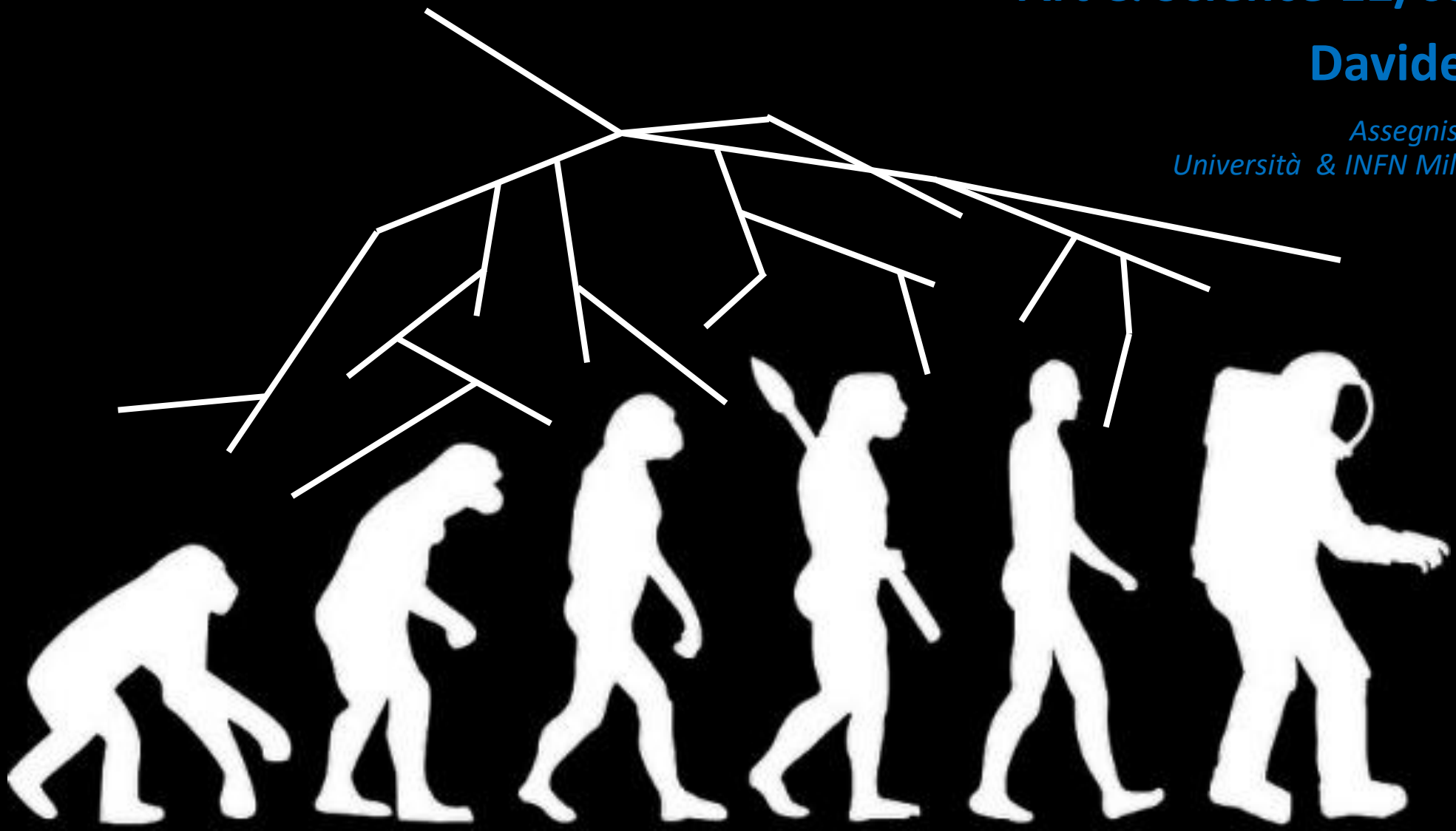
RAGGI COSMICI compagni di viaggio dell'umanità

Art & Science 12/03/2019

Davide Rozza

Assegnista di ricerca
Università & INFN Milano-Bicocca



PASSATO PRESENTE FUTURO

300000 anni fa

I Raggi Cosmici ci sono sempre stati!

Ma cosa sono?

PASSATO

PRESENTE

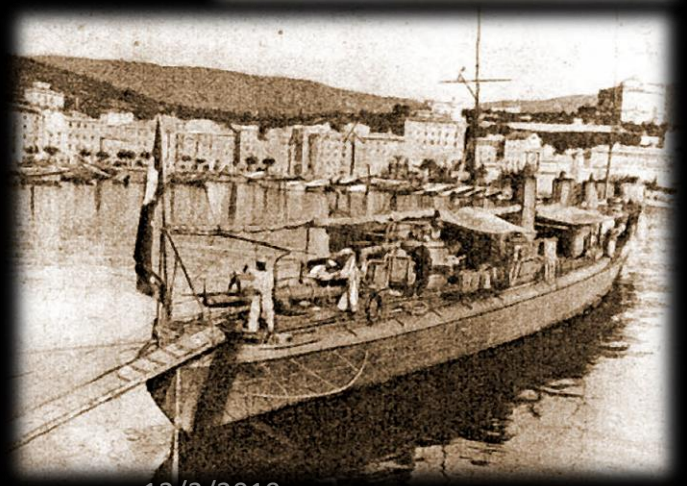
???

