

Further WIMP results from the CDMS experiment

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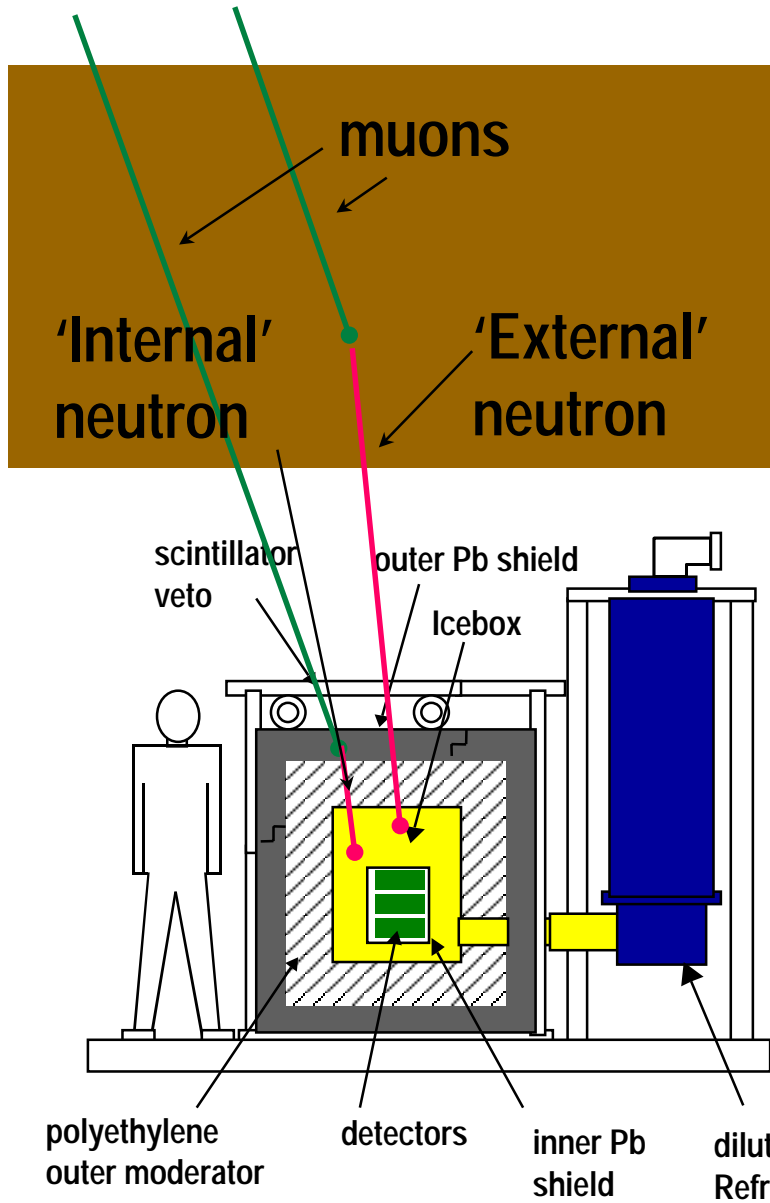
(Jul03 PLB)

Overview



- **CDMS I: 1998-1999 run of 3 Ge BLIPs**
 - ◆ 15.8 kg days after cuts
 - ◆ 23 single-detector & 4 multiple-detector nuclear-recoil candidates, most (or all) are neutrons
 - ◆ Final results in 35-page paper in Phys. Rev. D66, 122003 (2002), astro-ph/0203500
 - ◆ Conflict with DAMA, agreement from Edelweiss and Zeplin I.
- **Preparations for CDMS II at deep site**
 - ◆ New athermal phonon technology
 - ◆ Run first tower at SUF
 - ◆ Confirmed CDMS I results, hep-ex/0306001
 - ◆ Towers 1 and 2 now installed at Deep site facility, Soudan, Minnesota.
 - ◆ Assembly of Deep site facility at Soudan, Minnesota.

Stanford Underground Facility (SUF)



•Stanford Underground Facility

- ◆ 17 mwe of rock
- ◆ Hadronic component down by 1000
- ◆ Muon flux down by ~5

•Low Background Environment

- ◆ 15 cm Pb reduces photon flux by factor >1000
- ◆ 25 cm polyethylene reduces muon-induced neutron flux from rock and lead by factor >100
- ◆ Radiopure cold volume (10 kg)
- ◆ Additional internal (ancient) lead shielding

