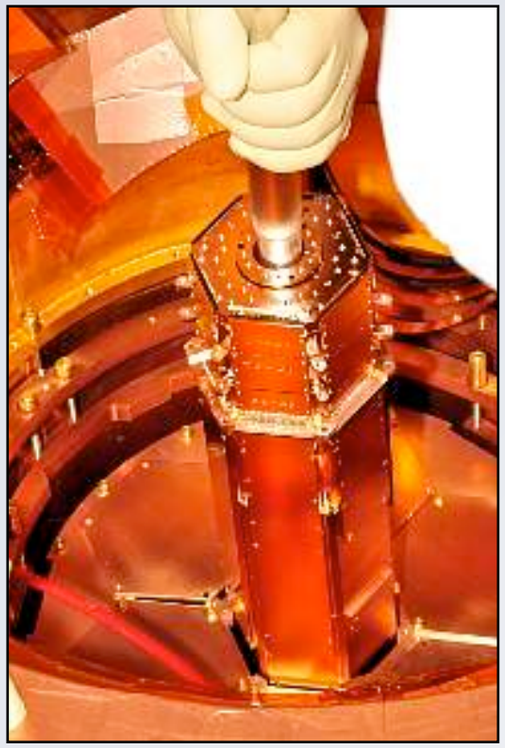
Stay Tuned...

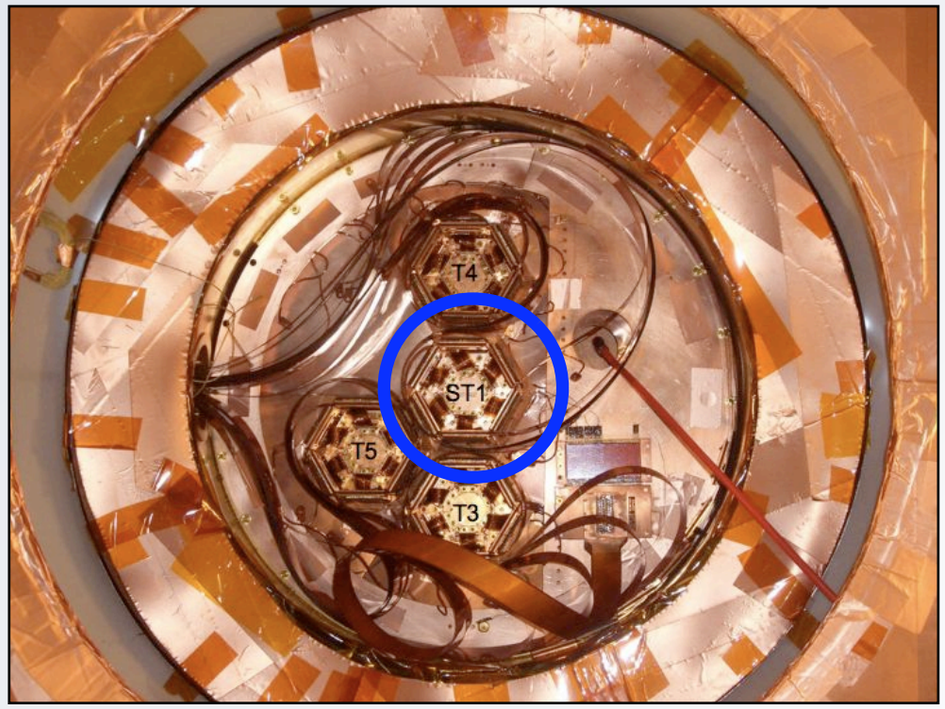
SuperCDMS Soudan

- CDMS-2 target exposure acquired
- 15kg Ge experiment to succeed CDMS-2 with target reach of 5 x 10^{-45} cm^2 at 60 GeV/c^2
- Detectors x2.5 more massive
- Phonon and Ionization sensors modified for better surface event rejection
- First SuperTower already installed









Summary

- Data taken between Oct. 2006 and July 2007 has been analyzed and a cross section limit of $< 4.6 \times 10^{-44} cm^2$ (90% CL) was placed for a WIMP of mass 60 GeV/c^2.
- CDMS II finished taking data on March 18, 2009. We are currently analyzing the last data sets.
- SuperCDMS Soudan will replace CDMS-2 and will extend reach to 5×10^{-45} cm^2 at 60 GeV/c^2.
- The first SuperTower has been built and has been commissioned at Soudan.