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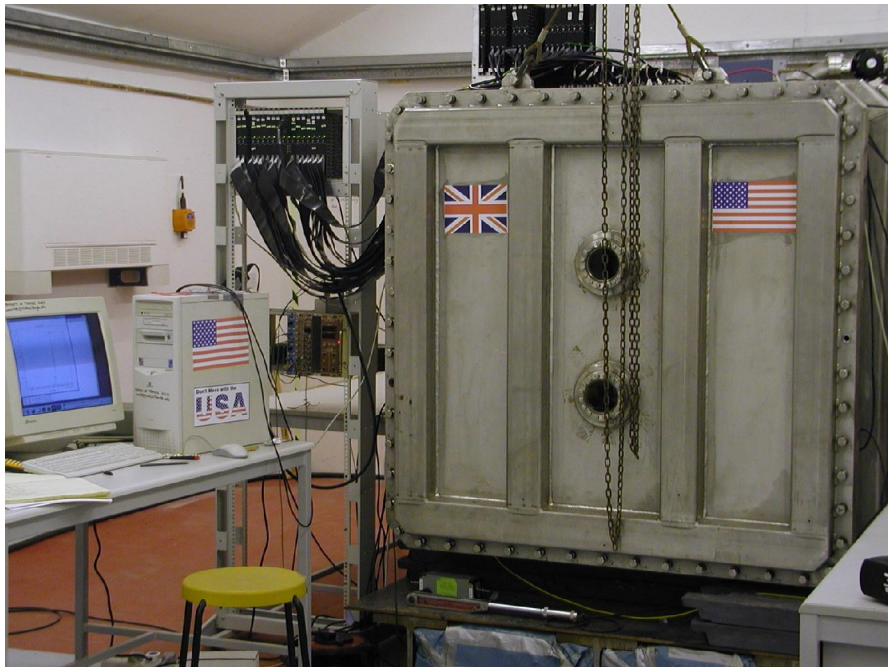
DRIFT I Differential Shielding Measurement at 3000 mwe

DRIFT proposals based on zero "accepted background" in a year.

Expected DRIFT I neutron rate in Boulby [mostly (α,n) from U, Th in salt] is ~ 1 per day.

THEREFORE....

...<u>we need neutron shielding to achieve proposal goals</u>.



Unshielded vessel

With .5m (8 tons) CH_2 shielding (installed March 23, 2004)

We also need to prove we can see the mine wall neutrons at 1/day.

- Where does 1/day come from?
  - CJM, DS-I used LNGS neutron measurements to predict rate 2/day before installation; shielding installed beneath vessel on Day One
  - RAL collaborator Peter Smith using home-brew FAUST Monte-Carlo and measured U, Th in Boulby also predicts 1-2 per day
  - GEANT 4 calculations by Sheffield students provide yet another check