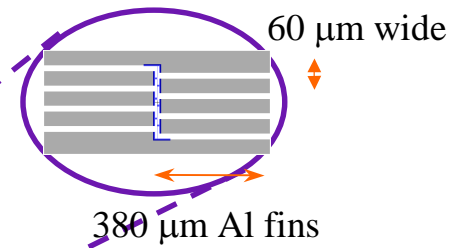
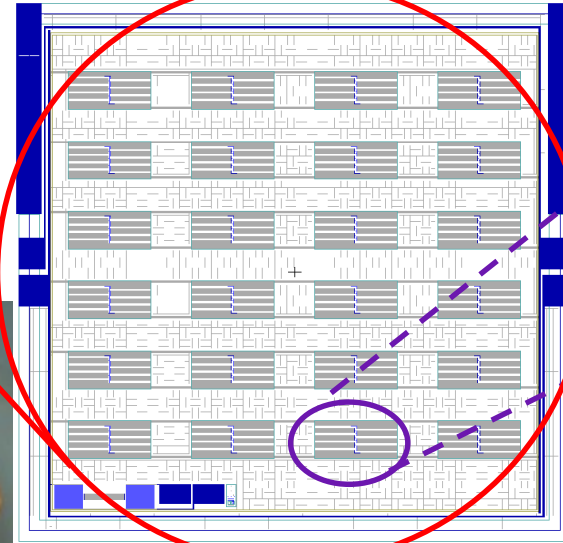
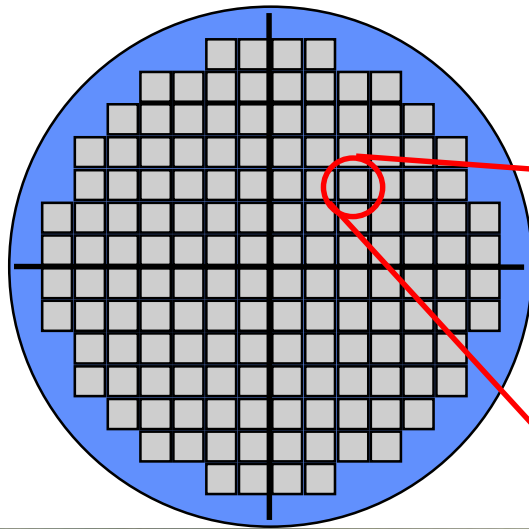
•Active Scintillator Muon Veto

- ◆ Muon veto >99.9% efficient
- ◆ Reject ~22 "internal" neutrons/ day produced by muons within shield

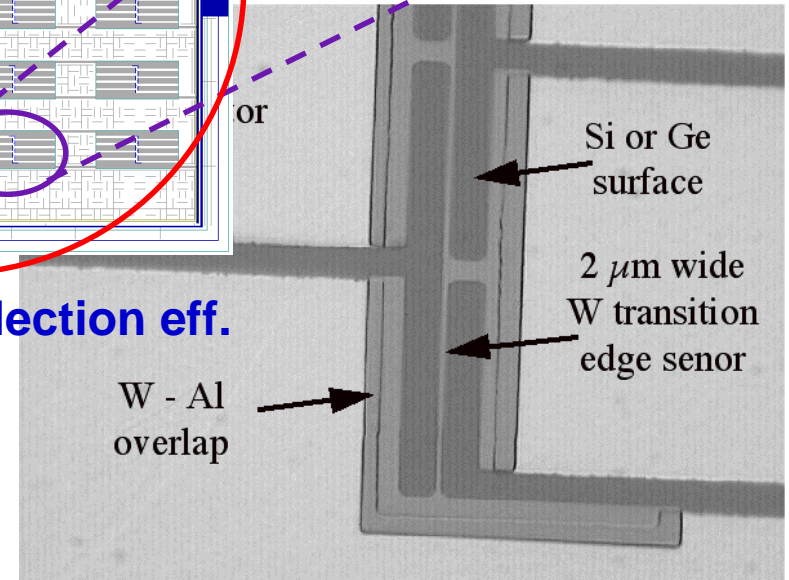
ZIP detector phonon sensor technology



- ◆ TES's patterned on the surface measure the full recoil energy of the interaction
- ◆ Phonon pulse shape allows for rejection of surface recoils (with suppressed charge)
- ◆ 4 phonon channels allow for event position reconstruction



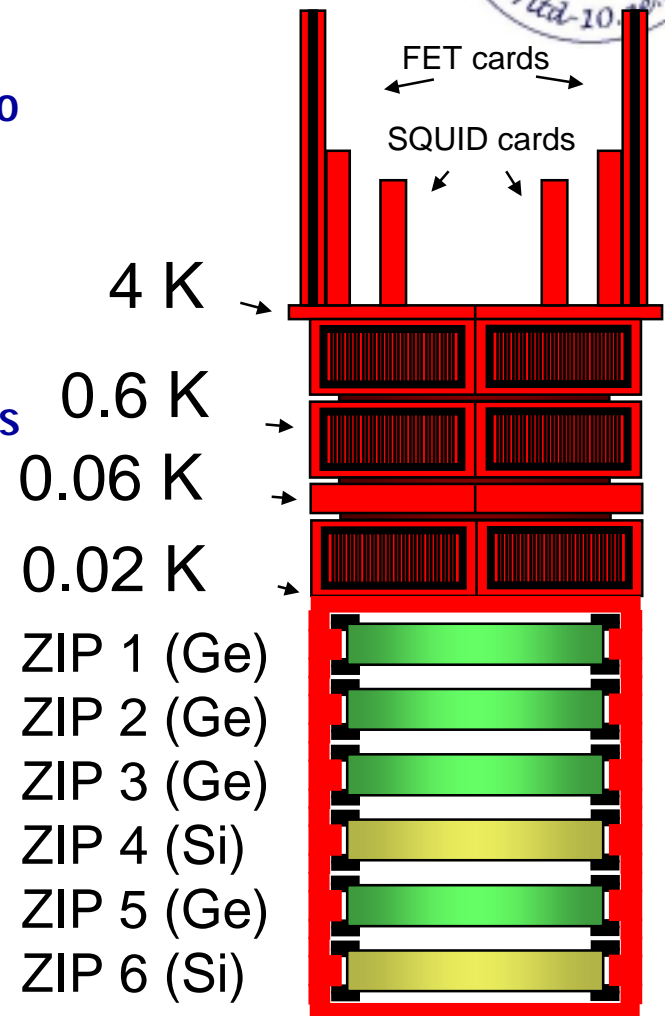
~25% QP collection eff.



