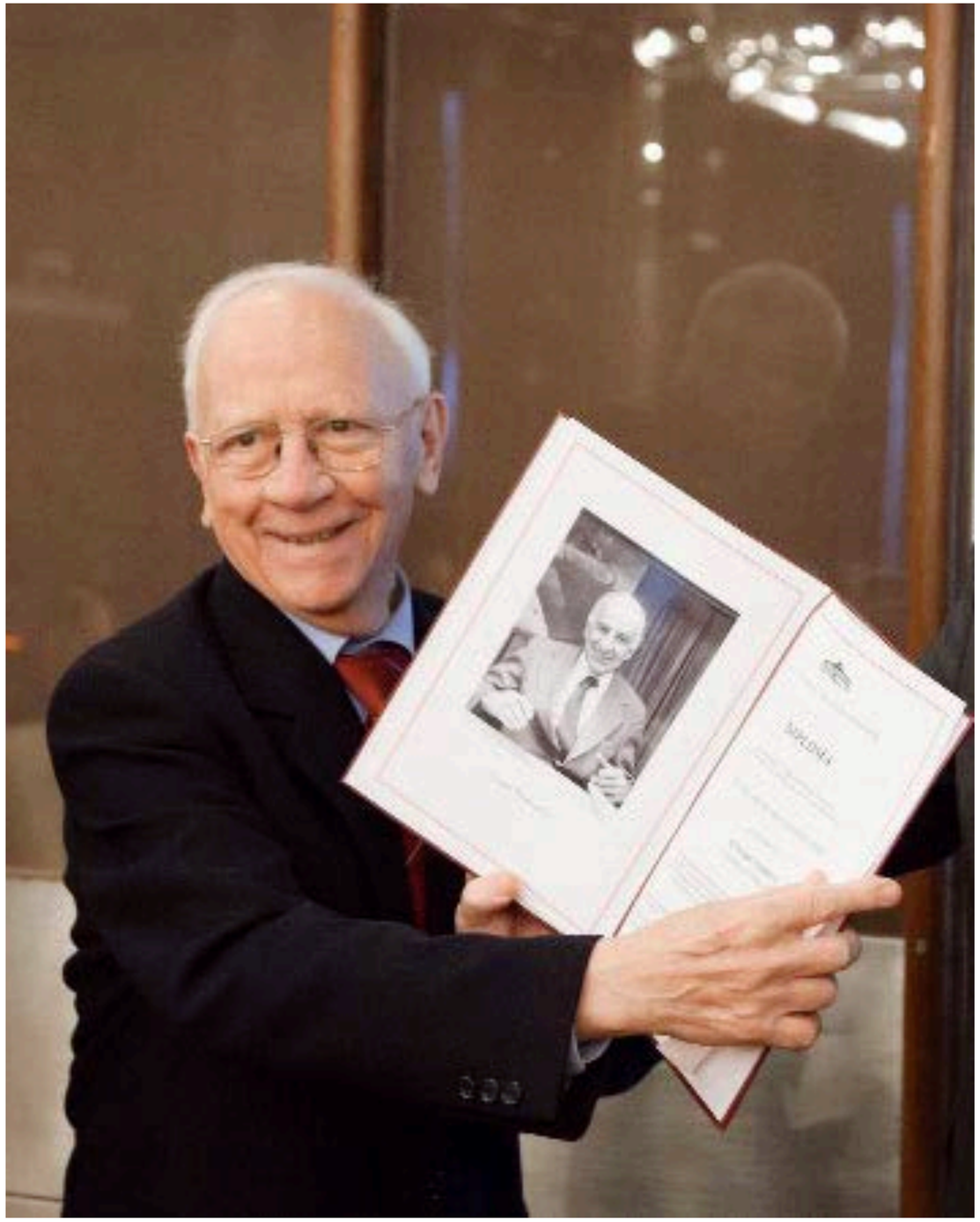
ETTORE FIORINI

a memory

Oliviero Cremonesi
INFN Milano Bicocca

Neutrino Telescopes - Venezia 23/10/2023



wikipedia …

Ettore Fiorini (19 April 1933 – 9 April 2023) was an Italian experimental particle physicist. He studied the physics of the weak interaction and was a pioneer in the field of double beta decay. He served as a professor of nuclear and subnuclear physics at the University of Milano-Bicocca.[1]

Ettore Fiorini	
Born	19 April 1933 Verona, Italy
Died	9 April 2023 (aged 89) Milan, Italy
Nationality	Italian
Education	University of Milan
Known for	Experimental particle physics
Awards	Enrico Fermi Prize (2007) Bruno Pontecorvo Prize (2012)
Scientific career	
Institutions	University of Milan CERN Duke University

Early life [edit]

Fiorini was born on 19 April 1933 in Verona. His father was the eminent surgeon Enoch Fiorini.[2][3]

Career [edit]

Fiorini graduated in physics from the University of Milan in 1955. After working as a research associate at Duke University from 1959 to 1969, he returned to Milan for the remainder of his academic career, except for a spell in Geneva at CERN (1979–82). He carried out the bulk of his research in Italy at the underground laboratories of Mont Blanc and Gran Sasso.[4]

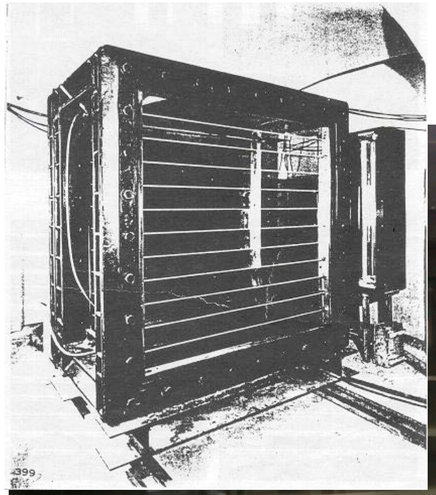
Scientific achievements [edit]

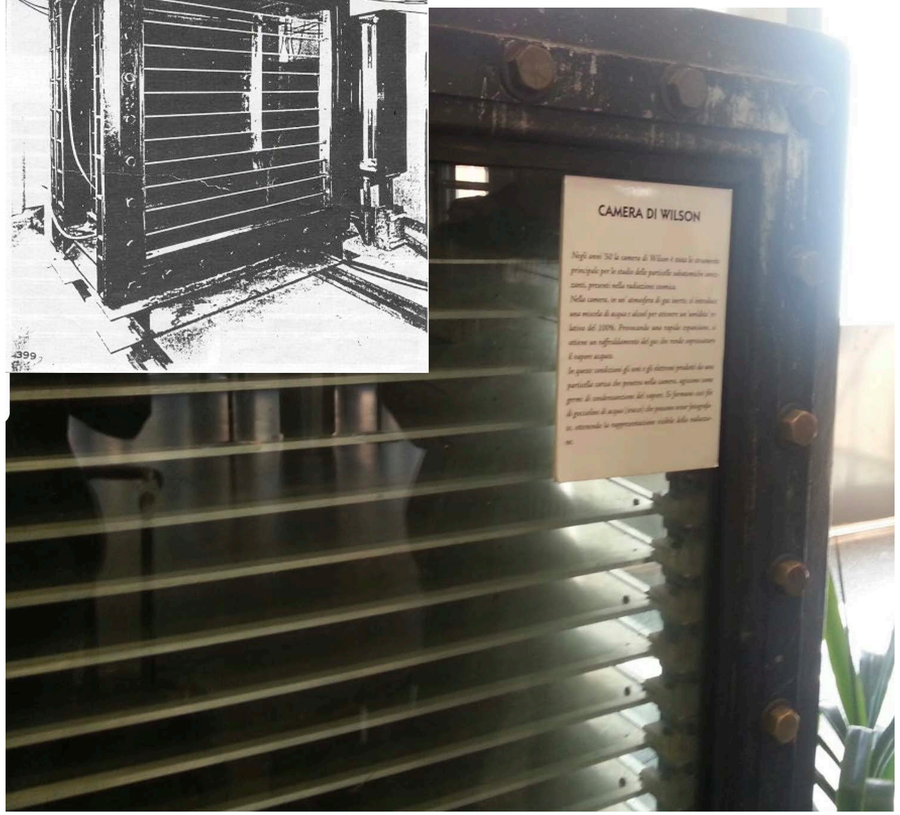
Fiorini had a longstanding research interest in weak interactions and related phenomena. In the 1970s he collaborated with André Lagarrigue to create the Gargamelle detector, a giant bubble chamber at CERN, and with Carlo Rubbia and Riccardo Giacconi on neutrino experiments

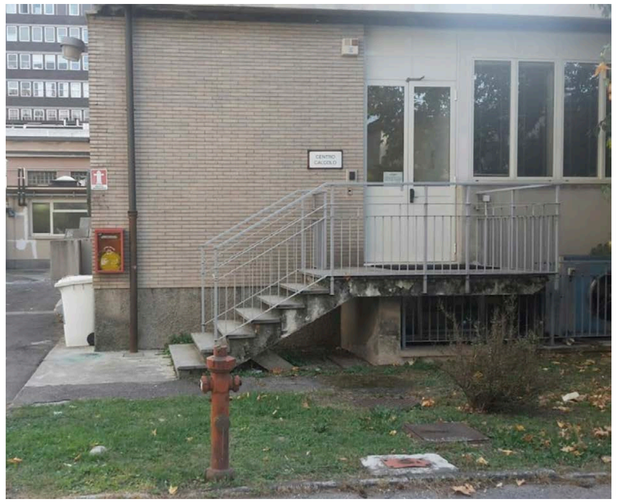
the beginning

Hunting in the high mountains

- "Sabbiun tera de punisiun" he used to repeat to me in the 1980s.
- This is the beginning for Ettore Fiorini, Gianpaolo Belllini, Sergio Ratti, Riccardo Giacconi and Carlo Rubbia and many other brave young physicists ...

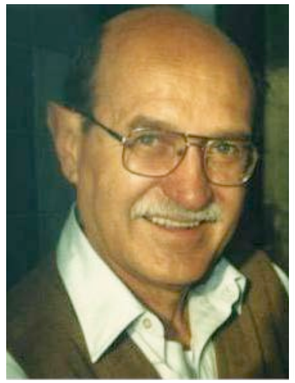




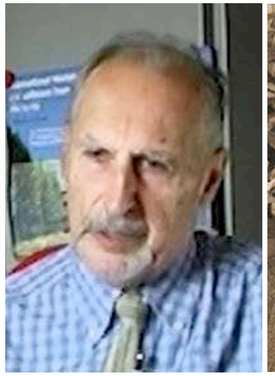



Sabbioni lake (~2500 m)









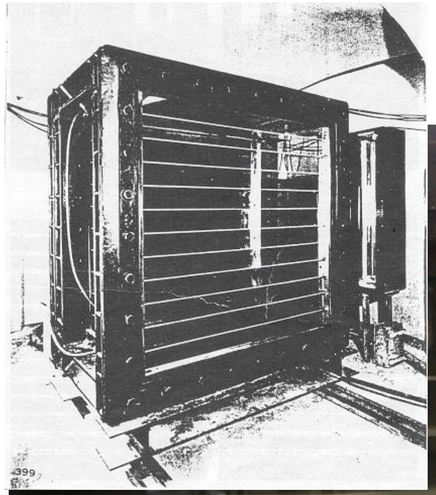


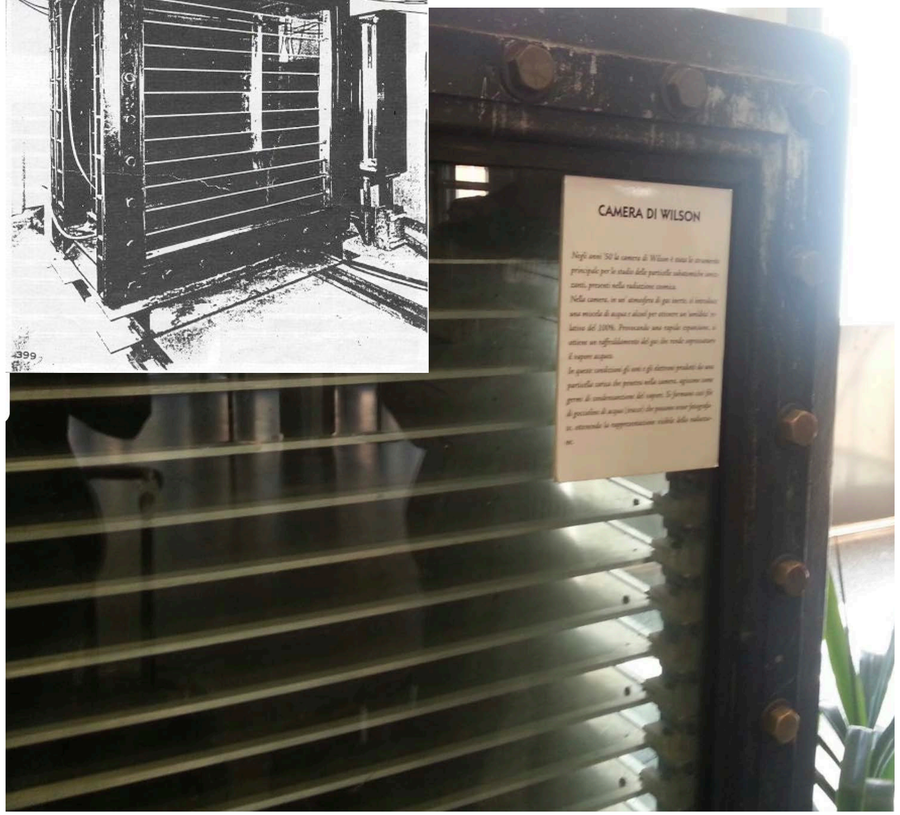


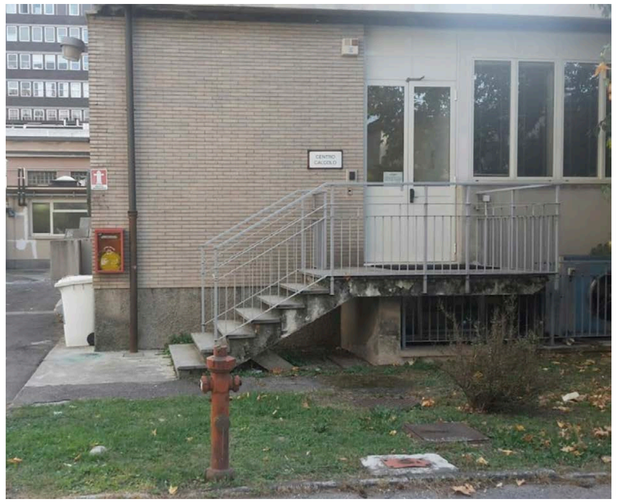
the beginning

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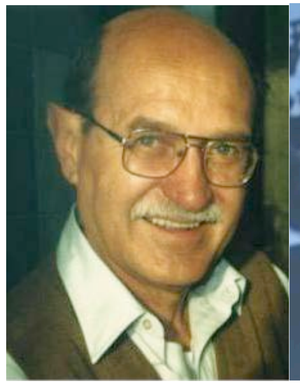




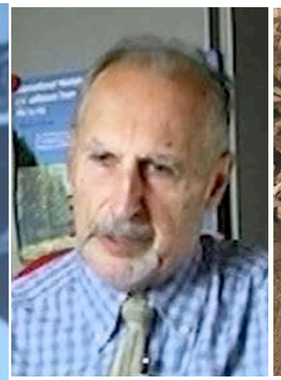
















Bubble chambers

- In the second half of the 1950s, emulsions (as well as balloons and high mountains) show their limits and Occhialini seeks a new way ...
- Martin Block is developing a bubble chamber at Duke University, and Ettore Fiorini is sent on an expedition
- This is followed by the long collaboration with the French (Ecole Polytechnique) during the 1960s until ….



Pion Diffraction Dissociation on Carbon Nuclei at 6.1 and 18.1 GeV/c.

G. Bellini, E. Fiorini, A. J. Herz (*), P. Negri and S. Ratti

Istituto di Fisica dell'Università - Milano
Istituto Nazionale di Fisica Nucleare - Sezione di Milano (**)

(ricevuto il 28 Febbraio 1963)

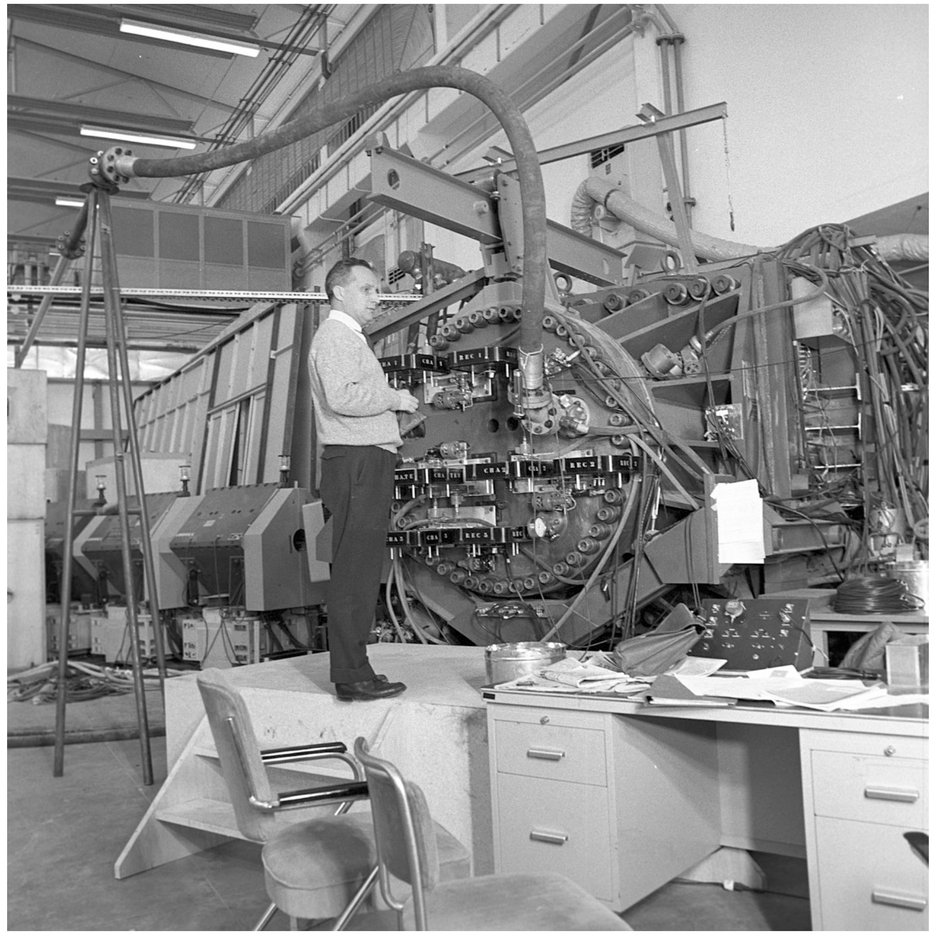
Summary. — Three-prong interactions by π^- of 6.1 and 18.1 GeV/c momentum have been studied in the École Polytechnique heavy liquid bubble chamber. It has been found that while most of the events at 6.1 GeV/c can be interpreted on the basis of a «peripheral» collision on a neutron, a large proportion of 18.1 GeV/c events cannot be interpreted in this way. They appear to be due to diffraction dissociation on a carbon nucleus acting coherently as suggested by Good and Walker. At both incoming momenta the invariant mass distribution of the three secondary pions show a bump in the region about 1200 MeV/c^2. At 18.1 GeV/c this bump can be explained as due to phase-space contraction in the diffraction process. However the existence of a similar bump at 6.1 GeV/c, where the diffraction dissociation on nuclei does not occur, may be explained either by the occurrence of diffraction dissociation on bound neutrons or by the existence of a resonant state at about 1200 MeV/c^2.

1. – Introduction.

The multiple production of pions on a neutral target according to the reaction

$$\pi^- + N \to N' + n\pi\,, \qquad (n>1) \tag{1}$$

(*) Now at the U.S. Naval Research Laboratory, Washington 25, D. C.
(**) The exposure was performed by: C. Baglin, H. Bingham, M. Bloch, D. Drijard, A. Lagarrigue, P. Mittner, A. Orkin-Lecourtois, P. Rançon, A. Rousset (École Polytechnique, Paris) and B. de Raad, R. Salmeron, R. Voss (C.E.R.N., Geneva).



GARGAMELLE (GGM)

1964 – A. Lagarrigue proposes the construction of a heavy liquid bubble chamber
Collaboration Ecole Polytechnique, RTW Aachen, UL Brussels, Milan, LAL Orsay, UCL, CERN is formed
1968 - Milan meeting and first physics proposal

CERN-TCC/70-12
16.3.70

PROPOSAL FOR A NEUTRINO EXPERIMENT IN GARGAMELLE

Aachen, Brussels, CERN, Ecole Polytechnique,
Milan, Orsay, University College

1. INTRODUCTION

Among the many problems posed in weak interactions, it appears that neutrino experiments in Gargamelle would be especially suitable to investigate the following : *)

i) Total cross-sections in the high energy region, for ν and $\bar{\nu}$;

ii) Inelastic continuum excitation of the hadronic amplitude-structure factors and "partons";

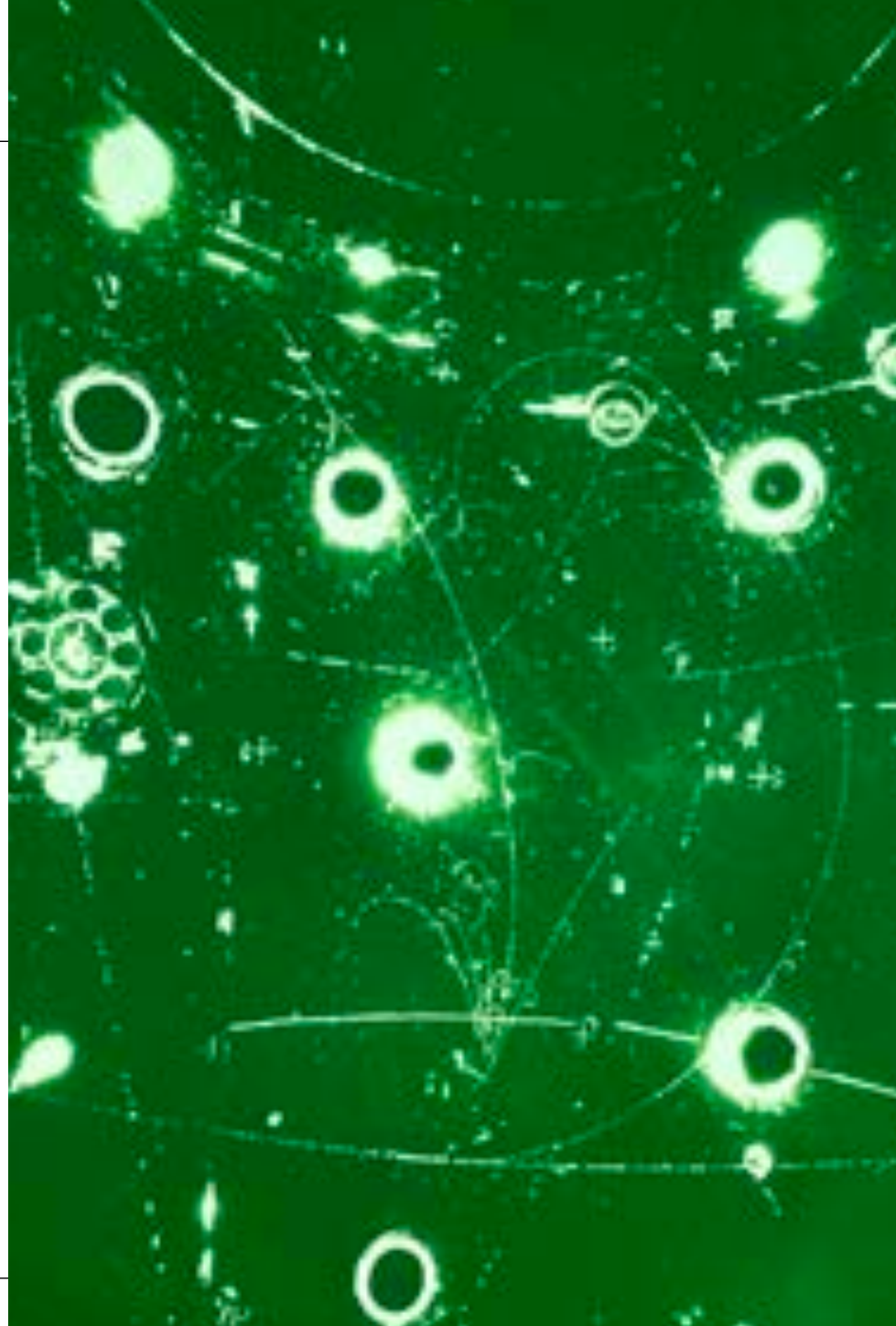
iii) Existence of the intermediate W-boson;

iv) Coupling constants for diagonal and non-diagonal weak interactions;

v) Neutral currents.

