

CORAM (COsmic Ray Mission) e ICD (International Cosmic Day)

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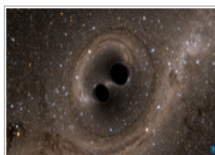




Astroparticle Physics European Consortium

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NEWS



GRAVITATIONAL WAVES EARN SPECIAL BREAKTHROUGH PRIZE

Gravitational waves earn Special Breakthrough Prize - 4 May 2016

More than 1000 scientists and engineers involved in the detection of gravitational waves have been awarded a special Breakthrough...

[Read more](#)



APPEC TOWN MEETING MAKES PROGRESS TOWARDS 2016 ROADMAP

The APPEC Town Meeting held in Paris on 6 and 7 April saw the astroparticle physics community gather and share information in preparation for the new APPEC Roadmap.

November 5, 2015 DESY, Zeuthen

The International Cosmic Day enables students to get in contact with astroparticle physicists to get a first insight into their research, experimental methods and everyday work.

Some basic questions which will be addressed are:

- What are cosmic particles?
- Where do they come from?
- How can they be measured?

The relatively young research field of astroparticle physics has been developing dynamically over the last years (some experiments are: ANTARES, Auger, BAIKAL, Fermi, HAWC, H.E.S.S., IceCube, MAGIC, Telescope Array, VERITAS). It connects particle physics (describing the interactions of elementary particles) with astrophysics (describing up to the biggest structures in the universe) and with cosmology (studying the history of the universe). One of the very interesting topics in astroparticle physics is trying to understand the acceleration mechanisms of cosmic ray particles to very high energies, much higher than accelerators on Earth can reach.

The universe is a big place. Cosmic rays drift around and get energy boosts from multiple sources. Some particles attain enormous energies. When they strike the upper atmosphere, they initiate Extended Air Showers. These events create thousands of particles that simultaneously reach a small section of Earth's surface. More energetic primaries affect larger sections of the surface.

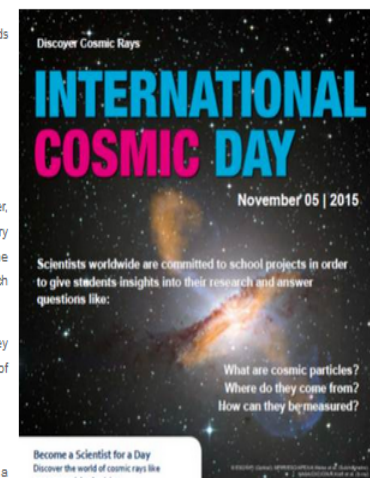
On the International Cosmic Day we will focus on two questions which will be addressed by student experiments:

- Coincident air shower measurements: Can you find out how often nearby detectors simultaneously "light up" with cosmic rays? If they do, is it a randomness or a measurement of one of these showers?
- Zenith angle distribution of air shower particles: Can you find out if the number of air shower particles arriving from the horizon is the same as from above? If it is not, what could cause this effect?

The 4th International Cosmic Day on November 5, 2015 is organized by DESY, together with Netzwerk Teilchenwelt, IPPOG, QuarkNet and Fermilab and will enable students in many different countries around the world to get to do their own experiments at nearby universities, research institutions or even in their classrooms.

We invite students to

- Perform their own cosmic particle experiment
- Analyze and present their data on a common website



More information:
<http://icd.desy.de>





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NEWS

A Worldwide Cosmic Particle Measurement Adventure Undertaken by Students from 12 Nations

On October 8th 2014 the third International Cosmic Day took place. On this day students worldwide learn about astroparticle physics with hands-on activities, sharing the experience of how researchers work and communicate with each other. Students get in contact with astroparticle physicists and have a first insight into their research and experimental methods, they even get the chance to collaborate with them.

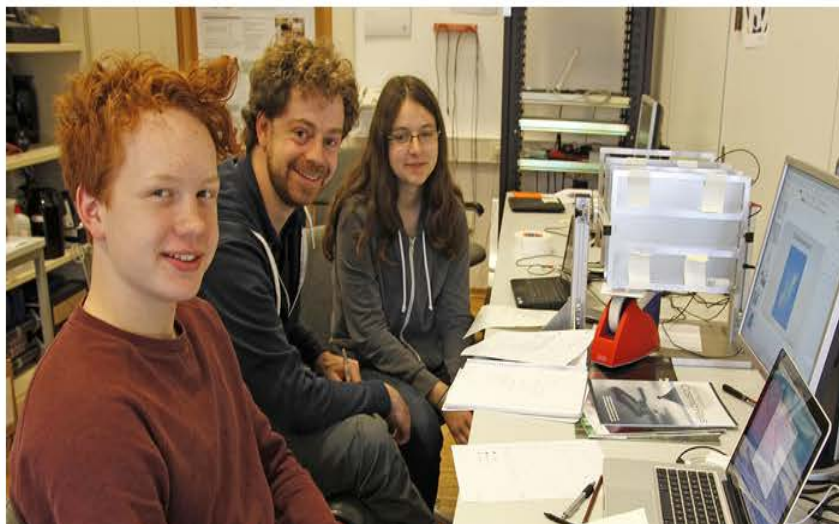


GRAVITATIONAL WAVES EARN SPECIAL BREAKTHROUGH PRIZE

Gravitational waves earn Special Breakthrough Prize - 4 May 2016

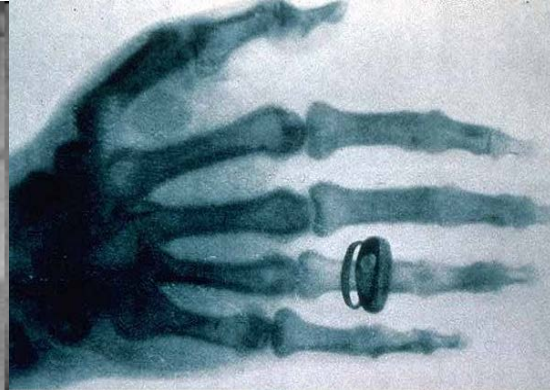
More than 1000 scientists and engineers involved in the detection of gravitational waves have been awarded a special Breakthrough...

[Read more](#)

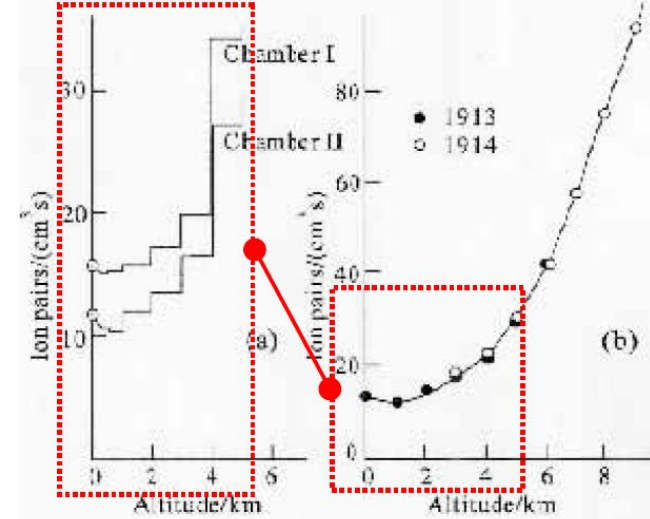


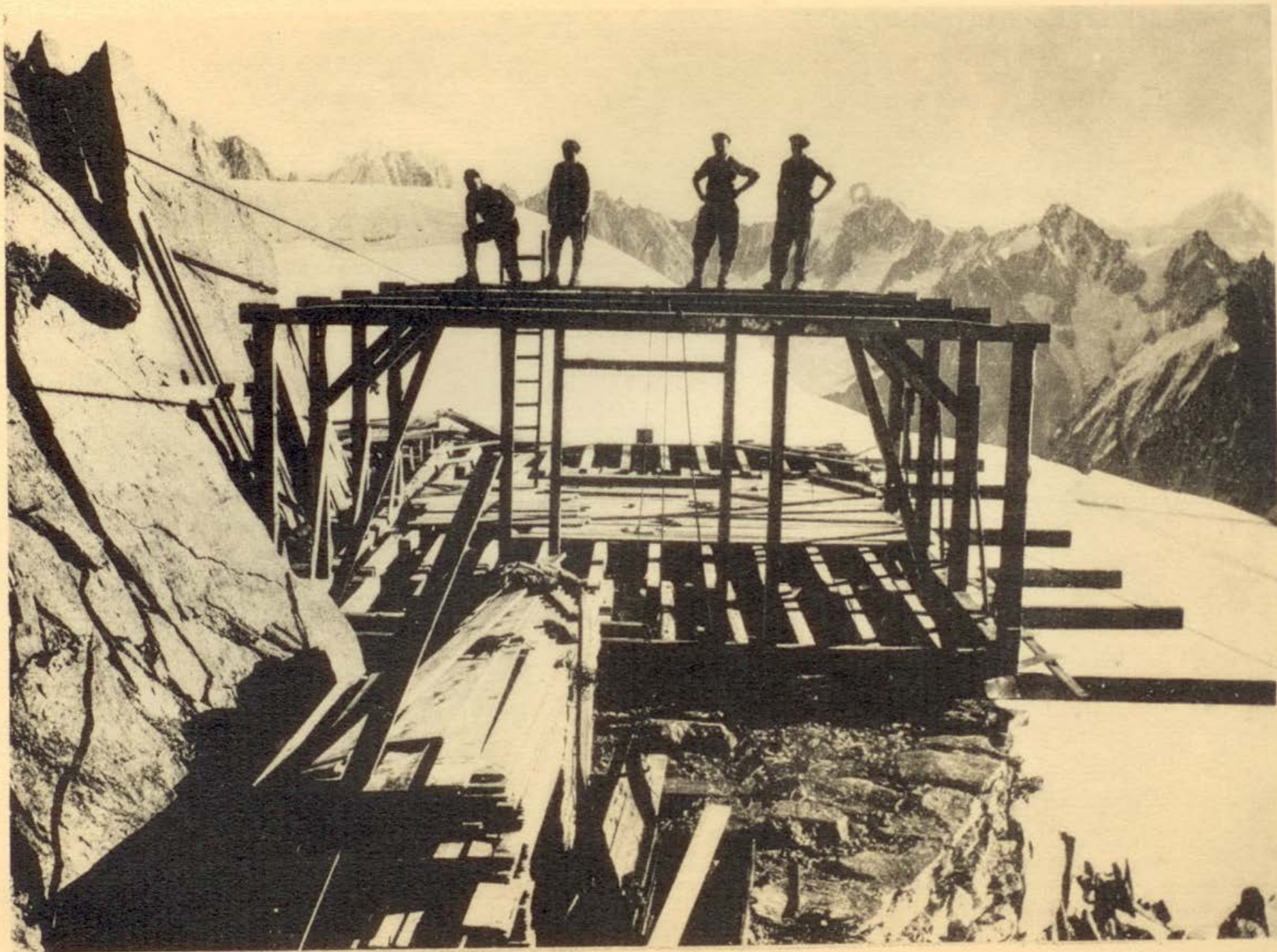
Contenuti

- Il flusso di raggi cosmici
- Alcuni esperimenti
- Un progetto con gli studenti: CORAM
- L'International Cosmic Day
- Le misure e l'elaborazione dei dati
- La presentazione dei risultati.



La scoperta e le prime misure





EXPLORER II – 11 Nov 1935 – 22000 m

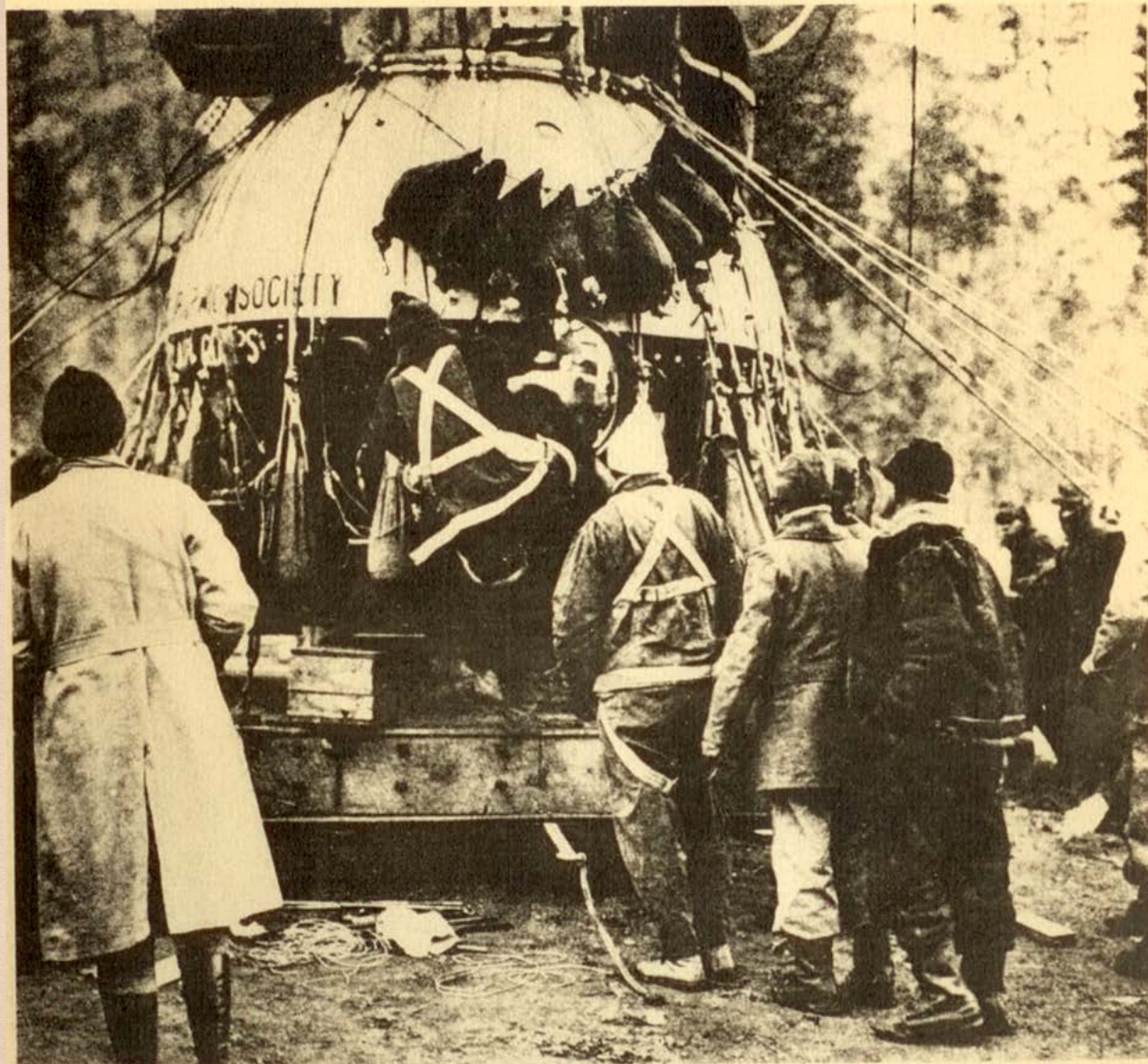
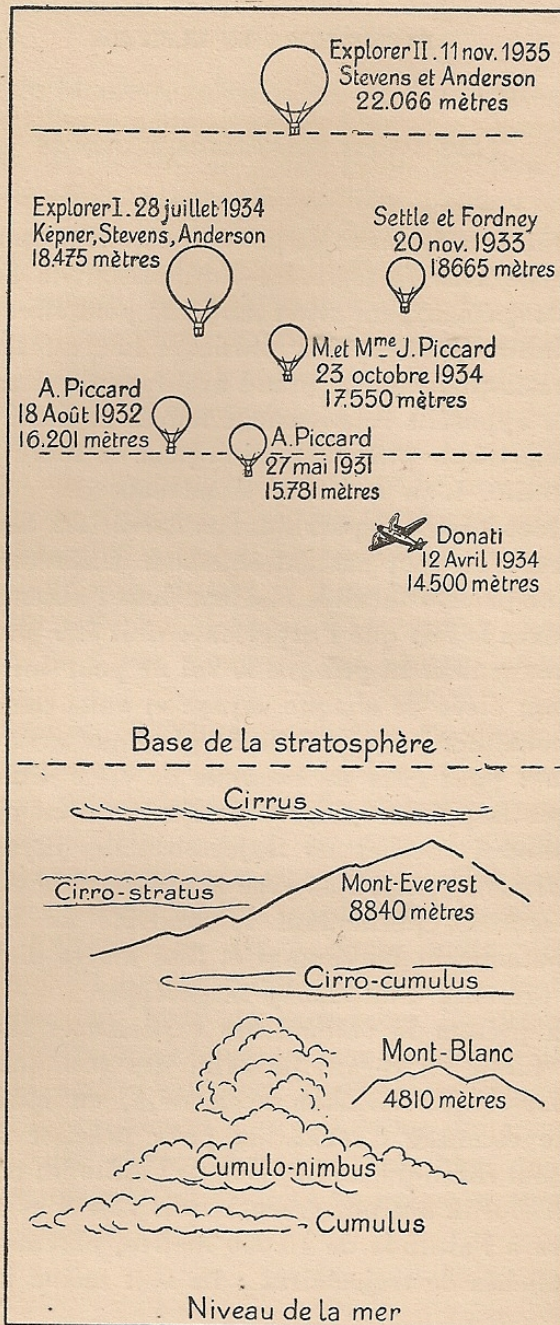
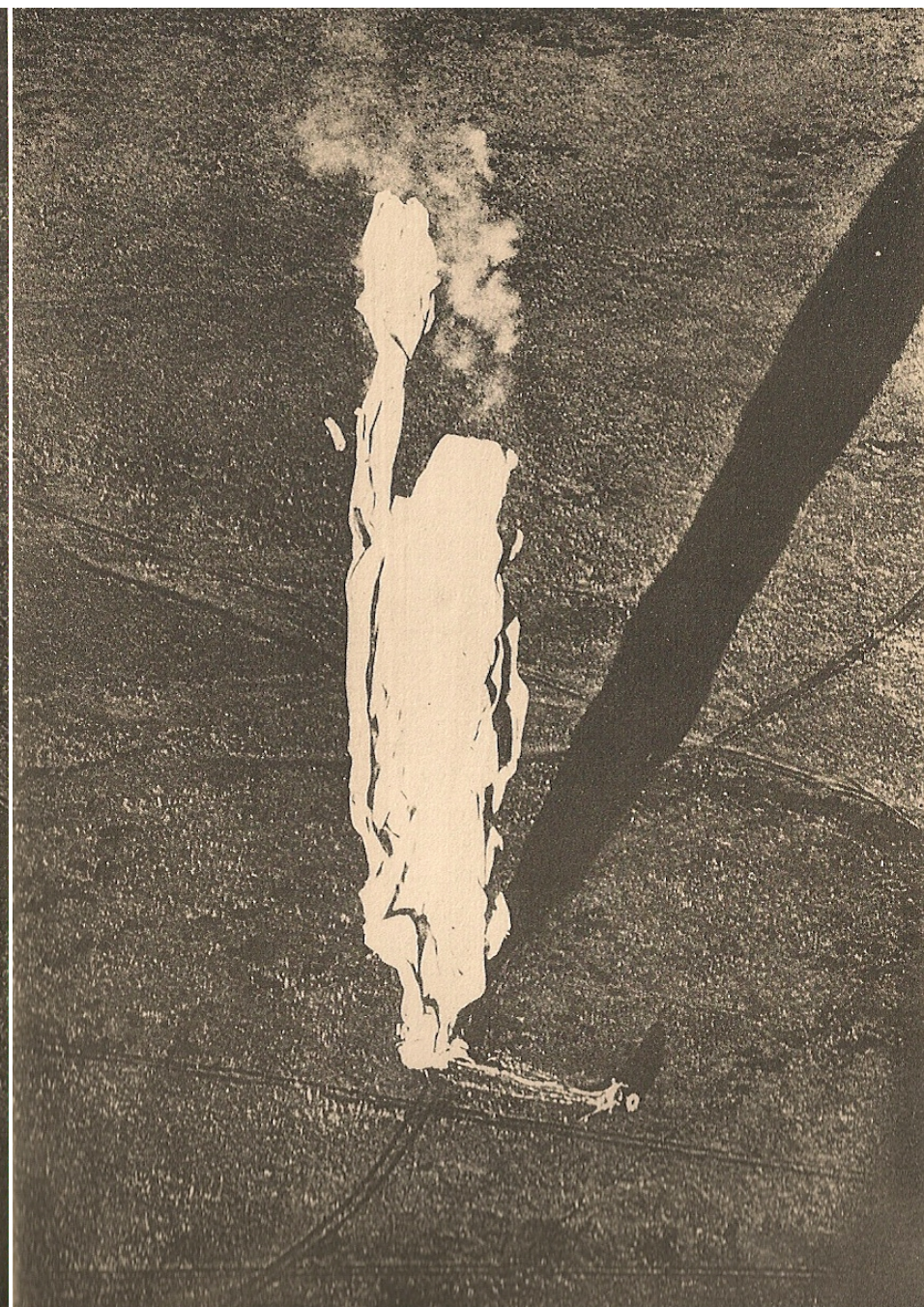
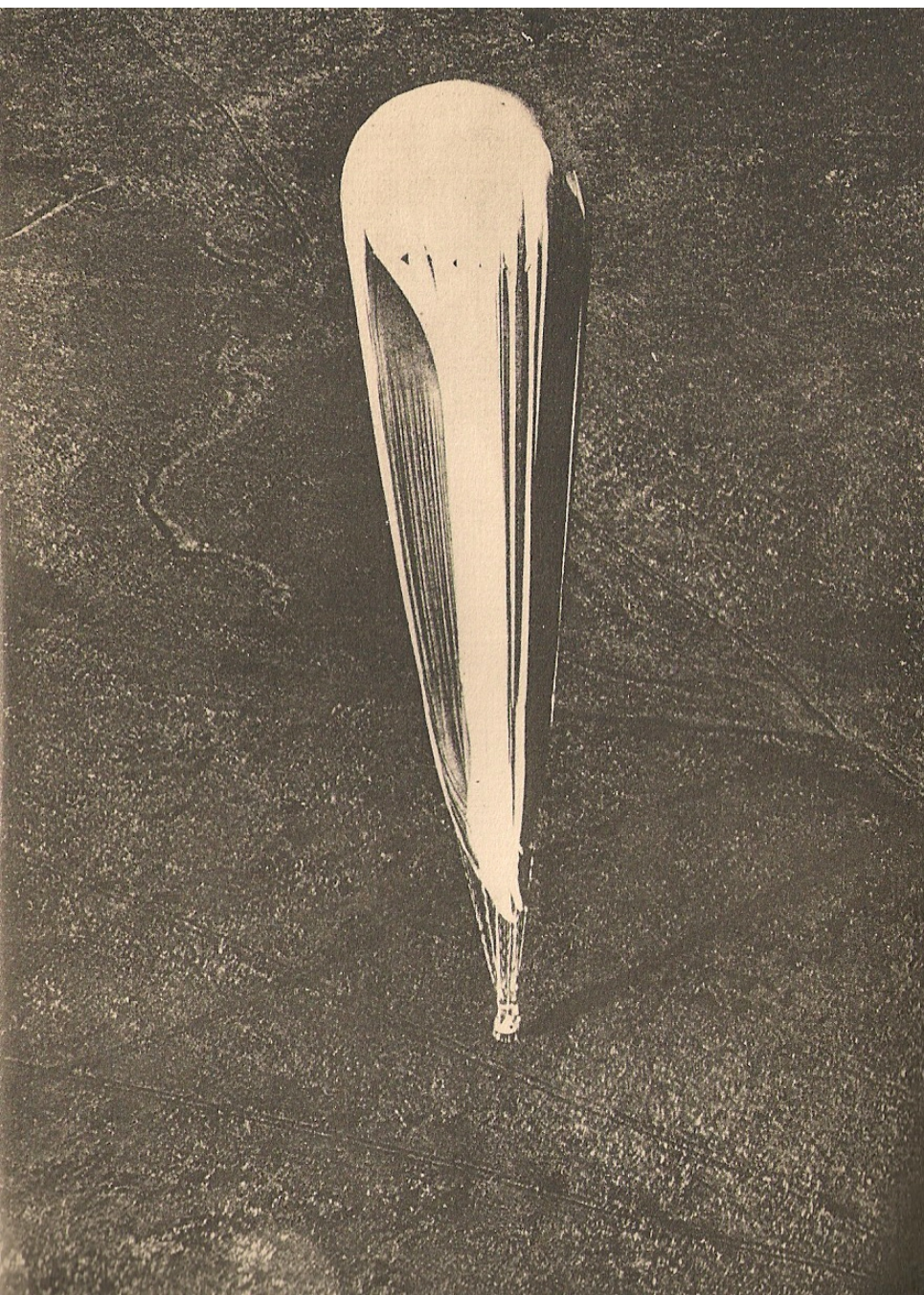


Fig. 39. — Les principaux vols stratosphériques.

EXPLORER II – Fase di discesa



Lancio di palloni-sonda
equipaggiati con
rivelatori e trasmettitori
radio

Compton et al.,
University of Chicago

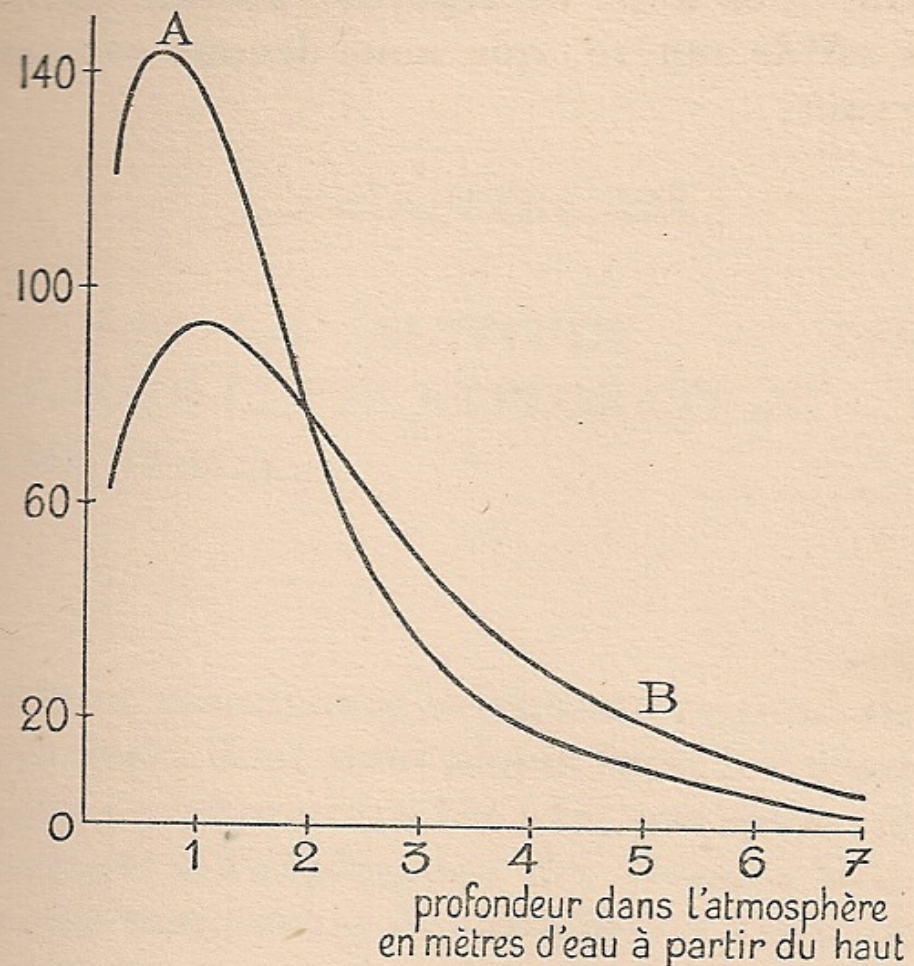


Fig. 38 — Intensité du rayonnement cosmique dans l'atmosphère. — B est la courbe obtenue à Madras, par 3 degrés de latitude magnétique; A est la différence entre la courbe obtenue à 38° et celle obtenue à Madras. — On observe une croissance très vive du rayonnement à partir du sol (10 mètres d'équivalent d'eau) jusqu'à environ un mètre d'équivalent d'eau, puis une décroissance aux altitudes supérieures.

MILLIKAN RETORTS HOTLY TO COMPTON IN COSMIC RAY CLASH

Debate of Rival Theorists
Brings Drama to Session
of Nation's Scientists.

THEIR DATA AT VARIANCE

New Findings of His Ex-Pupil
Lead to Thrust by Millikan
at 'Less Cautious' Work.

PROF. RUSSELL ELECTED

Astronomer Heads Association—
Secret of Purple Gold in Tomb
of Tut-ankh-Amen Rediscovered.

By WILLIAM L. LAURENCE.
Special to THE NEW YORK TIMES.

ATLANTIC CITY, Dec. 30.—Professor Robert A. Millikan, who won the Nobel Prize in physics for being

MILLIKAN DENIES 'CLASH' ON THEORY

Scientist Protests That the
Word 'Incautious' Was Not
Aimed at Compton.

DISCLAIMS ANY COOLNESS

Holds The Times Report Stated
"Exactly the Opposite" of the
Findings He Presented.

By Telegraph to the Editor of THE NEW
YORK TIMES.

WASHINGTON, D. C., Dec. 31.—It is not customary for me to attempt to correct erroneous newspaper reports, and that for the simple reason that with many newspapers it is a well-nigh hopeless undertaking. But THE NEW YORK TIMES is usually so dependable that I assume it will welcome correction and also will know how to effect the remedy for its error.

MILLIKAN'S DATA CONFIRM COMPTON

Results of Cosmic Ray Study
at Panama Tend to Back
Rival's Ideas.

RAY INTENSITY VARIES

Strength Is Greater at the Poles
—Equatorial Tests Are Now
Projected.

PASADENA, Cal., Feb. 4 (AP).—The stratosphere above equatorial regions of the earth should be the next scene of exploration in the quest of the secrets of the cosmic ray, Dr. Robert A. Millikan said here today.

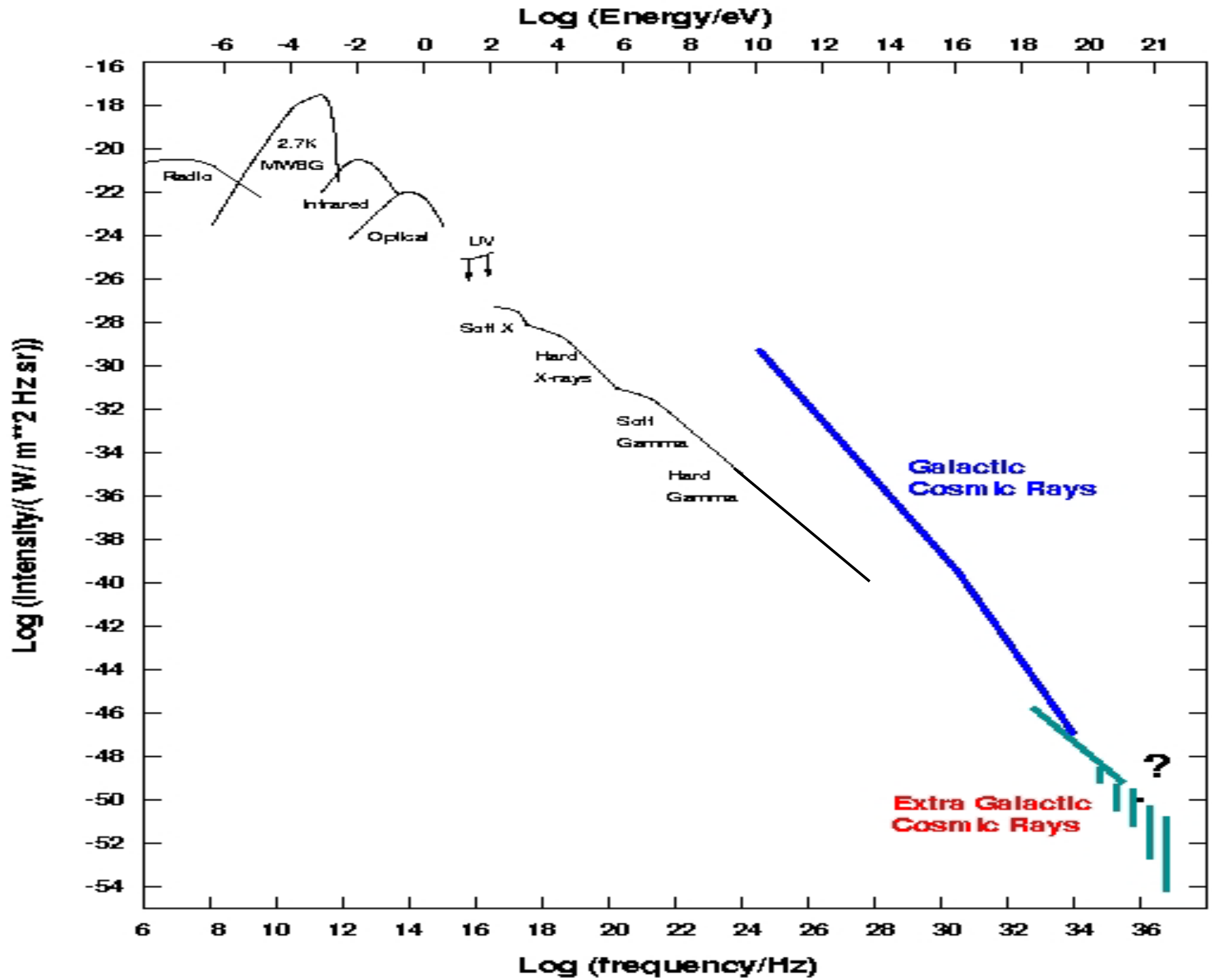
Announcing that observations of his co-workers at Panama confirmed the earlier reports of Dr. Arthur H. Compton of Chicago that the rays from interstellar space showed latitude effects, Dr. Millikan disclosed that the variance was as high as 8 per cent.

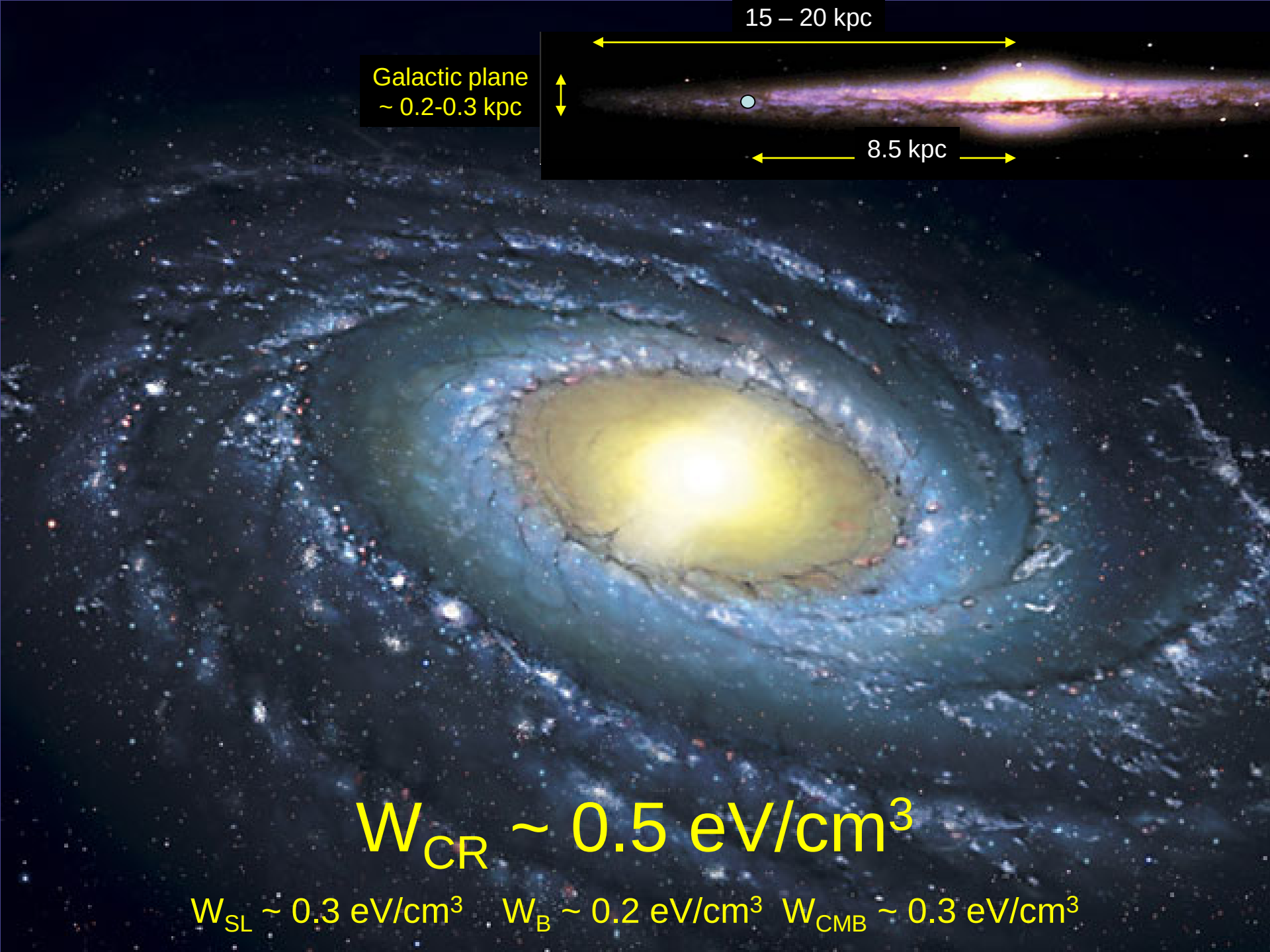
Domande fondamentali

- Quali sono le sorgenti di RC ?
- Quali sono e come funzionano gli “acceleratori” ?
- Quali sono i meccanismi di propagazione ?
-

Quantità Osservabili

- Spettri energetici
- Direzioni di arrivo
- Composizione chimica
-





$$W_{\text{CR}} \sim 0.5 \text{ eV/cm}^3$$

$$W_{\text{SL}} \sim 0.3 \text{ eV/cm}^3 \quad W_{\text{B}} \sim 0.2 \text{ eV/cm}^3 \quad W_{\text{CMB}} \sim 0.3 \text{ eV/cm}^3$$

Fondamentali i contributi italiani :

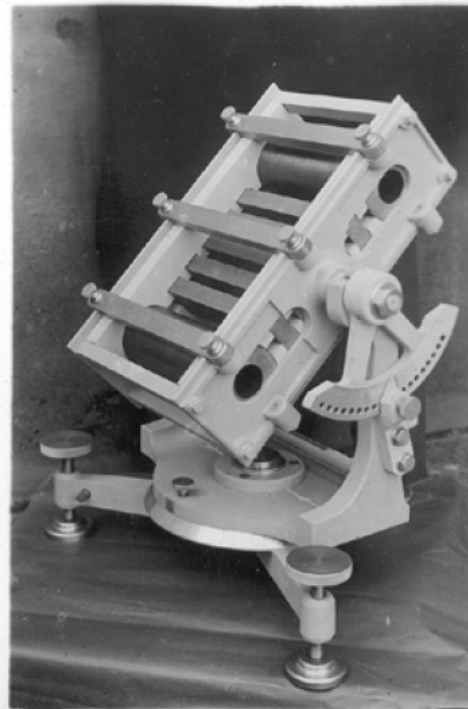
Fermi, Rossi, Occhialini, Conversi, ...

“ parrebbe ... che di tanto in tanto giungessero sugli apparecchi degli sciame molto estesi di corpuscoli i quali determinavano coincidenze fra contatori, anche piuttosto lontani l'uno dall'altro. Mi è mancato purtroppo il tempo di studiare più da vicino questo fenomeno ...”

