Dipartimento di Fisica Ettore Pancini

Napoli e i raggi cosmici

16/12/2015 - Paolo Mastroserio

Cenni sui raggi cosmici

La scoperta dei muoni

Protoni Neutroni Mesotroni (mesoni μ) ecc.	Elettroni Muoni ecc.

I muoni sono particelle che hanno una carica elettrica e una massa intermedia tra quella dell'elettrone e quella del protone.

Le prime conoscenze su queste particelle risalgono al 1935 grazie agli studi fatti da **Pierre Victor Auger** e poi, nel 1937, da **Neddermeyer e Anderson**. Inizialmente furono inserite in una famiglia di particelle dove troviamo anche i protoni e i neutroni e furono chiamate prima **mesotroni** e poi **mesoni mu (μ)**.

Poi si capì che avevano una natura completamente diversa, e furono inseriti in un'altra famiglia dove troviamo anche gli elettroni. Da quel momento in poi furono chiamati **muoni**.

Chi capì la vera natura dei muoni

Per arrivare a comprendere la vera natura di queste interessanti particelle si dovette attendere fino al 1945 quando fu pubblicato sulla rivista

The Physical Review

un articolo dal titolo:

Sulla Disintegrazione dei mesoni negativi

a firma di tre grandi scienziati italiani e cioè:

Marcello Conversi, Ettore Pancini e Oreste Piccioni.

Esperimento da premio Nobel per la Fisica

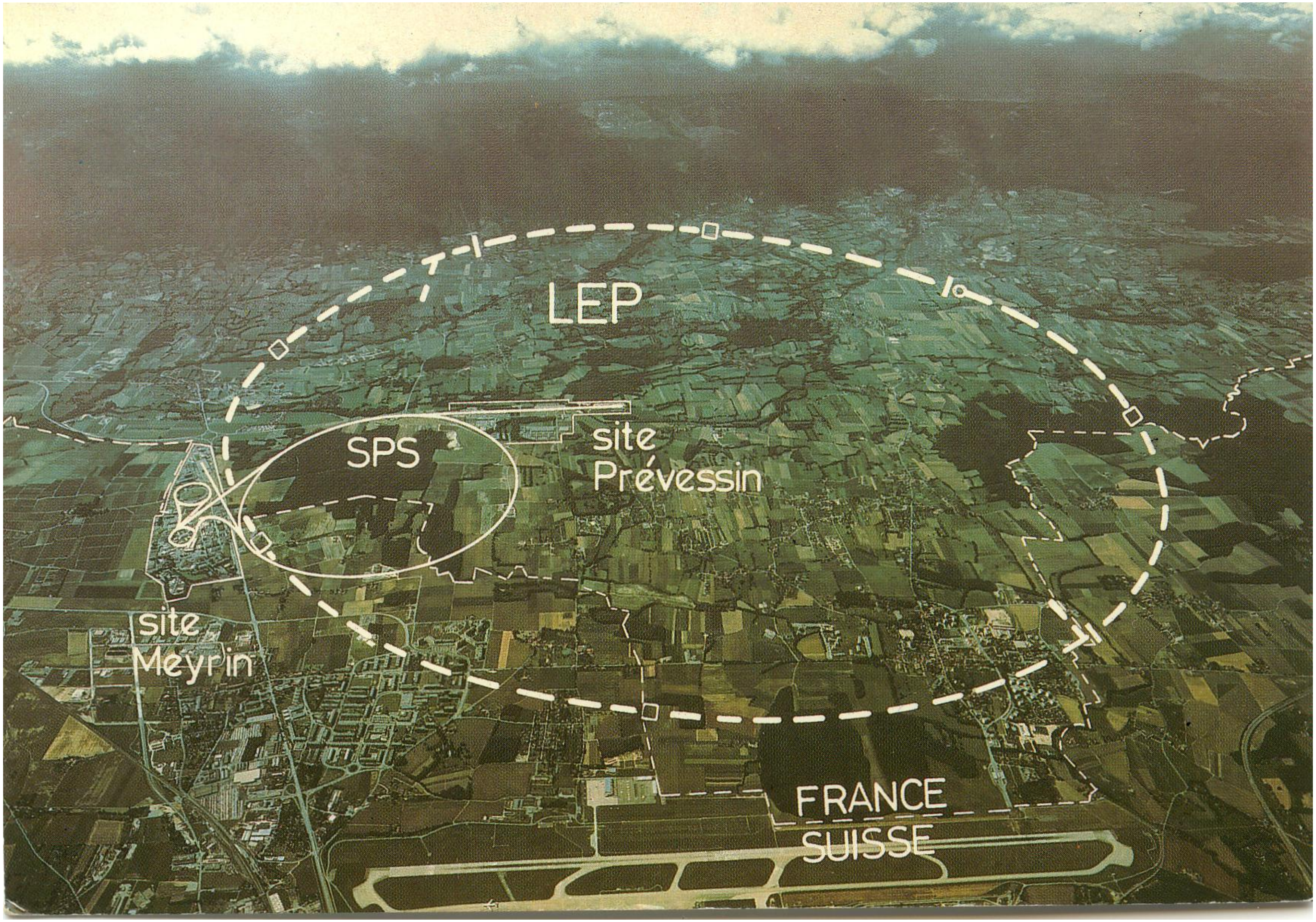
Marcello Conversi, Ettore Pancini e Oreste Piccioni

Quella ricerca venne spesso citata come **l'inizio della fisica delle alte energie** anche se **Conversi** disse di **“non esagerare”**. È comunque opinione di molti che gli scienziati che la condussero avrebbero meritato il premio **Nobel per la fisica.**

Perché si parlò di inizio della fisica delle alte energie?

I muoni (mostrati in rosso in questa simulazione al computer) in genere vengono prodotti all'inizio dello sviluppo dello sciame, e cioè da urti di particelle a energie enormemente maggiori di quelle che si ottengono …