Weak neutral currents

1973 the discovery



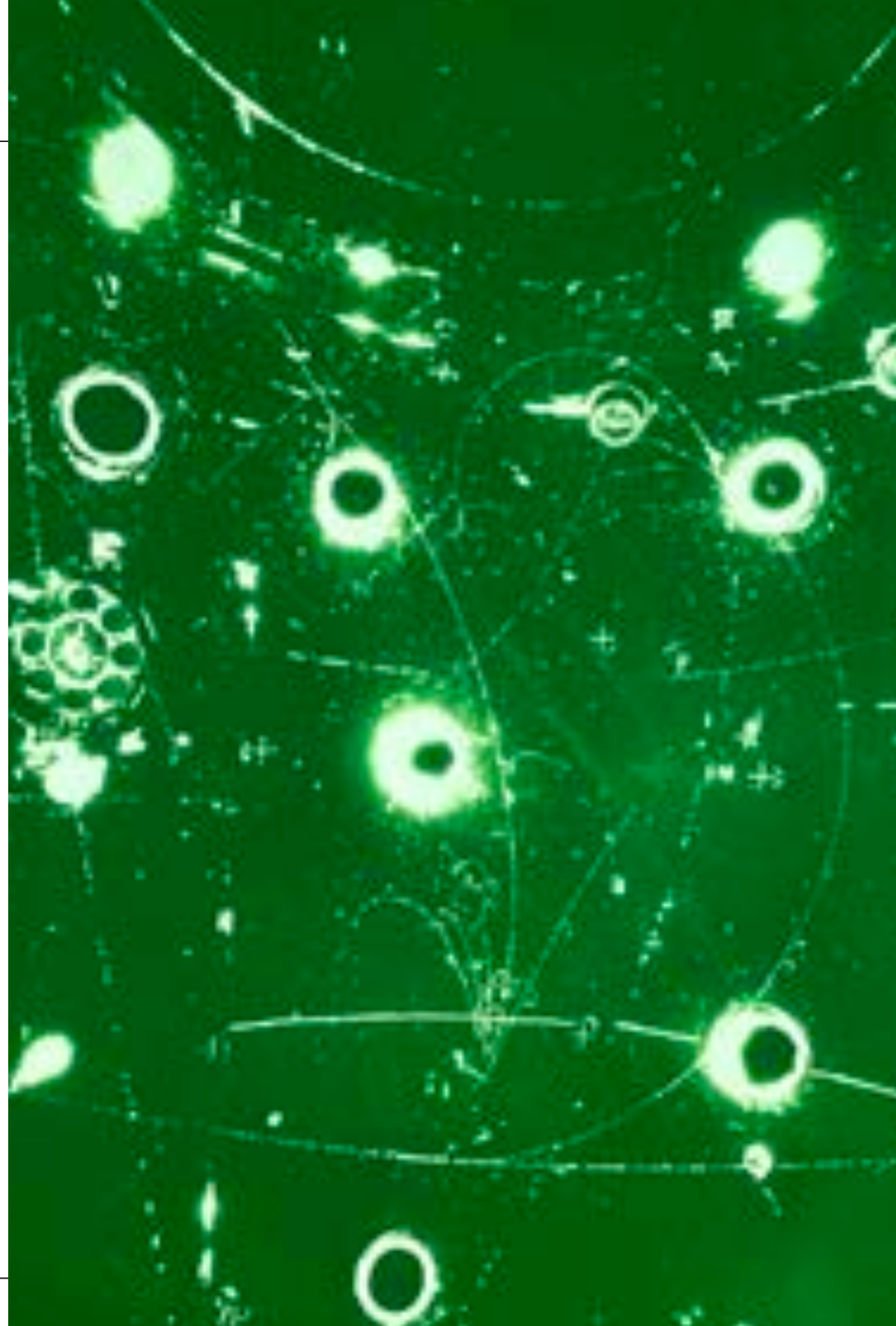
Weak neutral currents

1973 the discovery

1975 a candy with a hole in it

olume 60B, number 2 PHYSICS LETTERS 5 January 197



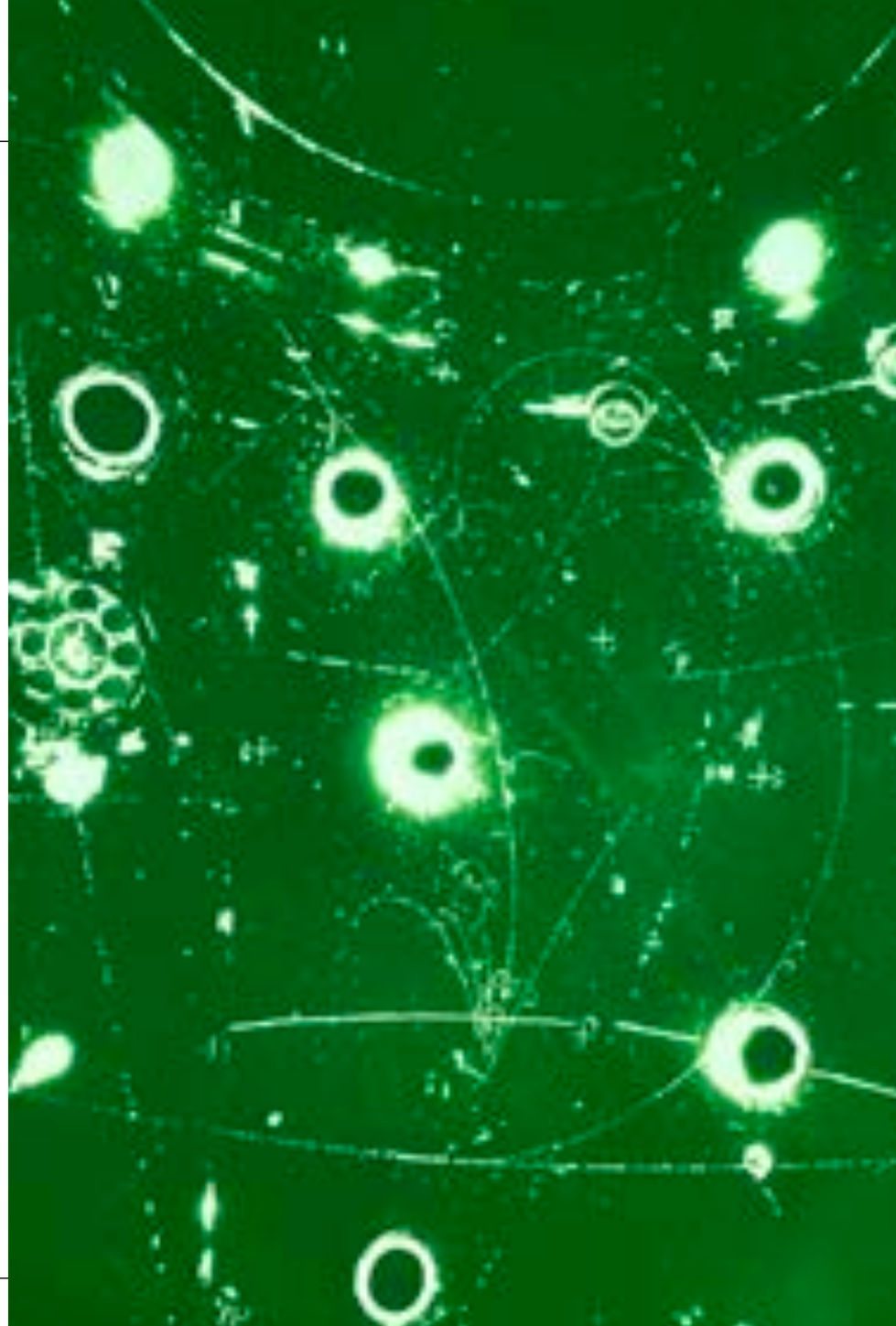


Weak neutral currents

1973 the discovery

1975 a candy with a hole in it ("CHARMS")





1973: weak neutral currents

Volume 46B, number 1 PHYSICS LETTERS 3 September 1973

OBSERVATION OF NEUTRINO-LIKE INTERACTIONS WITHOUT MUON OR ELECTRON IN THE GARGAMELLE NEUTRINO EXPERIMENT

F.J. HASERT, S. KABE, W. KRENZ, J. Von KROGH, D. LANSKE, J. MORFIN, K. SCHULTZE and H. WEERTS
III. Physikalisches Institut der Technischen Hochschule, Aachen, Germany

G.H. BERTRAND-COREMANS, J. SACTON, W. Van DONINCK and P. VILAIN*[1]
Interuniversity Institute for High Energies, U.L.B., V.U.B. Brussels, Belgium

U. CAMERINI*[2], D.C. CUNDY, R. BALDI, I. DANILCHENKO*[3], W.F. FRY*[2], D. HAIDT, S. NATALI*[4], P. MUSSET, B. OSCULATI, R. PALMER*[4], J.B.M. PATTISON, D.H. PERKINS*[6], A. PULLIA, A. ROUSSET, W. VENUS*[7] and H. WACHSMUTH
CERN, Geneva, Switzerland

V. BRISSON, B. DEGRANGE, M. HAGUENAUER, L. KLUBERG, U. NGUYEN-KHAC and P. PETIAU
Laboratoire de Physique Nucléaire des Hautes Energies, Ecole Polytechnique, Paris, France

E. BELOTTI, S. BONETTI, D. CAVALLI, C. CONTA*[8], E. FIORINI and M. ROLLIER
Istituto di Fisica dell'Università, Milano and I.N.F.N. Milano, Italy

B. AUBERT, D. BLUM, L.M. CHOUNET, P. HEUSSE, A. LAGARRIGUE, A.M. LUTZ, A. ORKIN-LECOURTOIS and J.P. VIALLE
Laboratoire de l'Accélérateur Linéaire, Orsay, France

F.W. BULLOCK, M.J. ESTEN, T.W. JONES, J. McKENZIE, A.G. MICHETTE*[9] G. MYATT* and W.G. SCOTT*[6,9]
University College, London, England

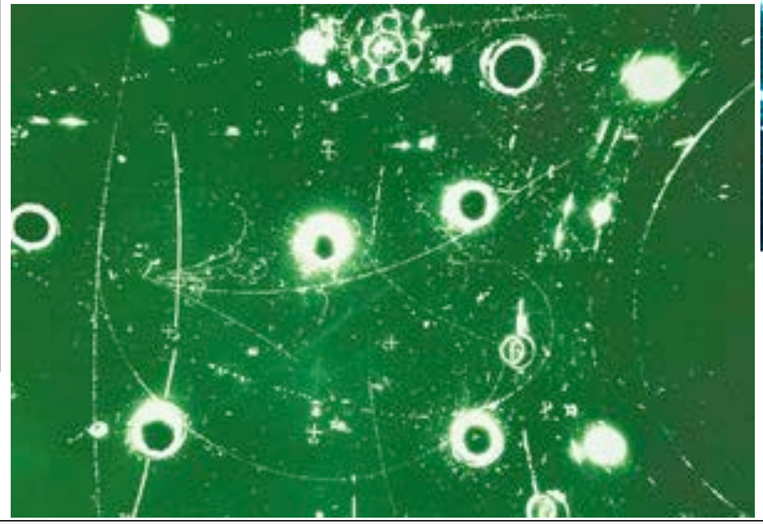
Received 25 July 1973

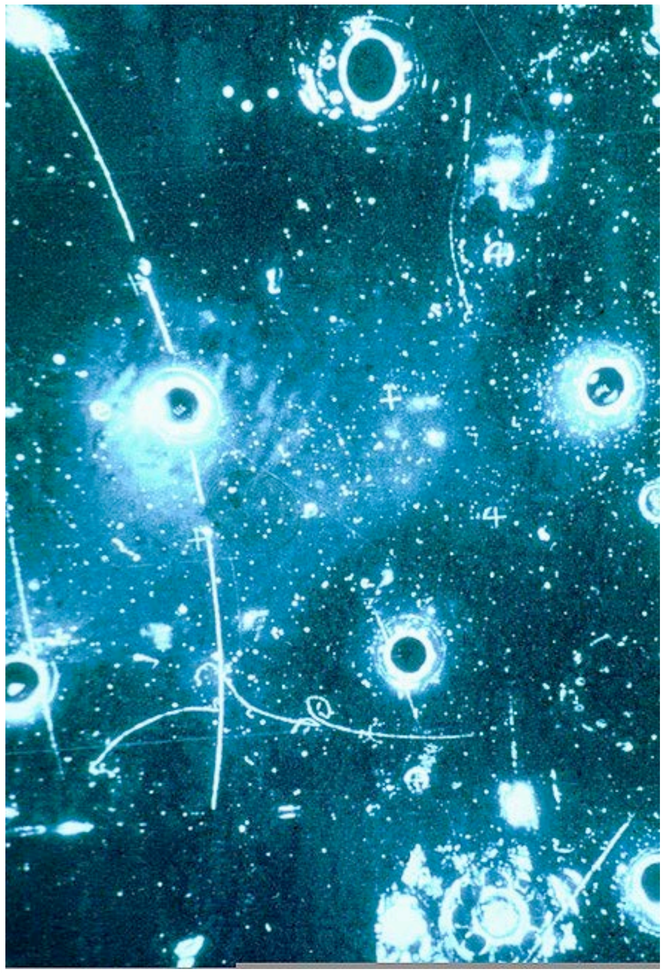
Events induced by neutral particles and producing hadrons, but no muon or electron, have been observed in the CERN neutrino experiment. These events behave as expected if they arise from neutral current induced processes. The rates relative to the corresponding charged current processes are evaluated.







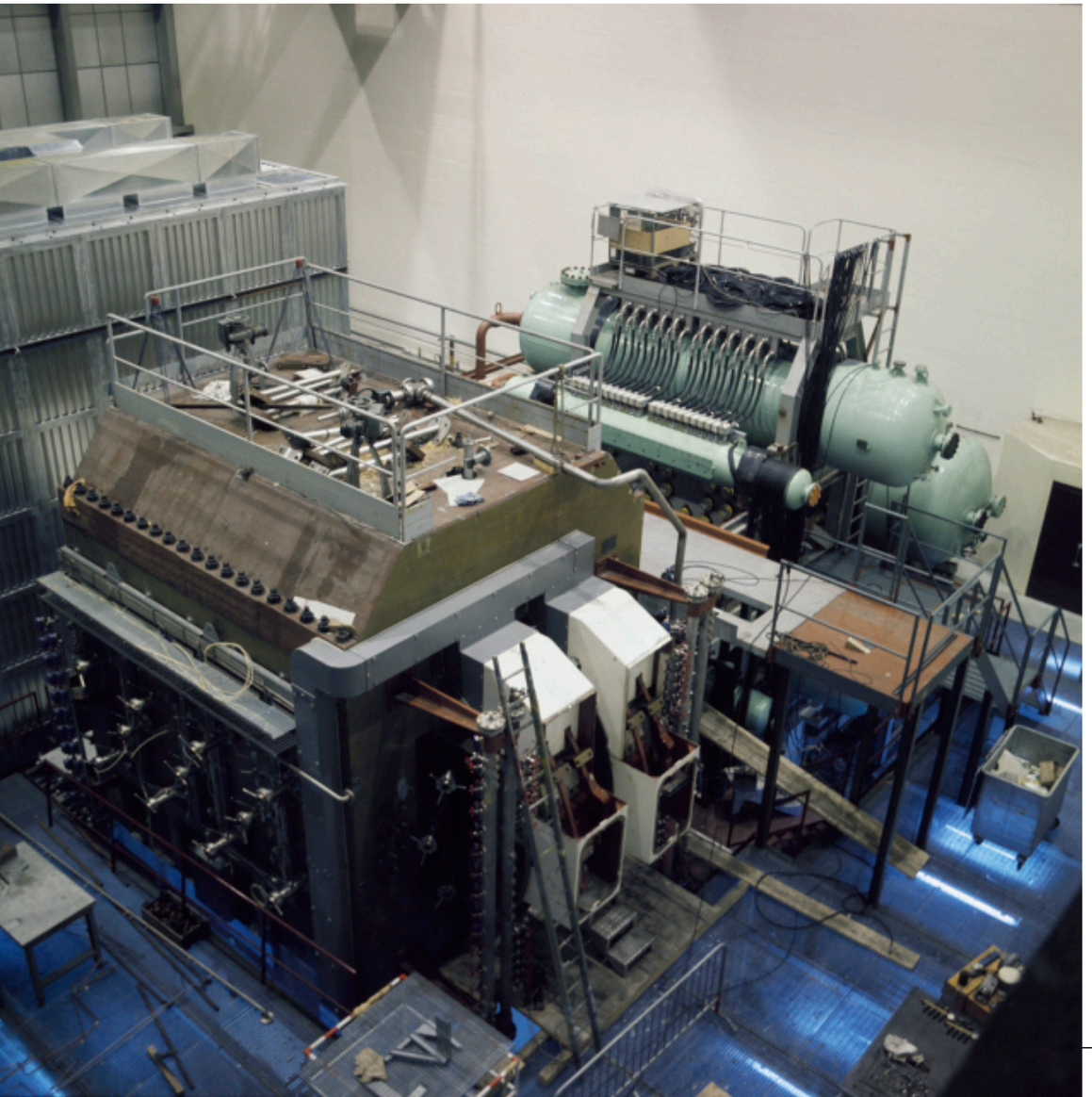


… joined a few years later by

- Luigi Zanotti
- Stefano Ragazzi
- Cesare Liguori

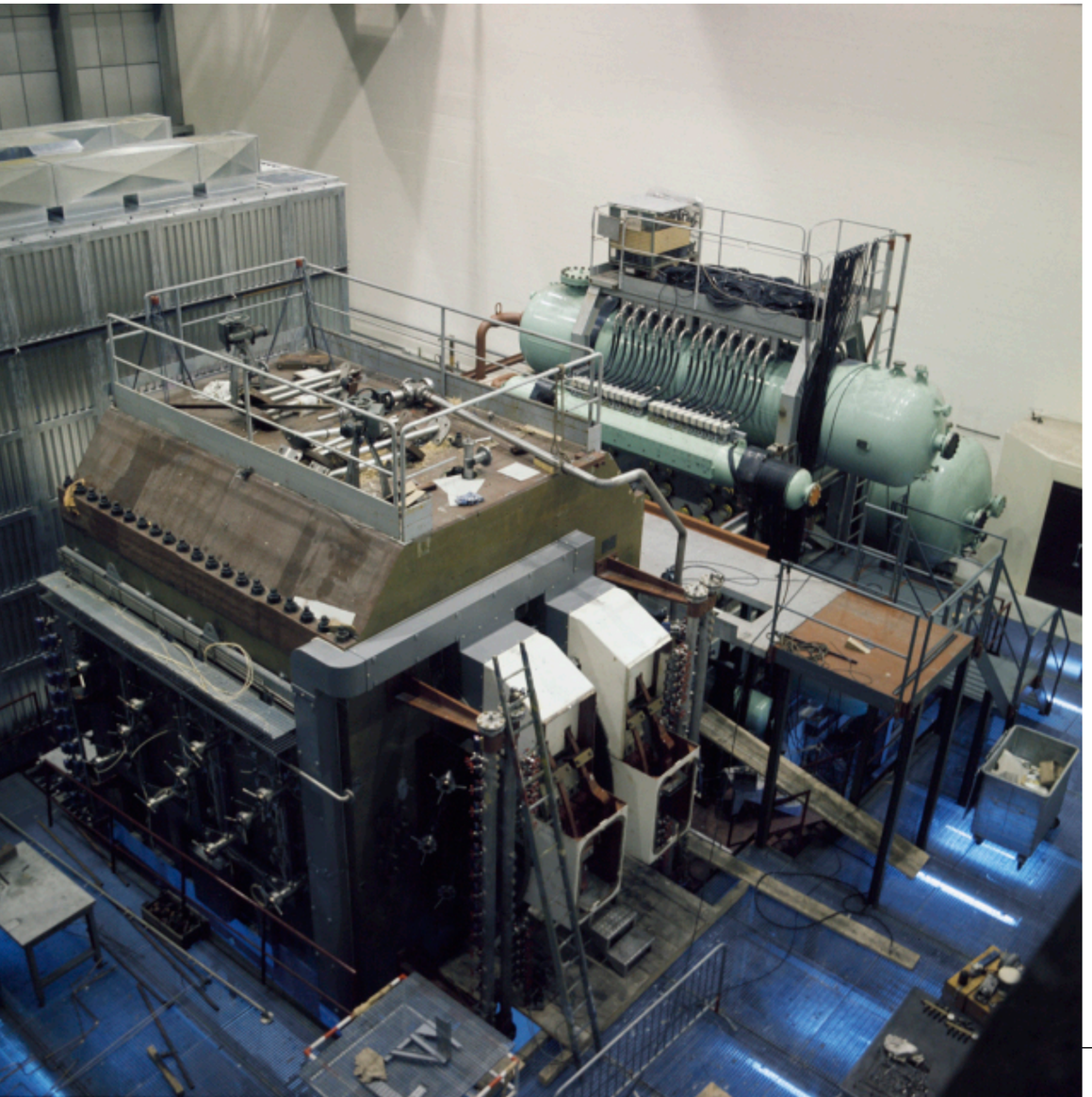
Towards the “transition”

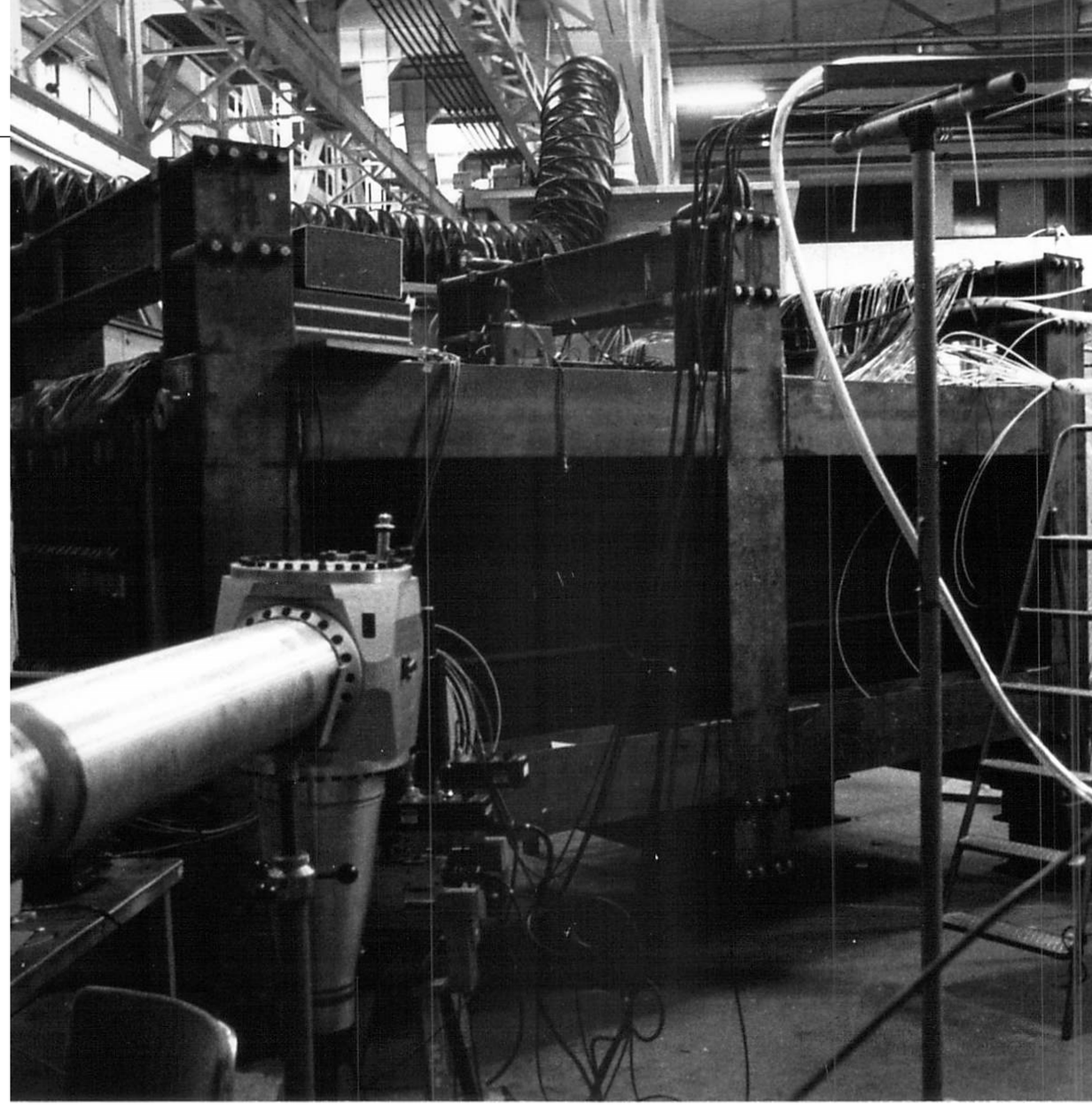
1978 GGM on the beam of "very high energy neutrinos"



Towards the “transition”

1978 GGM on the beam of "very high energy neutrinos"





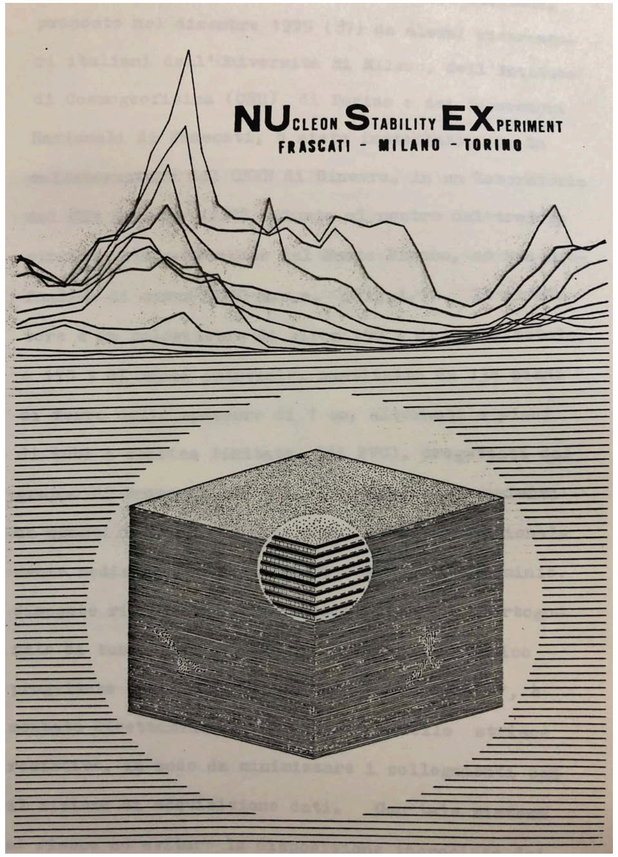
1980 “baby” NUSEX @ CERN

1981: NUSEX @ Mont Blanc

THE NUSEX DETECTOR

G. BATTISTONI [1], E. BELLOTTI [2], C. BLOISE [1], G. BOLOGNA [3], P. CAMPANA [1], C. CASTAGNOLI [3], V. CHIARELLA [1], O. CREMONESI [2], D. CUNDY [4], B. D'ETTORRE PIAZZOLI [3], E. FIORINI [2], E. IAROCCI [1], G. MANNOCCHI [3], G.P. MURTAS [1], P. NEGRI [2], G. NICOLETTI [1], P. PICCHI [3], M. PRICE [4], A. PULLIA [2], S. RAGAZZI [2], M. ROLLIER [2], F. RONGA [1], O. SAAVEDRA [3] and L. ZANOTTI [2]

[1] *INFN, Laboratori Nazionali di Frascati, Frascati, Italy*
[2] *Dipartimento di Fisica dell'Università and INFN, Sezione di Milano, Milano, Italy*
[3] *Istituto di Cosmogeofisica del CNR, Torino, Italy*
[4] *CERN, European Organization for Nuclear Research, Geneva, Switzerland*





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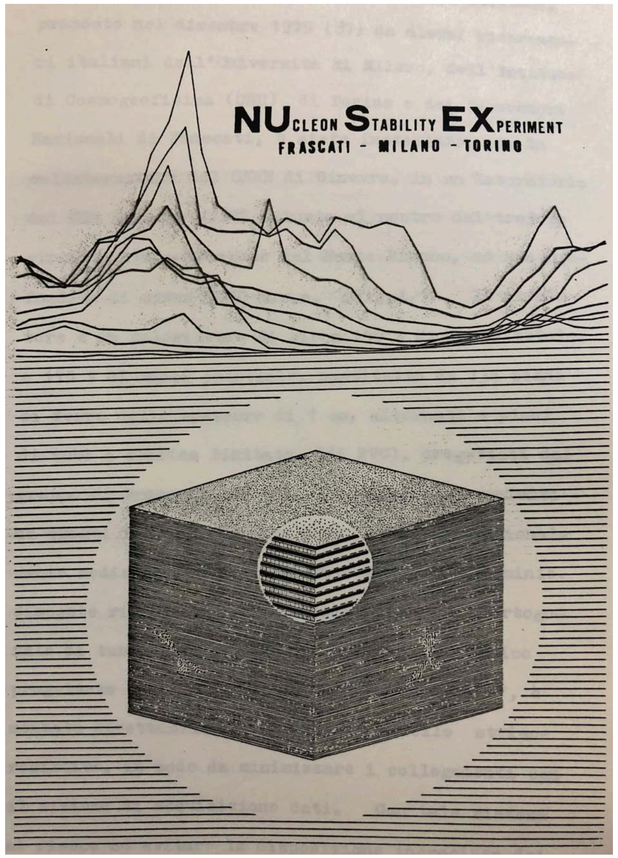
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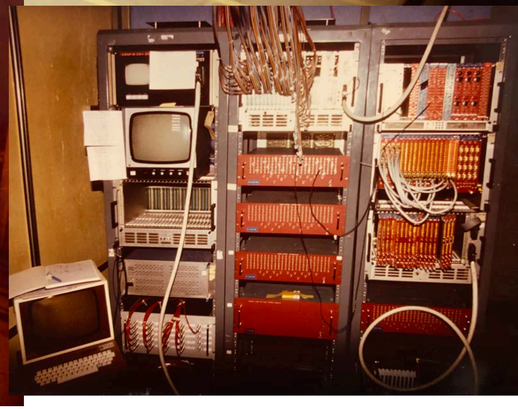
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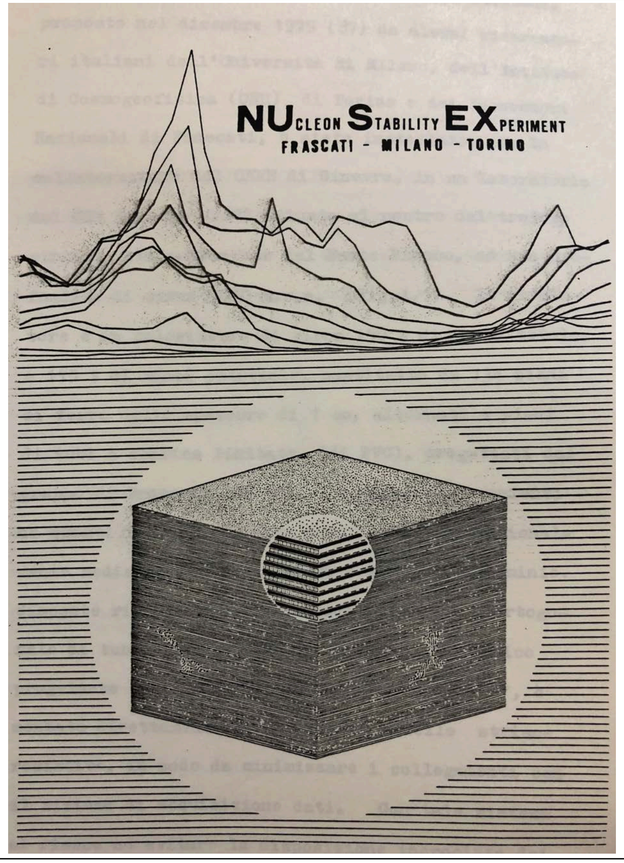
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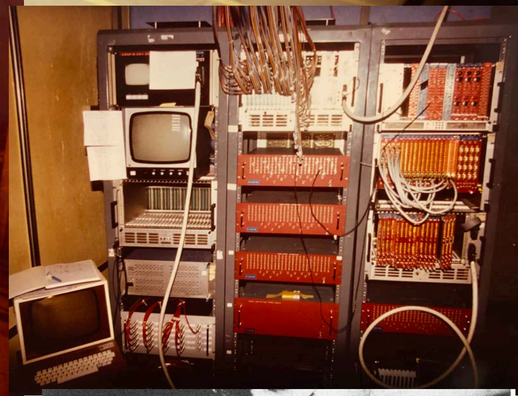
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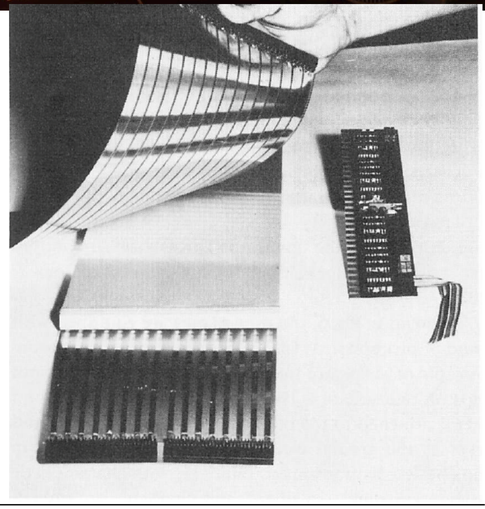