FUTURO

PASSATO | PRESENTE | FUTURO

1911-12

Domenico Pacini

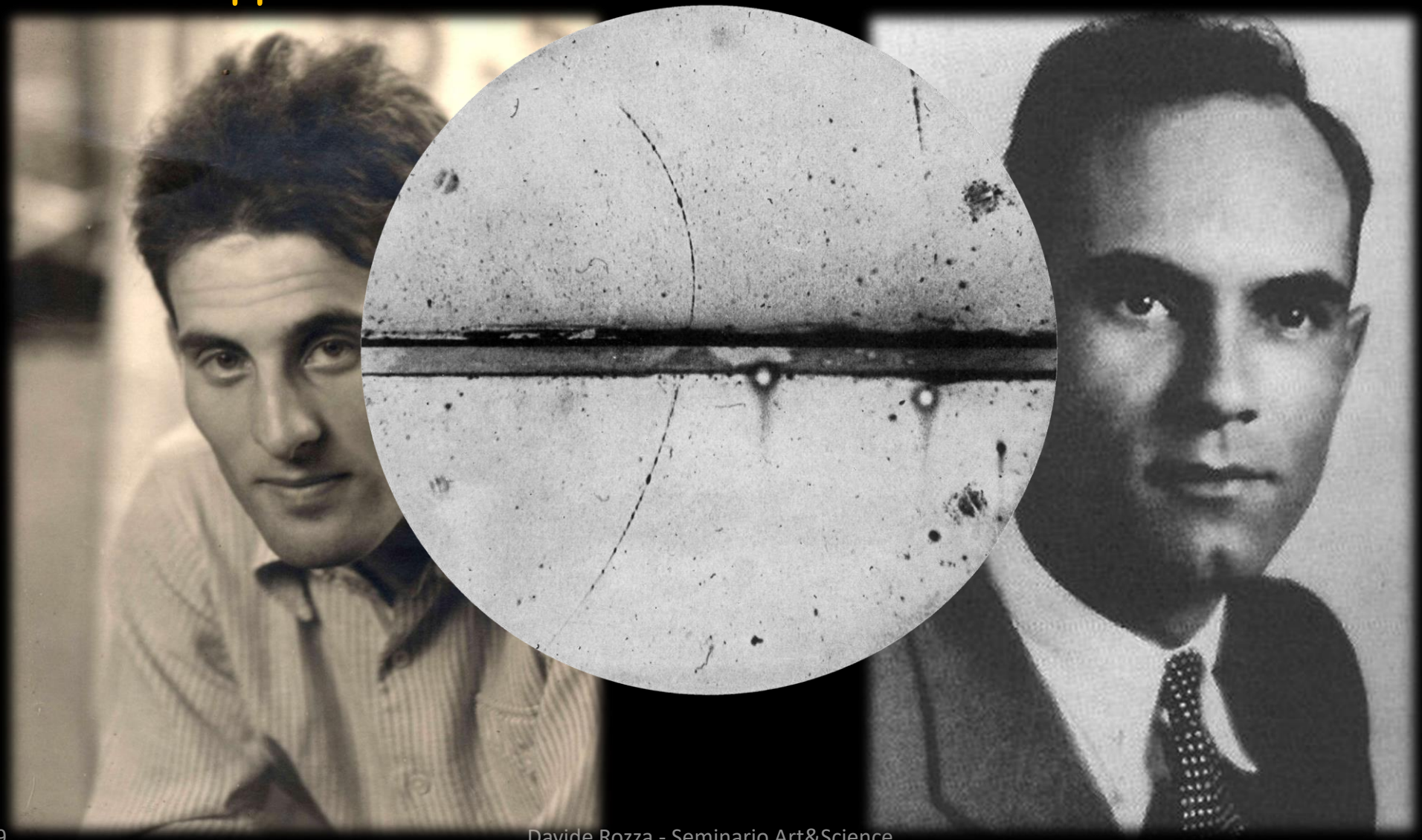


Victor Hess

PASSATO PRESENTE FUTURO

1932

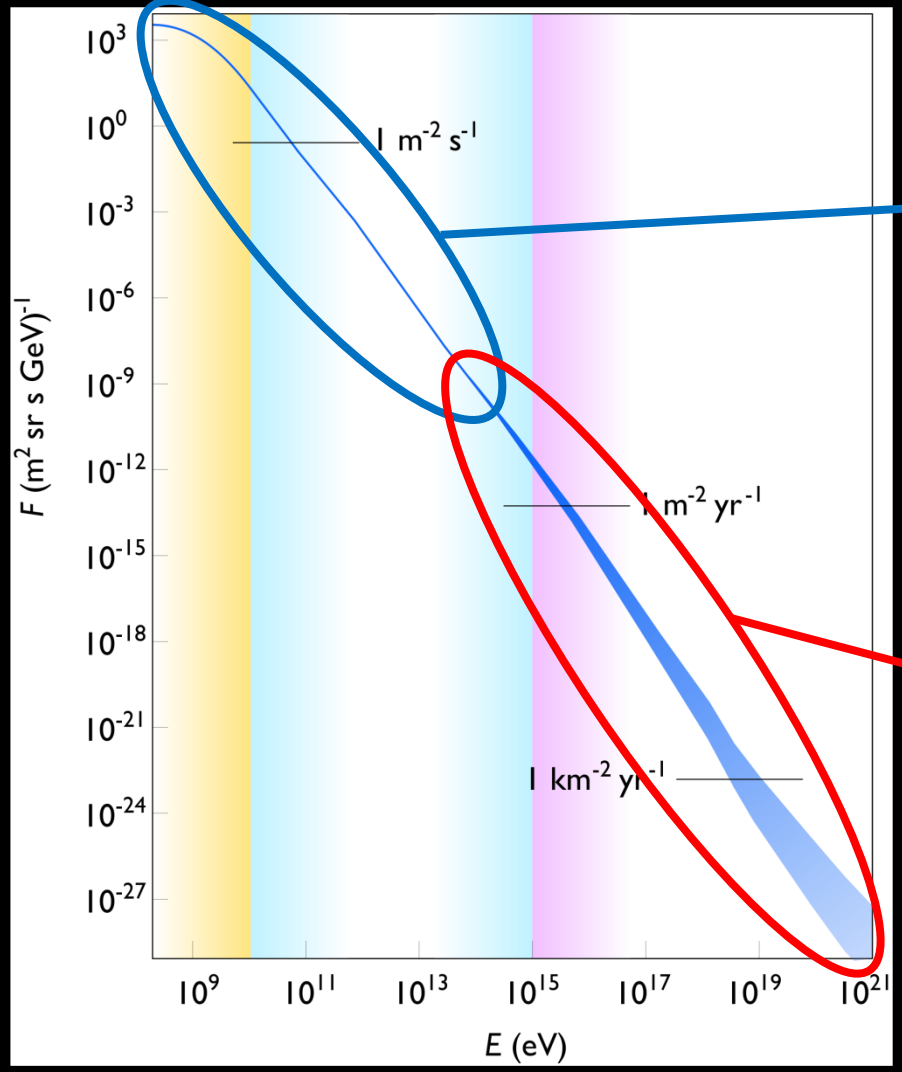
Giuseppe Occhialini



Carl D. Anderson

I Raggi Cosmici

I Raggi Cosmici sono particelle cariche, principalmente protoni, che viaggiano nella galassia ed arrivano anche in prossimità della Terra.



Rivelatori su pallone o nello spazio

Rivelatori a terra

AMS-02 a bordo della Stazione Spaziale Internazionale

PASSATO | PRESENTE | FUTURO

2010-11

AMS @ CERN

AMS @ NASA (CAPE CANAVERAL)

AMS @ ESA (ESTEC)