LHC al CERN

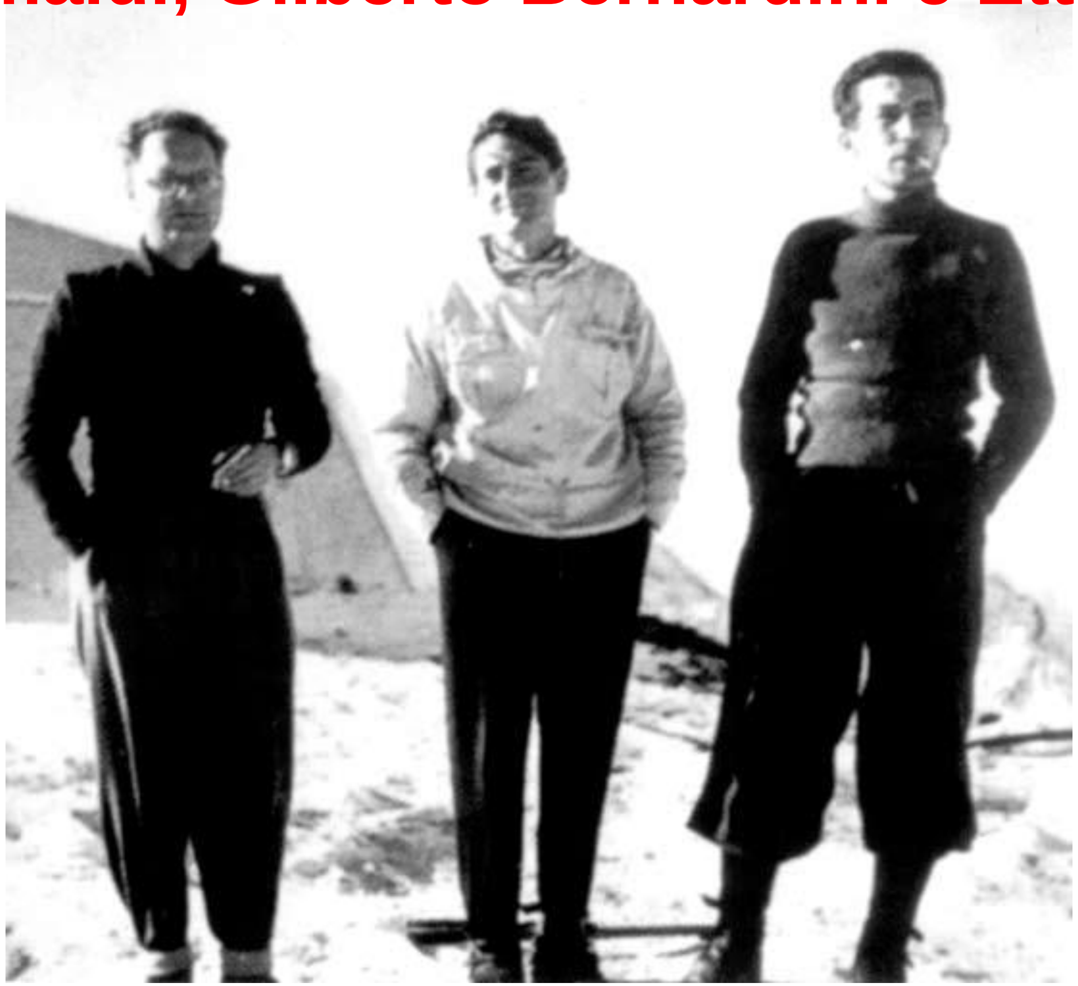


… nei più potenti acceleratori terrestri come ad esempio l’LHC del CERN, …

LHC, se fosse stato costruito nel golfo di Napoli …

… e quindi sono preziosi per la comprensione delle interazioni nucleari di altissima energia.

Edoardo Amaldi, Gilberto Bernardini e Ettore Pancini



Nel 1947 Pancini progettò e realizzò insieme con Gilberto Bernardini e Claudio Longo il laboratorio della Testa Grigia, in Val D'Aosta, a 3500 metri di quota che diresse fino al 1952.

Foto gentilmente concessa dall’arch. G. Pancini

Pancini nel rifugio laboratorio Testa Grigia al Plateau Rosa

Foto gentilmente concessa dall’arch. G. Pancini

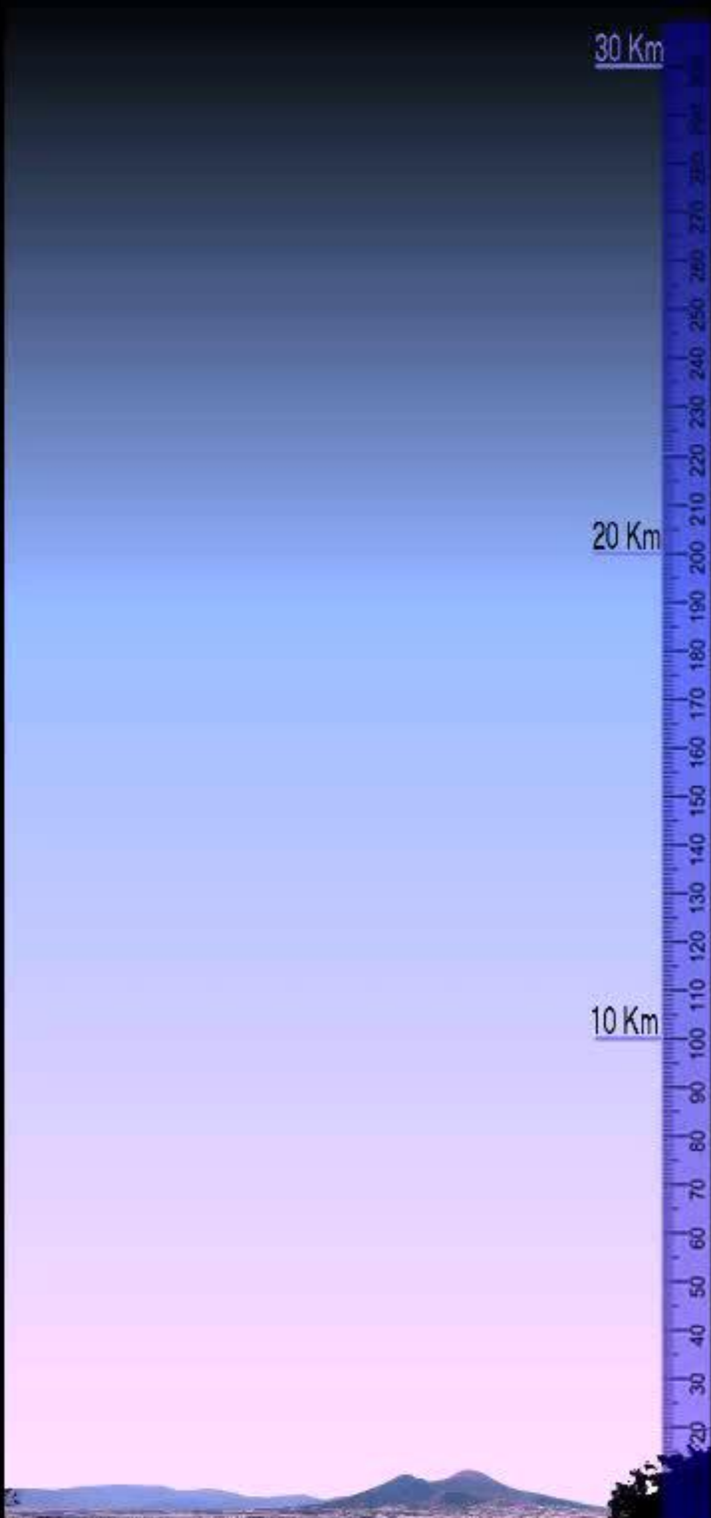
Ettore Pancini in Cina

Foto gentilmente concessa dall'arch. G. Pancini

I muoni: vari motivi di interesse

Da misure fatte in laboratorio, è noto che dal momento in cui produciamo dei muoni fino al momento in cui **decadono**, cioè si trasformano in altre particelle, passano in media **2.2 μs**

Come si spiega che i muoni vengono rilevati a terra?


