

LOW TEMPERATURE DETECTORS: YESTERDAY, TODAY , TOMORROW

Ettore Fiorini , Genova , July 7, 2003

Only a few application in fundamental physics, and a few personal recollections

T.Niinikosky observe a peculiar effect

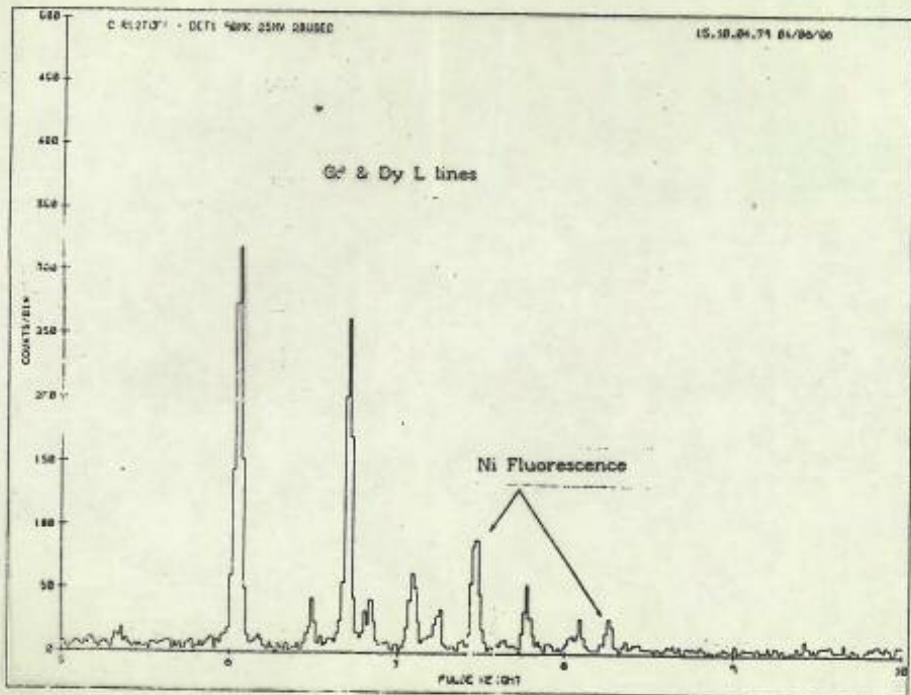
E. F. an T. Niinikoski

Dan McCammon et al

Dinner with B.Sadoulet

Excellent resolution





A few very important applications in fundamental physics. Obvious interest of
holometers in **astrophysics**. Measurement of **light** with a FWHM resolution of a
fraction of eV. Large arrays for **cosmic X and γ rays**. Future missions

