



I raggi cosmici

... a Lecce dal 1987

Paolo Bernardini

Dipartimento di Matematica e Fisica
"Ennio De Giorgi" - Università del Salento

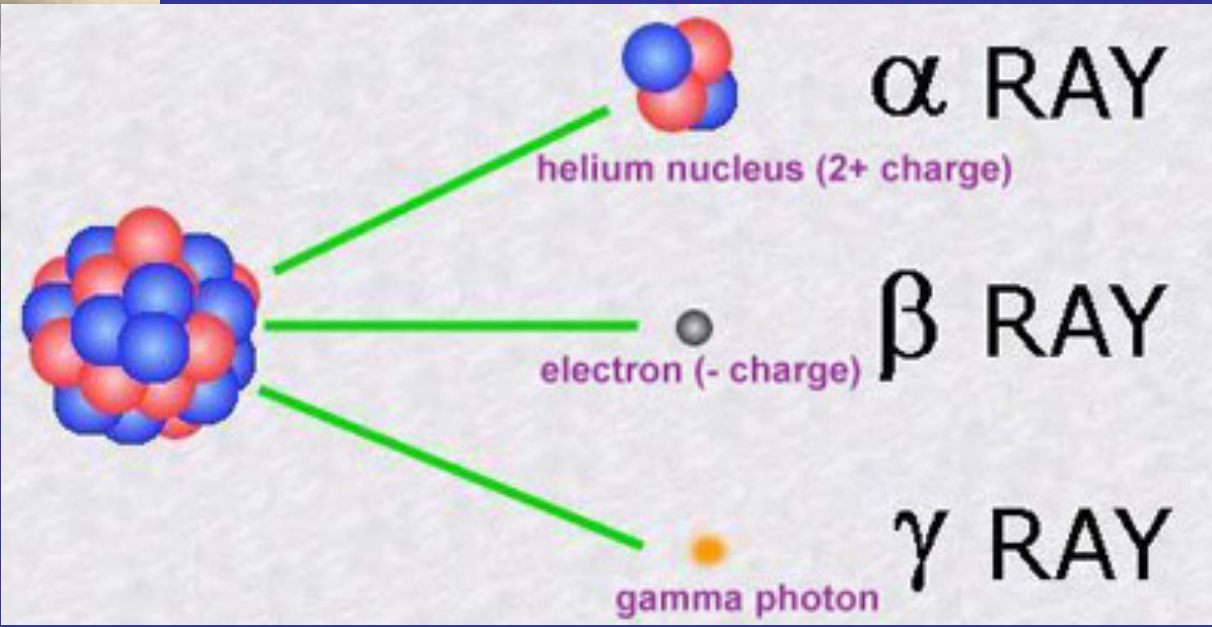
Istituto Nazionale Fisica Nucleare - Lecce



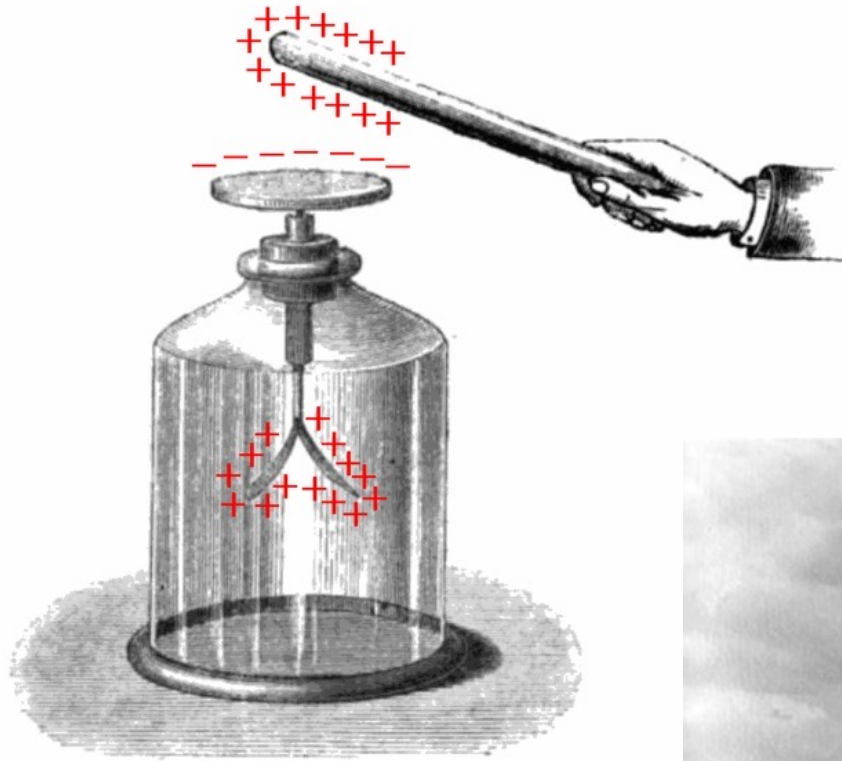
colorization © todayinsci.com

Becquerel 1896

Scoperta della radioattività



Misure sulla ionizzazione dell'aria



Quale radiazione
fa scaricare
gli elettroscopi ?



Agosto 1912, Viktor Hess
5350 m di quota



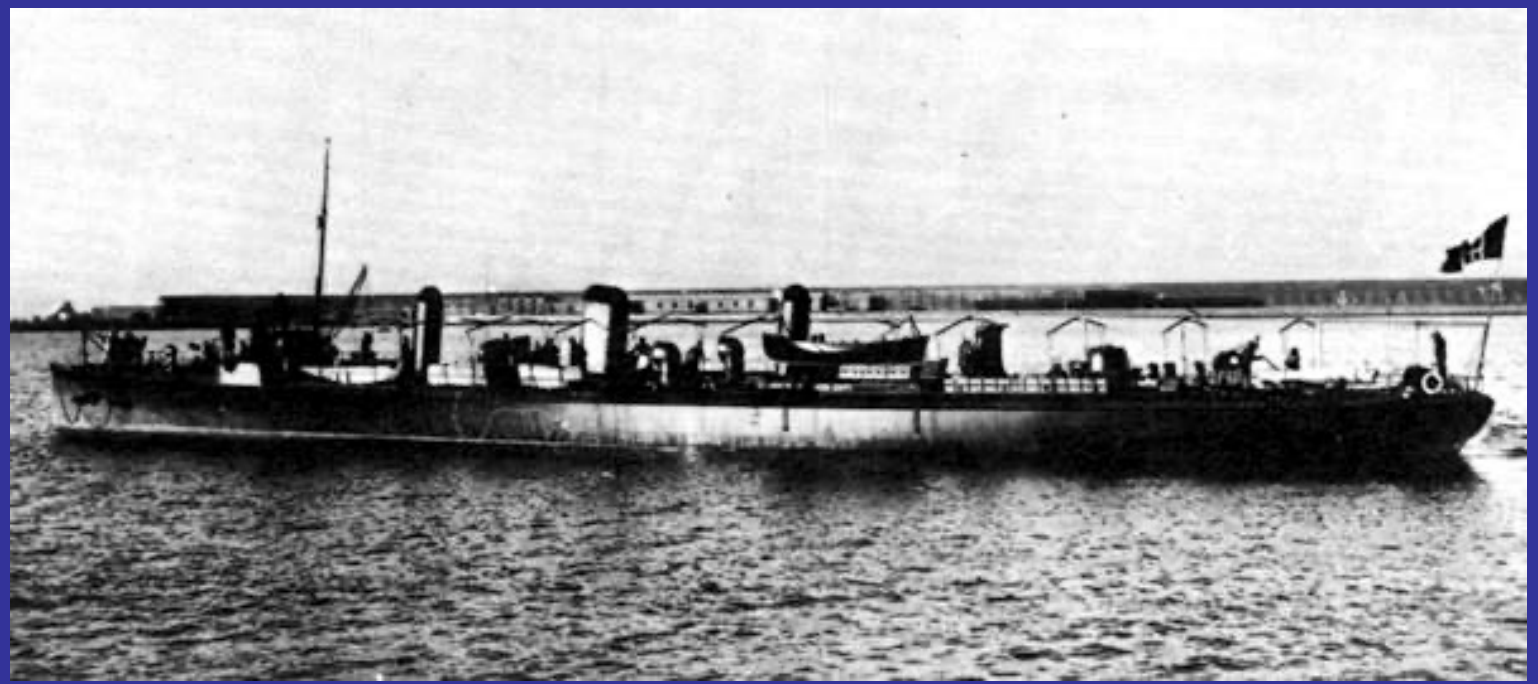
*... eine Strahlung von sehr hoher Durchdringungskraft
von oben her in unsere Atmosphäre eindringt ...*

_____ Viktor F. Hess, Physik. Zeitschr. XIII (1912) 1084



1912, Domenico Pacini

cacciatorpediniere
"Fulmine"