30 Km
20 Km
10 Km

Ettore Pancini

- Nasce a Stanghella (Pd) il 10 agosto 1915
- Consegue la maturità classica presso la scuola militare “La Nunziatella a Napoli”
- Tornò a Padova e si iscrisse al corso di Laurea in Matematica per poi passare a Fisica l’anno dopo

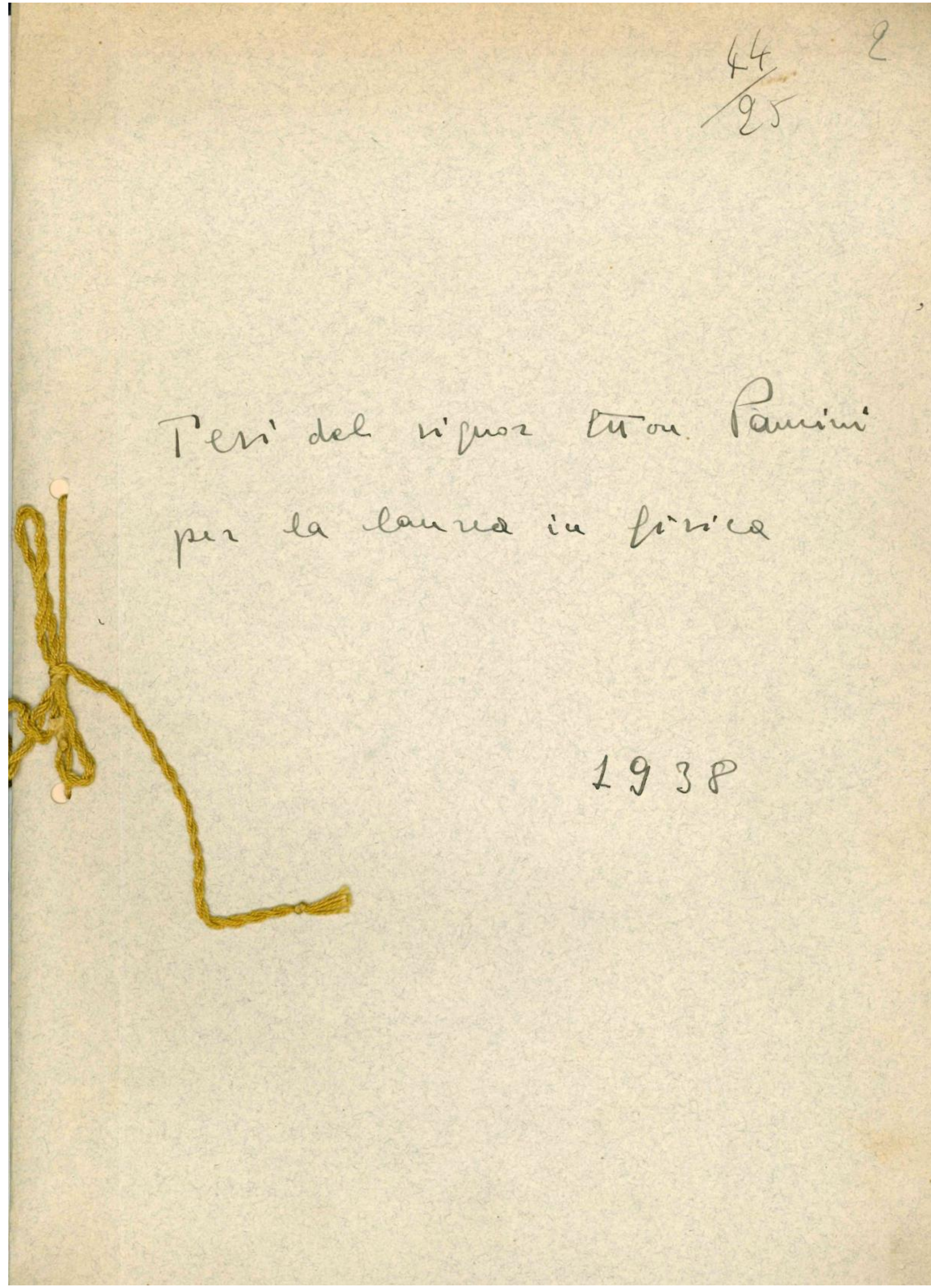
Tesi di Laurea
Ettore Pancini

Ieri sera mi ha scritto il **prof. Giulio Peruzzi** da Padova

Il 12/15/2015 08:07 PM, **Giulio Peruzzi** ha scritto:

Mi hanno mandato (per ora) solo il frontespizio della tesi di Pancini, da dove però non si ricava il titolo. Il plico con la tesi arriverà tra un paio di giorni.

Ti allego quello che ho:



Gli "spostamenti" di Pancini

Negli anni Pancini diventò titolare della cattedra di Fisica nelle seguenti Università:

- Sassari
- Genova
- Napoli

Pancini, primo direttore della Sezione di Napoli dell'INFN

La Sezione INFN di Napoli nacque nel 1963, dopo essere stata Sottosezione a partire dal 15 maggio 1961