Bruno Rossi, Asmara (Eritrea) 1933

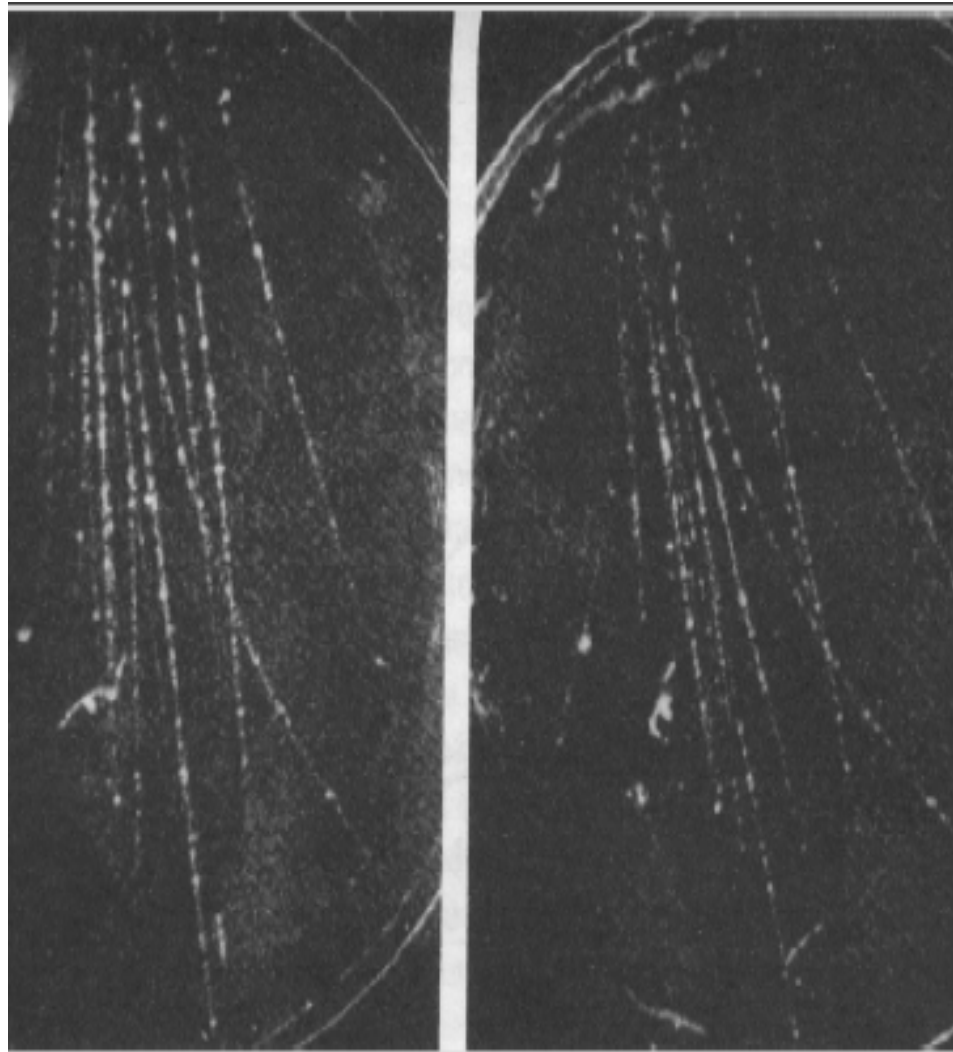
1-10-33									
0°	15°		30°		45°		60°		
21	20	20	16	20	12	20	11	20	10
29	22	30	25	30	24	30	22	30	22
30	31	30	31	30	16	30	20	30	7
30	31	30	21	30	17	30	10	30	7
20	24	20	22	20	17	20	15		
130	128	130	115	130	86	130	78	110	66

2-10-33									
30	30	30	24	30	22	30	13	50	22
22	14	22	20	22	20	22	10	63	22
41	33	41	45	41	21	41	22	30	10
30	37	30	36	30	25	30	21		
123	114	123	128	123	98	123	72	143	54

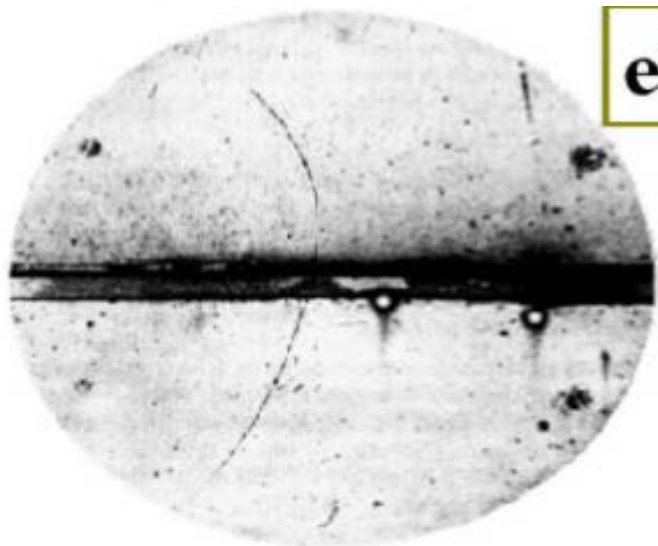


Si osservano i primi “**showers**”

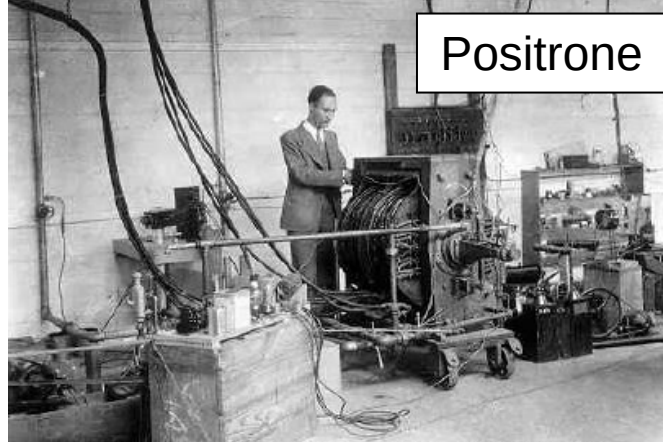
Occhialini usa la parola
“**sciame**” nelle conversazioni
telefoniche con Bruno Rossi



*Fotografia stereoscopica di uno sciame
(P. Blackett & G. Occhialini, 1933)*



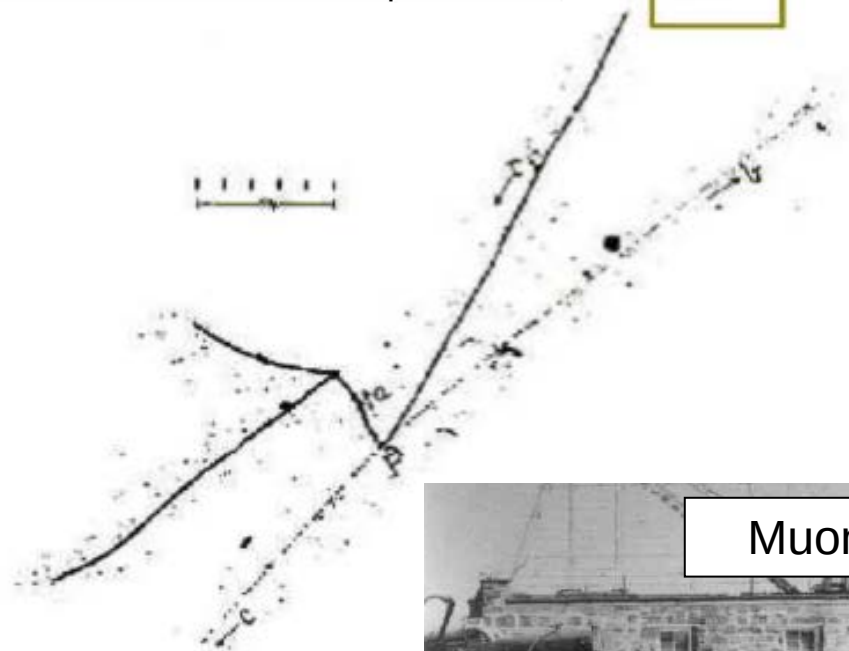
e^+



Positrone

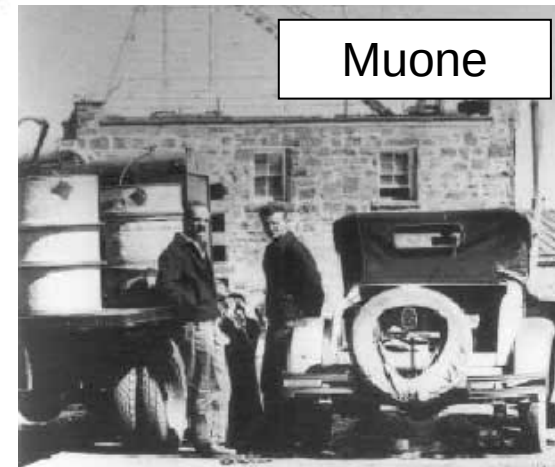
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$K^{\pm}$



$\pi^{\pm}$

Muone

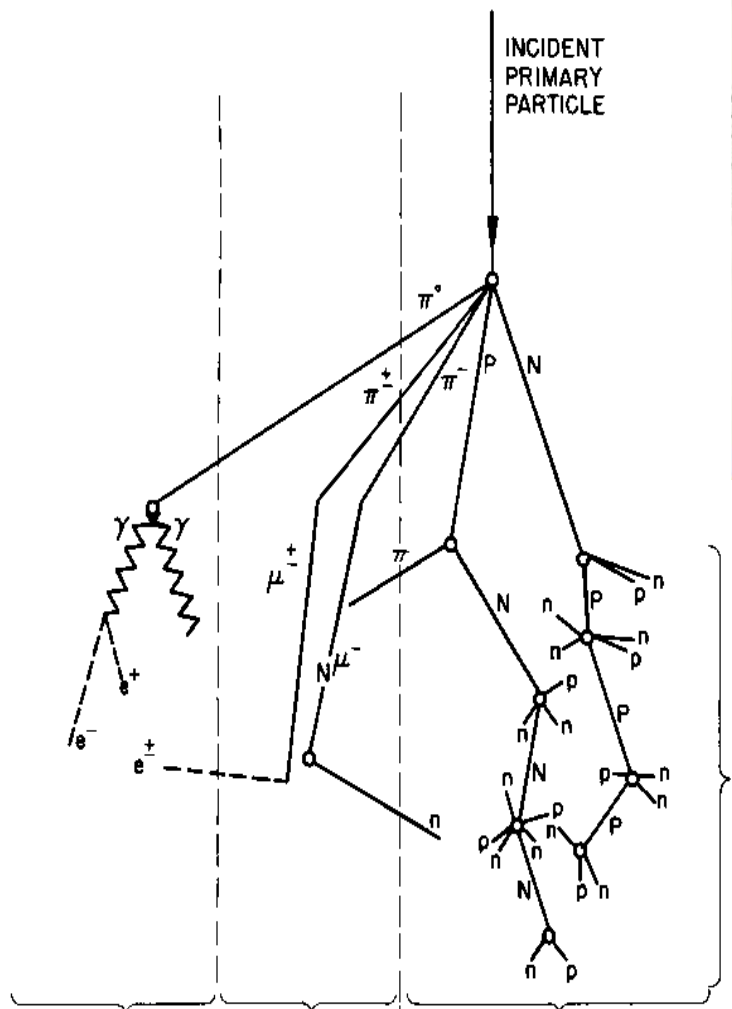


Particle	Year	Discoverer (Nobel Prize)	Method
e^-	1897	Thomson (1906)	Discharges in gases
p	1919	Rutherford	Natural radioactivity
n	1932	Chadwik (1935)	Natural radioactivity
e^+	1933	Anderson (1936)	Cosmic Rays
$\mu^\pm$	1937	Neddermeyer, Anderson	Cosmic Rays
$\pi^\pm$	1947	Powell (1950) , Occhialini	Cosmic Rays
$K^\pm$	1949	Powell (1950)	Cosmic Rays
π^0	1949	Bjorklund	Accelerator
K^0	1951	Armenteros	Cosmic Rays
Λ^0	1951	Armenteros	Cosmic Rays
Δ	1932	Anderson	Cosmic Rays
Ξ^-	1932	Armenteros	Cosmic Rays
$\Sigma^\pm$	1953	Bonetti	Cosmic Rays
p^-	1955	Chamberlain, Segre' (1959)	Accelerators
anything else	1955 $\implies$ today	various groups	Accelerators
$m_\nu \neq 0$	2000	KAMIOKANE	Cosmic rays

Vengono rivelati **sciami estesi** su superfici di decine di migliaia di metri quadrati e più.

Viene osservato il primo evento con $E > 10^{19}$ eV





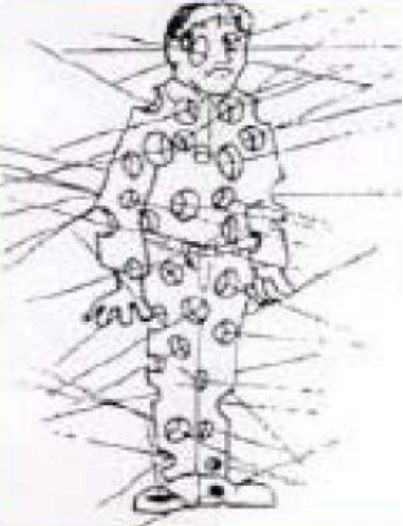
ELECTROMAGNETIC OR "SOFT" COMPONENT

MESON OR "HARD" COMPONENT

NUCLEONIC COMPONENT

ENERGY FEEDS ACROSS FROM NUCLEAR TO ELECTROMAGNETIC INTERACTIONS

SMALL ENERGY FEEDBACK FROM MESON TO NUCLEONIC COMPONENT



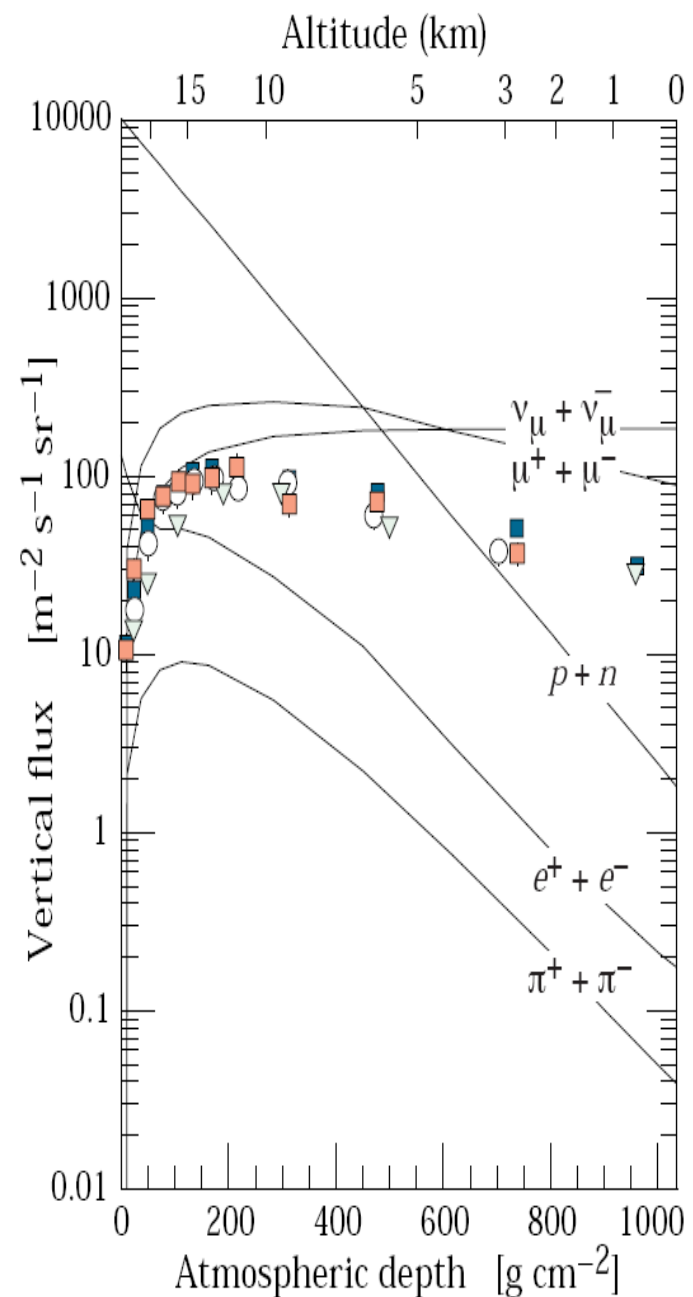
LOW ENERGY NUCLEONIC COMPONENT
(DISINTEGRATION PRODUCT NEUTRONS DEGENERATE TO "SLOW" NEUTRONS)

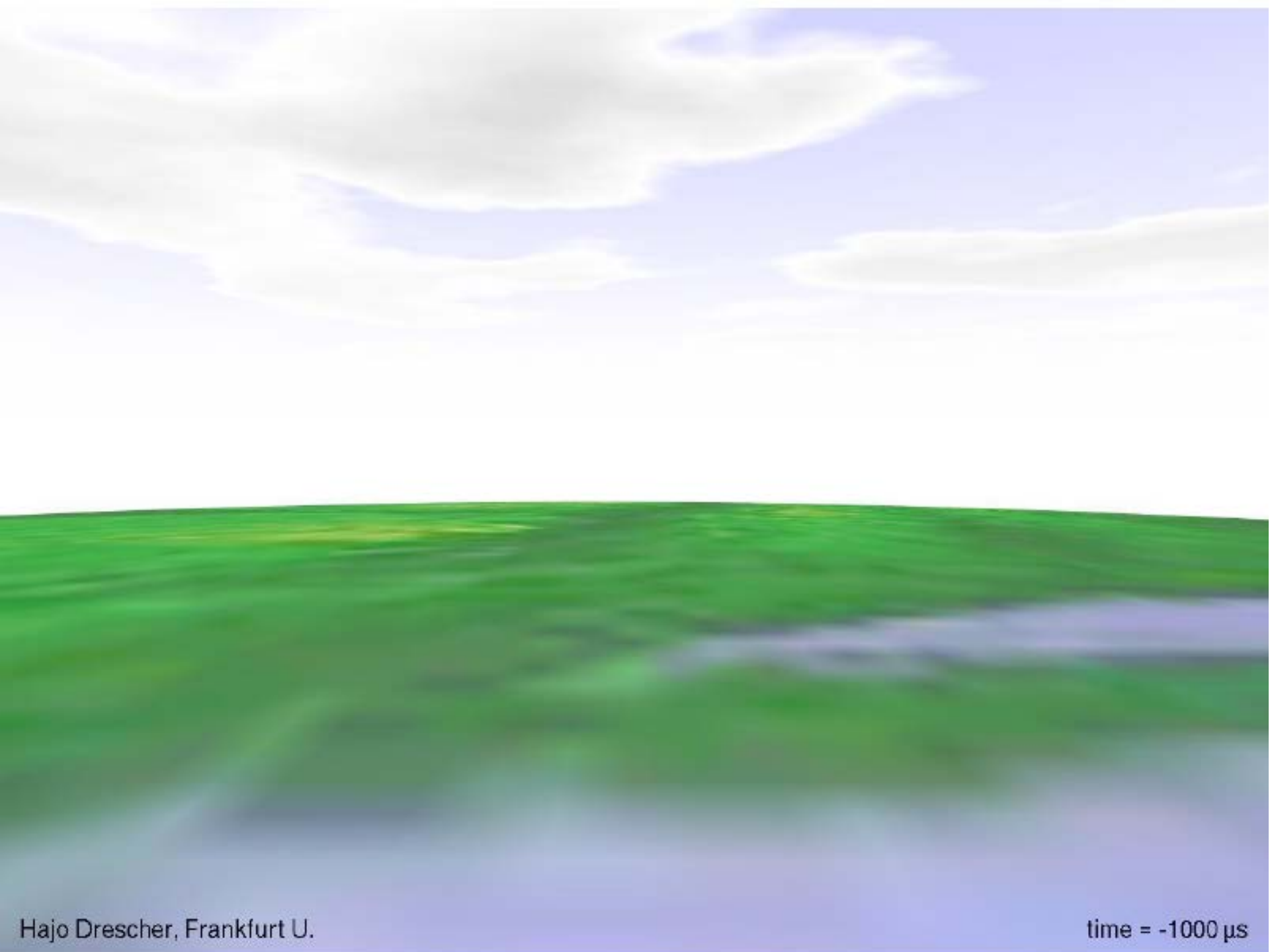
N, P = HIGH ENERGY NUCLEONS

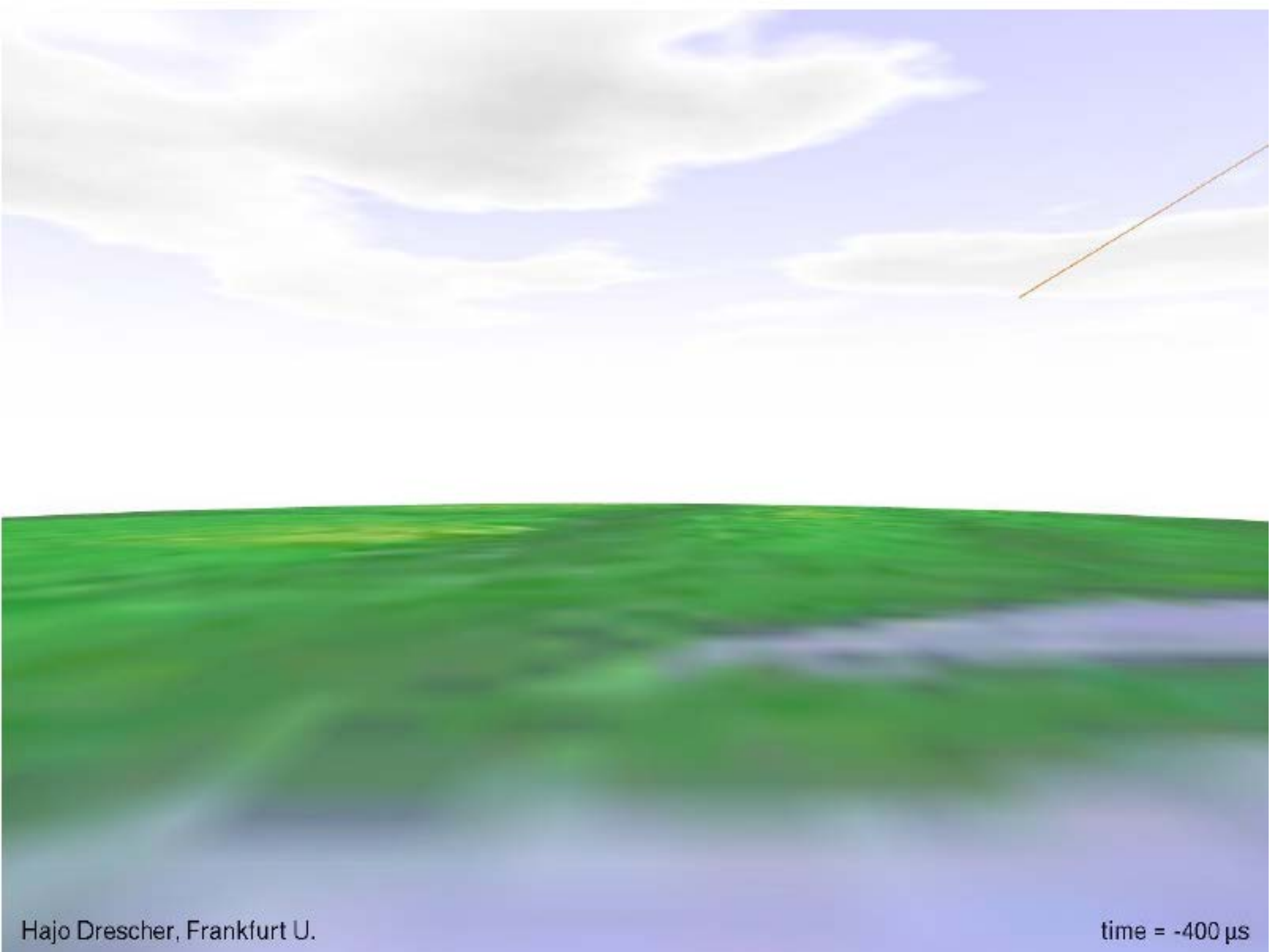
n, p = DISINTEGRATION PRODUCT NUCLEONS

$\star$ = NUCLEAR DISINTEGRATION

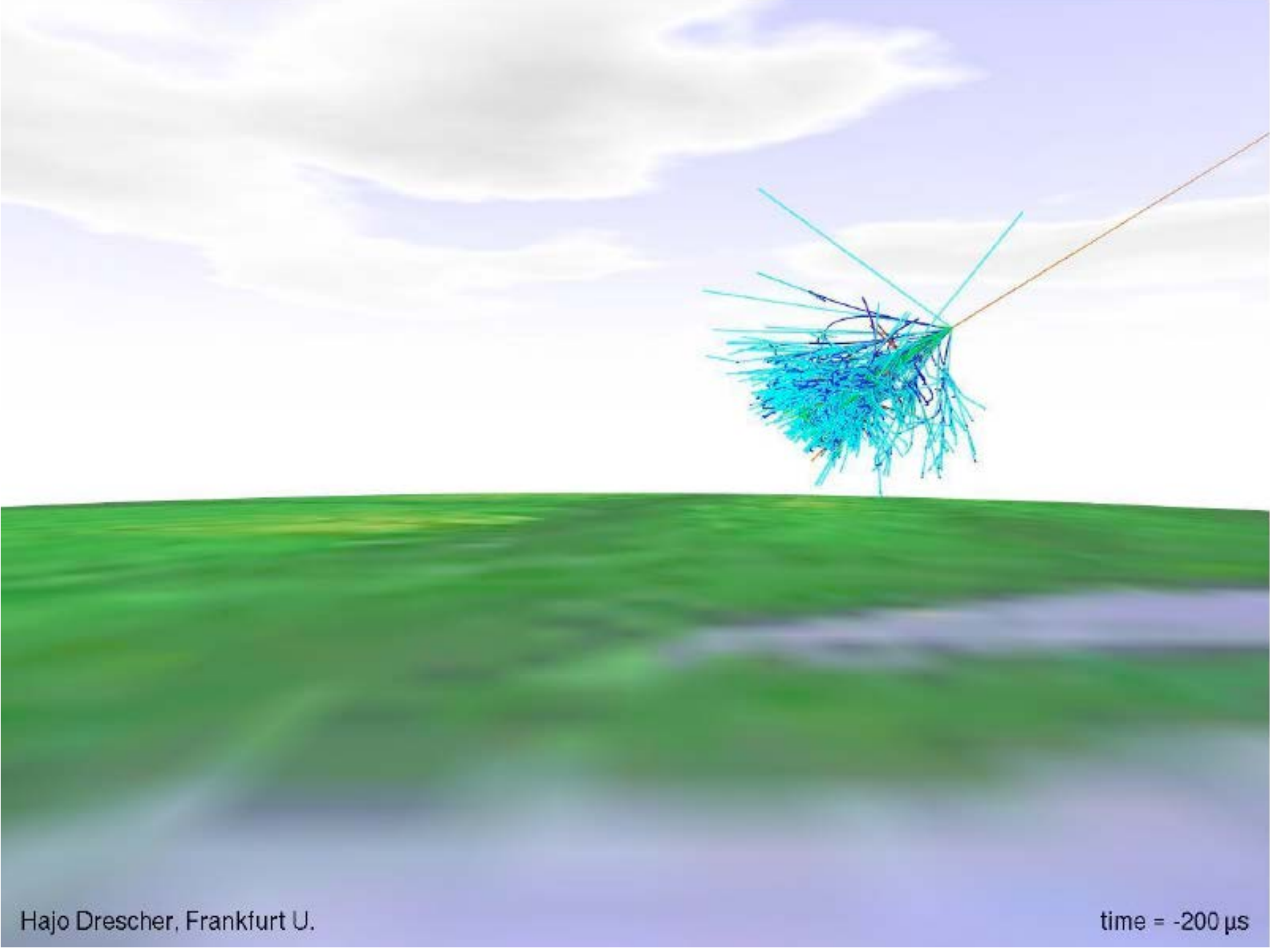
Schematic Diagram of Cosmic Ray Shower

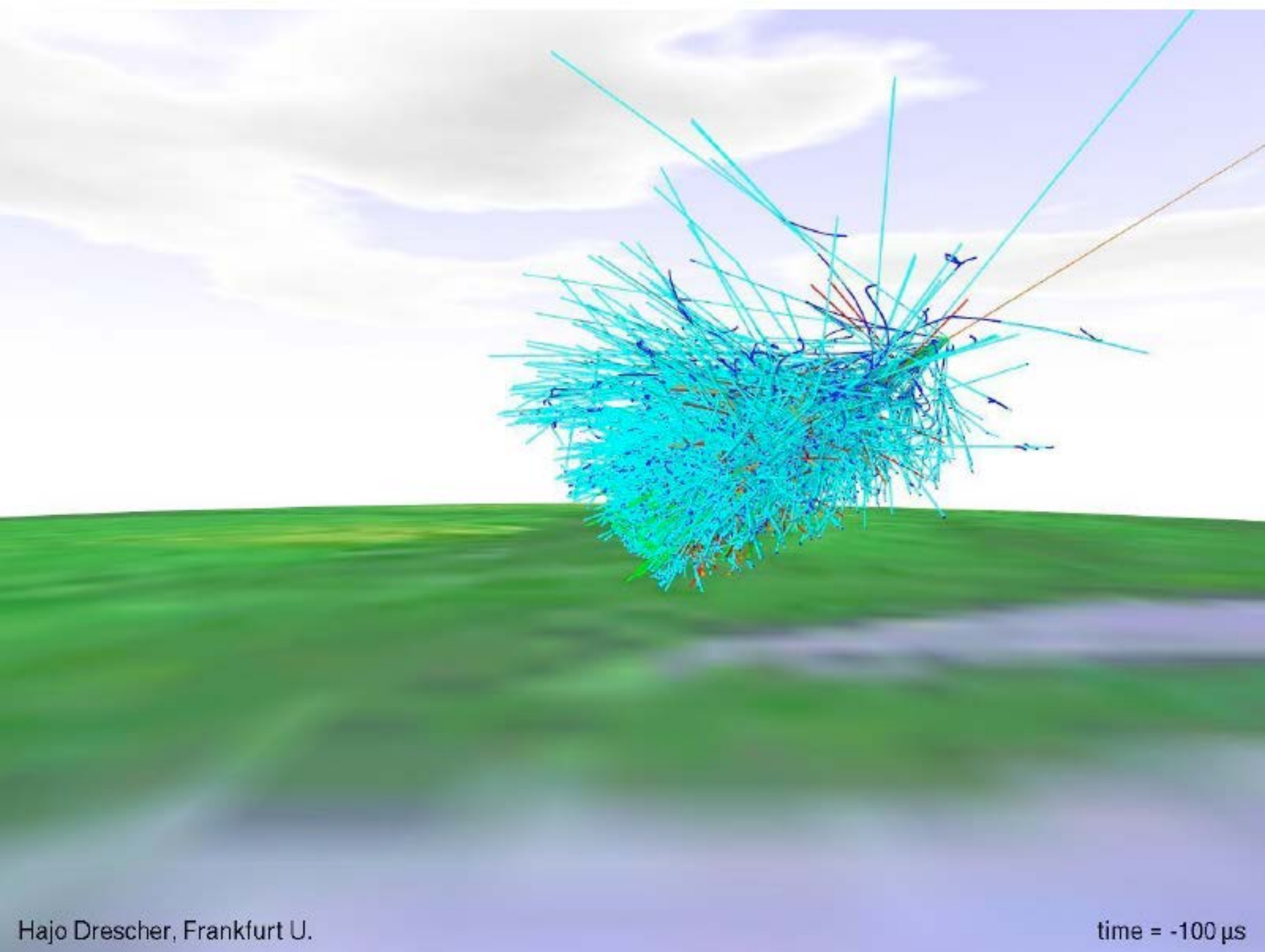


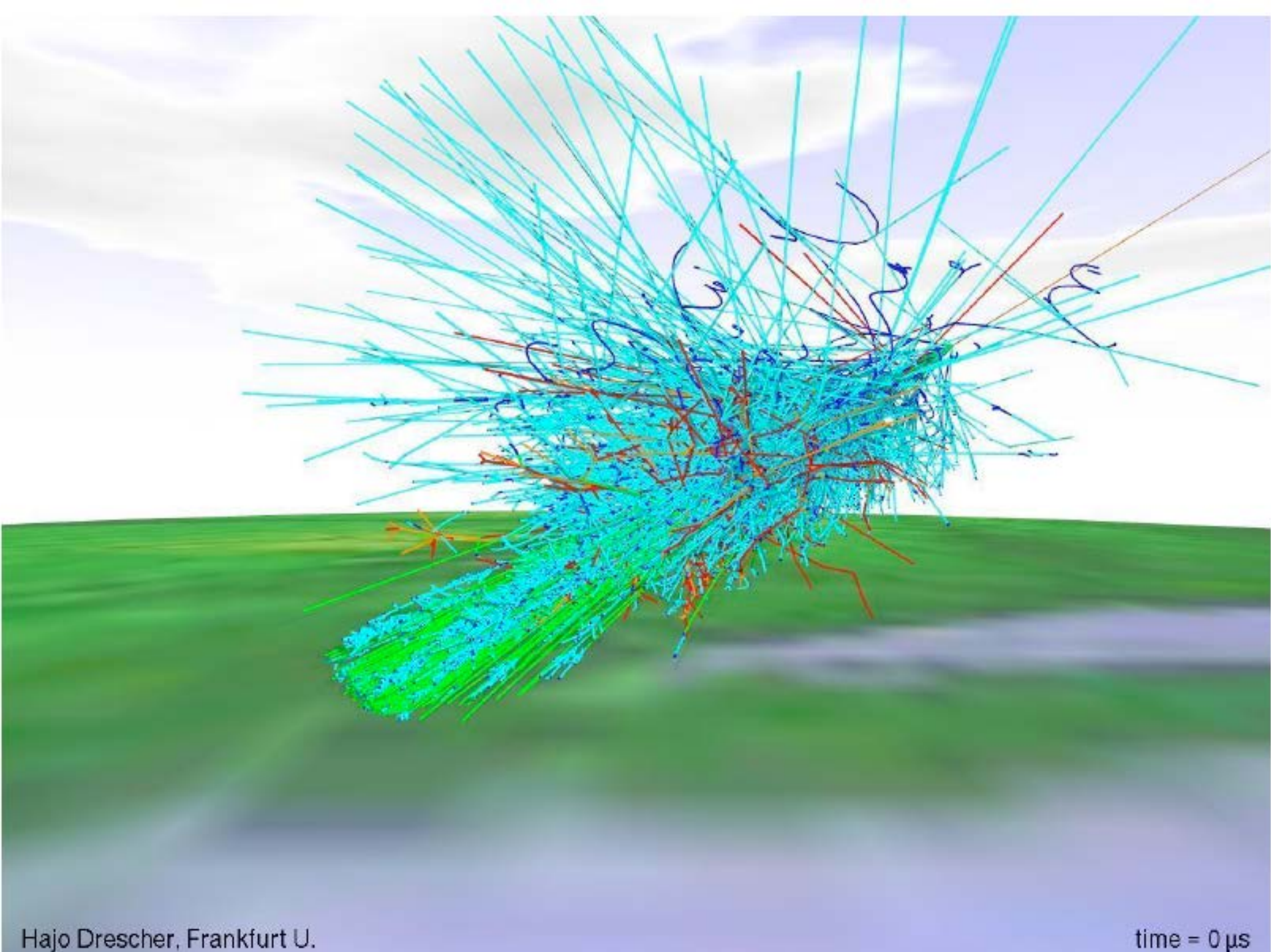


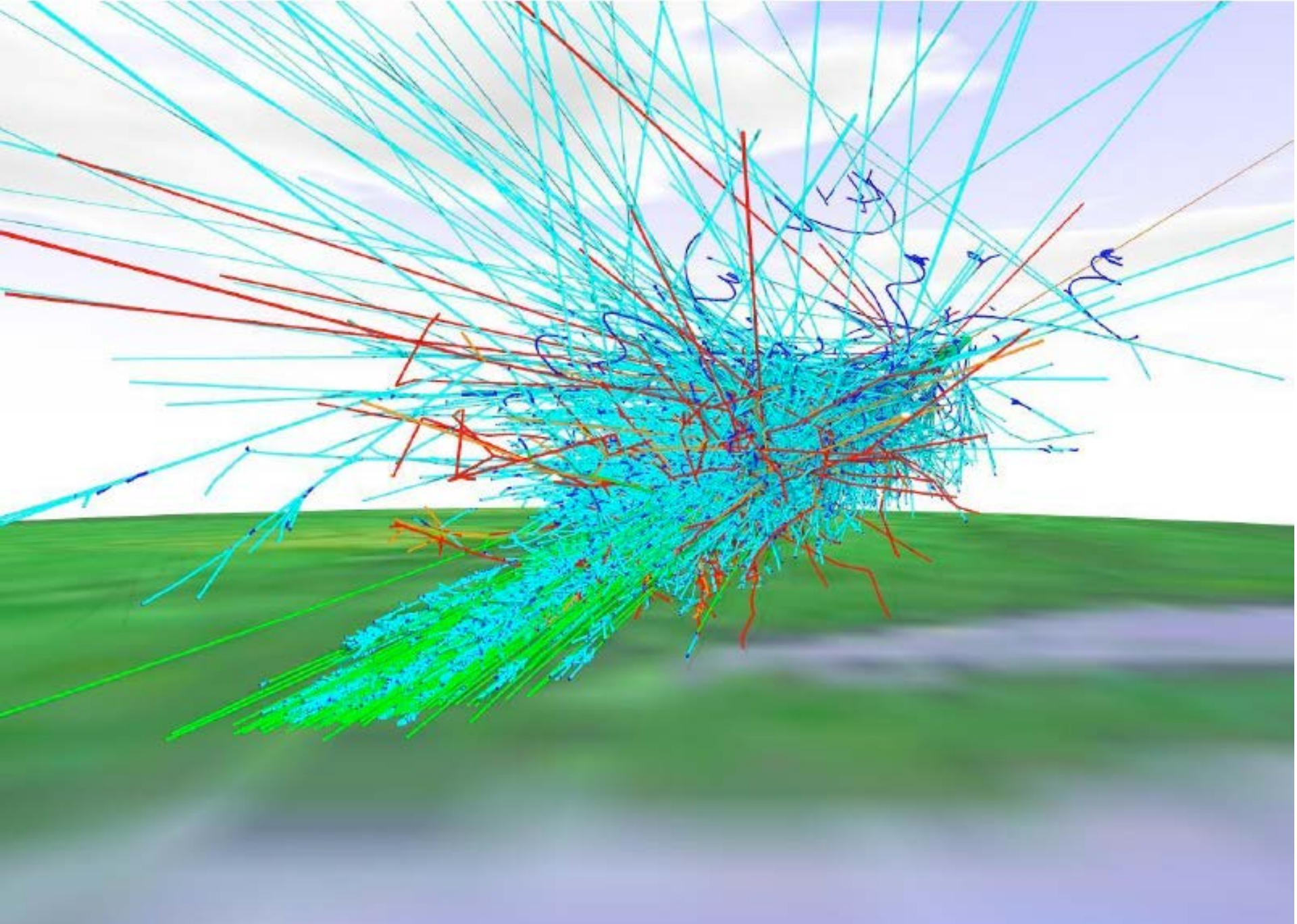






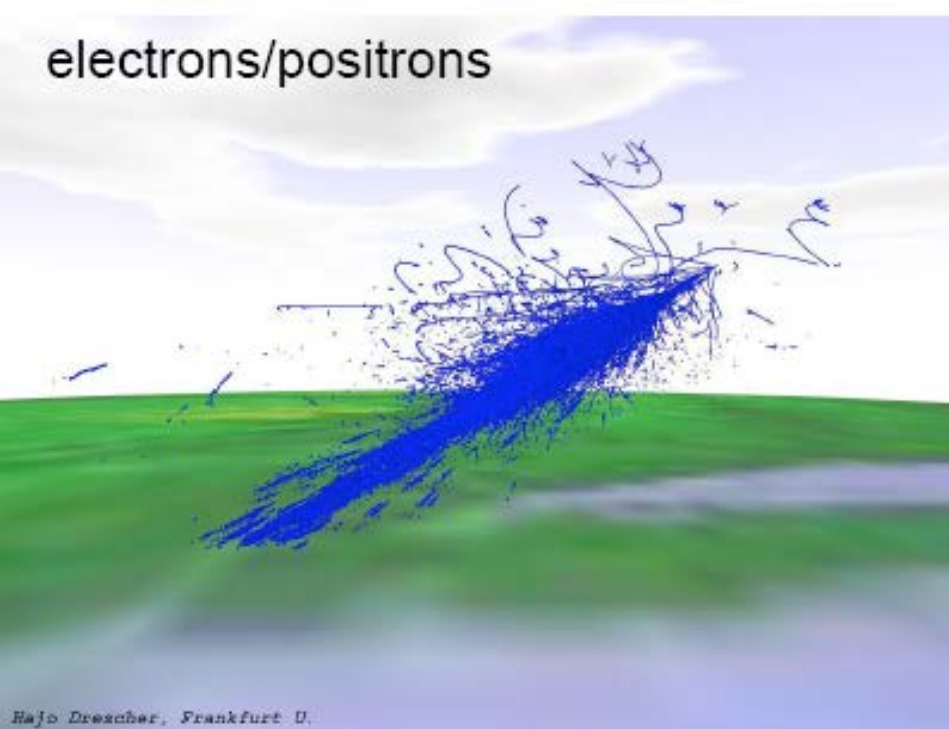




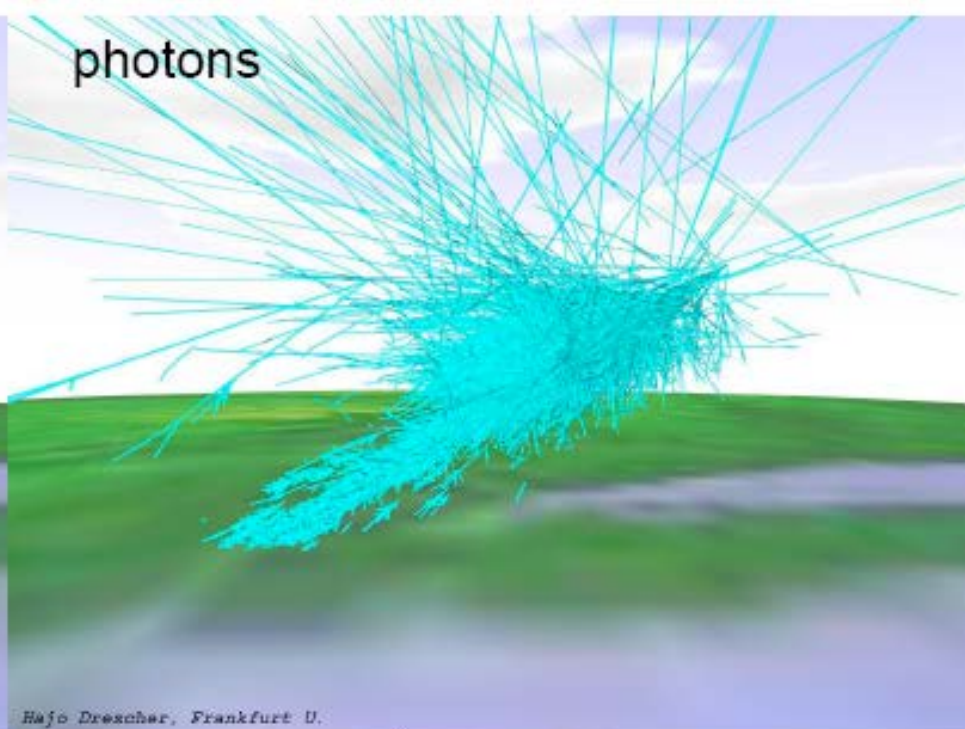


Hajo Drescher, Frankfurt U.

