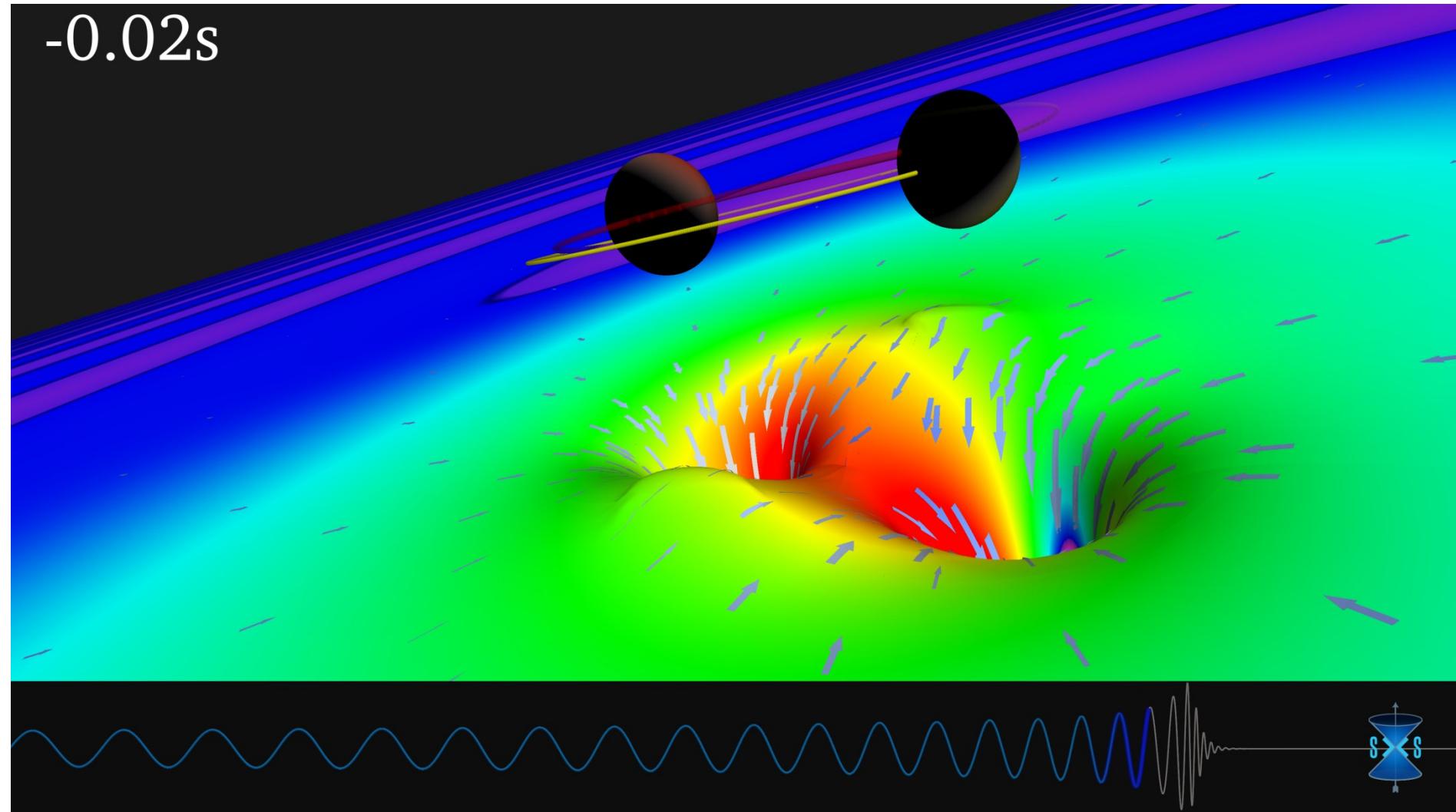


**Dietro le quinte delle grandi scoperte
della Fisica Moderna**

Catalina Curceanu, Giovanni Corradi