Ettore Pancini

Luglio 1962- Giugno 1965

L’Aula Ettore Pancini all’università di Genova

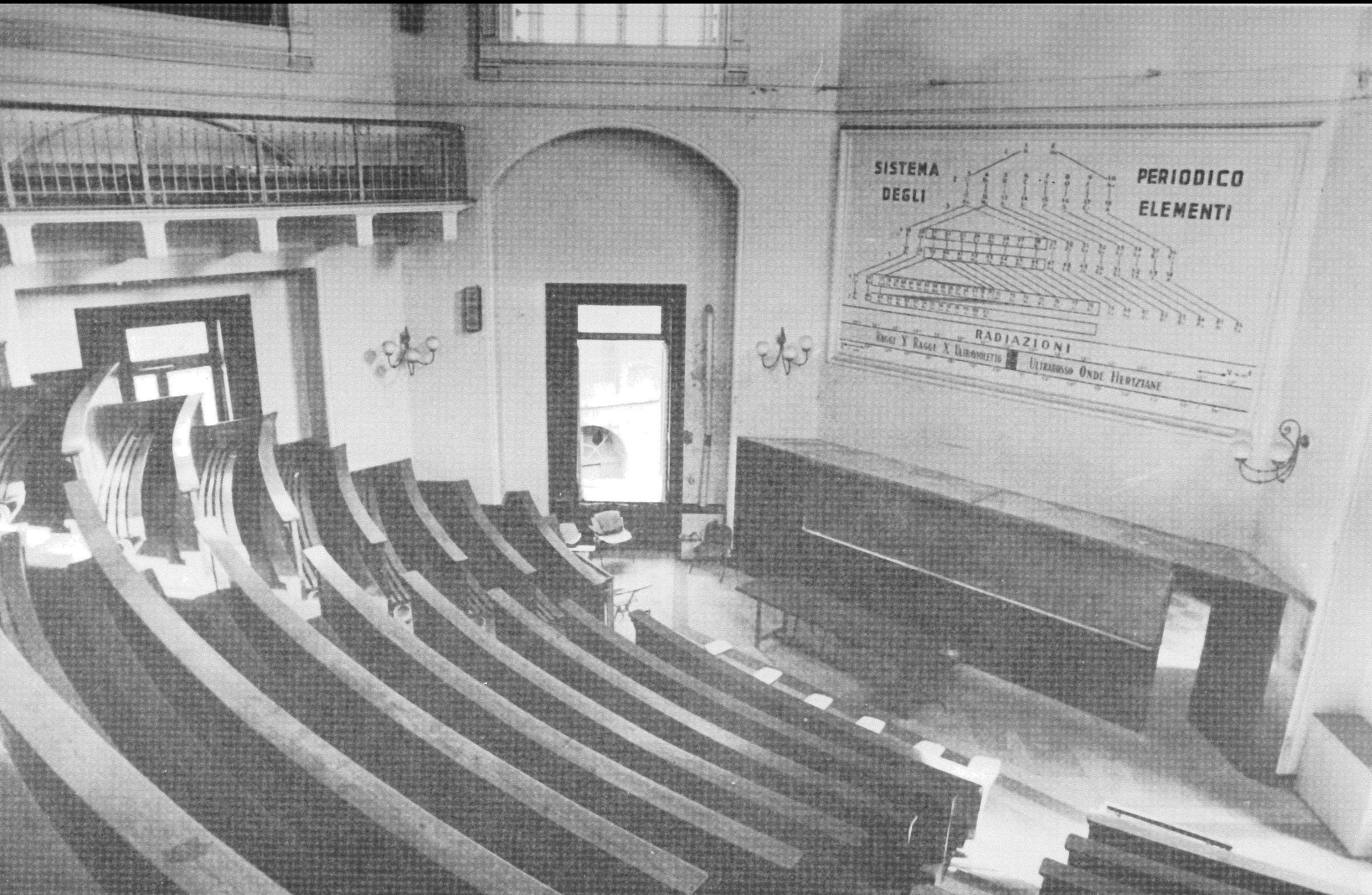
Foto gentilmente fornite dalla prof.ssa Nadia Robotti e dal prof. Francesco Guerra

L’Aula Ettore Pancini all’università di Genova

Foto gentilmente fornite dalla prof.ssa Nadia Robotti e dal prof. Francesco Guerra

L’Aula A della Federico II a Napoli

L’Aula A della Federico II a Napoli



I muoni:
altro importante motivo di interesse

I muoni **interagiscono poco** con la **materia** e sono in grado di **attraversarla** in funzione della loro energia.

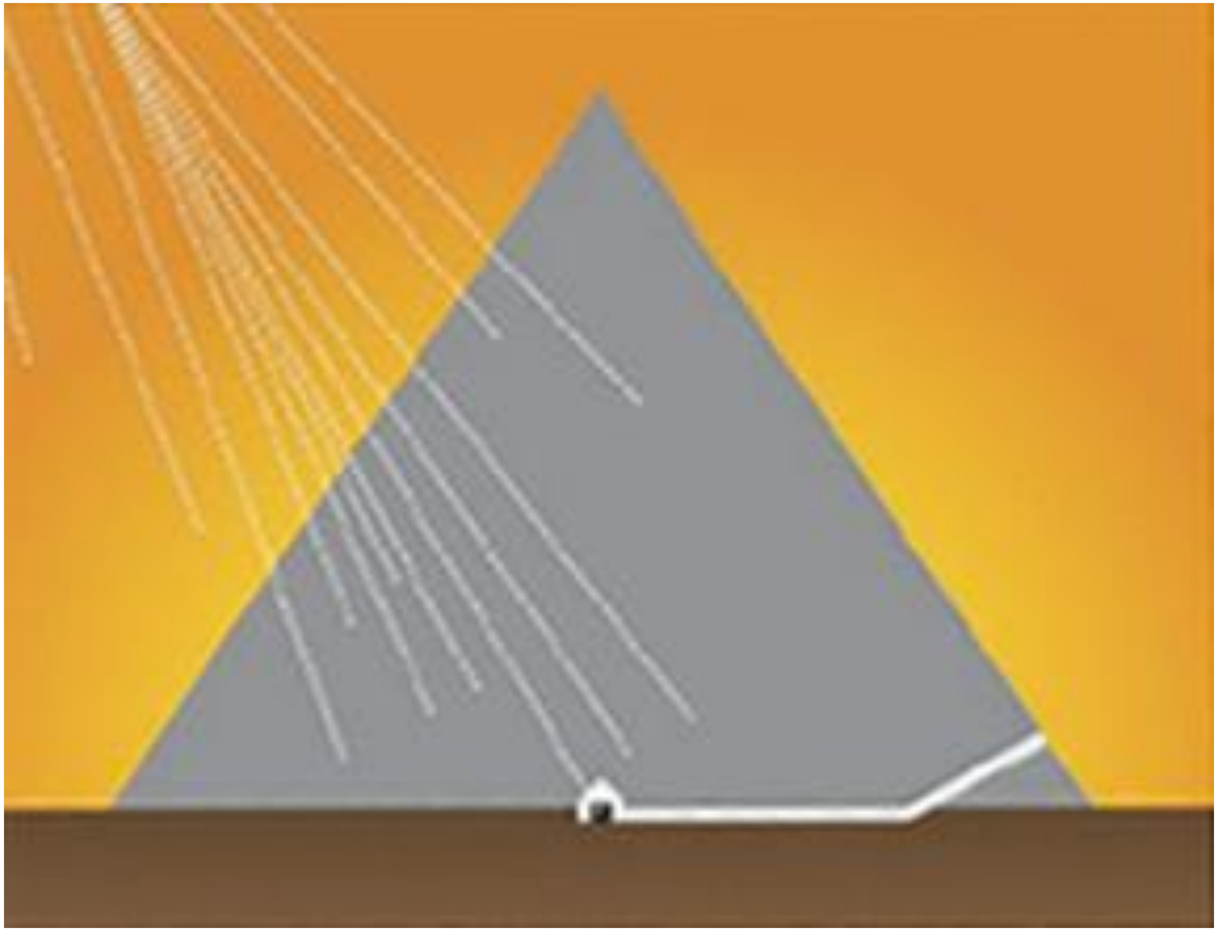
Il telescopio di muoni al Gran Sasso


In the heart of stars
Ungraspable

Le radiografie

Il corpo umano viene investito da una radiazione penetrante, i raggi X, questa viene assorbita in misura maggiore o minore a seconda della densità degli organi interni. L’immagine viene impressionata su una lastra.