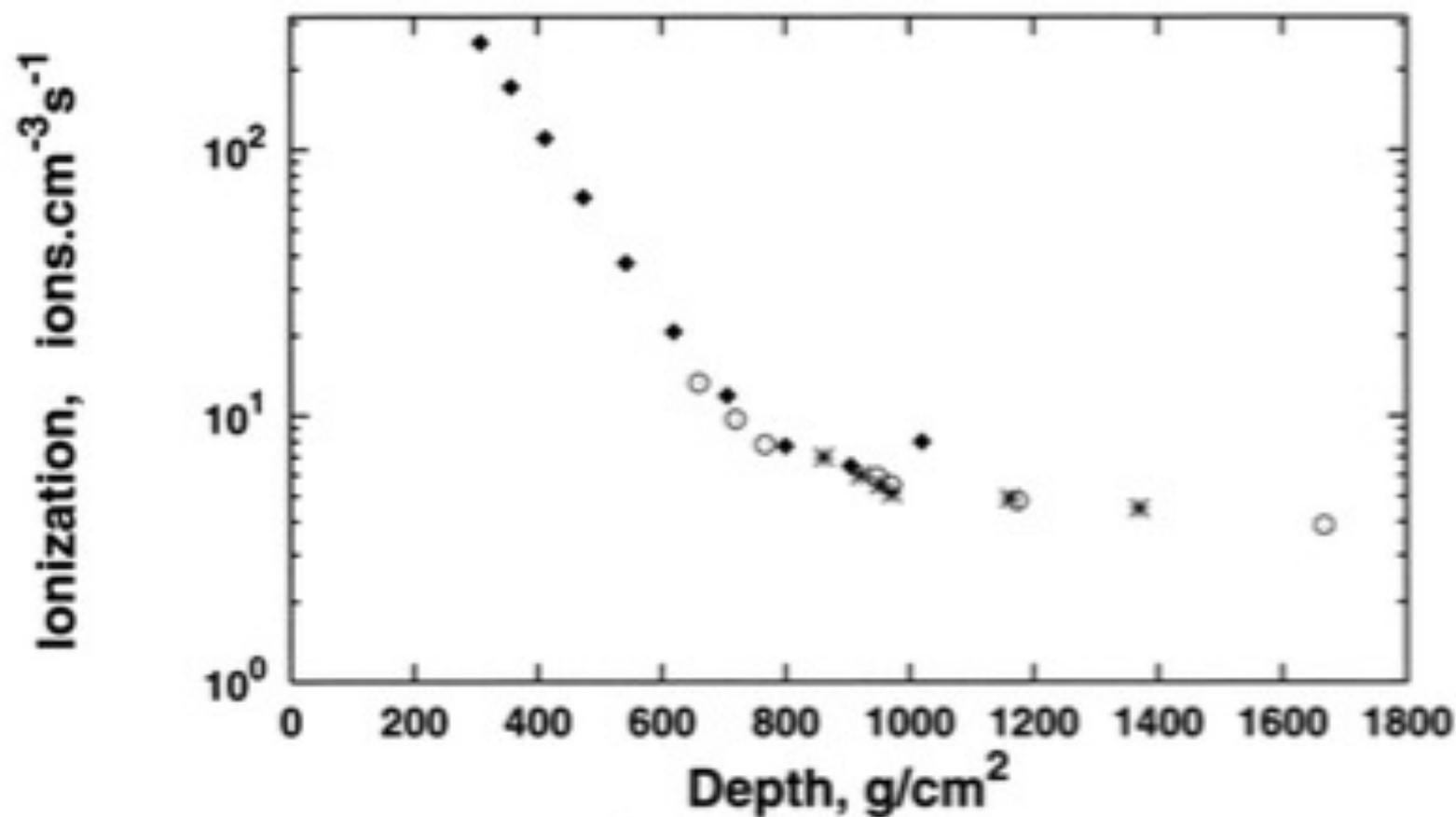
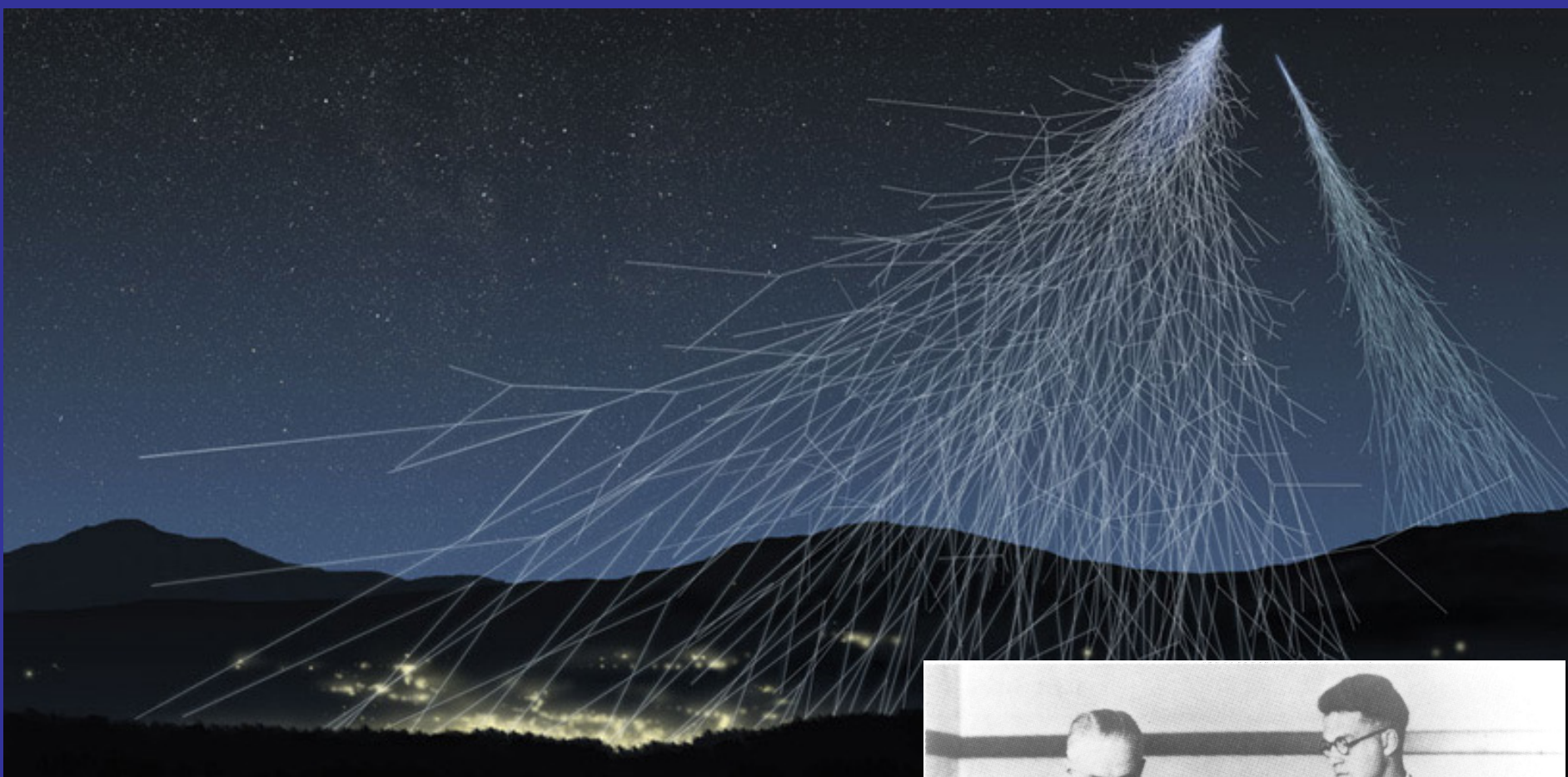
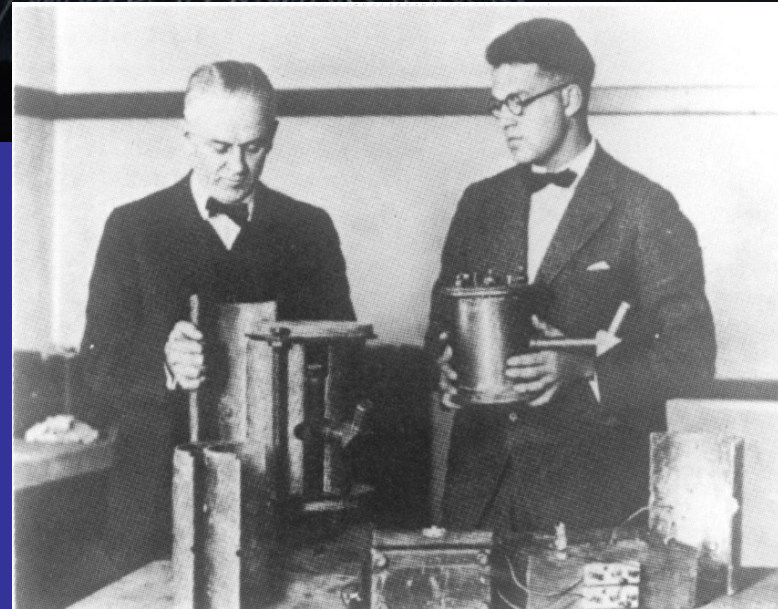


Fig. 1.1. The ionization as a function of the depth in the atmosphere. The diamonds are from the flight of Kohlhörster and the circles and asterisks are from the underwater measurements of Millikan.



"raggi cosmici"

Robert Millikan



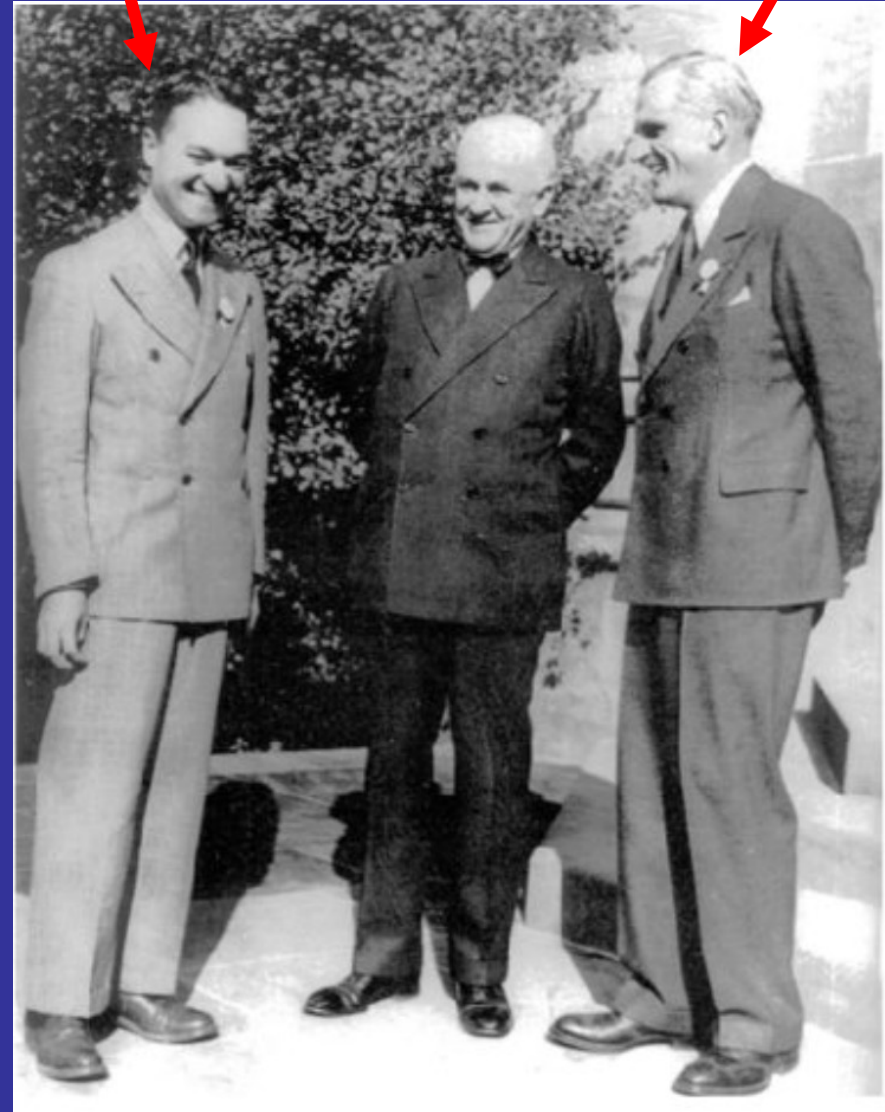
Bruno Rossi

Arthur H. Compton

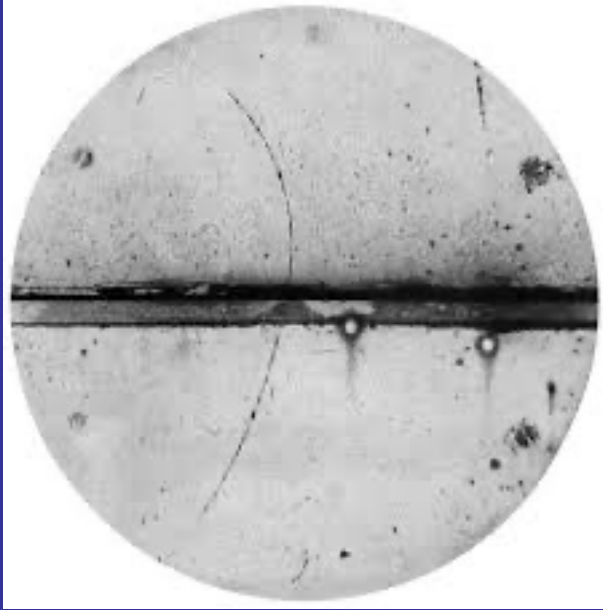
Effetti dovuti al campo
magnetico terrestre
sui raggi cosmici