LNF-INFN, Frascati

6 maggio 2019

-0.02s



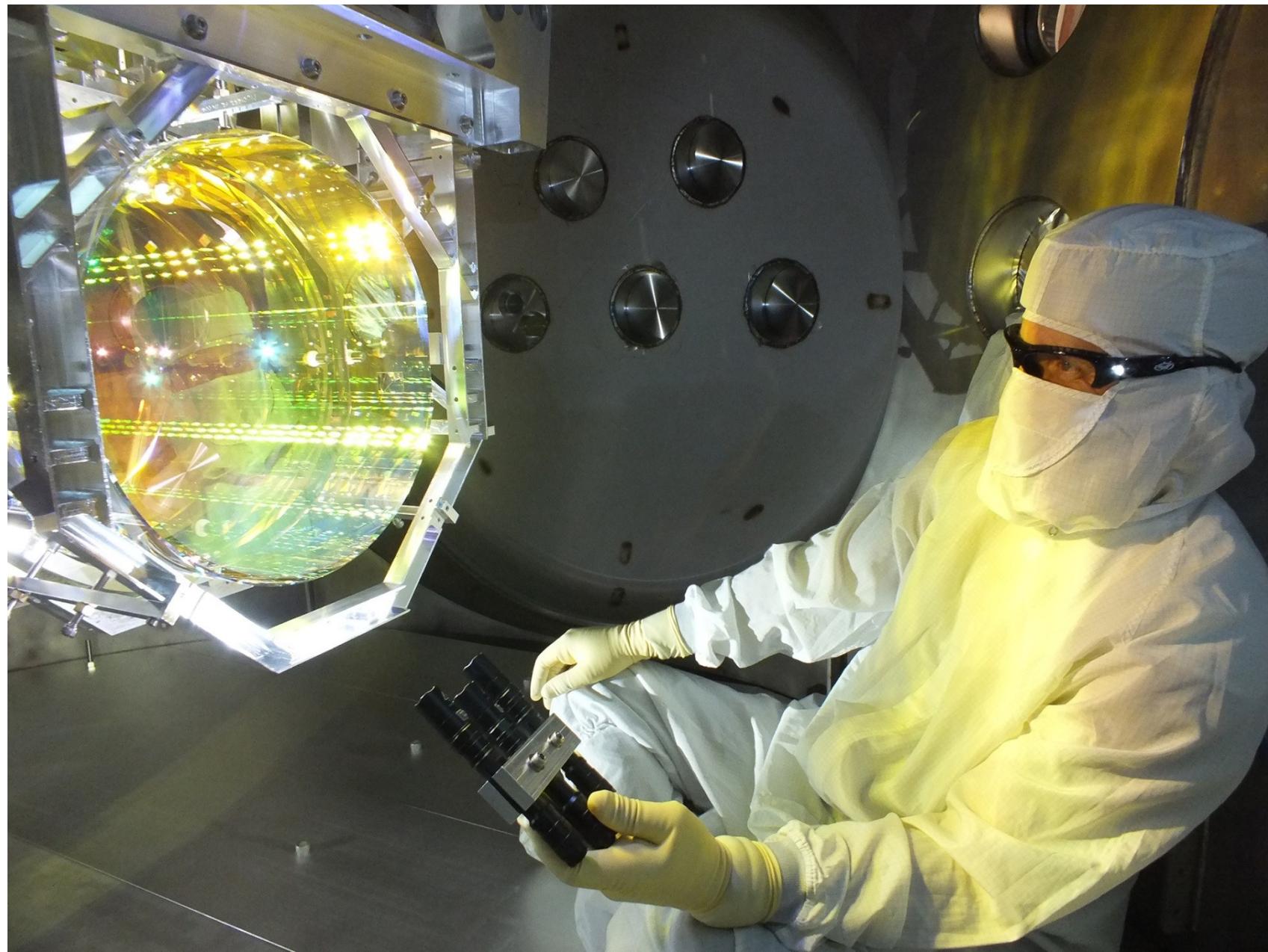
LIGO, NSF, Illustration: A. Simonnet (SSU)