The SUF Run 21 Tower



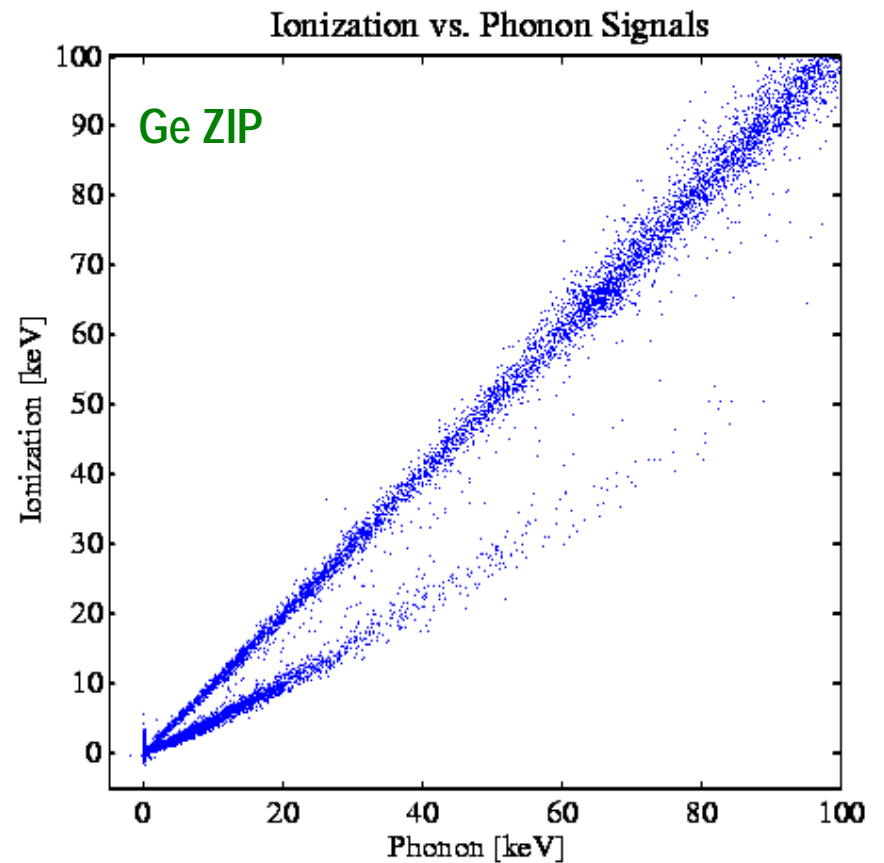
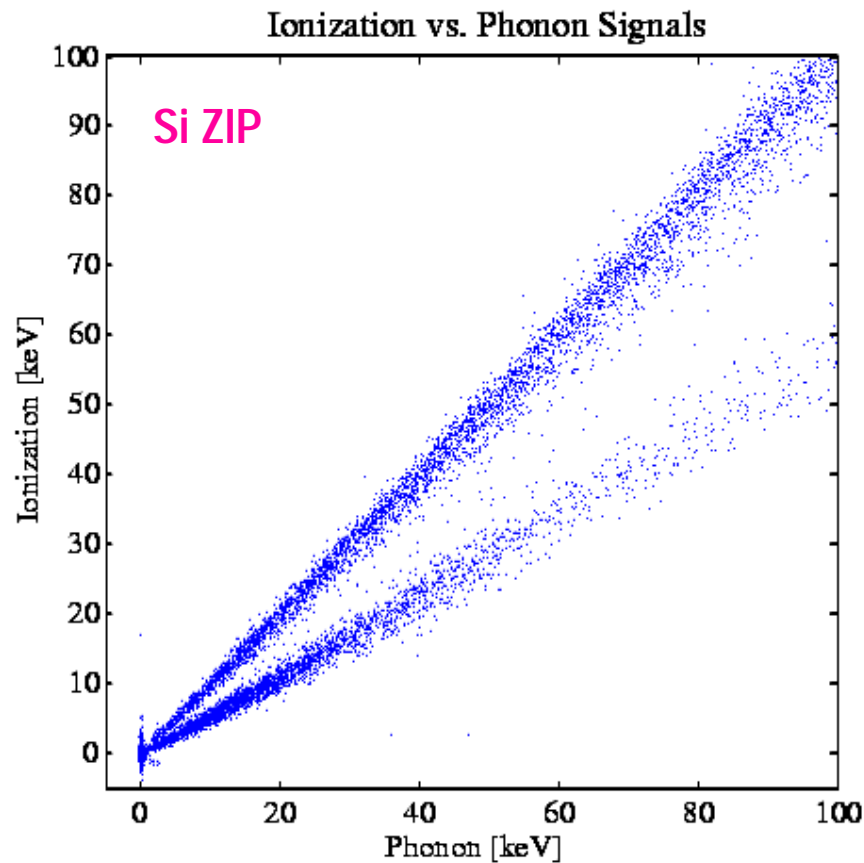
- Tower-1 for Soudan.
 - ◆ 4 Ge and 2 Si ZIPs - all worked well.
 - ◆ Run 'b' at SUF uninterrupted from November '01 to June '02.
 - ◆ 66 livedays at 3 V bias = 28 kg days after cuts.
 - ◆ 52 livedays at 6 V bias = 21 kg days after cuts.
- All Goals achieved
 - ◆ Establish the contamination levels of the detectors before their installation at Soudan: acceptable.
 - ◆ Measured gamma and beta rejection efficiencies: better than proposal.
 - ◆ Measure the muon anti-coincident flux at SUF simultaneously with Si & Ge ZIPs: achieved.
 - ◆ Test Monte Carlo predictions of neutron suppression rates due to addition of internal polyethylene: Monte Carlos correct.