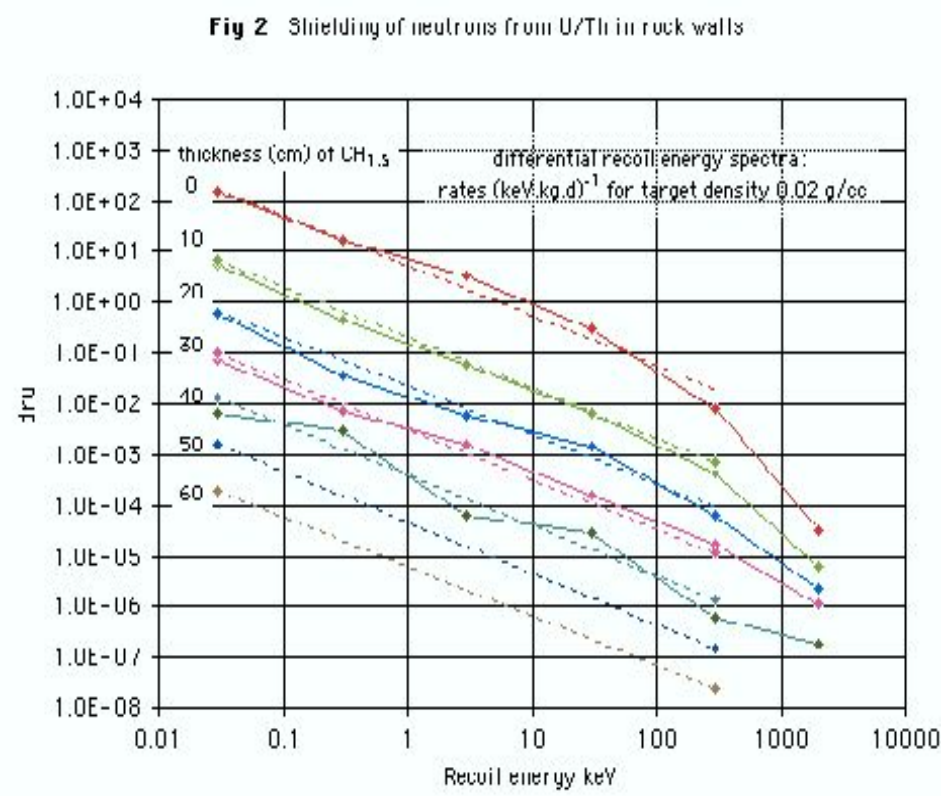
All models predict consistent rates

Cavern Neutron Spectrum

energy bin		flux normalised to 1	normalised flux per keV
from (keV)	to (keV)		
10	16	0.05	0.0081
16	25	0.06	0.0068
25	40	0.06	0.0041
40	62	0.07	0.0033
63	100	0.11	0.0029
100	160	0.12	0.0020
160	250	0.15	0.0016
250	400	0.12	0.0008
400	620	0.10	0.0004
650	1000	0.05	0.0001
1000	1600	0.05	0.0001
1600	2500	0.04	0.000004
2500	4000	0.02	0.000002
4000	6000	0	0