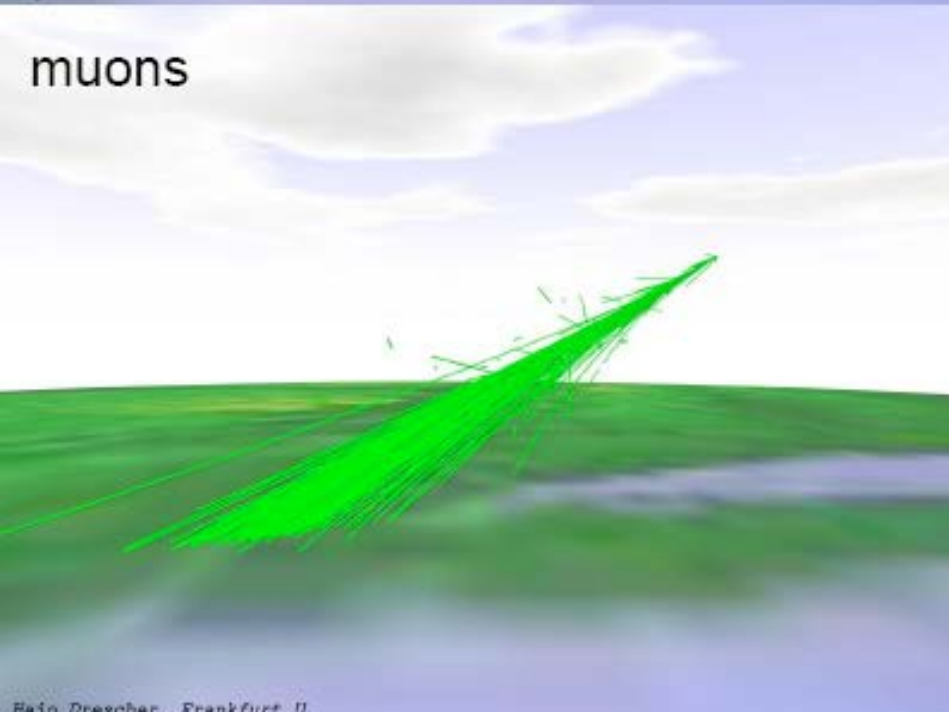
electrons/positrons



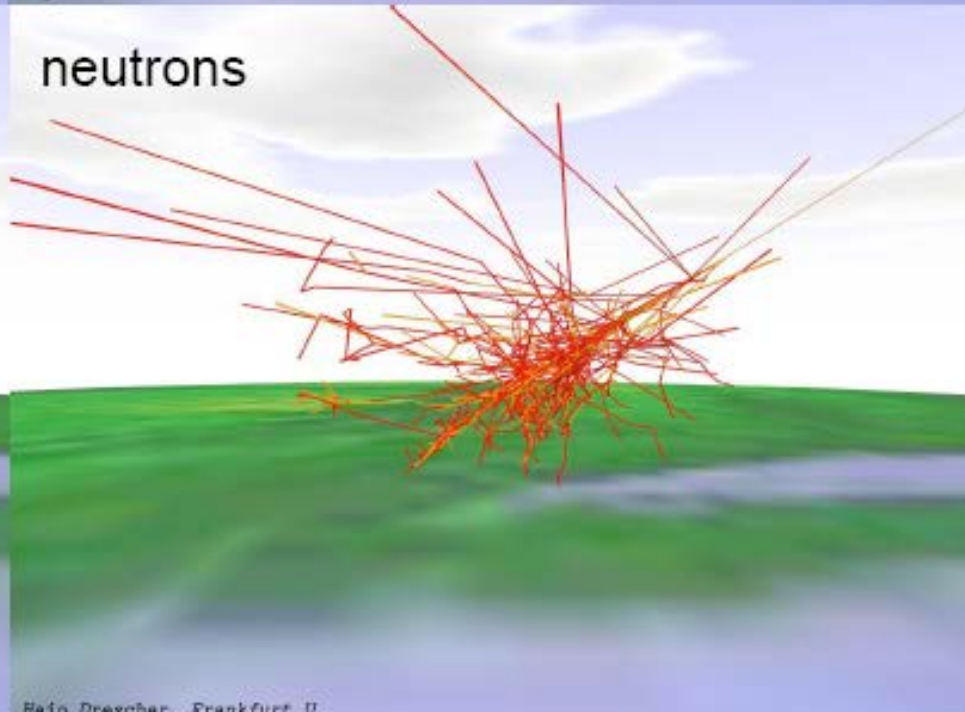
photons



muons

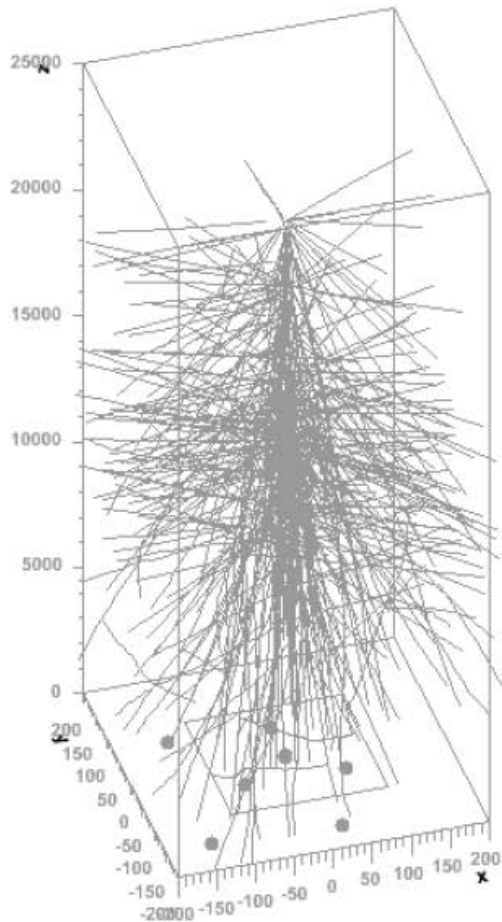


neutrons

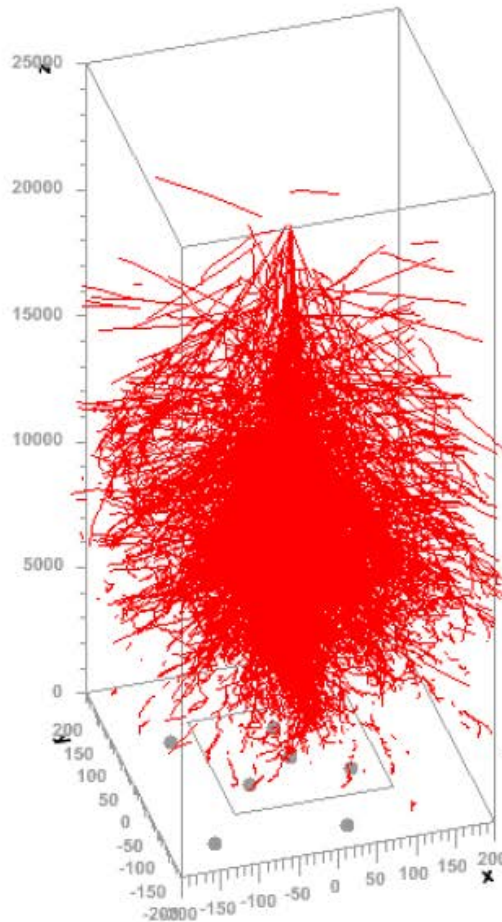


Shower particle tracks: proton

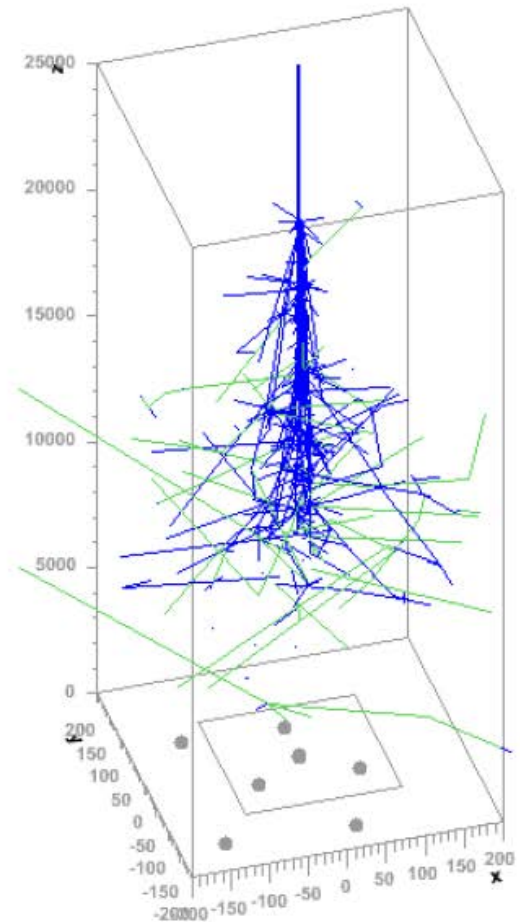
muons

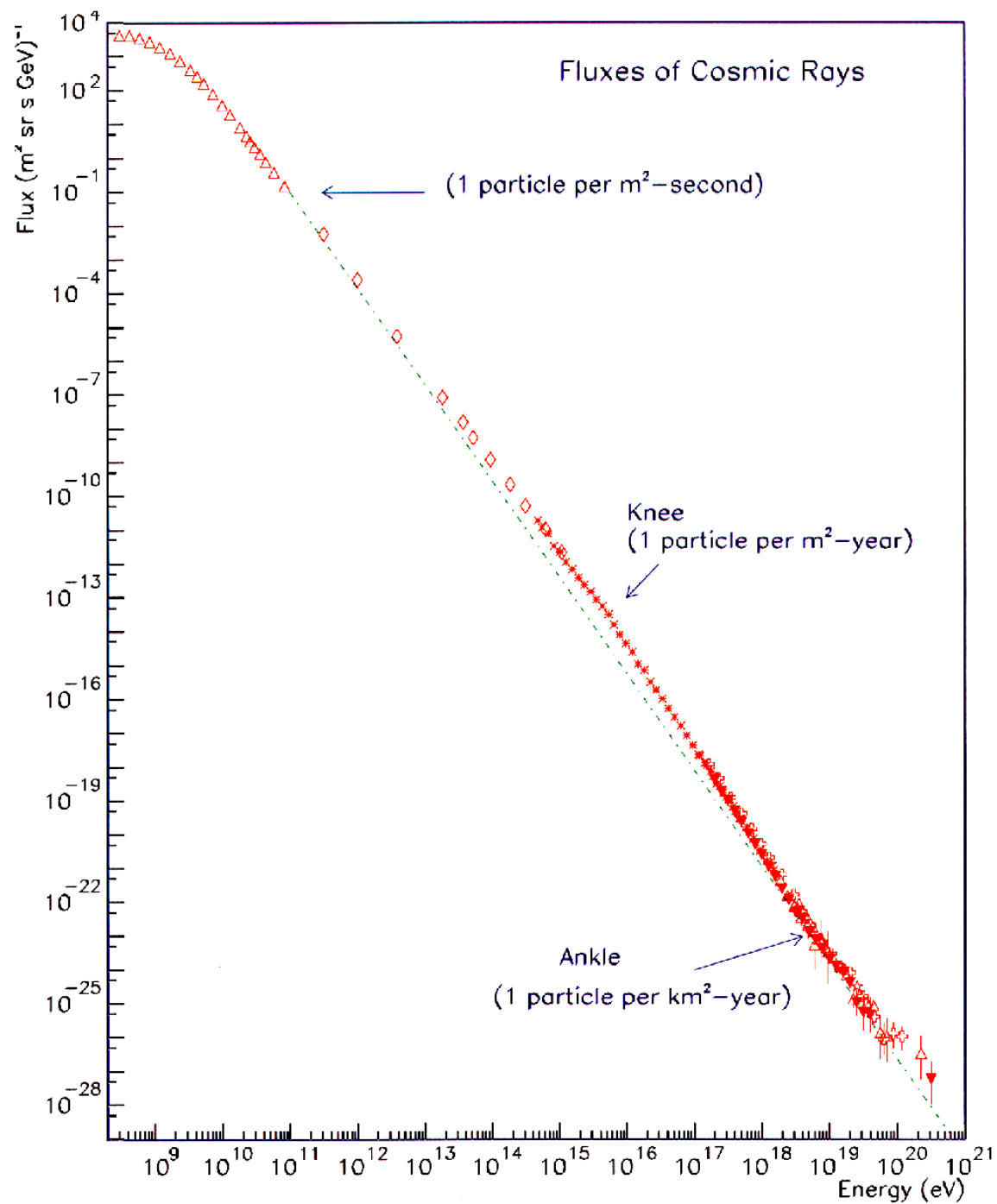


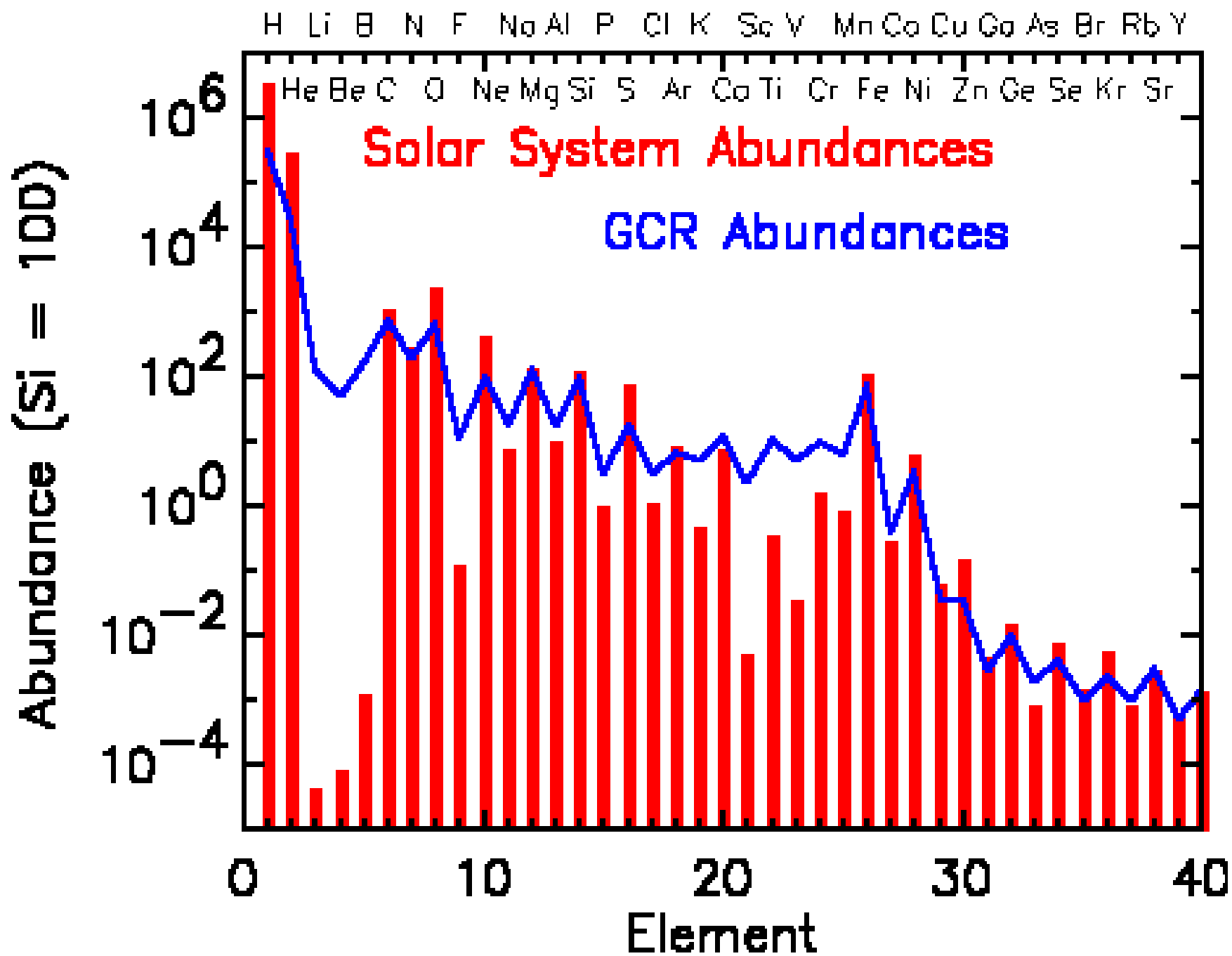
electrs



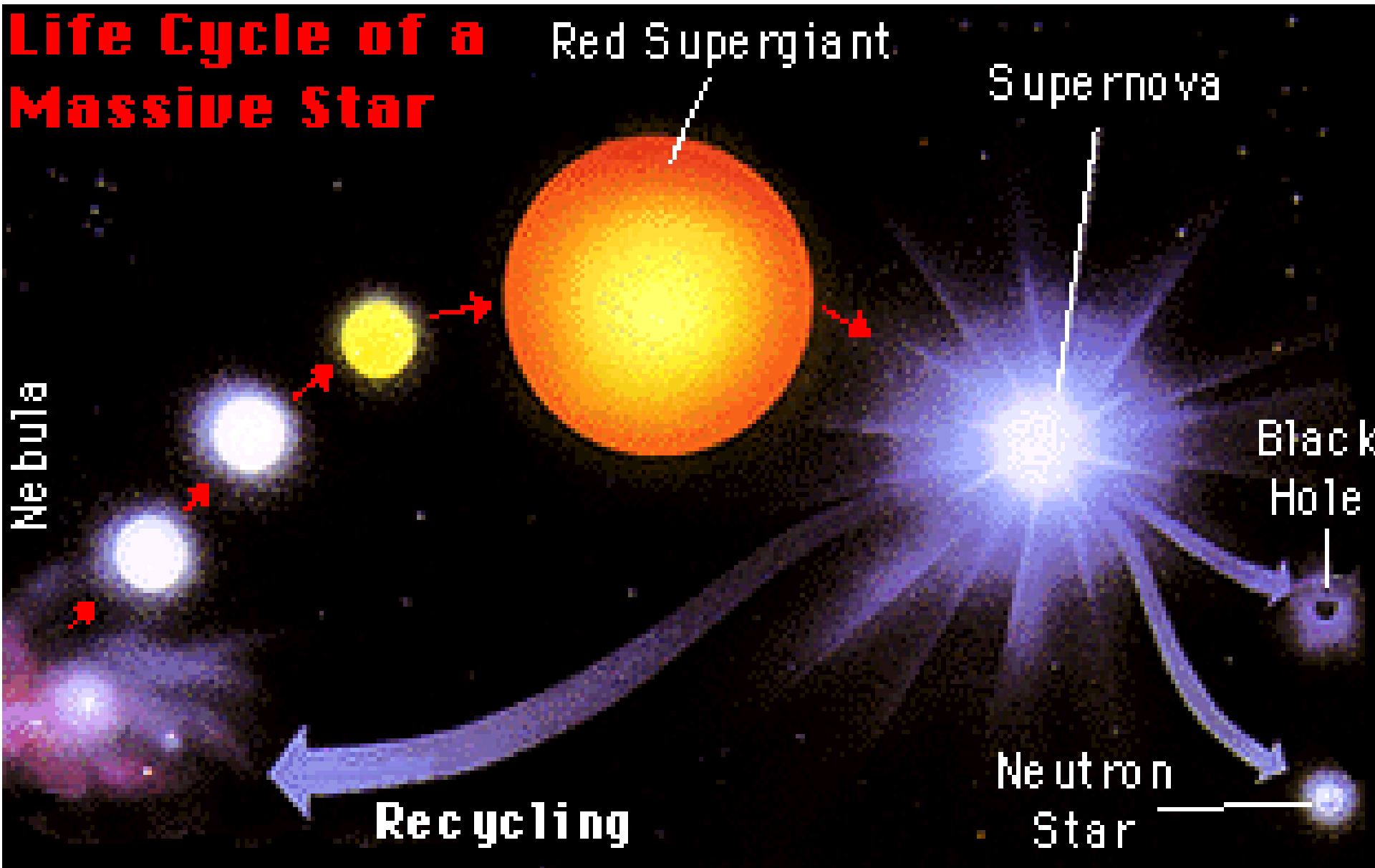
hadrons neutr

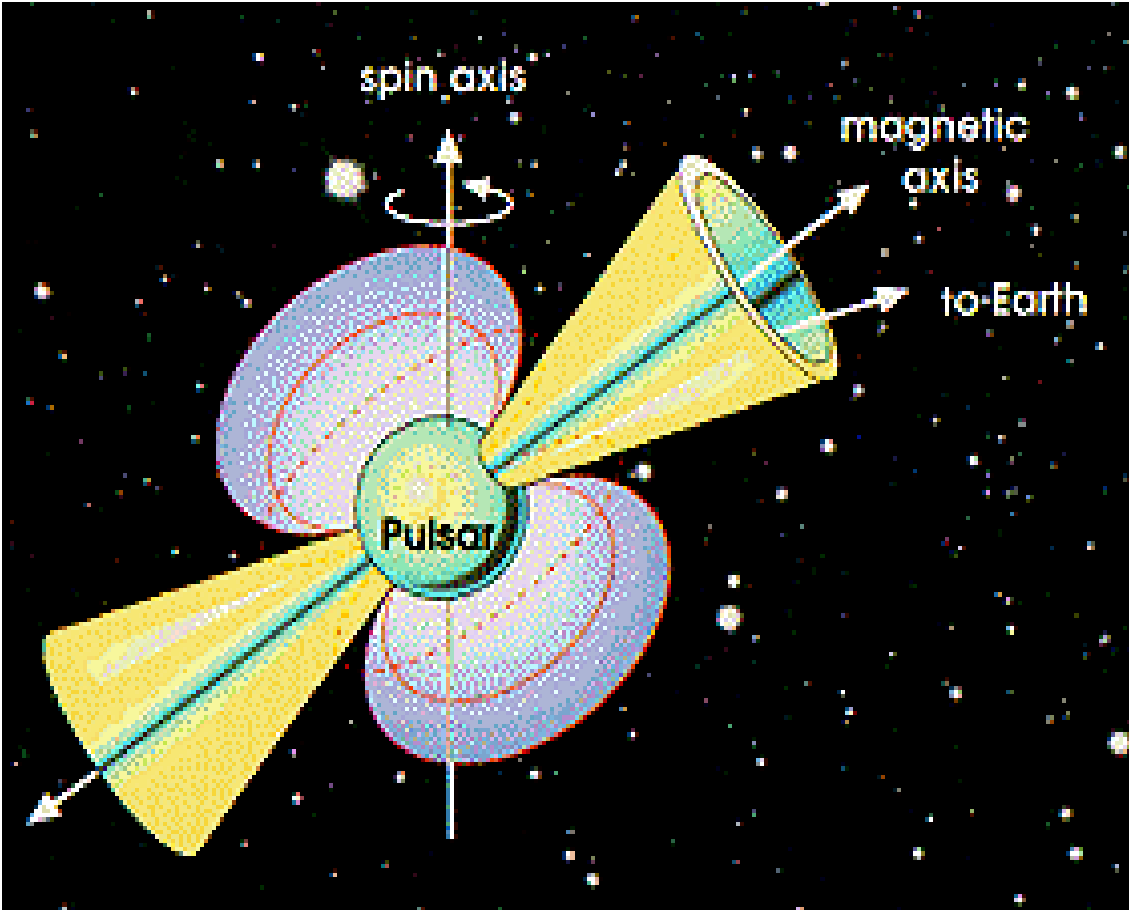






Life Cycle of a Massive Star



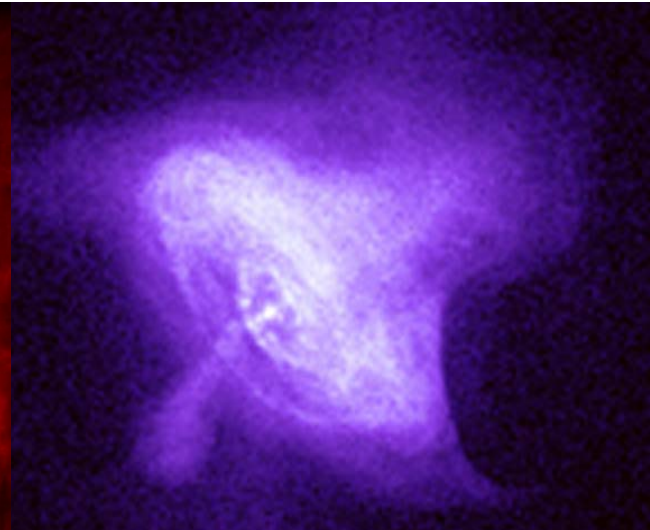
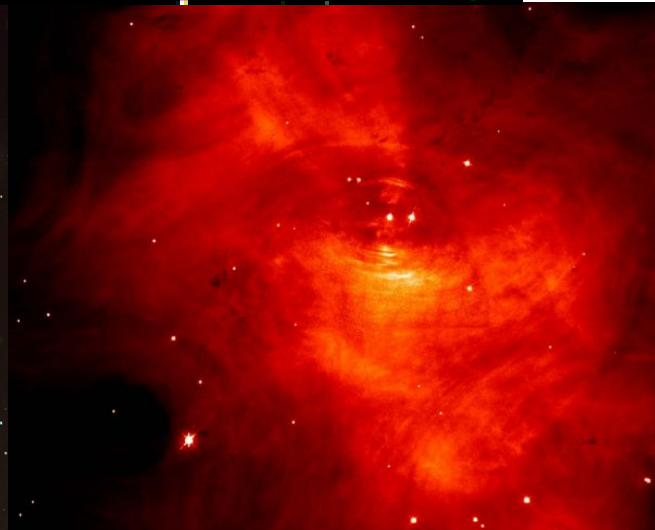


Stella di neutroni in rotazione ($T \sim 10^{-3} - 1$ s).
 Campo magnetico estremamente intenso ($B \sim 10^{12}$ gauss).

Osservate nei SNR.

Emissione "pulsata" osservata sino al GeV.

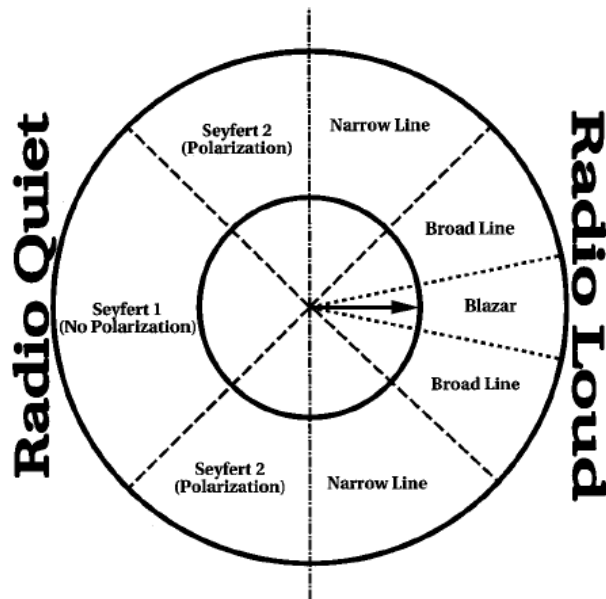
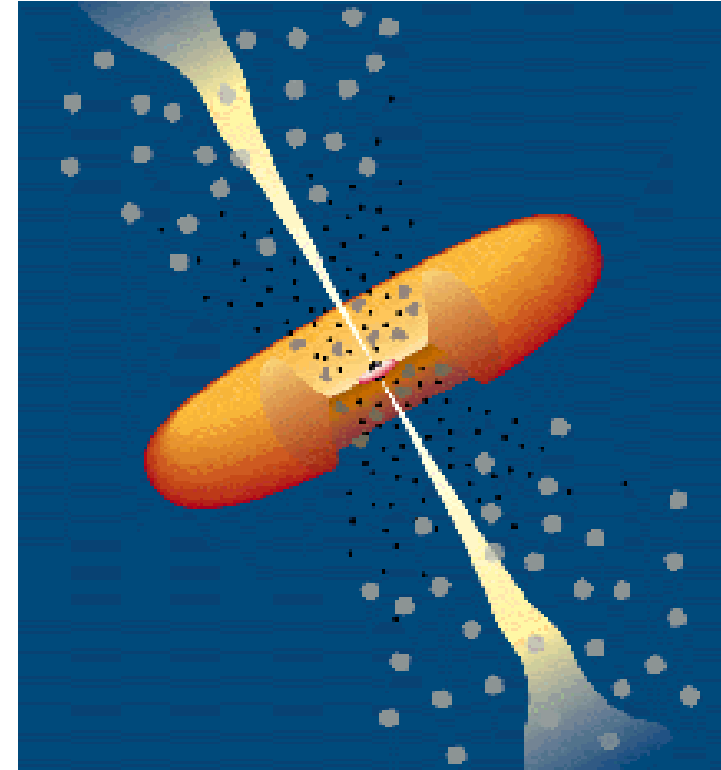
Emissione "continua" nella regione del TeV



Modello Unificato per gli AGN

Buco nero super-pesante
circondato da un disco di
accrescimento

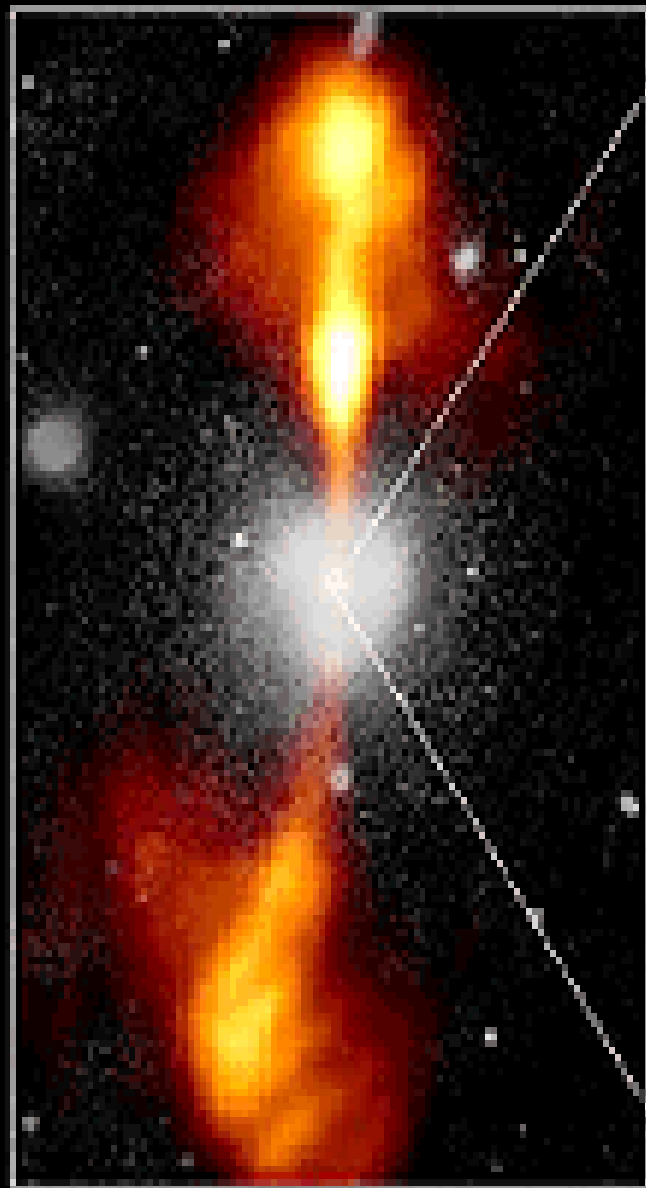
Accelerazione di particelle e
produzione di fotoni (e neutrini) di
alta energia all'interno dei jets



...ferma la proliferazione delle
definizioni di oggetti con diverse
caratteristiche

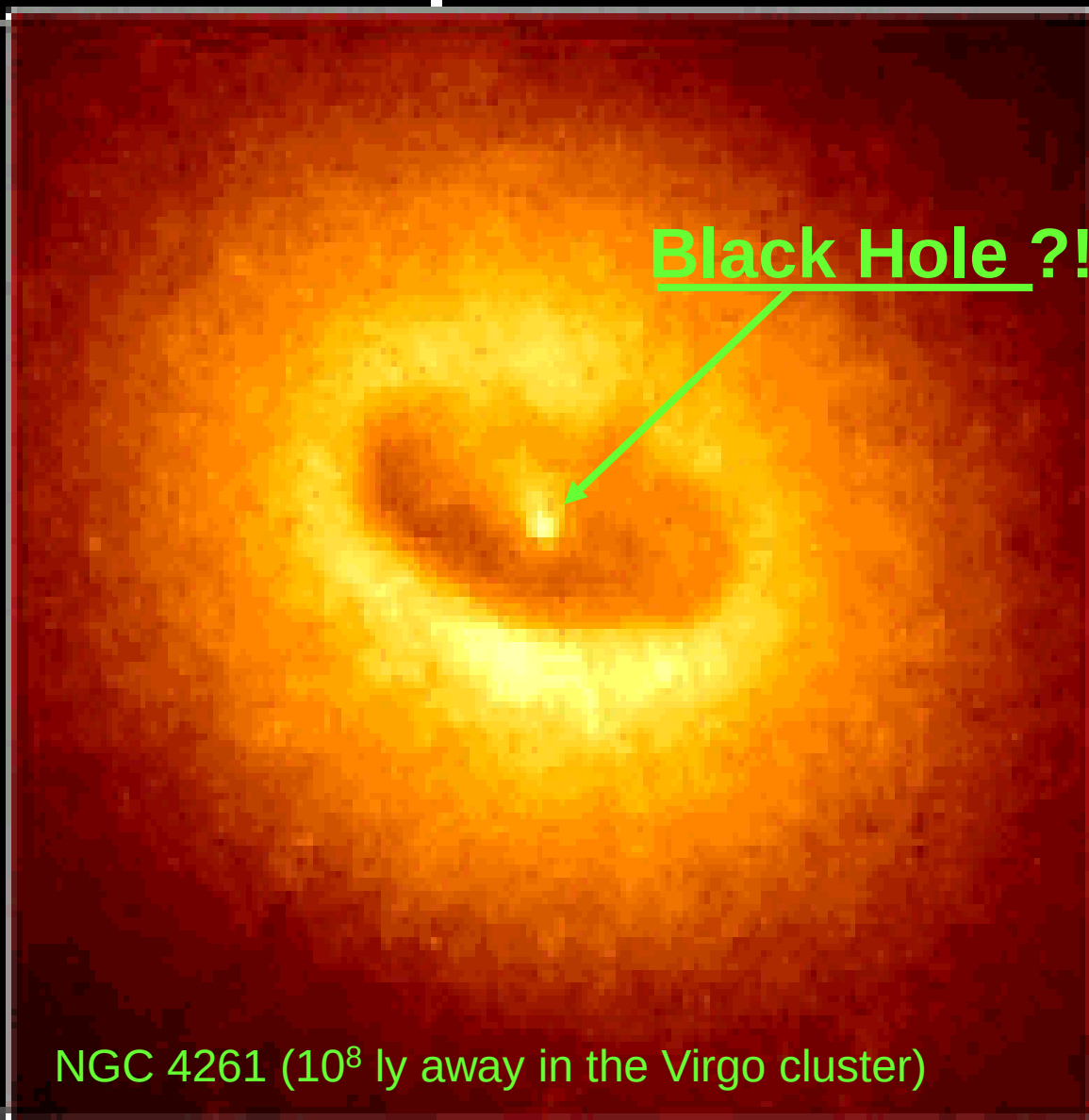
quasars, Seyfert galaxies (types I and II),
radio-quiet or radio-loud galaxies, Faranoff-
Riley galaxies (types I and II), narrow line,
broad line, no lines, highly polarized lines,
flat spectrum, steep spectrum, optically
violent variables, BL-Lac's,

Ground-based Optical/Radio Image



380 Arcseconds
88,000 Lightyears

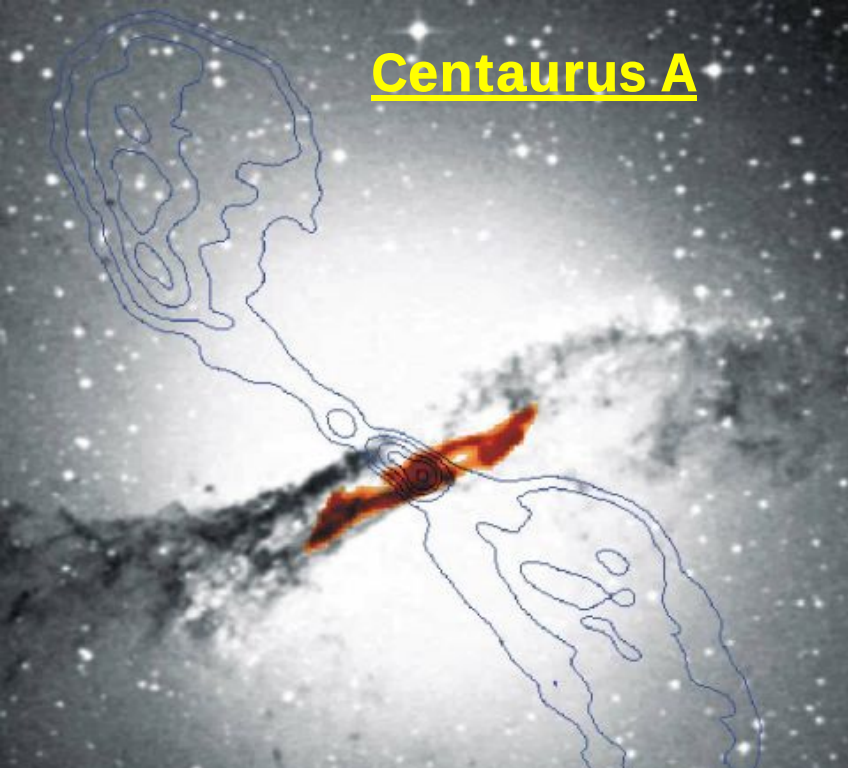
HST Image of a Gas and Dust Disk



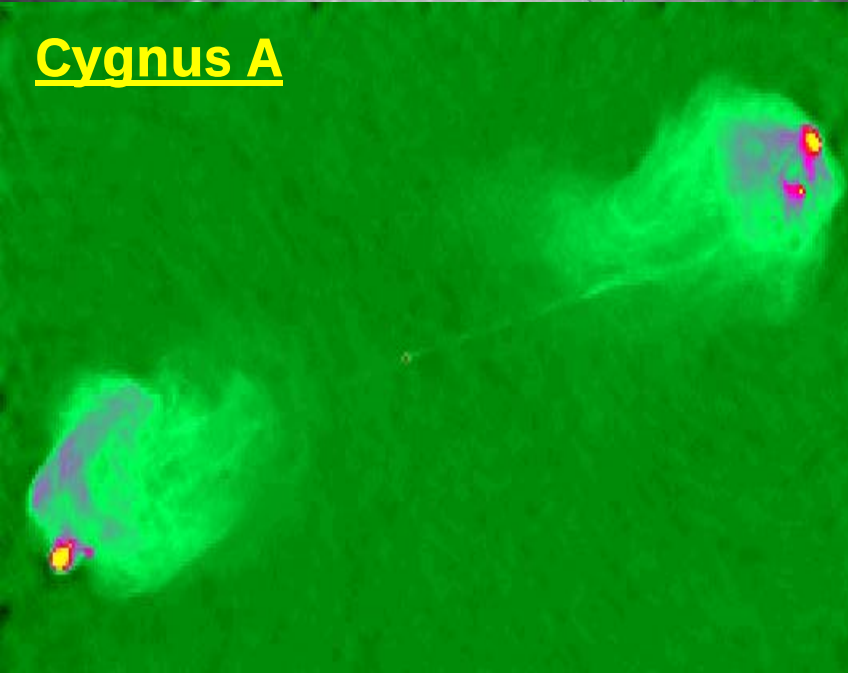
NGC 4261 (10^8 ly away in the Virgo cluster)