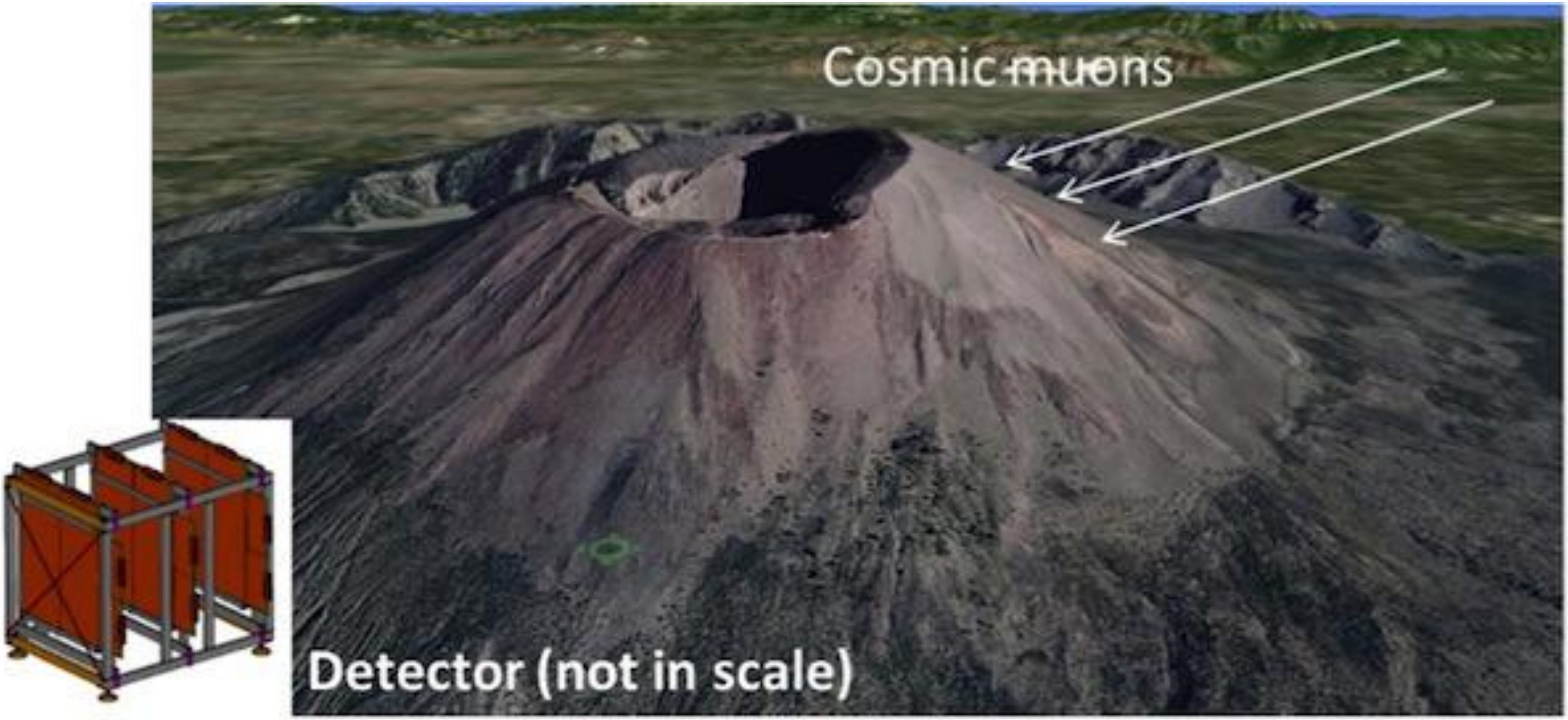
La muografia della piramide Chefren



Credito:
Fermi National Laboratory, Symmetry Magazine

Agli inizi degli anni '70 **il premio Nobel per la Fisica Louis Alvarez** si pose il problema effettuare una radiografia delle **piramide Chefren** pensando di sfruttare l'enorme capacità penetrative che hanno i muoni ma che non hanno i raggi X.