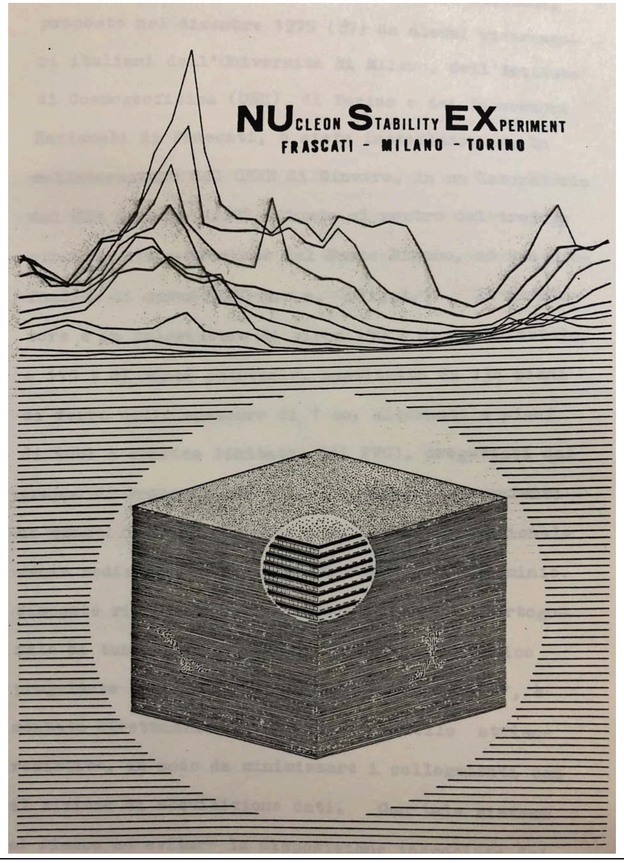
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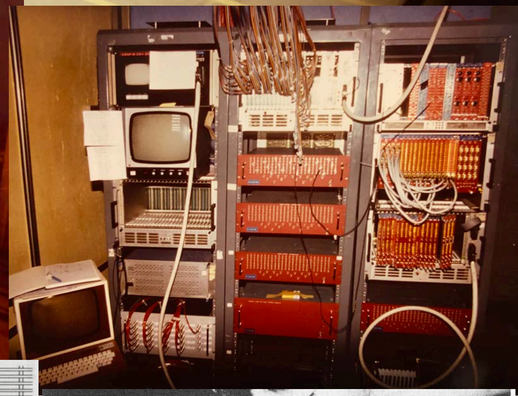
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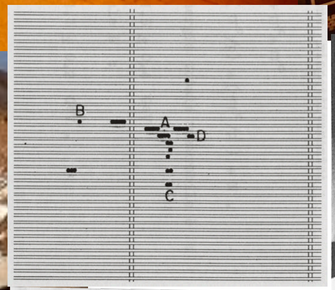


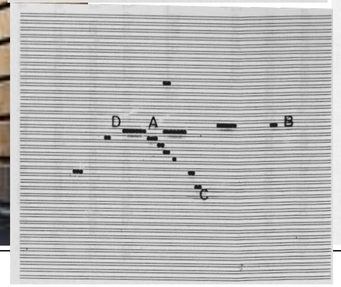


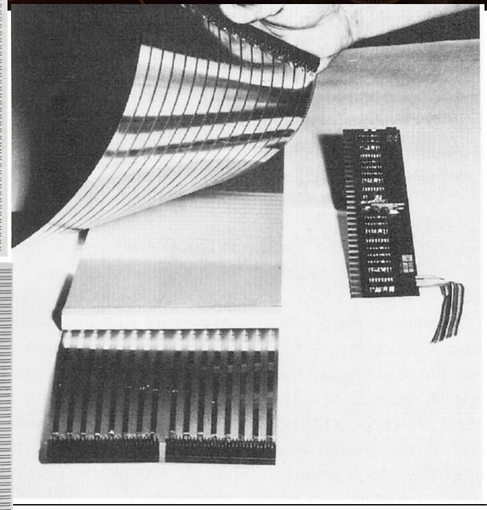












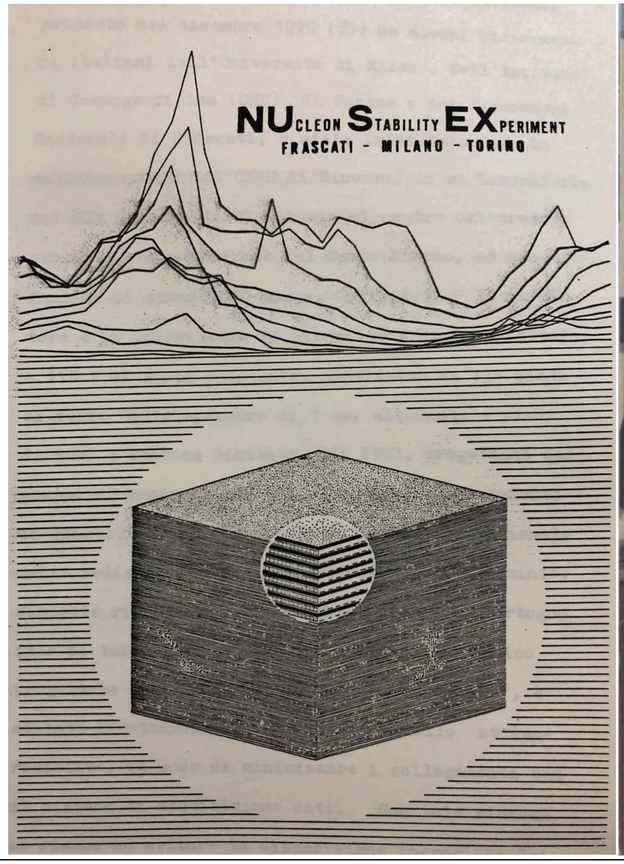
1981: NUSEX @ Mont Blanc

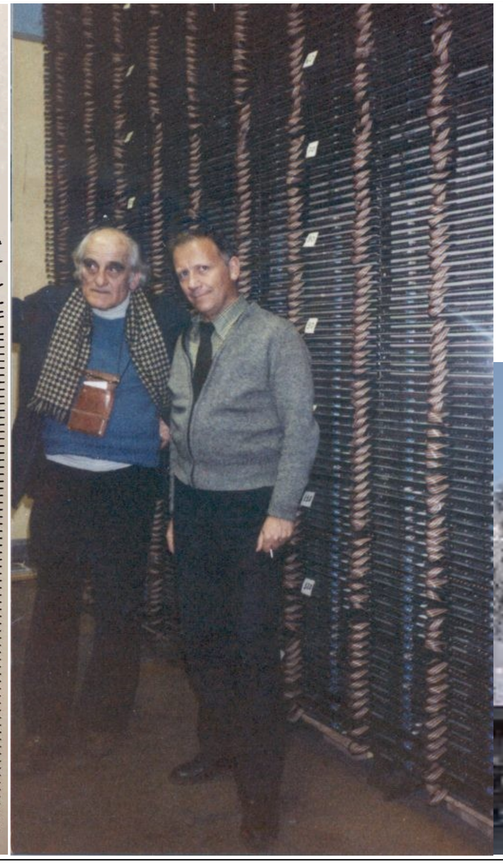
THE NUSEX DETECTOR

G. BATTISTONI [1], E. BELLOTTI [2], C. BLOISE [1], G. BOLOGNA [3], P. CAMPANA [1], C. CASTAGNOLI [3], V. CHIARELLA [1], O. CREMONESI [2], D. CUNDY [4], B. D'ETTORRE PIAZZOLI [3], E. FIORINI [2], E. IAROCCI [1], G. MANNOCCHI [3], G.P. MURTAS [1], P. NEGRI [2], G. NICOLETTI [1], P. PICCHI [3], M. PRICE [4], A. PULLIA [2], S. RAGAZZI [2], M. ROLLIER [2], F. RONGA [1], O. SAAVEDRA [3] and L. ZANOTTI [2]

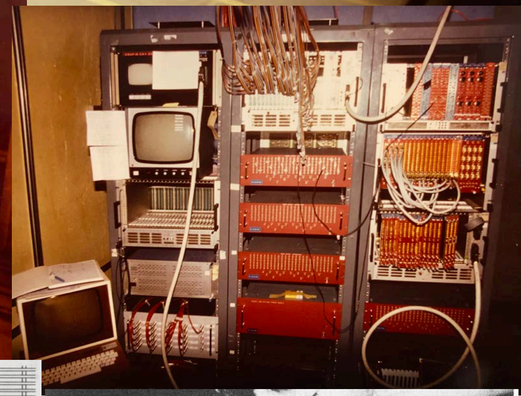
[1] *INFN, Laboratori Nazionali di Frascati, Frascati, Italy*
[2] *Dipartimento di Fisica dell'Università and INFN, Sezione di Milano, Milano, Italy*
[3] *Istituto di Cosmogeofisica del CNR, Torino, Italy*
[4] *CERN, European Organization for Nuclear Research, Geneva, Switzerland*



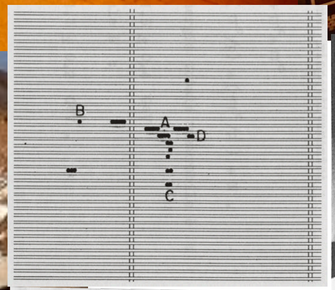


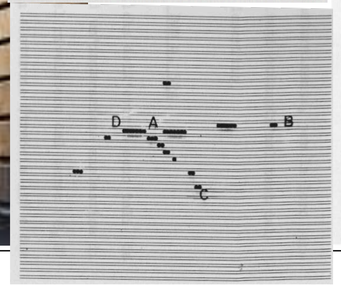


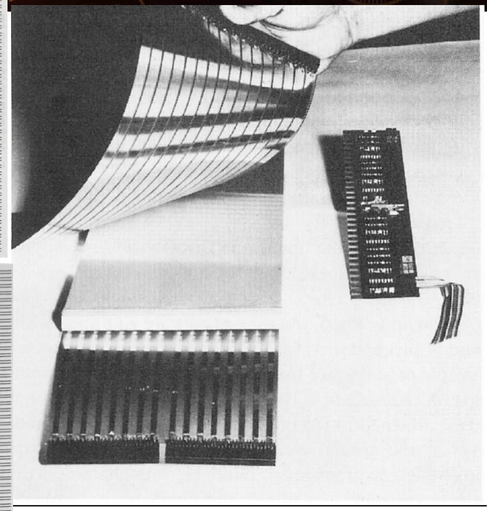












A genuine passion

Fiorini - 01

DOUBLE BETA DECAY

THE FUTURE

E. Fiorini Subdury 18.6.00

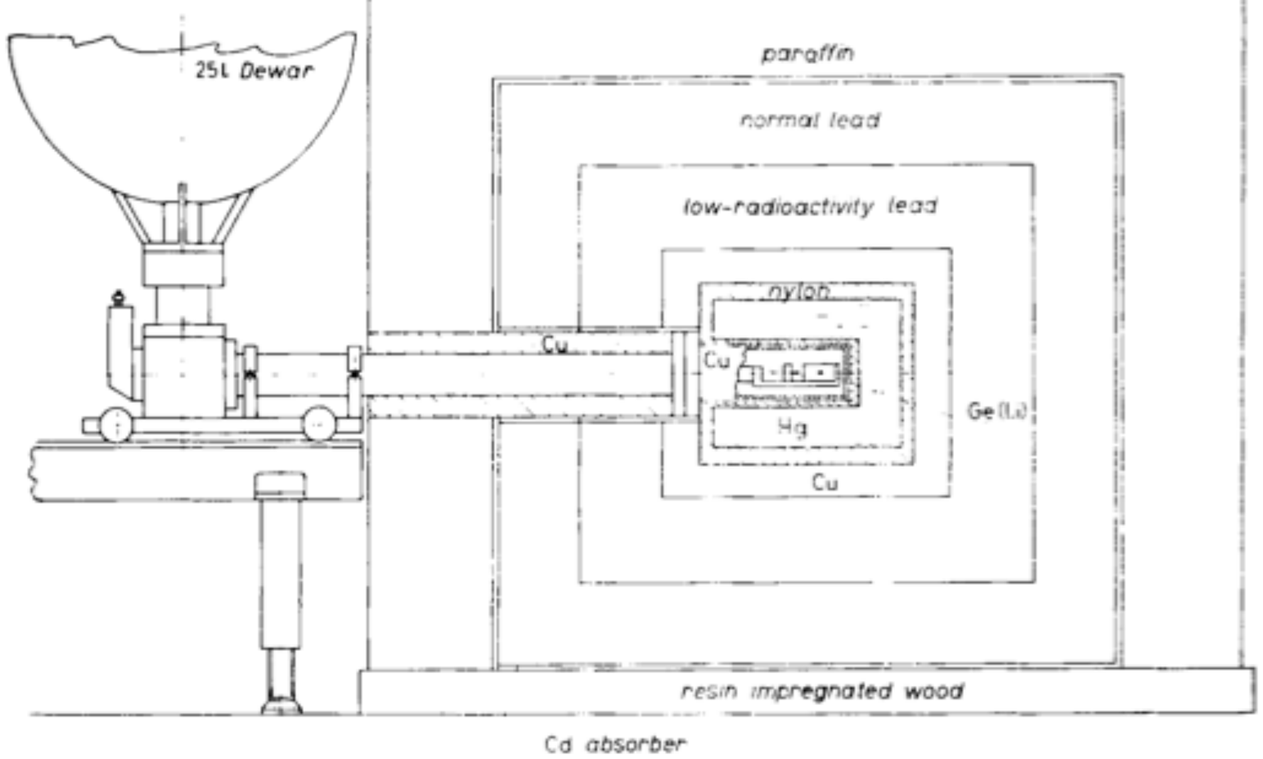
2ν DBD found in 9 nuclei
(also in excited state)
Recent theoretical calculations
in reasonable agreement with results

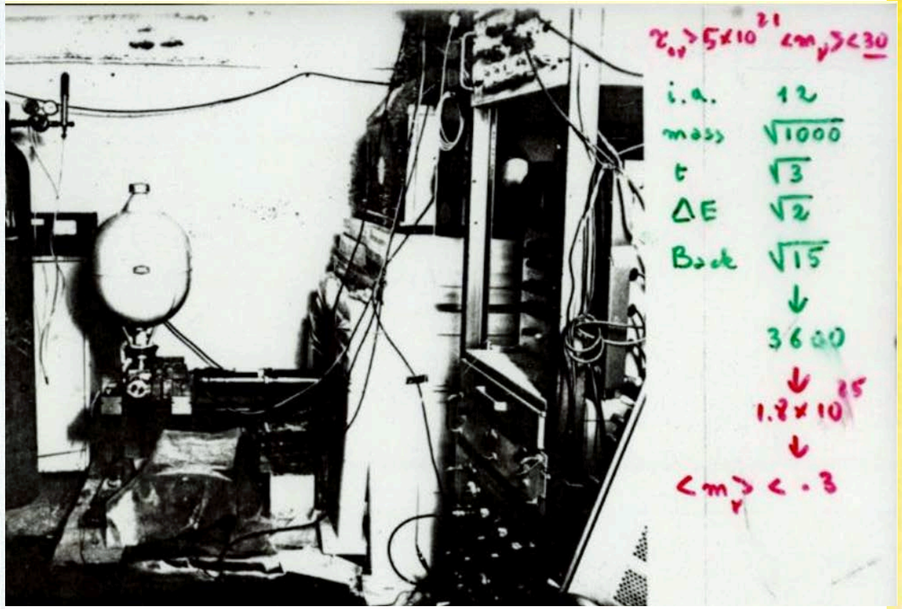
0ν, $0\nu X$, $0\nu XX$ have not been found.

CALCULATIONS ON LIFETIMES
OF NEUTRINOLESS DOUBLE BETA
DECAY SHOULD BE EASIER, BUT
THERE ARE STILL CONSIDERABLE
DISAGREEMENTS ON $\langle m_\nu \rangle$ and
g_X (η, λ)

THE FUTURE

THE RESULT ON THE 2ν DBD
ARE EXCELLENT, BUT STILL SOME
UNCERTAINTIES (^{128}Te, ^{130}Te, ^{136}Xe ...)







Chi l'ha visto ?

Ettore Majorana, ordinario di fisica teorica all'Università di Napoli, è misteriosamente scomparso dagli ultimi di marzo. Di anni 31, alto metri 1,70, snello, con capelli neri, occhi scuri, una lunga cicatrice sul dorso di una mano. Chi ne sapesse qualcosa è pregato di scrivere al R. P. E. Marianecci, Viale Regina Margherita 66 - Roma.

Double beta decay

- As early as the mid-1960s, Ettore Fiorini championed an interest in this decay to ... repeat over time

Experimental and Theoretical Remarks on the Double β-decay.

G. F. DELL'ANTONIO (*)

Physics Department, Northwestern University - Evanston, Ill.

E. FIORINI (**)

Istituto di Fisica dell'Università - Milano
Istituto Nazionale di Fisica Nucleare - Sezione di Milano

(ricevuto il 3 Agosto 1960)

CONTENTS. — **Introduction.** – **1. Outline of the theory of β-decay.** – **2. Theoretical aspects of the double β-decay.** – **3. Experimental results on the double β-decay.** 1. Counter experiments. 2. Cloud chamber experiments. 3. Nuclear emulsions experiments. 4. Experiments with chemical methods. **4. Mass and nuclear structure of suitable isotopic triplets.** 1. Informations about the energy of the nuclear states. 2. Nuclear structure. 3. Possible double β-transitions. – **Conclusions.**

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- ... a few years later, together with Tonino he initiates the first experiment with germanium diodes

A SEARCH FOR LEPTON NON-CONSERVATION IN DOUBLE BETA DECAY WITH A GERMANIUM DETECTOR

E. FIORINI and A. PULLIA
Istituto di Fisica dell'Università and INFN, Milano, Italy

G. BERTOLINI, F. CAPPELLANI and G. RESTELLI
Euratom, CCR, Ispra, Italy

Received 30 October 1967

A new technique is applied to the search for neutrinoless double β decay. A Ge(Li) crystal is used both as source and as detector of the $^{76}Ge \rightarrow {}^{76}Se$ transition. Our negative result ($\tau_{\frac{1}{2}} > 3 \times 10^{20}$ y) is consistent with the lepton conservation law.

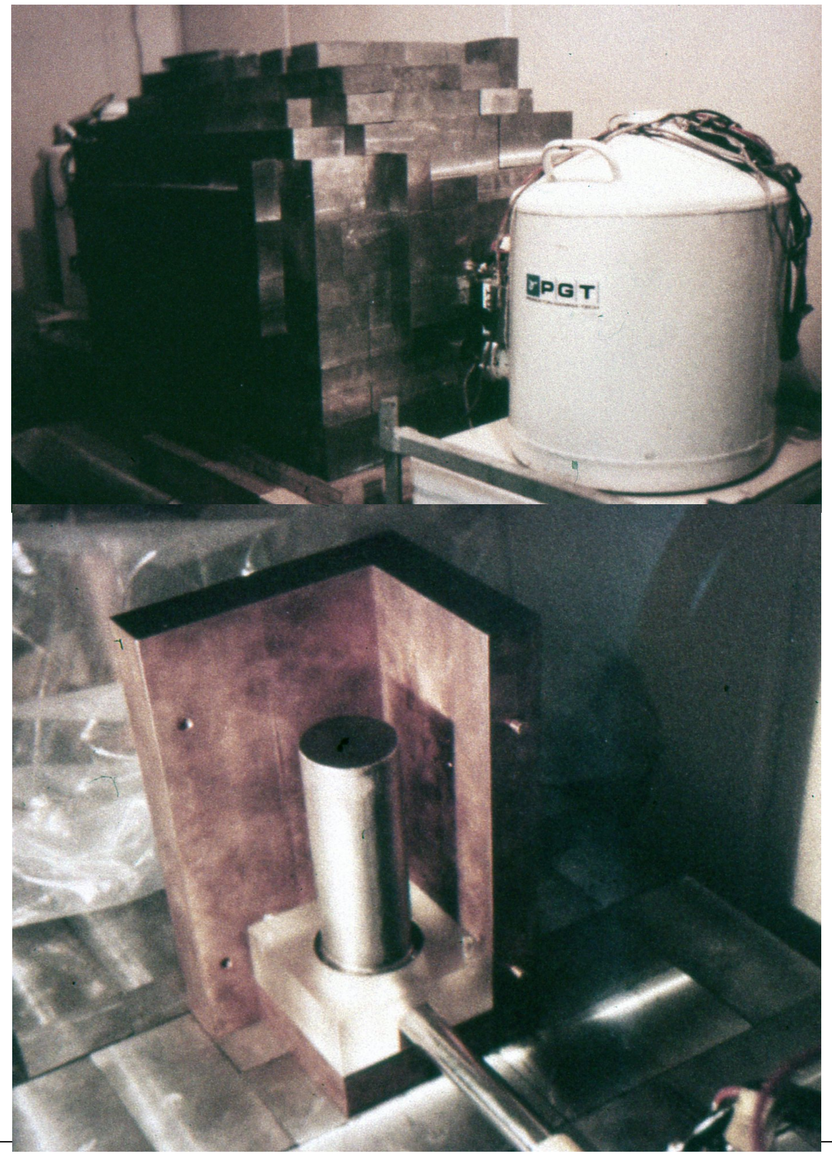


1983: DBD at Mont Blanc

Taking advantage of the first commercial diodes a new experiment is started at garage 27 with two Ge(Li) detectors

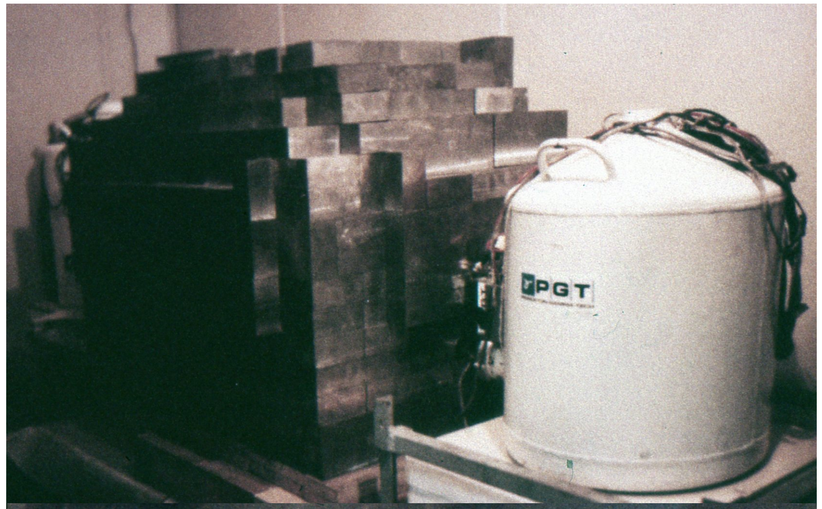
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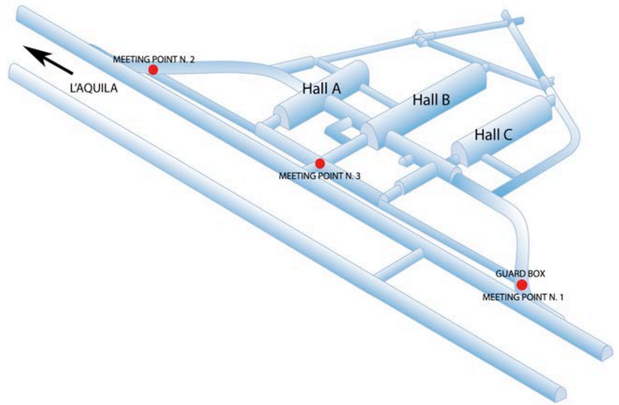
1984: Gran Sasso

The 1980s are very hectic:

- Mont Blanc is abandoned in favor of the nascent Gran Sasso laboratory.











Note manoscritte di A. Zichichi presentate nella Seduta della Commissione Lavori Pubblici del Senato convocata con urgenza dal Presidente del Senato per discutere la proposta del Progetto Gran Sasso (1979).



To summarize, the scientific aims of the "Gran Sasso" laboratory are the study of:

1) nuclear stability;
2) neutrino astrophysics;
3) new cosmic phenomenology;
4) neutrino oscillations;
5) biologically active matter;
6) ground scability.

NOT only $\tau_p \neq \infty$

LNGS: the beginning









LNGS: the beginning









DBD at Gran Sasso

1986: the labs are not yet ready, but Hector sets out to install a new experiment at LNGS:

- an isotopically enriched Xenon (HP gas) MWPC (^{136}Xe)
- the chamber is installed inside a trailer in one of the bypasses

MULTIELEMENT PROPORTIONAL CHAMBER FOR ^{136}Xe $\beta\beta$ DECAY

A. ALESSANDRELLO, E. BELLOTTI, D. CAMIN, O. CREMONESI, E. FIORINI, C. LIGUORI, S. RAGAZZI, L. ROSSI *, P. SVERZELLATI and L. ZANOTTI

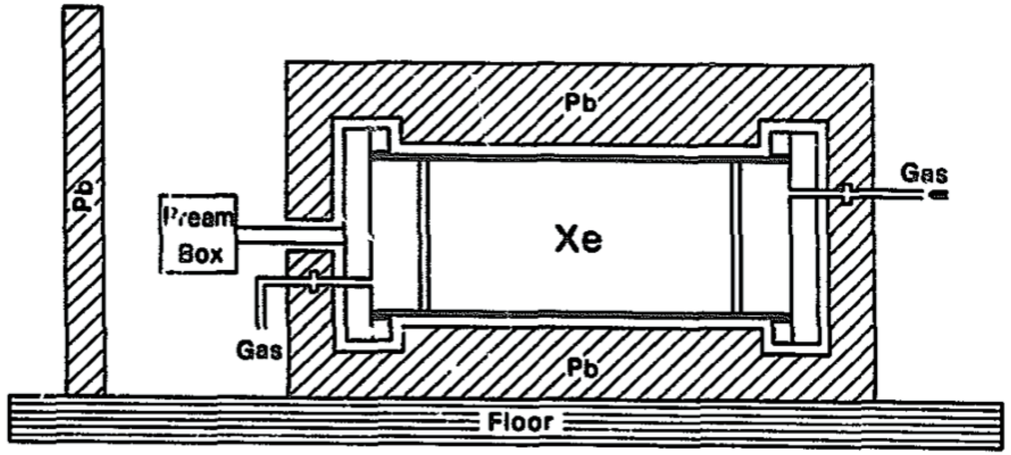
Dipartimento di Fisica dell'Universita', Milano and Istituto Nazionale di Fisica Nucleare, Sezione di Milano, Italy

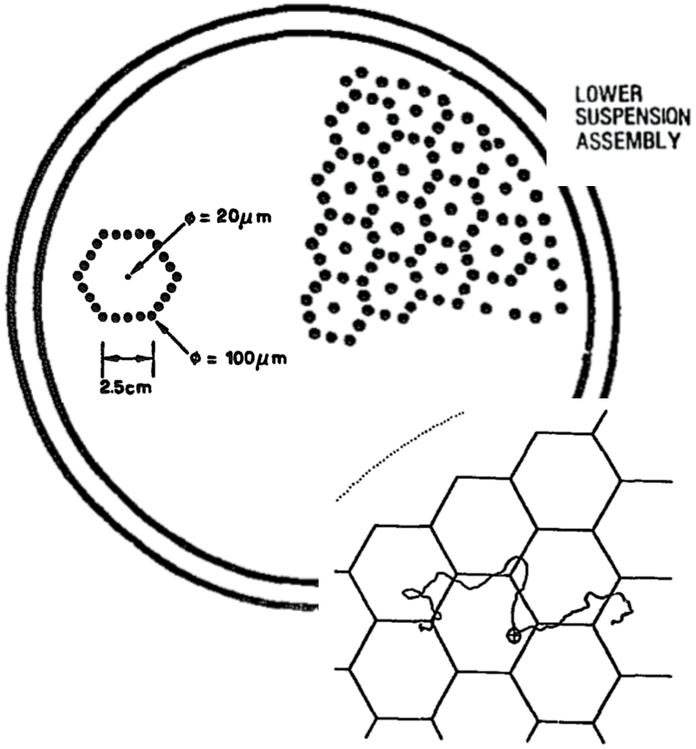
A Multielement Proportional Chamber designed to investigate $\beta\beta$ decay of ^{136}Xe is described. The detector consists of 61 cells arranged in a honeycomb structure. Each cell is 80 cm long and has a hexagonal cross section of 2.5 cm side. The anodes are 20 μm diameter gold plated tungsten wires. Each cathode consists of 24 copper–beryllium wires of 100 μm diameter. This structure is mounted in a titanium vessel of 40 cm diameter and 110 cm length.