Photon and Neutron Calibration



The response of the detectors is best demonstrated with calibration photon and neutron sources



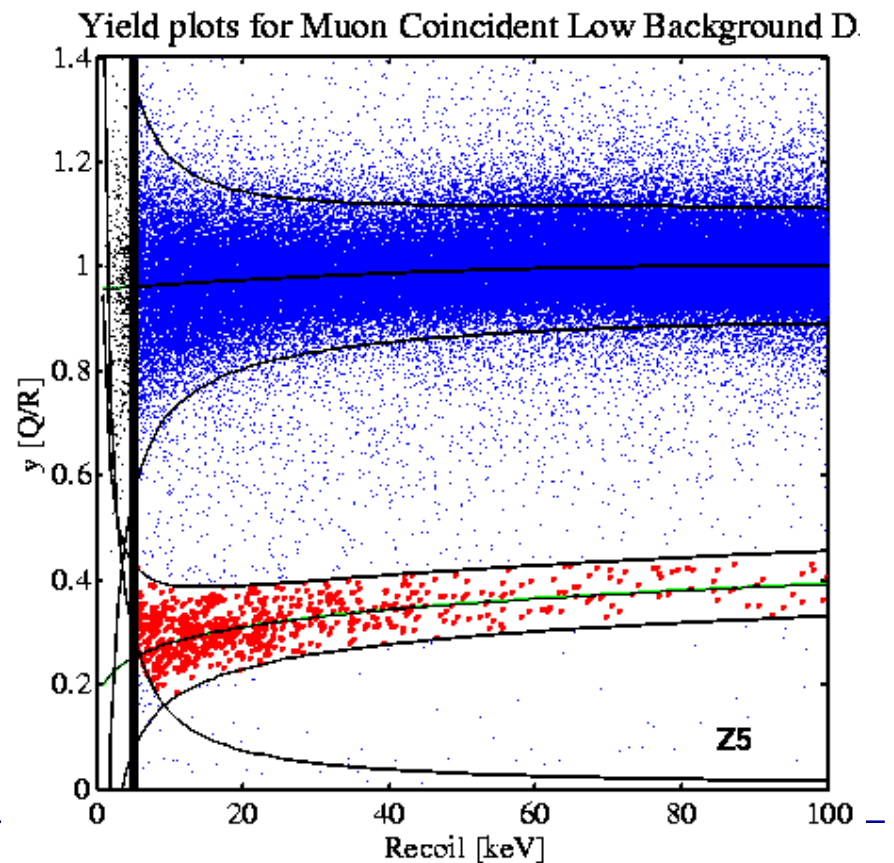
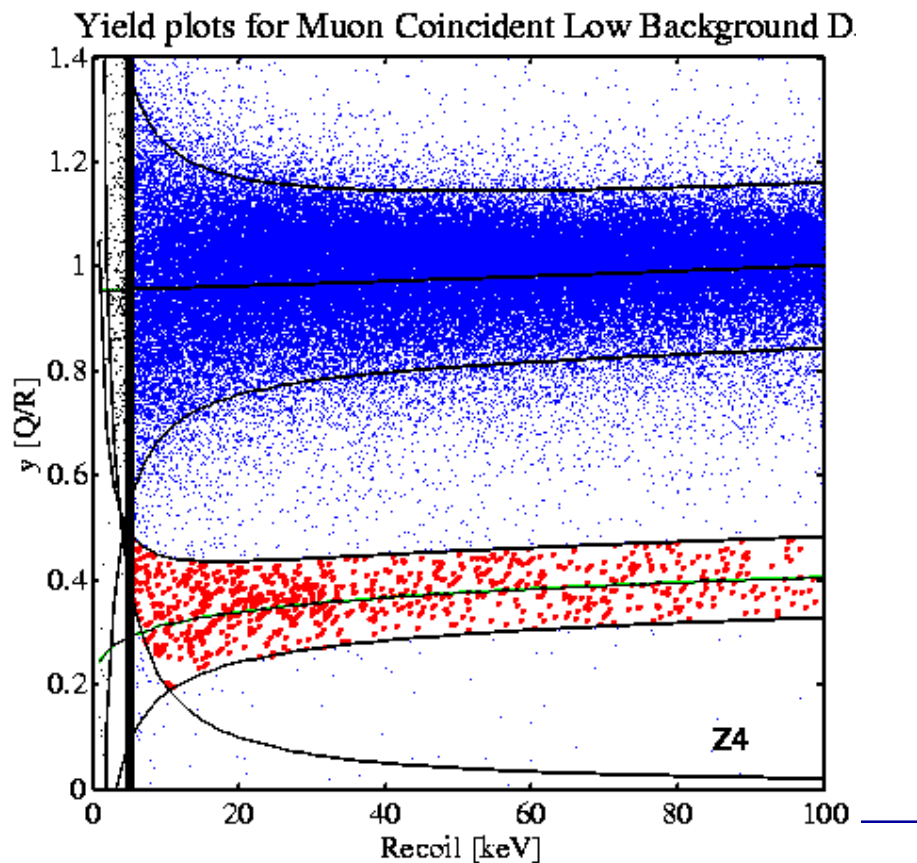
SUF 21 - Background Data