AMS @ ISS

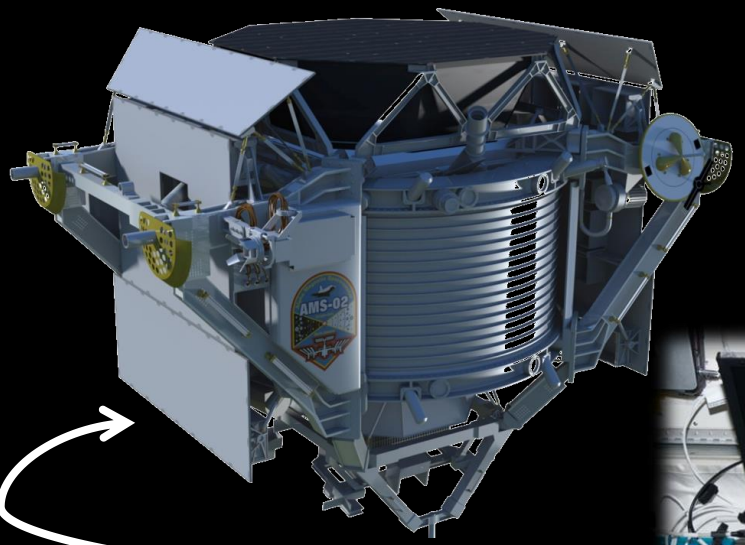

Alpha Magnetic Spectrometer
AMS-02
Europe • Asia
North America


EXPRESS RACK
AMS
SSC-9
LATCH LOCK
Unlock
Lock
EXHAUST
NITROGEN

PASSATO | PRESENTE | FUTURO

2011-31

AMS @ ISS



TDRS @ space

White Sands
@ New Mexico

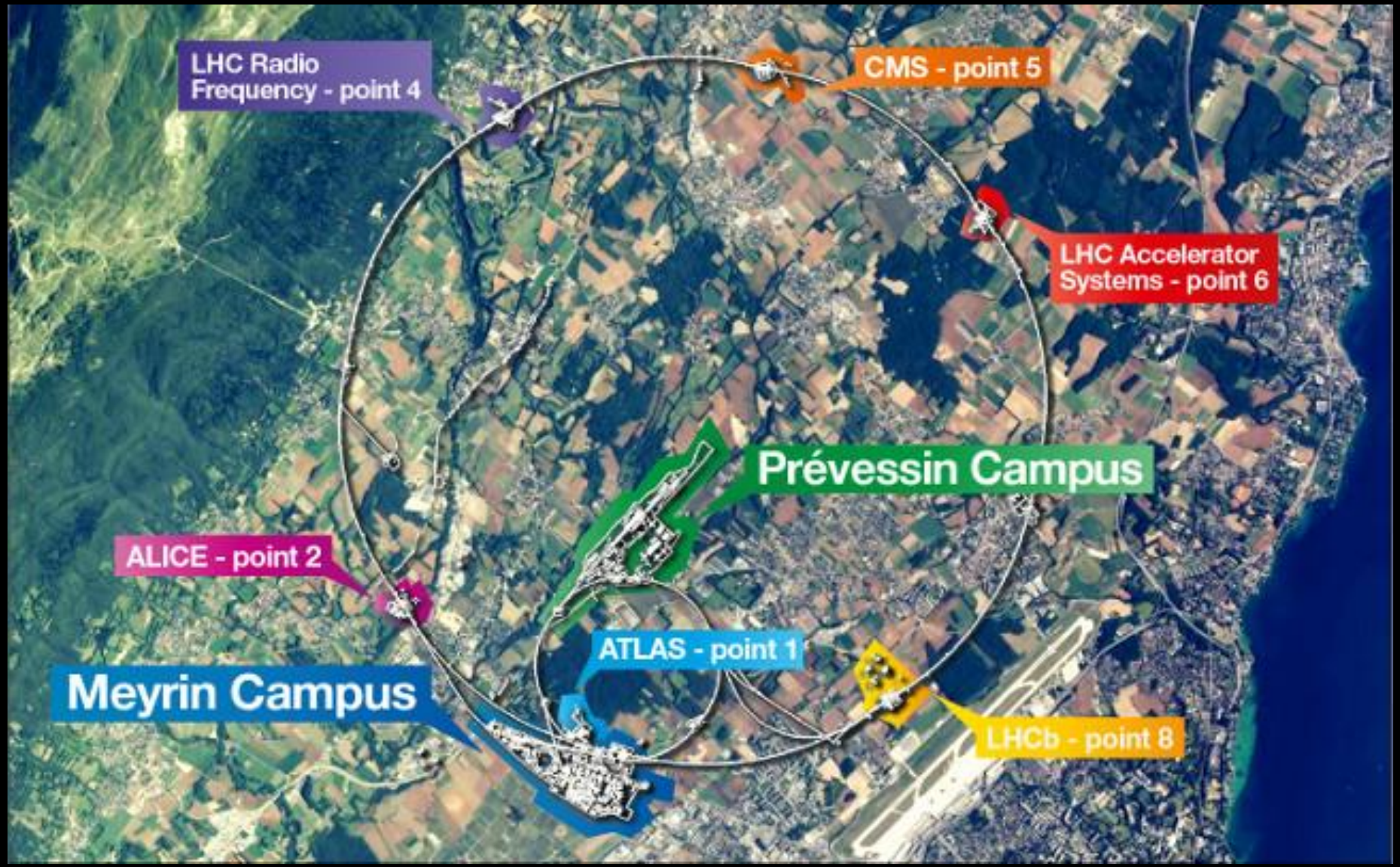
AMS Laptop @ ISS

AMS POCC @ CERN

AMSfeps @ MSFC-NASA

PASSATO PRESENTE FUTURO

2018

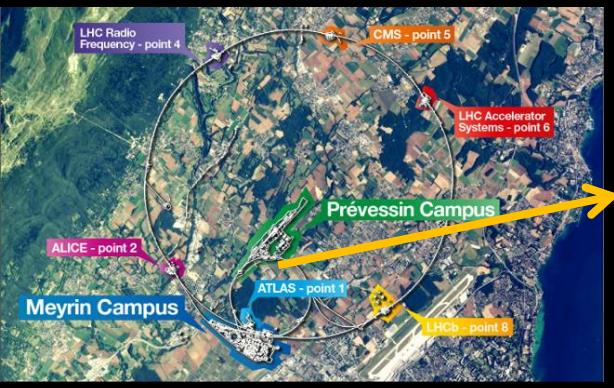


PASSATO

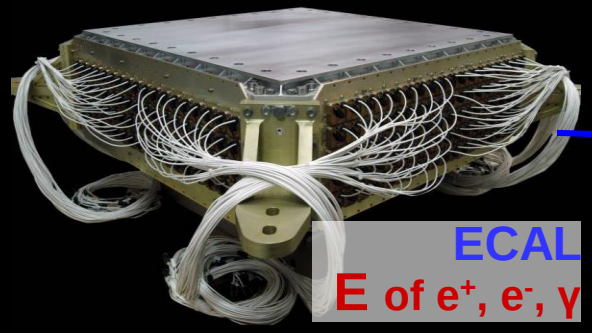
PRESENTE

FUTURO

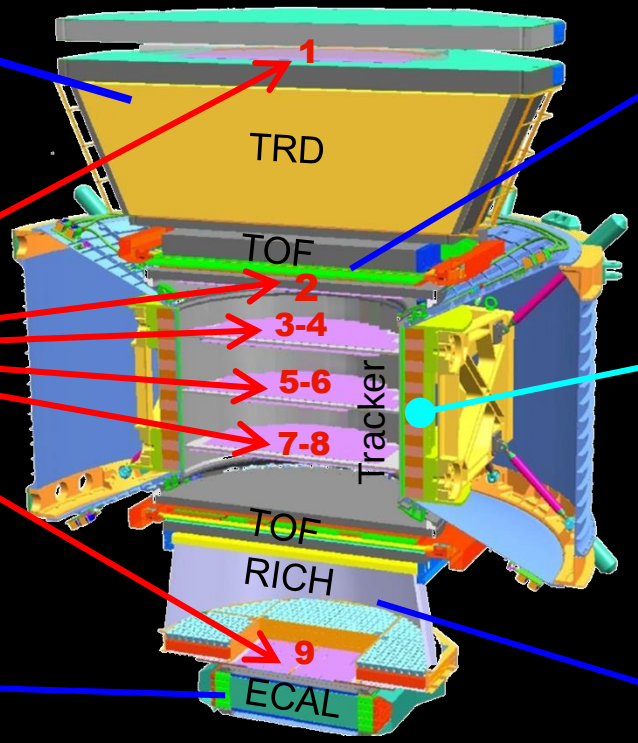
2018

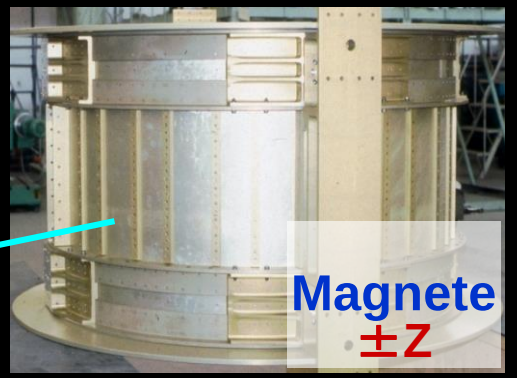


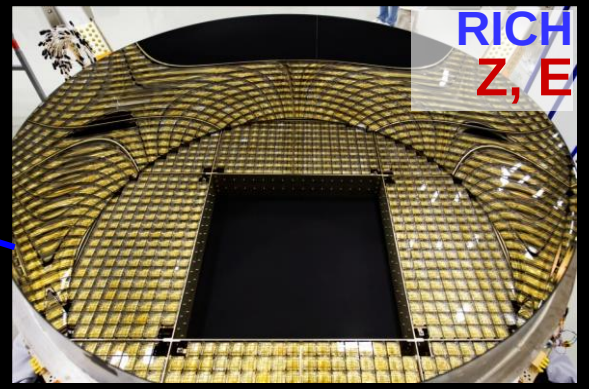
AMS-02



Z, P sono misurate indipendentemente da Tracker, RICH, TOF e ECAL



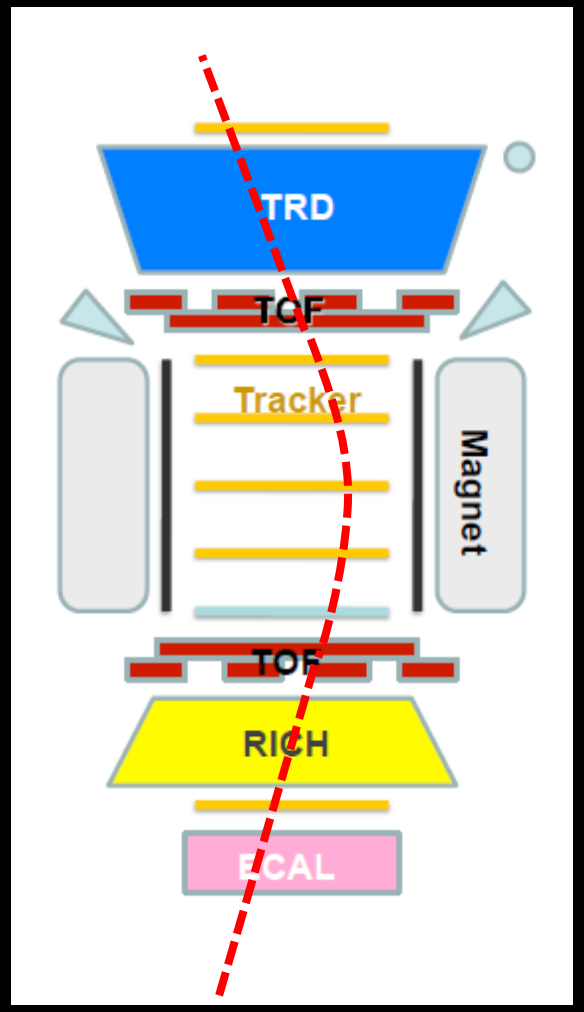




AMS-02