1.7 Arcseconds
400 Lightyears

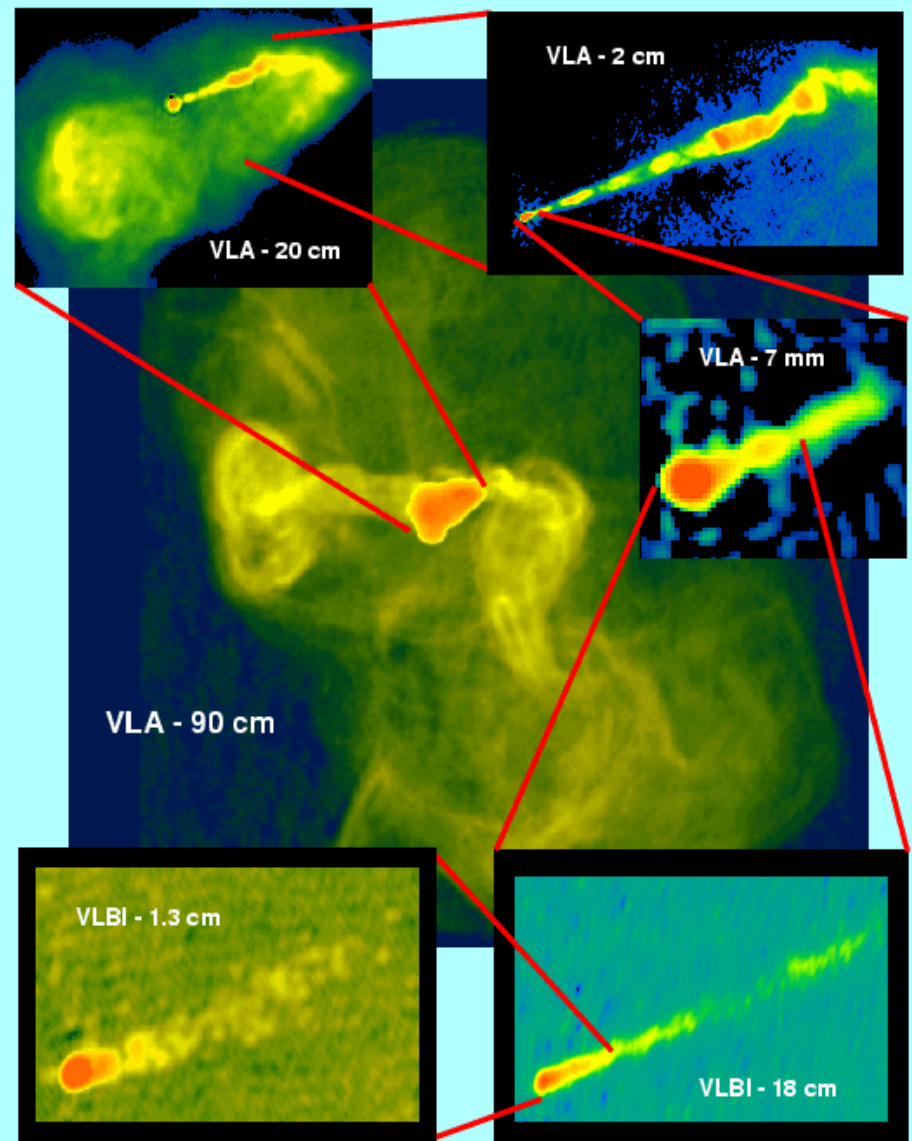
Centaurus A



Cygnus A

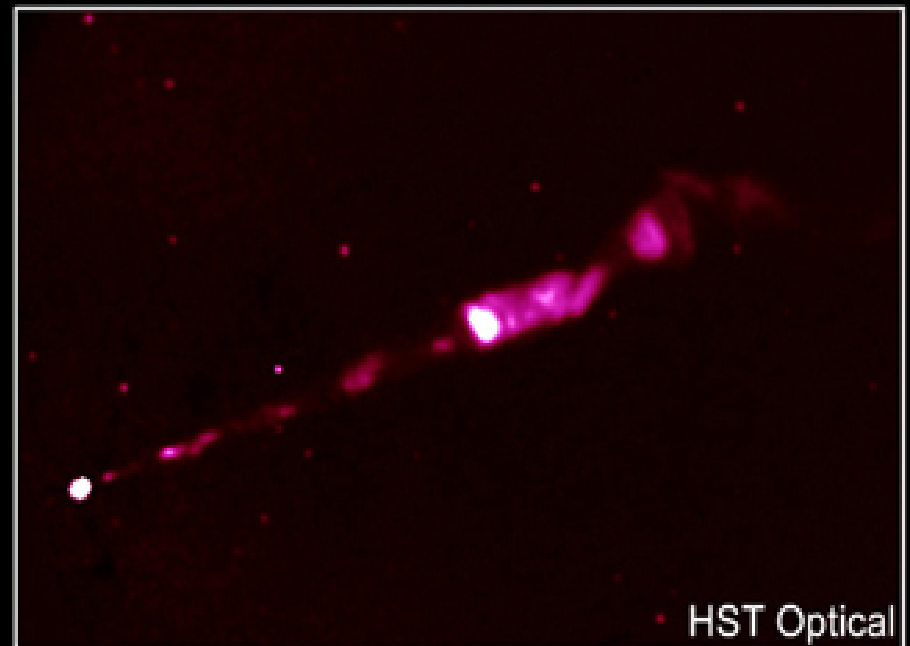
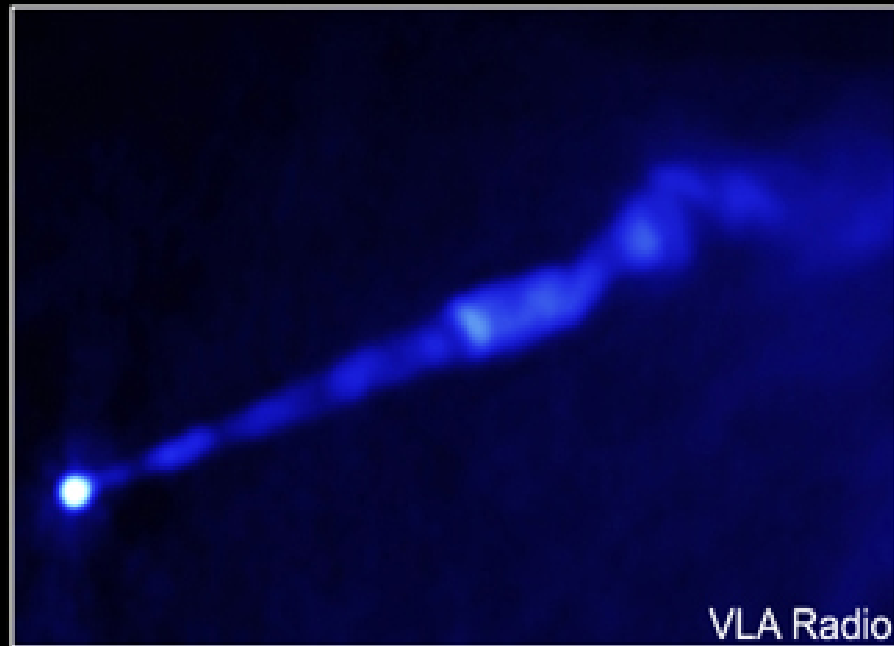


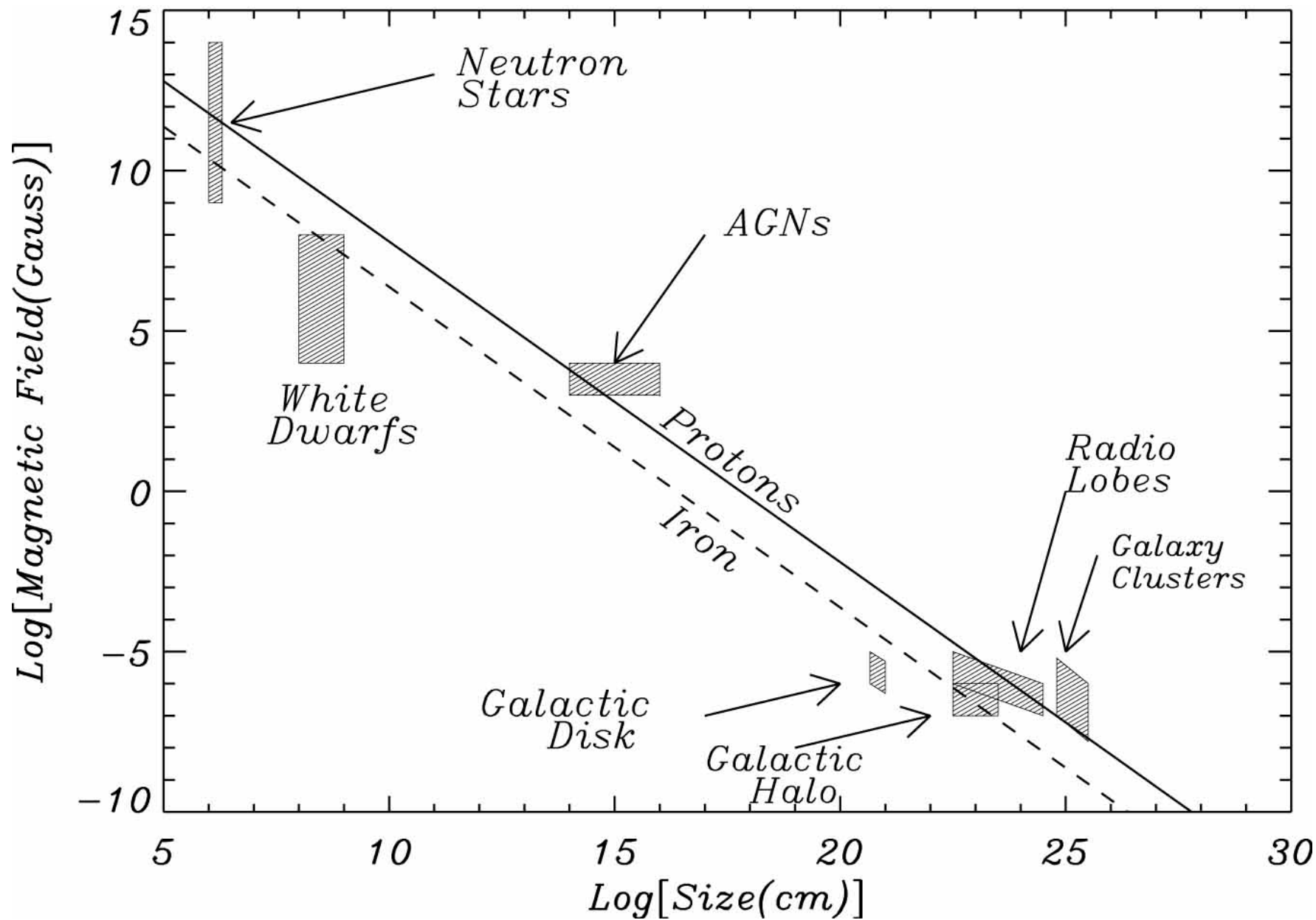
M87 -- From 200,000 Light-Years to 0.2 Light-Year



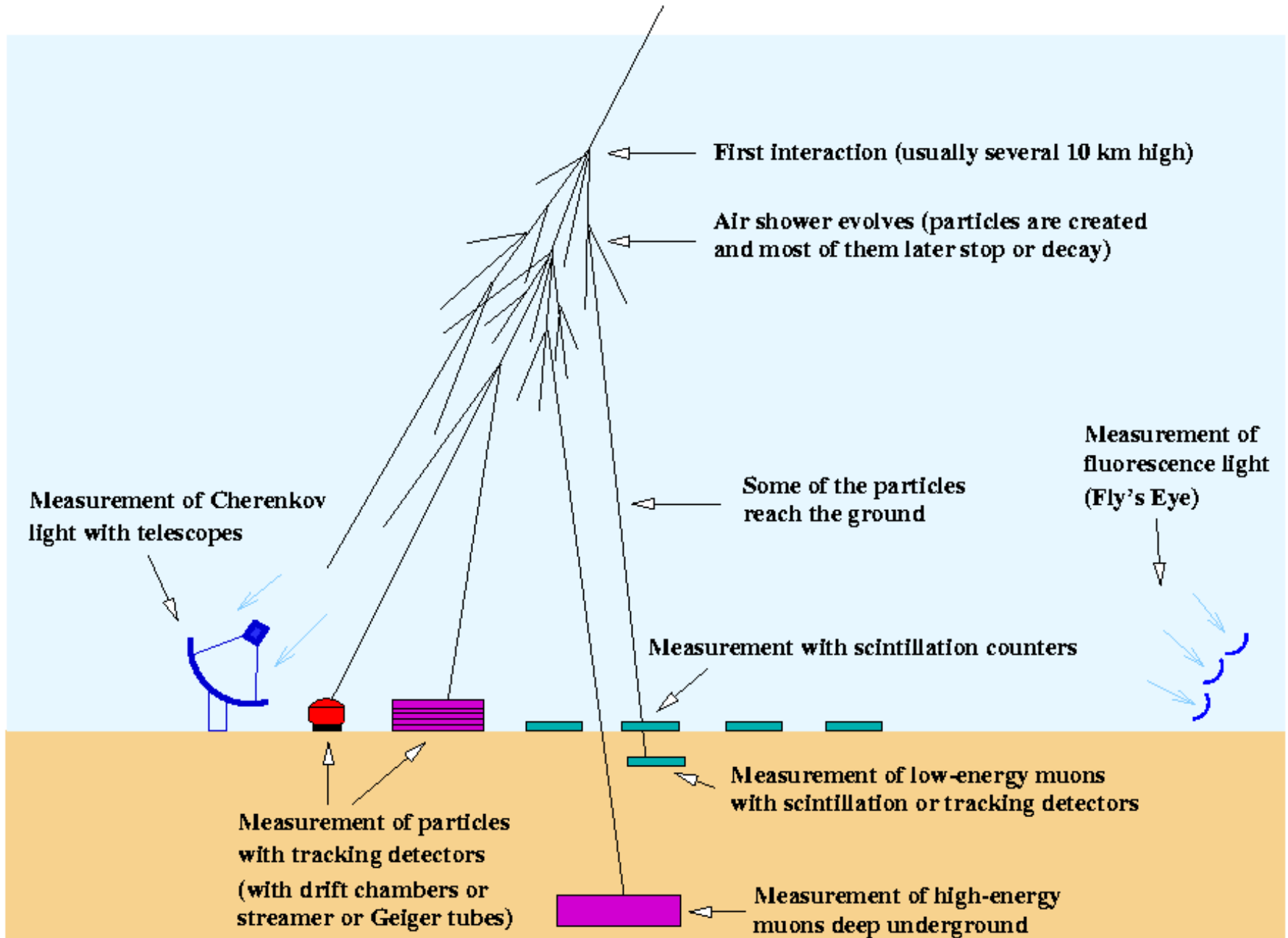
Credit: Frazer Owen (NRAO), John Biretta (STScI) and colleagues.
The National Radio Astronomy Observatory is a facility of the
National Science Foundation, operated under cooperative
agreement by Associated Universities, Inc.

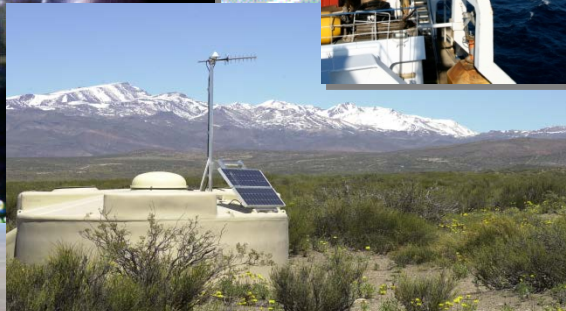
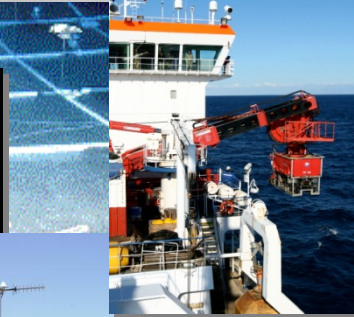
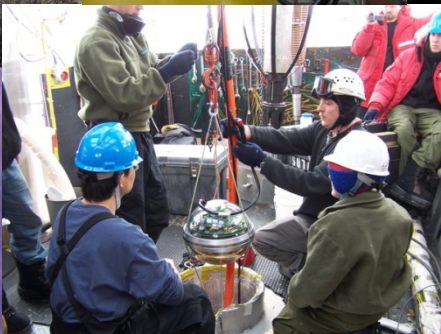
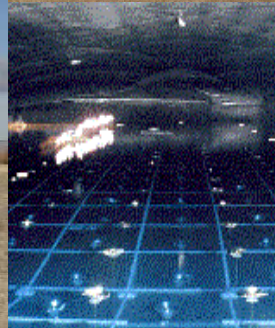
M87 jets



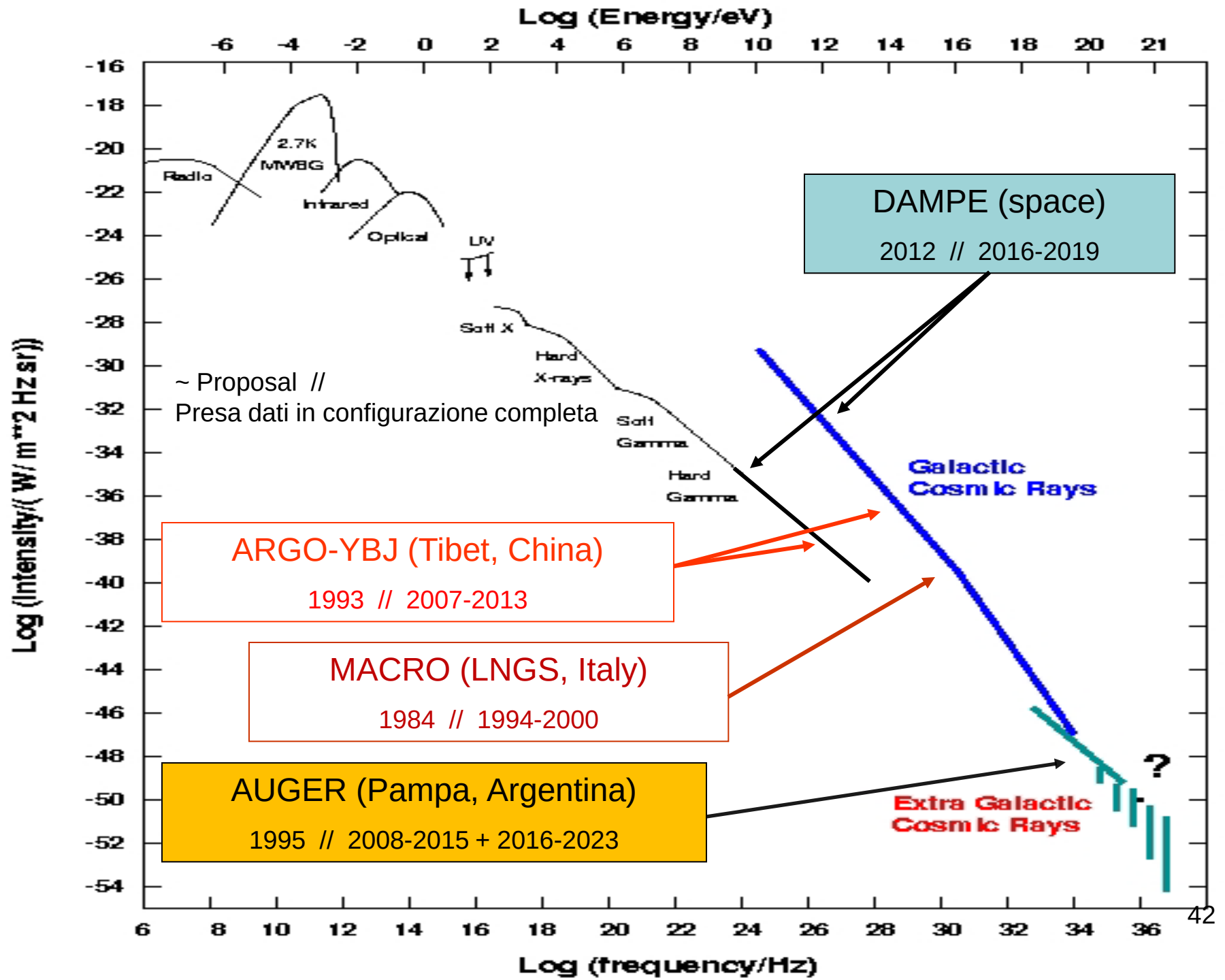


Measuring cosmic-ray and gamma-ray air showers





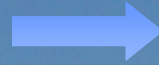
A Lecce...



L'Osservatorio Pierre Auger

Studio della radiazione cosmica
di altissima energia

$(10^{17}-10^{21})$ eV



Flusso ad $E > 10^{19.5}$ eV molto basso

1 particella / (km^2 sr secolo)



Apparato di grandi dimensioni:
 3000 km^2 (Pampa Argentina)

30 eventi/anno



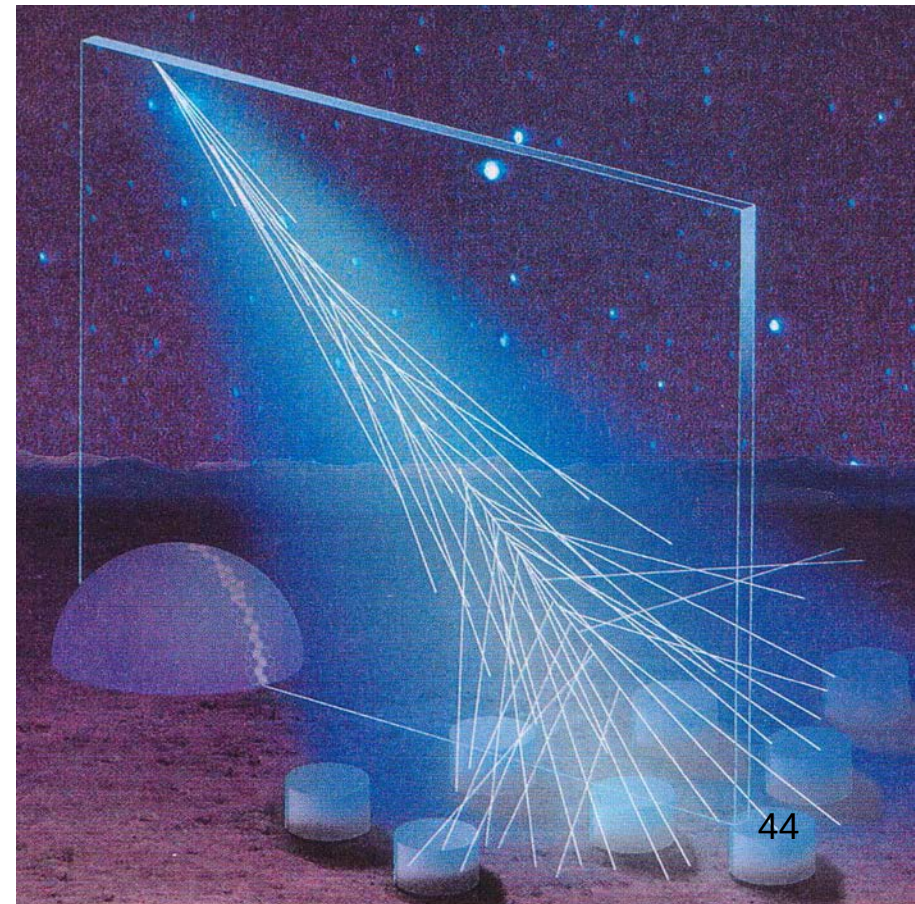
L'Osservatorio Pierre Auger

Fluorescence Detector (FD)

- Sviluppo longitudinale dello sciame in atmosfera
- Misura dell'energia (calibrazione)
- Direzione dello sciame
operativo il 12% del tempo

Surface Detector (SD)

- Rivelazione delle particelle a terra
- Direzione e stima dell'energia
operativo il 100% del tempo



La collaborazione Pierre Auger

Argentina

Australia

Bolivia

Brazil

Czech Rep.

France

Germany

Italy

Mexico

Netherlands

Poland

Portugal

Slovenia

Spain

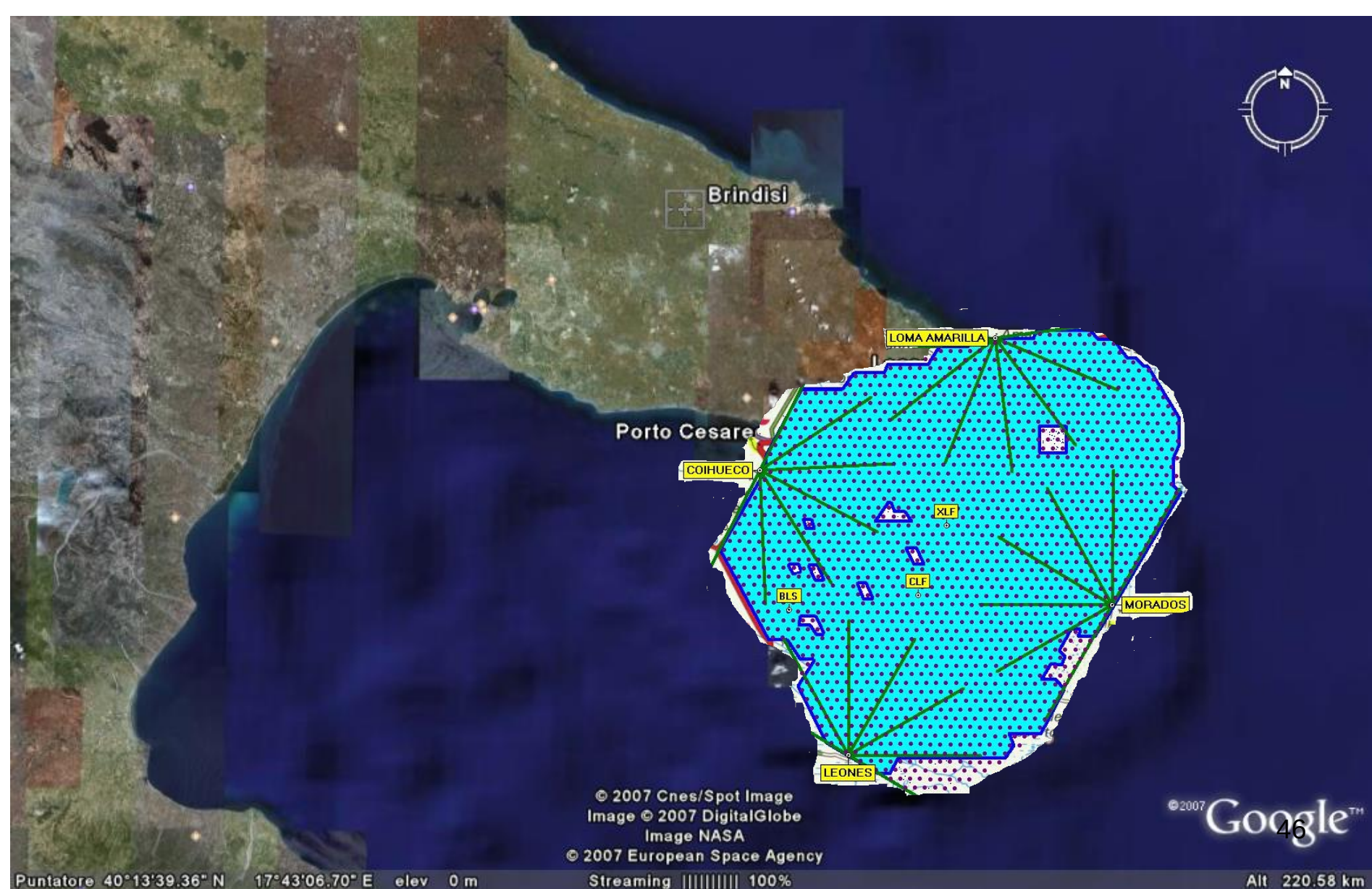
UK

USA

Vietnam



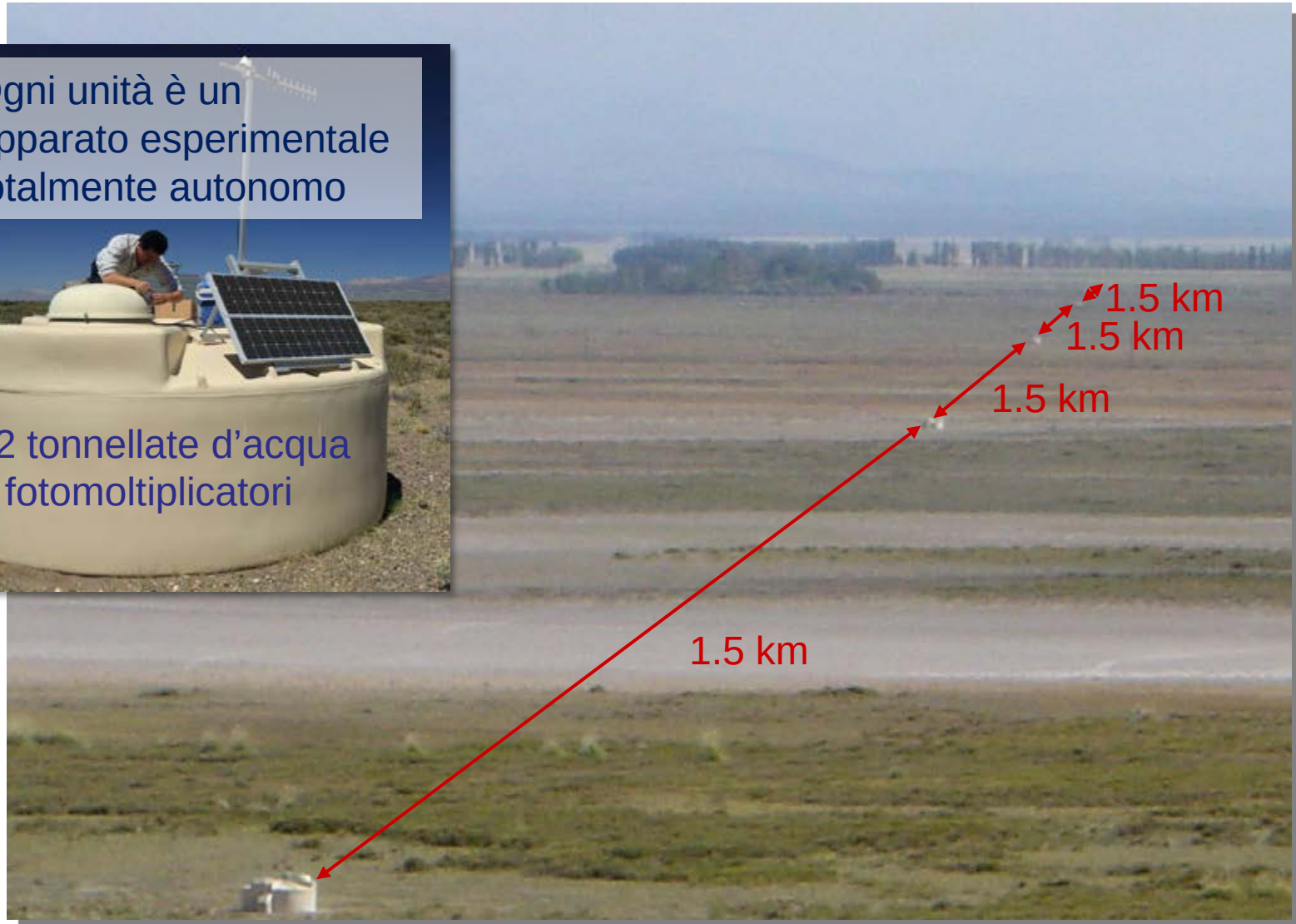
Se L'Osservatorio Pierre Auger venisse trasferito nel Salento...



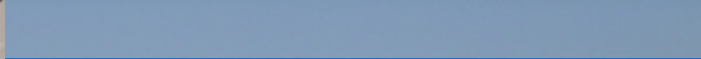
Il rivelatore di superficie (SD)

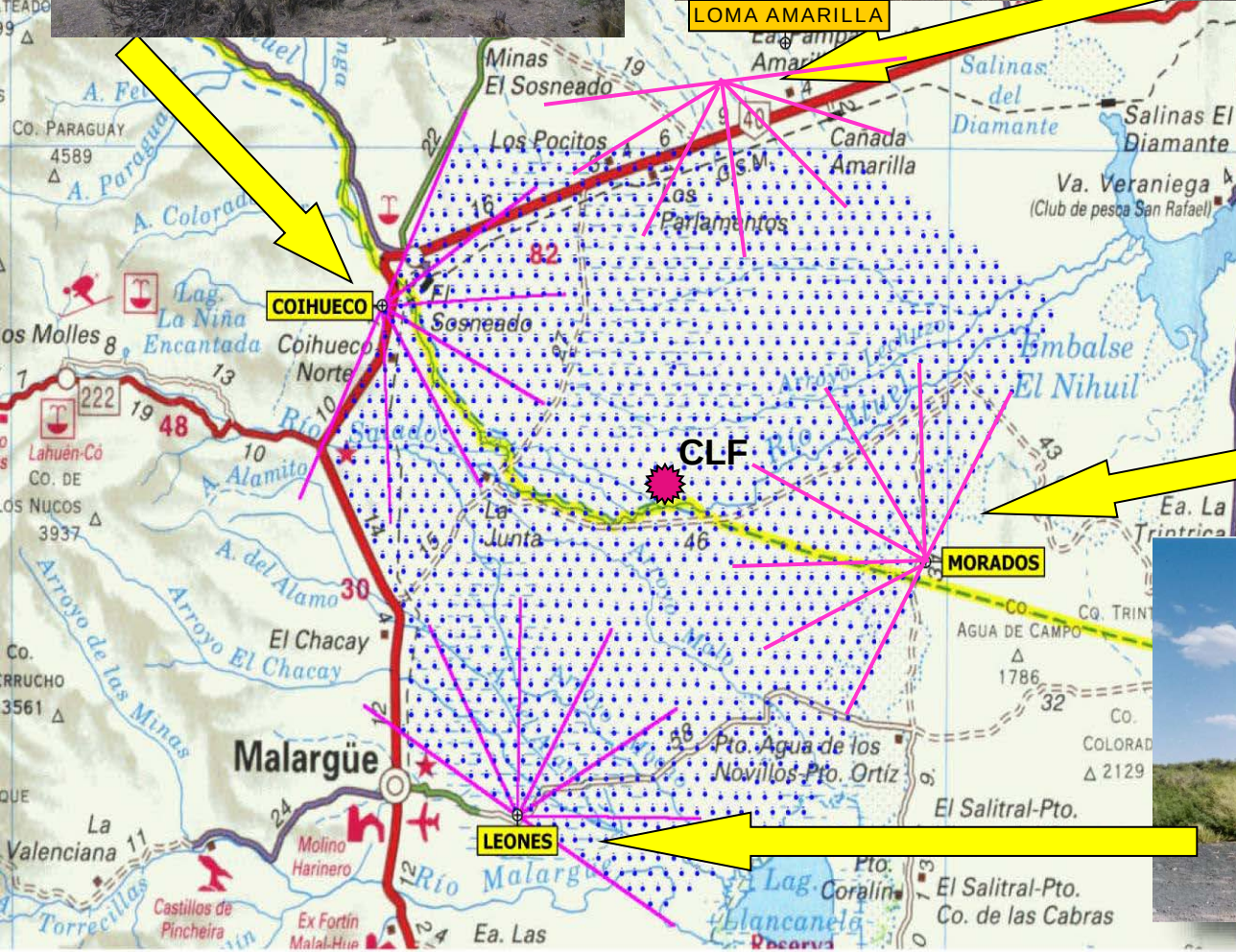
Ogni unità è un
apparato sperimentale
totalmente autonomo

12 tonnellate d'acqua
3 fotomoltiplicatori



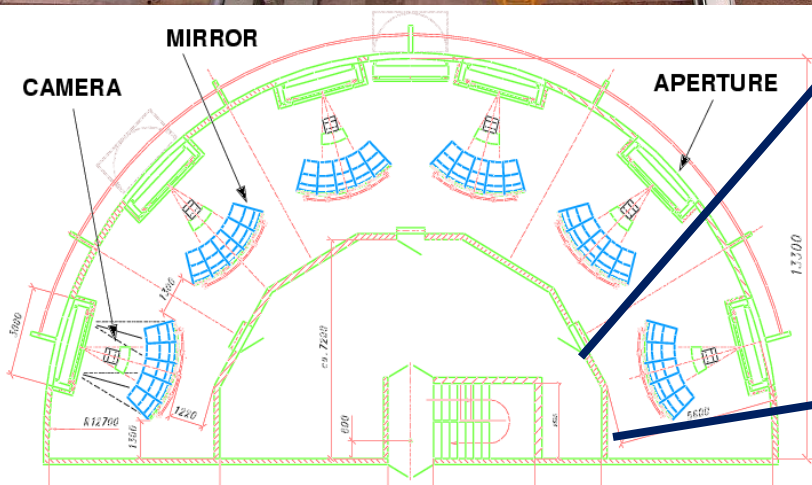
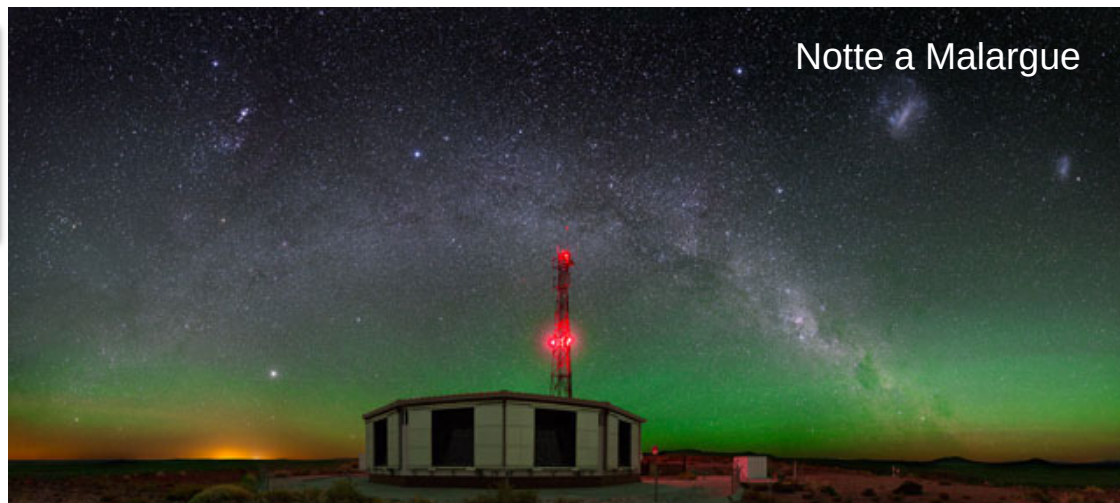
Cosa significa costruire un apparato di 3000 km² nella Pampa





Il rivelatore di fluorescenza (FD)

Ogni rivelatore è costituito da 6 telescopi, ognuno con campo di vista di $30^\circ \times 30^\circ$



Lo specchio

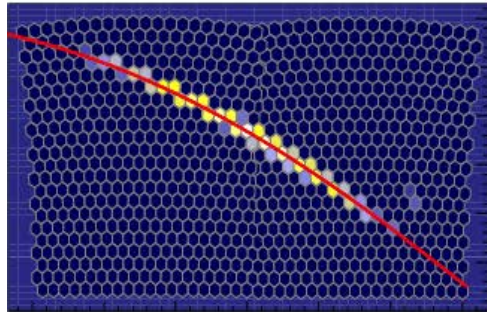
La Camera



Uno dei telescopi

Un evento stereo ibrido

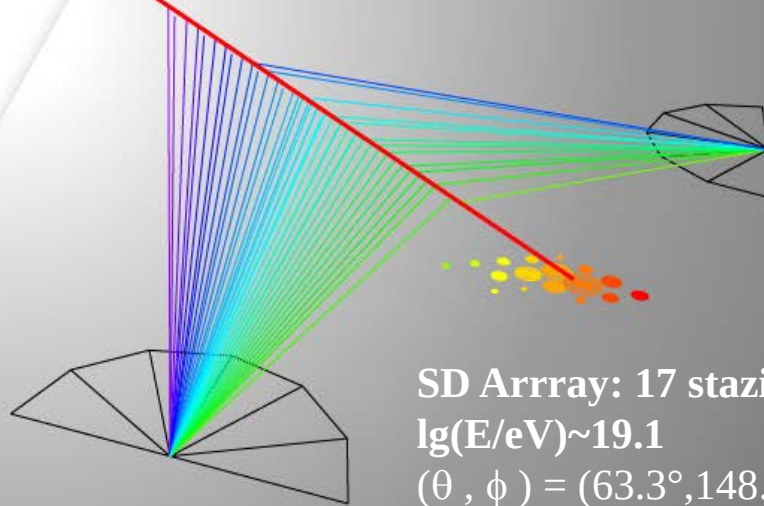
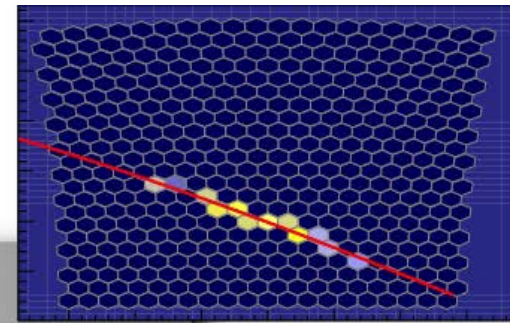
Evento: 1364365



Los Leones

$\lg(E/\text{eV}) \sim 19.3$
 $(\theta, \phi) = (63.7^\circ, 148.3^\circ)$

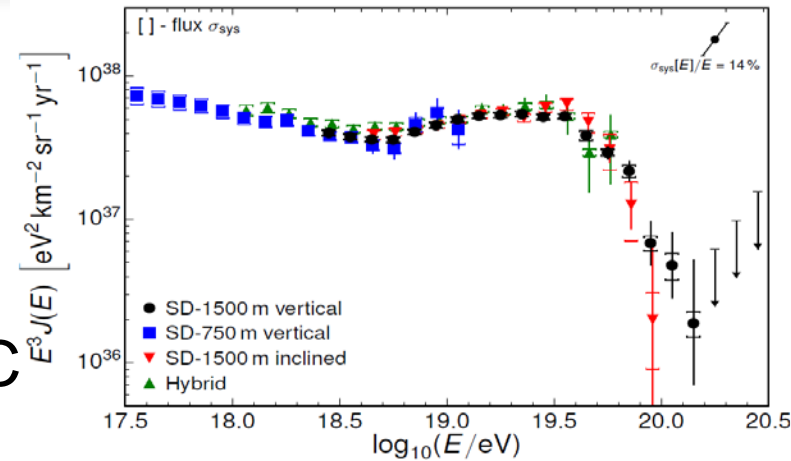
Los Morados
 $\lg(E/\text{eV}) \sim 19.2$
 $(\theta, \phi) = (63.7^\circ, 148.4^\circ)$



SD Array: 17 stazioni
 $\lg(E/\text{eV}) \sim 19.1$
 $(\theta, \phi) = (63.3^\circ, 148.9^\circ)$

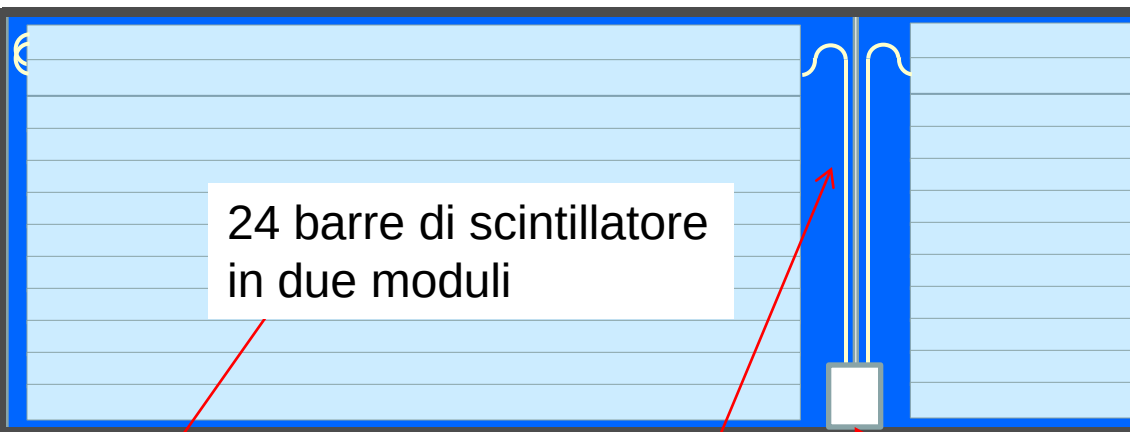
A Lecce, attività di analisi dati per :

- simulazione / monitoring del detector
- ricerca di fotoni di altissima energia
- misura dello spettro energetico dei RC

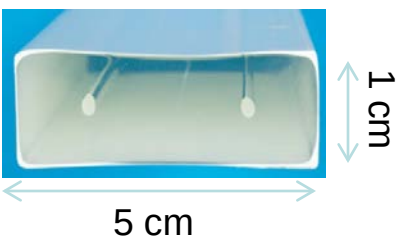


AUGER si sta potenziando...