↳ particelle
elettricamente
cariche
(non fotoni)

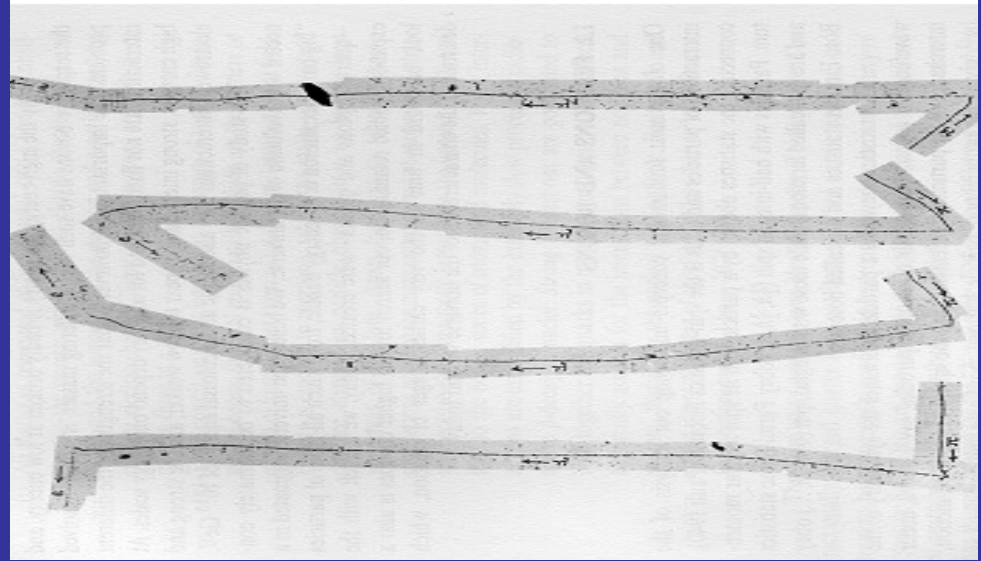
protoni, nuclei di elio,
elettroni (~ 3%)



positrone (1933)



pione (1947)



muone (1937)

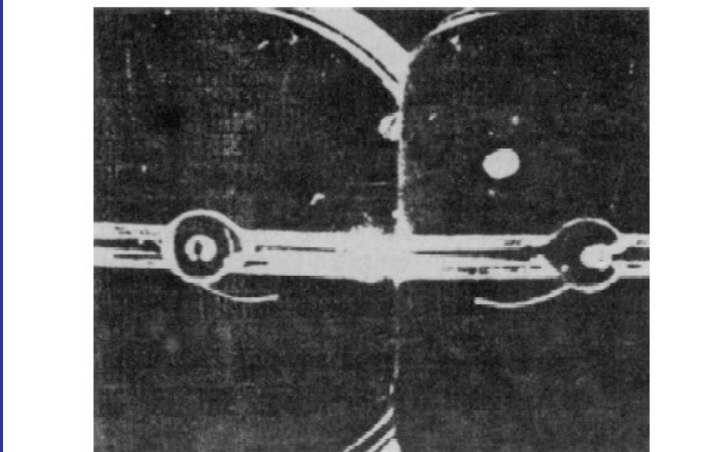
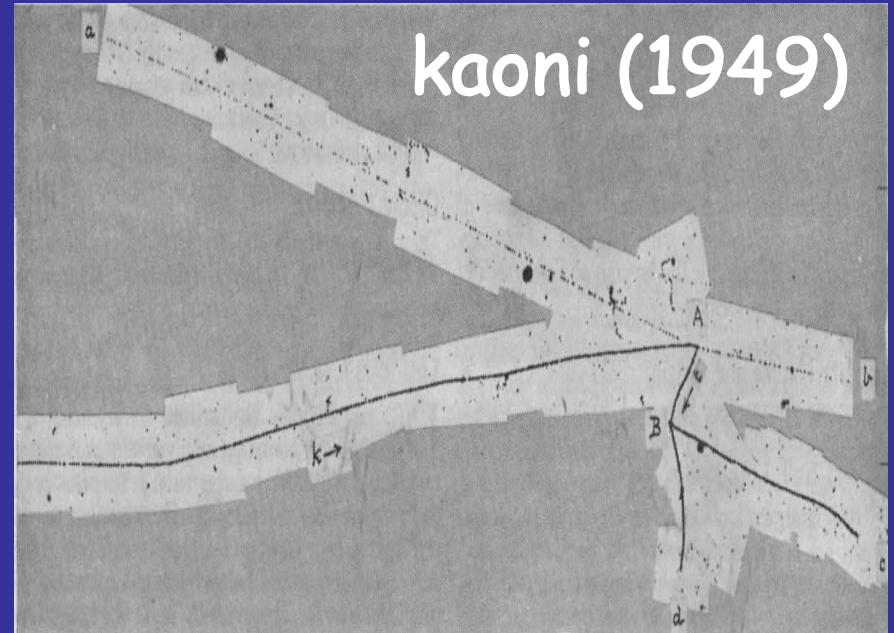
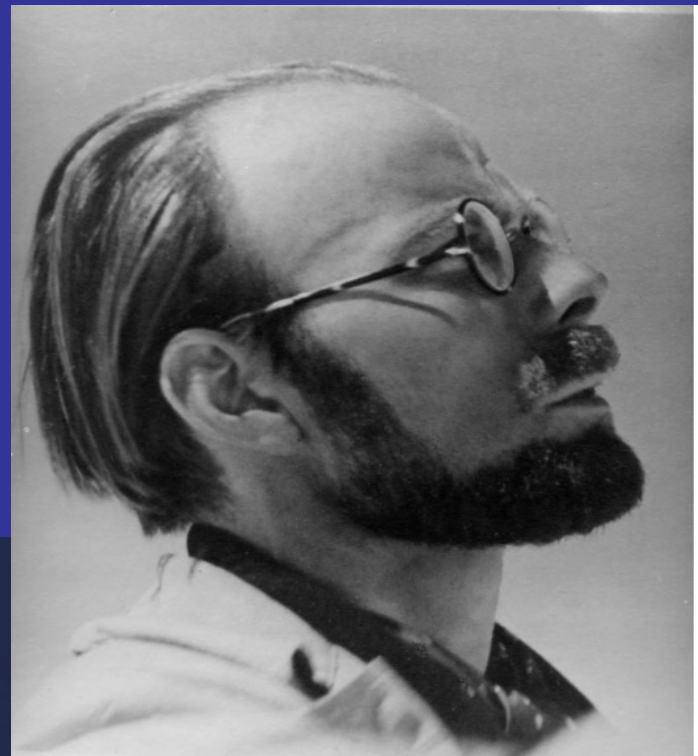


Fig. 1. - Evidenza in camera di Wilson di un muone positivo che attraversa un contatore di Geiger entro la camera [1]. La sensibilità della camera non poteva arrivare a rivelare l'elettrone di decadimento.

kaoni (1949)