units of 4e-6 n/cm^{2}sec

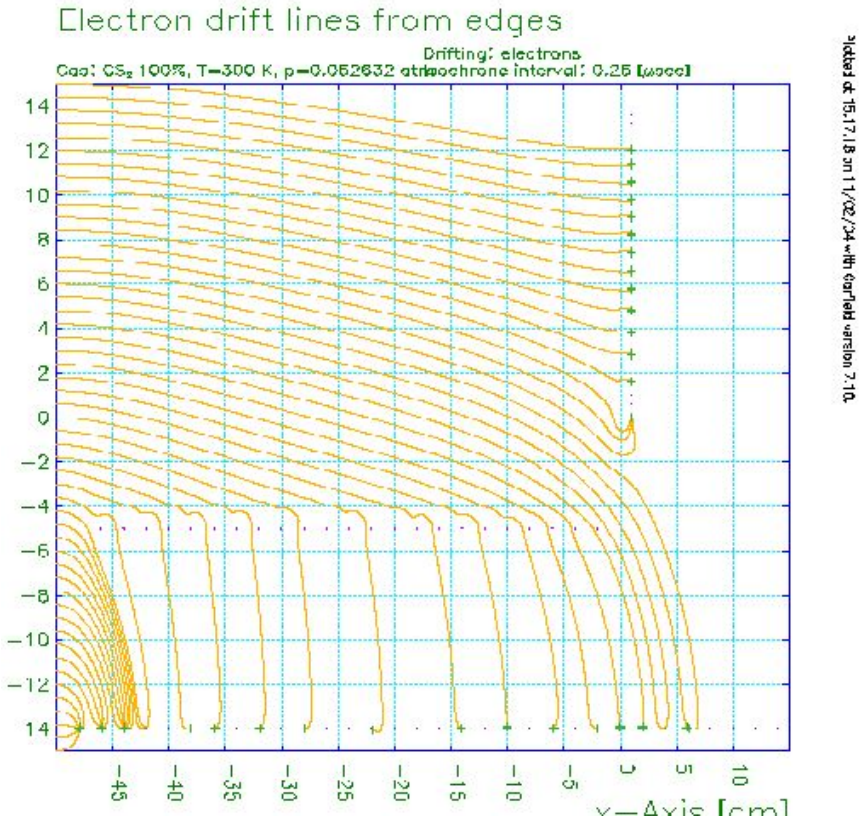
C, S Recoil Energy Spectrum



...but first we had to overcome a few difficulties

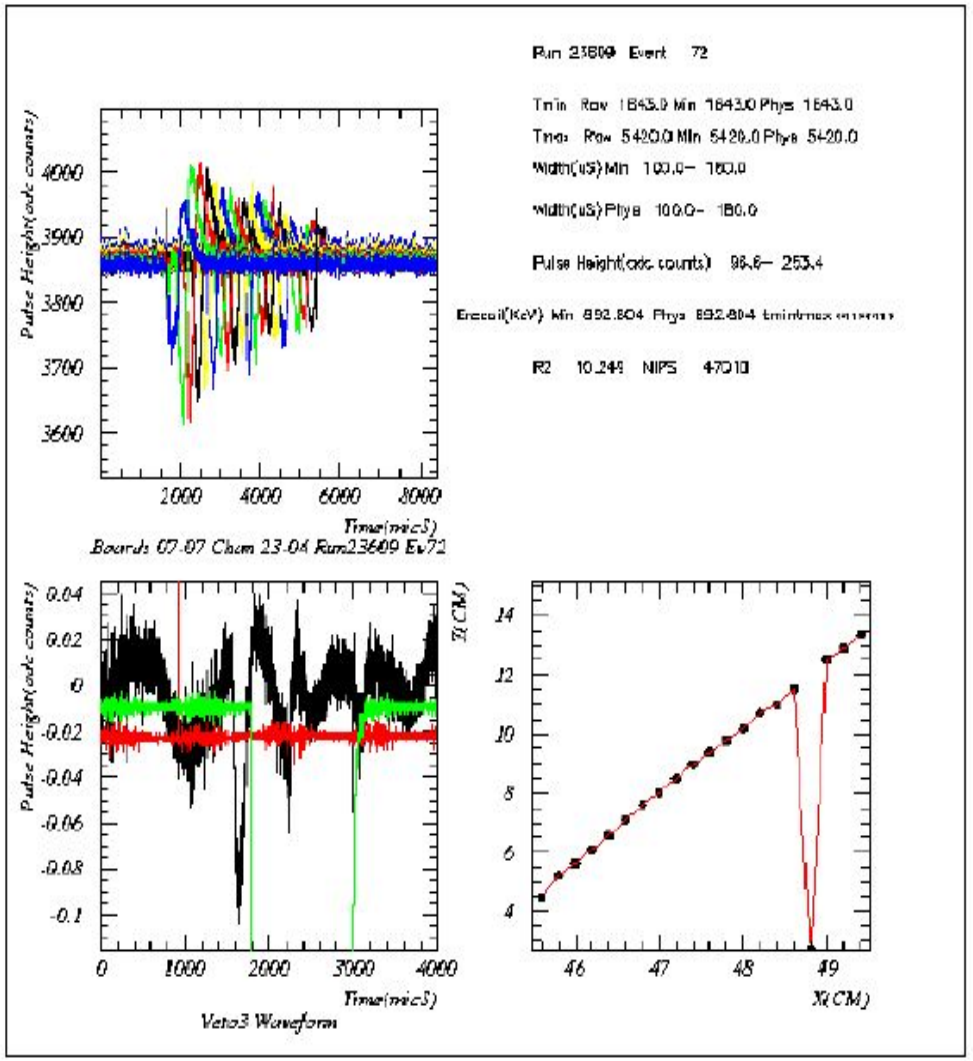
- Mechanical creep in low-background, all-plexiglass MWPC distorted wire tensions
  - only understood after long period of trauma with breaking wires, yeoman labor by UK collaborators
- Persistent vacuum leaks led to more unreliability and noise
- Several iterations of DAQ cabling needed to reduce noise
- Endcap boundary veto system was not working
  - allowed significant “sneaker alpha” background

Stable Running Achieved



- Each problem had to be fixed
  - MWPC futher rigidified
  - feedthru mechanism completely reworked
  - cabling optimized
  - vacuum leaks tracked down and fixed
  - drift field and amplifier configuration changed for vetoes