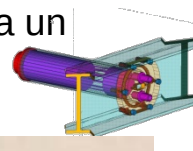
Un nuovo rivelatore è in costruzione a Lecce finanziato INFN



Gli scintillatori



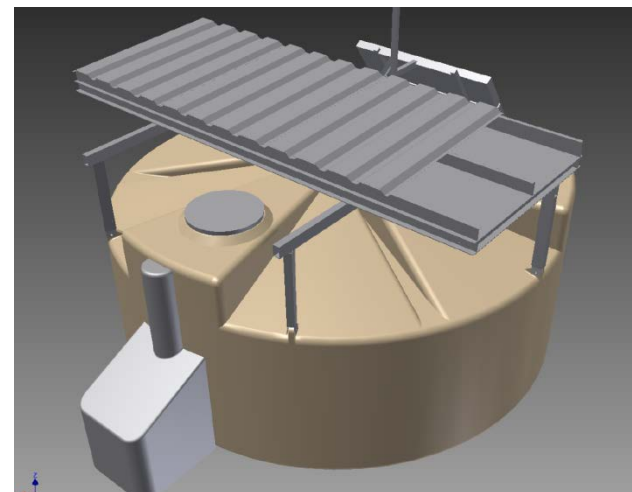
..quindi convertita in un
segnale elettrico da un
fotomoltiplicatore



La luce è
convogliata
con fibre
ottiche..



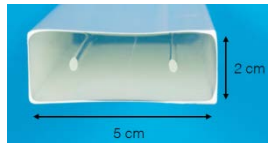
Ricostruzione 3D del
nuovo rivelatore
posizionato sopra
una "tank" di Auger



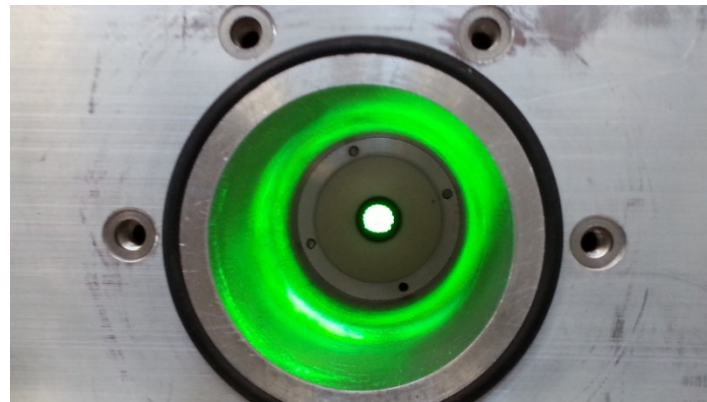
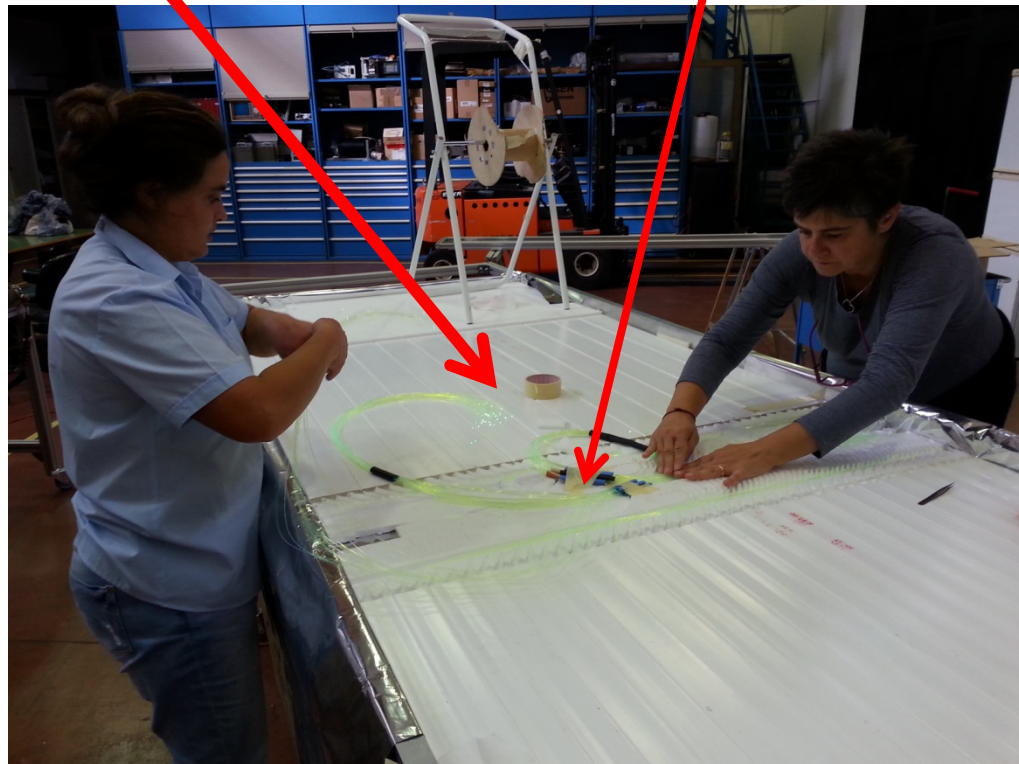
Il primo prototipo del Nuovo Rivelatore

Fasi dell'assemblaggio del primo prototipo nel Laboratorio Alte Energie a Lecce

Gli scintillatori



Le fibre ottiche



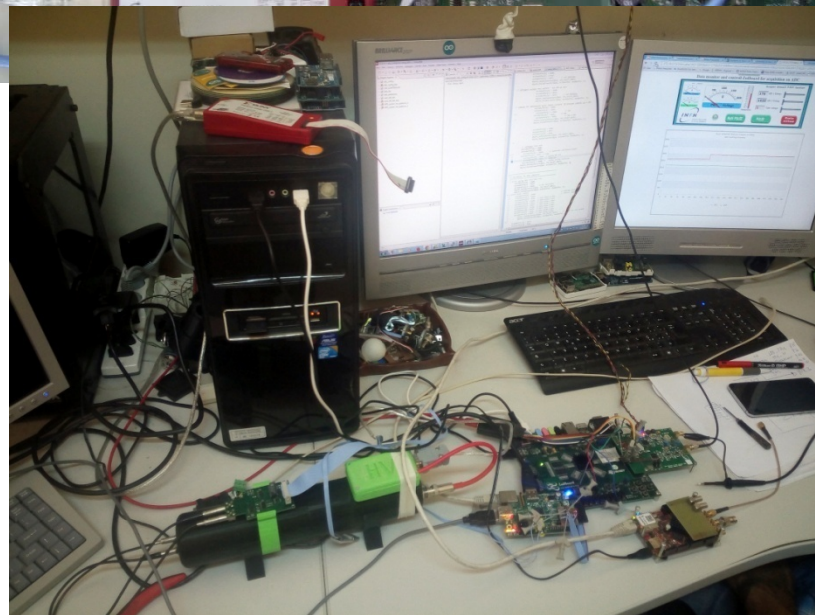
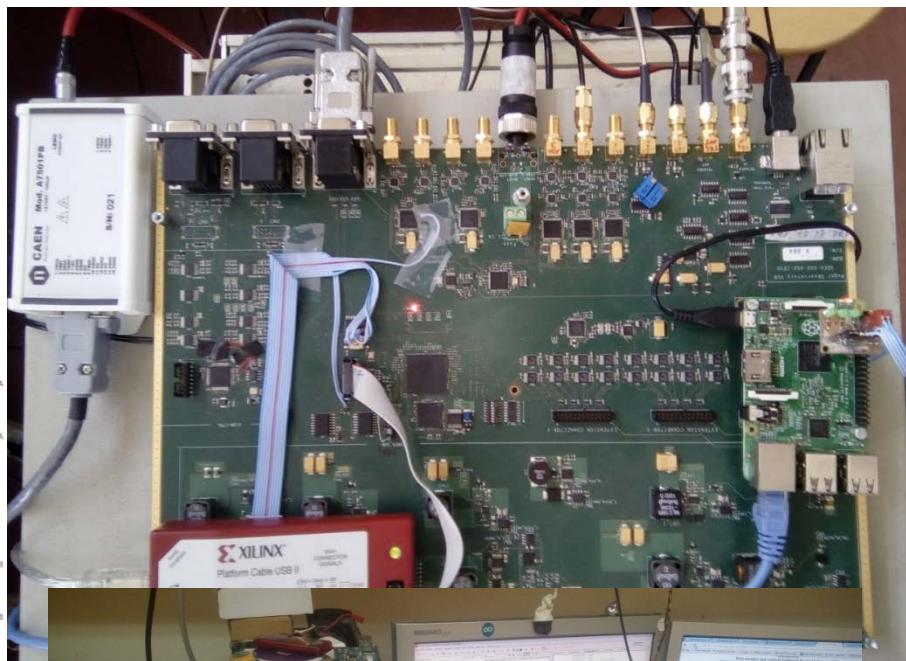
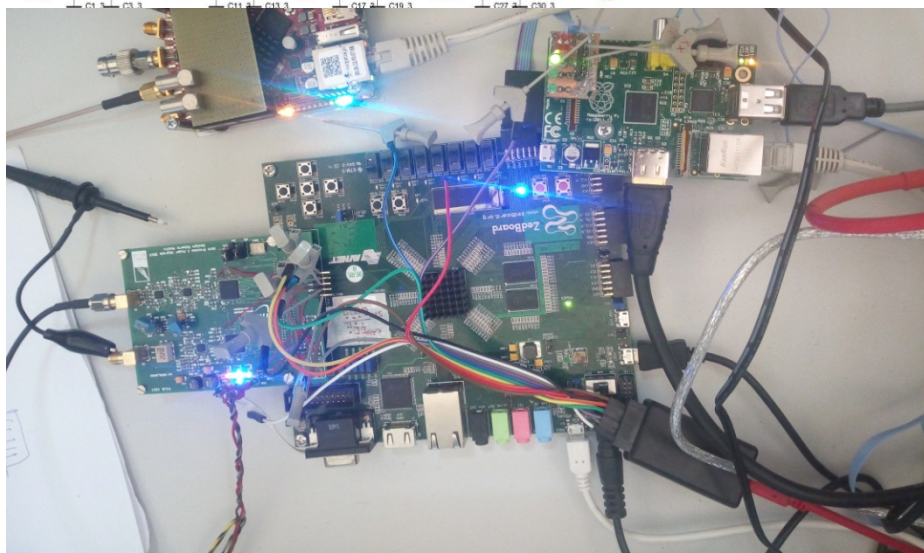
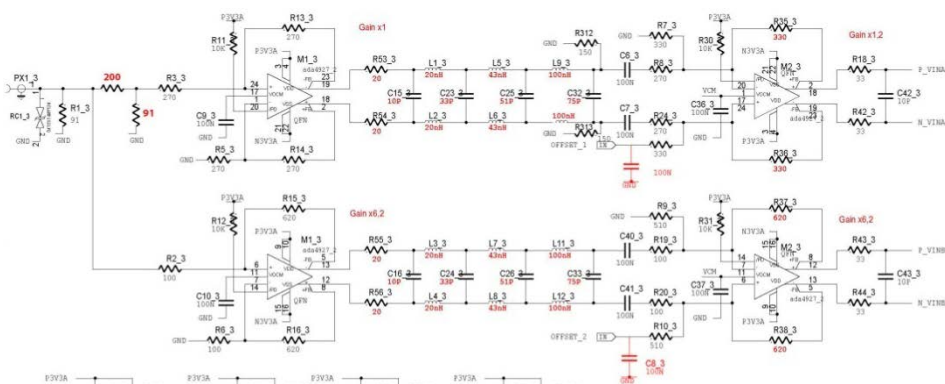
Le fibre convogliano la luce verso il fotomoltiplicatore



I primi segnali

Osservatorio Pierre Auger

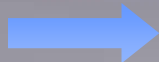
Non solo rivelatori di particelle ...
Progettazione della nuova elettronica
nei Laboratori di Lecce



DAMPE

Studio dei raggi cosmici
galattici con energie

$(10^{10}-10^{14})$ eV



Flussi sufficientemente elevati da
poter essere misurati “direttamente”
fuori dall’atmosfera con un satellite

Dec 17, 2015 0:12 UTC
DAMPE → WUKONG





Nsse

国家空间科学中心

microsat

上海微小卫星工程中心



紫金山天文台



高能物理研究所



中国科学技术大学



近代物理研究所



UNIVERSITÉ DE GENÈVE

日内瓦大学



INFN
Istituto Nazionale
di Fisica Nucleare

意大利国家核物理研究所



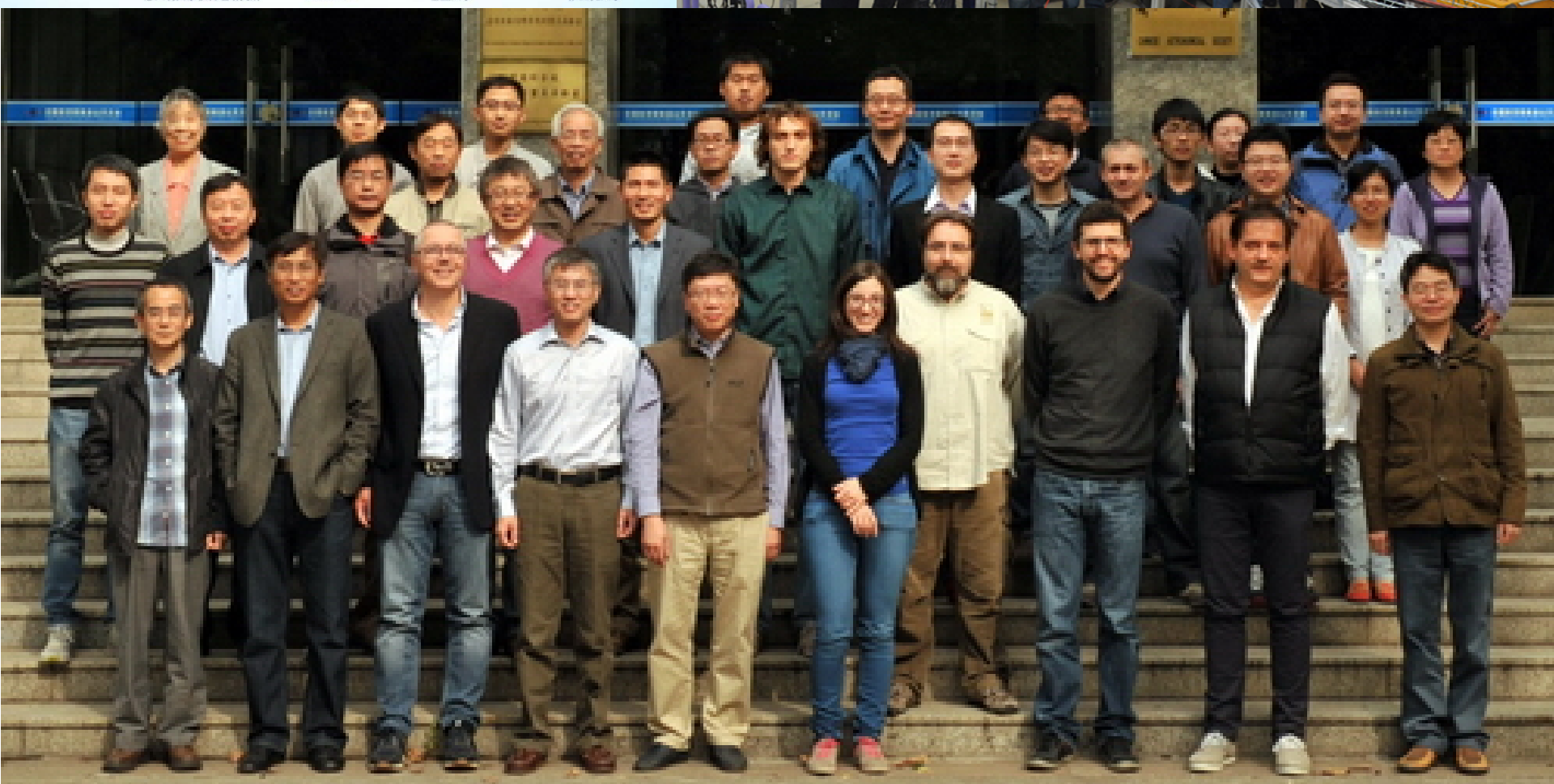
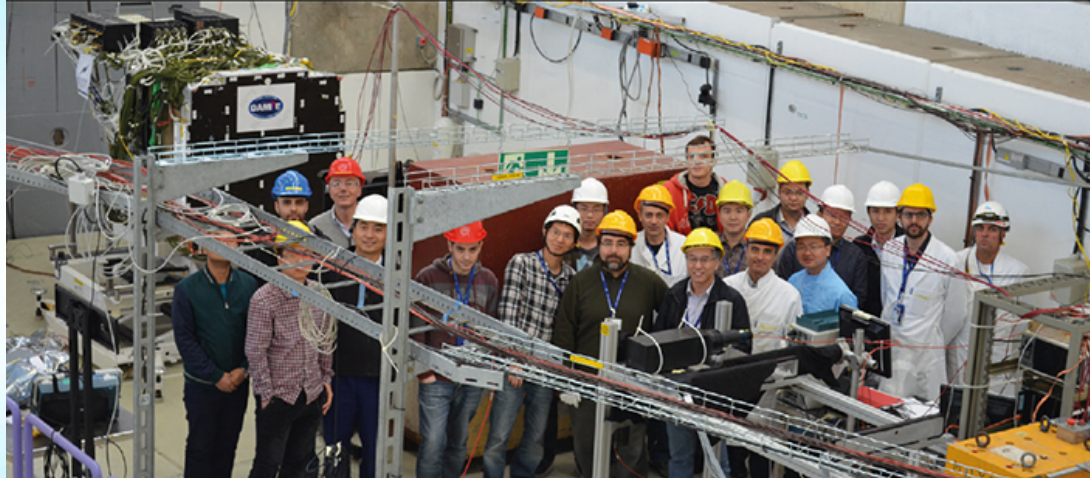
帕鲁贾大学

UNIVERSITÀ
DEGLI STUDI DI BARI
ALDO MORO

巴里大学

UNIVERSITÀ
DEL SALENTO

萨兰托大学



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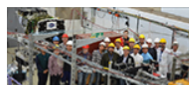
CERN COURIER

Feb 12, 2016

DAMPE joins the search for dark matter in space

On 17 December, the Chinese Academy of Sciences (CAS)

successfully launched the Dark Matter Particle Explorer (DAMPE) satellite from the Jiuquan Satellite Launch Center in northwest China, marking the entrance of a new player in the global hunt for dark matter.



The DAMPE detector

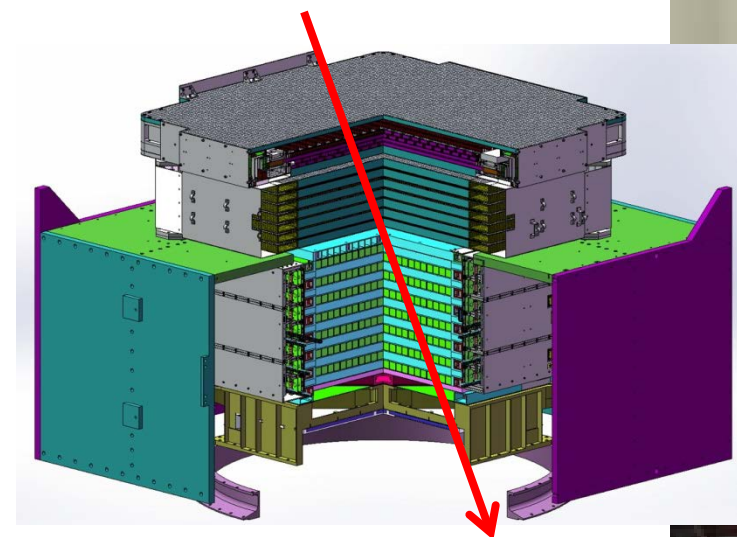
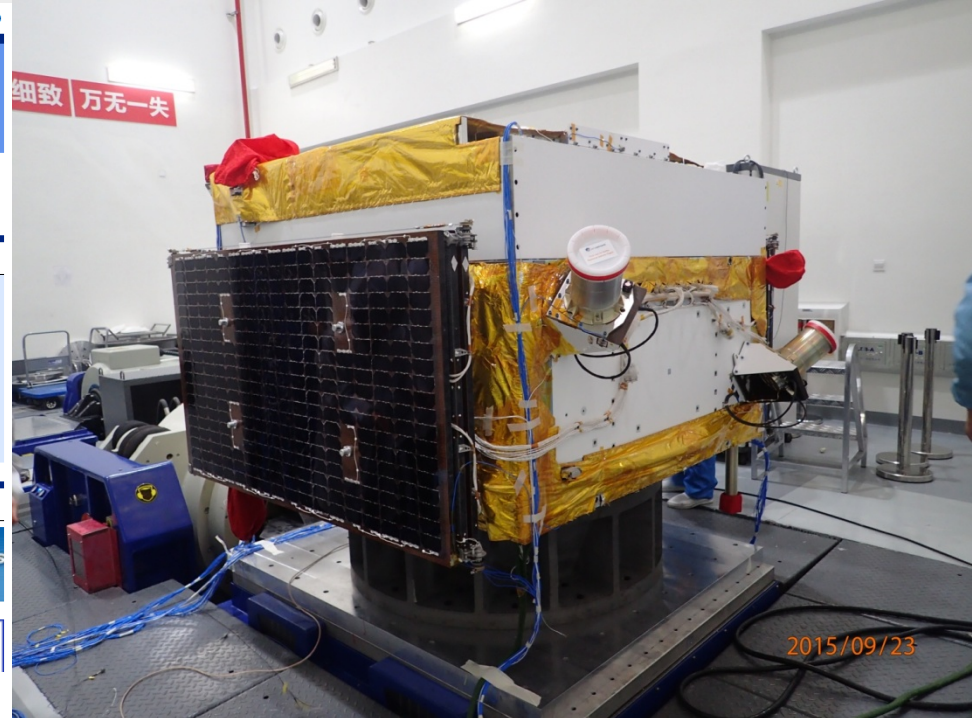
DIGITAL EDITION

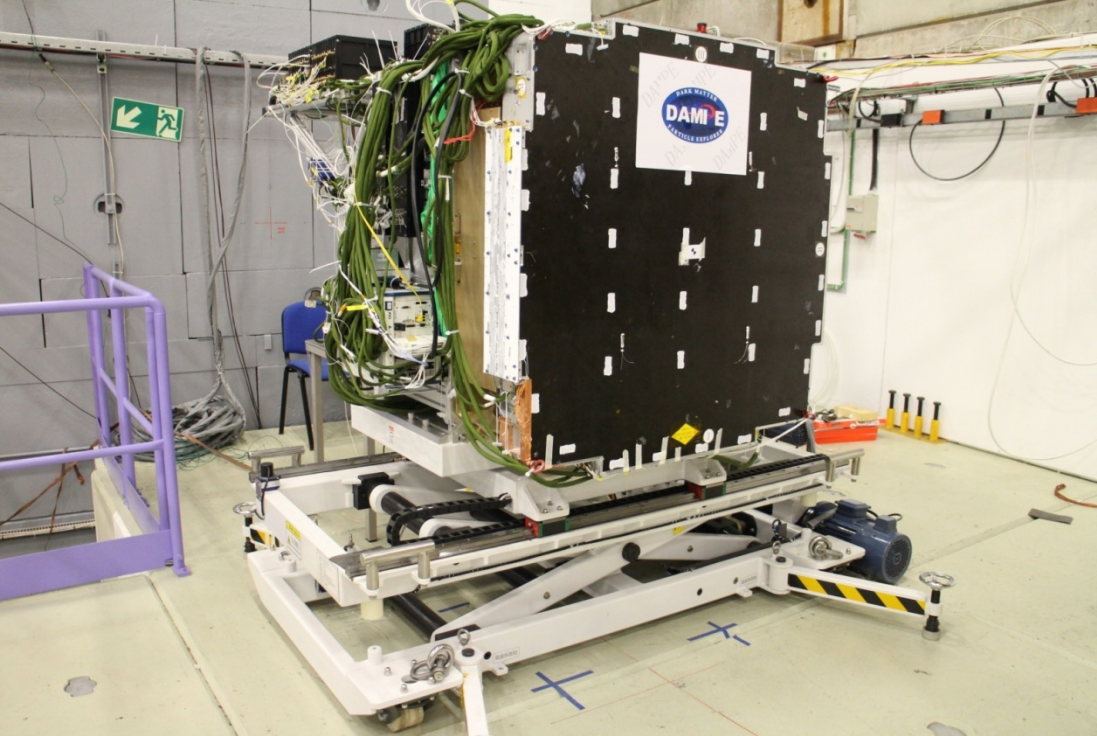
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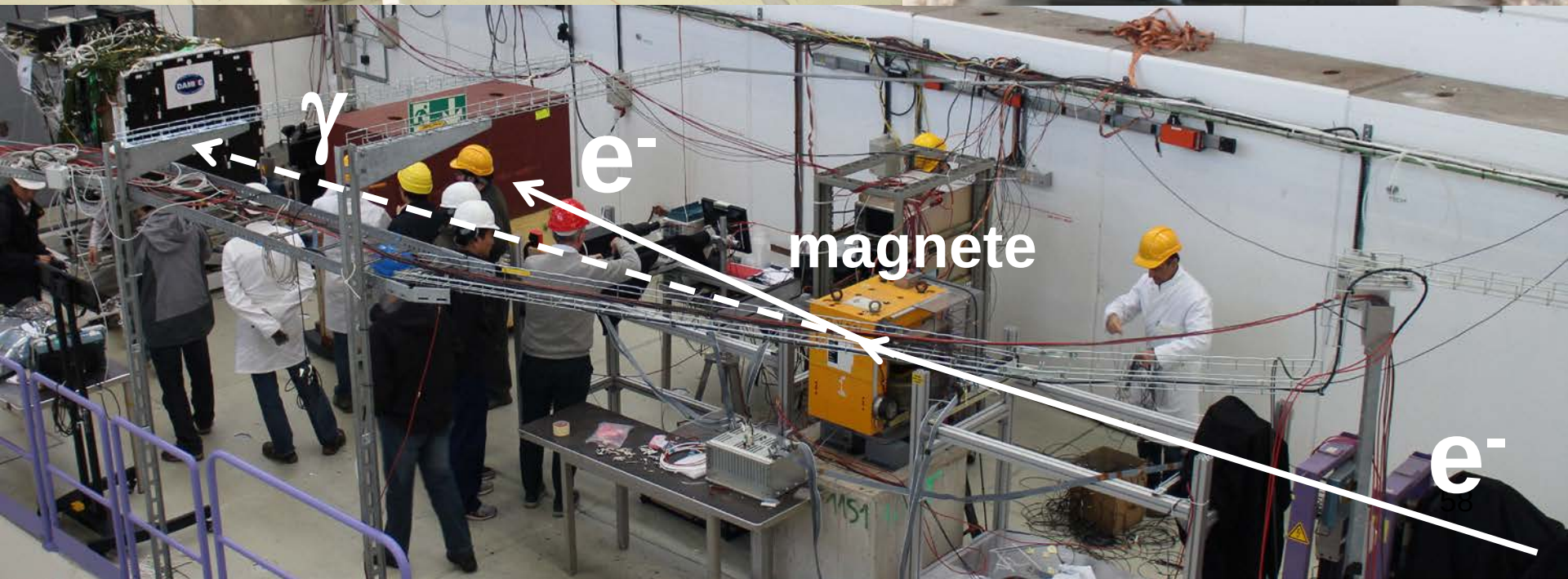
Huihong Technologies
Fiber Optics Manufacturer Since 1995

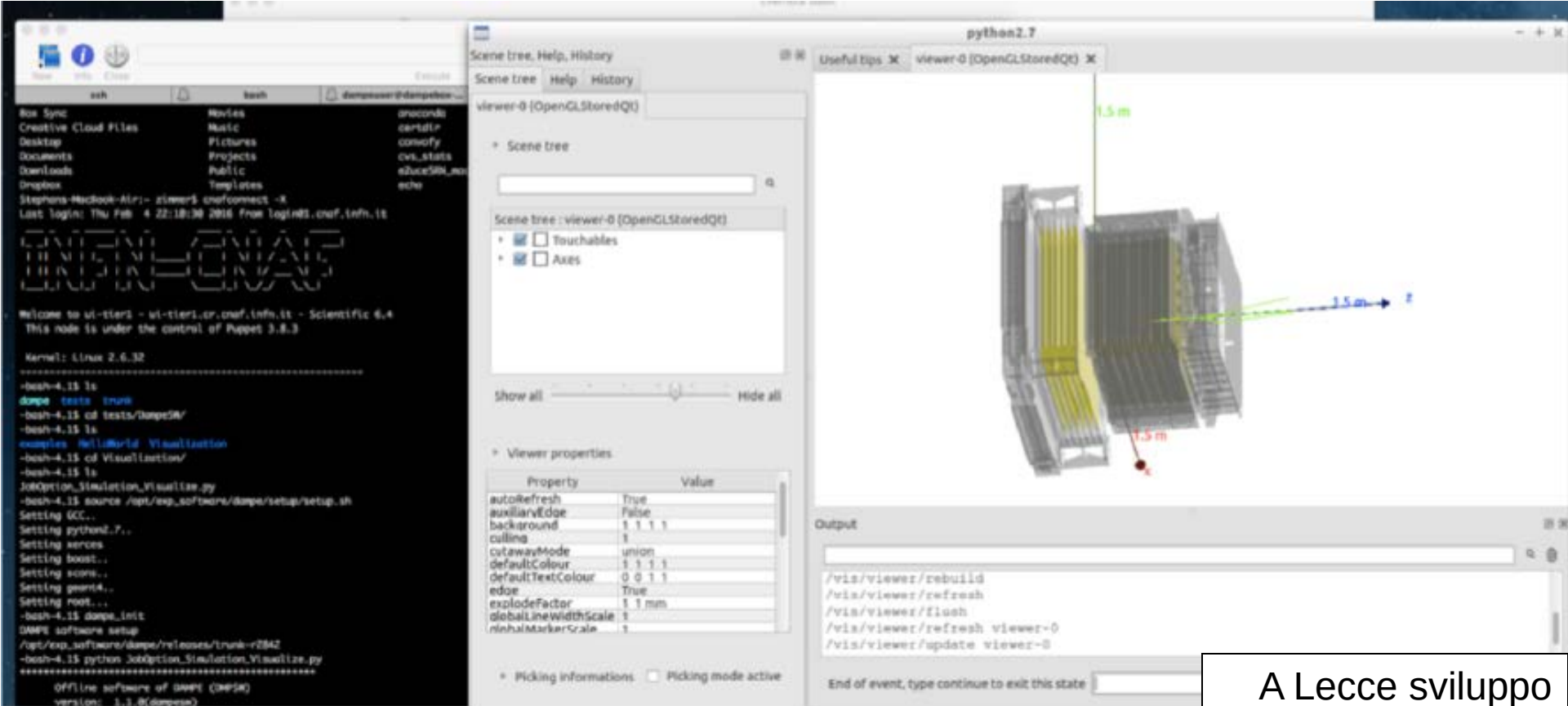
JANIS





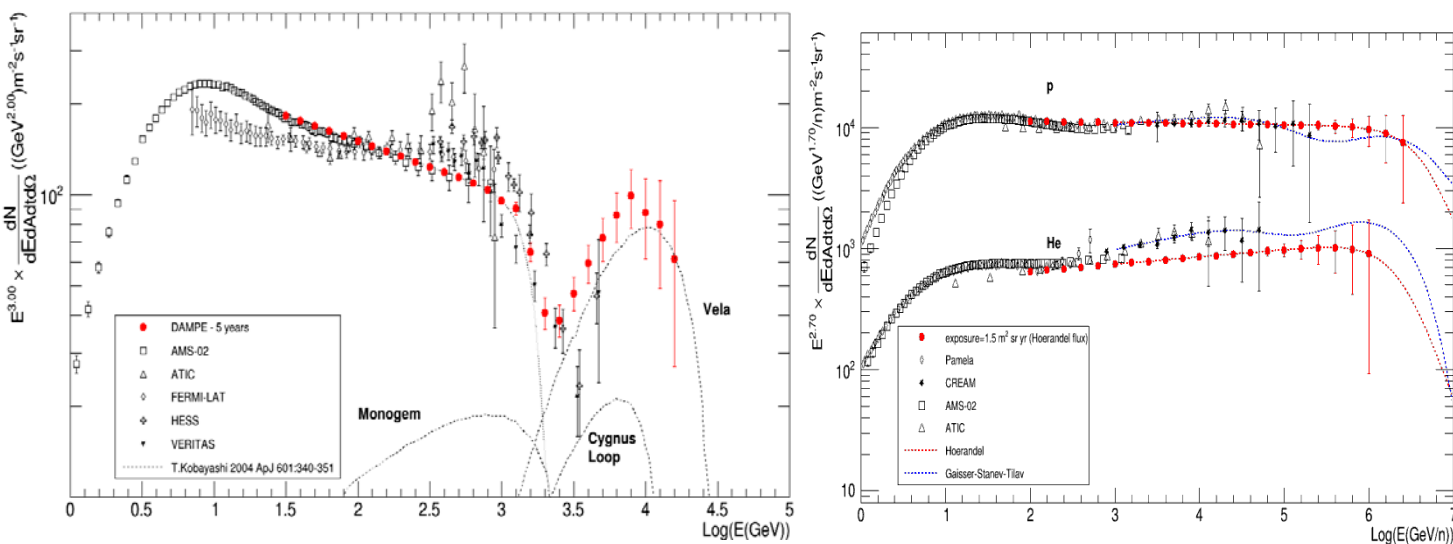
Gruppo leccese coinvolto nella calibrazione e test di un prototipo (1:1) su vari tipi di fasci di particelle al CERN





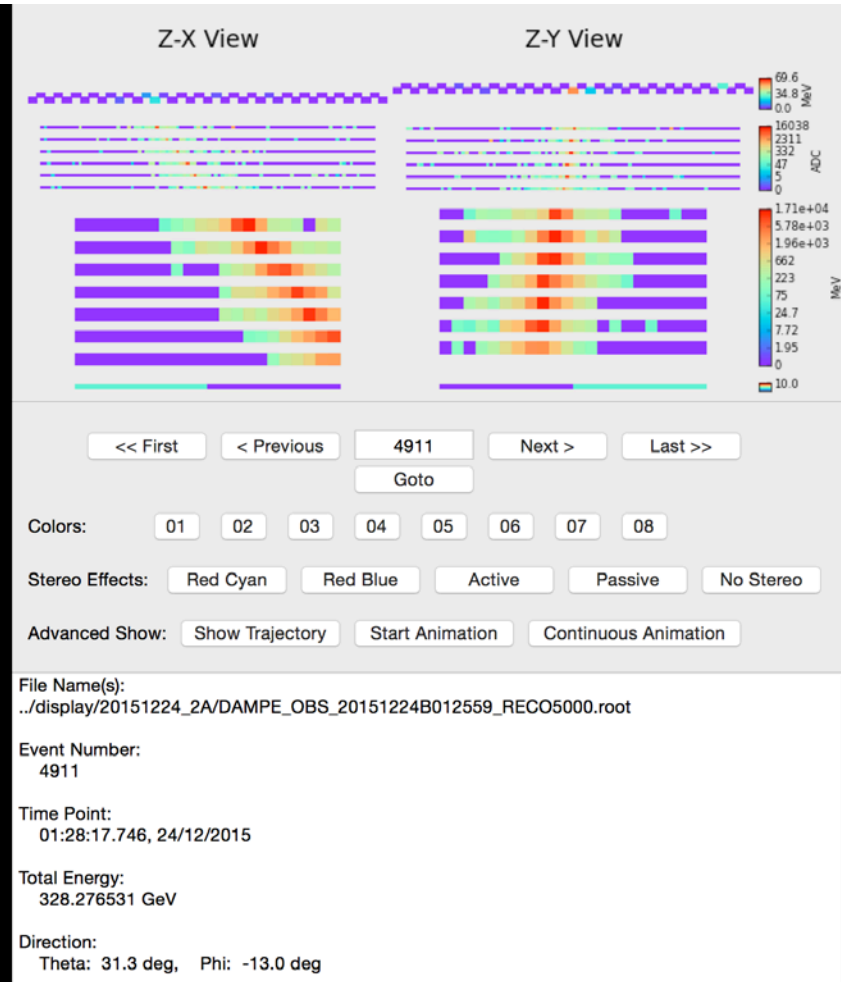
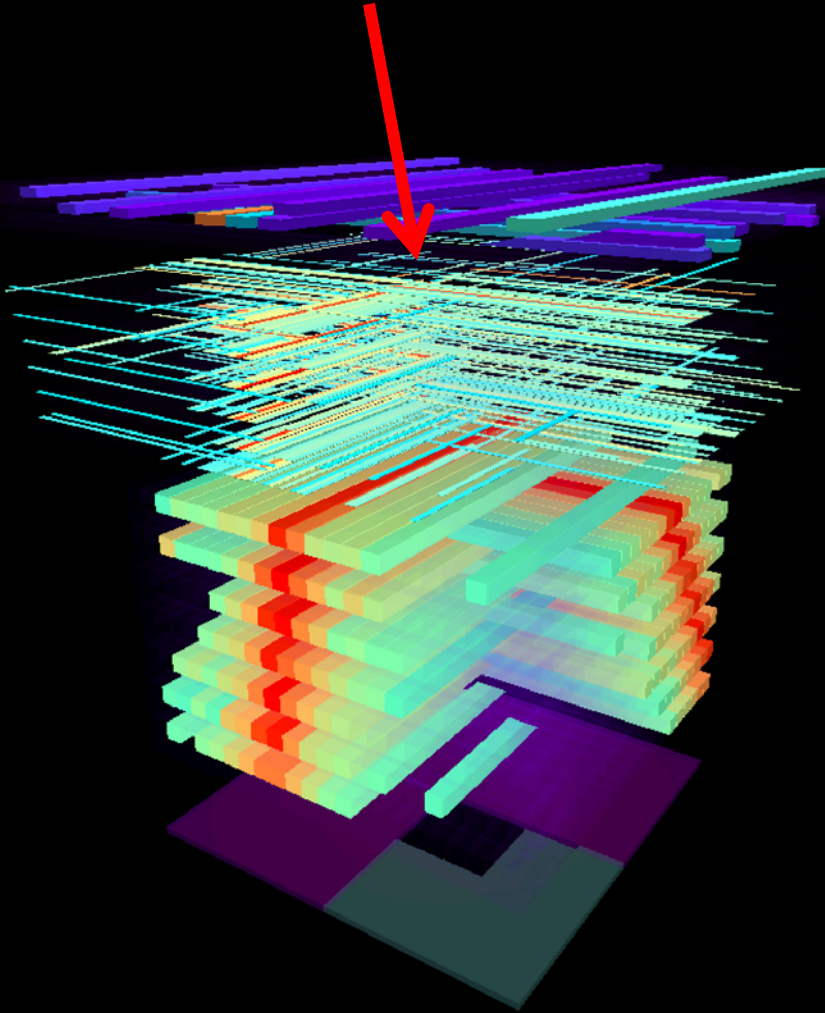
A Lecce sviluppo
di strumenti
software per
simulazione del
detector e analisi
dati.