Jungfraujoch

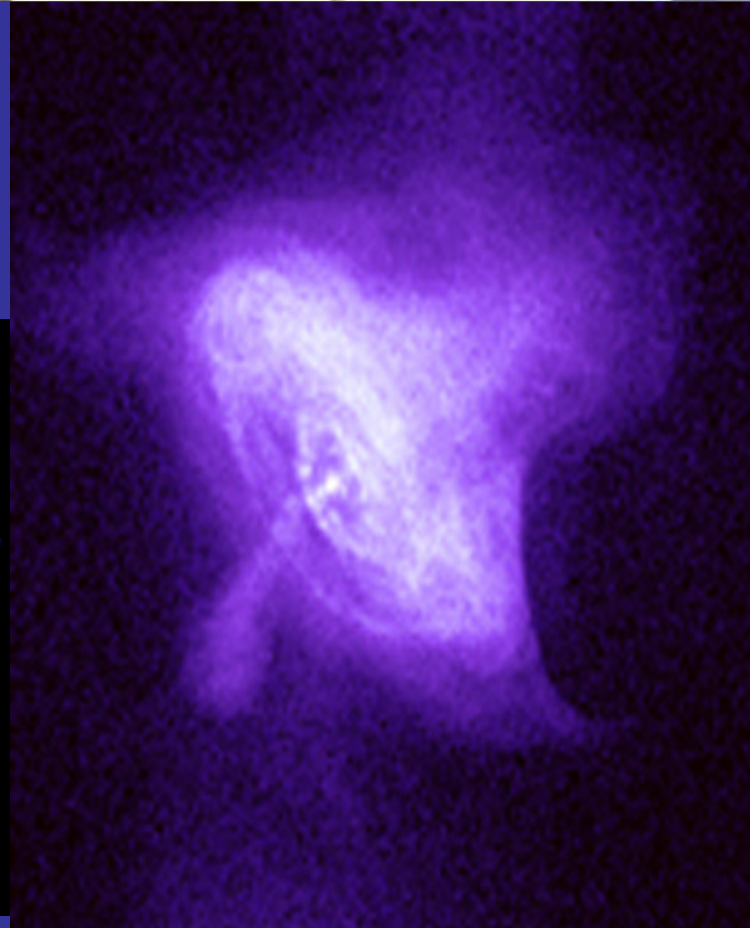
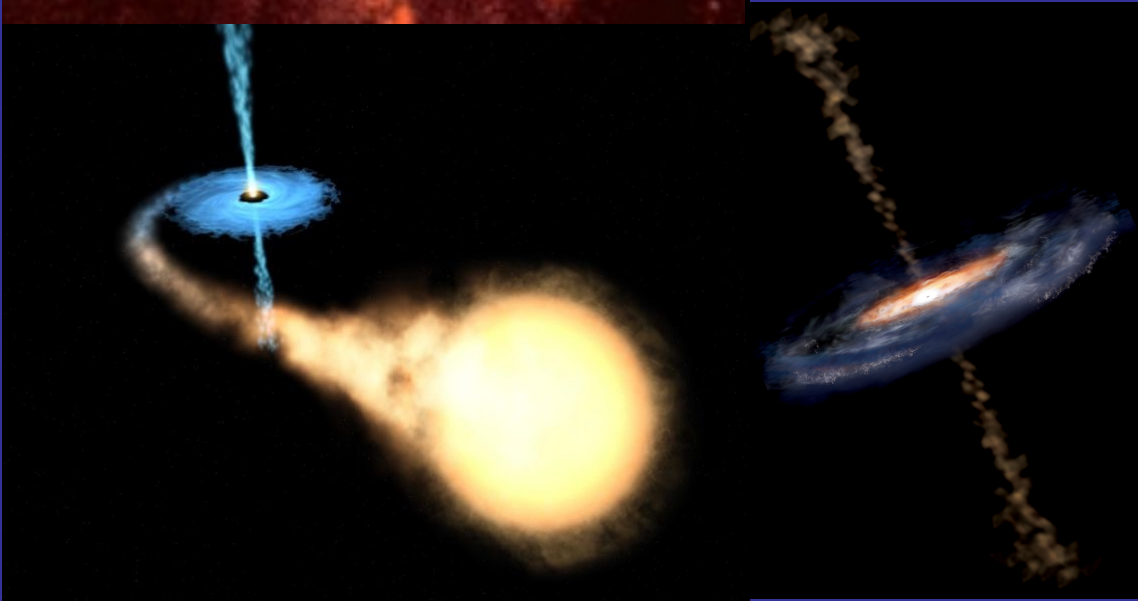
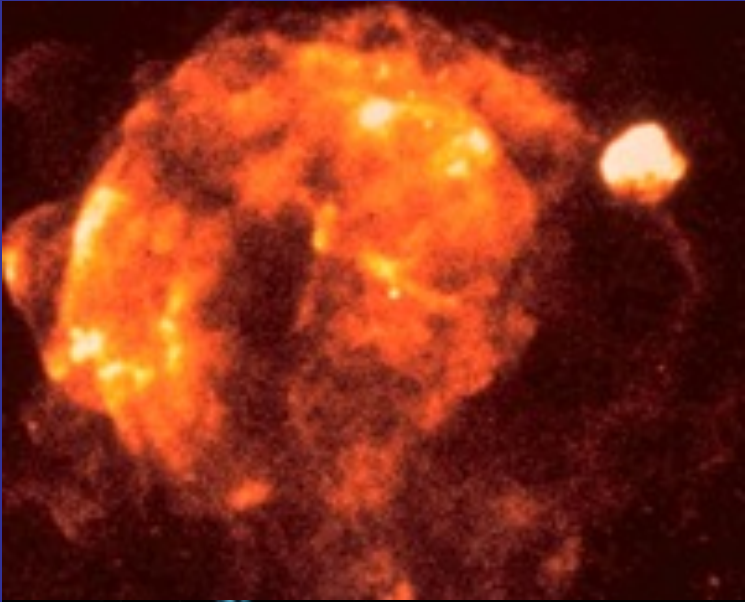
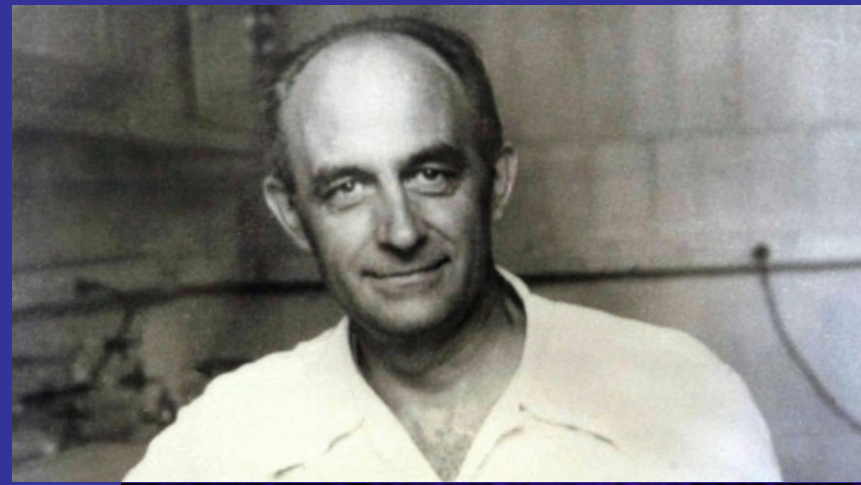


Pierre Auger, 1938

sciami estesi



1949, Enrico Fermi e gli acceleratori cosmici



EVIDENCE FOR A PRIMARY COSMIC-RAY PARTICLE WITH ENERGY 10^{20} eV

John Linsley

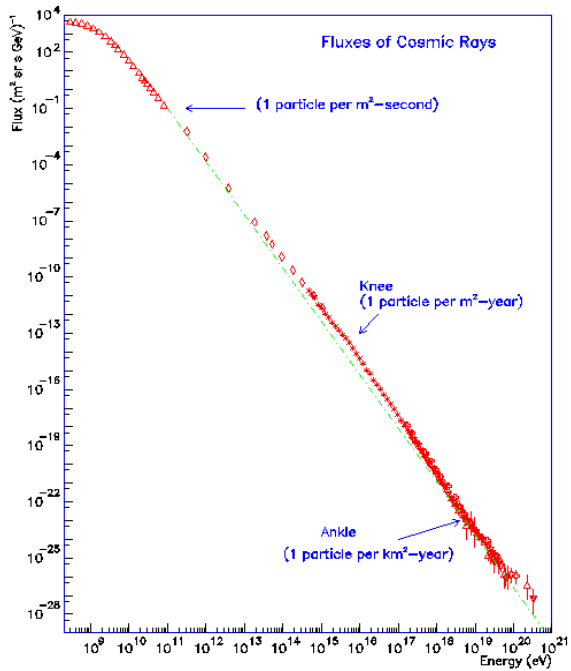
Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts

(Received 10 January 1963)

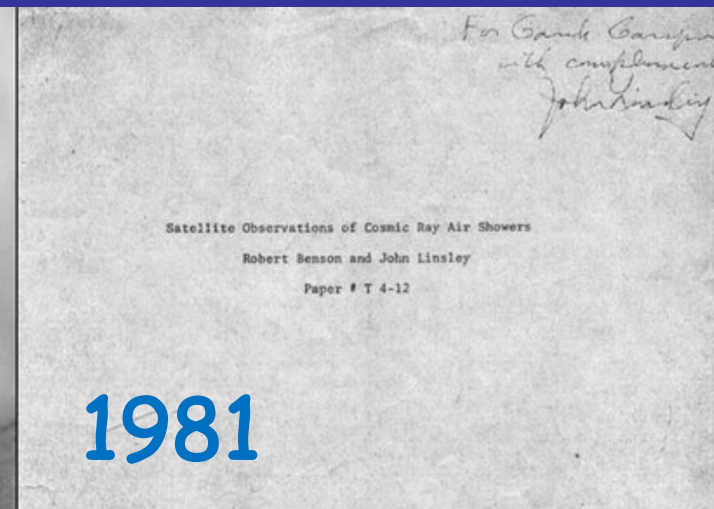
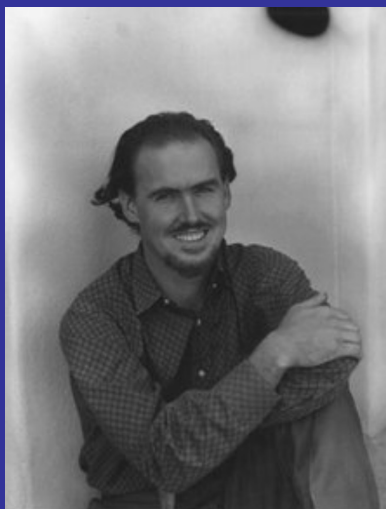
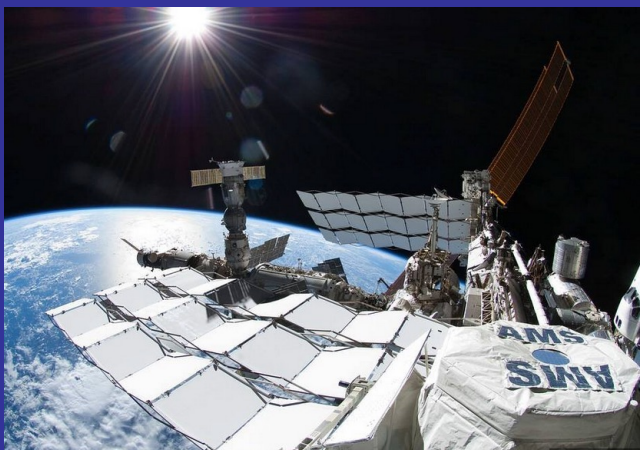


1963

Scintillator



John Linsley



1981

La ricerca degli acceleratori cosmici continua ...



MACRO al Gran Sasso



ARGO-YBJ in Tibet



PAO in Argentina



DAMPE in orbita



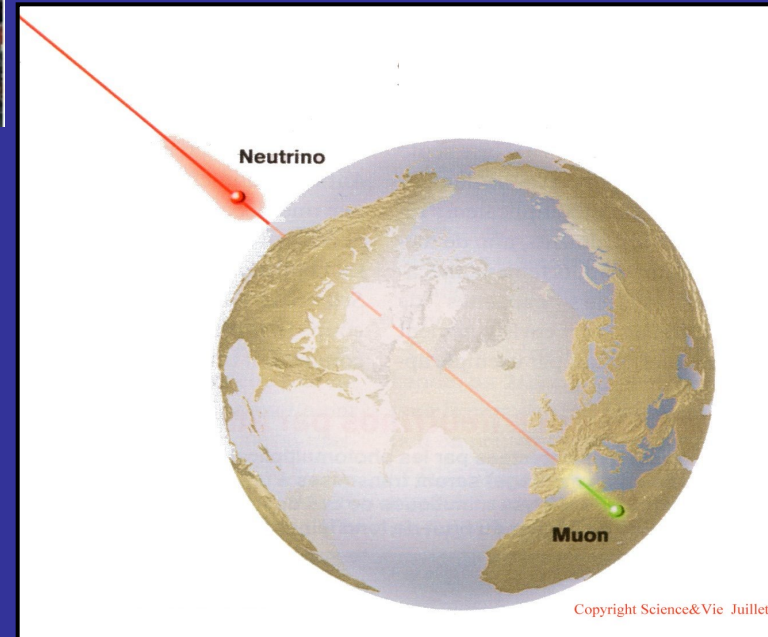
Laboratori sotterranei
per scrutare il cielo

MACRO al Gran Sasso (1987-2000)



Le tracce dal basso sono dovute a neutrini prodotti da raggi cosmici e che hanno attraversato l'intero pianeta