Yield plots for background data from the current run

– Muon Coincident Data

- Gamma background band is the dominant feature
- Muon coincident neutrons populate the nuclear recoil band
- A number of 'in between' events



SUF 21: internal muon-anticoincident neutrons



After Run 19, internal polyethylene added.

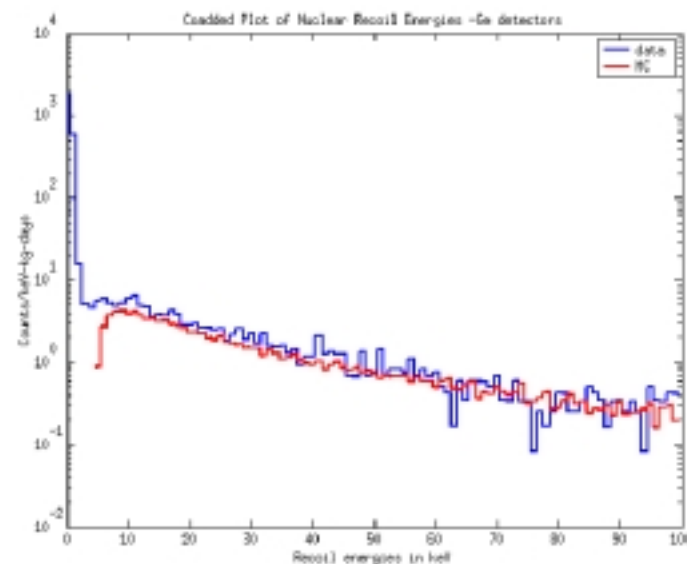
External, muon-coincident neutron rate dropped by a factor of 3.

Internal, muon-anticoincident neutron rate dropped by a factor of 2.3 - as predicted by the Monte Carlos!

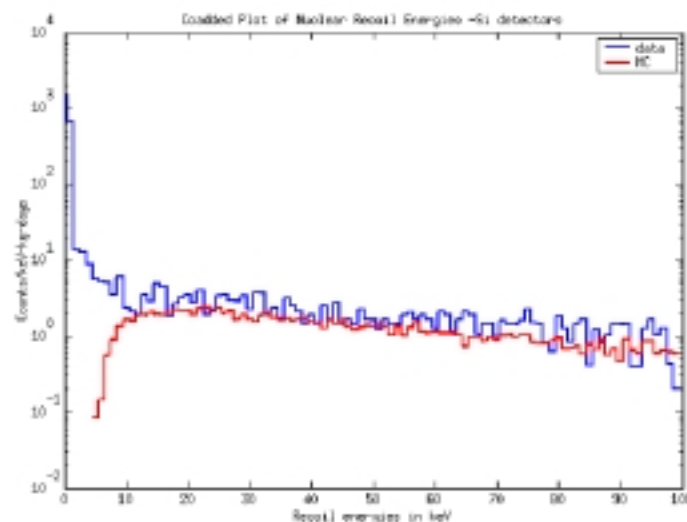
◆ Based on Run 19's 23 singles, 4 multiples in 15.8 kg days, expect ~17 Ge singles, ~3 Si Z4 singles, ~7 multiples in 28 kg days of Run 21.

◆ We see 20 Ge singles, 2 Si Z4 singles, 8 multiples in 28 kg days of 3 V bias data set of SUF Run 21.