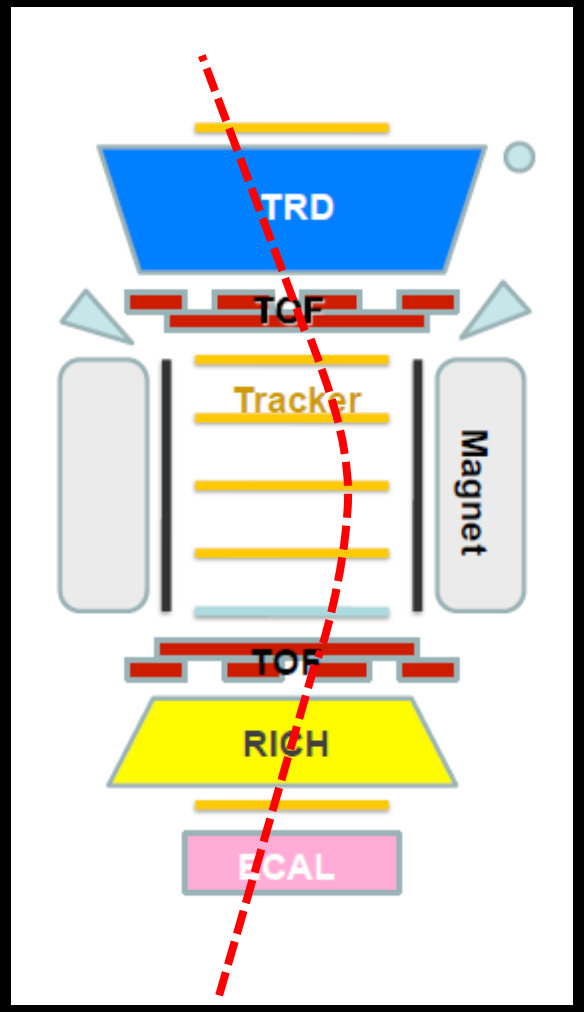

Magnet
TOF
TRD
ACC
RICH
Vacuum Cases
Safety Responsibility
ECAL
USS-02
+ numerous pieces of integration hardware & GSE
Electronics
TCS
Launch to ISS
AMS on ISS
GPS
Star Tracker
Tracker

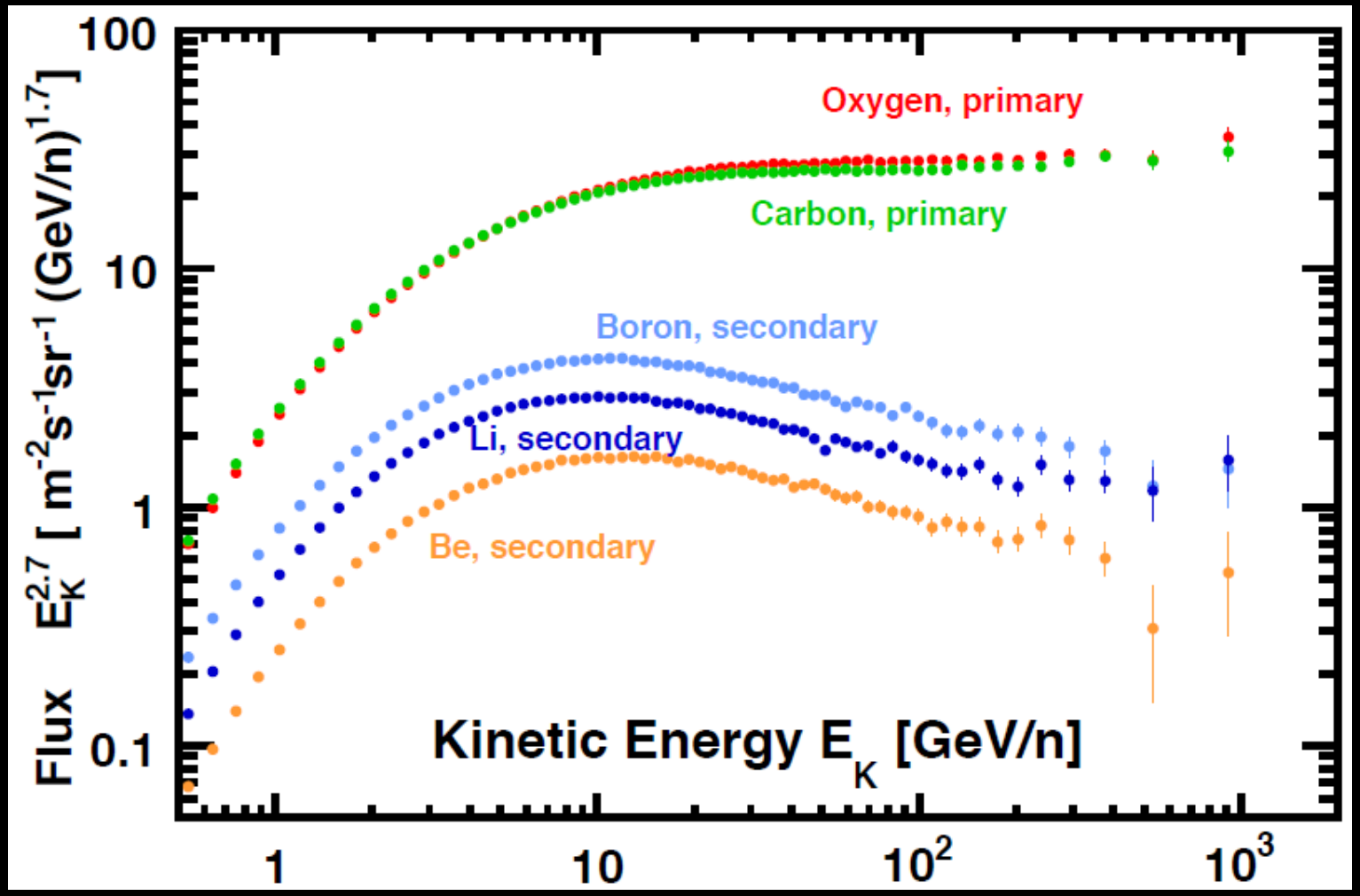
AMS-02



	e^-	P	Fe	e^+	$\bar{P}$	$\overline{He}$
TRD						
TOF						
Track						
RICH						
ECAL						
Physics example	Cosmic Ray Physics Strangelets			Dark matter		Antimatter

AMS-02


TRD
TOF
Tracker
Magnet
TOF
RICH
ECAL


Oxygen, primary
Carbon, primary
Boron, secondary
Li, secondary
Be, secondary
Flux $E_K^{2.7}$ [$m^{-2}s^{-1}sr^{-1}$ (GeV/n)$^{1.7}$]
Kinetic Energy E_K [GeV/n]
100
10
1
0.1
1
10
10^2
10^3

PASSATO PRESENTE FUTURO

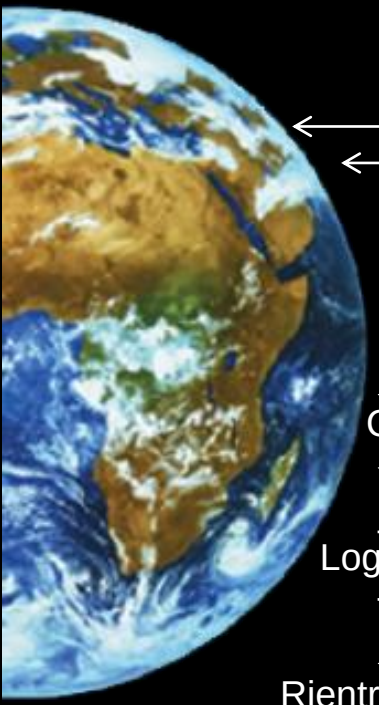
2015

Scott Kelly & Mark Kelly

PASSATO PRESENTE FUTURO

???