Un'anomalia nei dati

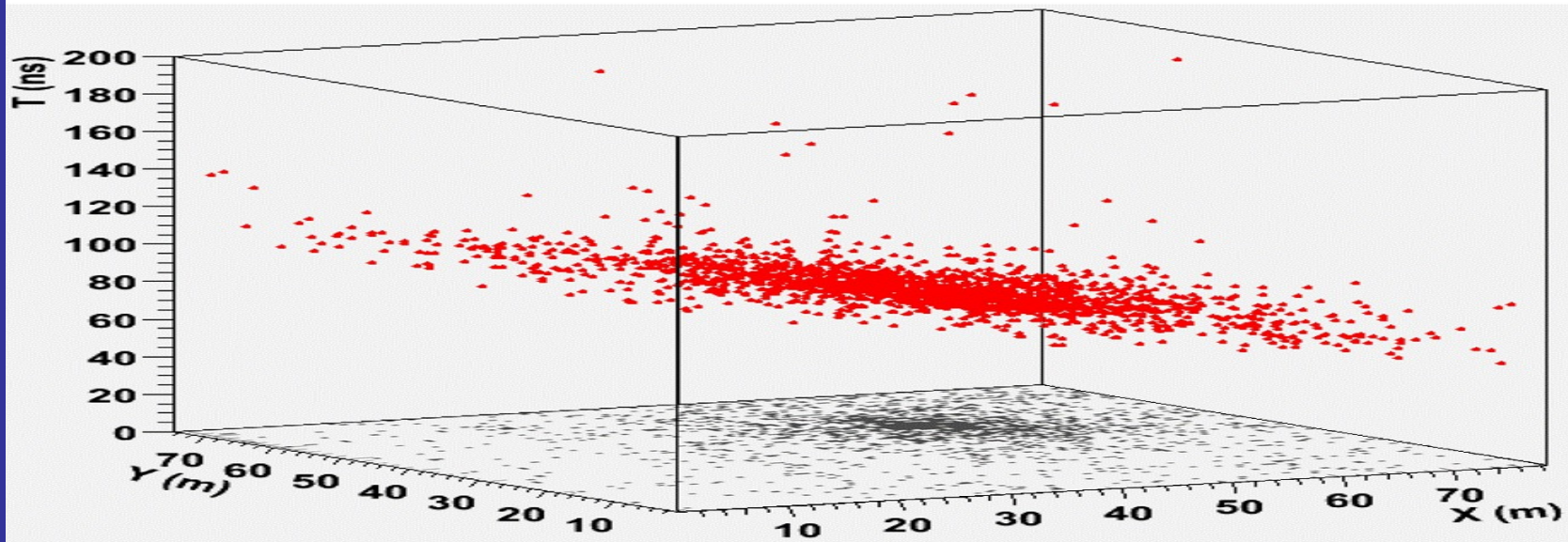
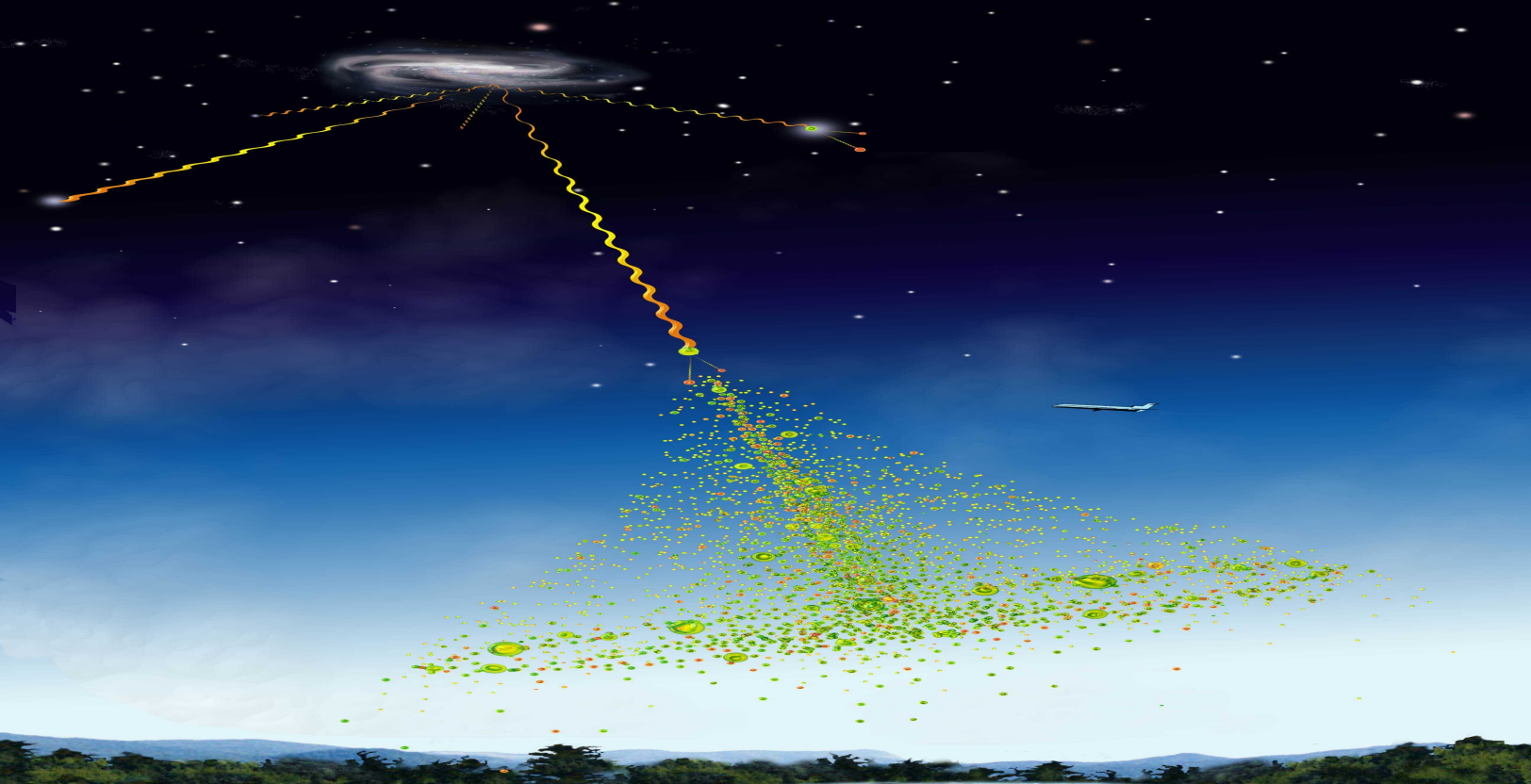


ARGO-YBJ in Tibet

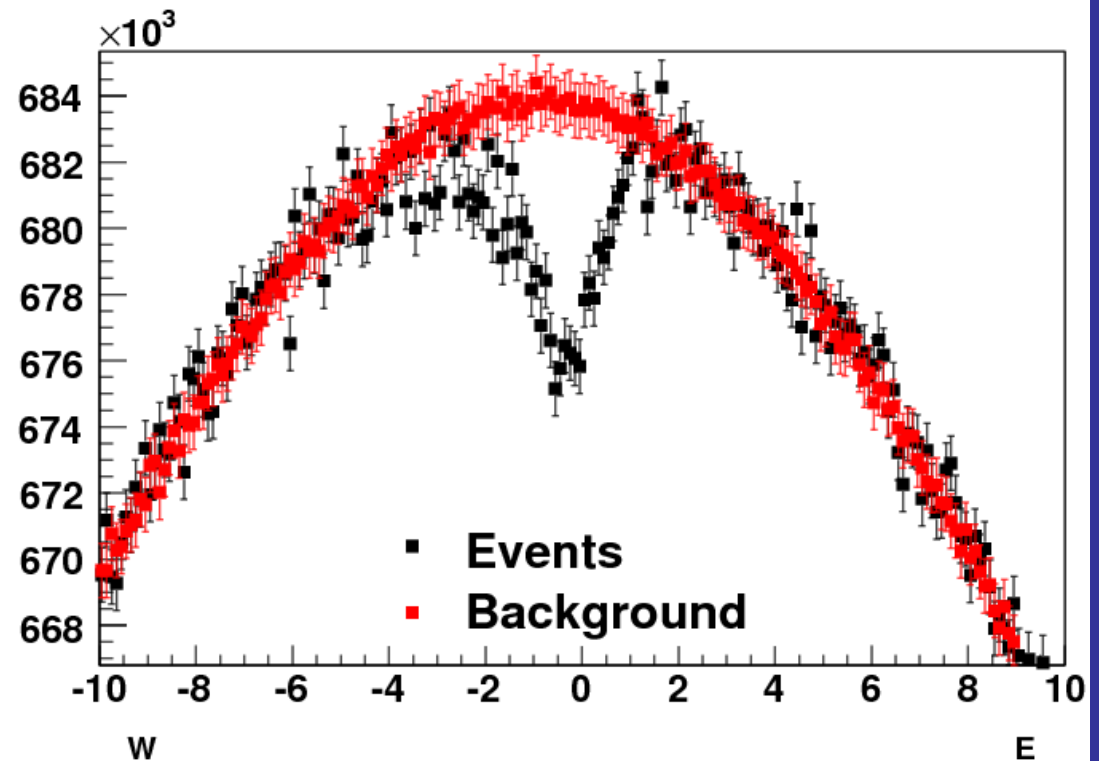
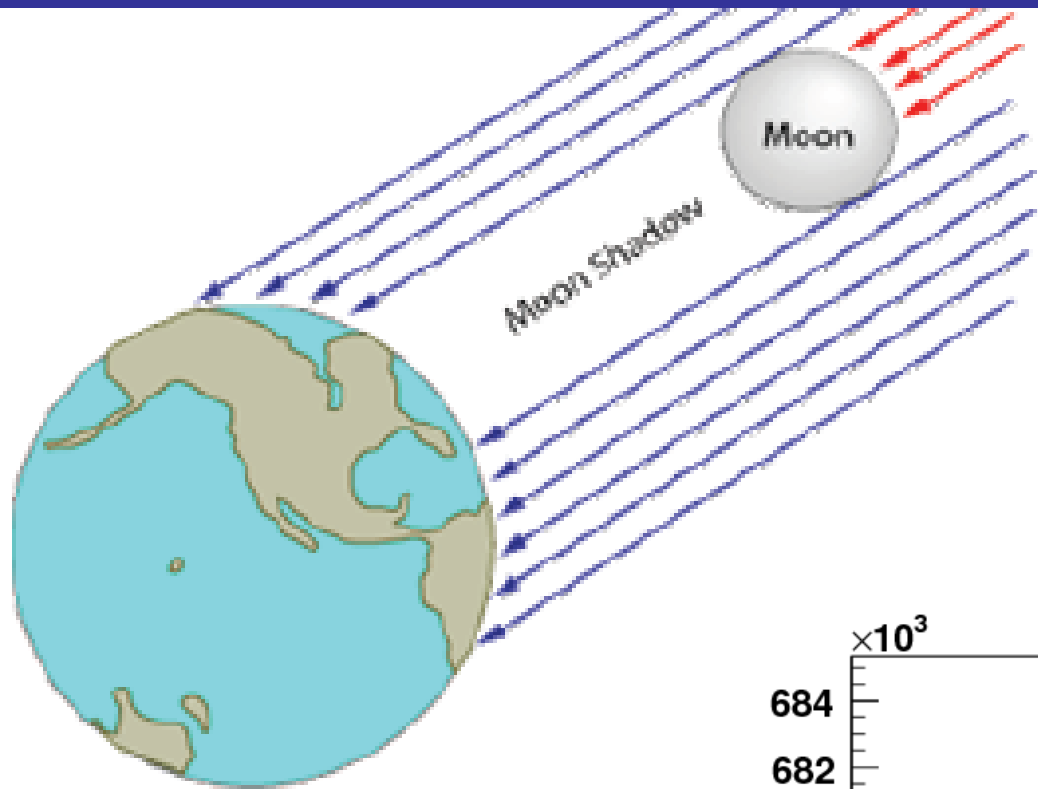