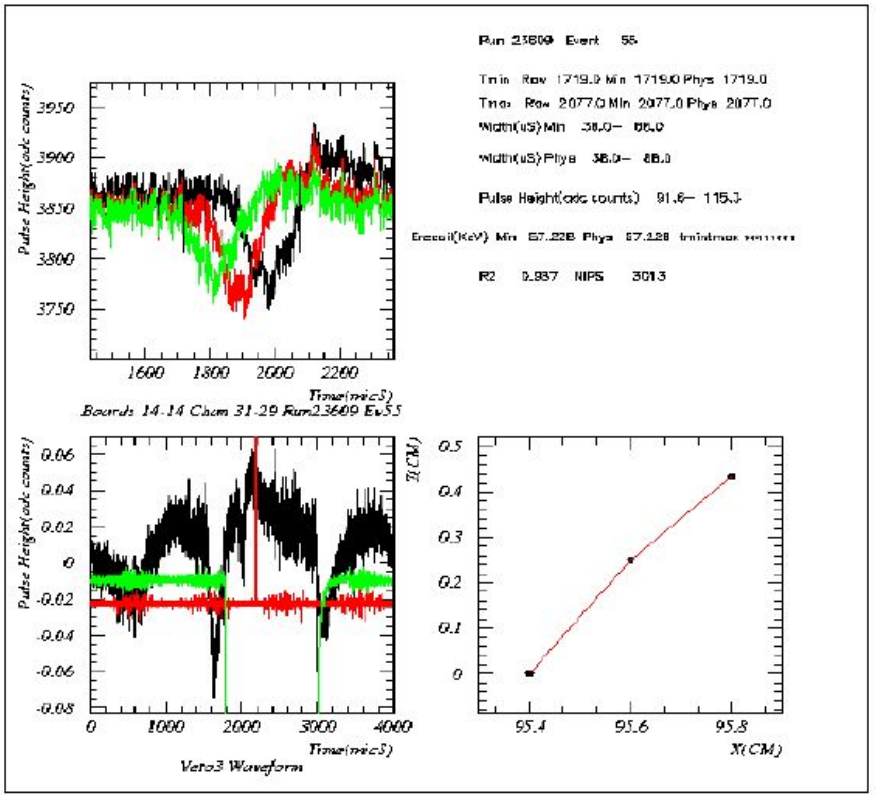
Present Status Summary



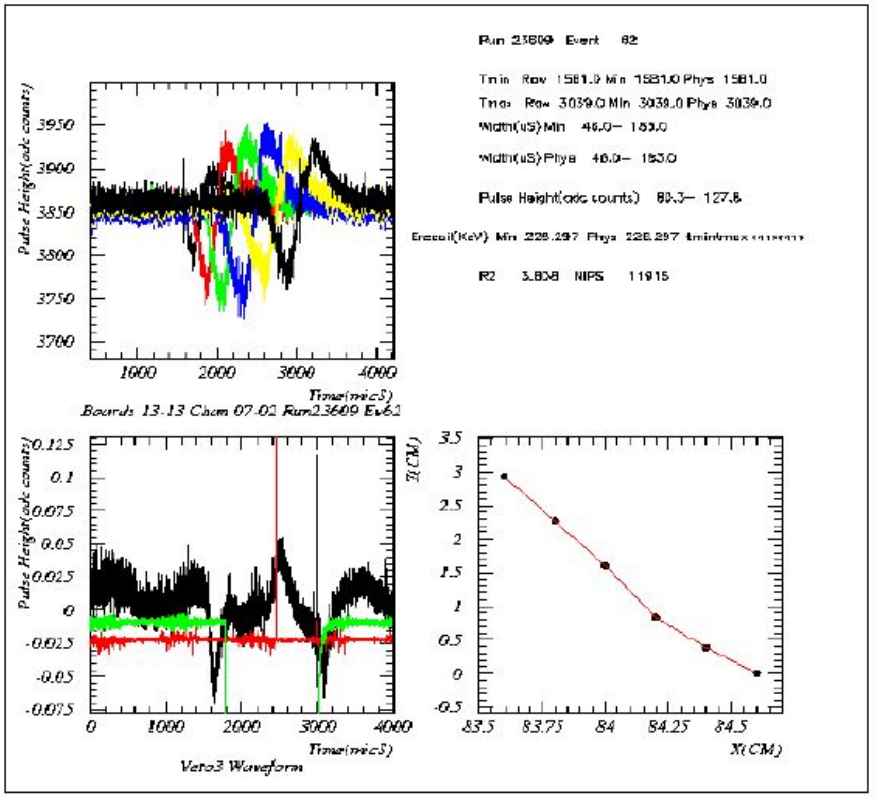
- Running 24/7 unattended with hardware + s/w vetoes since 13 Feb 04
  - 156 GB new data recorded
  - ~ 31,000 triggers
  - raw trigger rate below .05 Hz
  - no more problems!
- Remote location and time pressure of this meeting dictated very conservative approach:
  - Design pressure 40 T -> 60 T now
  - MWPC voltage reduced from nominal 60 T setting