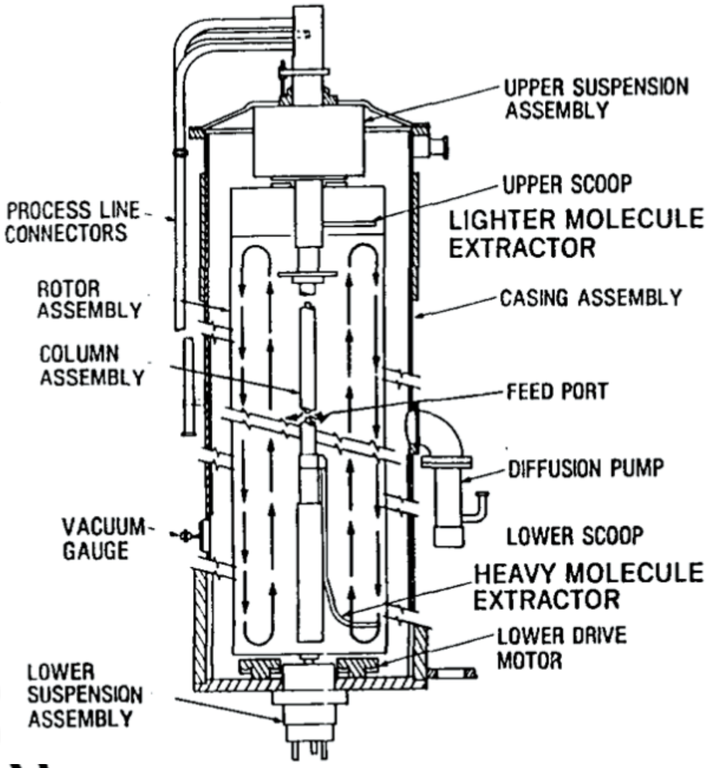
In order to obtain a very low background all the materials used were selected for their low intrinsic activities.

The detector is operated with Xe at 10 bar; a purification system keeps the oxygen like impurities below 0.2 ppm.

The electronics consists of 61 hybrid charge sensitive preamplifiers followed by 7 bit CAMAC flash-ADCs to digitize and store the pulses. An auxiliary output of the preamplifier is used to drive a trigger module that can be preset to any configuration of total energy and/or anode pattern. The chamber, presently under test, will soon be installed in the Gran Sasso underground Laboratory for data taking. Measurements on energy resolution over several cells and on charge transport are described.







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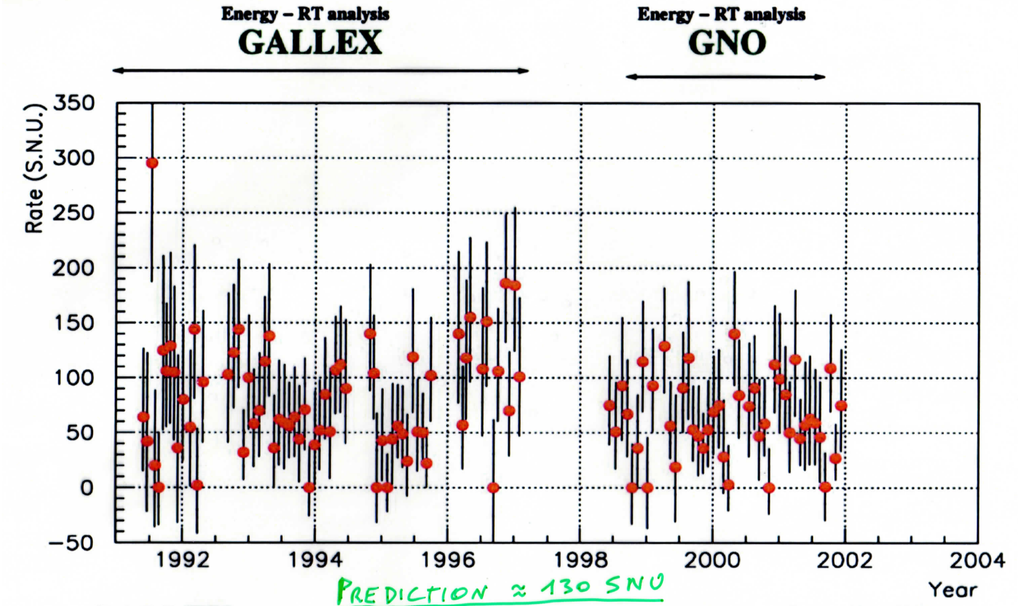
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GALLEX	**65 SR**	**77.5 +– 6.2 (stat) +– 4.5 (sys) SNU**
GNO	**43 SR**	**65.4 +– 6.5 (stat) +– 3.0 (sys) SNU**
GNO+GALLEX	**108 SR**	**71.0 +– 4.5 (stat) +– 3.8 (sys) SNU**

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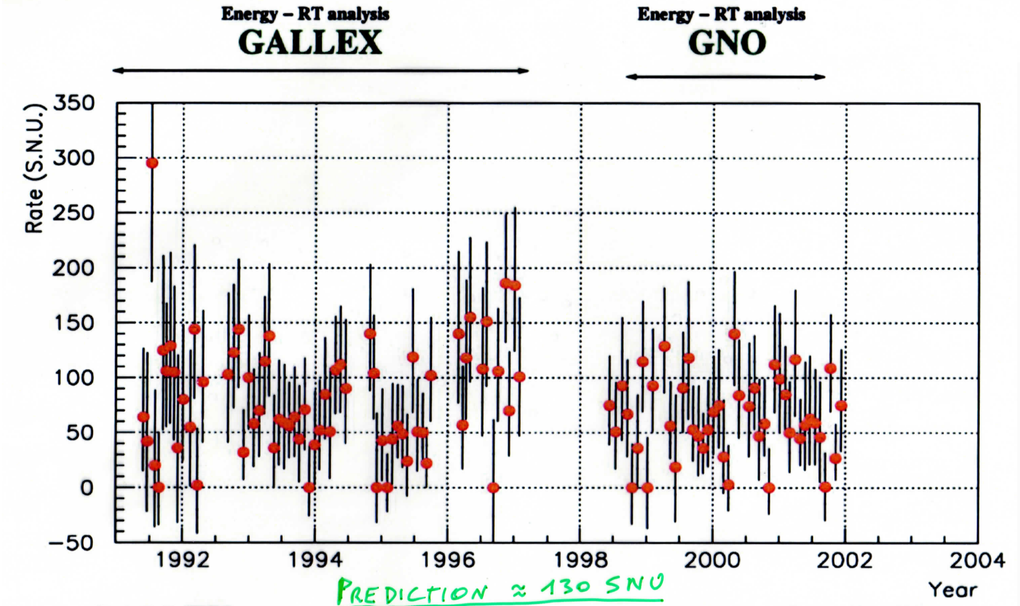
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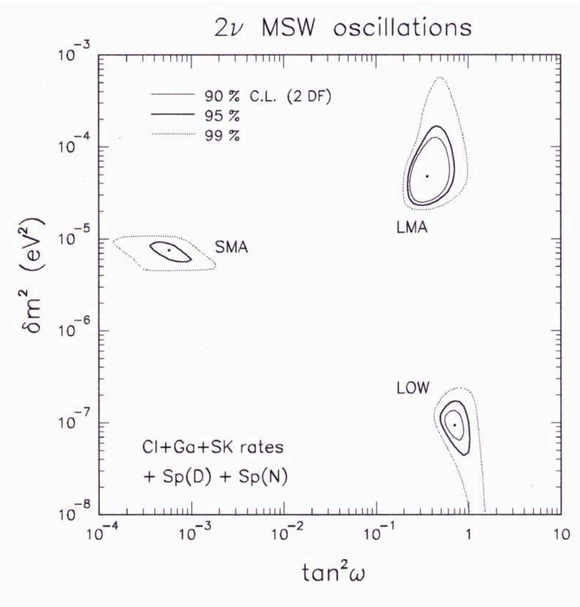
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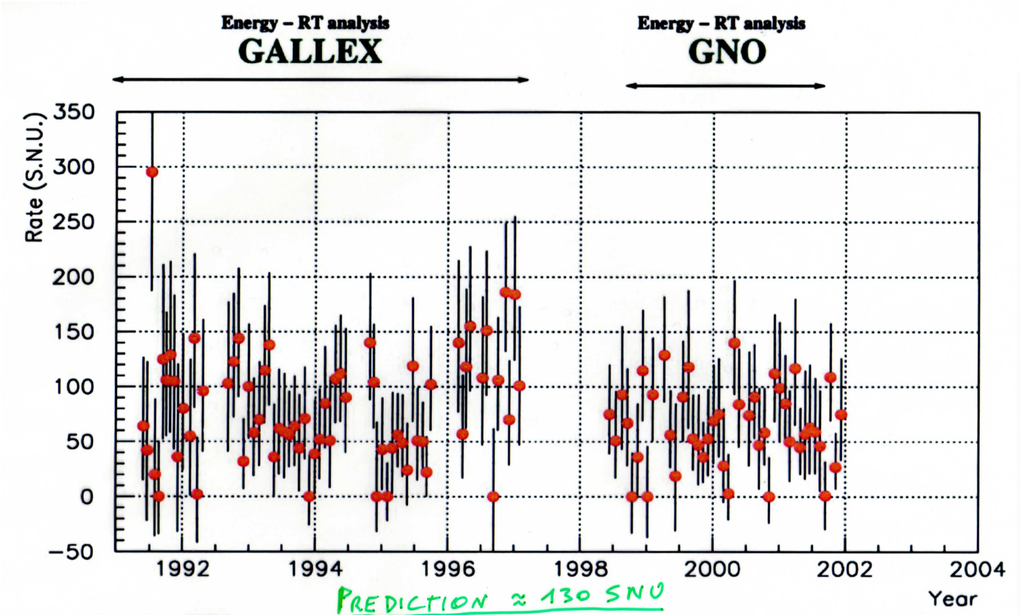
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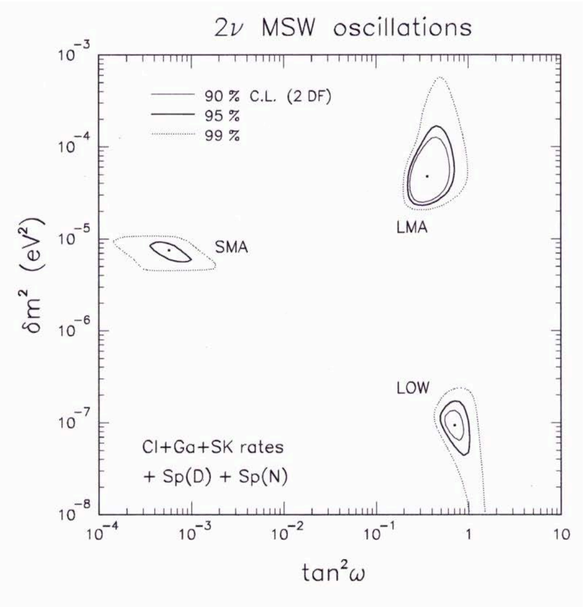
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GALLEX	**65 SR**	**77.5 +– 6.2 (stat) +– 4.5 (sys) SNU**
GNO	**43 SR**	**65.4 +– 6.5 (stat) +– 3.0 (sys) SNU**
GNO+GALLEX	**108 SR**	**71.0 +– 4.5 (stat) +– 3.8 (sys) SNU**



19 February 1998

PHYSICS LETTERS B

ELSEVIER

Physics Letters B 420 (1998) 114–126

Final results of the ^{51}Cr neutrino source experiments in GALLEX

GALLEX Collaboration

W. Hampel [a], G. Heusser [a], J. Kiko [a], T. Kirsten [a], M. Laubenstein [a], E. Pernicka [a], W. Rau [a], U. Rönn [a], C. Schlosser [a,1], M. Wójcik [a,2], R. v. Ammon [b], K.H. Ebert [b], T. Fritsch [b], D. Heidt [b], E. Henrich [b], L. Stieglitz [b], F. Weirich [b], M. Balata [c], F.X. Hartmann [c], M. Sann [c], E. Bellotti [d], C. Cattadori [d], O. Cremonesi [d], N. Ferrari [d], E. Fiorini [d], L. Zanotti [d], M. Altmann [e], F. v. Feilitzsch [e], R. Mößbauer [e], G. Berthomieu [f], E. Schatzman [f,3], I. Carmi [g], I. Dostrovsky [g], C. Bacci [h,4], P. Belli [h], R. Bernabei [h], S. d'Angelo [h], L. Paoluzi [h], A. Bevilacqua [i,5], M. Cribier [i], L. Gosset [i], J. Rich [i], M. Spiro [i], C. Tao [i,6], D. Vignaud [i], J. Boger [j], R.L. Hahn [j], J.K. Rowley [j], R.W. Stoenner [j], J. Weneser [j]

Two calibration runs with intense neutrino sources (^{51}Cr)

1992: GALLEX (followed by GNO)

Solar neutrinos observed by GALLEX at Gran Sasso

GALLEX Collaboration [1,2,3,4,5]

P. Anselmann, W. Hampel, G. Heusser, J. Kiko, T. Kirsten, E. Pernicka, R. Plaga [6], U. Rönn, M. Sann, C. Schlosser, R. Wink, M. Wójcik [7]
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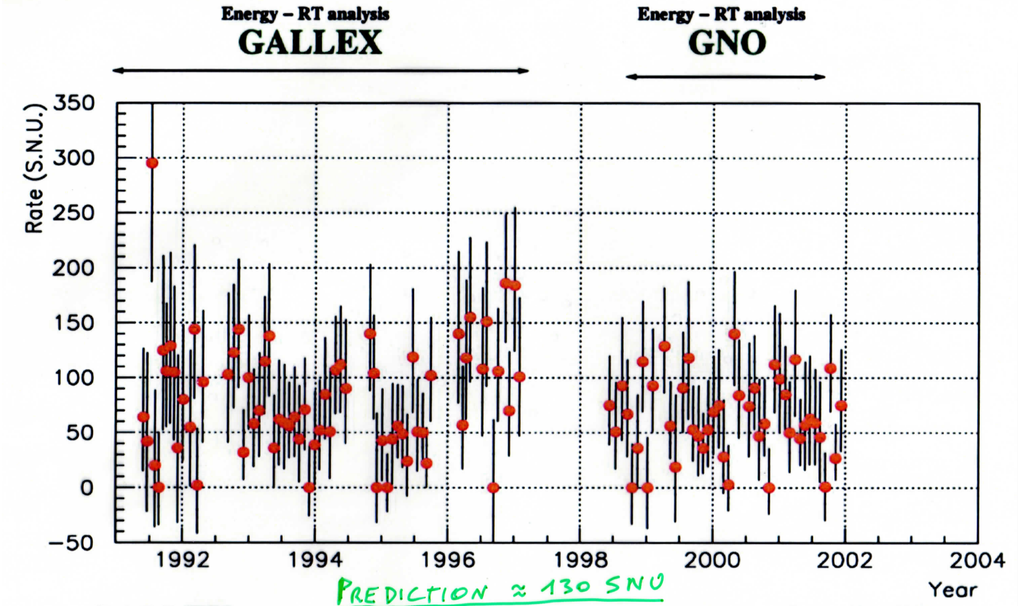
I. Carmi, I. Dostrovsky
Department of Environmental and Energy Research, Weizmann Institute of Science (WI), P.O. Box 26, 76100 Rehovot, Israel

C. Bacci [8], P. Belli, R. Bernabei, S. d'Angelo, L. Paoluzi
Dipartimento di Fisica II Università di Roma "Tor Vergata" and INFN – Sezione di Roma 2, via della Ricerca Scientifica, I-00133 Rome, Italy [3]

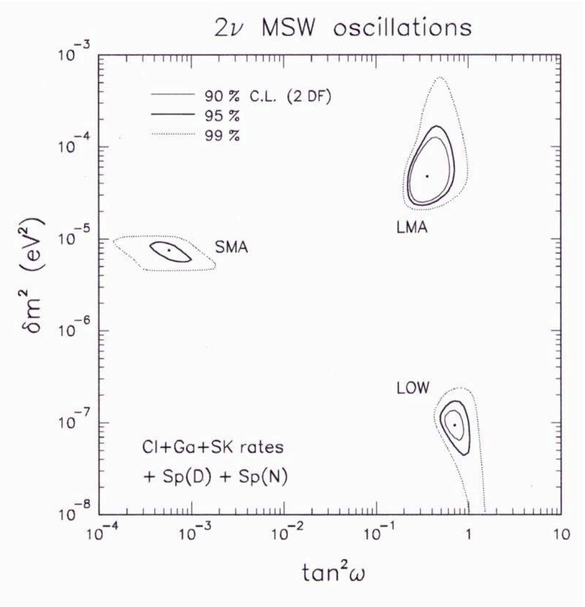
S. Charbit, M. Cribier, G. Dupont, L. Gosset, J. Rich, M. Spiro, C. Tao, D. Vignaud
DAPNIA/Service de Physique des Particules, CE Saclay, F-91191 Gif-sur-Yvette Cedex, France [4]

R.L. Hahn, F.X. Hartmann, J.K. Rowley, R.W. Stoenner and J. Weneser
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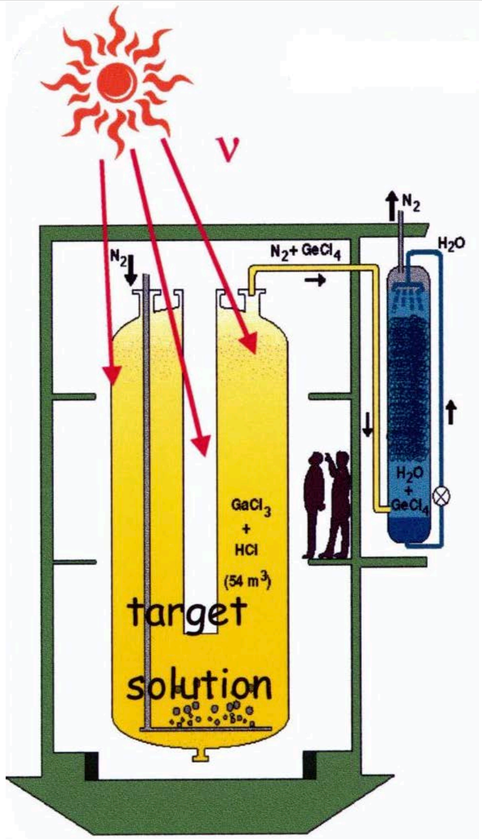
GALLEX Collaboration

W. Hampel [a], G. Heusser [a], J. Kiko [a], T. Kirsten [a], M. Laubenstein [a], E. Pernicka [a], W. Rau [a], U. Rönn [a], C. Schlosser [a,1], M. Wójcik [a,2], R. v. Ammon [b], K.H. Ebert [b], T. Fritsch [b], D. Heidt [b], E. Henrich [b], L. Stieglitz [b], F. Weirich [b], M. Balata [c], F.X. Hartmann [c], M. Sann [c], E. Bellotti [d], C. Cattadori [d], O. Cremonesi [d], N. Ferrari [d], E. Fiorini [d], L. Zanotti [d], M. Altmann [e], F. v. Feilitzsch [e], R. Mößbauer [e], G. Berthomieu [f], E. Schatzman [f,3], I. Carmi [g], I. Dostrovsky [g], C. Bacci [h,4], P. Belli [h], R. Bernabei [h], S. d'Angelo [h], L. Paoluzi [h], A. Bevilacqua [i,5], M. Cribier [i], L. Gosset [i], J. Rich [i], M. Spiro [i], C. Tao [i,6], D. Vignaud [i], J. Boger [j], R.L. Hahn [j], J.K. Rowley [j], R.W. Stoenner [j], J. Weneser [j]

Two calibration runs with intense neutrino sources (^{51}Cr)

GALLEX	**$77.5 \pm {}^{7.6}_{7.8}$ SNU**
re-evaluated	**$73.1 \pm {}^{7.1}_{7.3}$ SNU**
GNO (unchanged)	**$62.9 \pm {}^{6.0}_{5.9}$ SNU**
GALLEX+GNO	**69.3 ± 5.5 SNU**
re-evaluated	**67.5 ± 5.1 SNU**

GALLEX



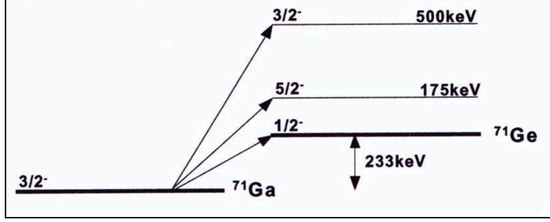
$\nu_e + {}^{71}Ga \rightarrow {}^{71}Ge + e^-$

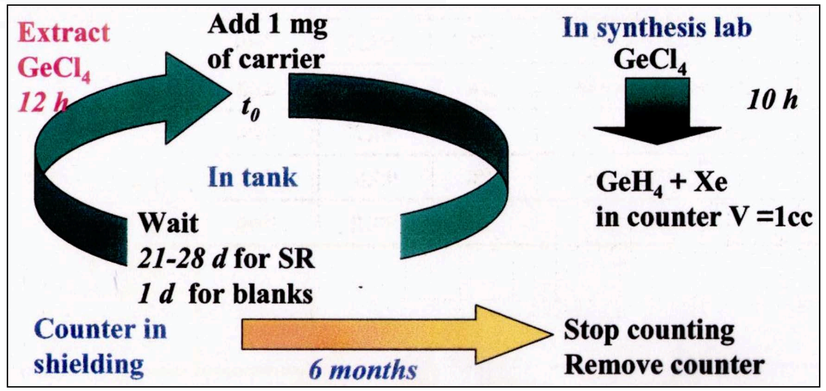
EC → ^{71}Ga

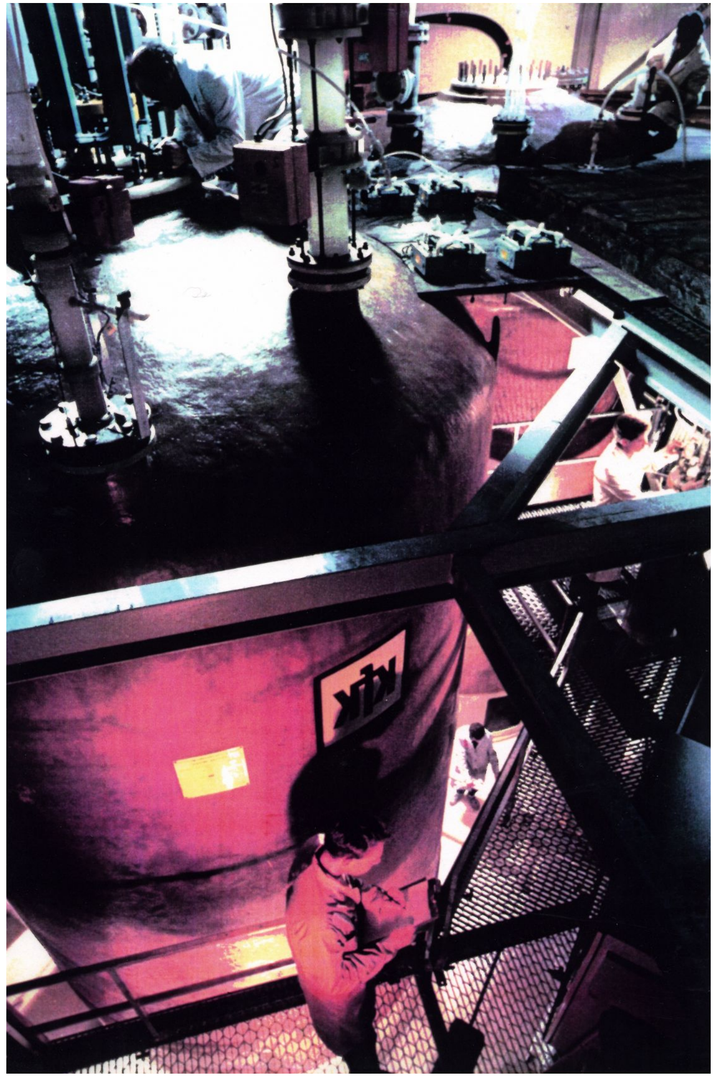
detected { X rays, Auger electrons

Threshold energy: 233 keV

Only sensitive to CC (ν_e)













1984: a crazy idea

Nuclear Instruments and Methods in Physics Research 224 (1984) 83–88
North-Holland, Amsterdam

Low temperature detectors are born!

- Ettore invents a new class of Particle detectors
- It is the beginning of a long development phase
- The first steps begin in the cryogenics laboratory of CERN but relations with Niniikosky are not easy and he moves back to Milan

LOW-TEMPERATURE CALORIMETRY FOR RARE DECAYS

E. FIORINI
Dipartimento di Fisica dell'Università and INFN, Milano, Italy

T.O. NIINIKOSKI
CERN, Geneva, Switzerland

Received 27 December 1983

The recent developments in underground low-counting experiments give limits to rare decays which are hard to improve since scaling the size and the resolution of the combined source–detector is difficult with the existing techniques. We explore here the possibility of low-temperature calorimetry to improve the limits on processes such as neutrinoless double-beta decay and electron decay.

1. Introduction

Detection of very low activities has become of considerable interest in nuclear and subnuclear physics. Recent examples are searches carried out with "passive" detectors, such as those on double-beta decay and electron stability.

Double-beta decay involves [1–4] a triplet of isotopes (A, Z), $(A, Z+1)$ and $(A, Z+2)$, where single-projection chambers (TPCs) [9–12], since ^{76}Ge and ^{136}Xe are good double-beta decay candidates. It would be of obvious interest to extend the "passive" detector techniques to other double-beta active materials, and also to increase the mass and possibly the resolution of the above-mentioned detectors.

Similar considerations apply to the problem of electron stability, which has also been investigated with passive detectors [13–16]. A method consists in the

… the beginning of the end

CONSTRUCTION OF A MASSIVE GERMANIUM THERMAL DETECTOR FOR EXPERIMENTS ON RARE DECAYS

A. ALESSANDRELLO, D.V. CAMIN, E. FIORINI and A. GIULIANI
Dipartimento di Fisica dell'Universita' di Milano and Sezione dell' INFN, I-20133 Milan, Italy

Received 22 December 1987

In view of future experiments on rare decays we have constructed and operated a composite germanium bolometer with an energy resolution of about 1% and a mass of about 0.7g, larger by more than three orders of magnitude than those of any existing thermal detector. Unlike the previous ones, this bolometer also presents heat capacity in good agreement with the Debye law, with a percentage of thermalized alpha particle energy of at least 70%.