9/17

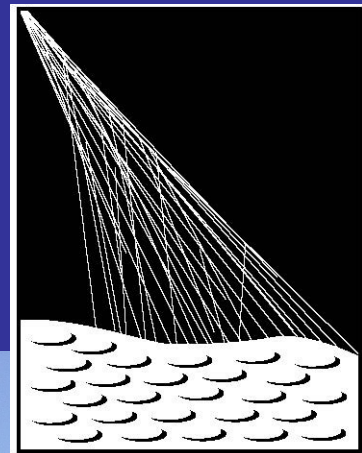


L'ombra della Luna



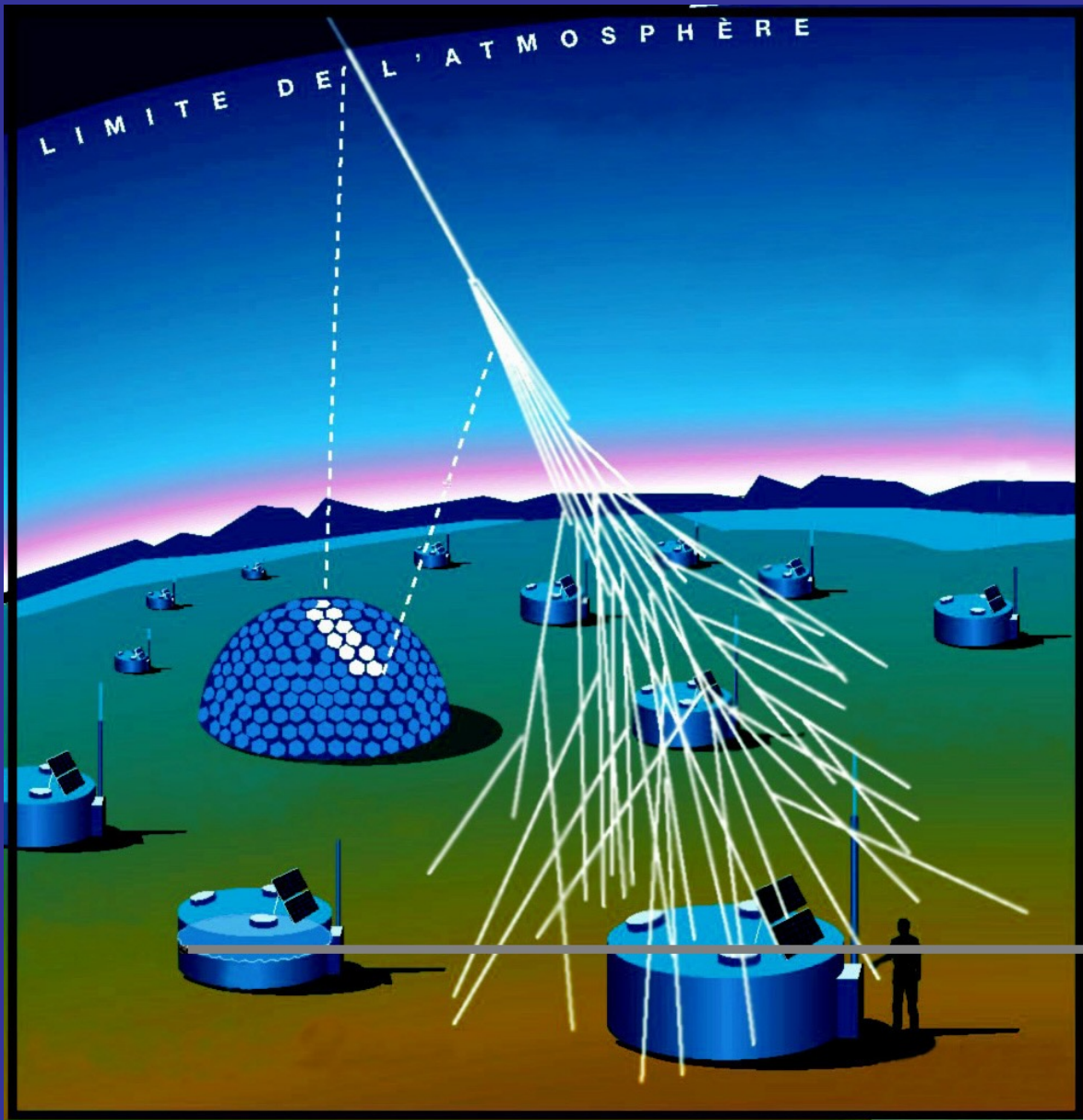
Pierre Auger Observatory

Pampa Amarilla, in Argentina



**PIERRE
AUGER**
OBSERVATORY





Una griglia di rivelatori permette di osservare lo sciame generato dal raggio cosmico quando penetra nell'atmosfera

Gli sciame di energia più alta sono rivelabili da griglie molto estese

Osservabile anche la luce di fluorescenza emessa dalle molecole di azoto eccitate dallo sciame