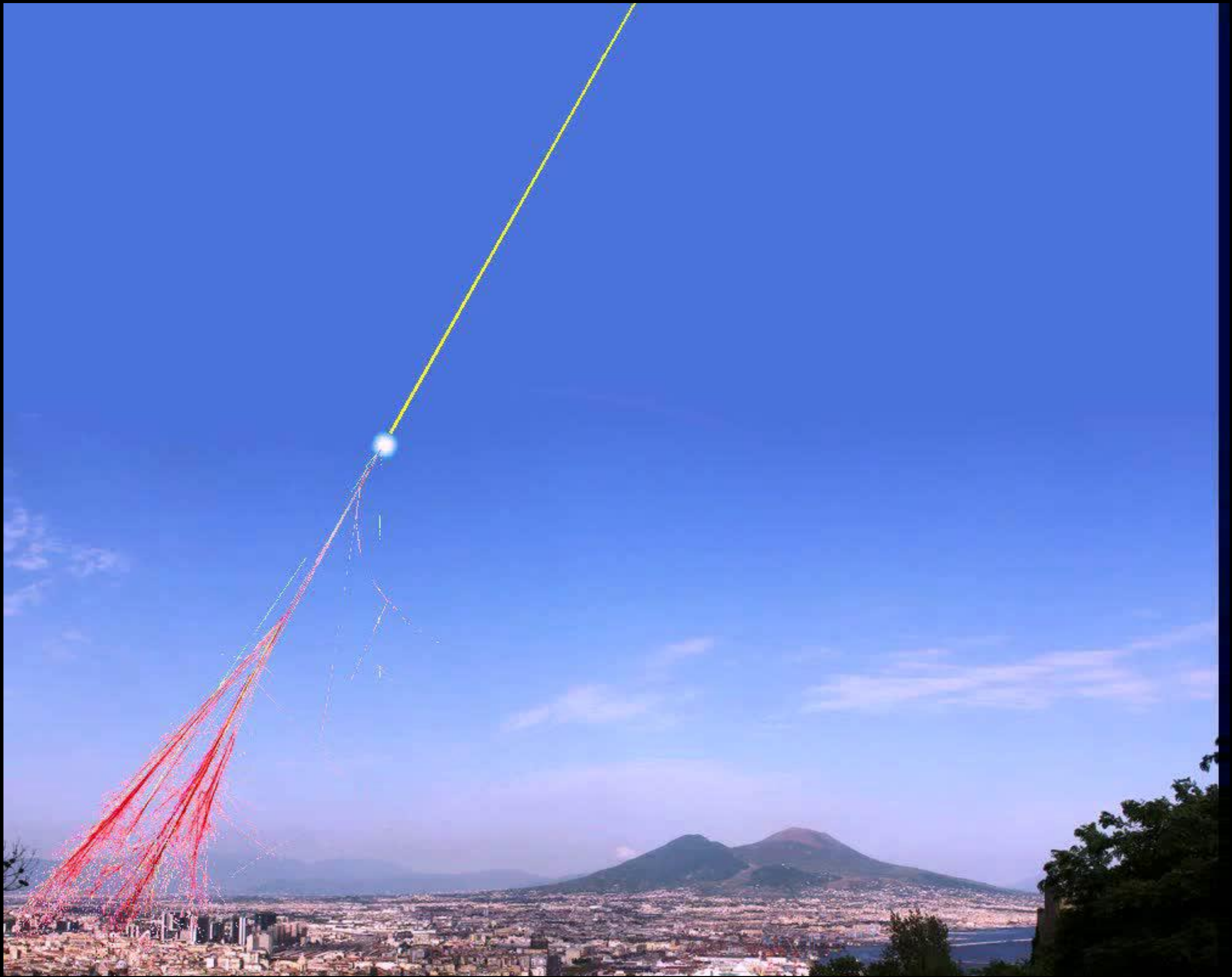
La muografia del Vesuvio



Interessante come ricaduta sul territorio

Nella fermata Toledo della Metropolitana di Napoli, tra le più belle al mondo …

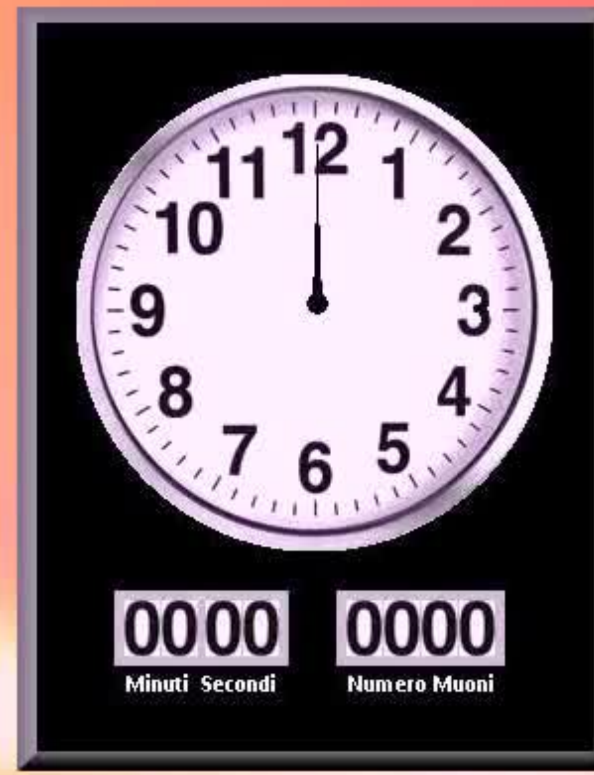
… è stato messo un telescopio muonico



Inaugurazione del telescopio (TG3 Campania)

Ripresa accelerata del Telescopio a Toledo


Istituto Nazionale di Fisica Nucleare
RAGGI COSMICI
IN DIRETTA


12
1
2
3
4
5
6
7
8
9
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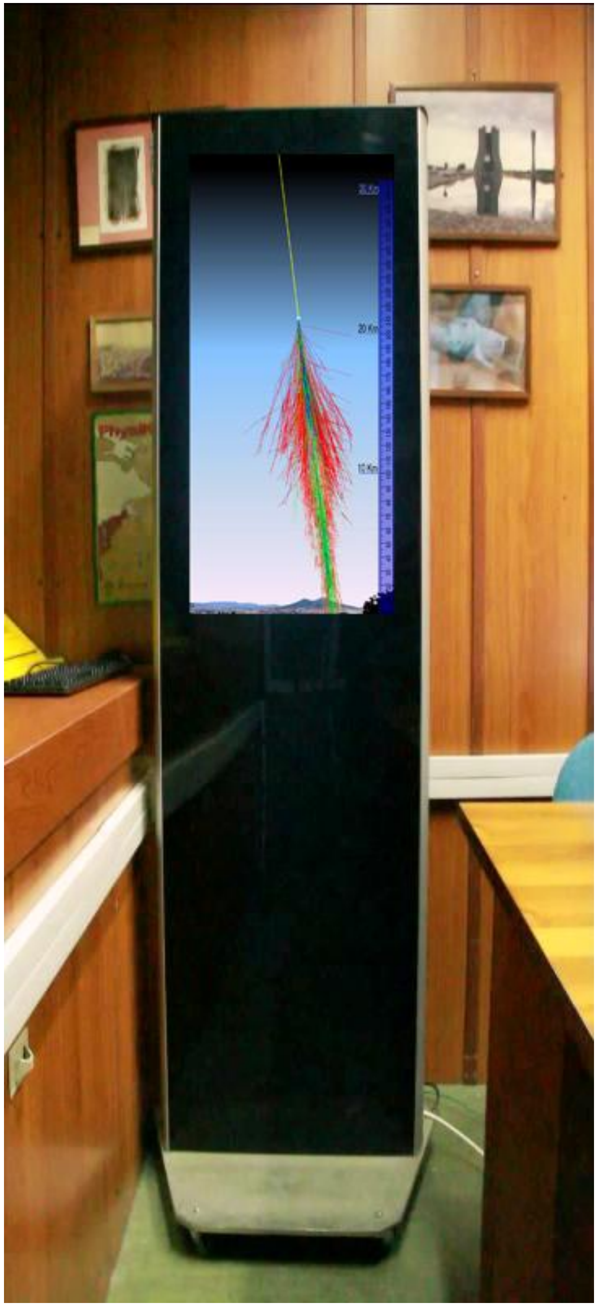
11
00 00
0000
Minuti Secondi
Numero Muoni

Un totem a fianco al telescopio muonico



A breve verrà installato un Totem a fianco al telescopio di Toledo contenente dei video a carattere divulgativo per soddisfare le curiosità dei passeggeri e come supporto alle guide turistiche

Le pubblicazioni su riviste

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EMIL

UNTER MITWIRKUNG

DER DEUTSCHEN PHYSIKALISCHEN GESELLSCHAFT

UND INSBESONDERE VON

M. PLANCK

HERAUSGEGEBEN VON

PAUL DRUDE.

MIT FÜNF FIGURENTAFELN.

LEIPZIG, 1905.

VERLAG VON JOHANN AMBROSIUS BARTH.

Magnetisierungskurven aufgenommen und ihre typischen Gesetzmäßigkeiten erkannt.

Durch Betrachtung der im Eisen bei Änderung der Induktion auftretenden Wirbelströme wurde der Verlauf der dynamischen Kurven erklärt.

Es wurde eine Methode gegeben[1]), mittels welcher die dynamischen Magnetisierungskurven für beliebige gegebene Fälle $\mathfrak{H} = f(t)$ angenähert konstruiert werden können.

Durch die so ermöglichte Prüfung einer Reihe von häufig vorkommenden Fällen dynamischer Magnetisierung wurde ein Teil der sie betreffenden Beobachtungen früherer Autoren bestätigt und erklärt.

Die Wirkungsweise des Magnetdetektors wurde auf die Gesetze der dynamischen Magnetisierung zurückgeführt; die Bedingungen seiner Empfindlichkeit wurden damit der induktiven Beurteilung zugänglich gemacht.