A cryogenic tellurium detector for rare events and gamma rays

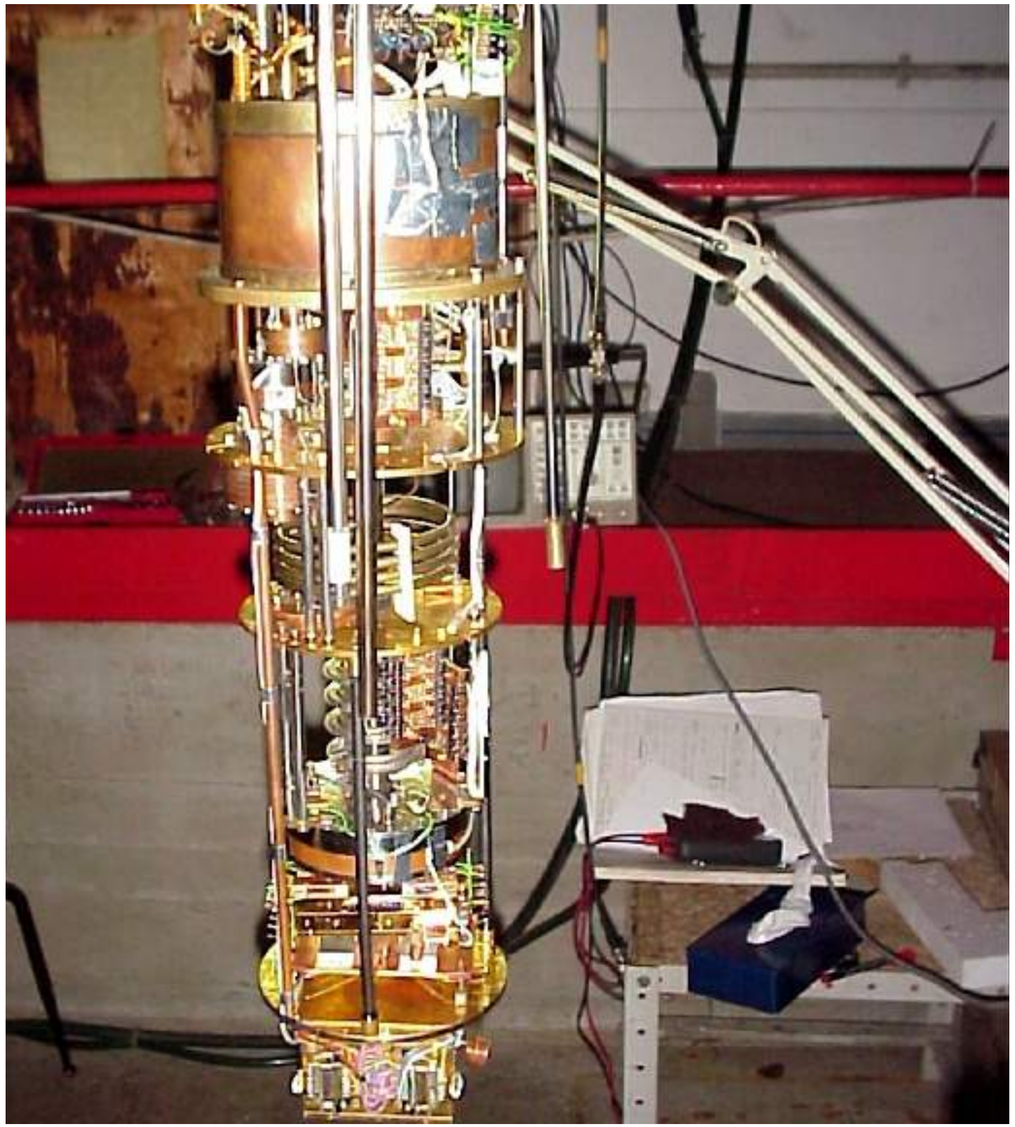
A. Alessandrello [1], C. Brofferio, D. Camin, O. Cremonesi, E. Fiorini, A. Giuliani and G. Pessina
Dipartimento di Fisica dell'Università di Milano and Sezione di Milano dell'INFN, I-20133 Milan, Italy

Received 11 June 1990

In view of a future experiment on double beta decay we have constructed and operated for the first time a bolometric detector made with an ultrapure tellurium crystal of about 2.1 gram. With this detector we have been able to measure high energy gamma rays from various calibration sources with an energy resolution of 2% in the region of neutrinoless double beta decay. The thermal properties of tellurium at very low temperature are determined for the first time in view of the construction of larger detectors.

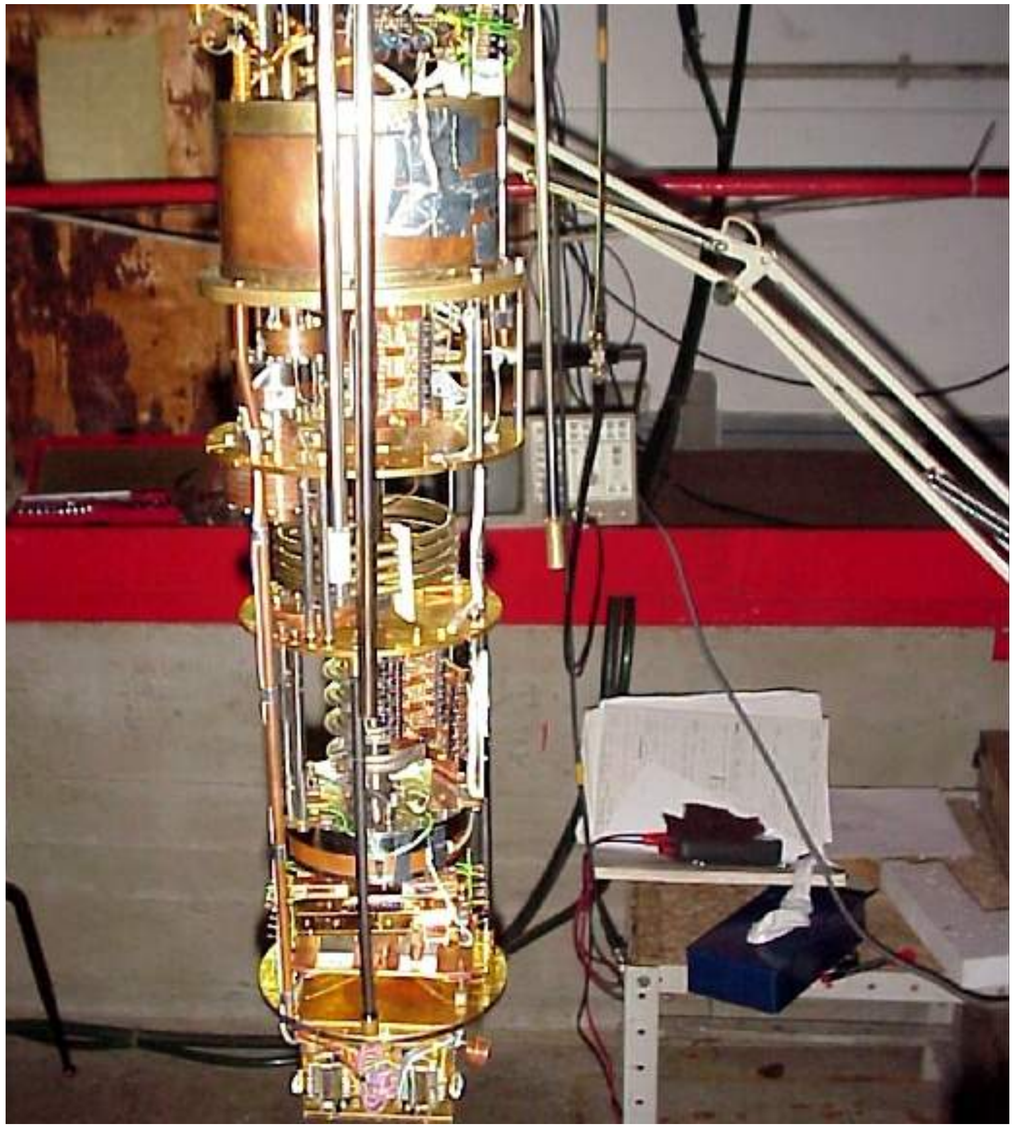
just the start of a very long adventure

First refrigerators

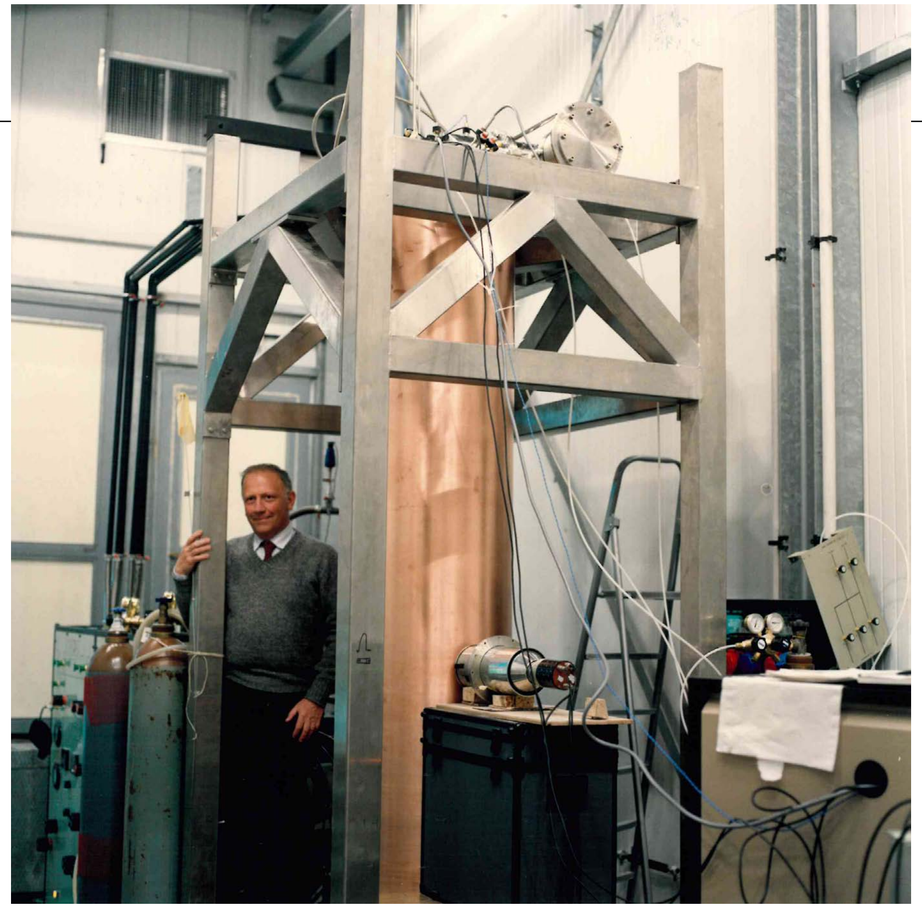


1987: Milan (LASA)

First refrigerators

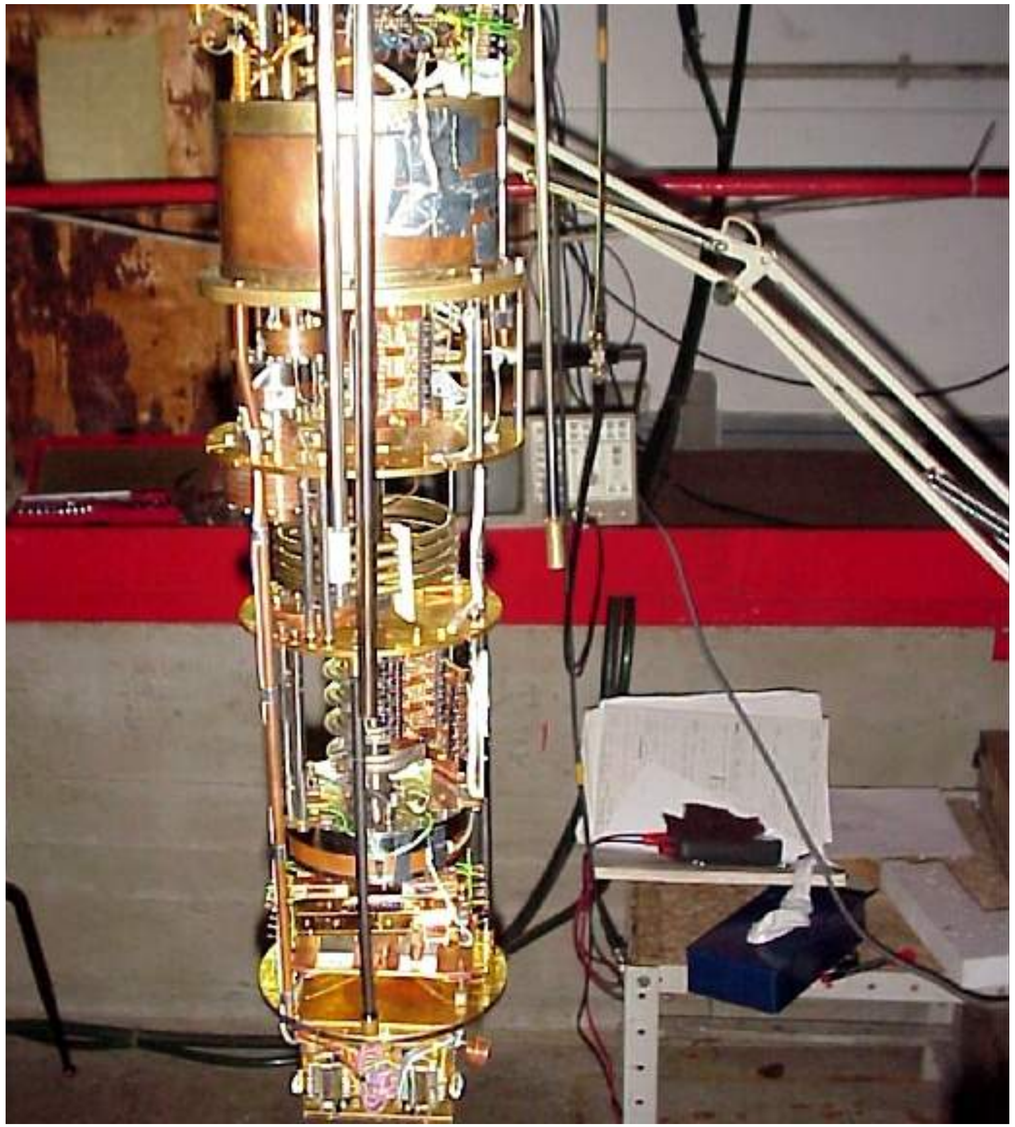


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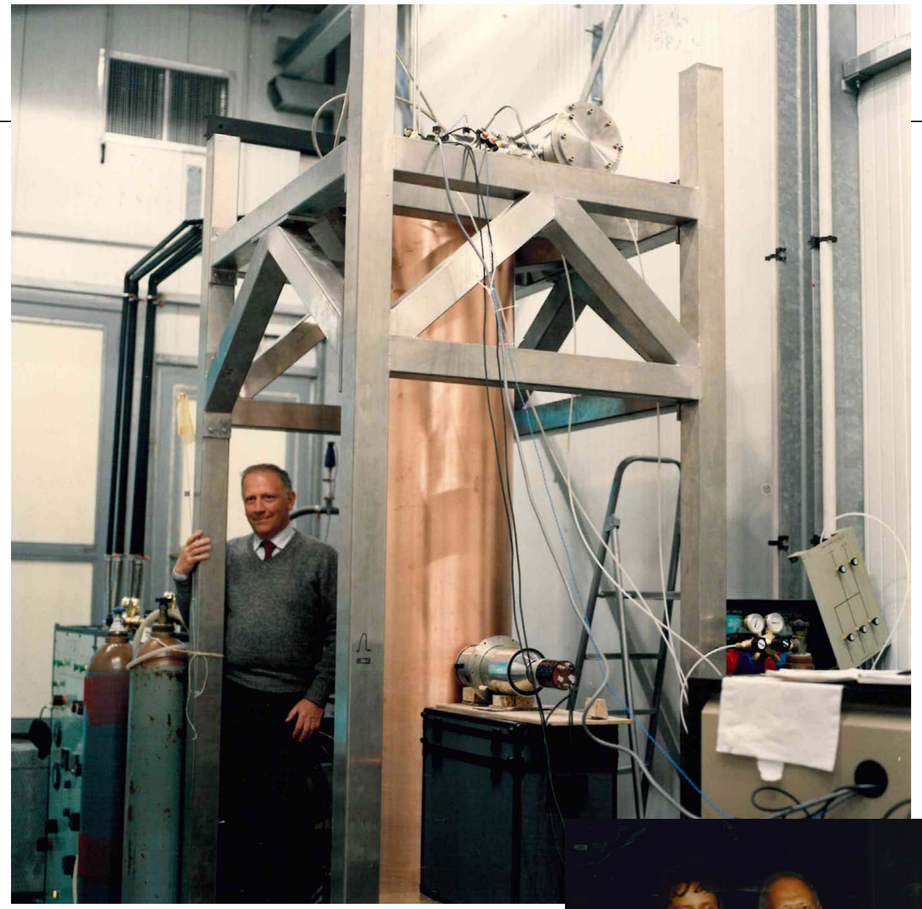


1989: LNGS (Hall A)

First refrigerators



1987: Milan (LASA)

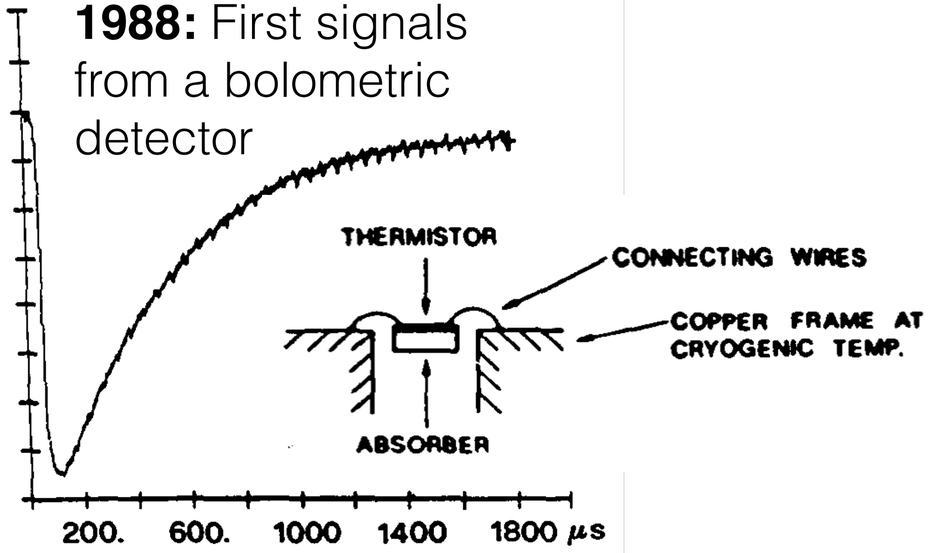


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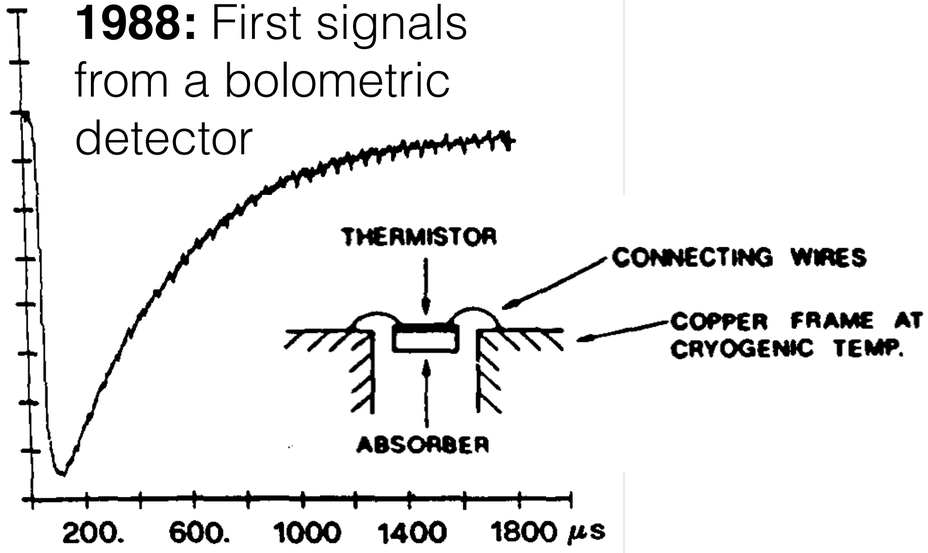
Bolometers

1988: First signals from a bolometric detector



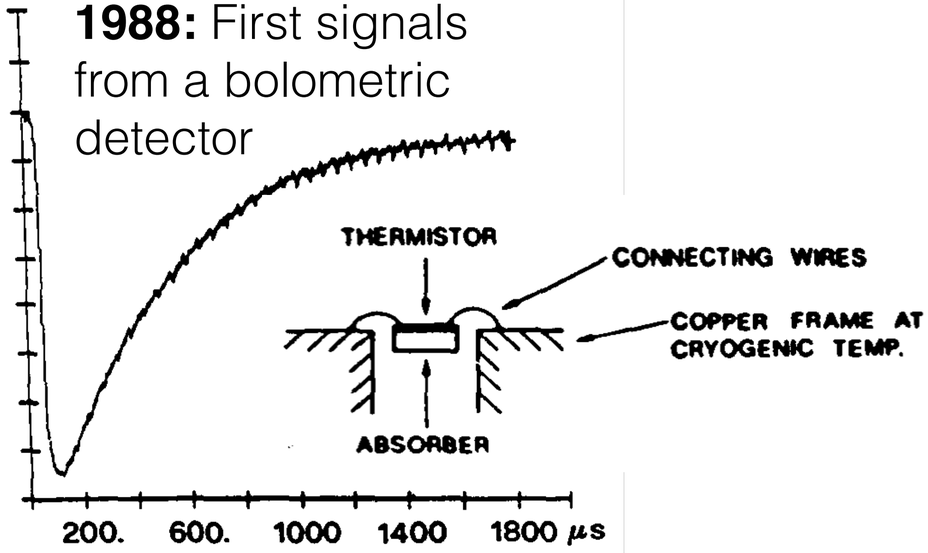
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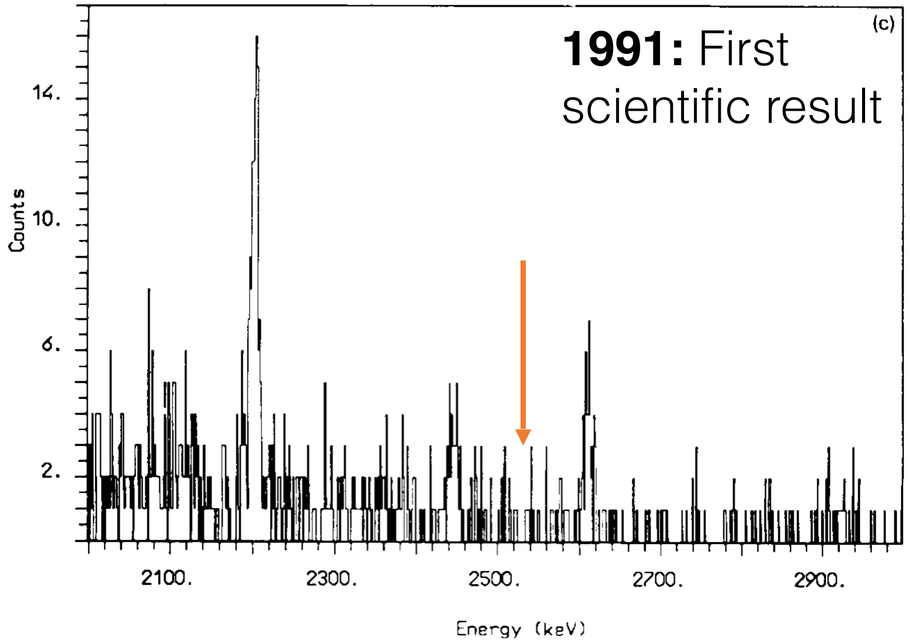


Bolometers

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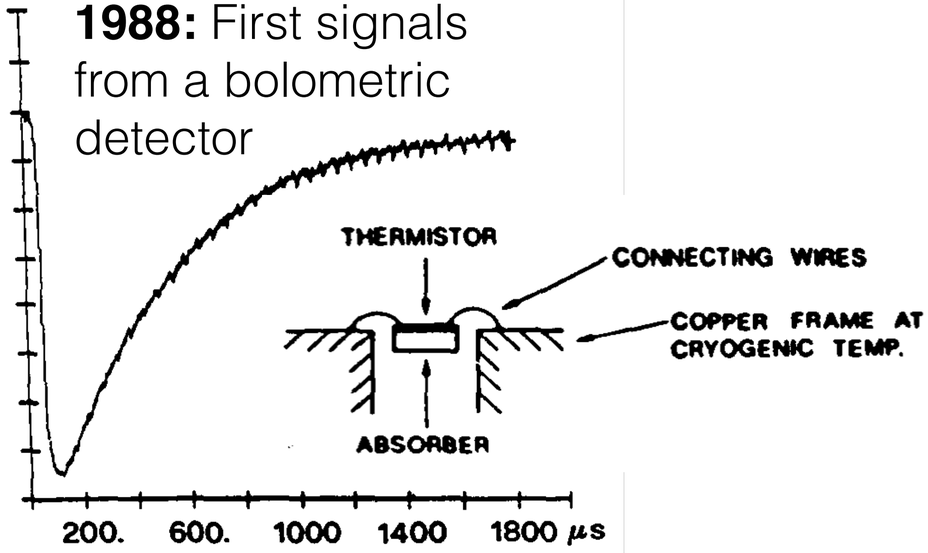