SINGLE BETA DECAY

NEUTRINO MASS

S.Vitale 1985 **Now Genoa and Milano**



RECENT RESULTS

$m_e < 15.6 \text{ eV}$

Entire spectrum. Negligible molecular problems

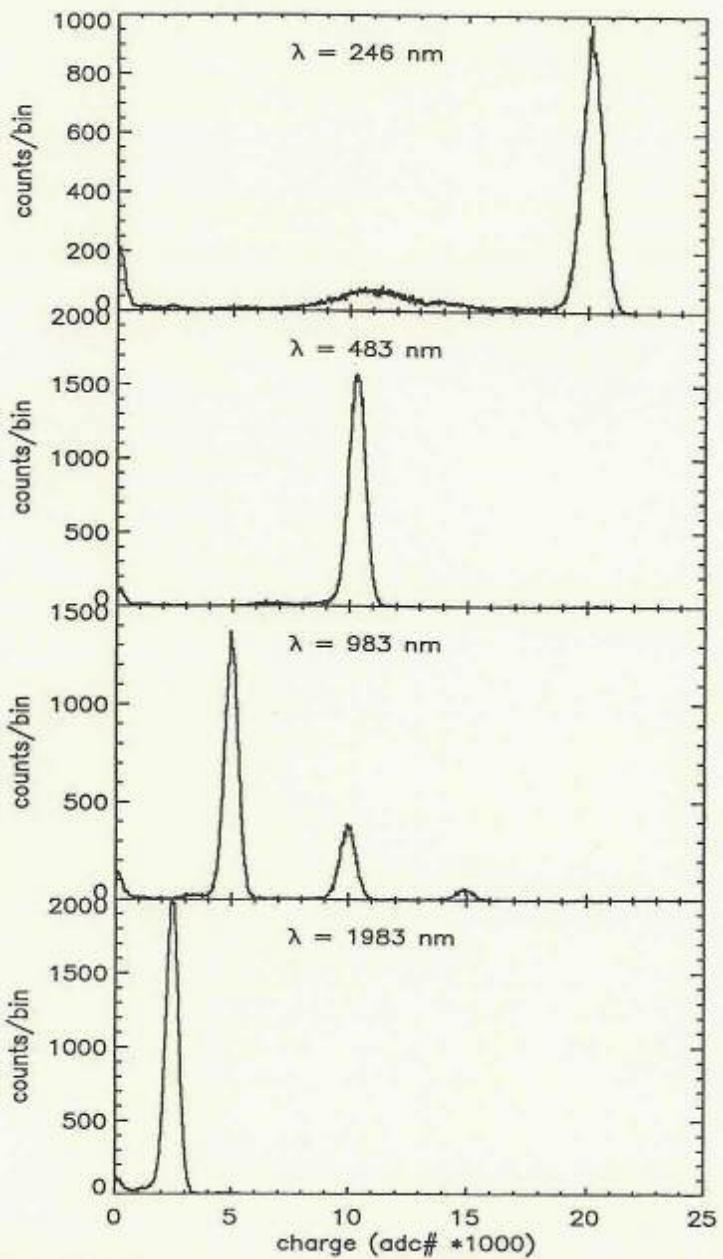


Fig.1. Single photon spectra at four wavelengths recorded with a $20 \times 20 \mu\text{m}^2$ STJ ($T=0.30 \text{ K}$, $V_{bias}=0.10 \text{ mV}$, $B=0.0075 \text{ T}$). The broad structure at lower pulse heights in the 246 nm spectrum is caused by false light from the monochromator. The three peaks in the 983 nm spectrum correspond to three grating orders of the monochromator ($\lambda=983, 983/2$ and $983/3 \text{ nm}$).

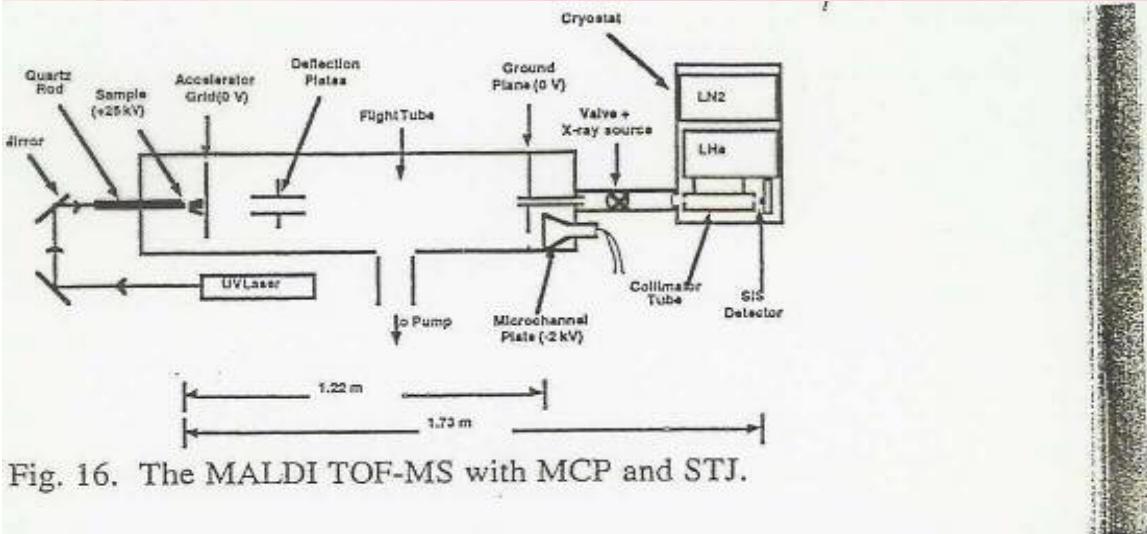
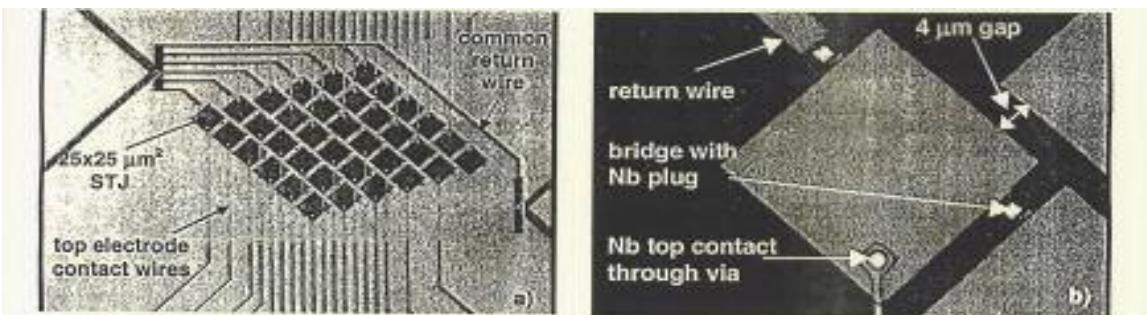


Fig. 16. The MALDI TOF-MS with MCP and STJ.