228,000,000 km



~1 - 3 anni richiesti

Comunicazioni (fino a 42 minuti)

~ 2 giorni richiesti

Comunicazioni (quasi in tempo reale)

Cambio equipaggio

Logistica e dispositivi per l'equipaggio

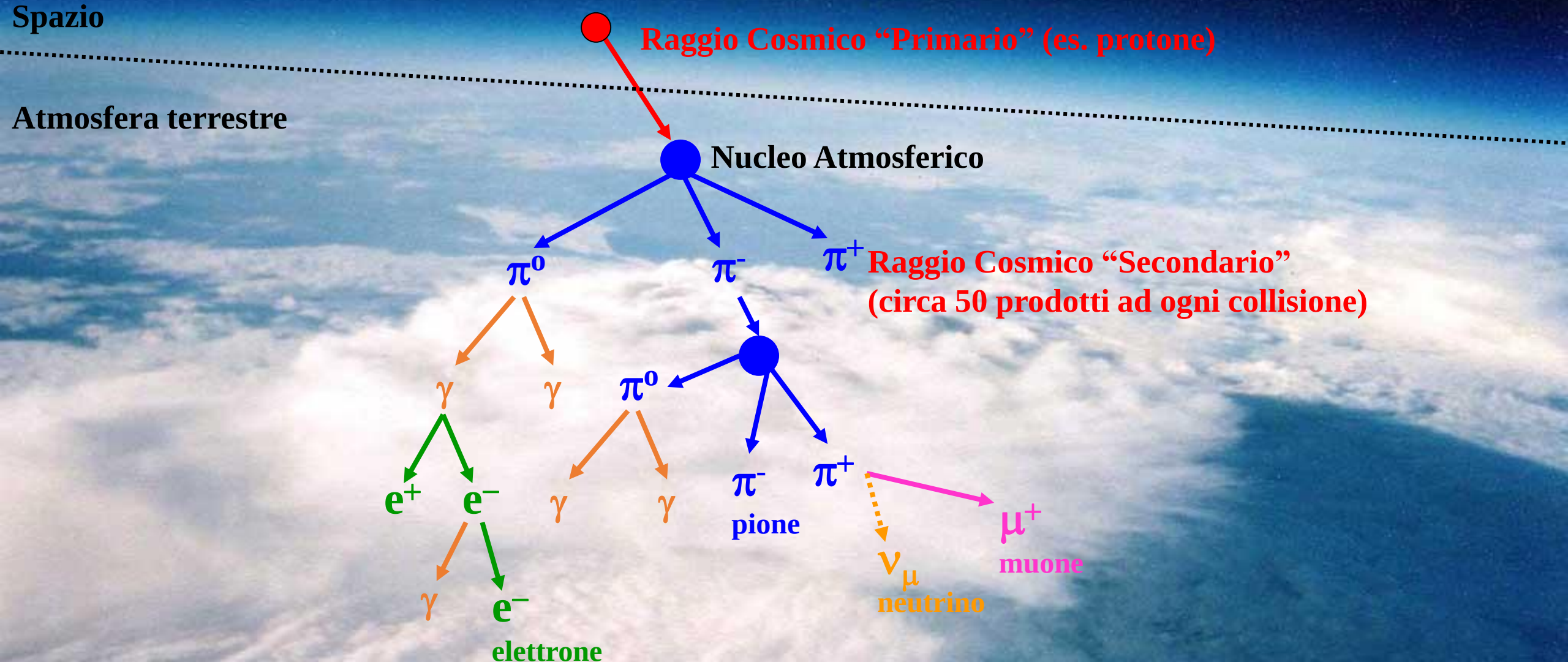
Modifica hardware

Rientro equipaggio in caso di emergenza

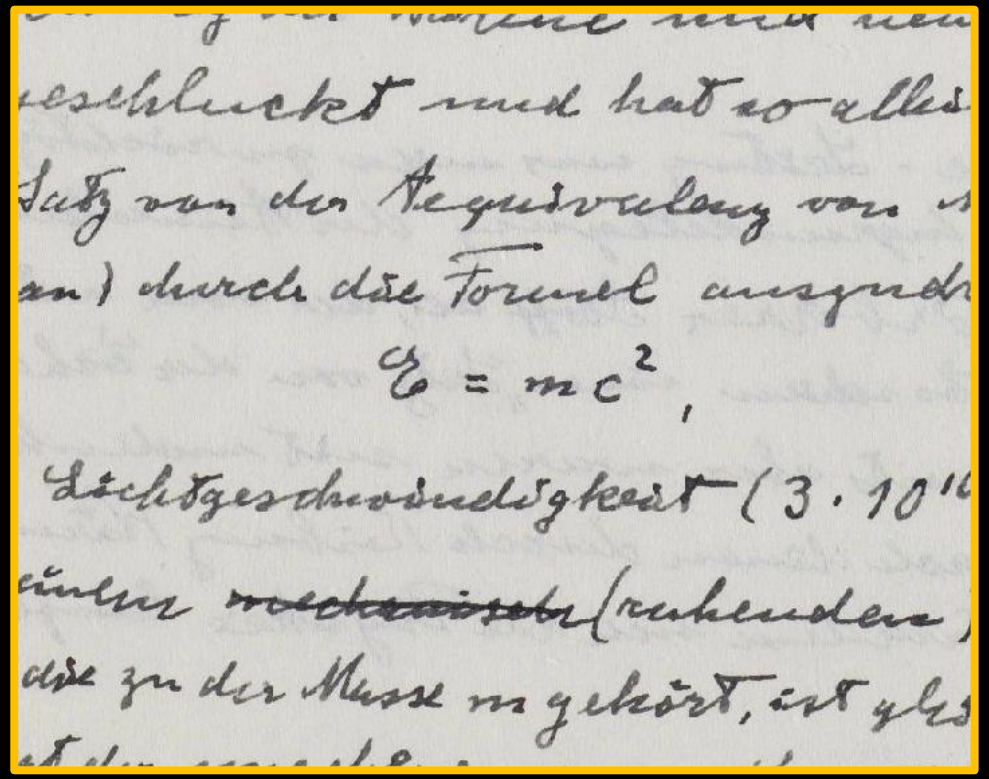
Rifiuti

390 km

I Raggi Cosmici sono particelle cariche, principalmente protoni che viaggiano nella galassia ed arrivano anche in prossimità della Terra.



I Raggi Cosmici interagiscono nell'atmosfera
come le particelle accelerate da LHC al CERN.