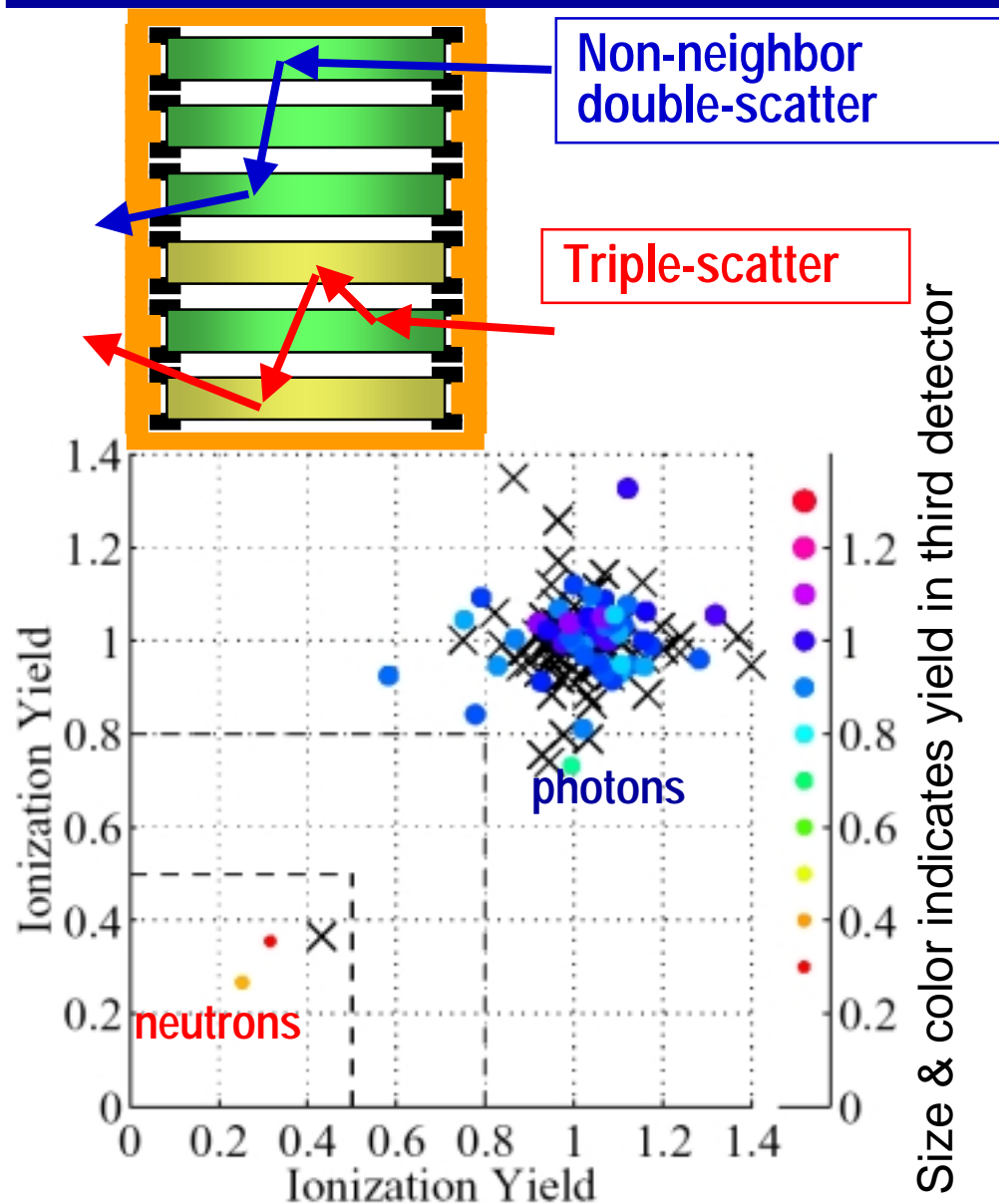
Coadded spectra for the Ge detectors – Data vs MC