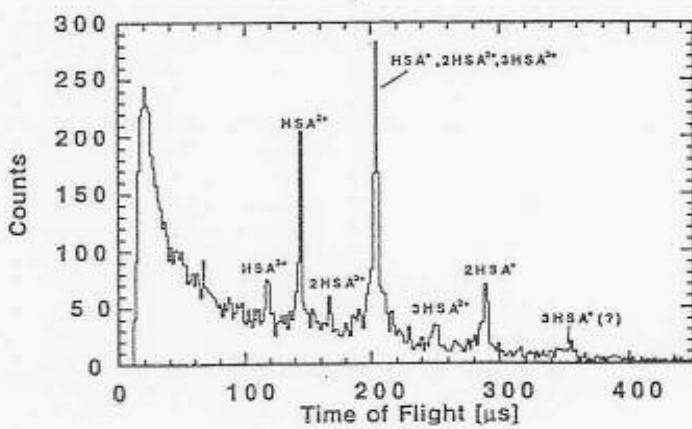
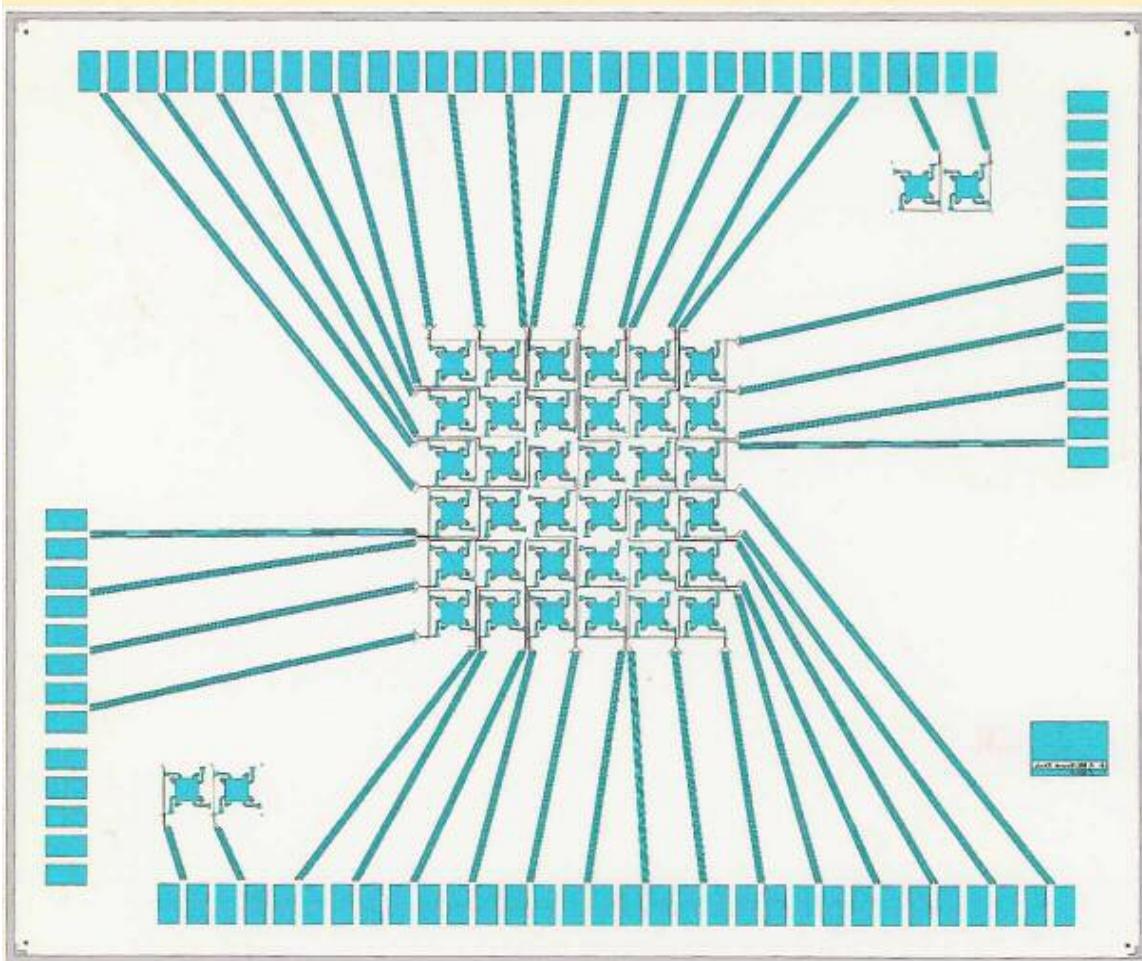
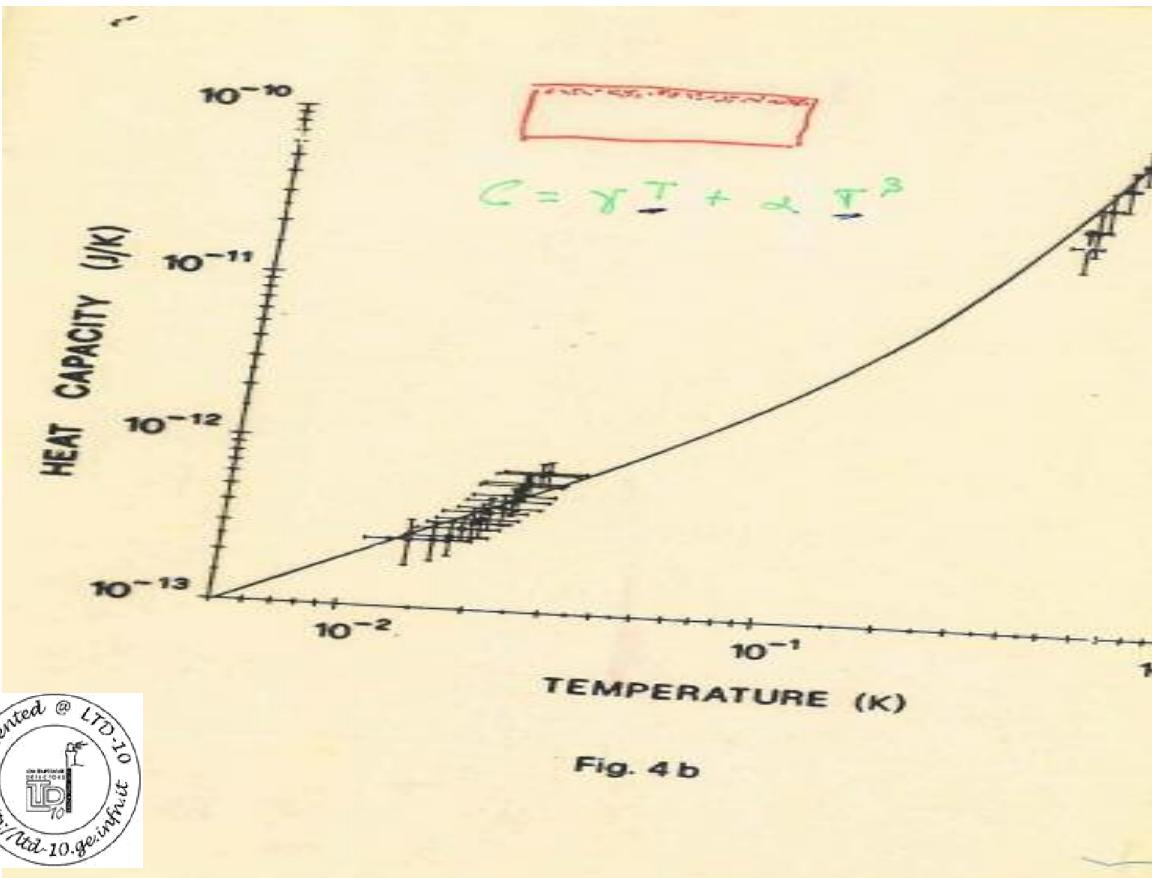