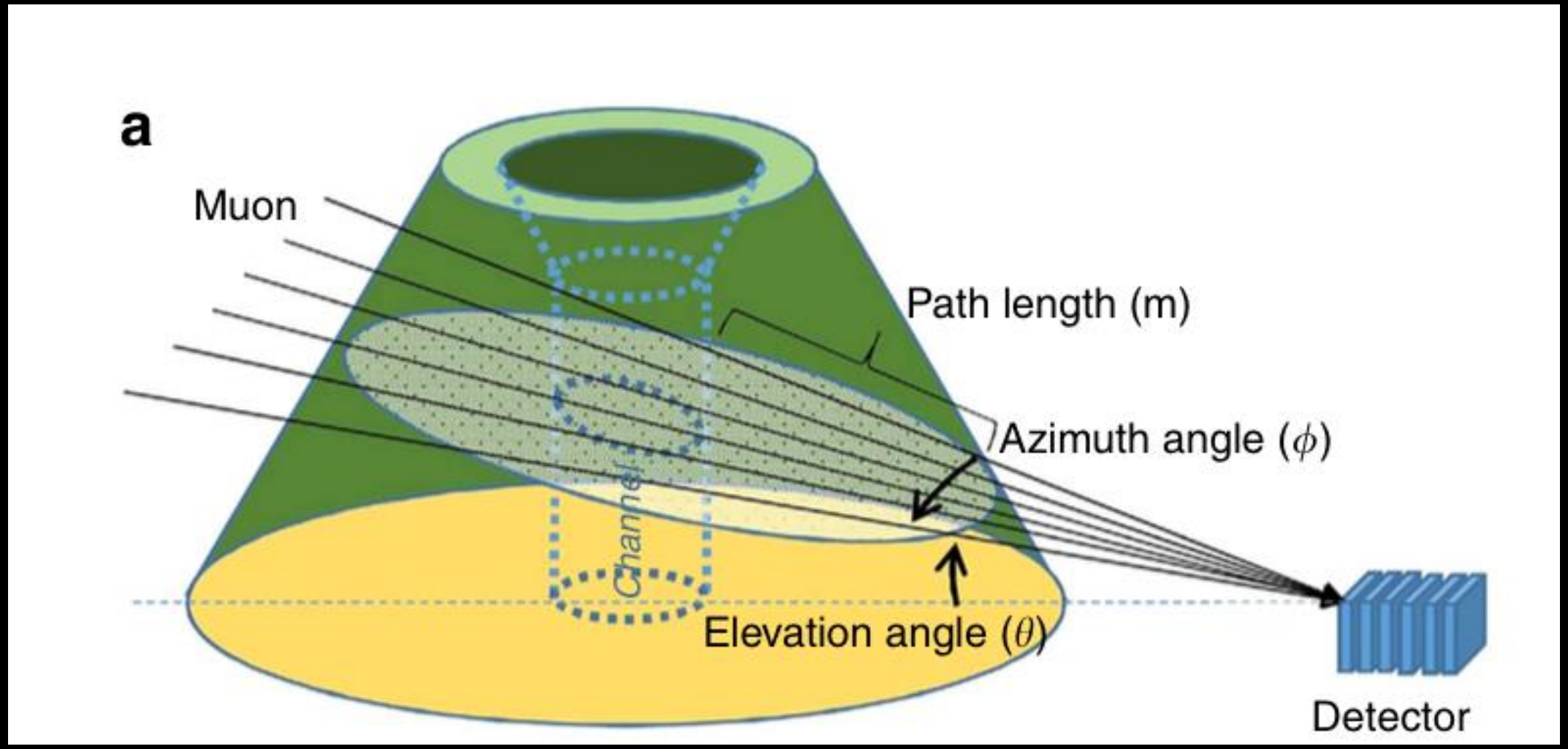
MUONI:

- Al livello del mare: ~ 1/(cm^{2}min)

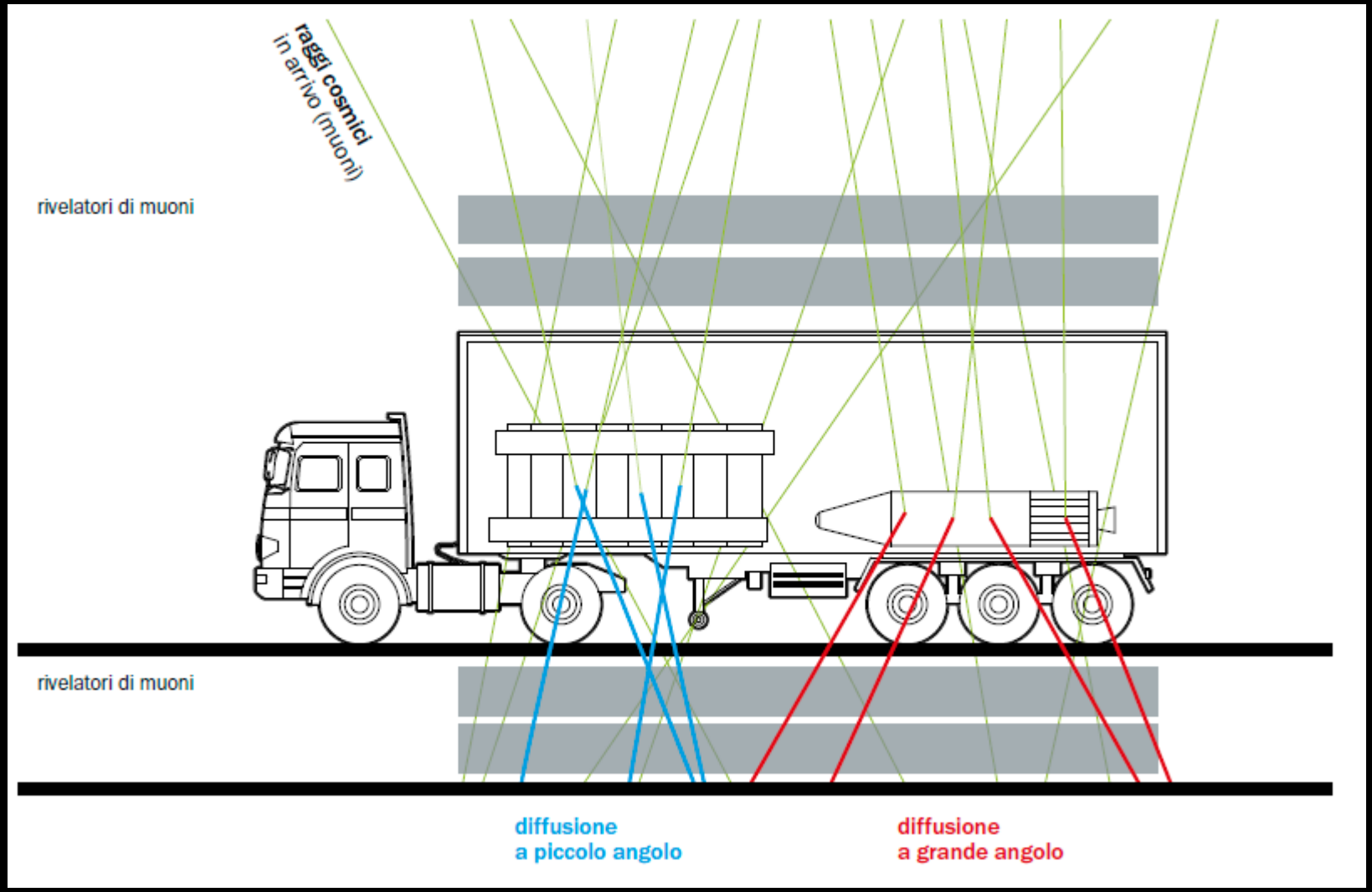
  ~ 1/(mano s)