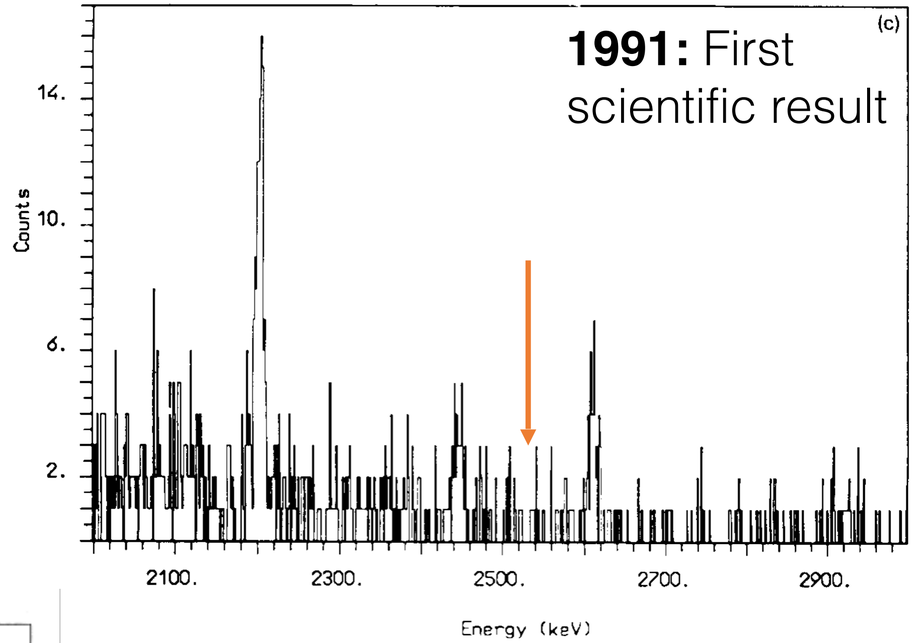
1991: First scientific result



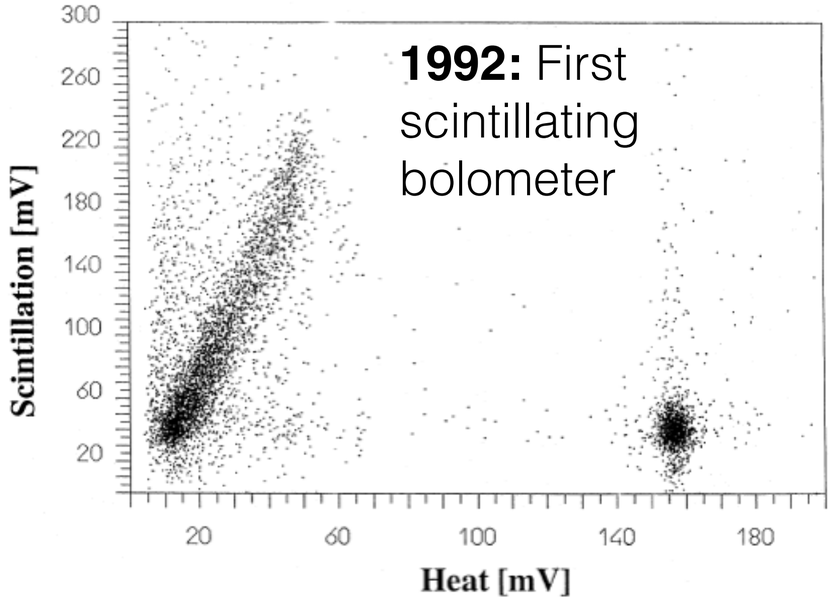
Bolometers

1988: First signals from a bolometric detector





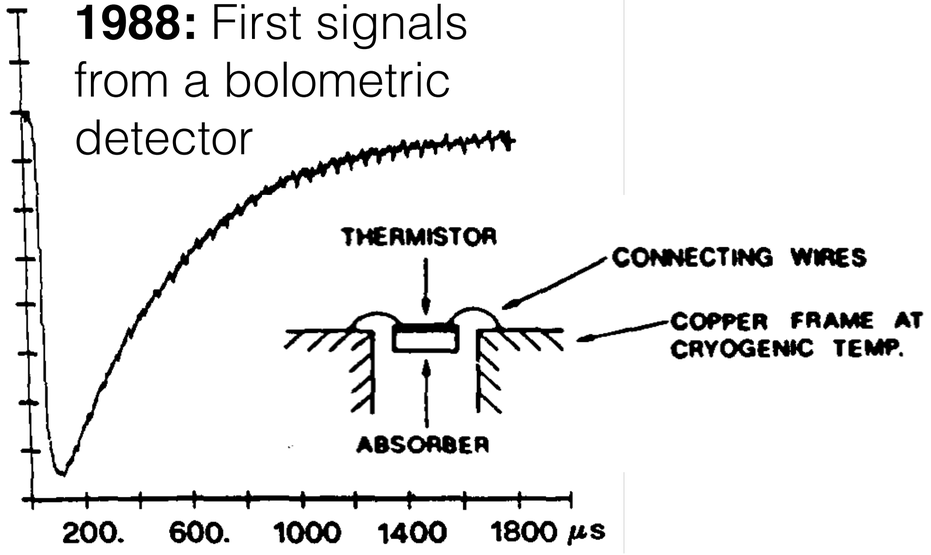
1991: First scientific result



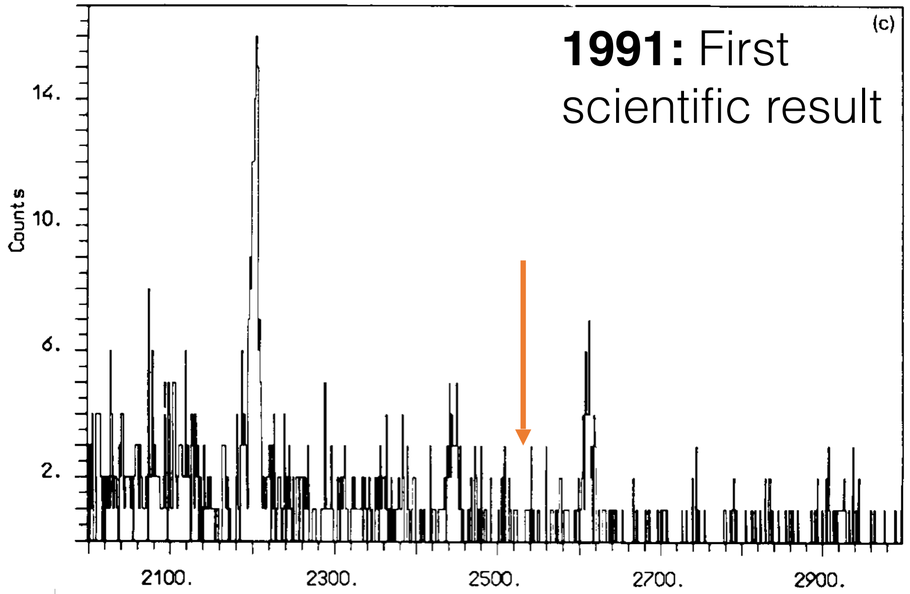
1992: First scintillating bolometer

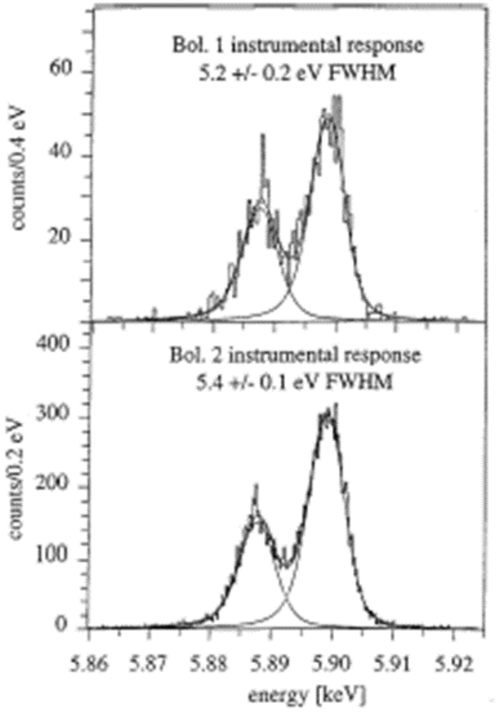
Bolometers

1988: First signals from a bolometric detector

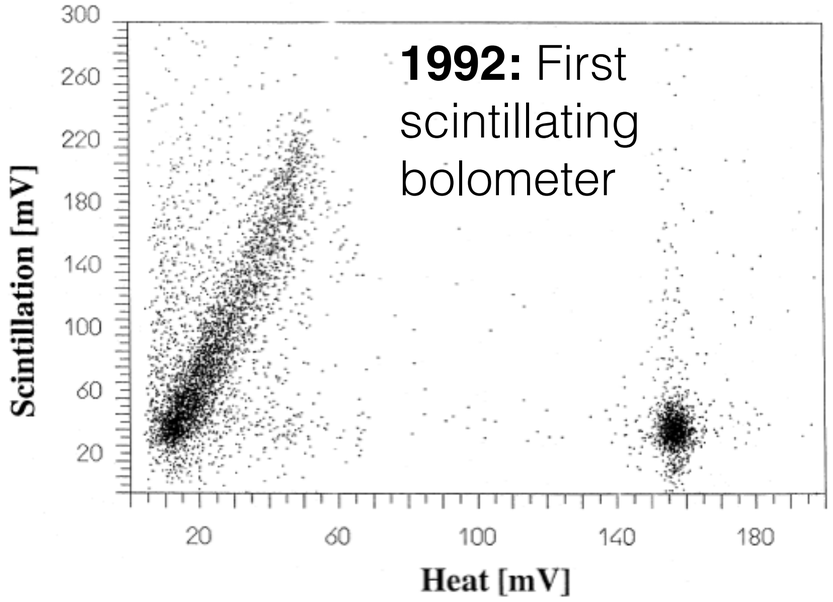


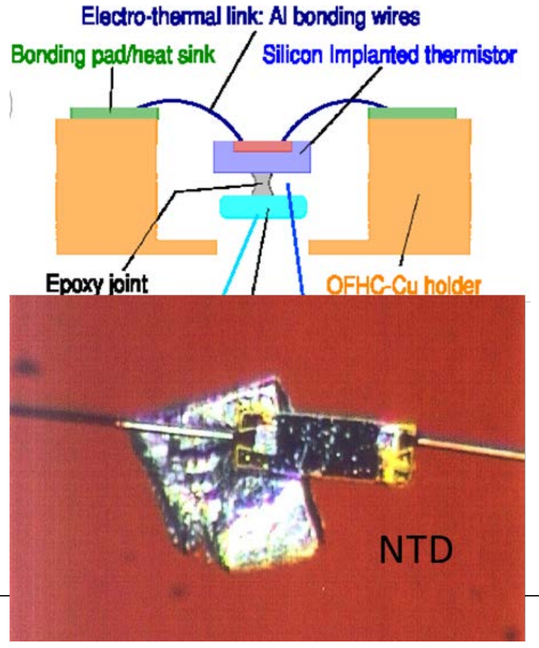
1991: First scientific result





1992: First scintillating bolometer





1998: High resolution μbolometers

CUORE

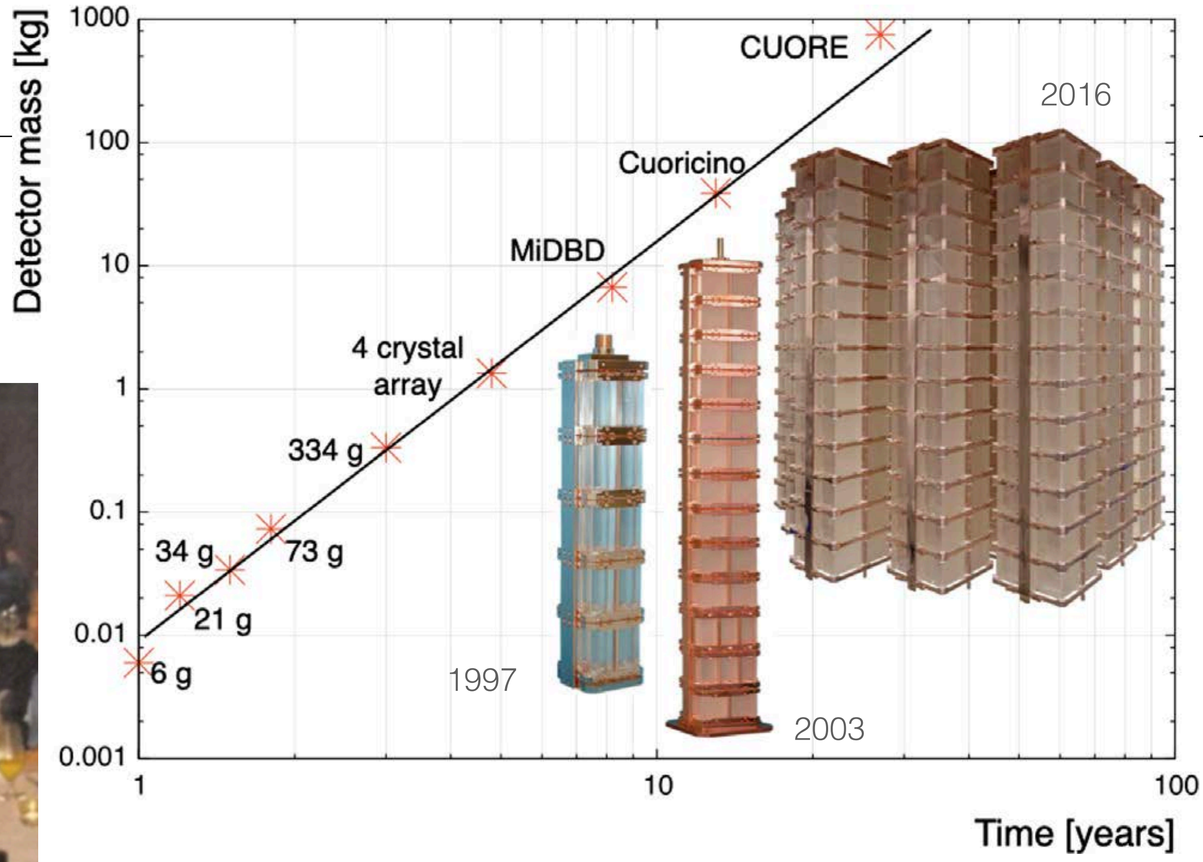
Ettore always liked to tell that the idea came to him during a walk with his friend Frank along the banks of the Volga



CUORE

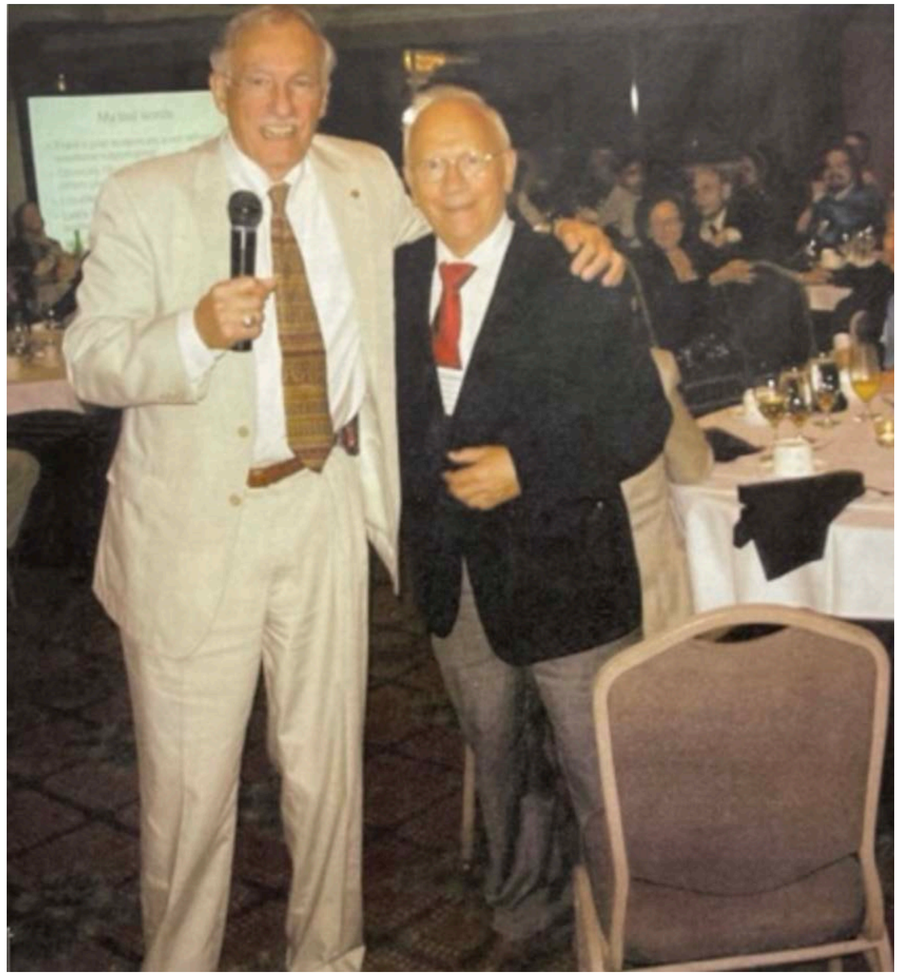
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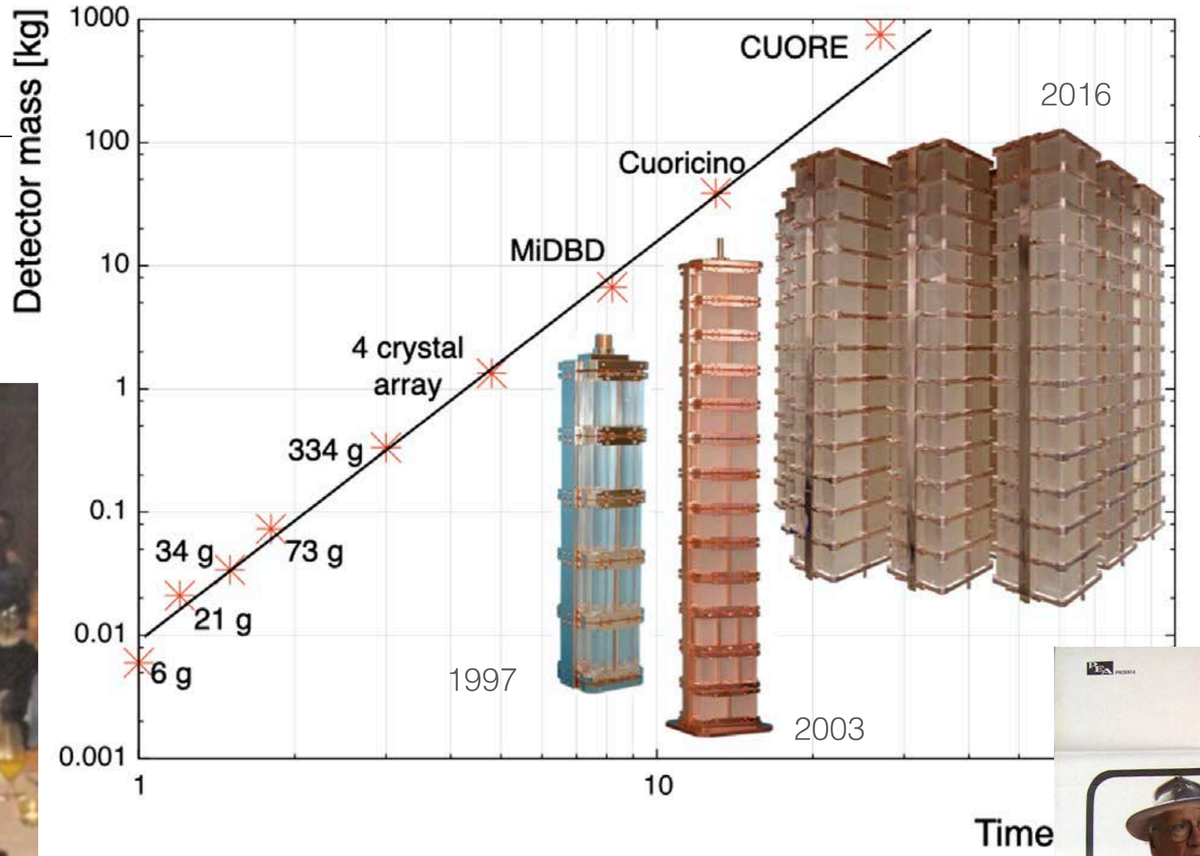




CUORE

Ettore always liked to tell that the idea came to him during a walk with his friend Frank along the banks of the Volga







ELSEVIER

Physics Reports 307 (1998) 309–317

PHYSICS REPORTS

CUORE: a cryogenic underground observatory for rare events

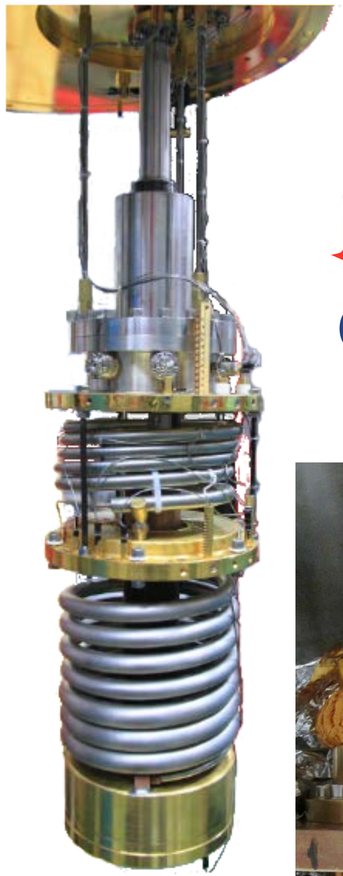
E. Fiorini[1]

Dipartimento di Fisica dell'Università di Milano e Sezione di Milano dell'INFN, I-20133 Milan, Italy

Abstract

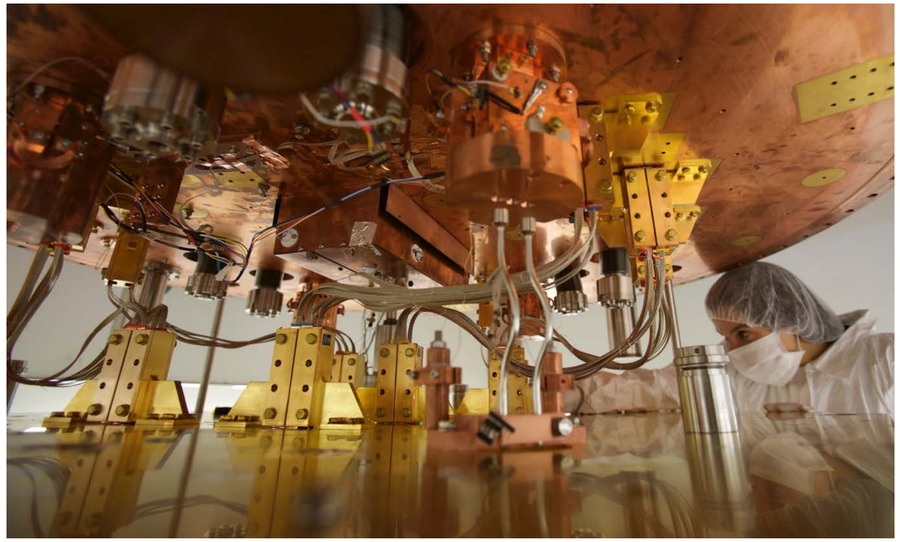
The proposal for an array of 1000 cryogenic detectors of a mass between 0.5 and 1 kg each is presented. It would be operated underground to search for neutrinoless double beta decay, interaction of WIMPS and of solar axions and for rare events in nuclear physics. The first results of an array of 20 TeO_2 detectors totaling a mass of almost 7 kg will be also reported. © 1998 Elsevier Science B.V. All rights reserved.

The coldest m³ in the known Universe



CUORE

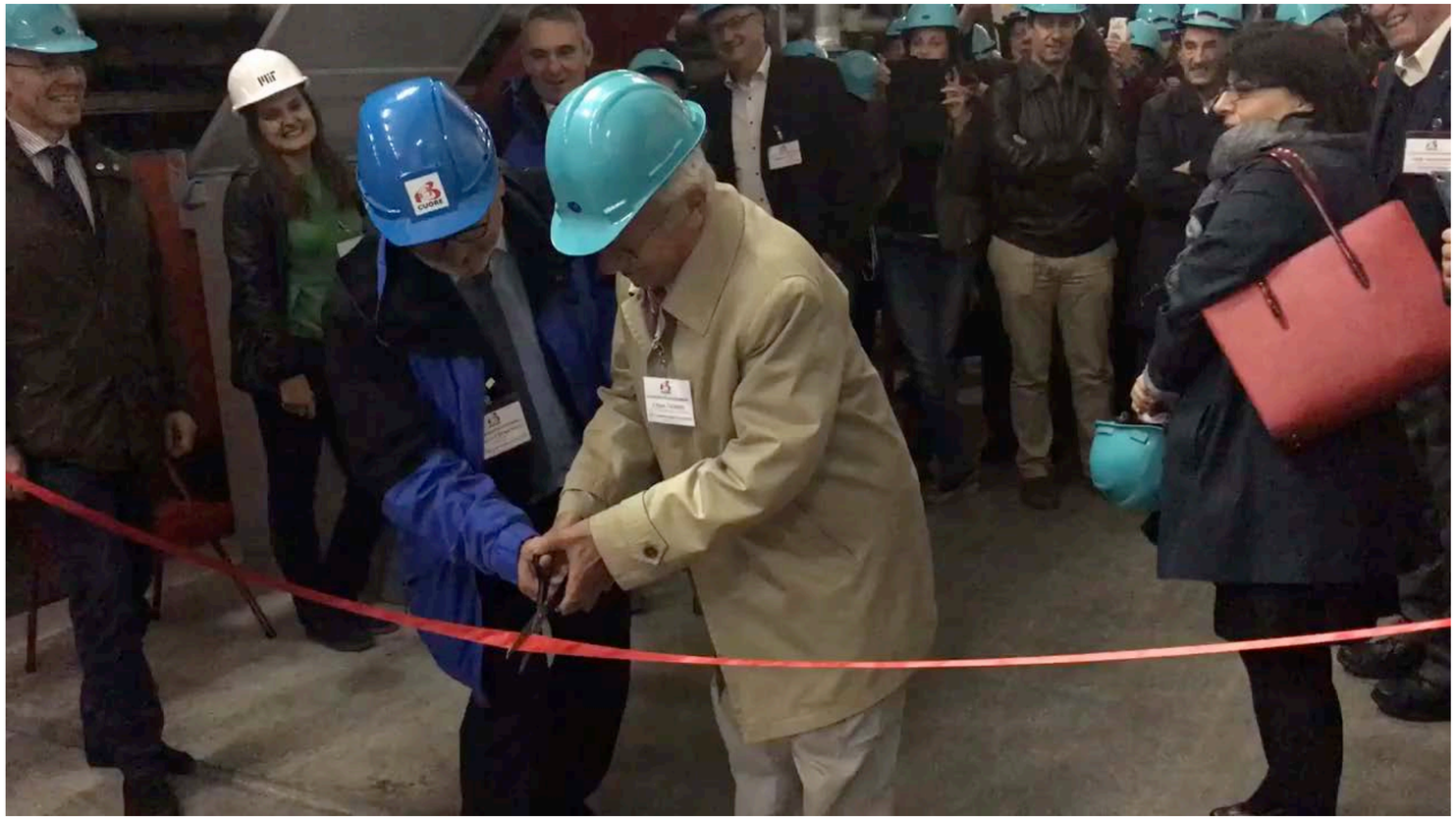








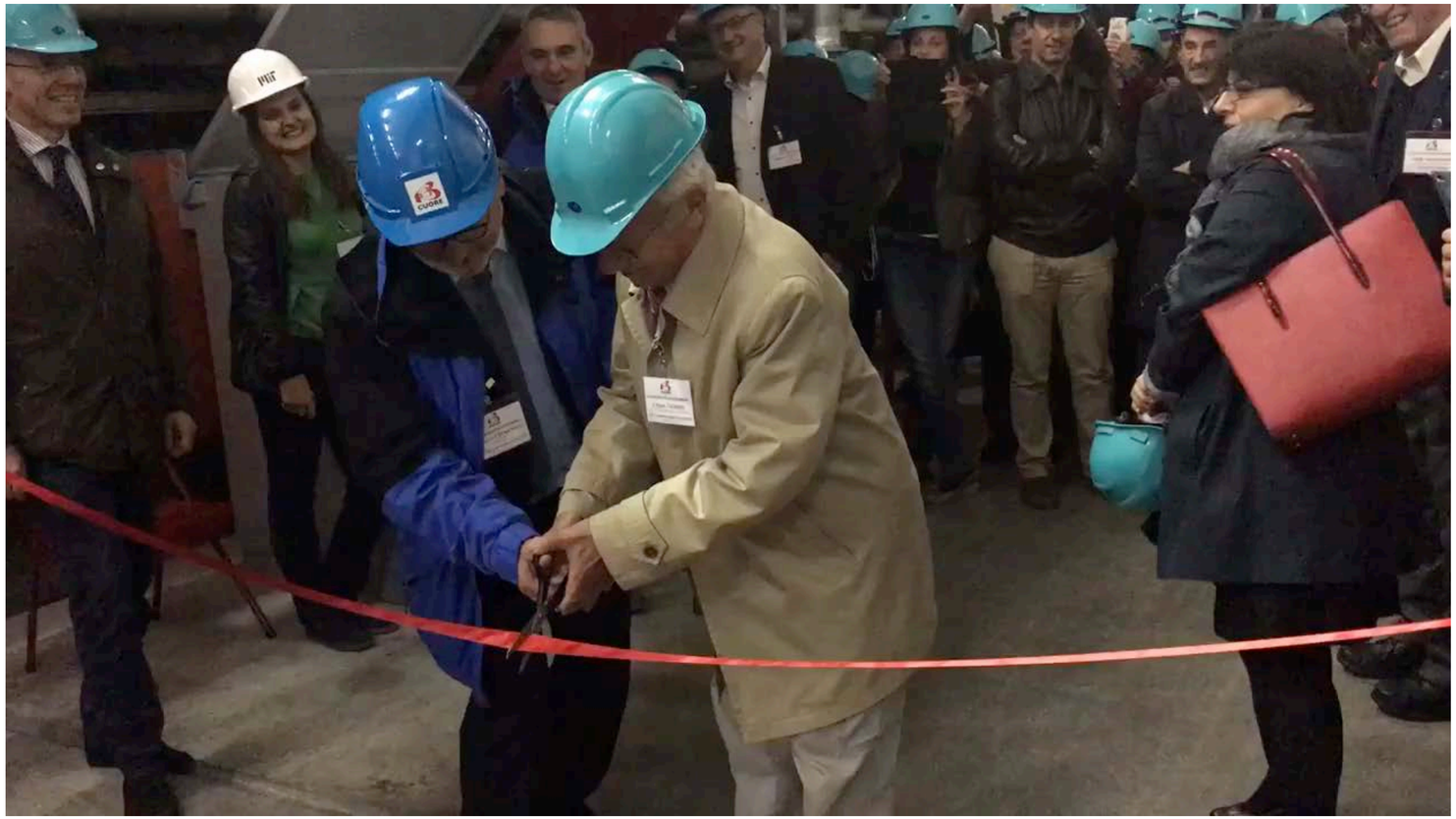
21/10/2017 - CUORE inauguration







21/10/2017 - CUORE inauguration







Social life













Social life















the “oddities”

- Environment (nuclear reactors accidents): Chernobyl (1986) , Spagna (1998), Fukushima (2011), ^{106}Ru (2017)
- Energy: “Cold fusion”
- Archeometry: Roman lead, Napoleon's hair, Sant’Imbenia and “Lupa Capitolina”
- And much more: depleted uranium, medical physics, …

Roman lead


1988: A Roman ship with a cargo of ~65 tons of lead is discovered off the “Mal di Ventre” island
Sardinia
Sicily
Carthage
navis oneraria magna

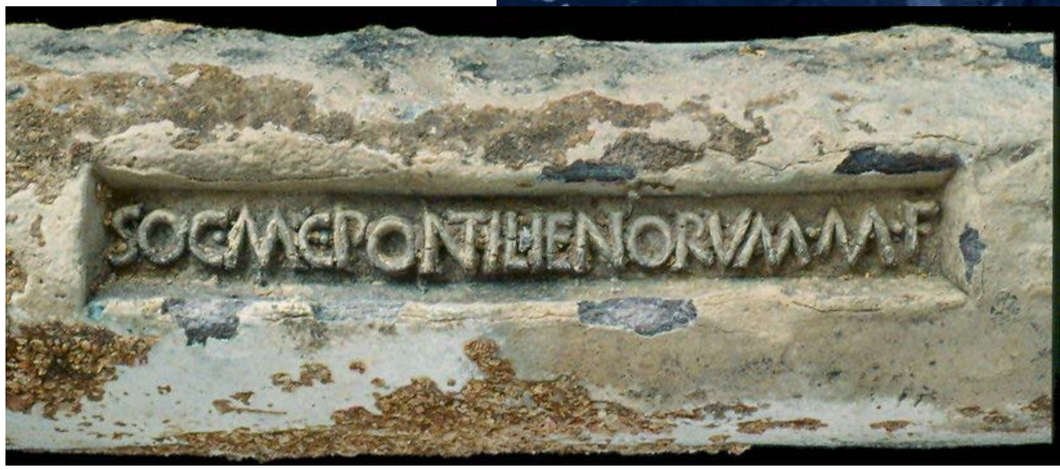
Roman lead





1993: INFN funds the mining of about 1,000 ingots





Roman lead

1988: A Roman ship with a cargo of ~65 tons of lead is discovered off the “Mal di Ventre” island



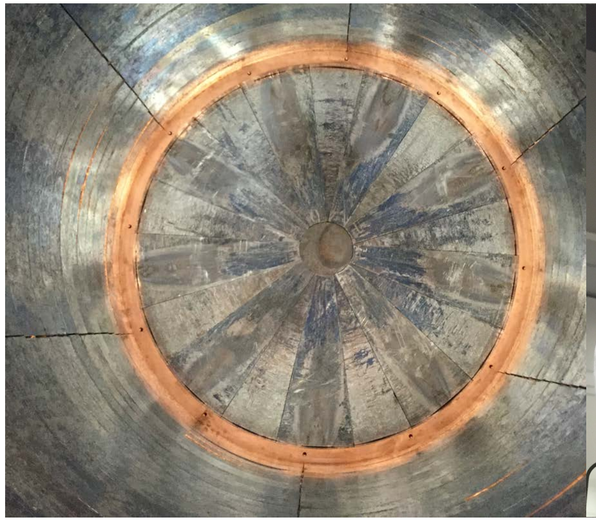
navis oneraria magna



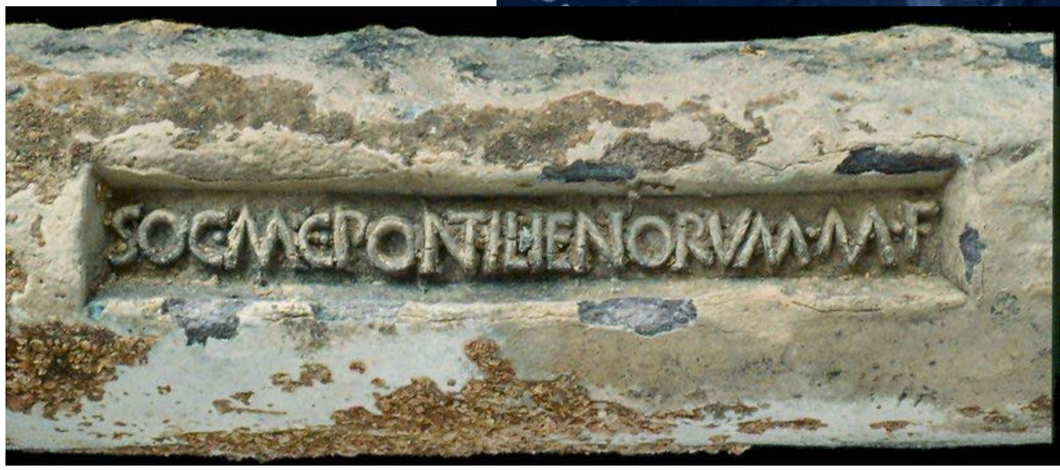
1993: INFN funds the mining of about 1,000 ingots



2014: the criogenic shield of CUORE is built







Napoleon thriller



- The doubt: was Napoleon murdered (poisoned)?