Fig. 17. The mass spectrum of human serum albumin measured with an STJ detector.





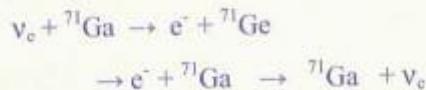
Search for the 17 keV neutrinos

BETA ENVIRONMENTAL FINE STRUCTURE

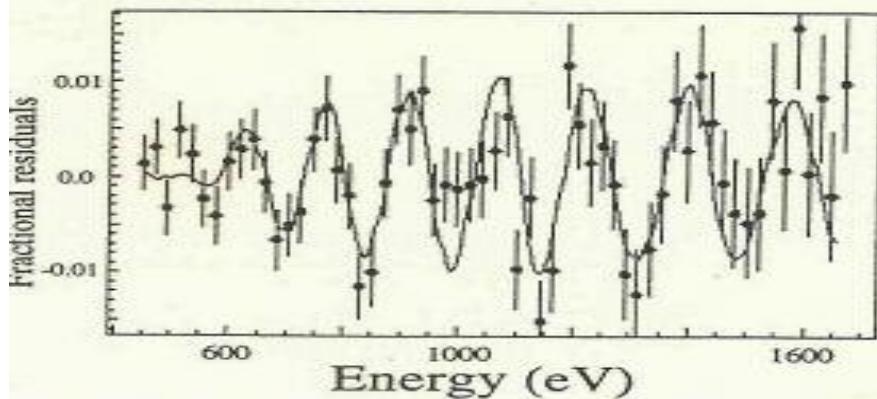
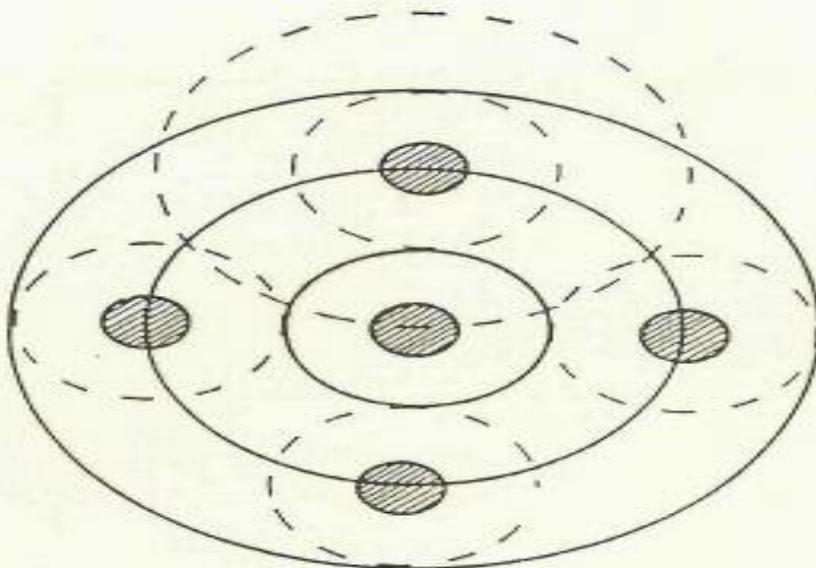
Electron capture of ${}^7\text{Be}$ and ${}^{263}\text{Ho}$