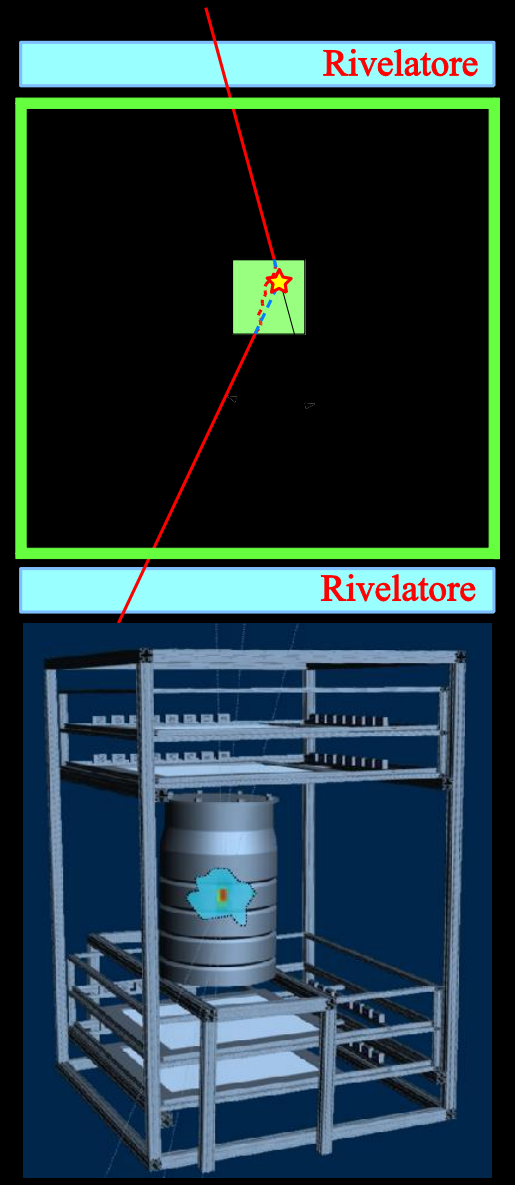
- 200 volte più massivi degli elettroni
- perdono poca energia attraversando la materia

Radiografia Muonica



Tomografia Muonica





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2500 a.C.

Cosmic Rays applied to Archeology

2500 a.C.

Piramide di Cheope:

- faraone Khufu (2509 aC a 2483 aC)

- alta 139 m e larga 230 m

- 3 camere conosciute: del Re, della Regina e la camera sotterranea

Article: Morishima et al 2017

LETTER

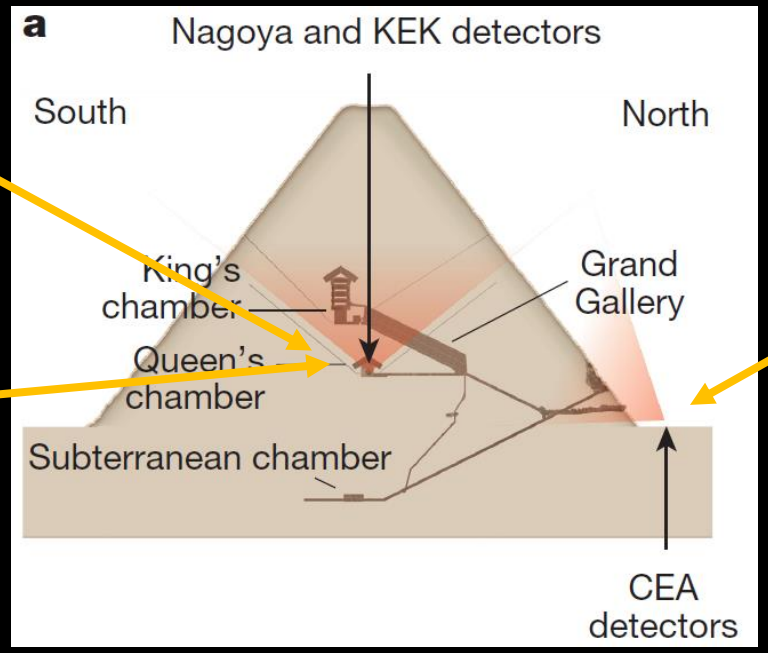
doi:10.1038/nature24647

Discovery of a big void in Khufu's Pyramid by observation of cosmic-ray muons

Kunihiro Morishima[1], Mitsuaki Kuno[1], Akira Nishio[1], Nobuko Kitagawa[1], Yuta Manabe[1], Masaki Moto[1], Fumihiko Takasaki[2], Hirofumi Fujii[2], Kotaro Satoh[2], Hideyo Kodama[2], Kohei Hayashi[2], Shigeru Odaka[2], Sébastien Procureur[3], David Attié[3], Simon Bouteille[3], Denis Calvet[3], Christopher Filosa[3], Patrick Magnier[3], Irakli Mandjavidze[3], Marc Riallot[3], Benoit Marini[4], Pierre Gable[5], Yoshikatsu Date[6], Makiko Sugiura[7], Yasser Elshayeb[8], Tamer Elnady[9], Mustapha Ezzy[8], Emmanuel Guerriero[5], Vincent Steiger[4], Nicolas Serikoff[4], Jean-Baptiste Mouret[10,11,12], Bernard Charlès[13], Hany Helal[4,8] & Mehdi Tayoubi[4,13]

Piani ad emulsione nucleare

Scintillatori



Rivelatori a gas

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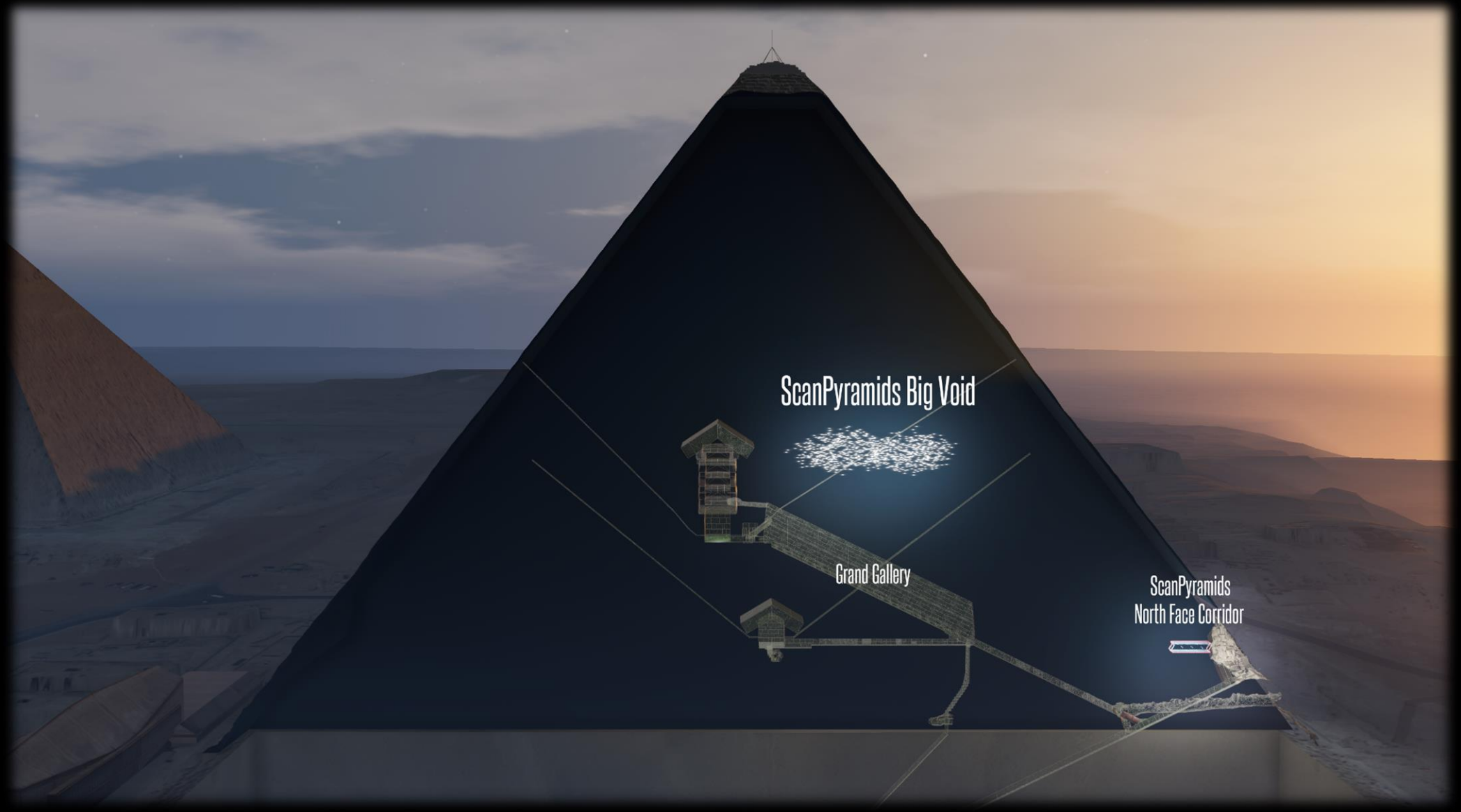
2500 a.C.