Coadded spectra for the Si detectors – Data vs MC

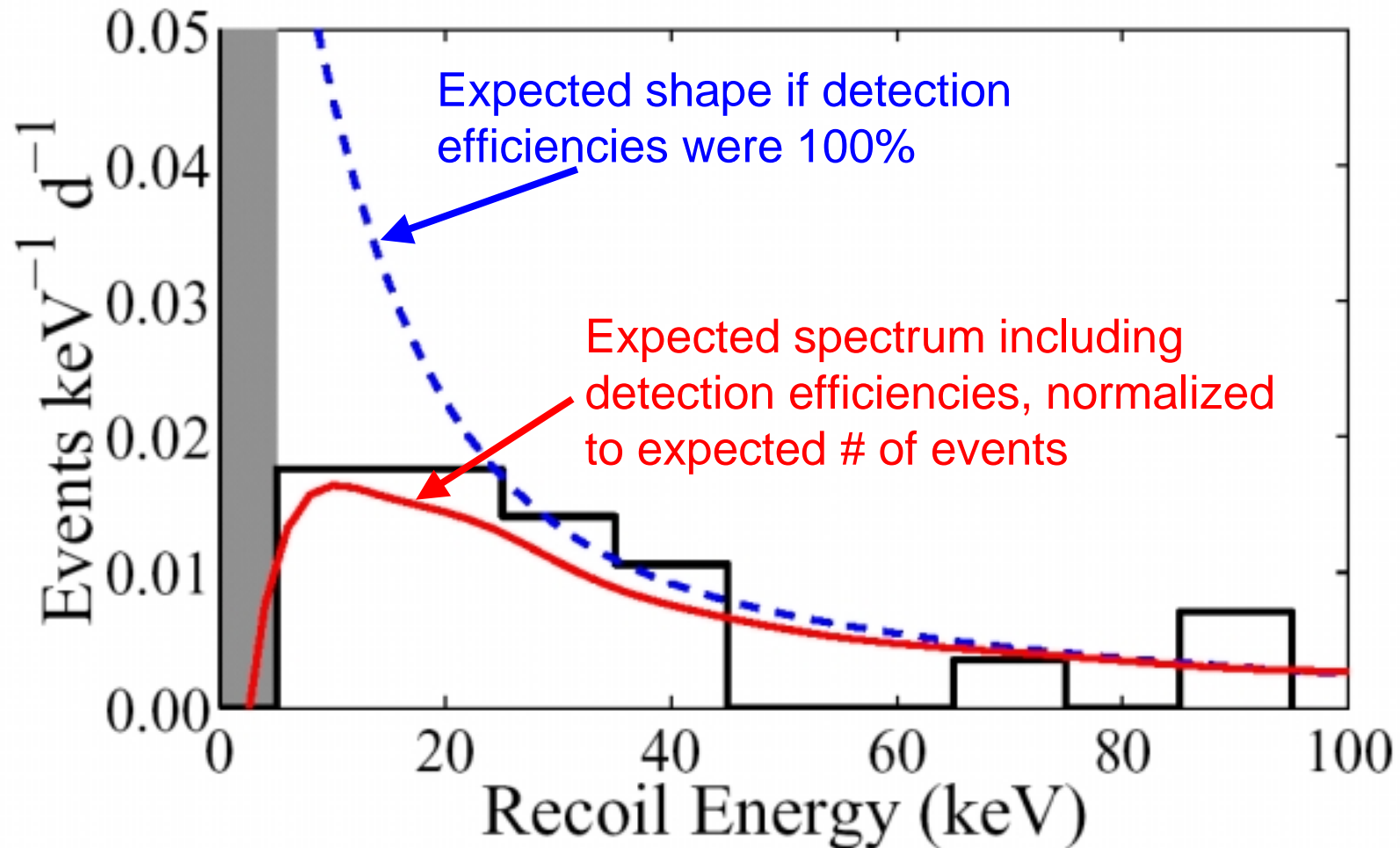


Neutron Multiple Scatters



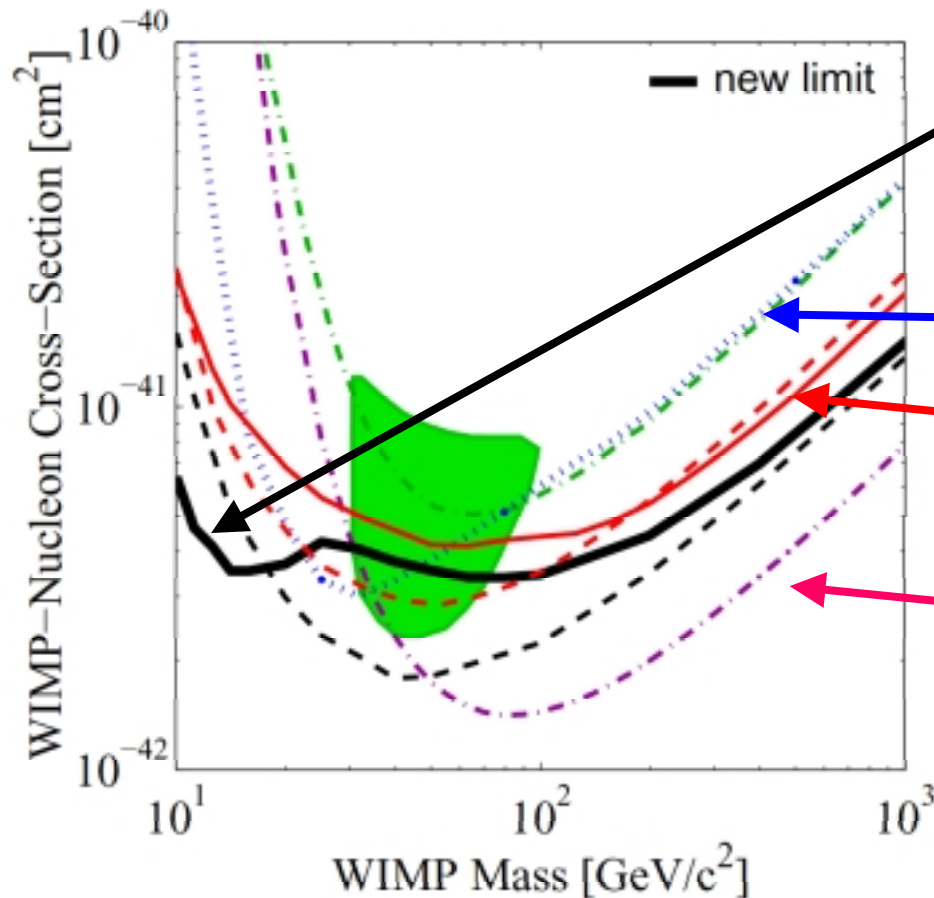
- **2 triple-scatter** (filled circles) and **1 non-nearest-neighbor double-scatter** NR candidates 5-100 keV
 - ◆ Ignore nearest-neighbor doubles because possible contamination by surface electrons
- Expect ~16 single-scatter neutrons per 3 multiple scatters
 - ◆ Implies many (or all) of 20 single-scatter WIMP candidates are neutrons

Energy Spectrum



- Energy spectrum agrees with expected neutron spectrum
 - ◆ Kolmogorov-Smirnof test indicates we should expect worse agreement 32% of time

3 V bias SUF Run 21 WIMP limit



New CDMS II 3 V bias SUF Run 21 limit, with neutron subtraction

SUF Run 19 limit

SUF Run 21 no neutron subtraction

Edelweiss 2002

•Exclude DAMA most likely points (x,o) at >90% even without neutron subtraction.