For solar neutrinos

Measurement of the X rays produced by solar neutrinos in the reaction



Dots are



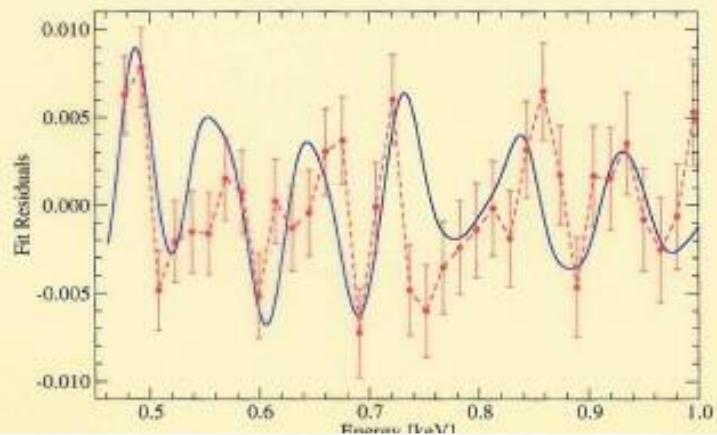
Milano neutrino mass experiment

Beta Environmental Fine Structure (BEFS)

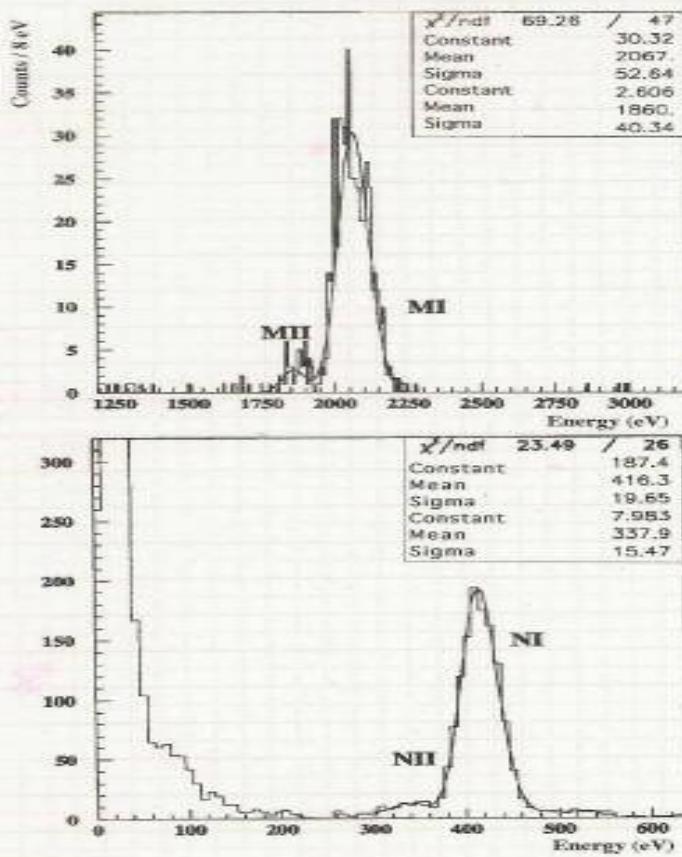
Theoretical prediction for $\Delta E_{FWHM} = 30\text{eV}$

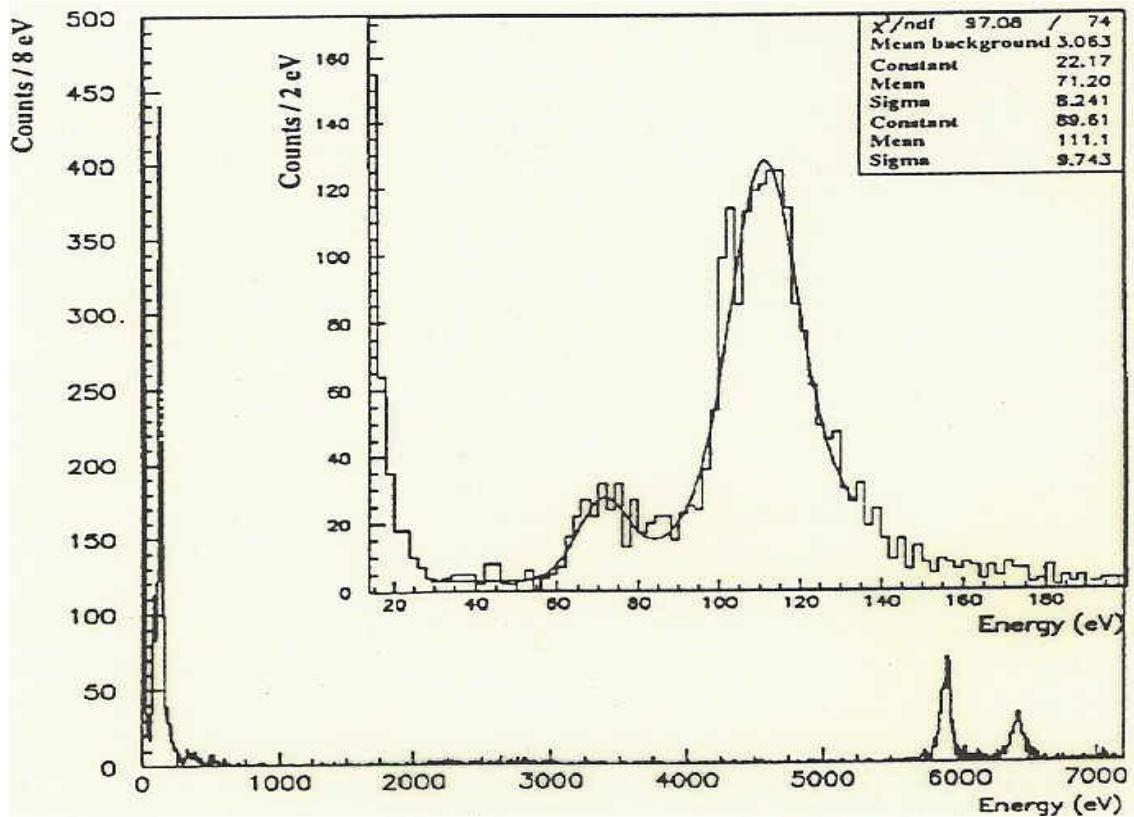
Experimental data:

- threshold: 470 eV
- statistics: 32157 h \times det



Ho 163 Electron Capture Lines





α - DECAY

Excellent resolution

~ 4 keV @ ~ 5.400 MeV



Discovery by scintillation + heat that ^{209}Bi is not stable

Measurement of very weak contamination in lead

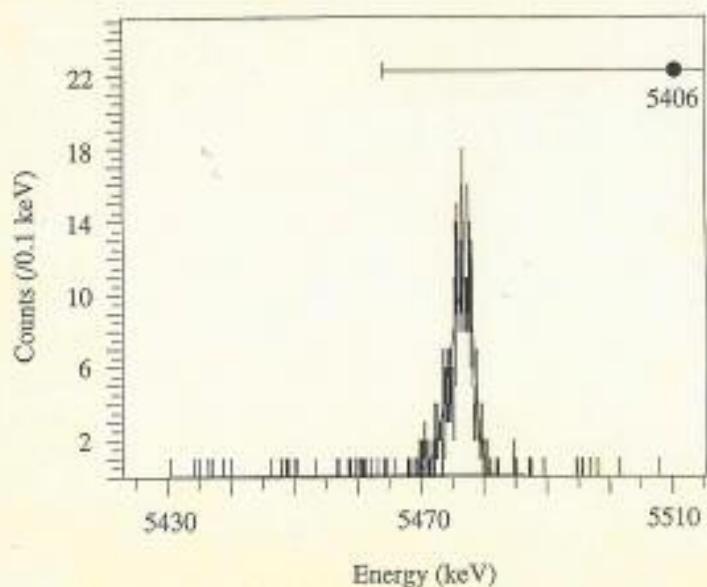
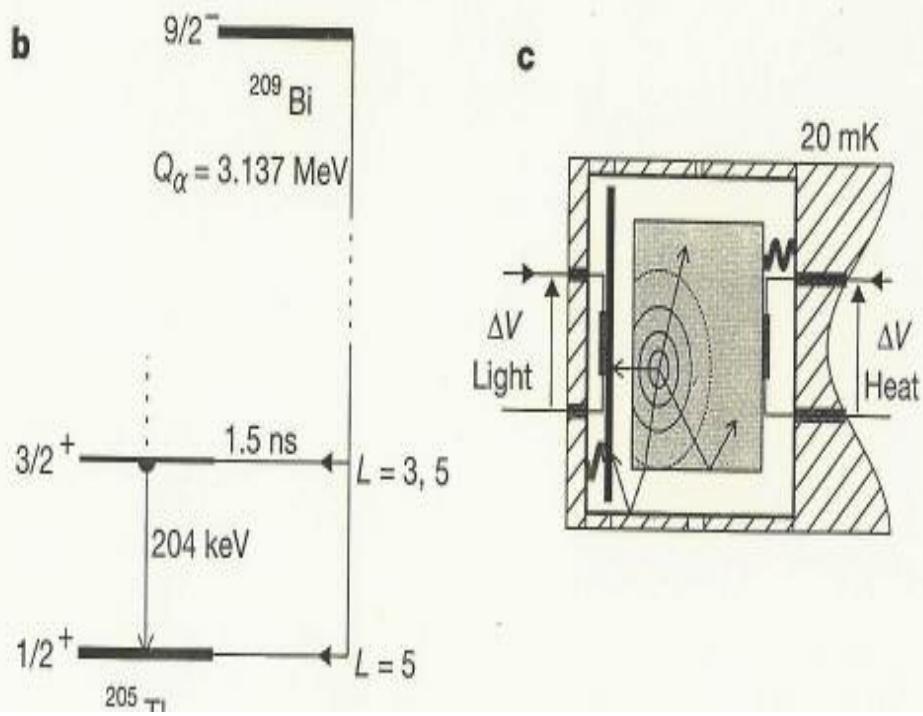
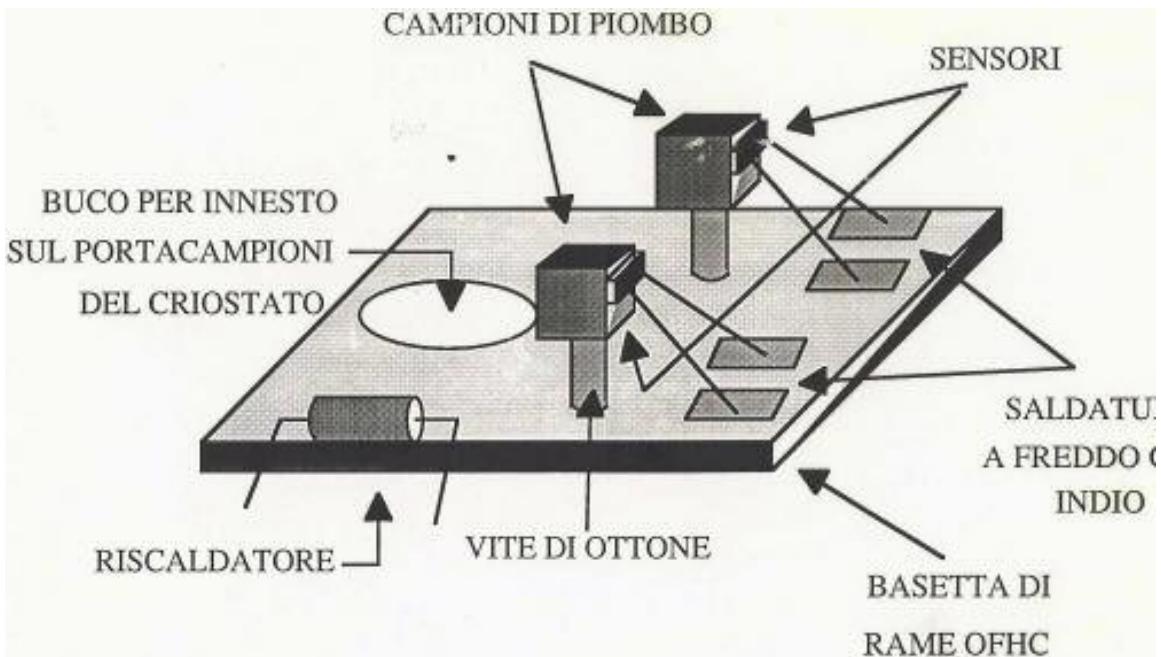
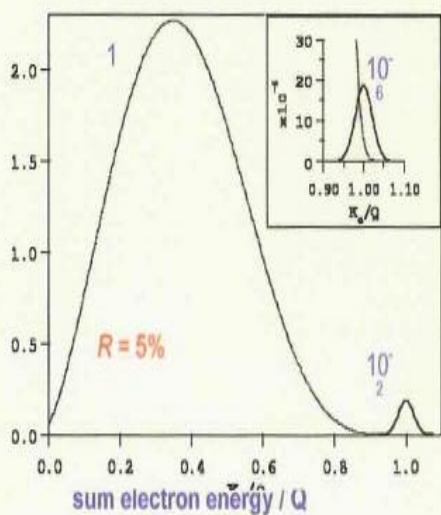
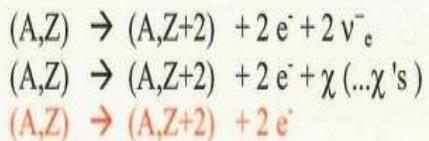