Discrimination With Vetoes

Vetoed “sneaker alpha”

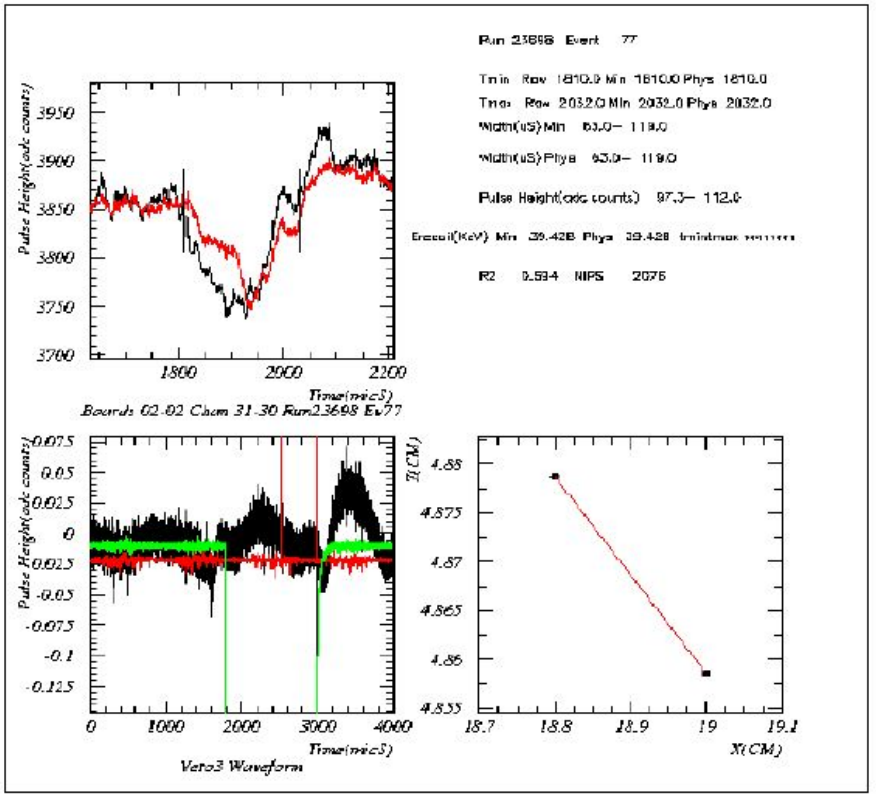


Alpha Bragg peak with veto

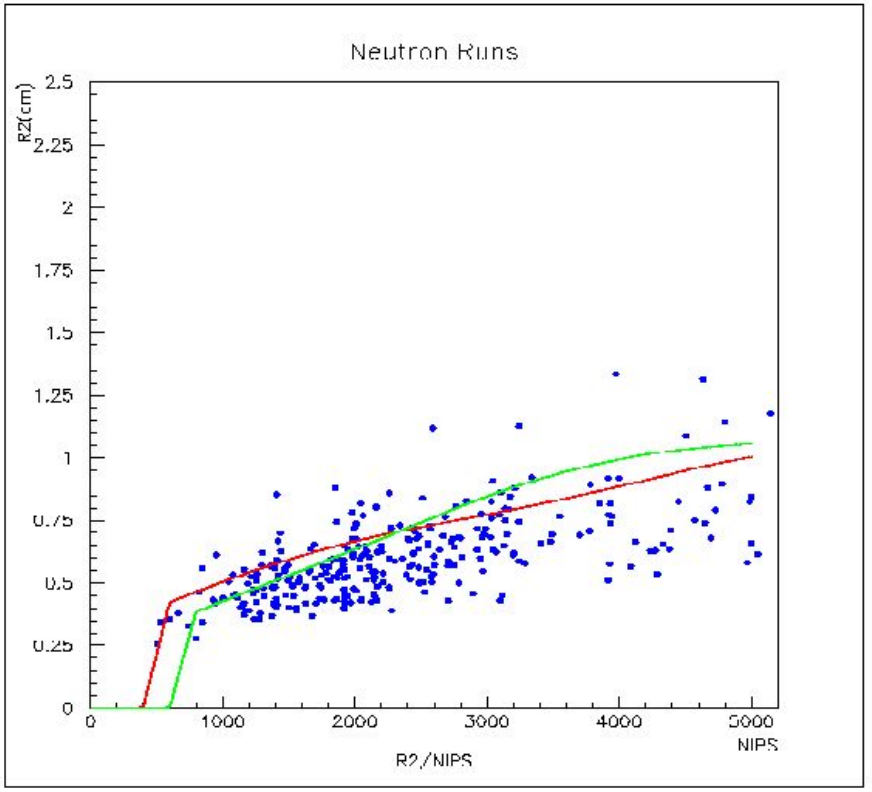


More Events

Clean neutron recoil



Range-Energy from 252-Cf source (shielded, no software veto)



green; unshielded n 90% limit

red: shielded n 90% limit

Analysis Procedures

```
reduce ON
!
! Analysis cuts
!
! Upper and Lower character case is significant
!
ReboundCut              ON  0.  2.0
HitToGroundCut          ON  150.  in adc counts .
ClippingCut             ON  33.  4095.  Saturation Vmin and Vmax
HFFWHMCut               ON  50.0 in uS
SparkNearByCut          ON  5.0 minimum Delta between two pulses in uS.
RingerCut               ON  MaxSamax & CrossLineFromBase% 30.0
MinimumDelToTime 15
RightWireCut            ON  8 Fibre of wires
ZeroClipCut             ON   10.0 Zero fluctuation in adc counts
TimeMinCut              ON   Tmin 1000.0 Tmax 3000.0
AdjacentCut             ON   1 wires pitch .
BASELINECUT             OFF -10.0 10.0
RMSCUT                  OFF -2.0 0.0
VETOCUT1                ON   -.07 20.0 20.0
VETOCUT2                OFF 0.0 20.0 20.0
SIDEWIRECUT             ON    16  16
RiseTimeCut             ON    27.5 300000.
AsymCut                 ON    -2.  10000.  0.  1.50  .25
VisualCut               OFF
PROCESSCUT              NO
! Run type:  Pmt55 = 2, Wimp = 5  Neutron = 4
RUNTYPE                 5
```

DST produced; then 14 simple, fully automated cuts applied

Bottom Line

unshielded:	live time	events
	254724	4
	97258	2
	134714	3
	11496	0
	11601	3
	258284	9
total sec	768077	21
total days	8.89	
total rate	2.36 per day	
	0.52 unc.	

shielded:	live time	events
	244854	4
	37149	0
	265009	4
	242984	3
	74262	0
	864258	11
	10.00	
	1.1 per day	
	0.33 unc.	