Misura spettri
energetici dei raggi
cosmici



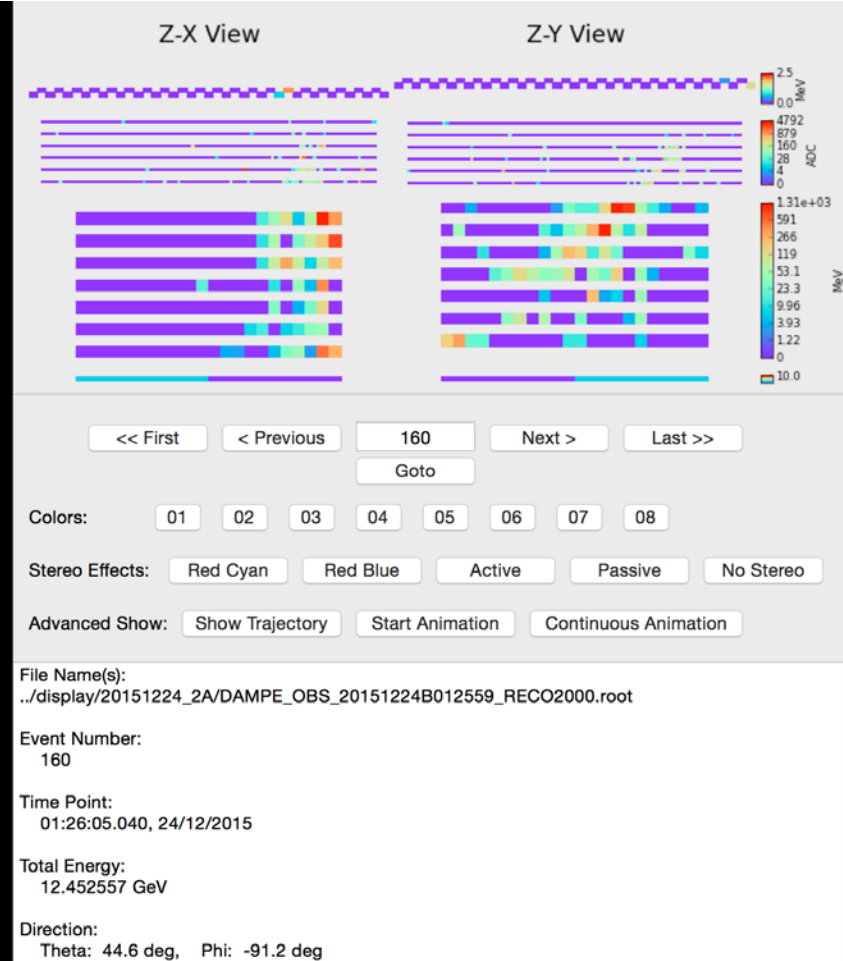
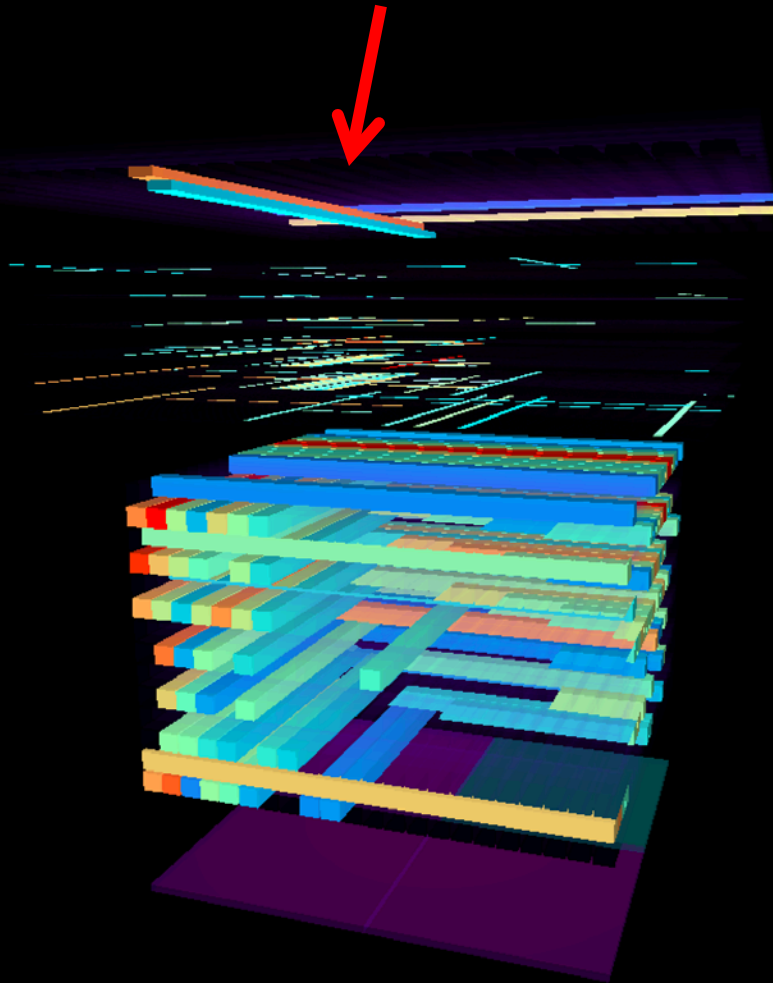
24 dicembre 2015: DAMPE “First Light”

Elettrone da 330 GeV



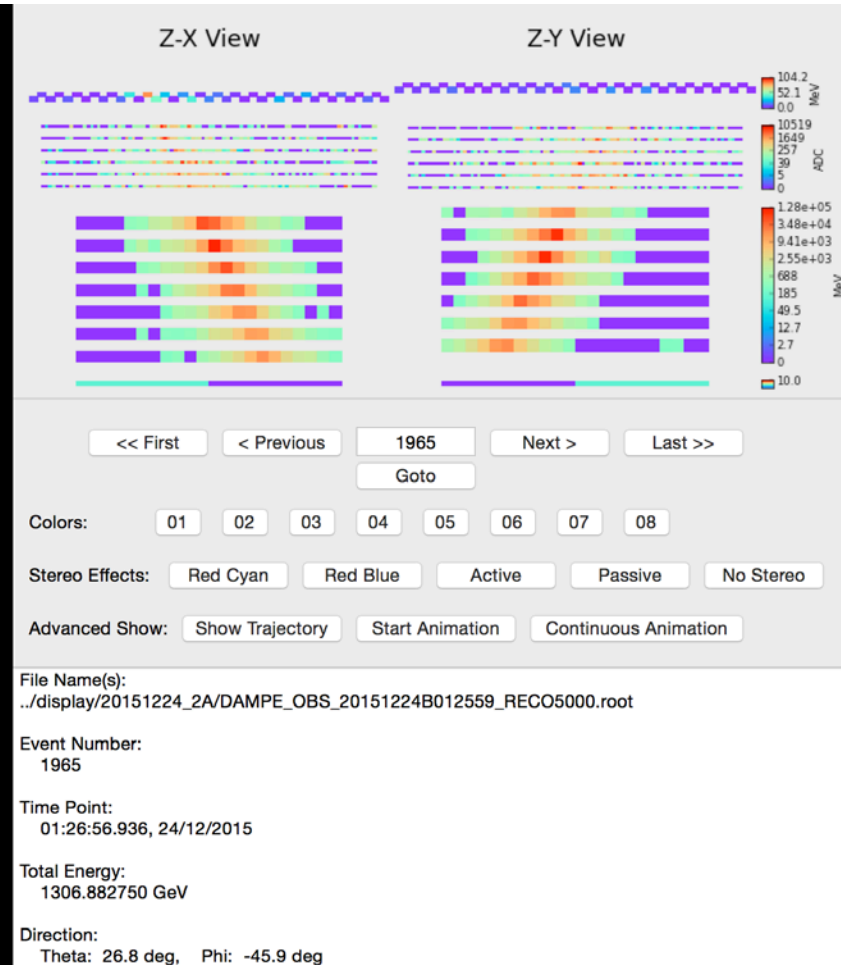
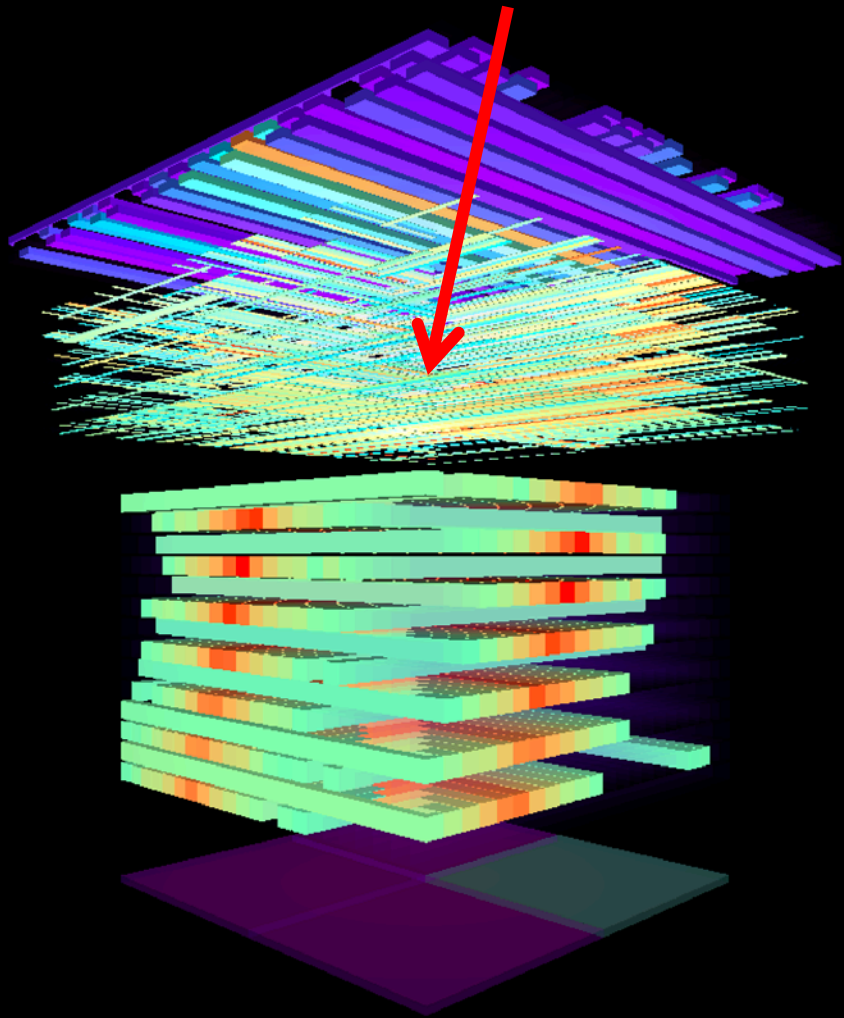
24 dicembre 2015: DAMPE “First Light”

Protone da 12 GeV



24 dicembre 2015: DAMPE “First Light”

Nucleo di Carbonio da 1.3 TeV

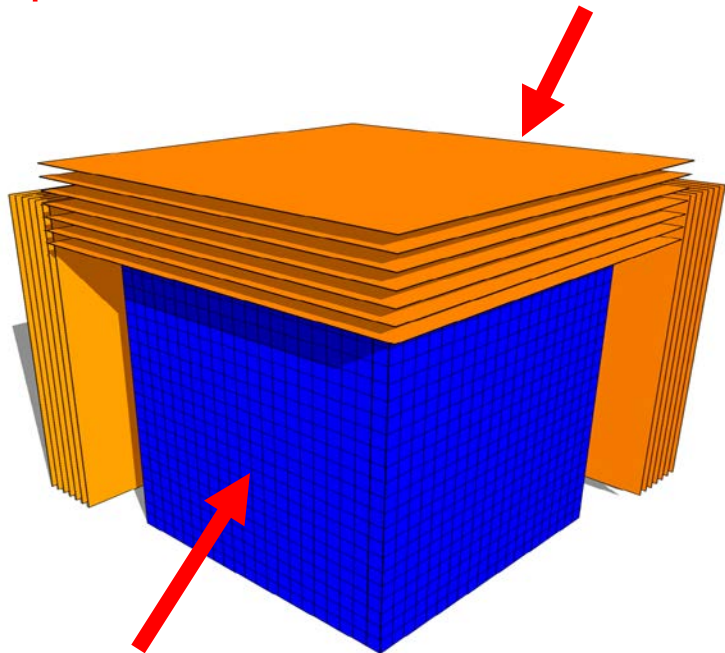


Il futuro

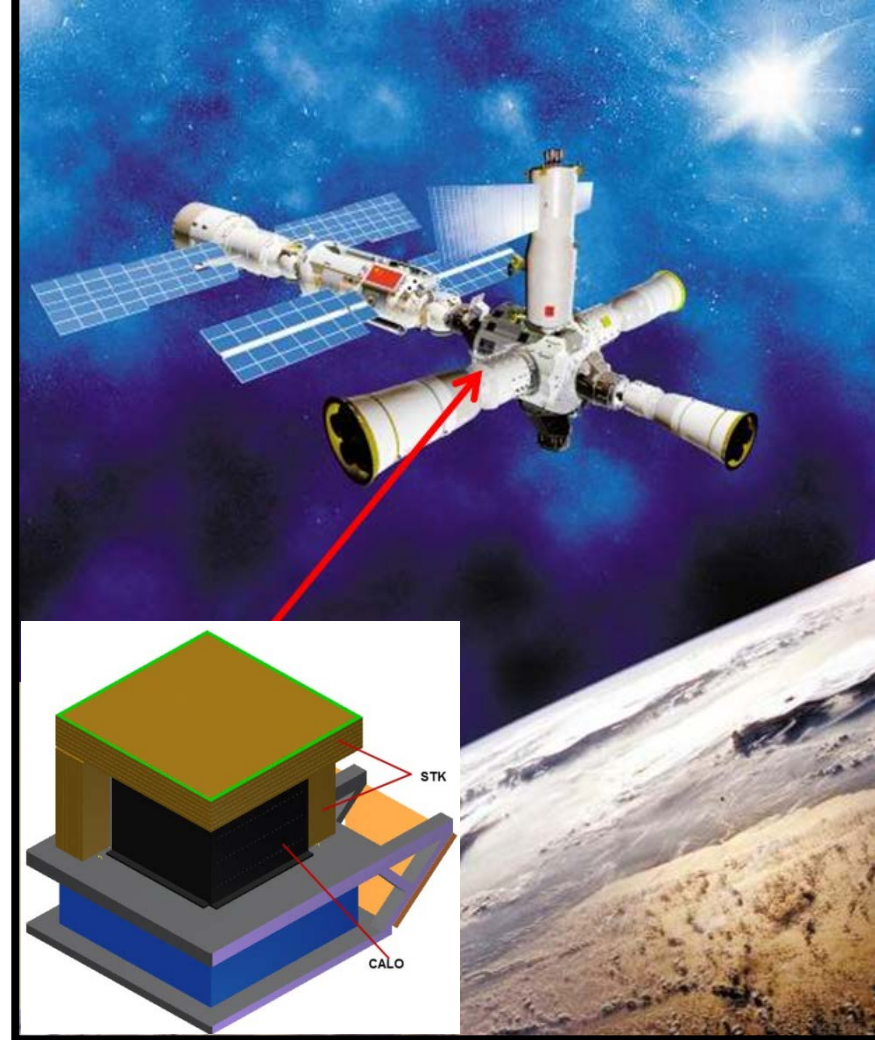
HERD (High Energy Radiation Detector)

Rilevatore di radiazione cosmica da installare sulla stazione spaziale cinese

Piani di rivelatore a Silicio-Tungsteno per identificare la traccia della particella



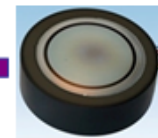
Calorimetro di cristalli di scintillatore per la misura dell'energia



Sistema di lettura della luce di scintillazione



LYSO+WLSF



ICCD系统

Optical fiber Taper

Image Intensifier

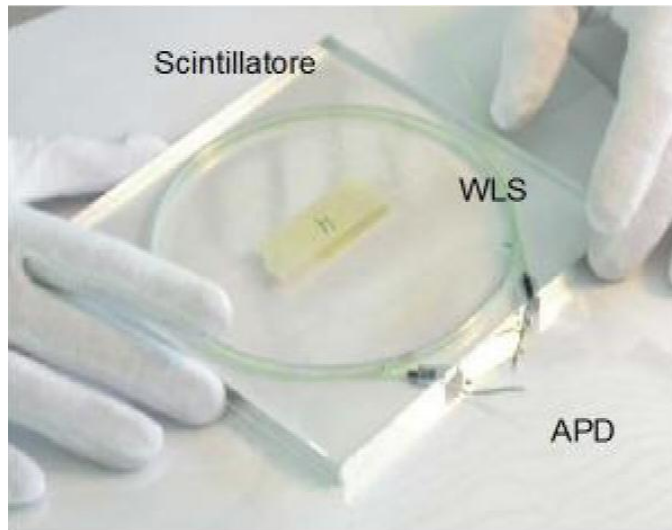
CCD

CORAM (COsmic RAY Mission)

Risultati delle misure ad alta quota



L'apparato sperimentale



Quattro piani di rivelatore a scintillazione (circa $14,5 \times 14,5 \times 1$ cm³), intervallati da assorbitori in ferro.

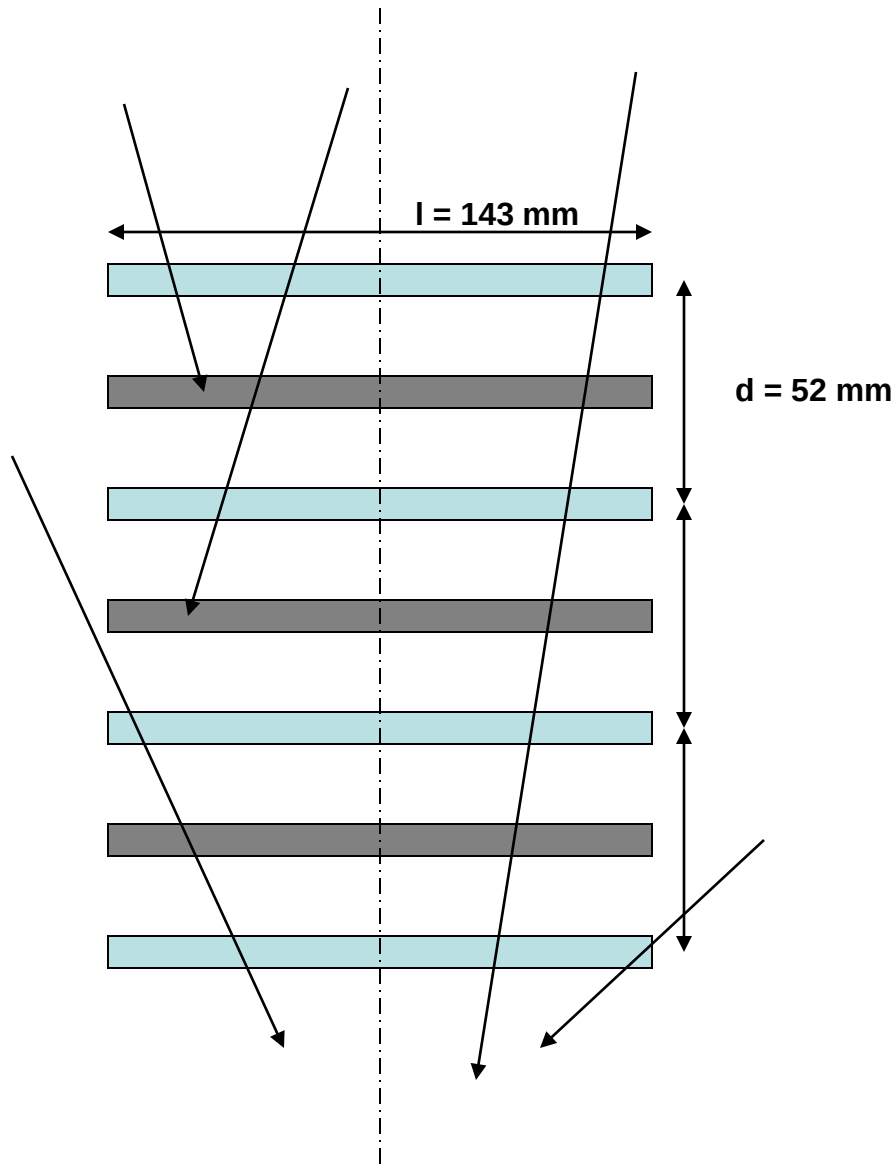
I segnali dei vari detector vengono “formati” a 60ns e messi in coincidenza in intervalli di 80ns.



Ad intervalli regolari di tempo ΔT (pari a 10s per questa serie di misure) viene registrato il numero di **singole** e di coincidenze **doppie**, **triple** e **quadruple**.

Il rate di coincidenze accidentali e' estremamente basso dato il valore della rate di fondo del singolo detector (≈ 1 Hz) e della finestra temporale scelta per le coincidenze.

L'apparato sperimentale



Quattro piani di rivelatore a scintillazione (circa $14,5 \times 14,5 \times 1 \text{ cm}^3$), intervallati da assorbitori in ferro.

I segnali dei vari detector vengono “formati” a 60ns e messi in coincidenza in intervalli di 80ns.

Ad intervalli regolari di tempo ΔT (pari a 10s per questa serie di misure) viene registrato il numero di **singole** e di coincidenze **doppie**, **triple** e **quadruple**.

Il rate di coincidenze accidentali e' estremamente basso dato il valore della rate di fondo del singolo detector ($\approx 1 \text{ Hz}$) e della finestra temporale scelta per le coincidenze.

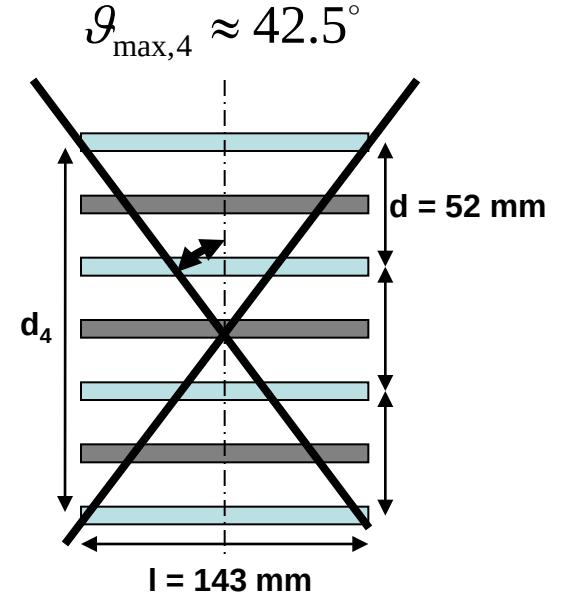
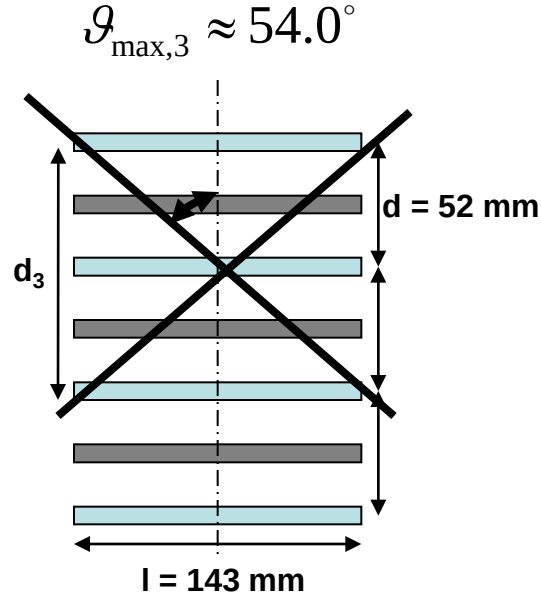
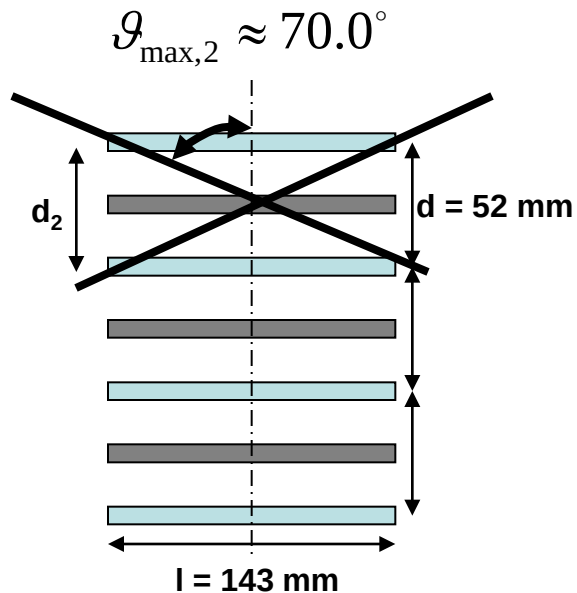
Field of view (FoV)

A diversi tipi di coincidenza corrispondono diversi valori del campo di vista (FoV).

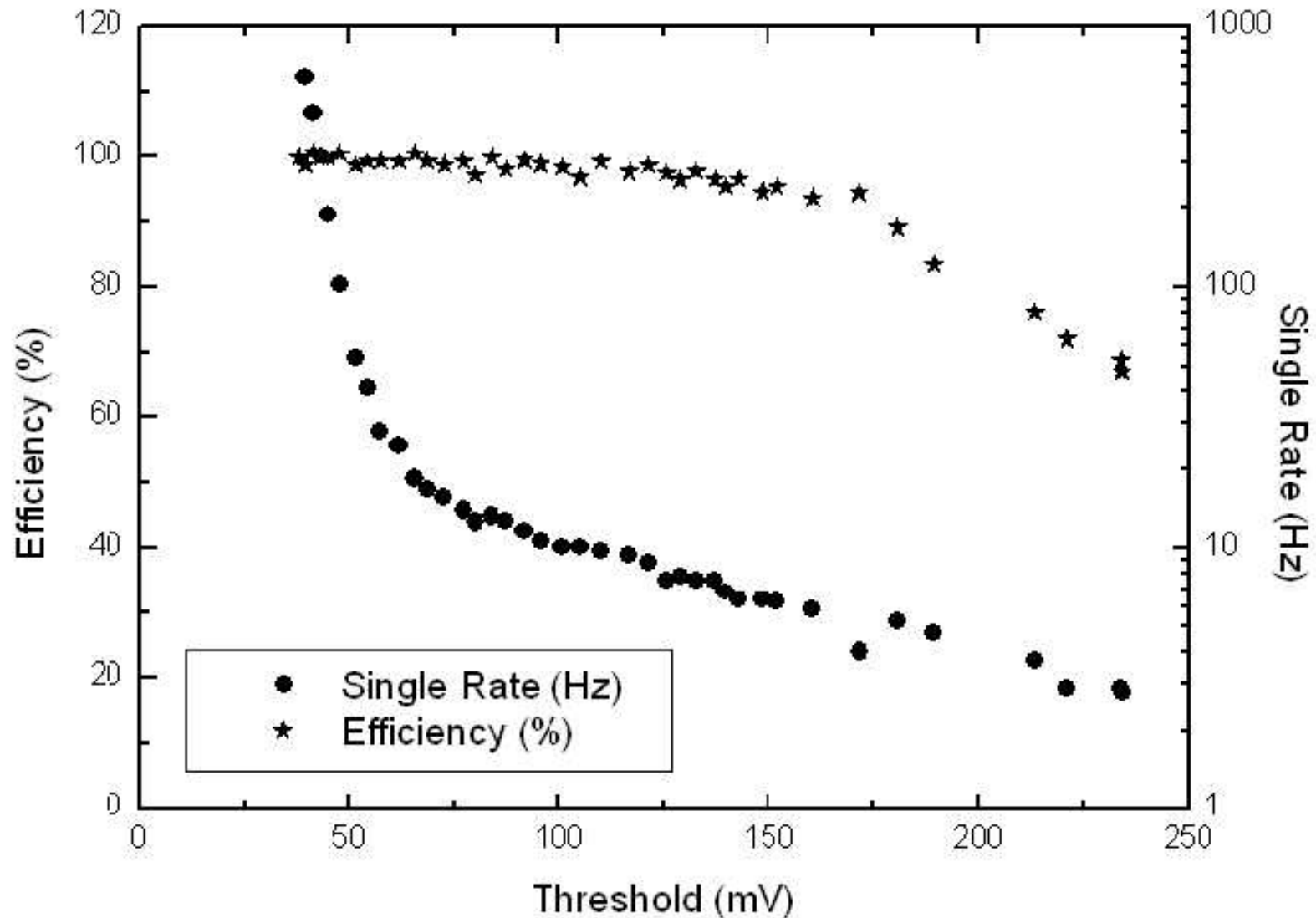
Assumendo un flusso di particelle solo dall'alto:

Per le singole (k=1): $\vartheta_{\max,2} \approx 90^\circ$

Per le doppie (k=2), triple (k=3) e quaduple (k=4):
$$\operatorname{tg}(\vartheta_{\max,k}) \approx \frac{l/2}{d_k/2} = \frac{l}{d_k} = \frac{l}{(k-1) \cdot d}$$



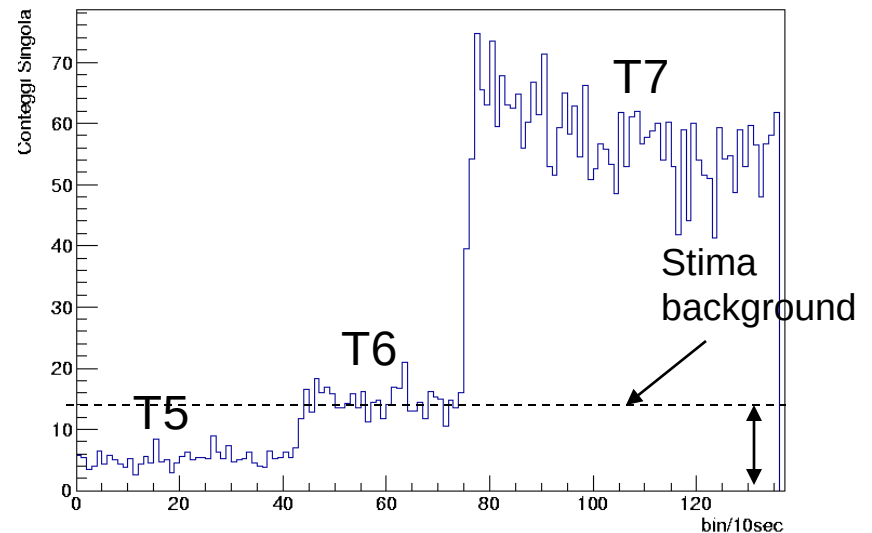
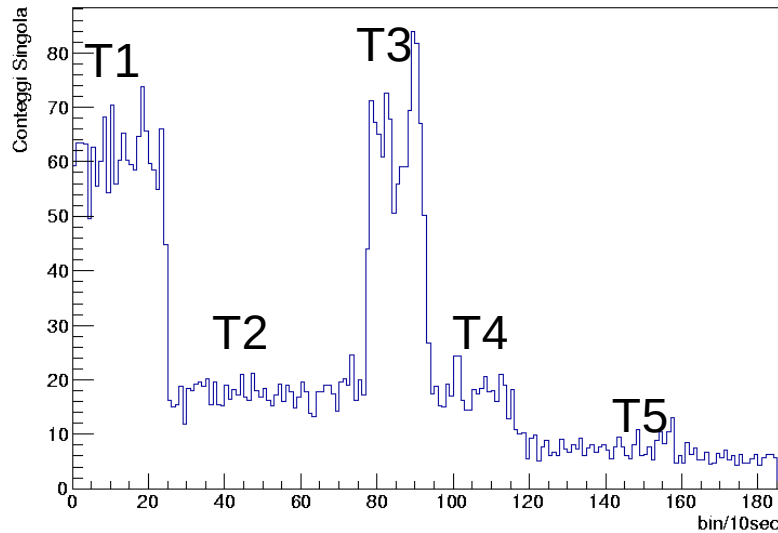
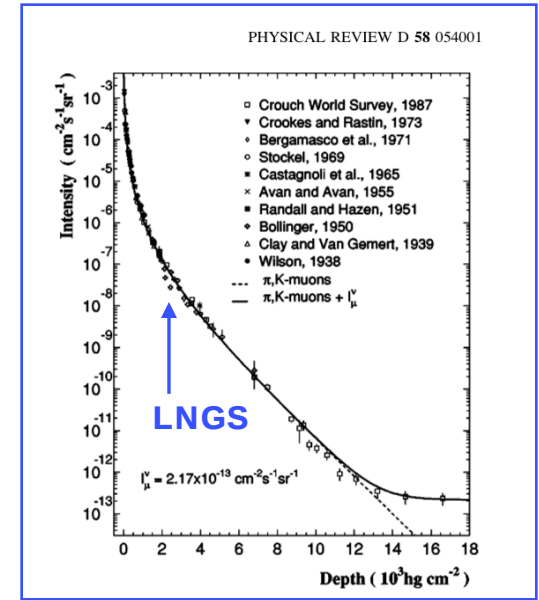
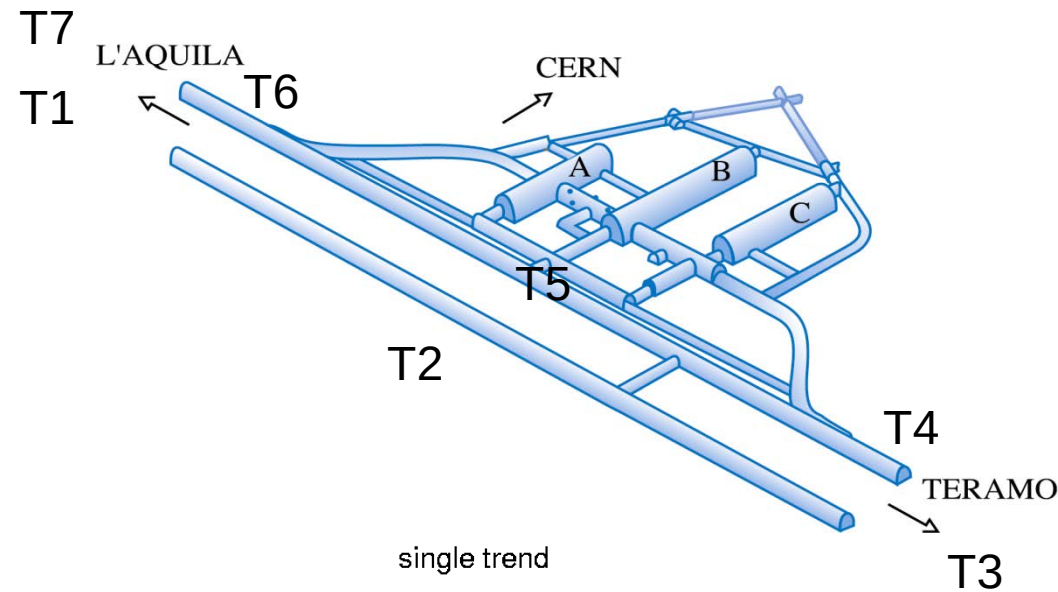
Misure di efficienza (in laboratorio)



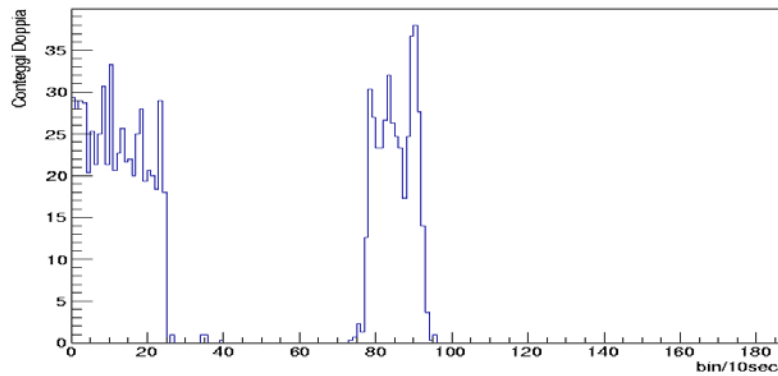
Misure in galleria (LNGS)



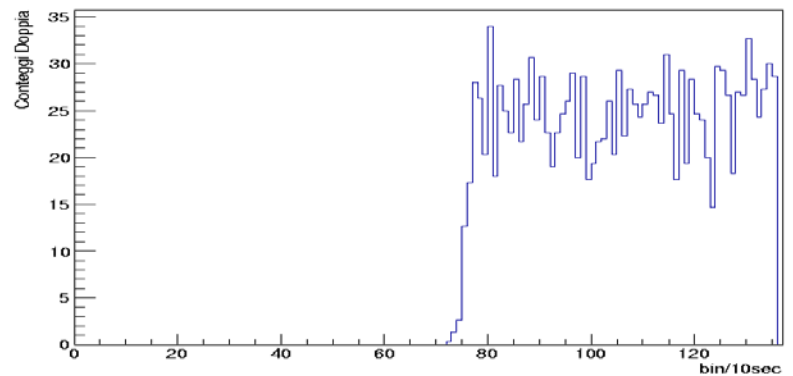
Misure in galleria (LNGS)



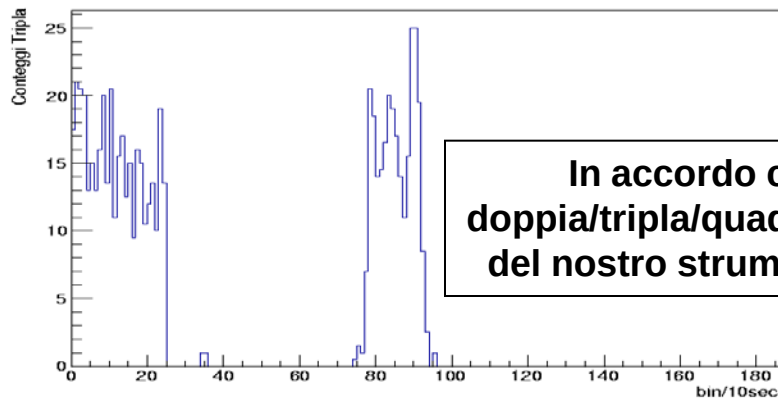
doppie trend



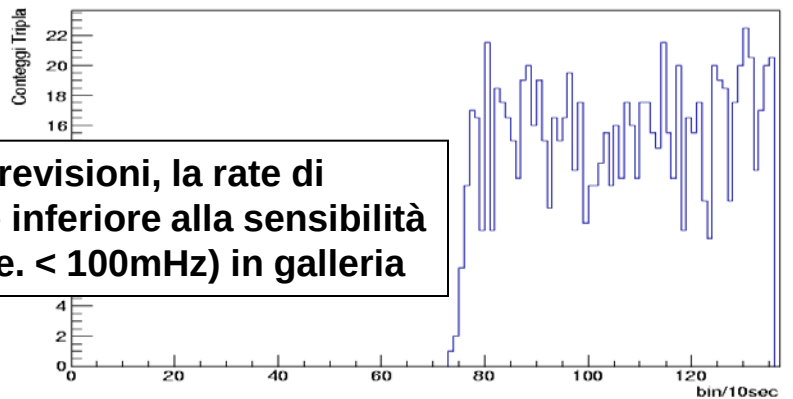
doppie trend



Triple trend

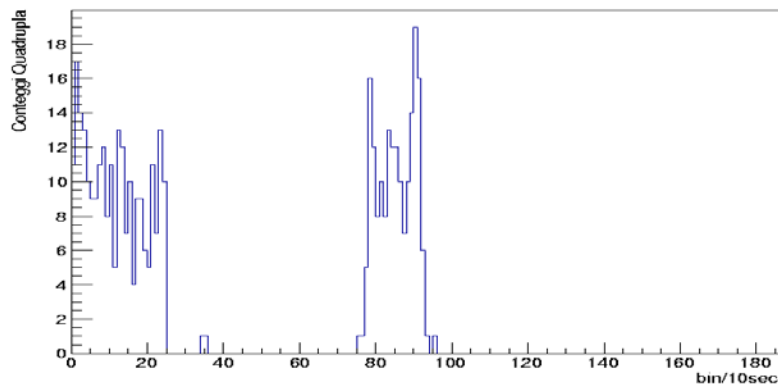


Triple trend

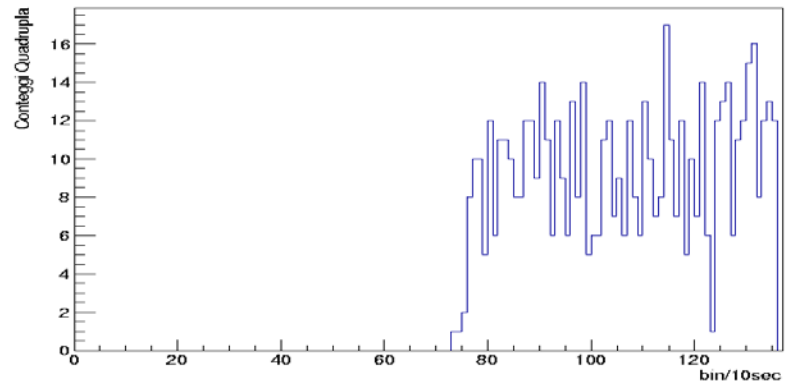


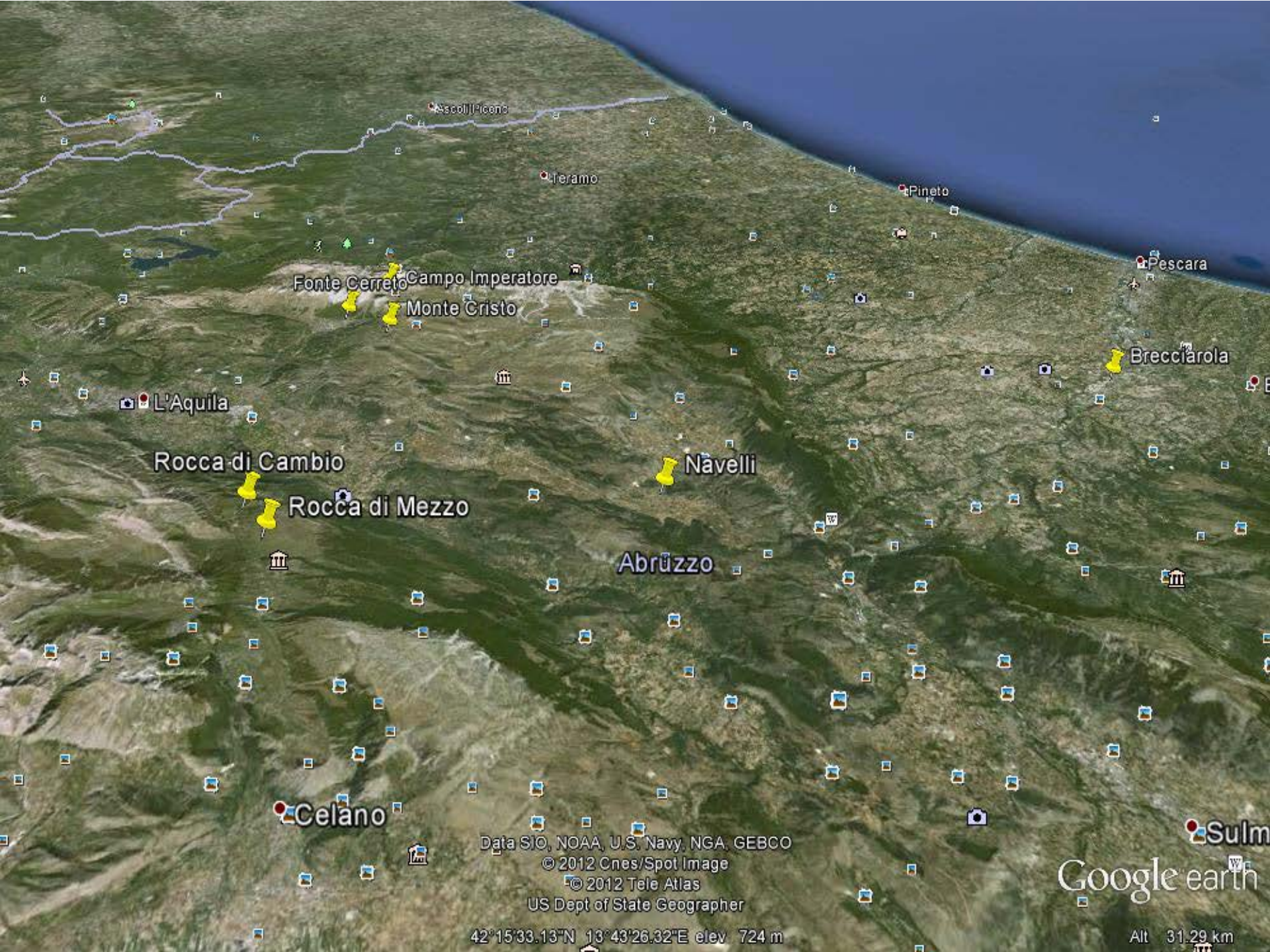
**In accordo con le previsioni, la rate di
doppia/tripla/quadrupla è inferiore alla sensibilità
del nostro strumento (i.e. < 100mHz) in galleria**