Fig. 3



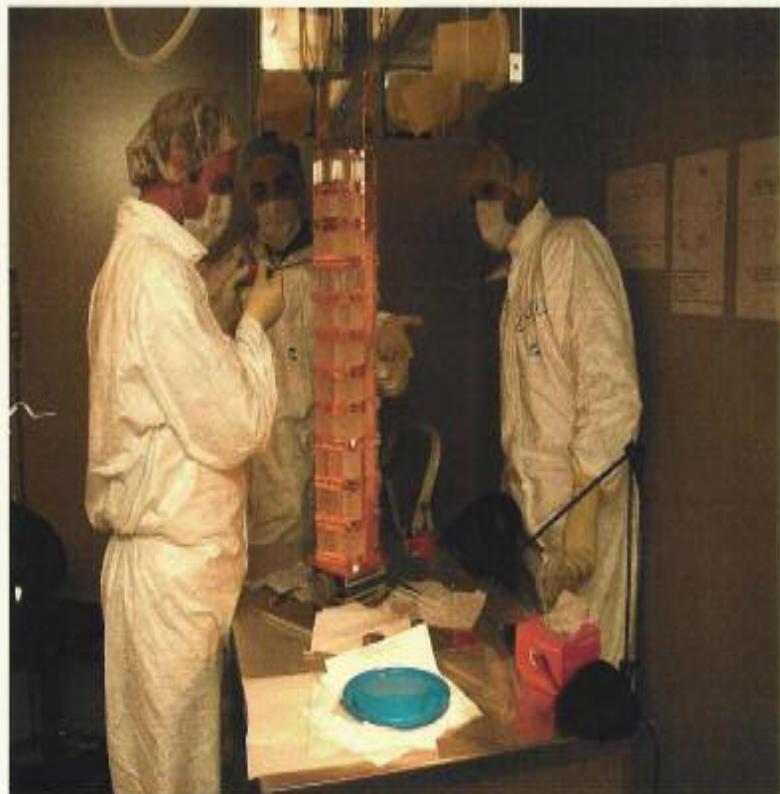


DOUBLE BETA DECAY



Compound	Isotopic abundance of the candidate nucleus	Transition energy
⁴⁸ CaF ₂	.0187 %	4272 keV
⁷⁶ Ge	7.44 "	2038.7 "
¹⁰⁰ MoPbO ₄	9.63 "	3034 "
¹¹⁶ CdWO ₄	7.49 "	2804 "
¹³⁰ TeO ₂	34 "	2528 "
¹⁵⁰ NdF ₂	4.64 "	3368 "