Napoleon thriller



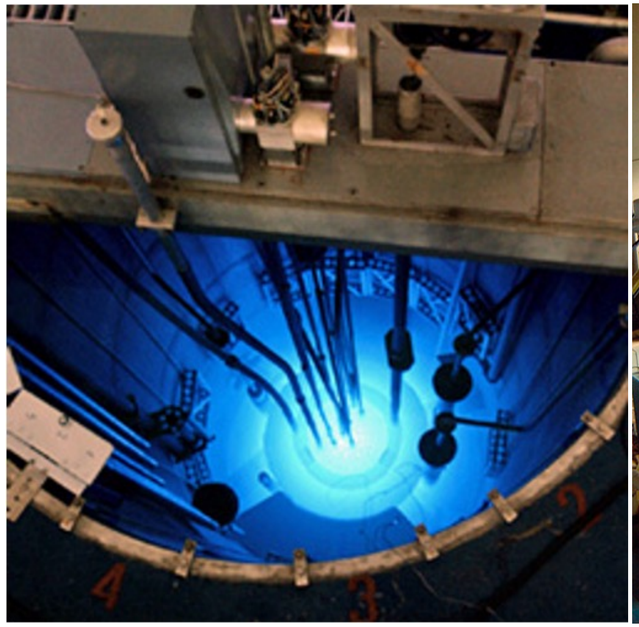
- The doubt: was Napoleon murdered (poisoned)?
- Solution: analysis of arsenic in his hair
  - An adventure known as "Napoleon's hair”

Napoleon thriller

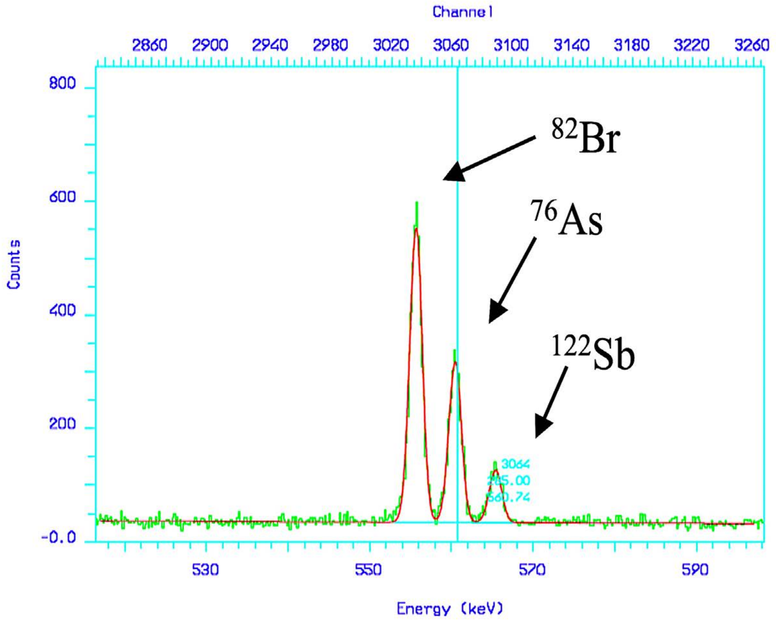


- The doubt: was Napoleon murdered (poisoned)?
- Solution: analysis of arsenic in his hair
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$$n + {}^{75}As \rightarrow {}^{76}As \rightarrow {}^{76}Se + \gamma\,(559\ keV)$$







LENA (Pavia University)
TRIGA MARK II Reactor

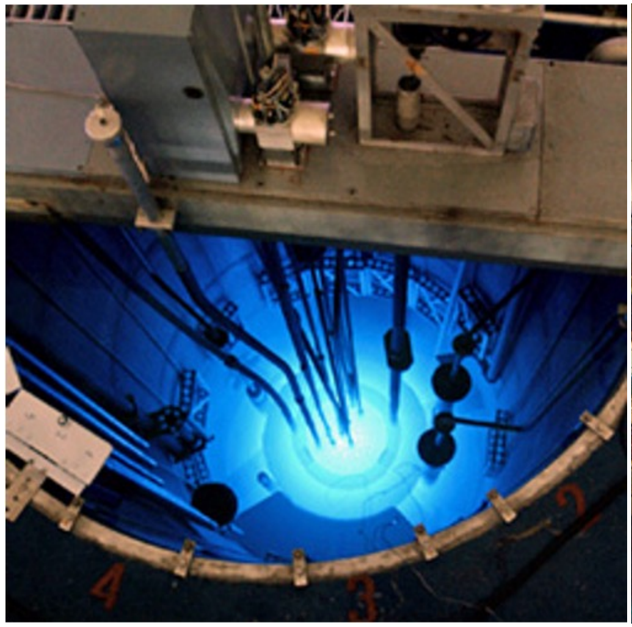
Napoleon thriller



- The doubt: was Napoleon murdered (poisoned)?
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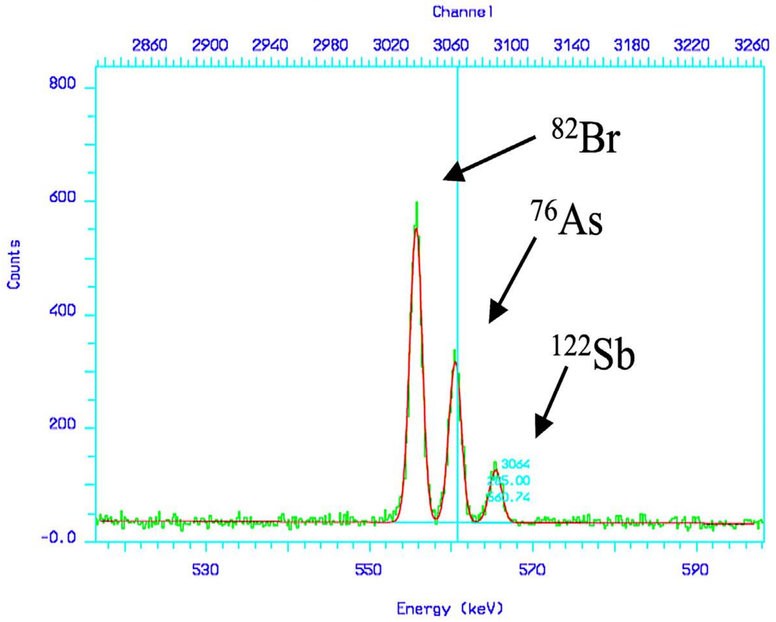
$$n + {}^{75}As \rightarrow {}^{76}As \rightarrow {}^{76}Se + \gamma\,(559\ keV)$$

- Arsenic concentration in Napoleon's hair is 100 times higher wrt present values
- However …
  - No variations in As concentrations are found along Emperor's life
  - Measurements on the hair of his family members give comparable results
- Findings are not compatible with the hypothesis of poisoning by As





LENA (Pavia University)
TRIGA MARK II Reactor



Low activity labs



1996: LNGS

Ettore understands that low activity measurements are crucial for scientific research and useful for social life

1998: LNGS

Low activity labs



1996: LNGS

Ettore understands that low activity measurements are crucial for scientific research and useful for social life



1998: LNGS

Low activity labs



1996: LNGS

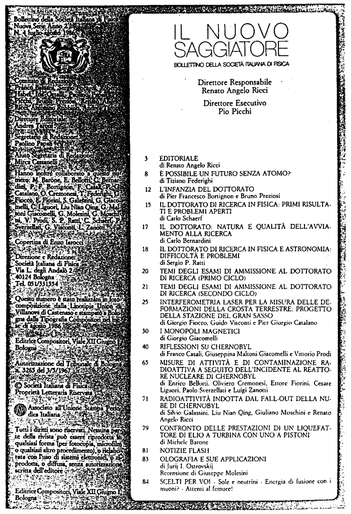
Ettore understands that low activity measurements are crucial for scientific research and useful for social life

- **1986**: Environmental monitoring after Chernobyl

E. Bellotti, O. Cremonesi, E. Fiorini, C. Liguori, P. P. Sverzellati, L. Zanotti

"Misure di attività e di contaminazione radioattiva a seguito dell' incidente al reattore nucleare di Chernobyl"

Il Nuovo Saggiatore. **4** (1986), 65 (Anno II)



IL NUOVO SAGGIATORE

BOLLETTINO DELLA SOCIETÀ ITALIANA DI FISICA

Direttore Responsabile
Renato Angelo Ricci

Direttore Esecutivo
Pio Picchi

3 EDITORIALE di Renato Angelo Ricci
8 È POSSIBILE UN FUTURO SENZA ATOMO? di Tiziano Federighi
12 L'INFANZIA DEL DOTTORATO di Pier Francesco Bortignon e Bruno Preziosi
15 IL DOTTORATO DI RICERCA IN FISICA: PRIMI RISULTATI E PROBLEMI APERTI di Carlo Schaerf
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20 TEMI DEGLI ESAMI DI AMMISSIONE AL DOTTORATO DI RICERCA (PRIMO CICLO)
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25 INTERFEROMETRIA LASER PER LA MISURA DELLE DEFORMAZIONI DELLA CROSTA TERRESTRE: PROGETTO DELLA STAZIONE DEL GRAN SASSO di Giorgio Fiocco, Guido Visconi e Pier Giorgio Catalano
30 I MONOPOLI MAGNETICI di Giorgio Giacomelli
40 RIFLESSIONI SU CHERNOBYL di Franco Casali, Giuseppina Maloni Giacomelli e Vittorio Prodi
65 MISURE DI ATTIVITÀ E DI CONTAMINAZIONE RADIOATTIVA A SEGUITO DELL'INCIDENTE AL REATTORE NUCLEARE DI CHERNOBYL di Enrico Bellotti, Oliviero Cremonesi, Ettore Fiorini, Cesare Liguori, Paolo Sverzellati e Luigi Zanotti
71 RADIOATTIVITÀ INDOTTA DAL FALL-OUT DELLA NUBE DI CHERNOBYL di Silvio Galeazzi, Liu Nian Qing, Giuliano Moschini e Renato Angelo Ricci
79 CONFRONTO DELLE PRESTAZIONI DI UN LIQUEFATTORE DI ELIO A TURBINA CON UNO A PISTONI di Michele Barone
81 NOTIZIE FLASH
83 OLOGRAFIA E SUE APPLICAZIONI di Iurii I. Ostrovskii. Recensione di Giuseppe Molesini
84 SCELTI PER VOI - Sole e neutrini - Energia di fusione con i muoni? - Attenti al fumare!

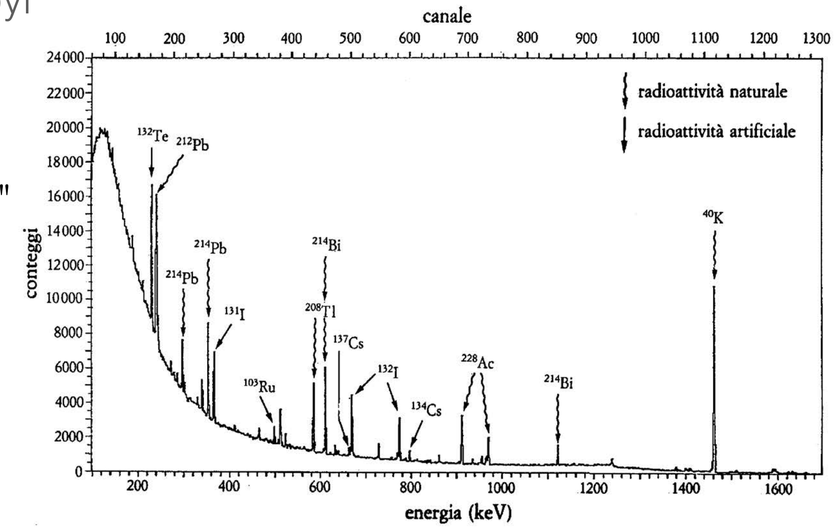


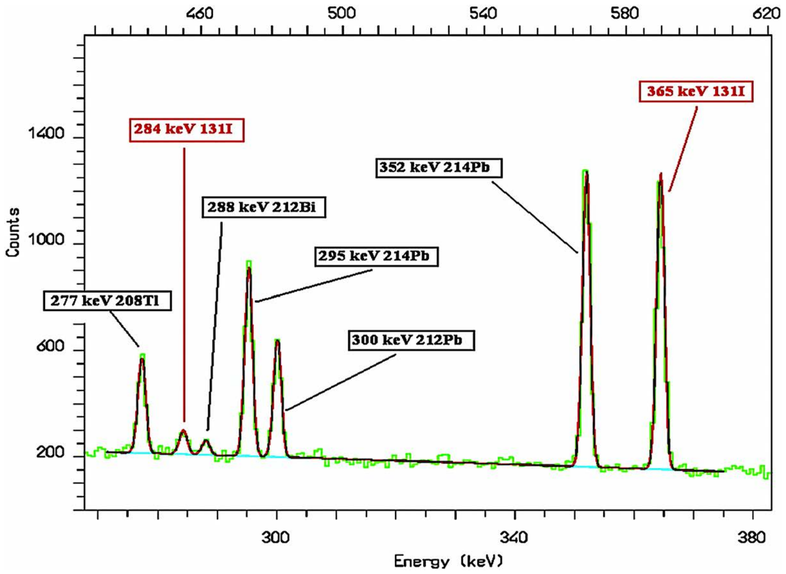
Table 2 Classification of nuclear wastes according to their lifetime

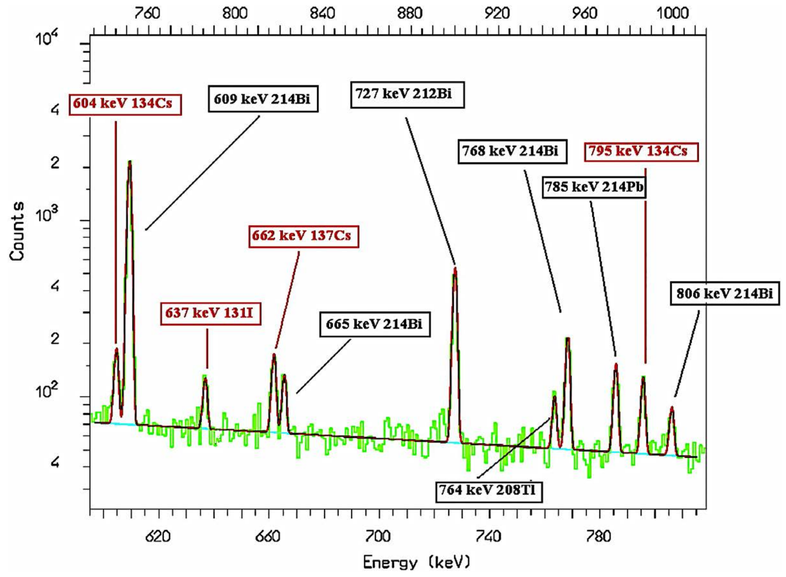
Lifetime	Fission products
1–10 days	^{72}Zn, ^{67}Ga, ^{77}As, ^{82}Br, ^{90}Y, ^{95}Nb, ^{99}Mo, ^{103}Rh, ^{105}Rh, ^{109}Ag, ^{115}Cd, ^{115}I, ^{127}Sb, ^{131}Te, ^{131}I, ^{132}Te, ^{129}Xe, ^{133}Xe, ^{135}Xe, ^{135}Ba, ^{140}La, ^{143}Ce, ^{147}Pm, ^{14}Pm, ^{151}Eu, ^{153}Eu, ^{155}Eu, ^{161}Gd, ^{161}Tb, ^{166}Dy, ^{166}Ho
10–100 days	^{86}Ru, ^{89}Sr, ^{91}Y, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{115}Cd, ^{117}Sn, ^{124}Sb, ^{126}Sb, ^{125}Te, ^{129}Te, ^{131}Xe, ^{131}Cs, ^{143}Pr, ^{147}Nd, ^{151}Pmk, ^{156}Eu, ^{131}Te, ^{131}Te, ^{131}Te, ^{131}Te,
100 days–10 years	^{119}Sn, ^{123}Sn, ^{121}Te, ^{127}Te, ^{134}Cs, ^{144}Ce, ^{147}Pm, ^{154}Eu, ^{135}Eu, ^{151}Sm
$10^{-5} \times 10^{8}$ years	^{85}Kr, ^{90}Sr, ^{93}Zr, ^{93}Nb, ^{99}Tc, ^{107}Pd, ^{107}Cd, ^{107}Ag, ^{121}Sn, ^{126}Sn, ^{129}I, ^{135}Cs, ^{137}Cs, ^{131}Te,
$>5 \times 10^{8}$ years	^{82}Se, ^{87}Ru, ^{116}Cd, ^{130}Te, ^{114}Nd, ^{147}Sm, ^{152}Gd,



1998: LNGS

Fukushima





^{137}Cs and ^{131}I in air (Milan)

Journal of Environmental Radioactivity 114 (2012) 113–118

Contents lists available at SciVerse ScienceDirect

Journal of Environmental Radioactivity

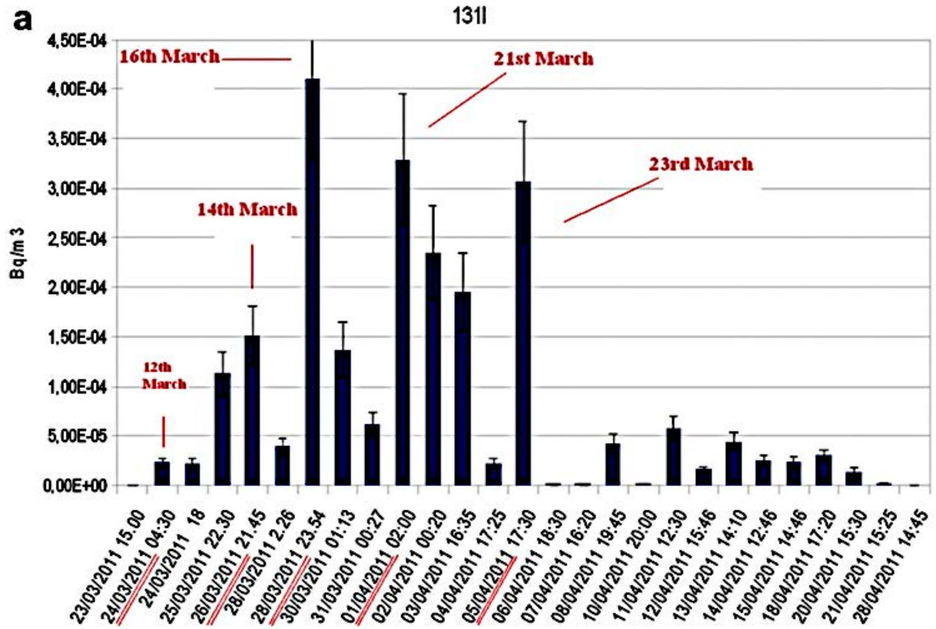
journal homepage: www.elsevier.com/locate/jenvrad



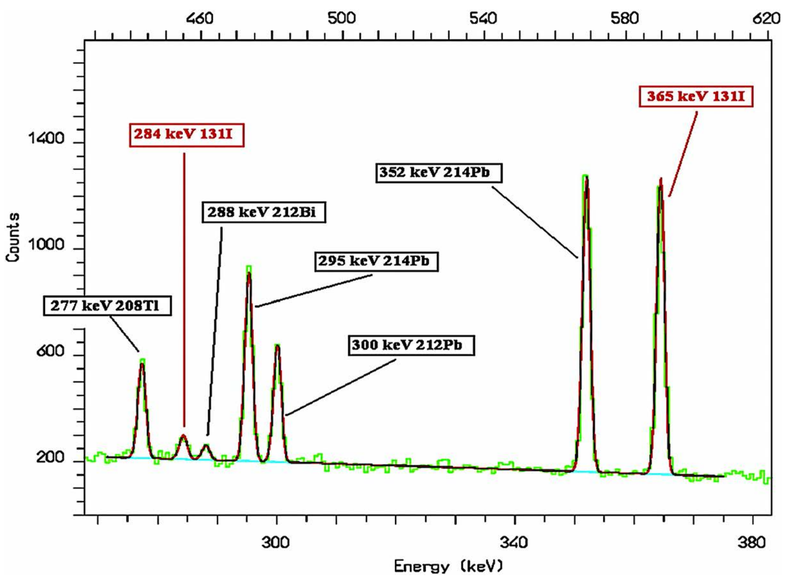
Measurement of airborne ^{131}I, ^{134}Cs and ^{137}Cs due to the Fukushima reactor incident in Milan (Italy)☆

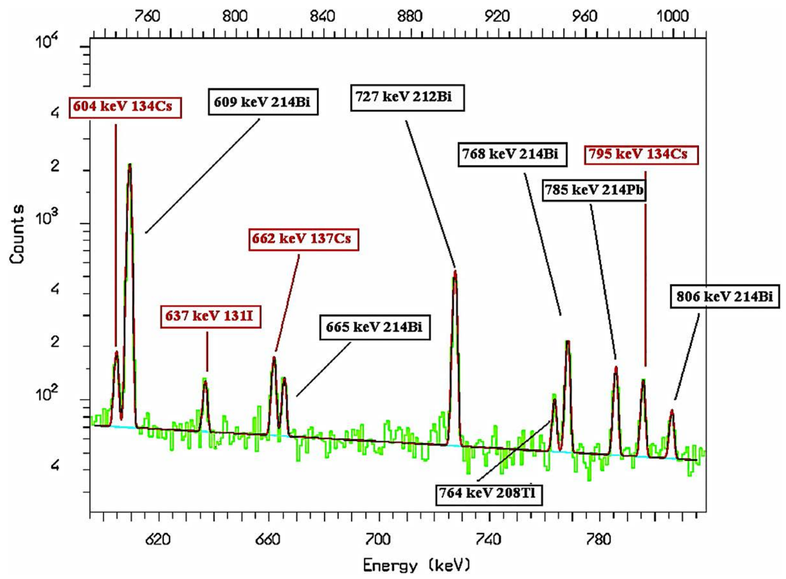
M. Clemenza*, E. Fiorini, E. Previtali, E. Sala

University of Milano Bicocca, Physics Department "G. Occhialini" and INFN sec. of Milano Bicocca - Piazza della Scienza 3, 20126 Milan, Italy



Fukushima





^{137}Cs and ^{131}I in air (Milan)

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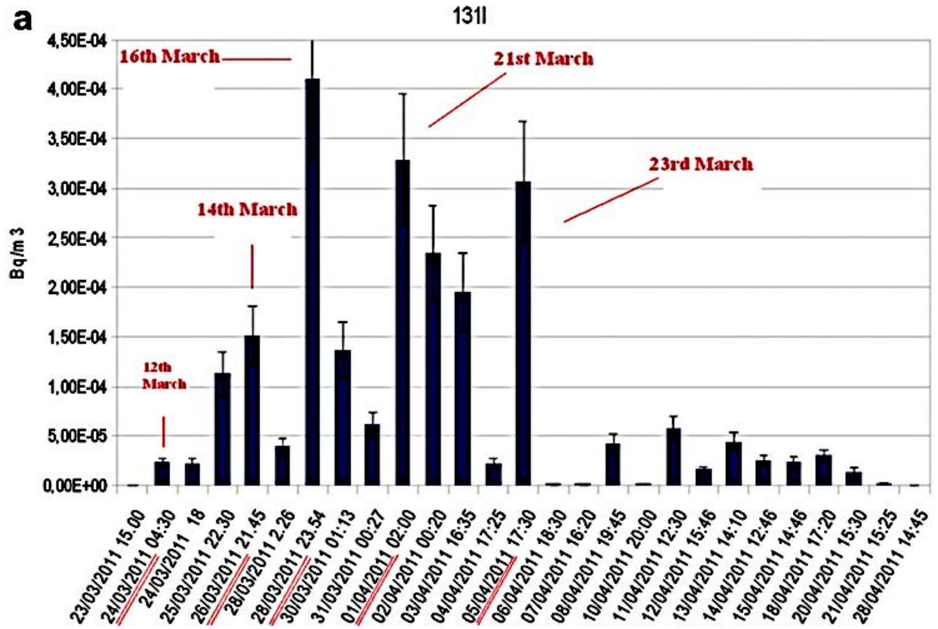
Journal of Environmental Radioactivity

journal homepage: www.elsevier.com/locate/jenvrad

Measurement of airborne ^{131}I, ^{134}Cs and ^{137}Cs due to the Fukushima reactor incident in Milan (Italy)☆

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… and undeclared events

Atmospheric Environment 212 (2019) 239–249

Contents lists available at ScienceDirect

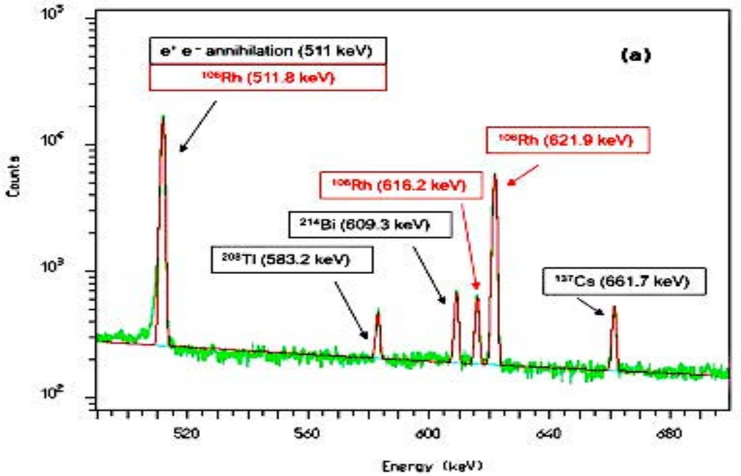
Atmospheric Environment

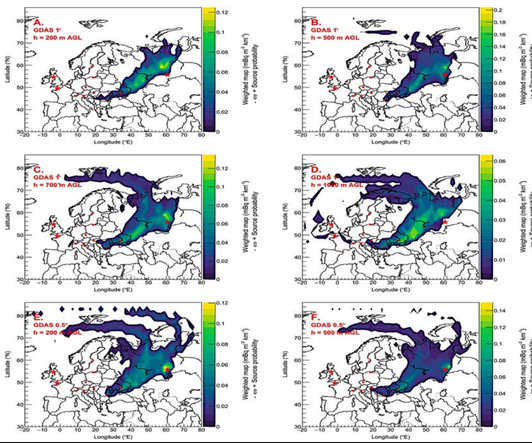
journal homepage: www.elsevier.com/locate/atmosenv

The Ruthenium-106 plume over Europe in 2017: a source-receptor model to estimate the source region

Niccolò Maffezzoli[a,b,*], Giovanni Baccolo[c,d], Elena Di Stefano[d,e], Massimiliano Clemenza[d,f]

[a] Institute for the Dynamics of Environmental Processes, IDPA-CNR, Via Torino 155, 30172, Venice, Italy
[b] Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Juliane Maries Vej 30, Copenhagen, 2100, Denmark
[c] Department of Environmental Sciences, University of Milano-Bicocca, P.zza della Scienza 1, 20126, Milano, Italy
[d] INFN, section of Milano-Bicocca, P.zza della Scienza 3, 20126, Milano, Italy
[e] Graduate School in Polar Sciences, University of Siena, Via Laterina 8, 53100, Siena, Italy
[f] Physics Department G. Occhialini, University of Milano-Bicocca, P.zza della Scienza 3, 20126, Milano, Italy





Sant'Imbenia (Sardinia)

Archaeological and Anthropological Sciences (2021) 13: 181
https://doi.org/10.1007/s12520-021-01425-x

ORIGINAL PAPER

Sant'Imbenia (Alghero): further archaeometric evidence for an Iron Age market square

M. Clemenza[1,2] · B. Billeci[3,4] · M. Carpinelli[3,5] · M. Ferrante[6] · E. Fiorini[1,2] · G. Gasperetti[4] · S. Nisi[7,8] · P. Oliva[3,9] · V. Sipala[3,5] · P. R. Trincherini[8] · I. M. Villa[1,10,11] · M. Rendeli[3,5]

Received: 12 January 2021 / Accepted: 5 August 2021 / Published online: 5 October 2021
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Abstract
Lead isotope compositions were determined for 18 metal objects from the archaeological site of Sant'Imbenia, NW Sardinia, dating to the end of the ninth century BCE onwards. The provenance of some objects is unambiguously traced to SW Sardinia; other objects could derive either from central Sardinia or the Iberian coastal ranges. The variety of the provenances attests to a wide trade network that spanned the entire island of Sardinia and extended to the Iberian sites.