"Pierre Auger" Observatory in Argentina ~ 3000 km²

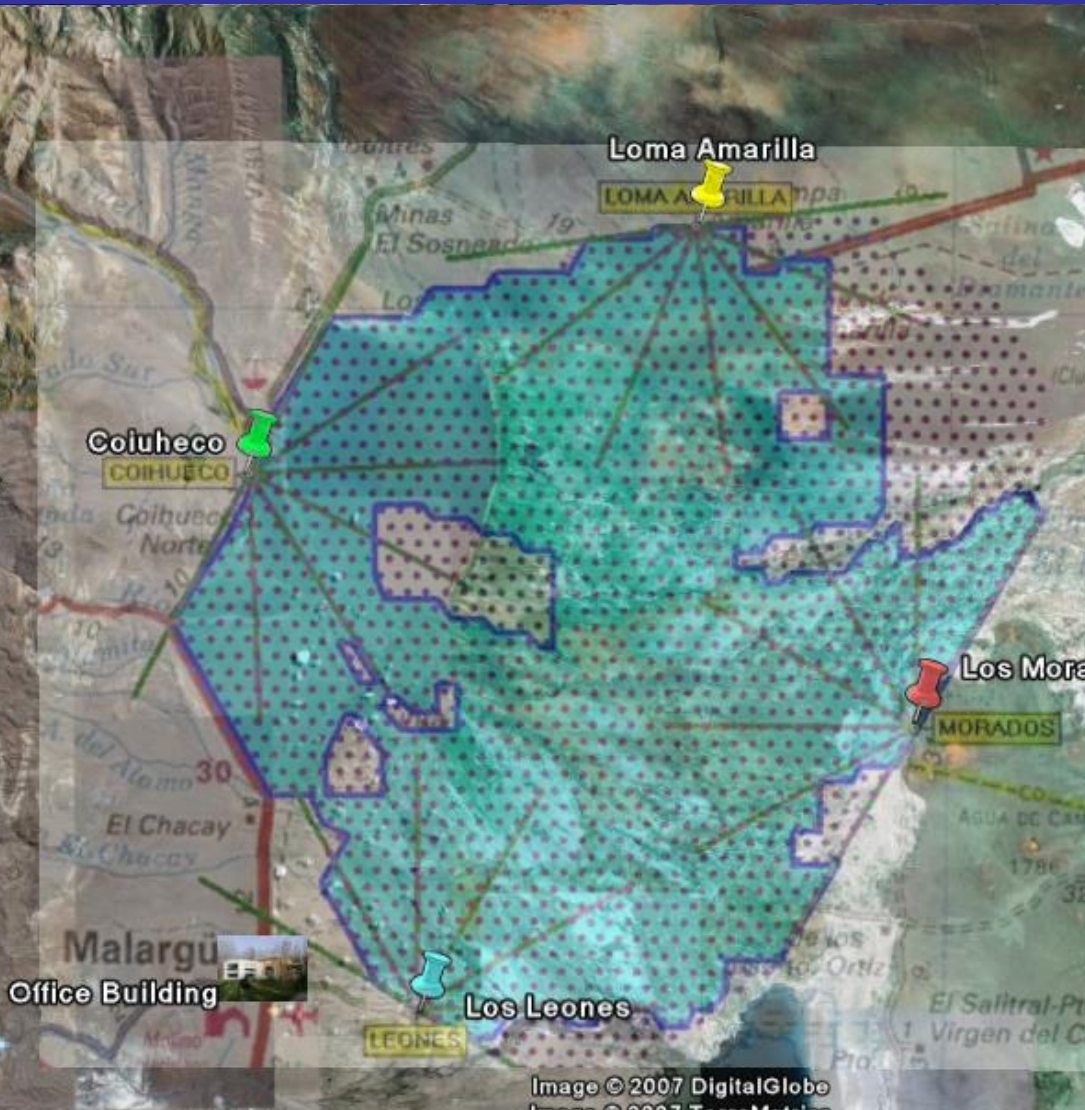


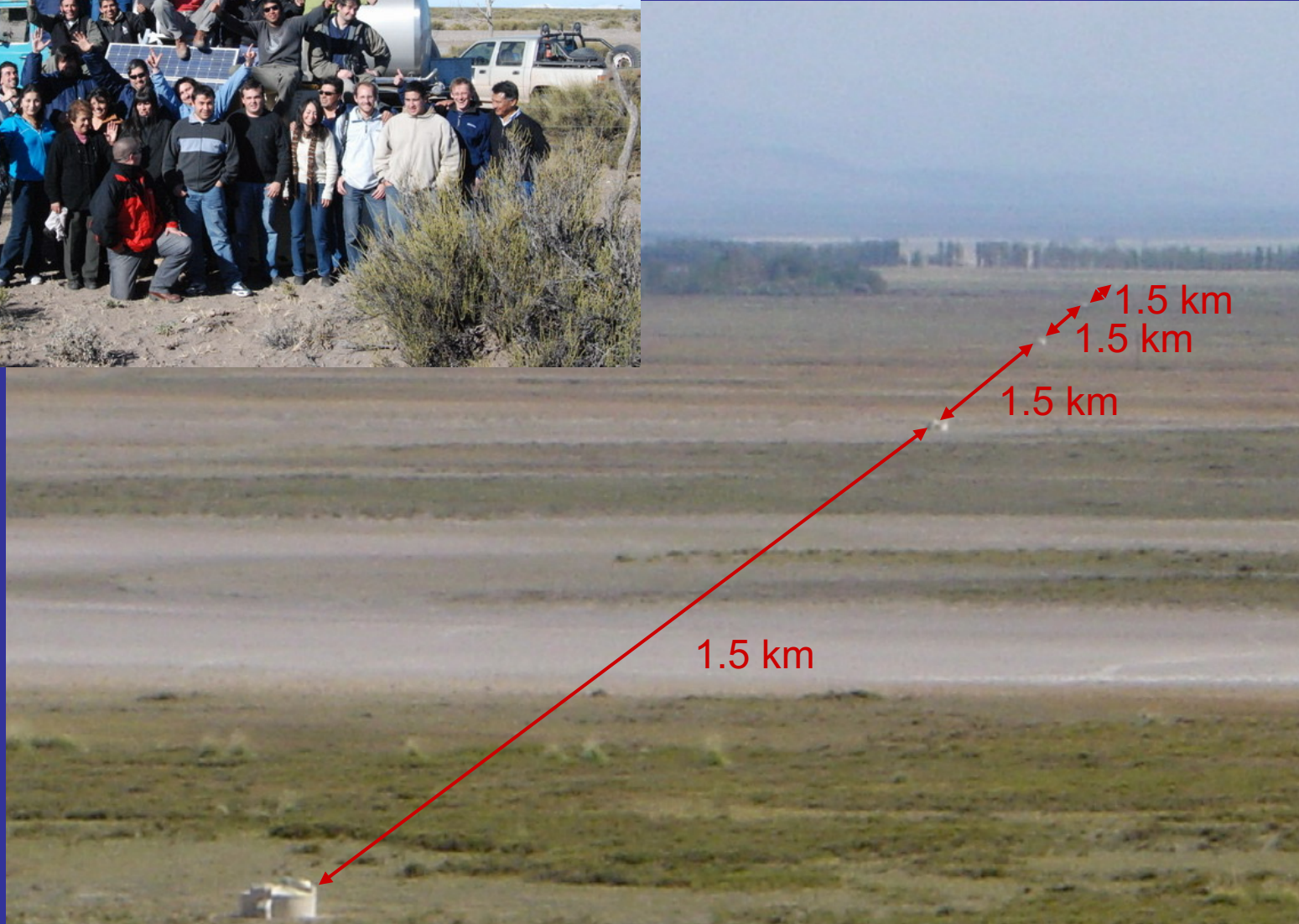
Image © 2007 DigitalGlobe
Image © 2007 TerraMetrics

© 2007 Google™

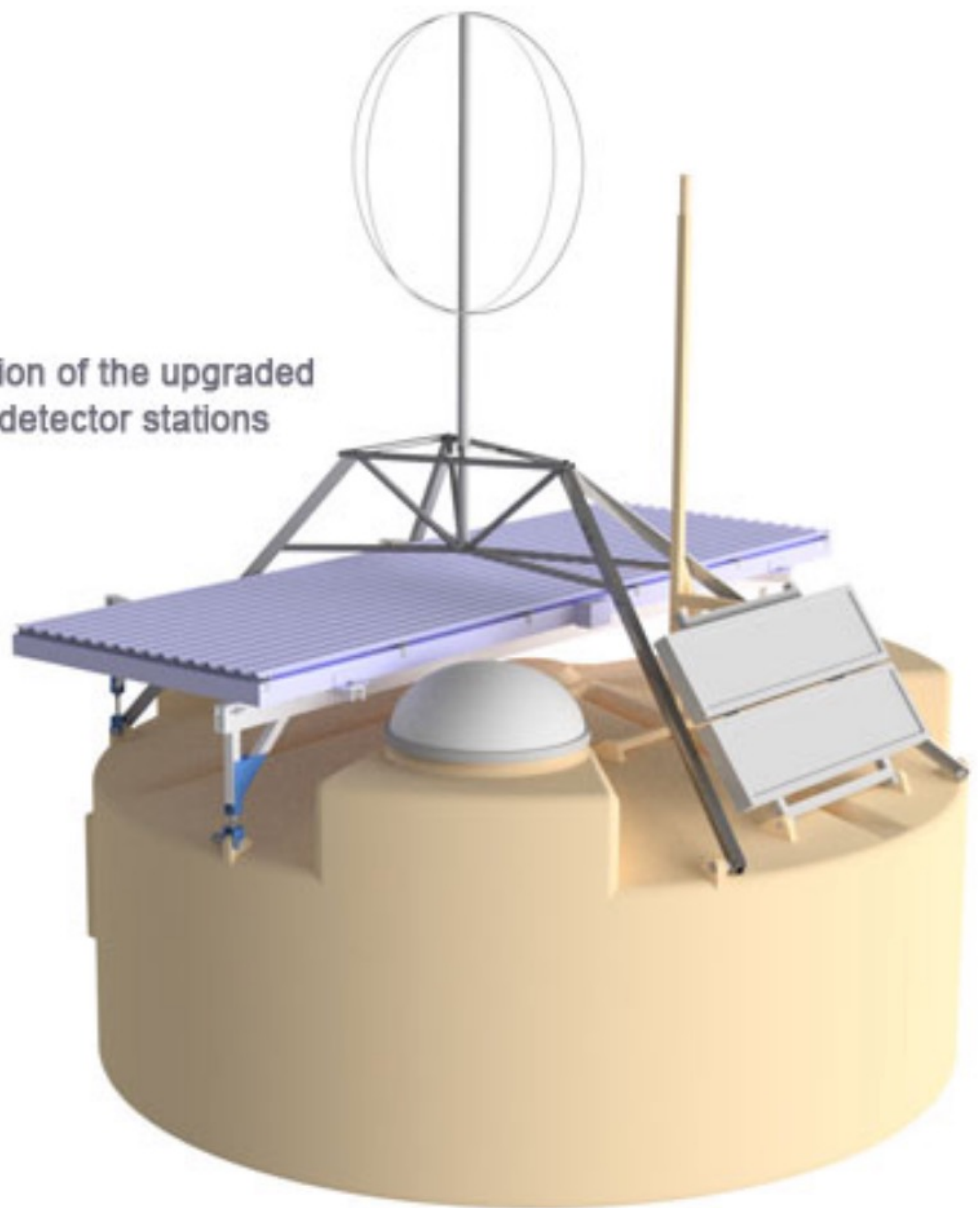
"Pierre Auger" Observatory ... grande come il Salento

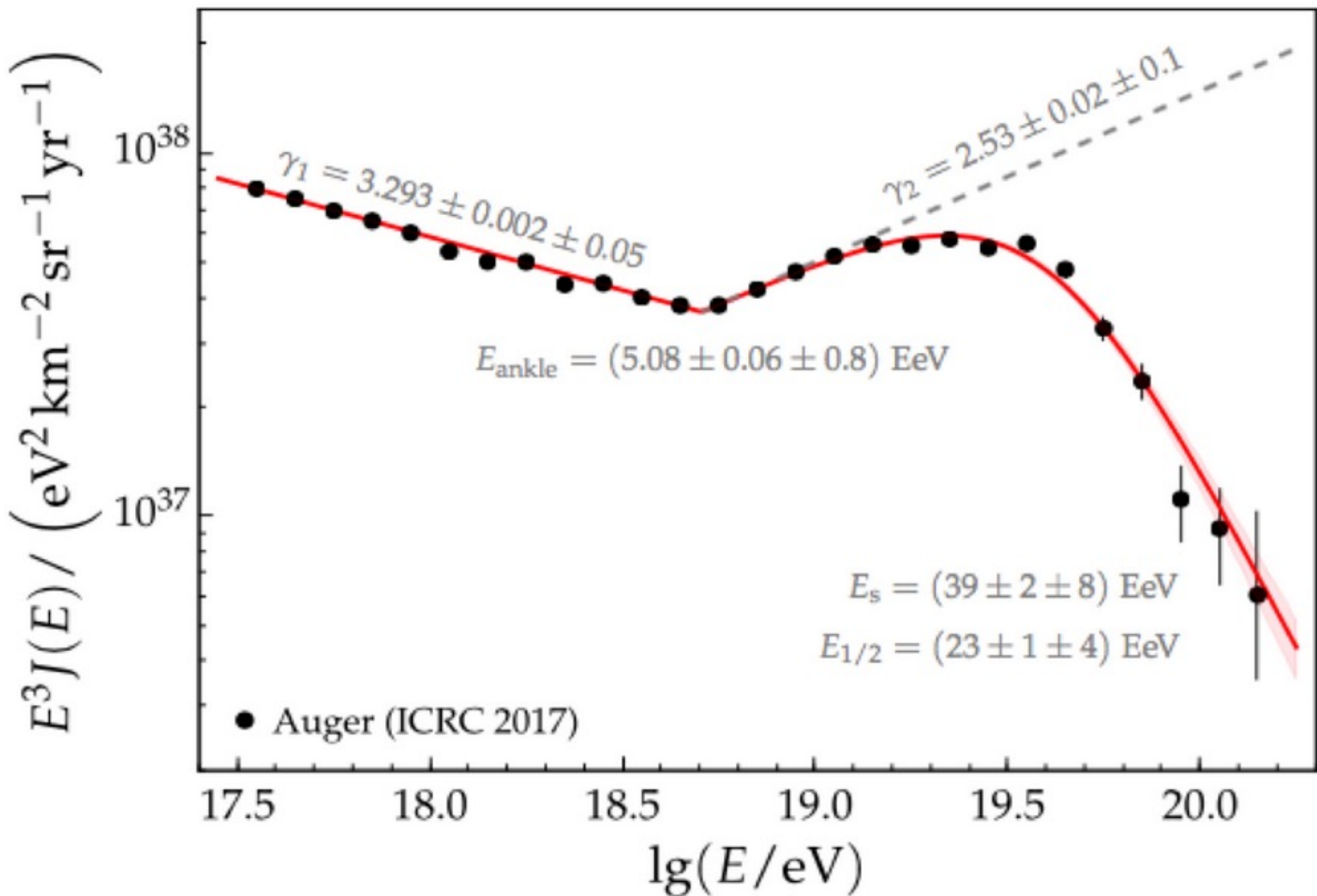


Ultimo rivelatore (13 giugno 2008)