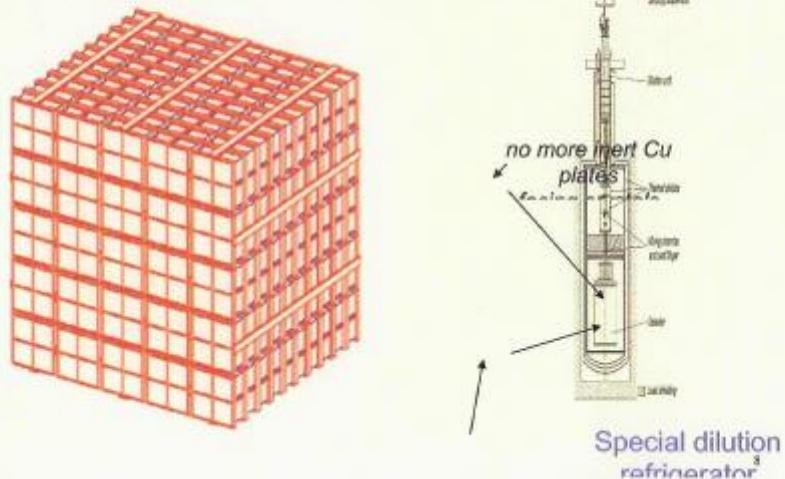
CUORICINO $\tau > 5 \times 10^{23}$ years for ¹³⁰Te $\Rightarrow m_\nu < 0.6$ eV



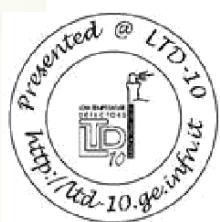
FUTURE

CUORE

CUORE : an array of 1000 natural crystals of TeO_2 of $5 \times 5 \times 5 \text{ cm}^3 \approx 790 \text{ kg}$ to study double beta decay of ^{130}Te . They have been already tested $\Delta E = 46 \text{ keV} @ 46 \text{ keV}$ and $3.2 \text{ keV} @ 5.4 \text{ keV}$



DARK MATTER \Rightarrow DIRECT DETECTION OF WIMPS



THE ALBERTSON COLLEGE DIRECT DARK MATTER DETECTION TEAM

Art...



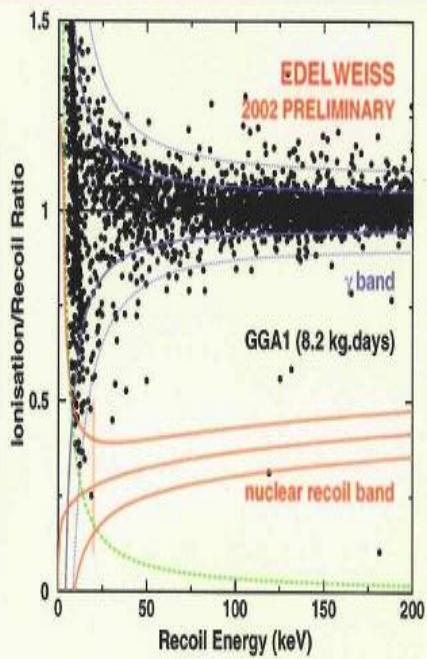
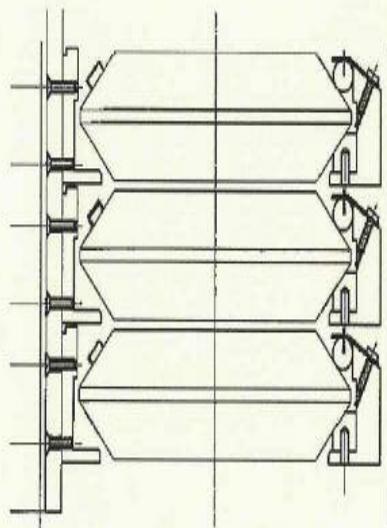
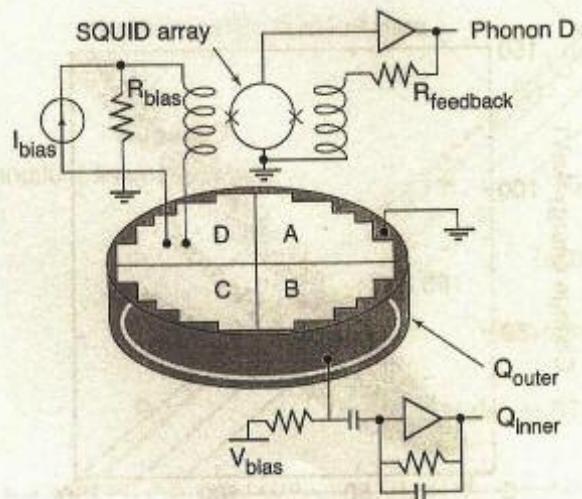
Dark Matter - Columbia - Apr 2009

Rick Gaitskell

From Rick Gaitskell

CRYOGENIC DETECTORS

IONIZATION+HEAT



Increased statistics, but three possible candidates. Limit remain the same!

THE FUTURE (obviously including the running ones)

CDMS II	5 kg Ge + 2 Kg Si	Soudan
CRESST 2	2- 10 kg CaWO ₄	Gran Sasso
EDELWEISS 2	2-21 kg x 320 Ge > 120 kg Ge	L.Mosca
CUORICINO	40 kg Te O ₂ MPavan	Frejus
CUORE	790 kg Te O ₂	Gran Sasso
ORPHEUS	R&D	Gran Sasso
ROSEBUD	100-300 g BGO and CaWO ₄	Canfranc
HERON	Liquid helium	?
TOKIO	NaF+LiF Ogawa	Japan

CRESST Phase II

The cryogenic scintillator setup (CaWO₄ crystal)