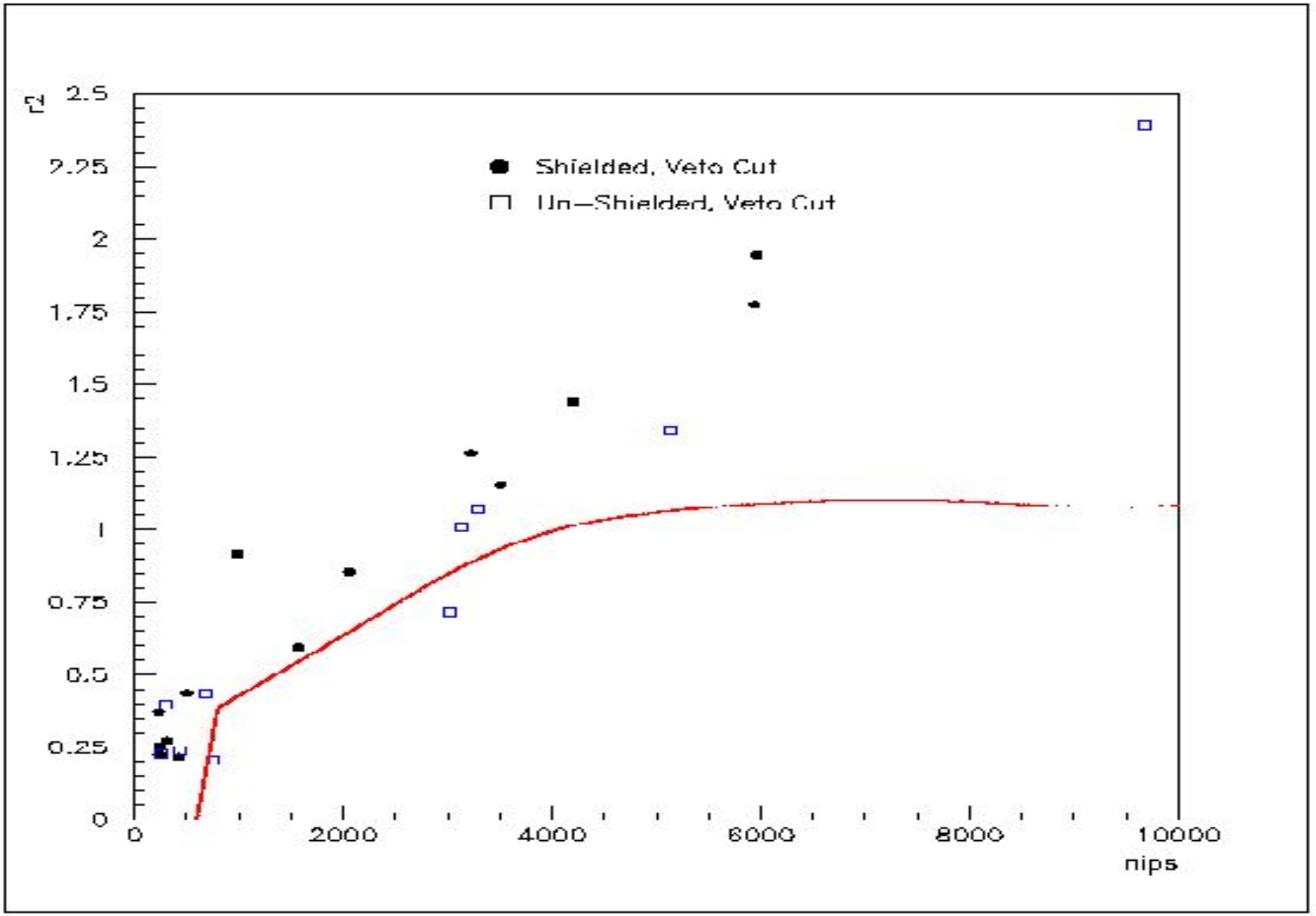
shielding effect:

1.26 ev/day

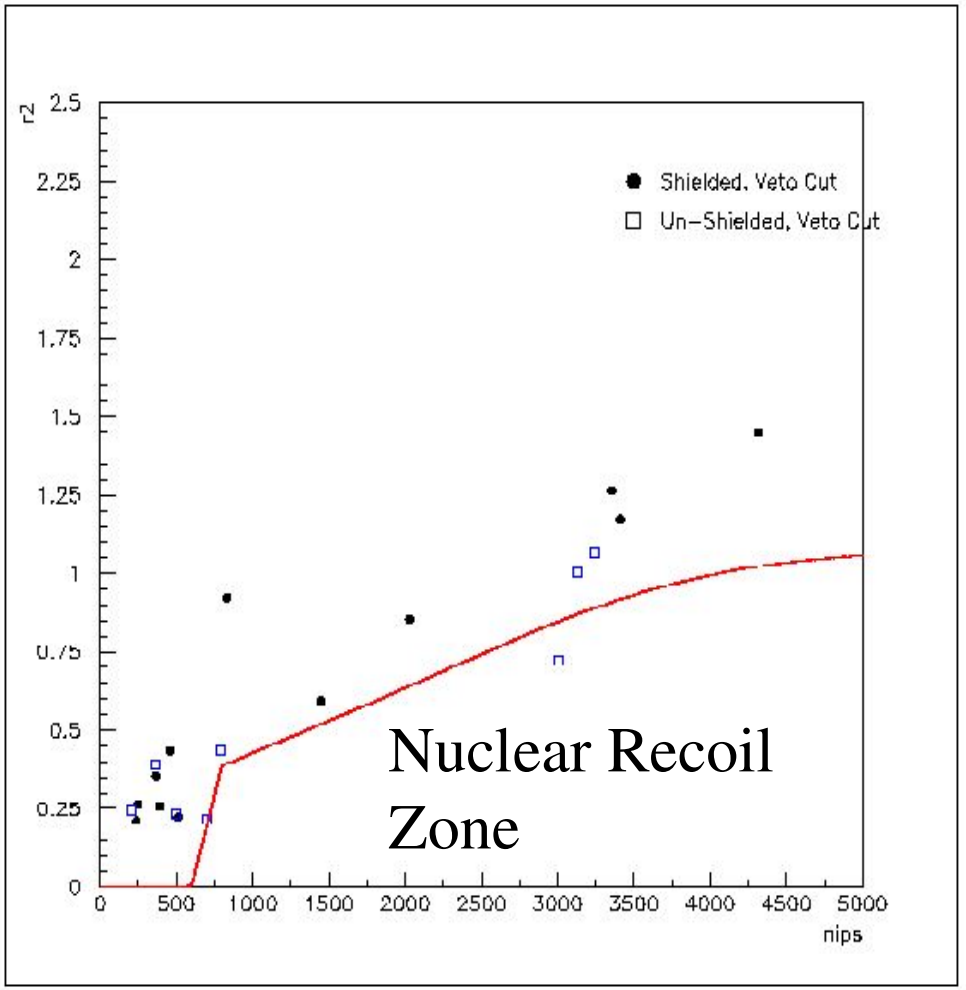
0.61 unc.