Quadrup trend



Quadrup trend





Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
© 2012 Tele Atlas
US Dept of State Geographer

42°15'33.13"N 13°43'26.32"E elev 724 m

Sulm
Google earth

Alt 31.29 km



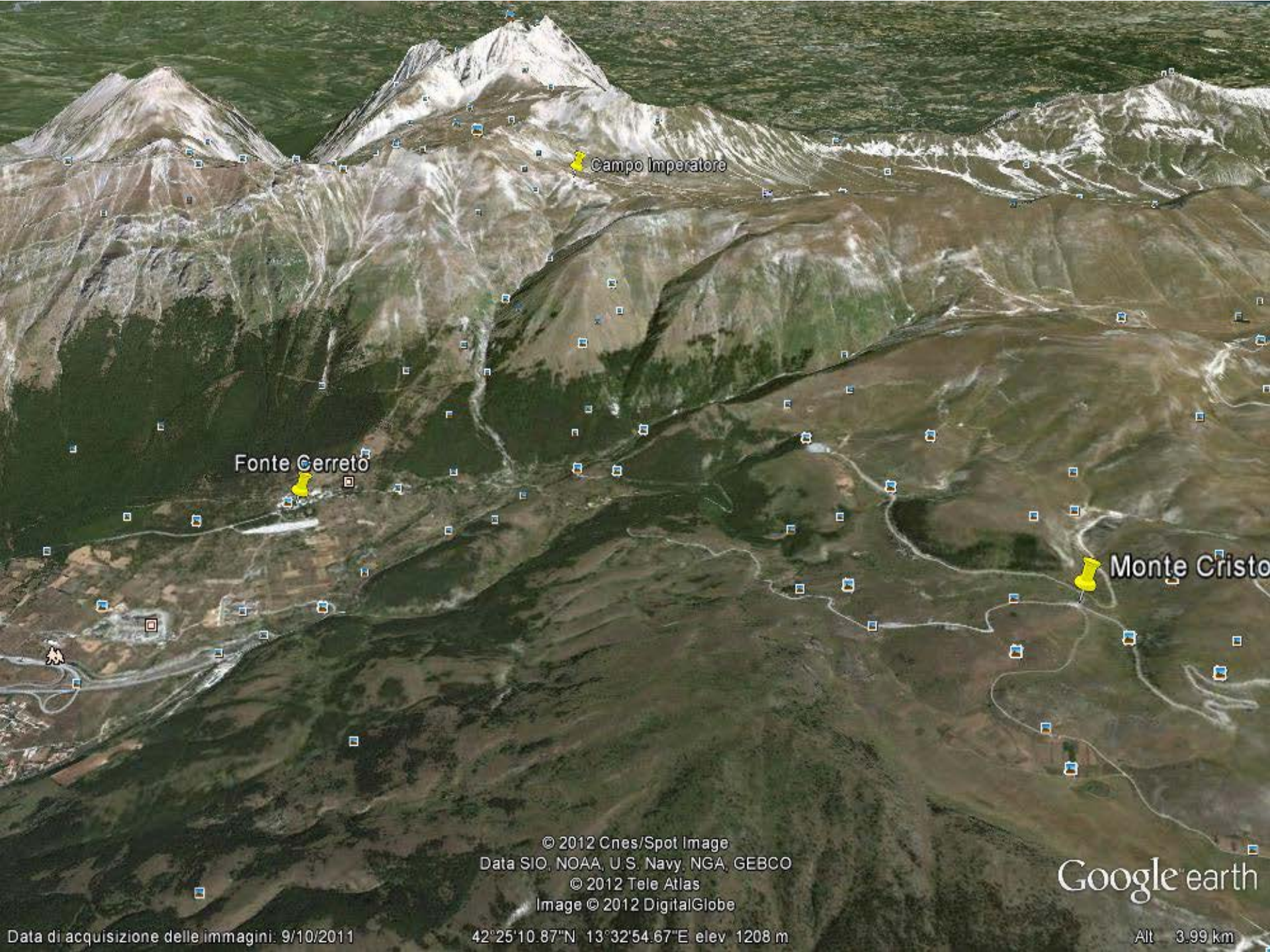
© 2012 Cnes/Spot Image
© 2012 MapLink/Tele Atlas
© 2012 Tele Atlas
Image © 2012 DigitalGlobe

Google earth

Data di acquisizione delle immagini: 9/10/2011

42°13'33.47"N 13°33'12.68"E elev 1243 m

Alt 3.25 km



Campo Imperatore

Fonte Cerreto

Monte Cristo

© 2012 Cnes/Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Tele Atlas
Image © 2012 DigitalGlobe

Google earth

Data di acquisizione delle immagini: 9/10/2011

42°25'10.87"N 13°32'54.67"E elev 1208 m

Alt 3.99 km



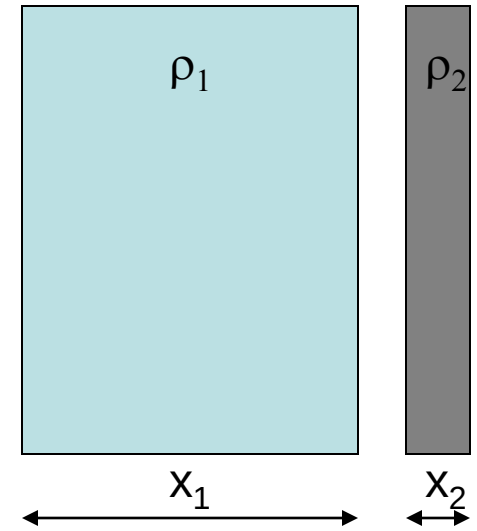
Nell'interazione tra la radiazione e la materia ciò che conta non è lo spessore di materiale, ma il prodotto

spessore x densità = grammage

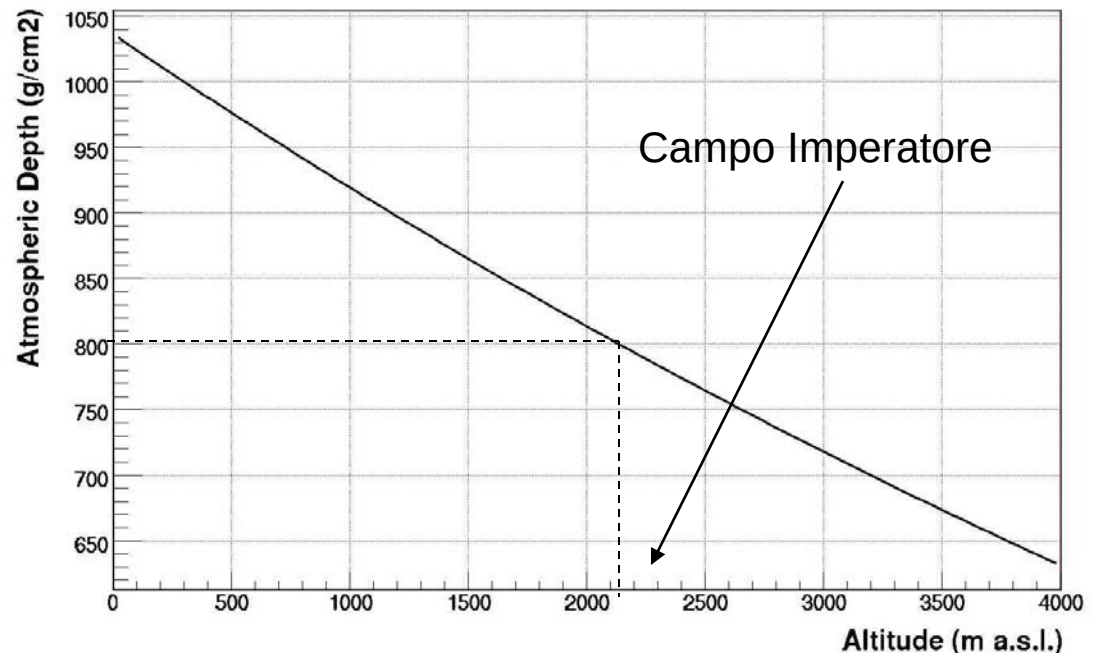
Ad esempio 10cm di piombo equivalgono a più di un metro di acqua:

$$10\text{cm} \times 11.35\text{g/cm}^3 = 113.5\text{g/cm}^2 = 113.5\text{cm} \times 1\text{g/cm}^2$$

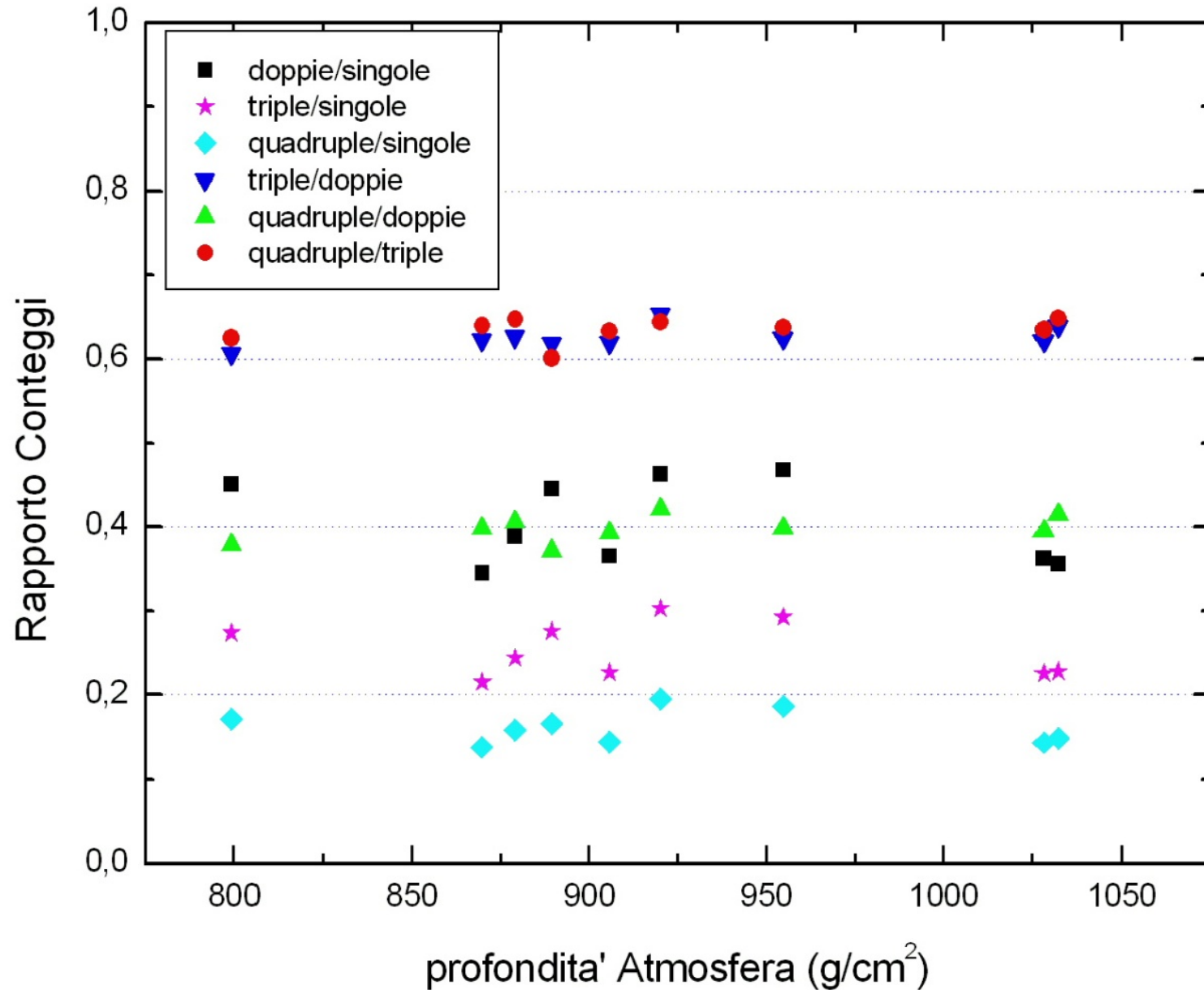
Lo spessore dell'atmosfera, al livello del mare, è pari a circa 1033g/cm² (circa 1013 mbar) pari a circa 10m di acqua.



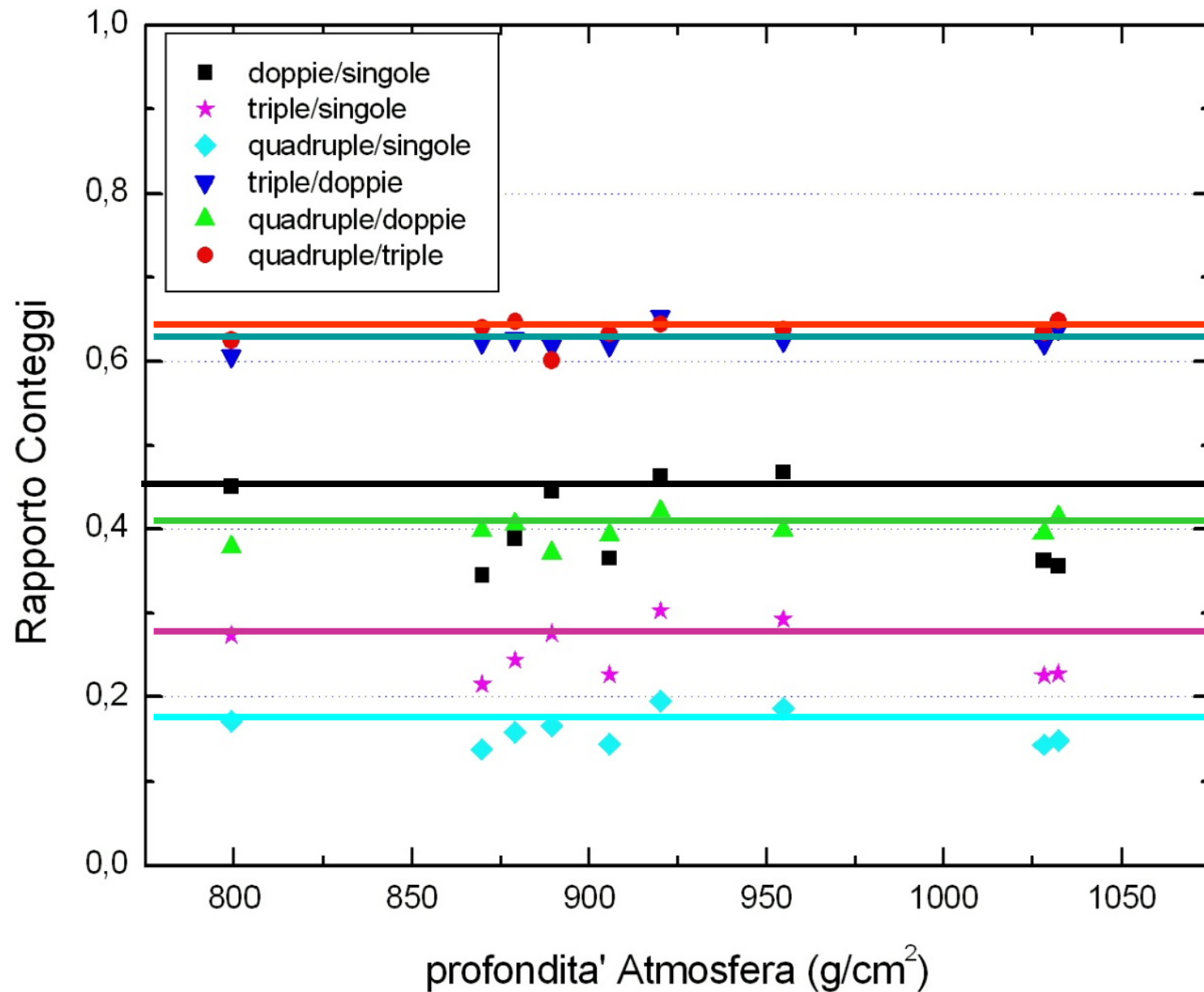
	Quota (m s.l.m.)
Brecciarola	65
Navelli	684
LNGS esterni	990
Rocca di Cambio	1270
Rocca di Mezzo	1366
Fonte Cerreto	1120
Monte Cristo	1453
Campo Imperatore	2140



I rapporti tra le rates (e quindi le efficienze) sono indipendenti dalla quota.



Assumendo: $\langle \varepsilon \rangle \approx 92\%$ $R^s_{bck} \approx 1.8 \text{ Hz}$



THE PHYSICAL REVIEW

A Journal of Experimental and Theoretical Physics Established by E. L. Nichols in 1893

VOL. 57, No. 6

MARCH 15, 1940

SECOND SERIES

The Variation of the Hard Component of Cosmic Rays with Height and the Disintegration of Mesotrons

BRUNO ROSSI, *University of Chicago, Chicago, Illinois*

NORMAN HILBERRY, *New York University, University Heights, New York, New York*

AND

J. BARTON HOAG, *University of Chicago, Chicago, Illinois*

(Received January 10, 1940)

The vertical intensity of the hard component of cosmic rays was measured at different altitudes with a threefold coincidence counter tube arrangement. Measurements were taken with and without a graphite layer above the counters in order to compare the absorption of the hard component in air and in carbon. The counting rate observed under a given mass of air-plus-carbon was found to be considerably larger than the rate observed under the same mass of air alone. We interpret the difference as due to the spontaneous decay of the mesotrons which form the hard component of cosmic rays.



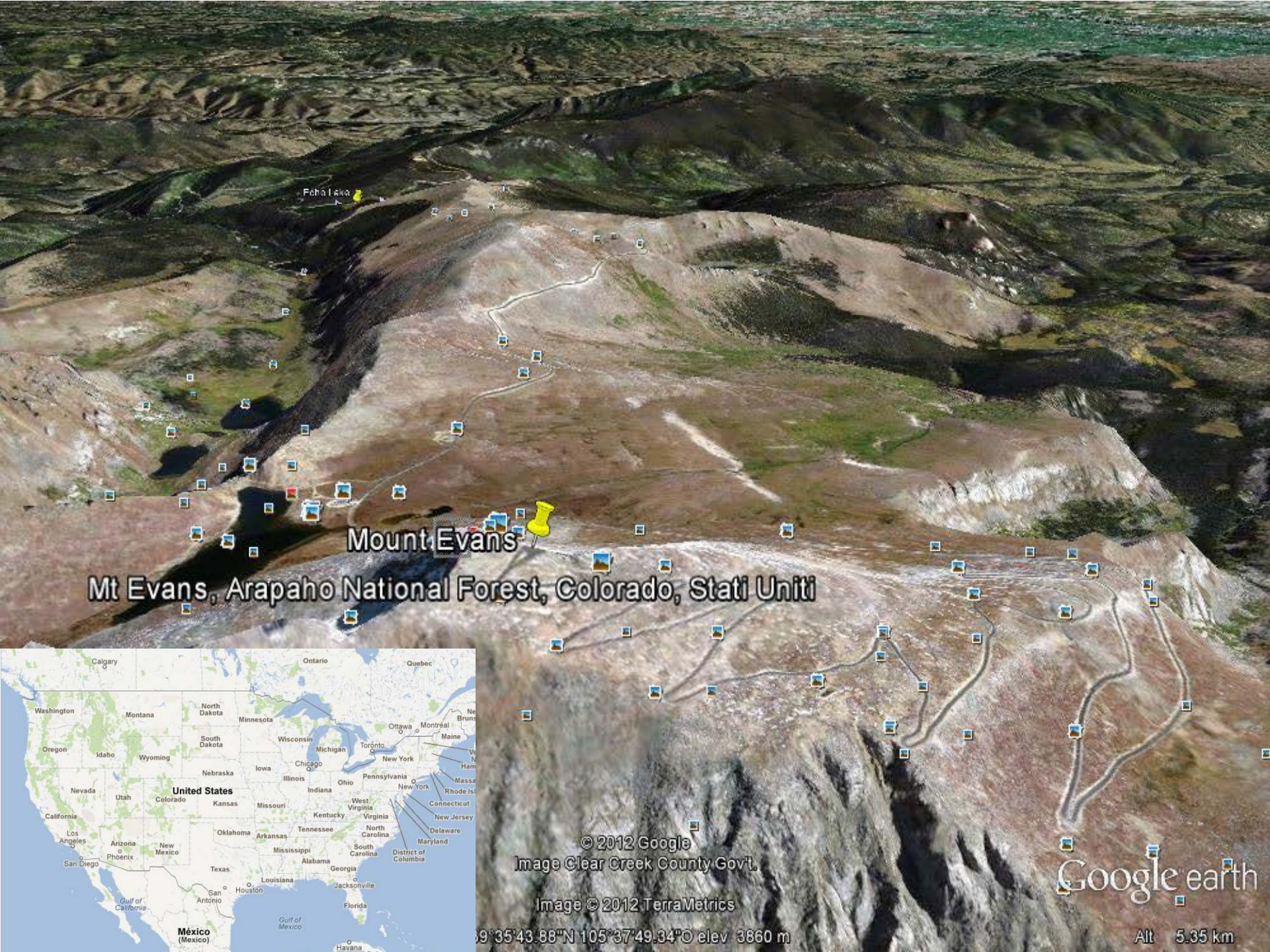
Bruno Rossi e la moglie Nora Lombroso su Mt. Evans (1939)

Nel 1939, Bruno Rossi effettua una campagna di misure a diverse quote, sulle montagne rocciose, per indagare il fenomeno dell'assorbimento anomalo dei "mesotroni" (i muoni).

L'apparato sperimentale e' costituito da contatori Geiger e assorbitori di piombo e grafite.

Le misure vengono effettuate, a bordo di un bus dell'Università di Chicago, a varie quote sul livello del mare:

Chicago (180 m), Denver (1600m), Echo Lake (3240m), Mt. Evans (4300m)



Patch Lake

Mount Evans

Mt Evans, Arapaho National Forest, Colorado, Stati Uniti



© 2012 Google
Image Clear Creek County Gov't

Image © 2012 TerraMetrics

39°35'43.88"N 105°37'49.34"E elev 3860 m

Google earth

Alt 5.35 km

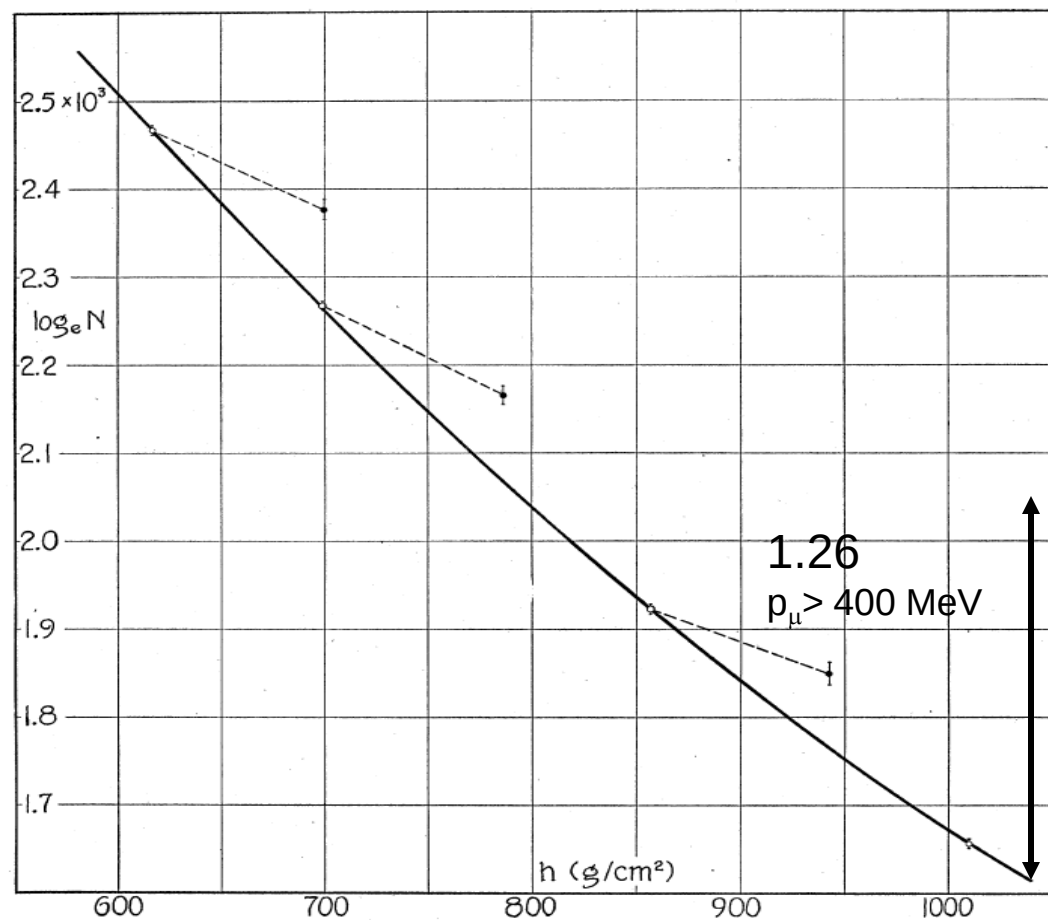
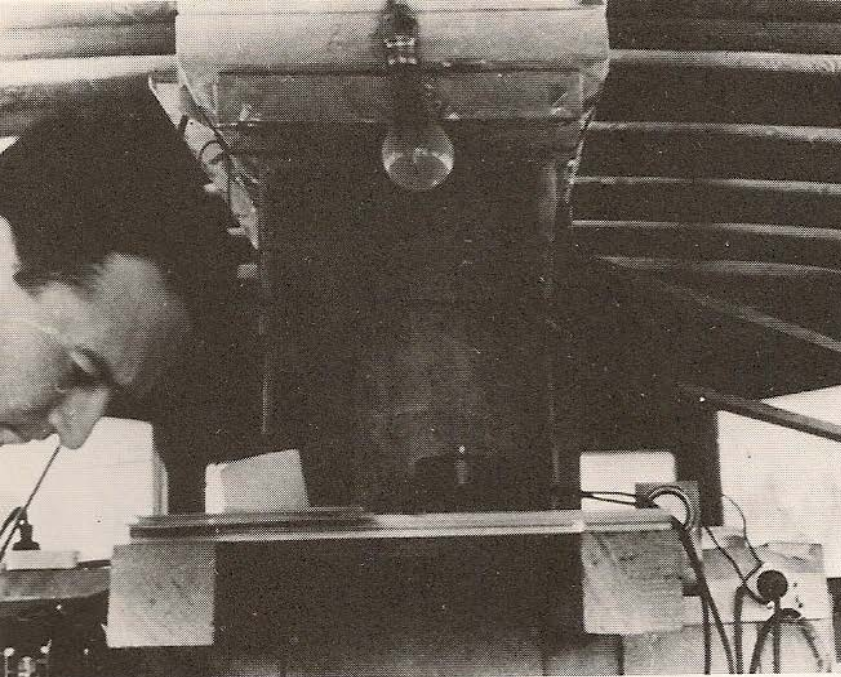
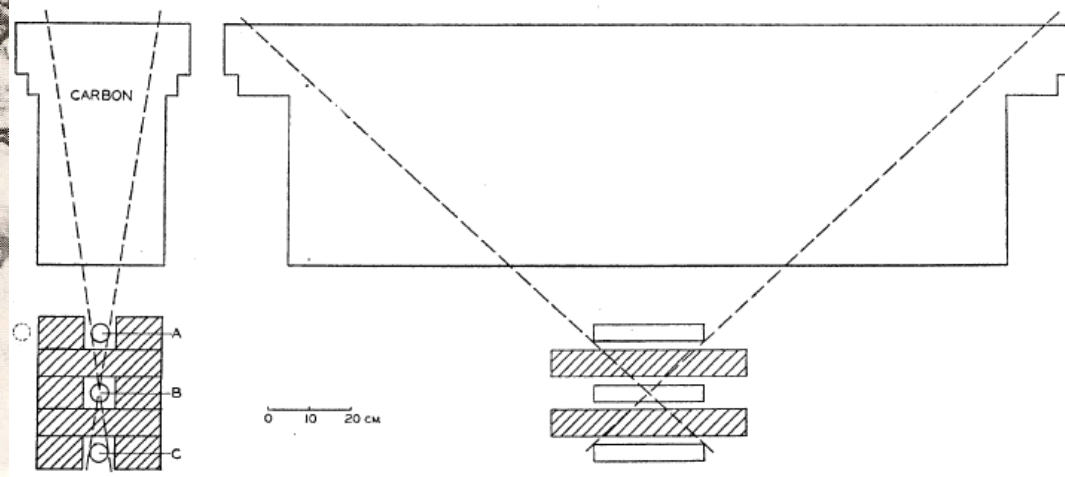
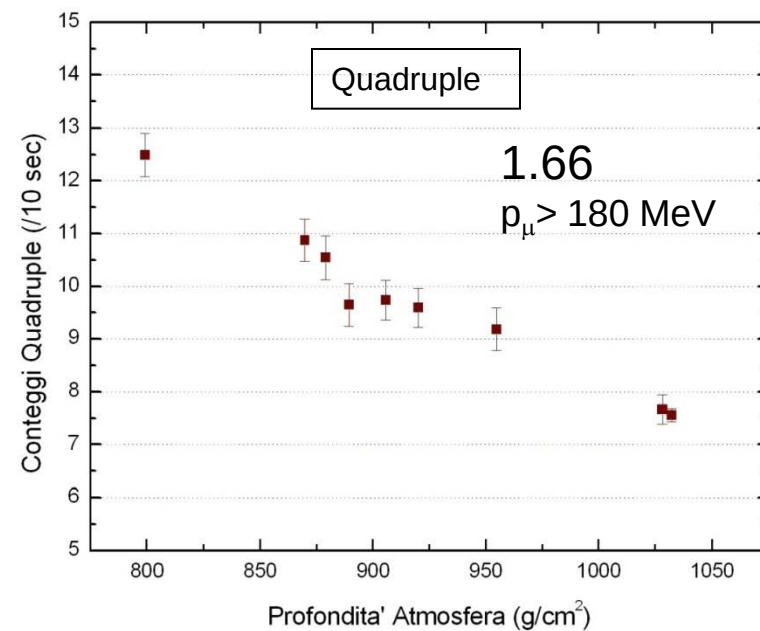
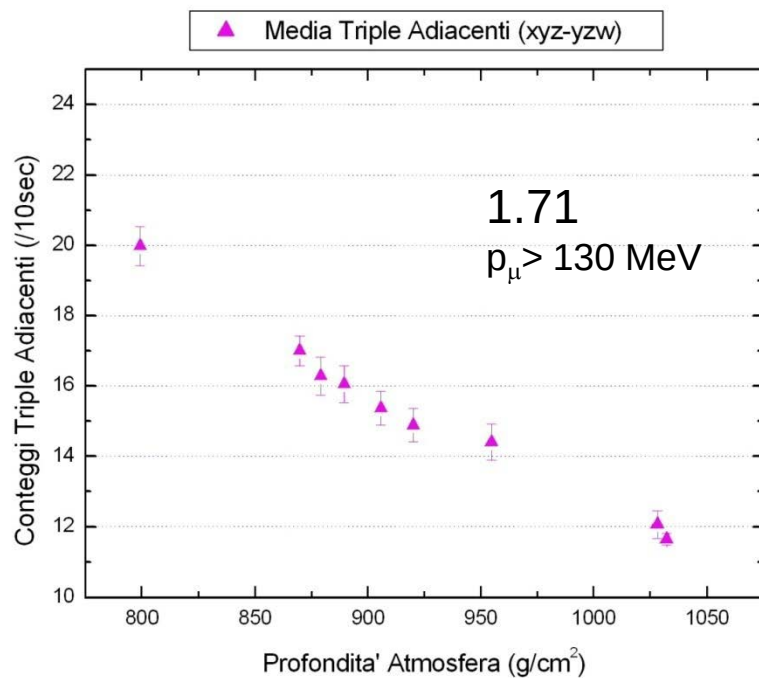
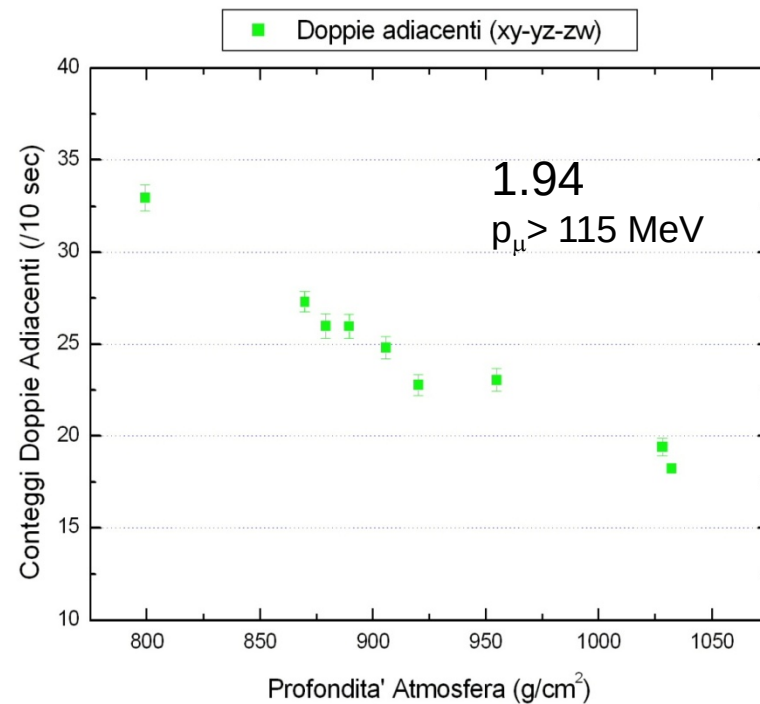
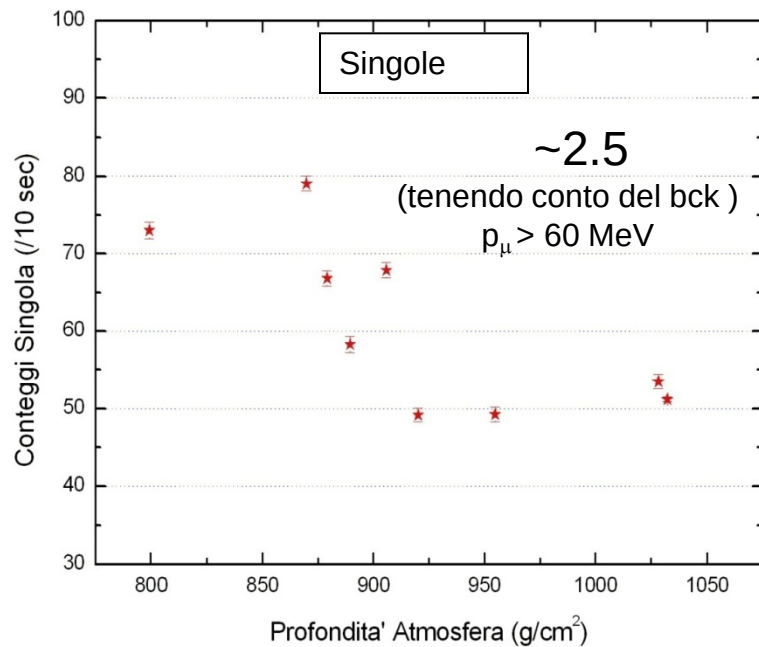


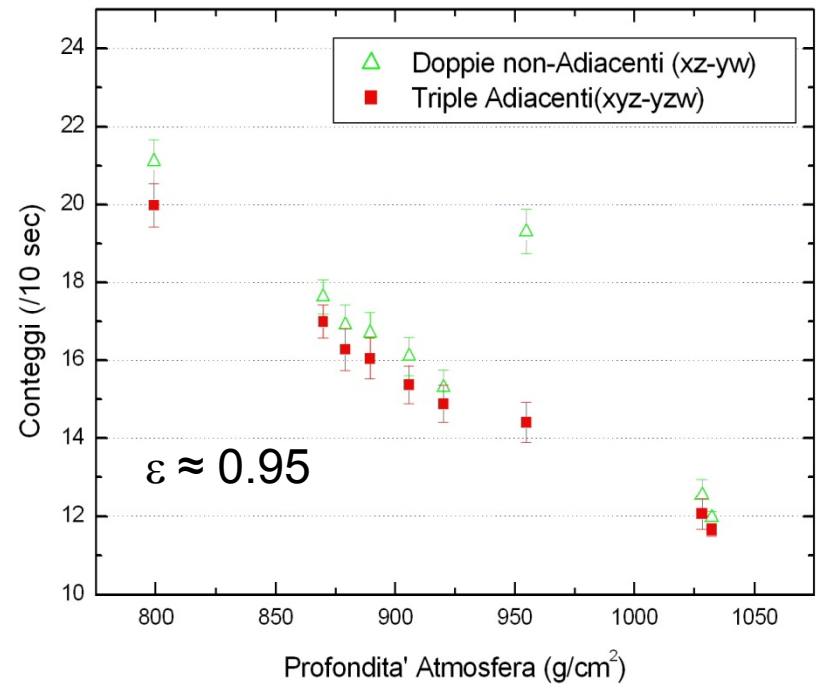
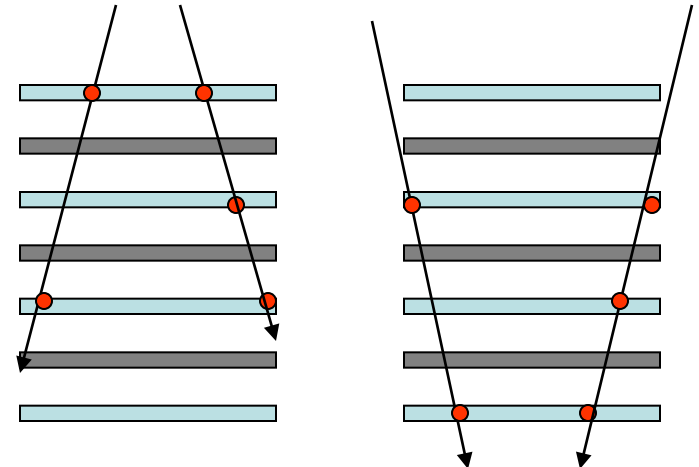
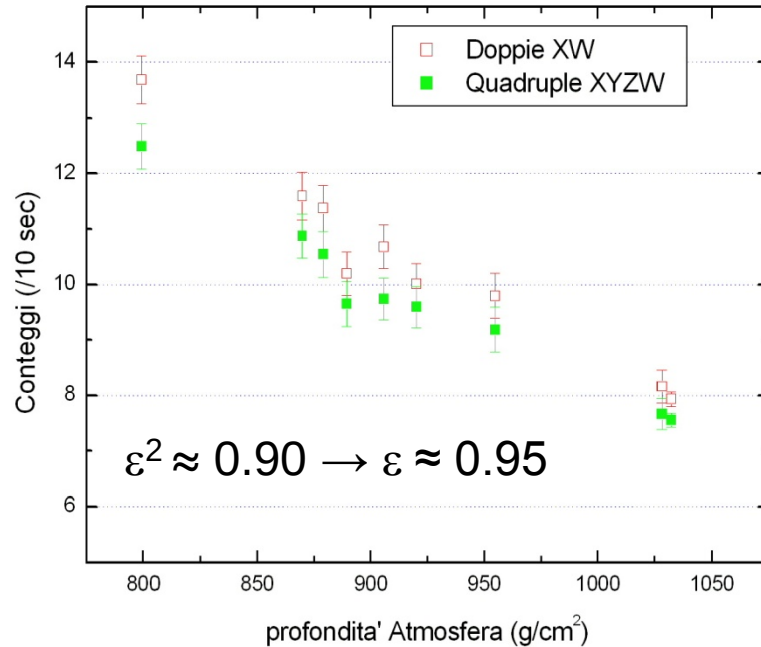
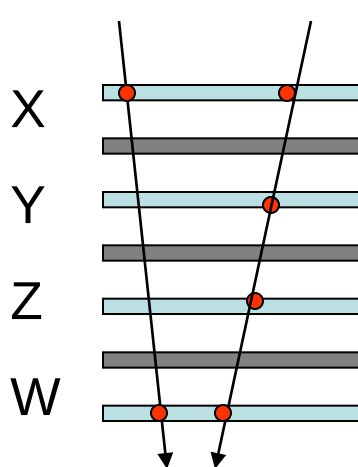
FIG. 3. Intensity of cosmic-ray mesotrons as a function of the depth.