Keywords Iron Age Sardinia · Sant'Imbenia · Alghero · Lead isotope analysis · Provenances



Fig. 9 Representation of different Sardinian clusters and possible overlap with Sant'Imbenia

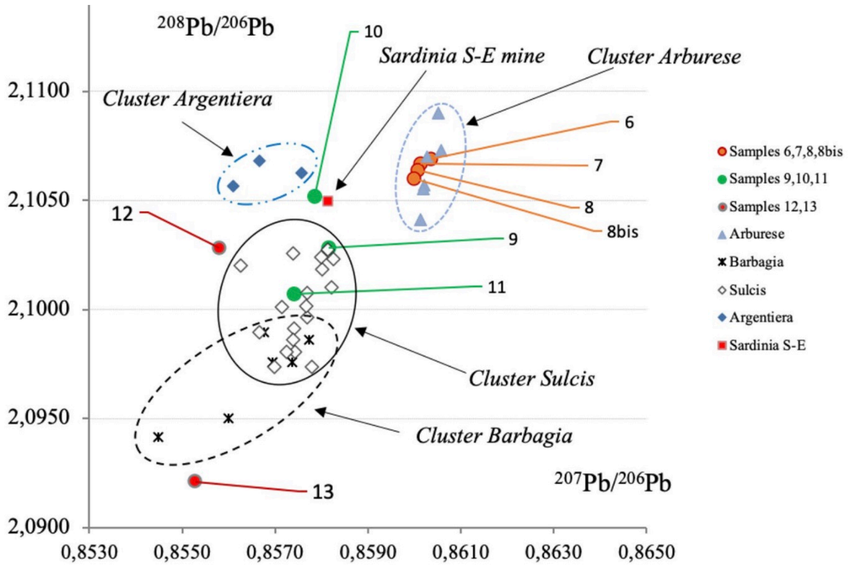
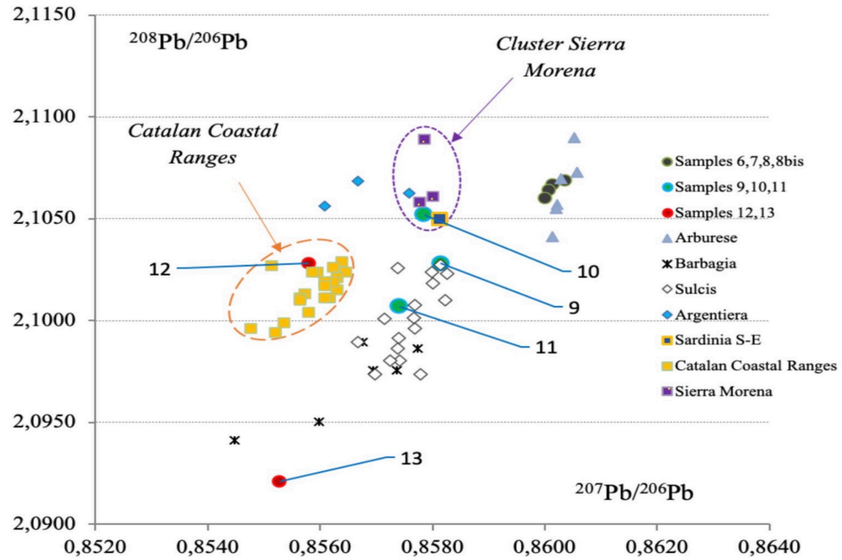


Fig. 10 Overlap of samples 10 and 12 with Sierra Morena and Catalan Coastal Ranges



with his “students”







a sincere admiration



a sincere admiration



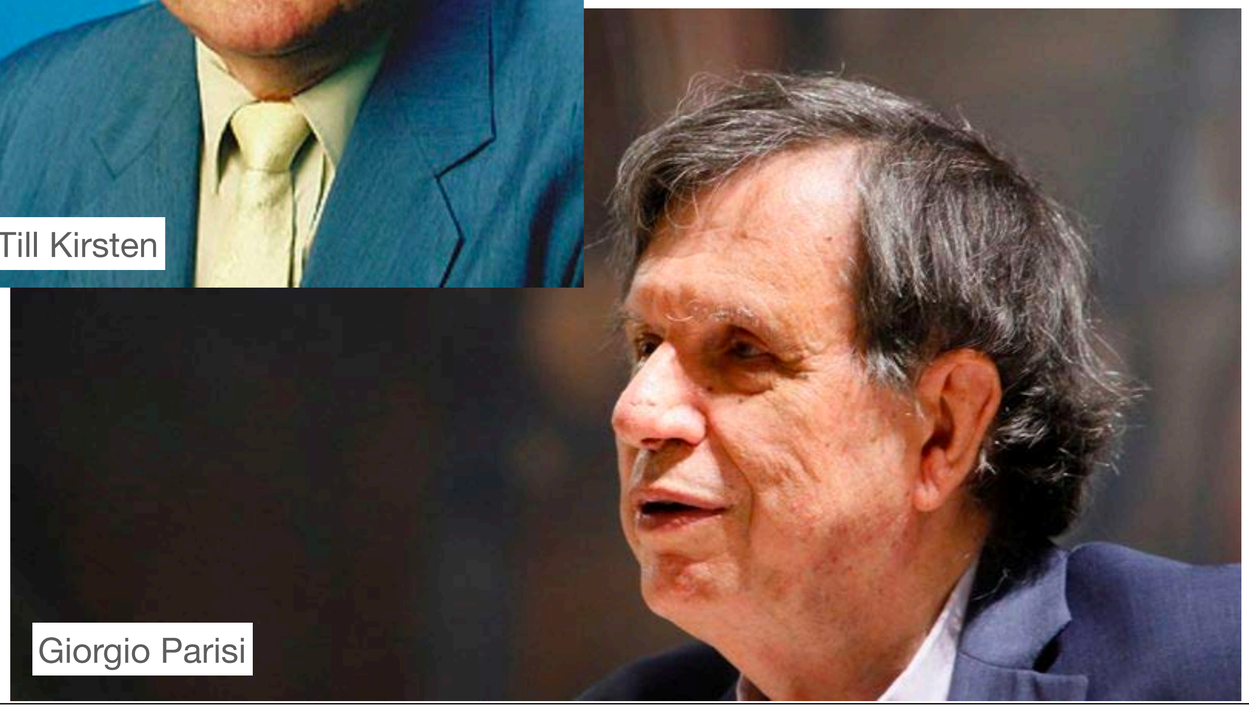


a sincere admiration



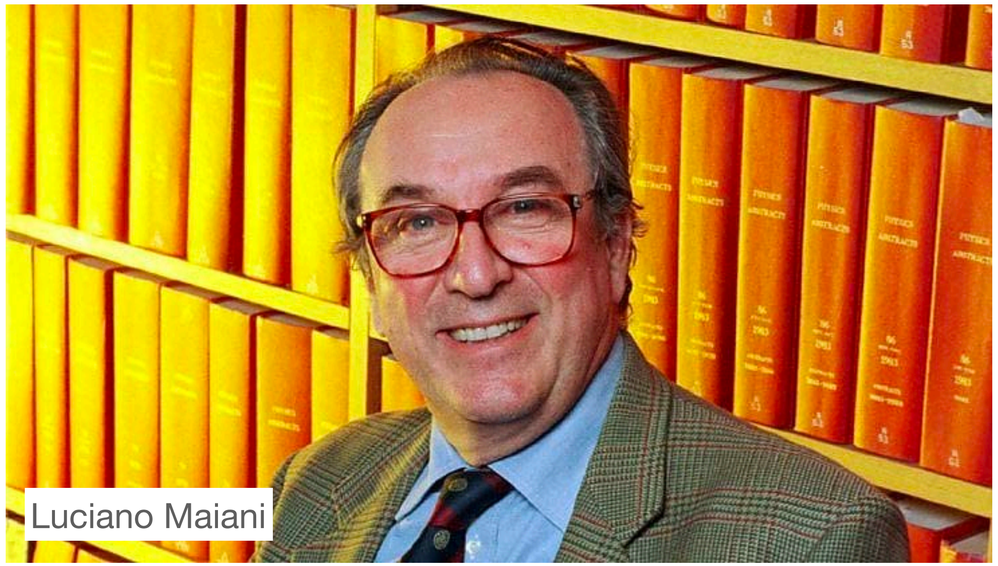


Till Kirsten



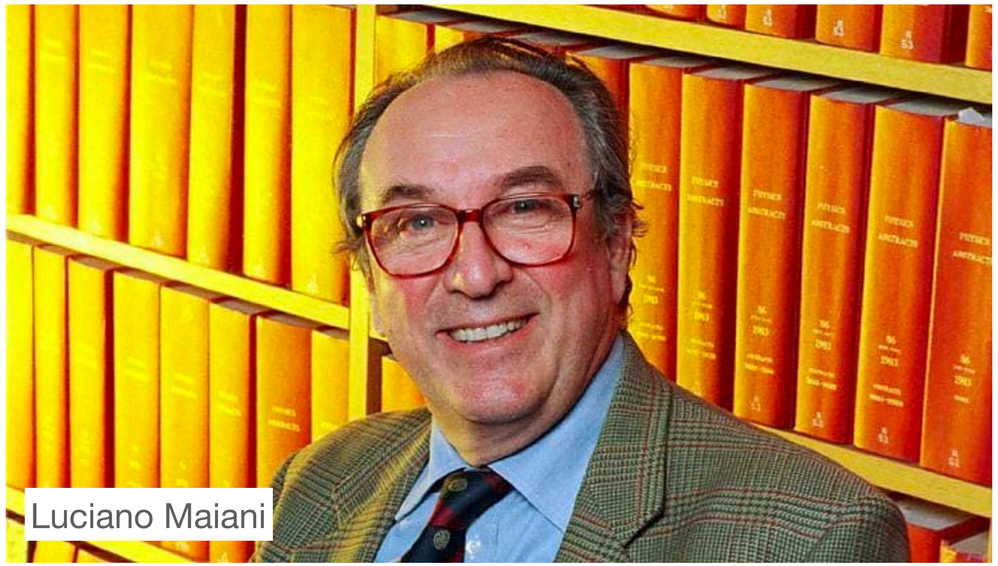
Giorgio Parisi

true friends


Luciano Maiani


Milla Baldo Ceolin

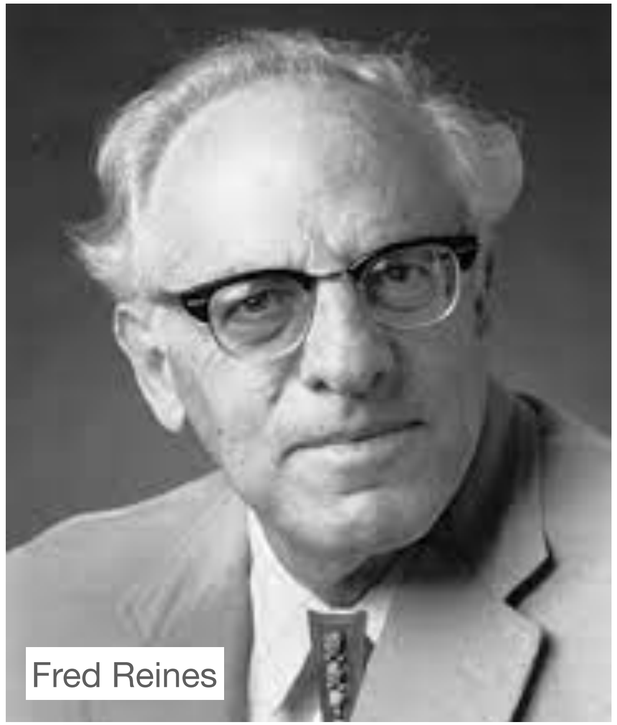
true friends


Luciano Maiani

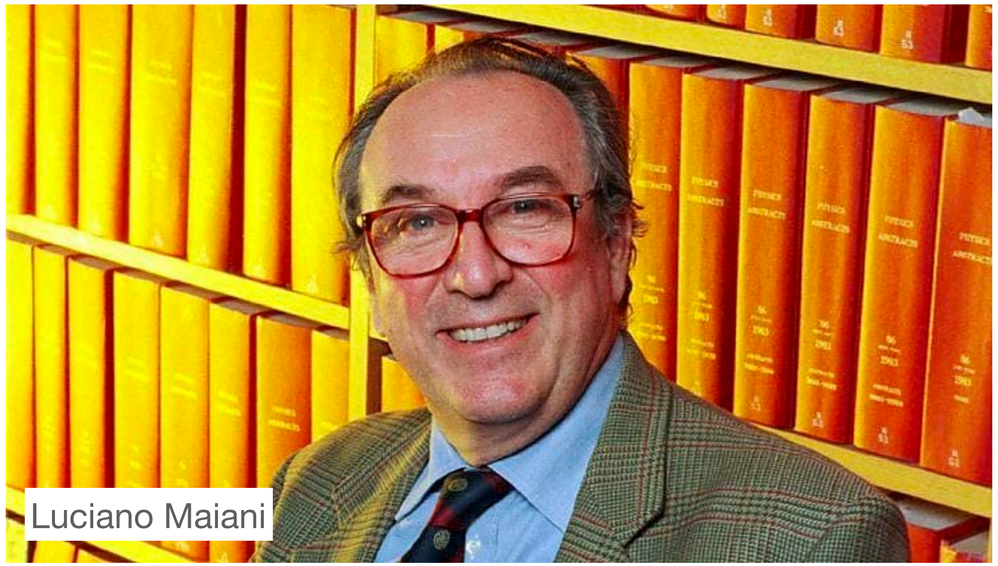

Milla Baldo Ceolin



Peter Rosen


Fred Reines

true friends

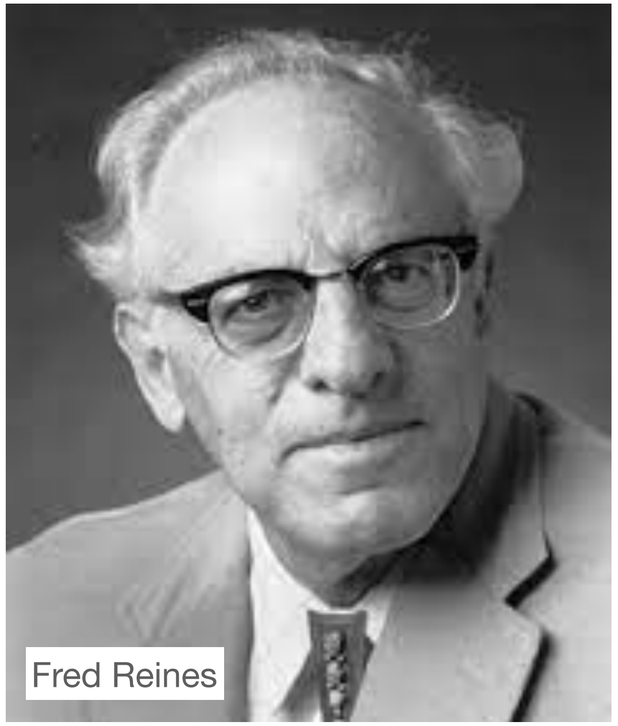

Luciano Maiani



Peter Rosen


Antonino Pullia


Milla Baldo Ceolin

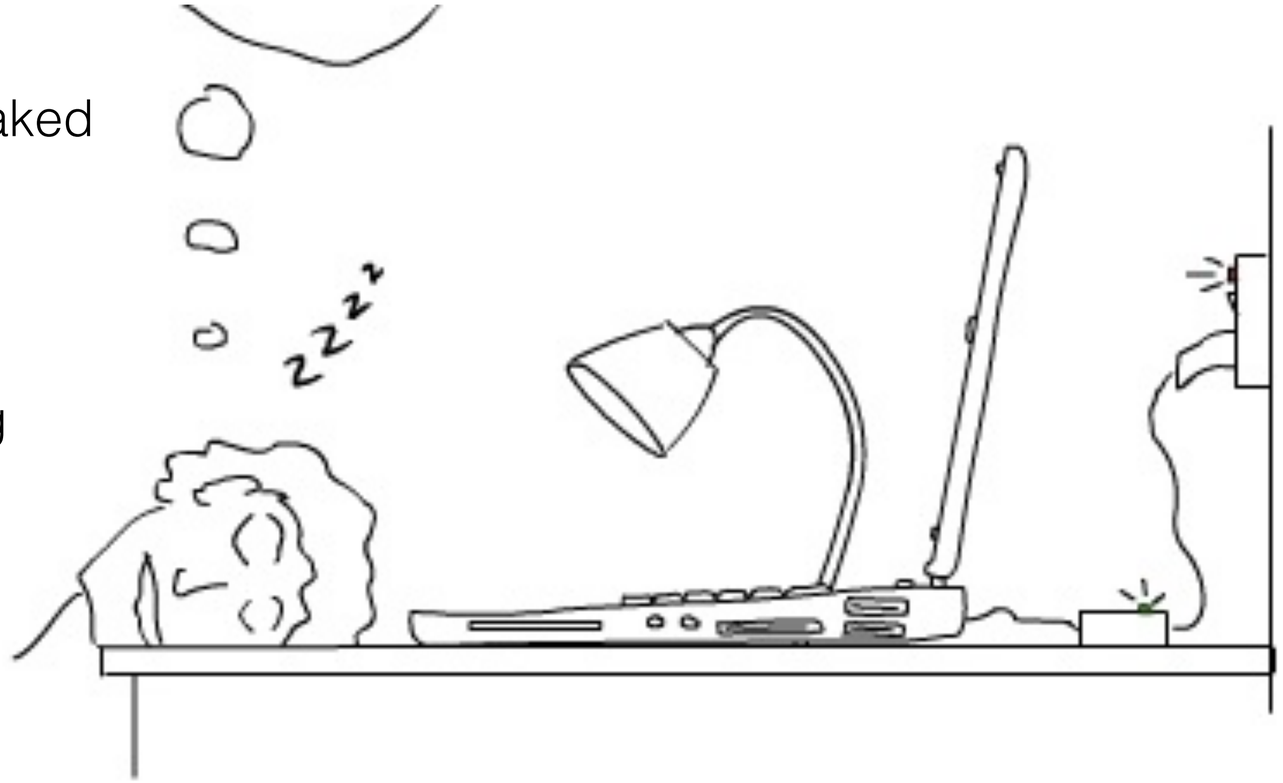

Fred Reines


“Puccio” Bellotti

Singularities

The only person I know …

- who can romanticize anything
- who cites Pinocchio and “I promessi sposi” as the most exciting and instructing novel of all the times
- who sleeps (as the rest of the audience) at a boring or incomprehensible talk and just awaked by the applause, immediately starts with comments, questions and appreciations
- who sleeps during exams
- who … I never met anyone who is not “a big friend of him”
- who brings flowers to secretaries
- who steels candies
- who sometimes stays silent

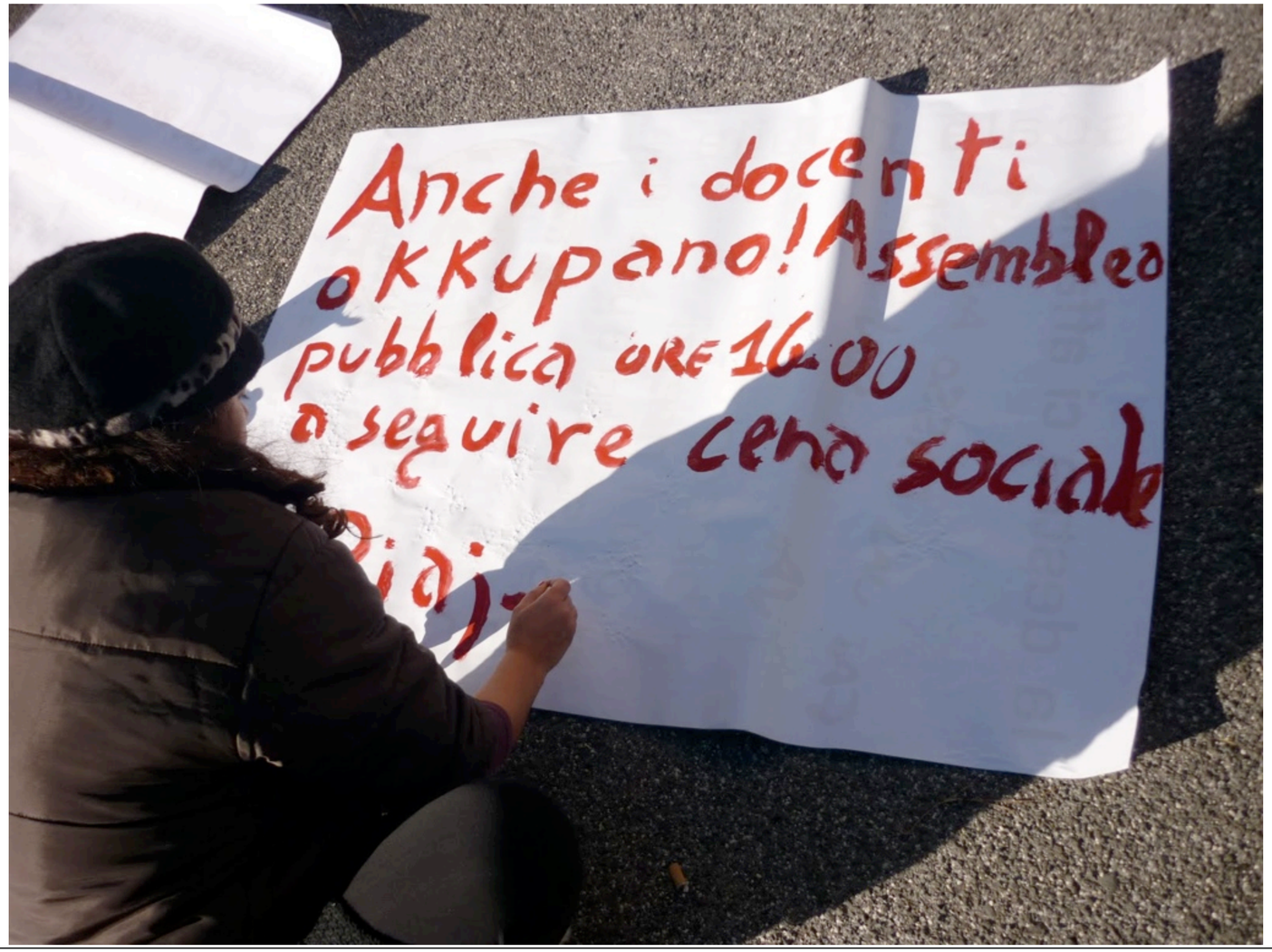


A beloved teacher

- Enthusiast
- Amusing
- With the right word for everyone
  (included the parents)

A beloved teacher

- Enthusiast
- Amusing
- With the right word for everyone (included the parents)



- in the 60's he got his own 'tazebao'
- … and dared to sleep in the same room with the leader of the students in revolt who woke him up with the breakfast

Honors

- Professor emeritus @ Milano Bicocca University
- Lincei academician

Honors

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- Lincei academician

Awards

Feltrinelli

- **1983**: Discovery of weak neutral currents

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- Professor emeritus @ Milano Bicocca University
- Lincei academician

Awards

Feltrinelli
- **1983**: Discovery of weak neutral currents

Fermi (SIF)
- **2007**: Discovery of weak neutral currents and solar neutrinos

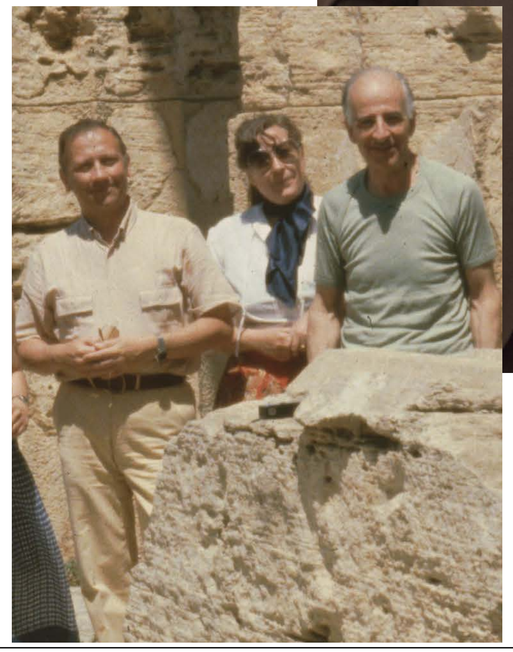
Honors

- Professor emeritus @ Milano Bicocca University
- Lincei academician



Awards

Feltrinelli
- **1983**: Discovery of weak neutral currents



Fermi (SIF)
- **2007**: Discovery of weak neutral currents and solar neutrinos

Pontecorvo (JINR)
- **2013**: rare events physics

ciao Ettore