Two independent analyses (Temple, Oxy-Sheffield) consistent on this effect.

Accepted Background: still zero

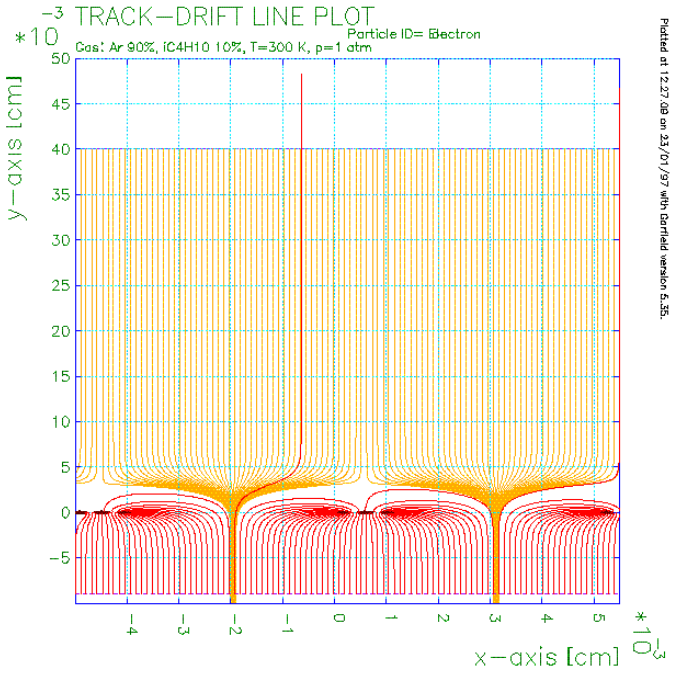


Focus on WIMP region



- At 60 Torr, discrimination below 1000 NIPS is difficult
- One event in 9 days unshielded data looks like a room neutron
- 5 more below 1000 NIPS are probably neutrons
- This is consistent with shielding effect in gross rate

Future of DRIFT



- Continue to run DRIFT I until background shows. May return to design P, V_{MWPC}
- R&D for 100 kg or larger device is crucial
  - HIGHER SPATIAL RESOLUTION
  - MORE TARGET DENSITY
  - 1 BAR OPERATION

Micropattern Detectors and Helium Mixtures

- NI drift and gain works fine with GEMs (physics-0310124 Miyamoto et al [with CJM; experiments run at Temple]
  - allow pixelization to few 100 um with row-and-column readout
  - MicroMegas now in development at 3M
- Helium buffer gas allows NI drift and gain at total pressure 1 bar (see CJM talk at http://www.unine.ch/phys/tpc.html)
  - NO vacuum vessel- great cost and BG savings