Durch die Benutzung des Varleyschen Beobachtungsmaterials wurde gefunden, daß meine Resultate durch Extrapolation auf Frequenzen sich erweitern lassen, bei denen eine Beobachtung mit der Braunschen Röhre ausgeschlossen ist.

Zum Schlusse ist es mir eine angenehme Pflicht, meinem verehrten Lehrer Herrn Prof. H. Th. Simon an dieser Stelle für seine Unterstützung bei dieser Arbeit meinen Dank auszusprechen.

Göttingen, Physikalisches Institut der Universität, Abteilung für angewandte Elektrizitätslehre, März 1905.

1) Vgl. Original-Dissertation, Göttingen 1905.

(Eingegangen 2. August 1905).

3. Zur Elektrodynamik bewegter Körper; von A. Einstein.

Daß die Elektrodynamik Maxwells — wie dieselbe gegenwärtig aufgefaßt zu werden pflegt — in ihrer Anwendung auf bewegte Körper zu Asymmetrien führt, welche den Phänomenen nicht anzuhaften scheinen, ist bekannt. Man denke z. B. an die elektrodynamische Wechselwirkung zwischen einem Magneten und einem Leiter. Das beobachtbare Phänomen hängt hier nur ab von der Relativbewegung von Leiter und Magnet, während nach der üblichen Auffassung die beiden Fälle, daß der eine oder der andere dieser Körper der bewegte sei, streng voneinander zu trennen sind. Bewegt sich nämlich der Magnet und ruht der Leiter, so entsteht in der Umgebung des Magneten ein elektrisches Feld von gewissem Energiewerte, welches an den Orten, wo sich Teile des Leiters befinden, einen Strom erzeugt. Ruht aber der Magnet und bewegt sich der Leiter, so entsteht in der Umgebung des Magneten kein elektrisches Feld, dagegen im Leiter eine elektromotorische Kraft, welcher an sich keine Energie entspricht, die aber — Gleichheit der Relativbewegung bei den beiden ins Auge gefaßten Fällen vorausgesetzt — zu elektrischen Strömen von derselben Größe und demselben Verlaufe Veranlassung gibt, wie im ersten Falle die elektrischen Kräfte.

Beispiele ähnlicher Art, sowie die mißlungenen Versuche, eine Bewegung der Erde relativ zum „Lichtmedium" zu konstatieren, führen zu der Vermutung, daß dem Begriffe der absoluten Ruhe nicht nur in der Mechanik, sondern auch in der Elektrodynamik keine Eigenschaften der Erscheinungen entsprechen, sondern daß vielmehr für alle Koordinatensysteme, für welche die mechanischen Gleichungen gelten, auch die gleichen elektrodynamischen und optischen Gesetze gelten, wie dies für die Größen erster Ordnung bereits erwiesen ist. Wir wollen diese Vermutung (deren Inhalt im folgenden „Prinzip der Relativität" genannt werden wird) zur Voraussetzung erheben und außerdem die mit ihm nur scheinbar unverträgliche

L'elettrodinamica del corpo in movimento

3. *Zur Elektrodynamik bewegter Körper;*
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Letters to the Editor

PUBLICATION of brief reports of important discoveries in physics may be secured by addressing them to this department. The closing date for this department is, for the issue of the 1st of the month, the 8th of the preceding month and for the issue of the 15th, the 23rd of the preceding month. No proof will be sent to the authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents. Communications should not exceed 600 words in length.

On the Disintegration of Negative Mesons

M. Conversi, E. Pancini, and O. Piccioni*

Centro di Fisica Nucleare del C. N. R. Istituto di Fisica dell'Università di Roma, Italia

December 21, 1946

IN a previous Letter to the Editor,[1] we gave a first account of an investigation of the difference in behavior between positive and negative mesons stopped in dense materials. Tomonaga and Araki[2] showed that, becuase of the Coulomb field of the nucleus, the capture probability for negative mesons at rest would be much greater than their decay probability, while for positive mesons the opposite should be the case. If this is true, then practically all the decay processes which one observes should be owing to positive mesons.

Several workers[3] have measured the ratio η between the number of the disintegration electrons and the number of mesons stopped in dense materials. Using aluminum, brass, and iron, these workers found values of η close to 0.5 which, if one assumes that the primary radiation consists of approximately equal numbers of positive and negative mesons, support the above theoretical prediction. Auger, Maze, and Chaminade,[4] on the contrary, found η to be close to 1.0, using aluminum as absorber.

Last year we succeeded in obtaining evidence of different behavior of positive and negative mesons stopped in 3 cm of iron as an absorber by using magnetized iron plates to concentrate mesons of the same sign while keeping away mesons of the opposite sign (at least for mesons of such energy that would be stopped in 3 cm of iron). We obtained results in agreement with the prediction of Tomonaga and Araki. After some improvements intended to increase the counting rate and improve our discrimination against the "mesons of the opposite sign," we continued the measurements using, successively, iron and carbon as absorbers. The recording equipment was one which two of us had previously used in a measurement of the meson's mean life.[5] It gave threefold (III) and fourfold (IV) delayed coincidences. The difference (III)−(IV) (after applying a slight correction for the lack of efficiency of the fourfold coincidences) was owing to mesons stopped in the absorber and ejecting a disintegration electron which produced a delayed coincidence. The minimum detected delay was about 1 μsec. and the maximum about 4.5 μsec. Our calculations of the focusing properties of the magnetized plates (20 cm high; $\beta = 15{,}000$ gauss) and including roughly the effects of scattering, showed that we should expect almost complete cut-off for the "mesons of the opposite sign." This is confirmed by our results, since otherwise it would be very hard to explain the almost complete dependence on the sign of the meson observed in the case of iron.

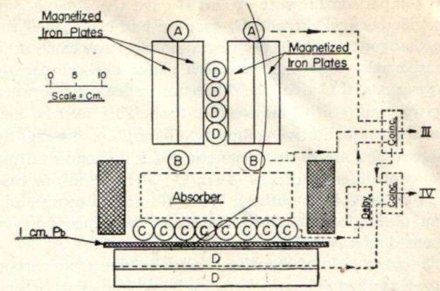

Fig. 1. Disposition of counters, absorber, and magnetized iron plates. All counters "D" are connected in parallel.

The results of our last measurements with two different absorbers are given in Table I. In this table "Sign" refers to the sign of the meson concentrated by the magnetic field. $M = (\mathrm{III}) - (\mathrm{IV}) - P(\mathrm{IV})$, the number of decay electrons, is corrected for the lack of efficiency (p) in our fourfold coincidences (~ 0.046).

The value M_- (5 cm Fe) is but slightly greater than the correction for the lack of efficiency in our counting, so that we can say that perhaps no negative mesons and, at most, only a few (~ 5) percent undergo β-decay with the accepted half-life.