Come possiamo osservare i raggi cosmici?

PASSATO PRESENTE FUTURO

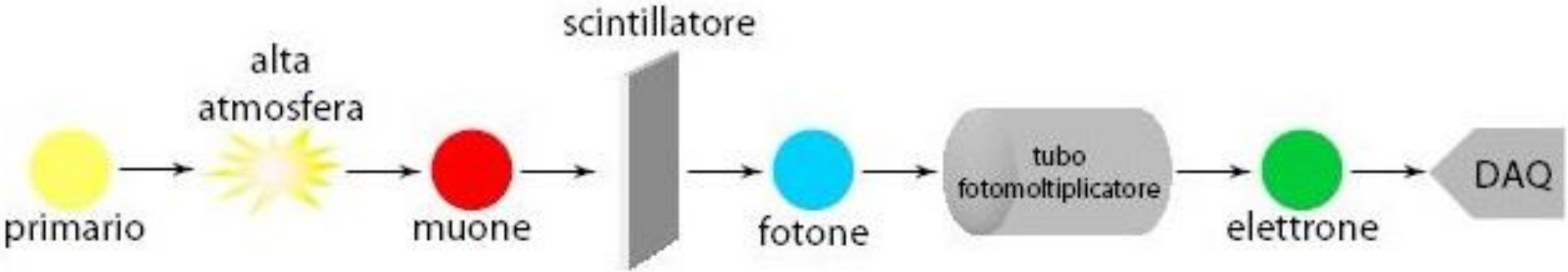
2016

Ossigeno atomico → verde; Ossigeno molecolare → rosso; Azoto → blu.

PASSATO PRESENTE FUTURO

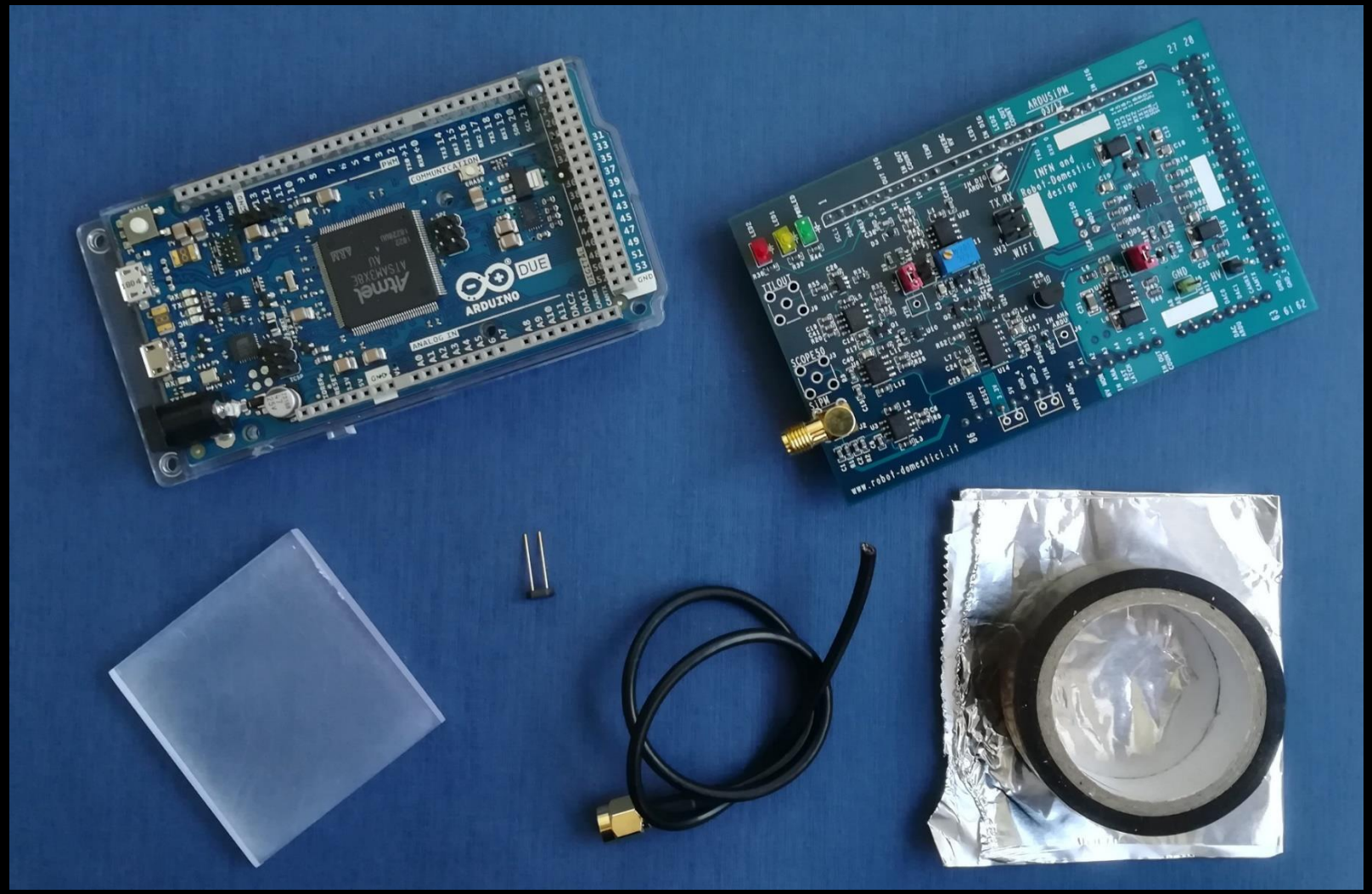
2019

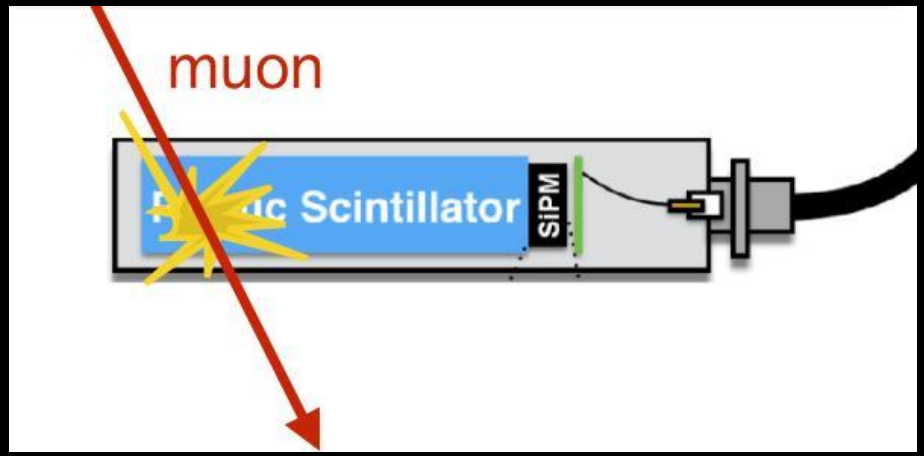
Meccanismo di rilevamento



PASSATO | PRESENTE | FUTURO

2019





Scintillatore plastico

Cavo coassiale

Fotomoltiplicatore al Si: SiPM

Alluminio e nastro isolante

Fissare il SiPM allo scintillatore

Avvolgere il tutto con il foglio di alluminio

Oscurare con nastro isolante nero

Ora tocca a noi…

Grazie per l'attenzione!