Ulteriori misure di efficienza



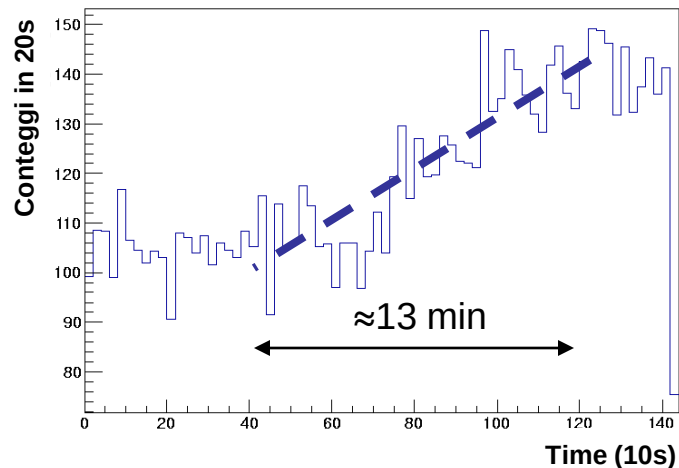
Misure durante la salita in funivia



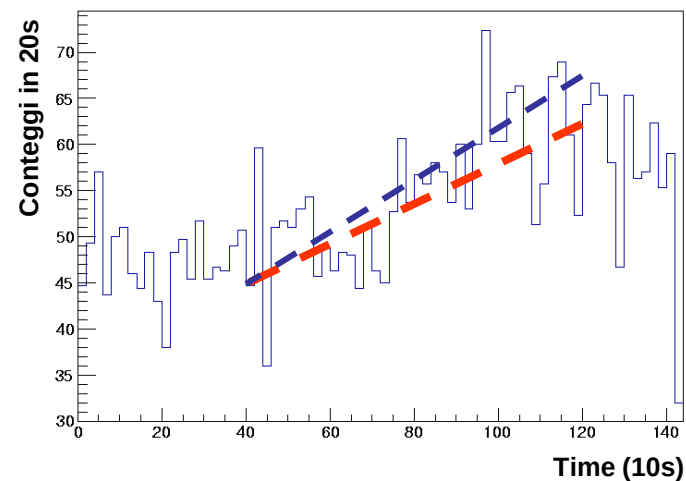
Misure durante la salita in funivia

da Fonte Cerreto (1100m) a Campo Imperatore (2100m)

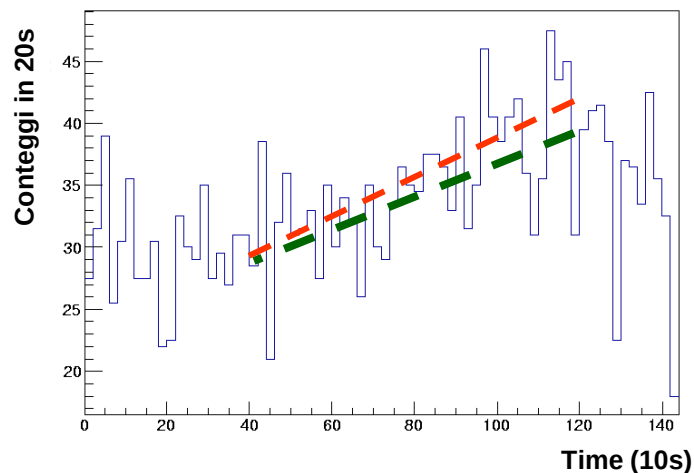
single trend



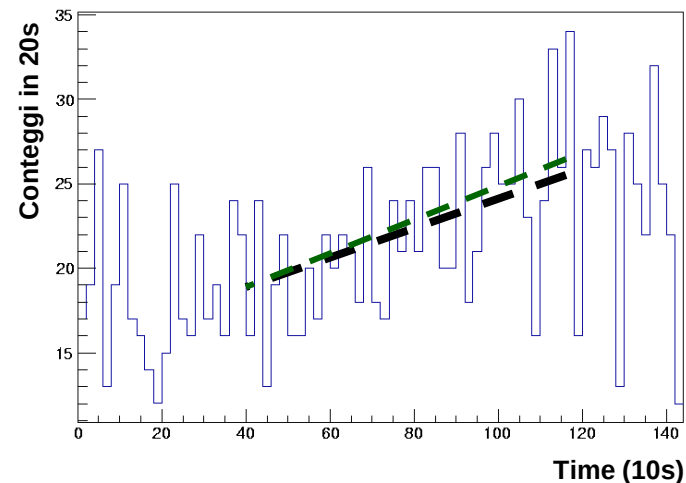
doppie trend



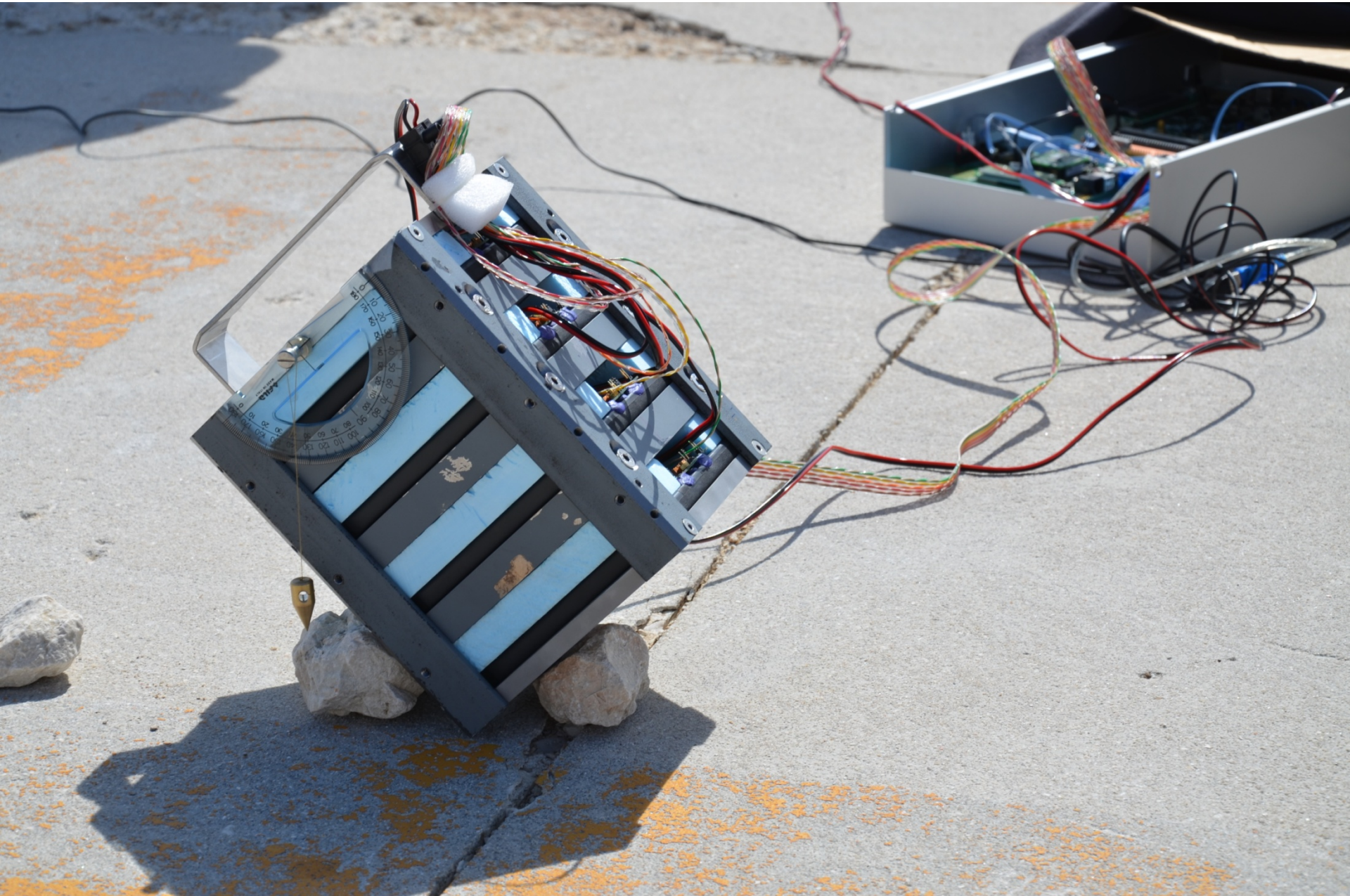
Triple trend



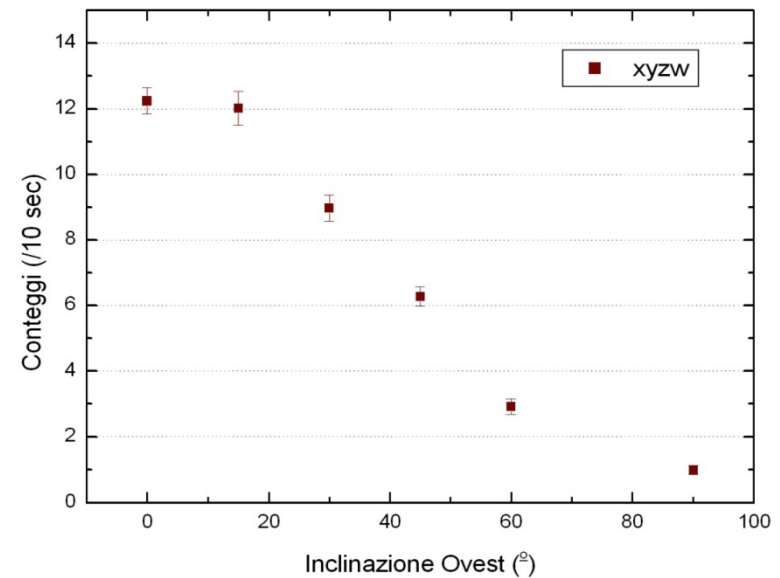
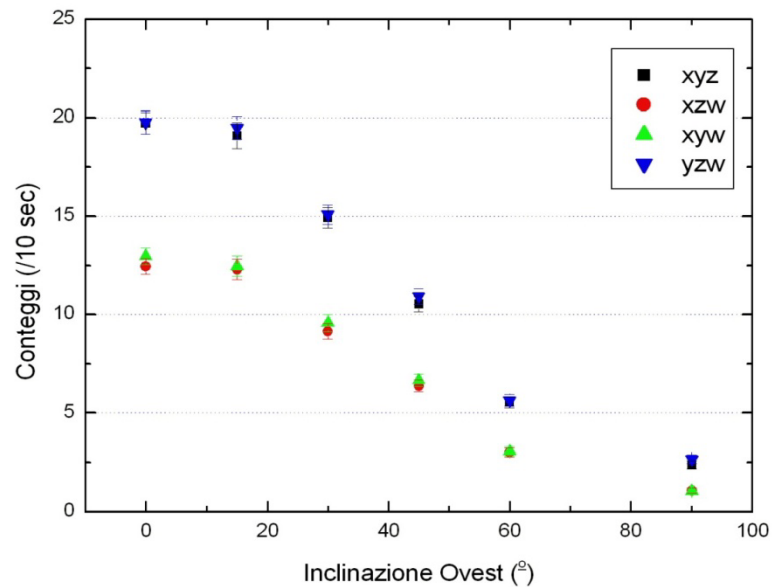
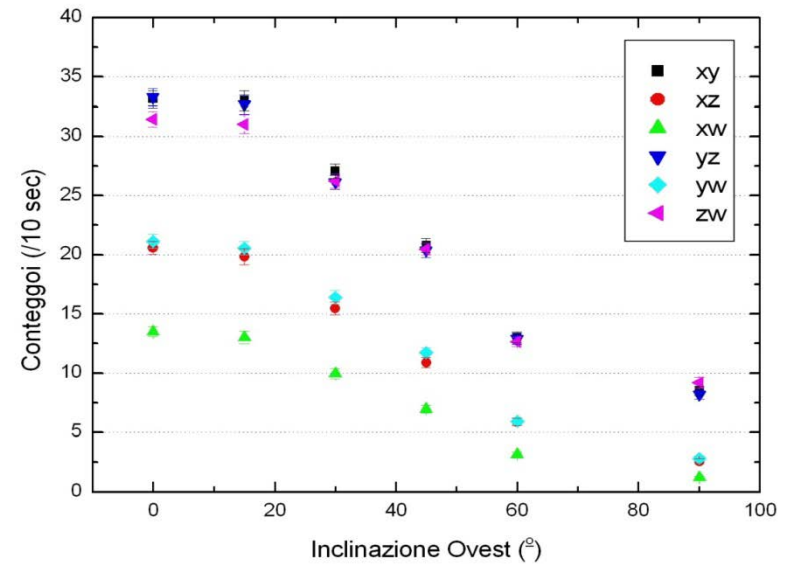
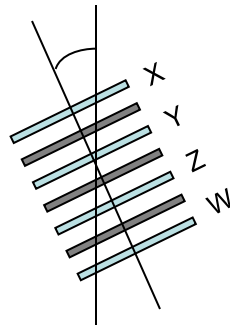
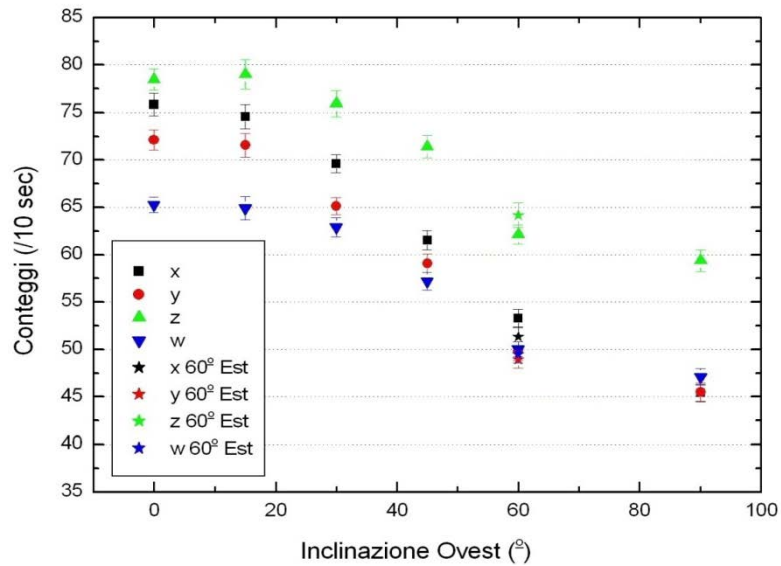
Quadrup trend



Dipendenza dall'angolo di zenith



Dipendenza dall'angolo di zenith





Analisi dati

Test detector

Upgrade detector

Nuove campagne di misure

.....

International Cosmic Day

HOME

International Cosmic Day 2015



Audience

12 to 15 years
15 to 18 years

Language

English

Duration

1 day

Credit

Anneli Schulz

Contact

icd@desy.de

Rankings

☆☆☆☆☆
No votes yet

Tags

astroparticle physics
cosmic rays
AUGER
data analysis

Purpose

Allowing high school student all over the world to perform their own measurements of cosmic rays and discuss their results with other students across the world.

Information

The International Cosmic Day enables students to get in contact with astroparticle physicists to get a first insight into their research, experimental methods and everyday work as a scientist. Some questions which will be addressed are:

- What are cosmic particles?
- Where do they come from?
- How can they be measured?

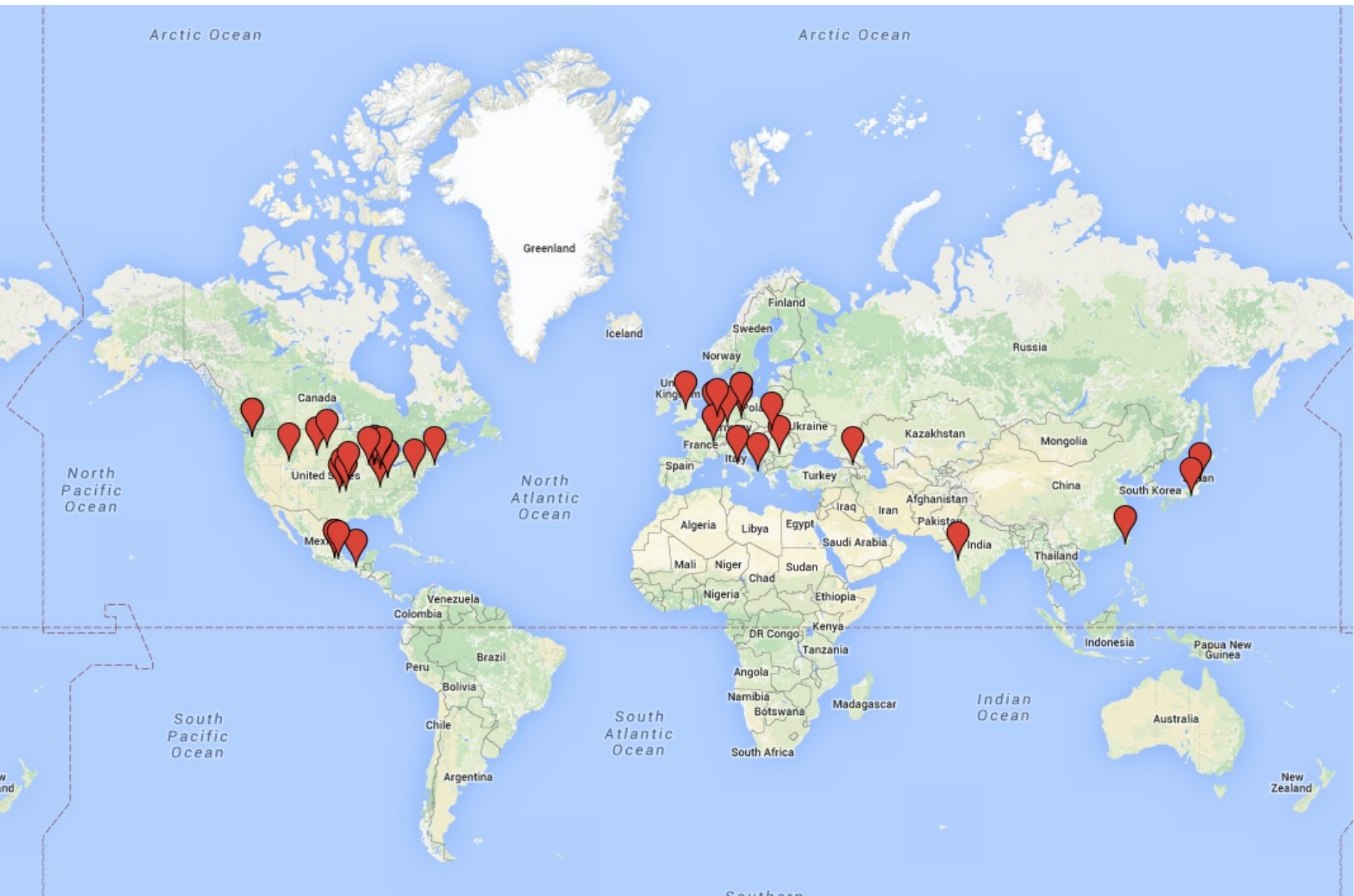
All further information at: <http://icd.desy.de>

Progetto internazionale per gli Istituti Superiori organizzato da DESY Accelerator Laboratory (Amburgo), FERMI National Laboratory (Chicago) e CERN (Ginevra)

Gli studenti entrano in contatto con le attività di ricerca:

- Portano a termine un piccolo esperimento sui raggi cosmici
- Analizzano i dati
- Confrontano i propri risultati con gli altri gruppi collegati da altre università o centri di ricerca nel mondo
- Lavorano per un giorno come in una collaborazione internazionale

ICD 2015

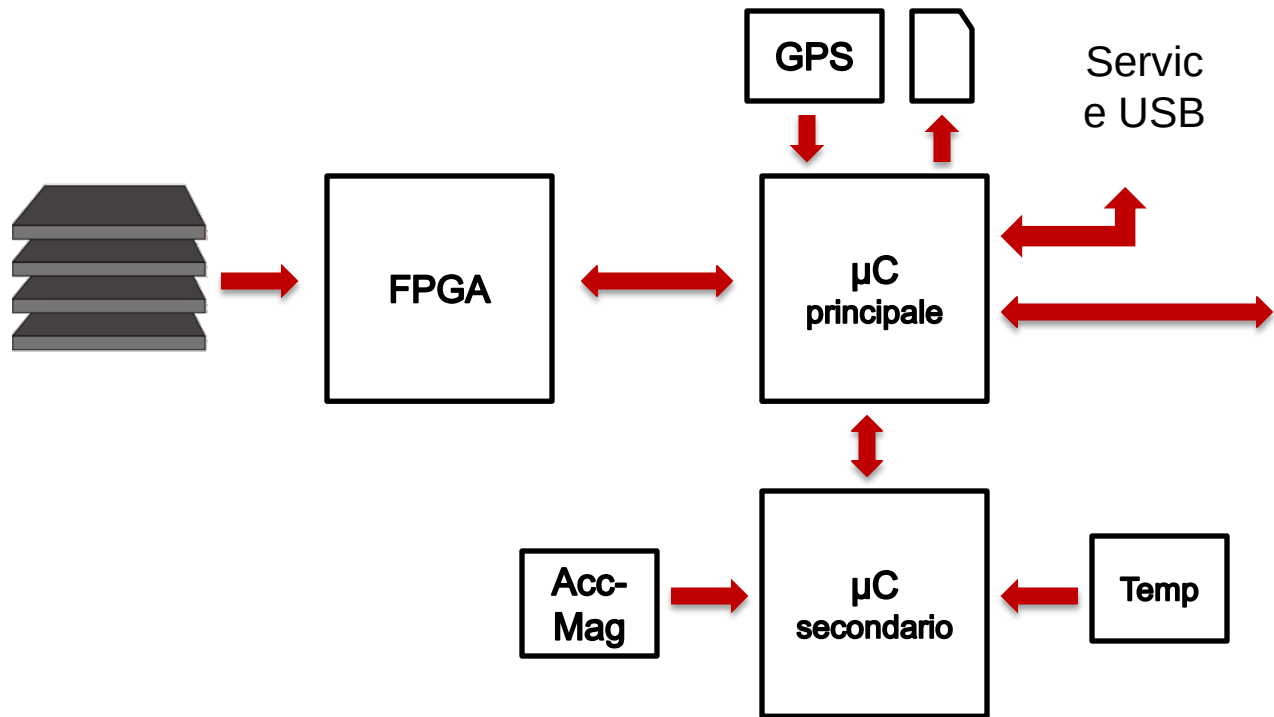


Programma ICD 2015

- Introduzione sui Raggi Cosmici
- Introduzione sul rivelatore
- Presa dati e analisi dati
- Skype chat dalle 09.00
- Video chat alle 12.00
- Dopo una settimana circa:
Poster con risultati – Uno per ogni Istituto

Sistema di acquisizione DAQ

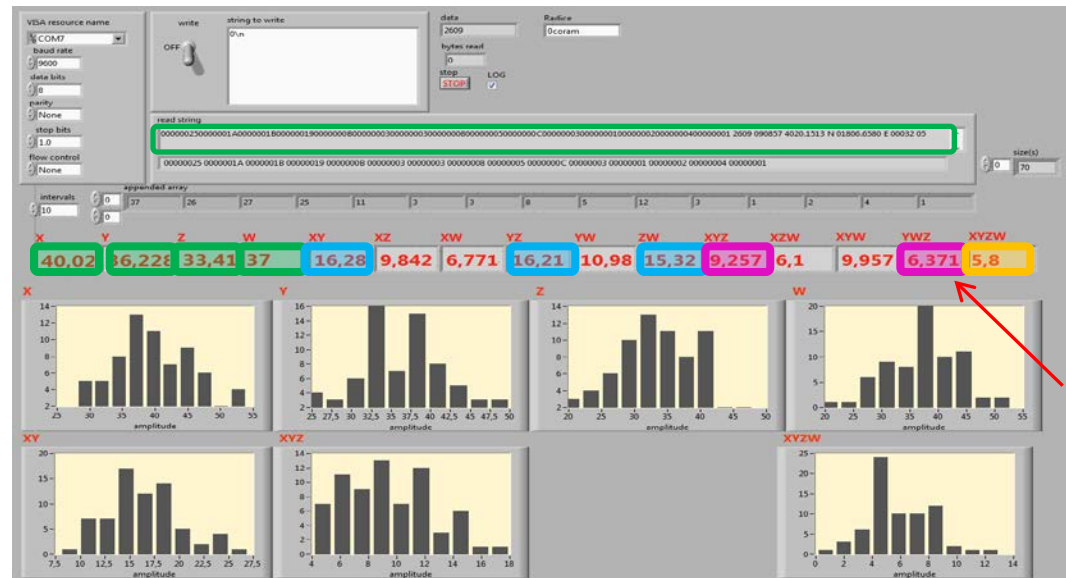
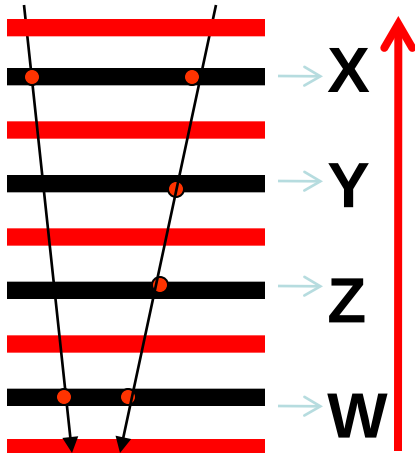
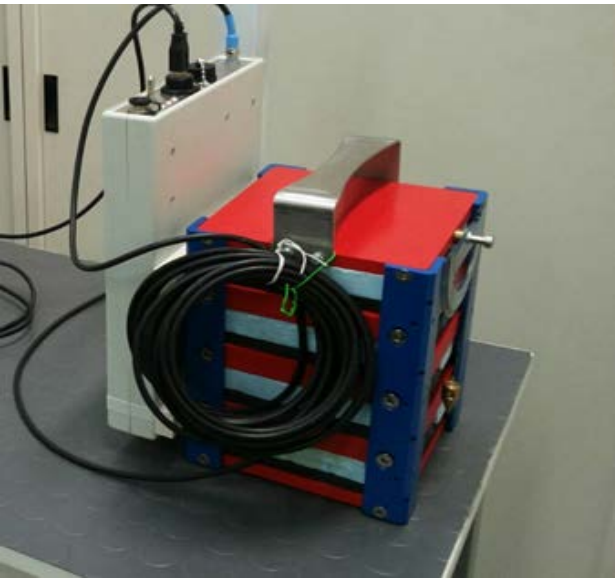
Il DAQ deve raccogliere i segnali provenienti dal rivelatore, digitalizzarli ed integrarli con le informazioni per la geolocalizzazione; effettuare il time stamping e trasferire tali informazioni verso il sistema di telemetria del pallone



Il DAQ è reso completamente ridondante duplicando il circuito

Misuriamo le rate di singola, doppia, tripla e quadrupla.
(Per le doppie e le triple consideriamo solo quelle dei piani adiacenti)

- singole -> X Y Z W
- doppie (2 piani adiacenti) -> XY YZ ZW
- triple (3 piani adiacenti) -> XYZ YZW
- quadrupla XYZW



Media delle
coincidenze dei
piani

SINGOLE
QUADRUPLA

DOPPIE

TRIPLE

File Dati

Per ogni misura fatta, oltre al file .png con la schermata finale dell'interfaccia grafica, viene fornito anche il file .txt con i dati salvati (conteggi al secondo).

0gradi.txt - Notepad

File	Edit	Format	View	Help													
1,0000	0,0000	3,0000	2,0000	2,0000	2,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
1,0000	0,0000	1,0000	2,0000	4,0000	1,0000	0,0000	0,0000	0,0000	0,0000	1,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
1,0000	0,0000	2,0000	7,0000	3,0000	4,0000	1,0000	1,0000	0,0000	2,0000	1,0000	1,0000	1,0000	0,0000	0,0000	1,0000	0,0000	0,0000
1,0000	0,0000	2,0000	2,0000	3,0000	3,0000	1,0000	1,0000	0,0000	1,0000	0,0000	1,0000	1,0000	0,0000	0,0000	0,0000	0,0000	0,0000
1,0000	0,0000	5,0000	7,0000	1,0000	1,0000	2,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
1,0000	0,0000	0,0000	0,0000	2,0000	1,0000	1,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
1,0000	0,0000	7,0000	3,0000	3,0000	11,0000	2,0000	1,0000	1,0000	2,0000	2,0000	3,0000	1,0000	1,0000	1,0000	2,0000	1,0000	1,0000
1,0000	0,0000	4,0000	4,0000	3,0000	3,0000	1,0000	0,0000	0,0000	1,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
1,0000	0,0000	1,0000	4,0000	1,0000	4,0000	0,0000	0,0000	0,0000	1,0000	1,0000	1,0000	0,0000	0,0000	0,0000	1,0000	0,0000	0,0000
1,0000	0,0000	6,0000	5,0000	4,0000	5,0000	0,0000	0,0000	0,0000	0,0000	0,0000	2,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
1,0000	0,0000	7,0000	5,0000	4,0000	4,0000	3,0000	1,0000	2,0000	1,0000	2,0000	1,0000	1,0000	1,0000	2,0000	1,0000	1,0000	1,0000
1,0000	0,0000	3,0000	4,0000	6,0000	6,0000	1,0000	2,0000	1,0000	2,0000	1,0000	4,0000	1,0000	1,0000	0,0000	1,0000	0,0000	0,0000
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1,0000	0,0000	3,0000	2,0000	7,0000	5,0000	0,0000	1,0000	1,0000	1,0000	0,0000	2,0000	0,0000	1,0000	0,0000	0,0000	0,0000	0,0000
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1,0000	0,0000	7,0000	5,0000	4,0000	6,0000	1,0000	1,0000	1,0000	2,0000	4,0000	3,0000	1,0000	1,0000	1,0000	2,0000	1,0000	1,0000
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1,0000	0,0000	3,0000	2,0000	2,0000	5,0000	0,0000	0,0000	0,0000	1,0000	1,0000	1,0000	0,0000	0,0000	0,0000	1,0000	0,0000	0,0000

Misure fatte a 7 angoli diversi: 0, 15, 30, 45, 60, 75, 90 deg.

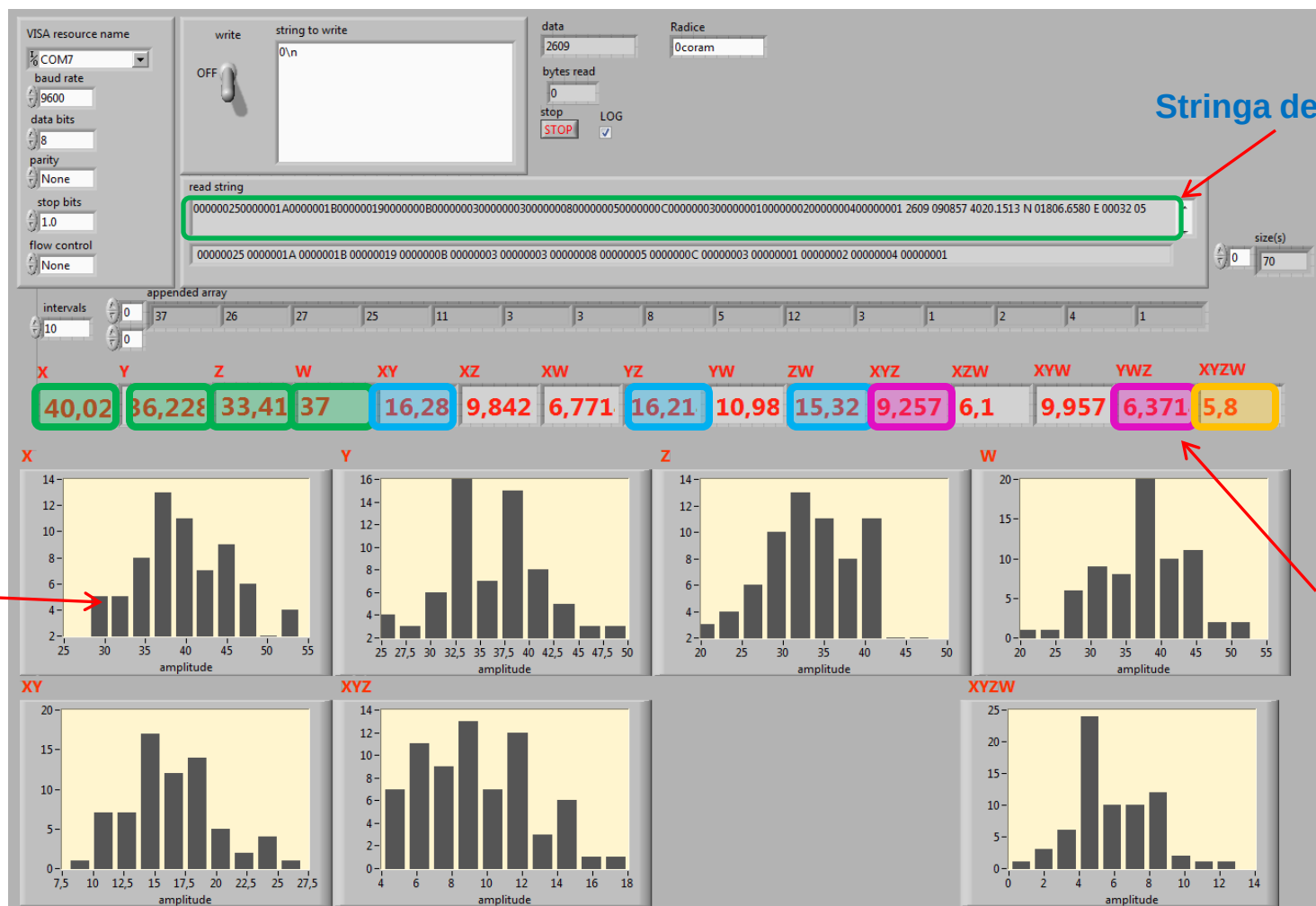
Nel nome del file si riporta l'angolo cui è stata fatta la misura.

In ogni file ci sono 17 colonne che corrispondono a :

Data - ora - **x** - **y** - **z** - **w** - **xy** - xz - xw - **yz** - yw - **zw** - **xyz** - xzw - xyw - **yzw** - **xyzw**

NB data e ora non corrette perché il GPS non prendeva.

Interfaccia Grafica



Stringa dell'evento

Conteggi
/10s

Media delle
coincidenze
dei piani

Istogram
mi
delle
coincidenze

SINGOLE

DOPPIE

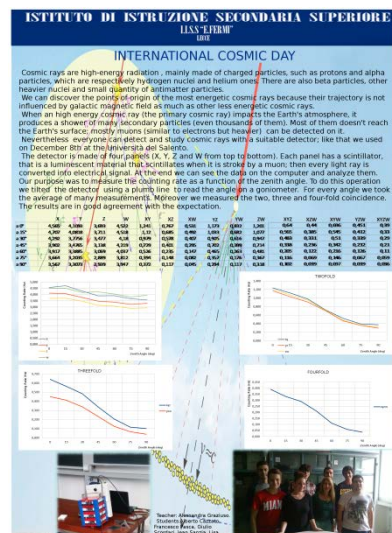
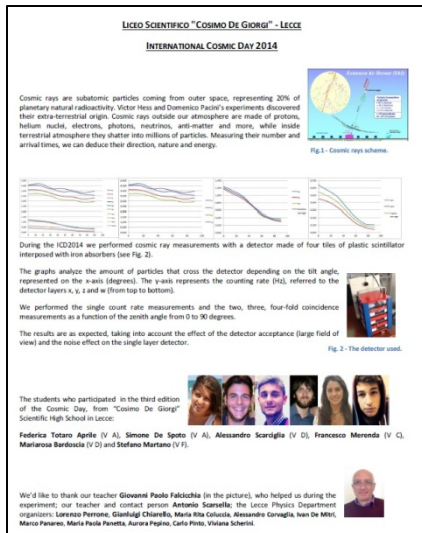
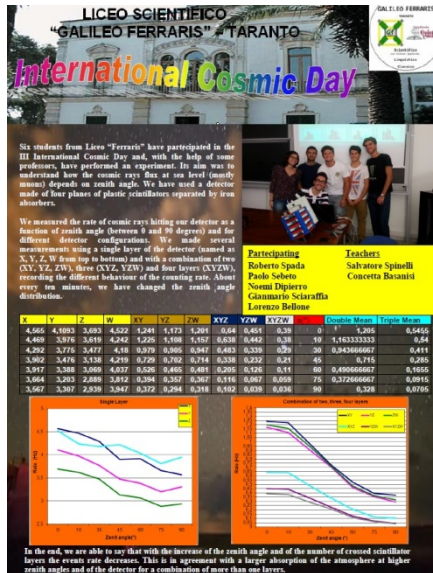
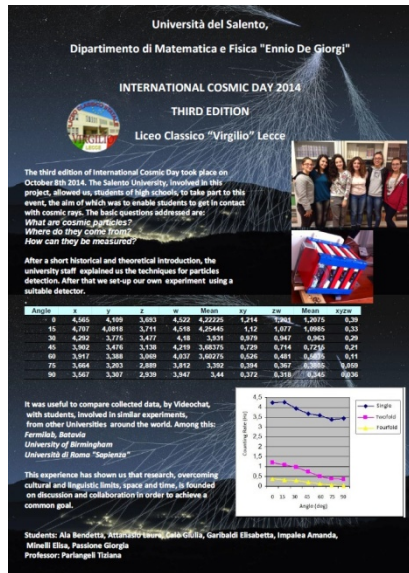
TRIPLE

QUADRUPLA

Booklet 2015

- Risultati pubblicati su booklet con quelli dei colleghi delle altre scuole di tutto il mondo
- I dati delle misure fatte vengono consegnati ad ogni gruppo
- Ogni gruppo di studenti deve:
 - Analizzare i dati e produrre un grafico
 - Preparare una pagina pdf con:
 1. Introduzione
 2. Risultati
 3. Foto
 4. Nome Istituto e partecipanti

Alcuni poster



Che cosa è
richiesto per la
pubblicazione
sul booklet!

INTERNATIONAL COSMIC DAY 2014

THIRD EDITION

Liceo Classico "Virgilio" Lecce



The third edition of International Cosmic Day took place on October 8th 2014. The Salento University, involved in this project, allowed us, students of high schools, to take part to this event, the aim of which was to enable students to get in contact with cosmic rays. The basic questions addressed are:
 What are cosmic particles?
 Where do they come from?
 How can they be measured?

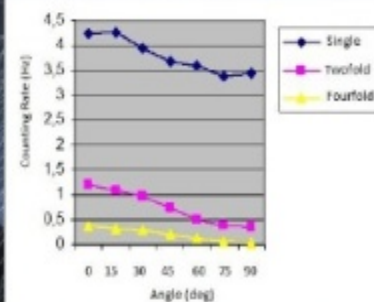
After a short historical and theoretical introduction, the university staff explained us the techniques for particles detection. After that we set-up our own experiment using a suitable detector.

Angle	x	y	z	w	Mean	xy	zw	Mean	xyzw
0	4,565	4,109	3,693	4,522	4,22225	1,214	1,201	1,2075	0,39
15	4,707	4,0818	3,711	4,518	4,25445	1,12	1,077	1,0985	0,33
30	4,292	3,775	3,477	4,18	3,931	0,979	0,947	0,963	0,29
45	3,902	3,476	3,138	4,219	3,68375	0,729	0,714	0,7215	0,21
60	3,917	3,388	3,069	4,037	3,60275	0,526	0,481	0,5035	0,11
75	3,664	3,203	2,889	3,812	3,392	0,394	0,367	0,3805	0,059
90	3,567	3,307	2,939	3,947	3,44	0,372	0,318	0,345	0,036

It was useful to compare collected data, by Videochat, with students, involved in similar experiments, from other Universities around the world. Among this:
 Fermilab, Batavia
 University of Birmingham
 Università di Roma "Sapienza"

This experience has shown us that research, overcoming cultural and linguistic limits, space and time, is founded on discussion and collaboration in order to achieve a common goal.

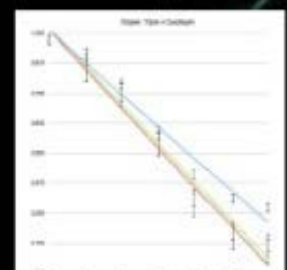
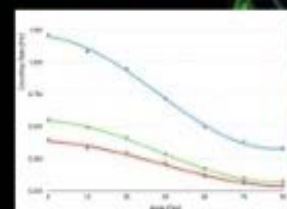
Students: Ala Bendetta, Attanasio Laura, Calò Giulia, Garibaldi Elisabetta, Impalea Amanda,
 Minelli Elisa, Passione Giorgia
 Professor: Parlangei Tiziana



Zenith Angle Distribution of Air Shower Particles



The aim of this activity was to introduce us to cosmic rays physics. In order to have a clear evidence of this class of phenomena, we used two different muon detectors. Both devices were composed by four scintillating layers, interposed by iron absorbers. The first one, designed mainly for didactic purposes, gave us the possibility of handling directly its components. However, we performed more accurate measurements using the second one, in order to analyze the ratio of the inclined to the vertical muon flux as a function of the zenith angle θ (fig. 1) or of $\cos^2\theta$ (fig.2). The signals released by the muons in the scintillators were processed by its software, which gave us their count rates, at different angles, taken over ten minutes long time intervals. To maximize the signal to background ratio, we considered the rate of two, three and four-fold coincidences, as shown in the graphs on the left and in the chart on the top. Graphs in fig 1. show a vertical shifting, if compared with a $\cos^2\theta$ function, because of the finite detector angular acceptance. However, graphs in fig 2, as expected, show a linear behavior.

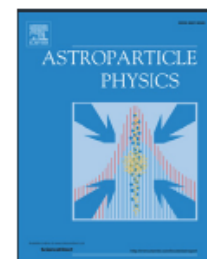




Contents lists available at ScienceDirect

Astroparticle Physics

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



Searching for ultra-high energy cosmic rays with smartphones



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Dustin Burns^b

^a Department of Physics and Astronomy, University of California, Irvine, CA 92697, United States

^b Department of Physics, University of California, Davis, CA, United States

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ABSTRACT

We propose a novel approach for observing cosmic rays at ultra-high energy ($>10^{18}$ eV) by repurposing the existing network of smartphones as a ground detector array. Extensive air showers generated by cosmic rays produce muons and high-energy photons, which can be detected by the CMOS sensors of smartphone cameras. The small size and low efficiency of each sensor is compensated by the large number of active phones. We show that if user adoption targets are met, such a network will have significant observing power at the highest energies.

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