Impression of the upgraded
surface detector stations







The launch: Dec 17th 2015, 0:12 UTC



Jiuquan Satellite Launch Center
Gobi desert, China

Orbit: Sun-synchronous
Altitude: 500 km
Period: 1.5 hours

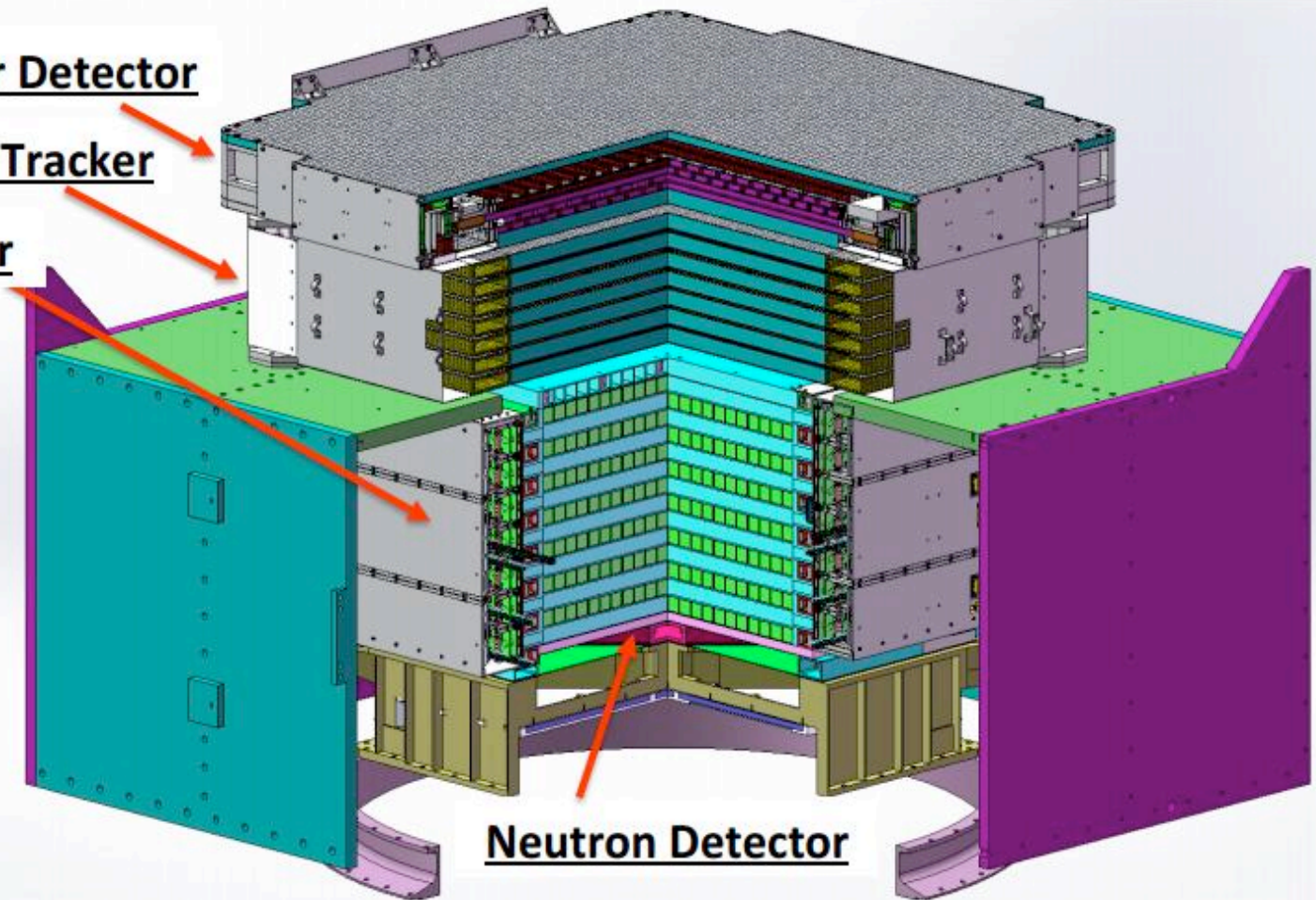
Dec 24th, 2015: HV on



Plastic Scintillator Detector

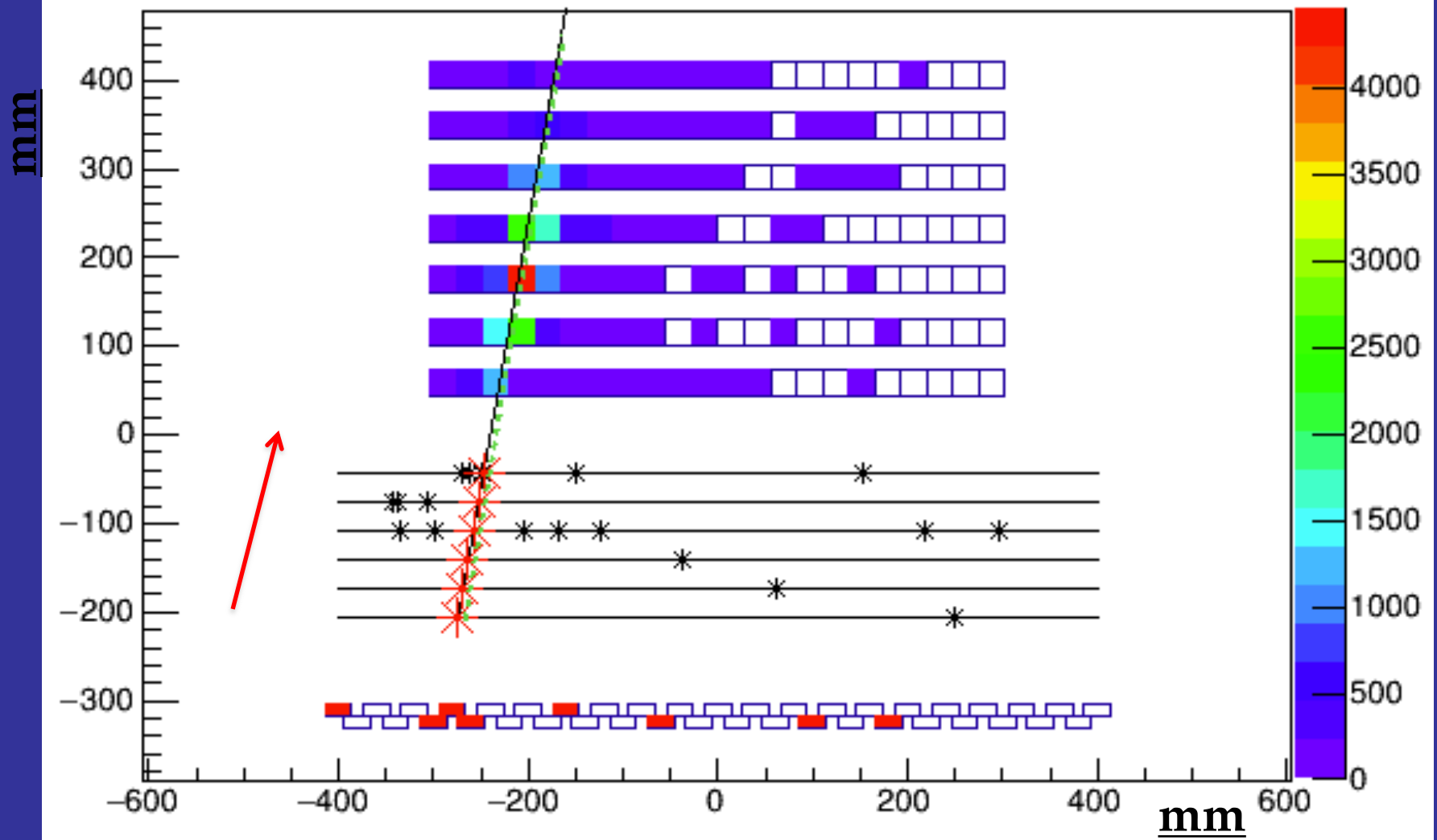
Silicon-Tungsten Tracker

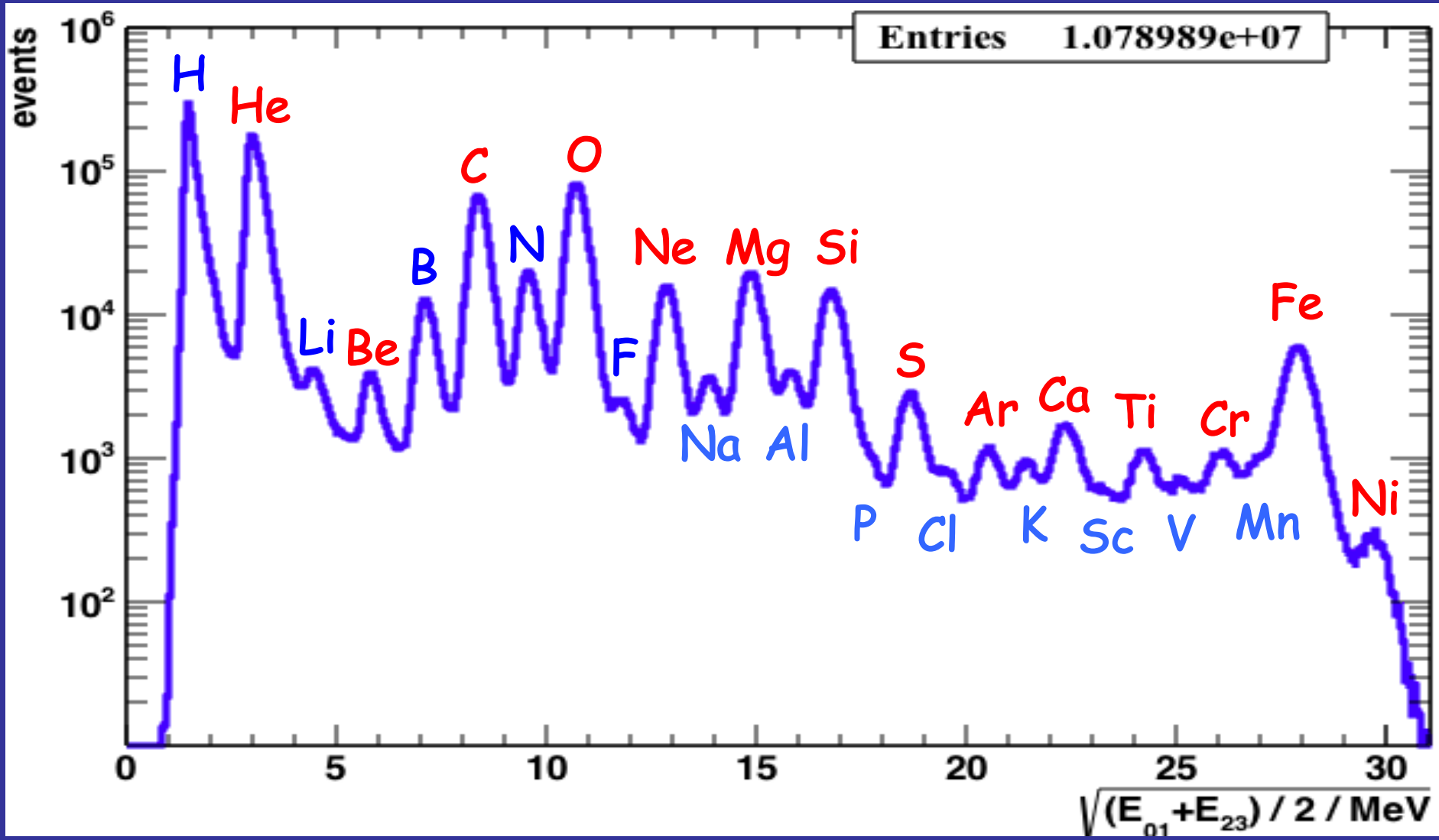
BGO Calorimeter



Neutron Detector

yz view - $E_{BGO} = 54.683$ GeV





Il futuro: HERD sulla stazione spaziale cinese