The results with carbon as absorber turn out to be quite inconsistent with Tomonaga and Araki's prediction. We used cylindrical graphite rods having a mean effective thickness of 4 cm because we were unable to procure a graphite plate. In addition, when concentrating negative mesons, we placed above the graphite a 5-cm thick plate of iron to guard against the scattering of very low energy mesons which might destroy the concentrating effect of our magnets. We alternated the following three measurements:

A. Negative mesons with 4 cm C and 5 cm Fe,
B. Negative mesons with 6.2 cm Fe (6.2 cm Fe is approximately equivalent to 4 cm C+5 cm Fe as far as energy loss is concerned.
C. Positive mesons with 4 cm C.

Table I. Results of measurements on β-decay rates for positive and negative mesons.

Sign	Absorber	III	IV	Hours	M/100 hours
(a) +	5 cm Fe	213	106	155.00′	67 ± 6.5
(b) −	5 cm Fe	172	158	206.00′	3
(c) −	none	71	69	107.45′	−1
(d) +	4 cm C	170	101	179.20′	36 ± 4.5
(e) −	4 cm C+5 cm Fe	218	146	243.00′	27 ± 3.5
(f) −	6.2 cm Fe	128	120	240.00′	0

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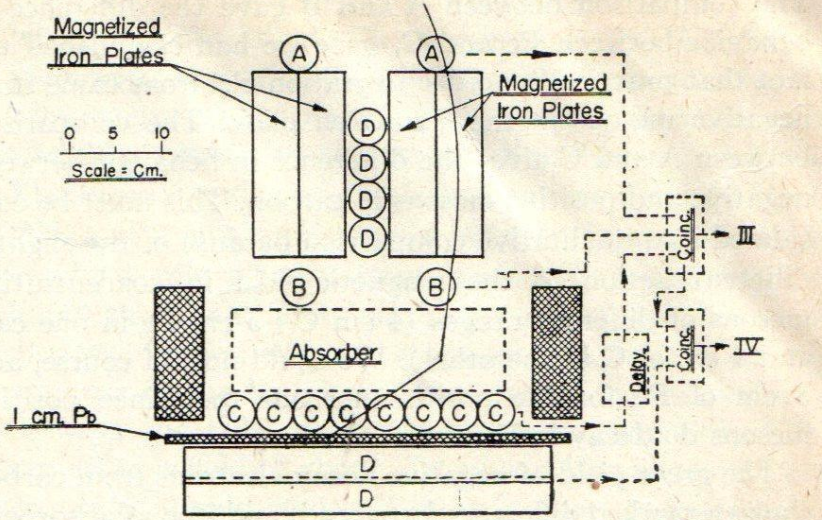

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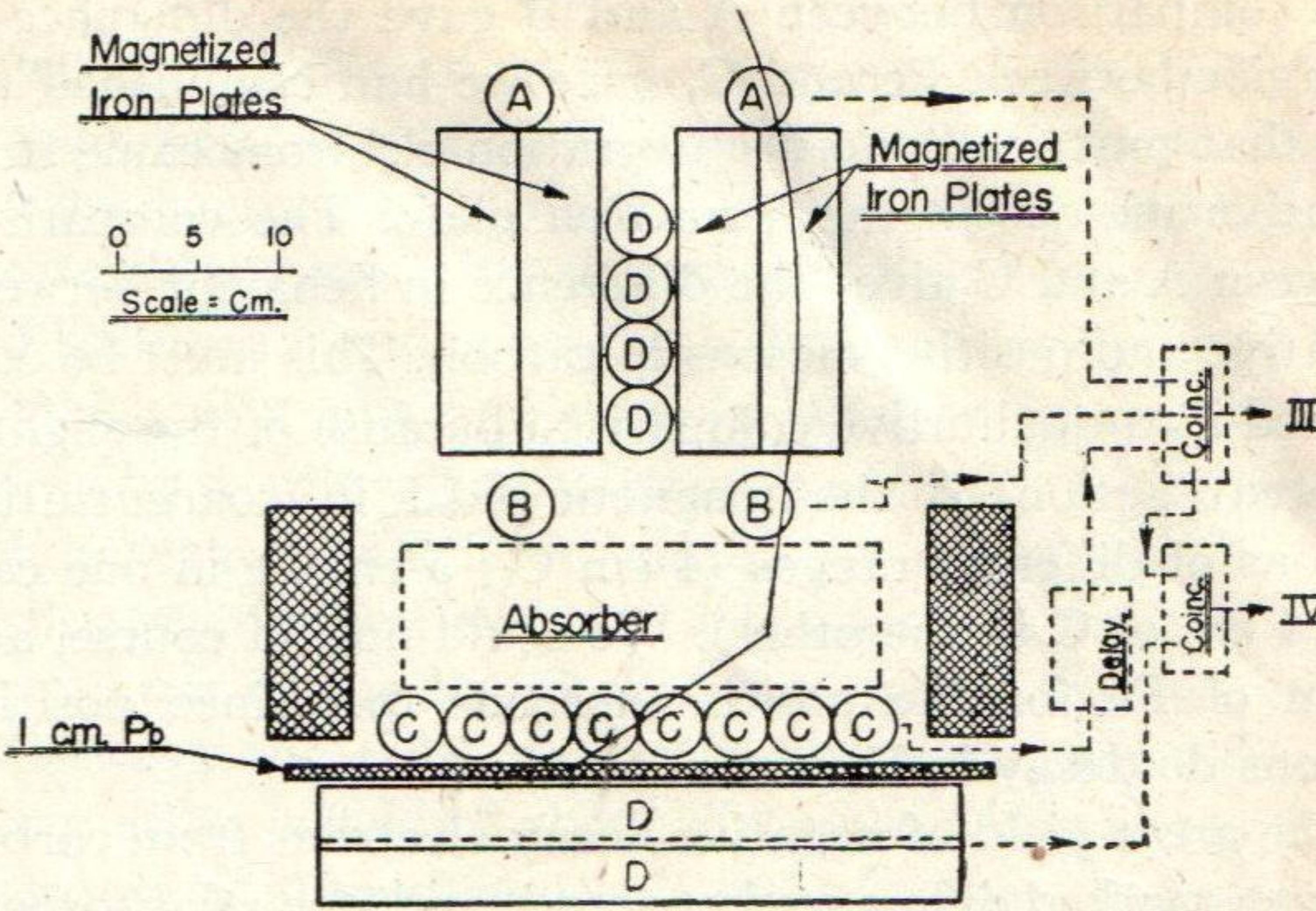

FIG. 1. Disposition of counters, absorber, and magnetized iron plates. All counters "D" are connected in parallel.


Vagando per i
sotterranei del
Dipartimento …


GILSON
Minipuls 2

Prof Pancini


CERN
CERN COURIER


Statometer
H 1407
Nr.


HERFURTH
Statometer
H 1407
Herfurth G.m.b.H.
Hamburg-Altona
Nr. 474


60 50 40 30 20 10 0
0 10 20 30 40 50 60
30 20 10 0 10 20 30
V/cm

Grazie per la vostra attenzione