Expected sensitivities calculated from expected neutron background of 3.3 multiple-scatters, 18 single scatters in Ge, and an expected background in Si of 0.8 electrons and 3.6 neutrons.

Current and Projected CDMS Limits

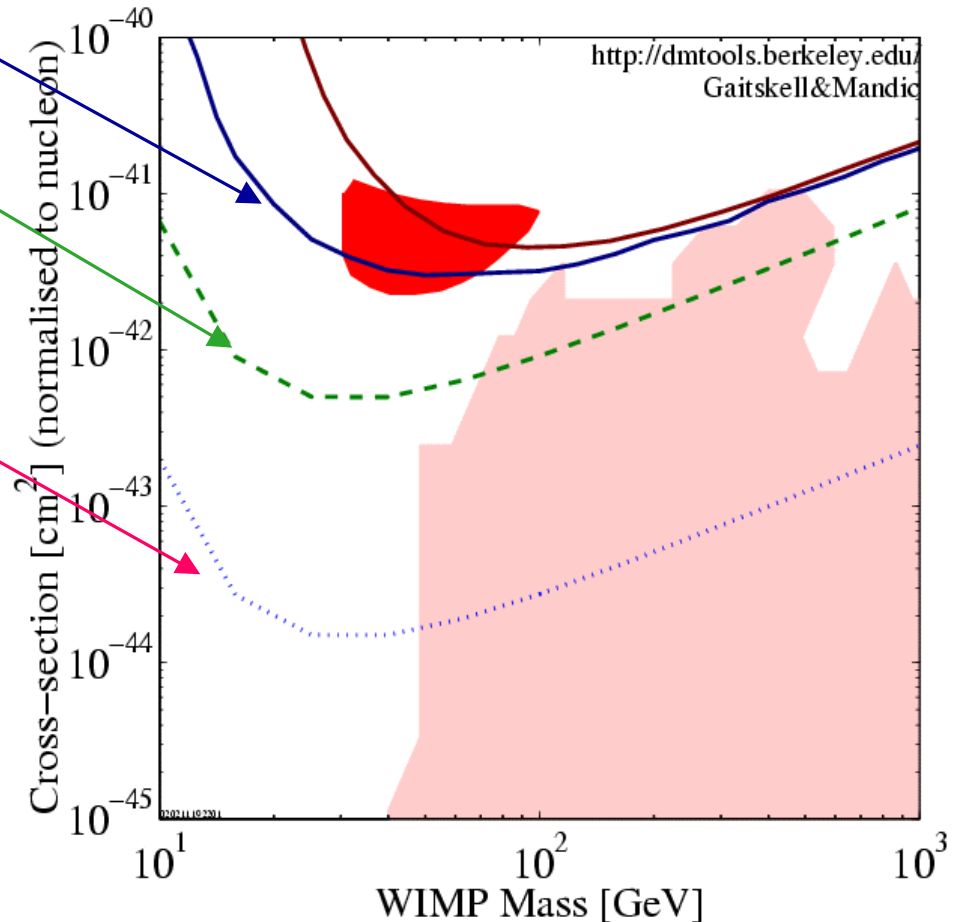


Current CDMS SUF R19 Limit

Projected CDMS SUF Limit

Projected CDMS Soudan Limit:
x 100 than present limit at SUF
(0.01 events/kg/keV/day).

- Increase detector mass by 10.
- Go deep, Cosmics down by 1000.
- Gamma leakage down by 2. (o.k.)
- Beta contamination down by 20. (?)



■ DATA listed top to bottom on plot
 ■ Edelweiss, 4.5 kg-days Ge(320g) June 2001 limit
 ■ CDMS Feb. 2000 ver. sub. to PRL
 ■ DAMA 2000 58k kg-days NaI Ann.Mod. 3sigma, w/o DAMA 1996 limit
 ■ CDMS, projected at SUF
 ■ CDMS, projected at Soudan mine
 ■ Baltz and Gondolo, spin indep. sigma in MSSM, without muon g-2 constraint
 020211102201

Soudan, Minnesota : The CDMS II Deep Site

See Poster D07 ...

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

Conclusions



- CDMS I (1995-1999)

- ◆ Results for **scalar-interacting** ($\sigma \sim A^2$) **WIMPs** probed are best upper limits of any experiment for the mass range 10 to 35 GeV.
- ◆ CDMS data are **incompatible** with DAMA signal at high confidence.
- ◆ Sensitivity limited by external neutron background from muons interacting in surrounding rock.

- CDMS II (1999-2005)

- ◆ Construction completed at deep site: Soudan, Minnesota.
- ◆ First tower of 6 detectors exceed performance expectations.
- ◆ Reduction of neutron background by factor of 2.3 due to installation of internal moderator in agreement with Monte Carlo predictions.
- ◆ More work required on surface-beta rejection/identification/subtraction in order to fully utilize deep site?
- ◆ Towers 1 & 2 now installed at Soudan, first dark