INSPIRAL

RINGDOWN

MERGER

HANFORD, WASHINGTON
LIVINGSTON, LOUISIANA





© REUTERS

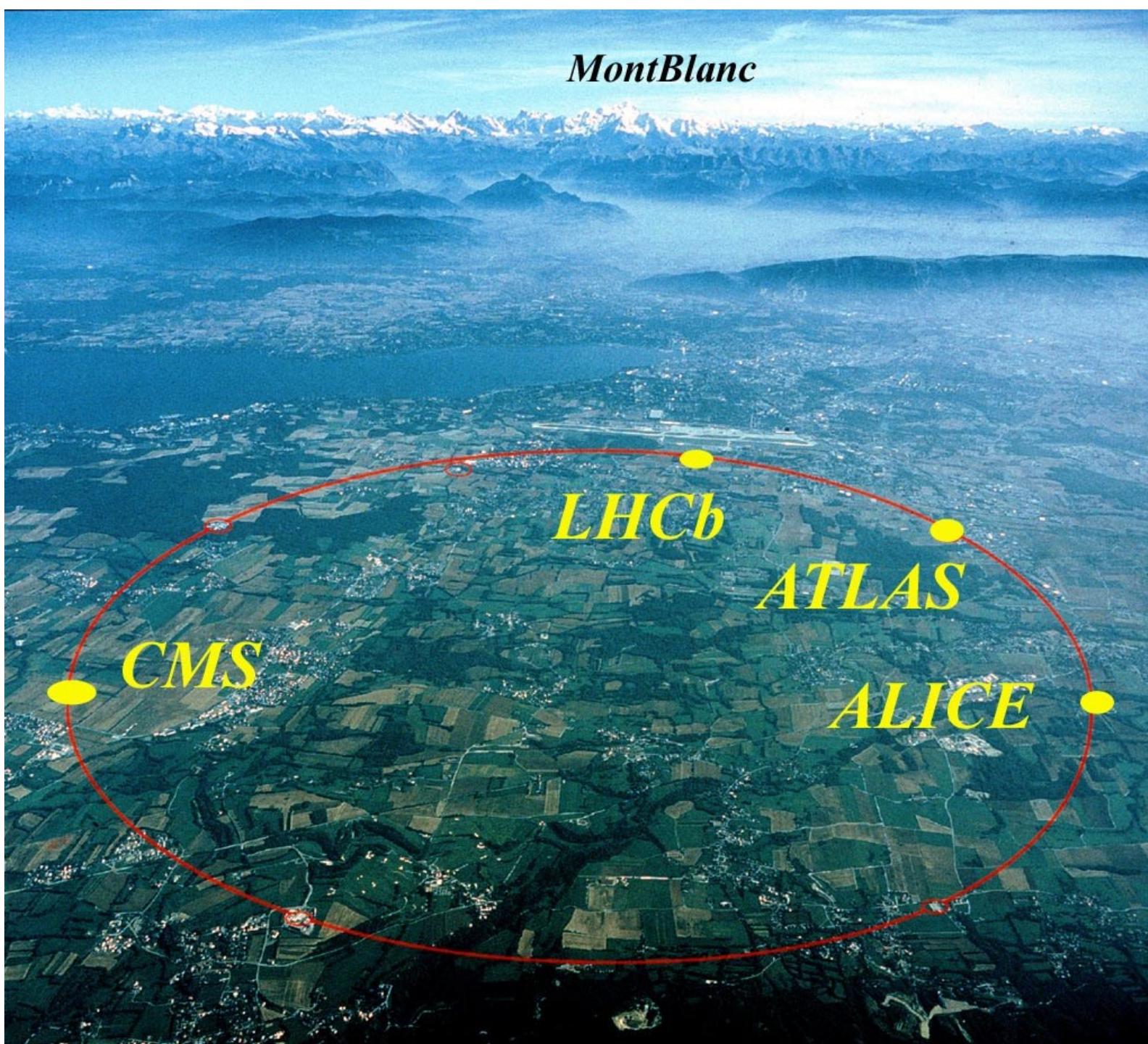




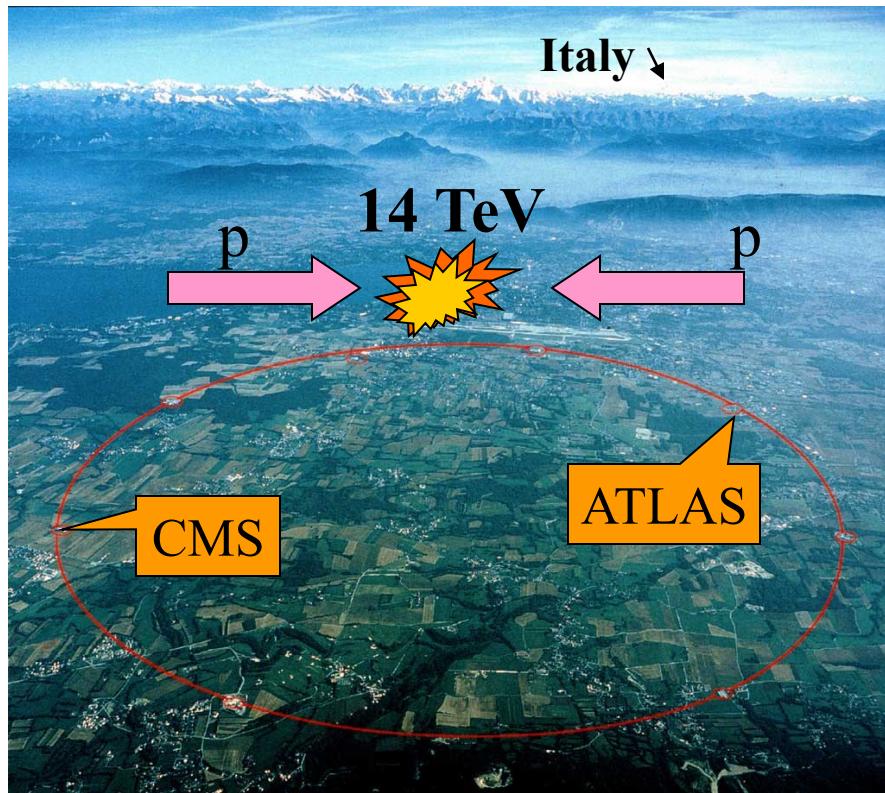
NAUTILUS ai LNF-INFN



MontBlanc



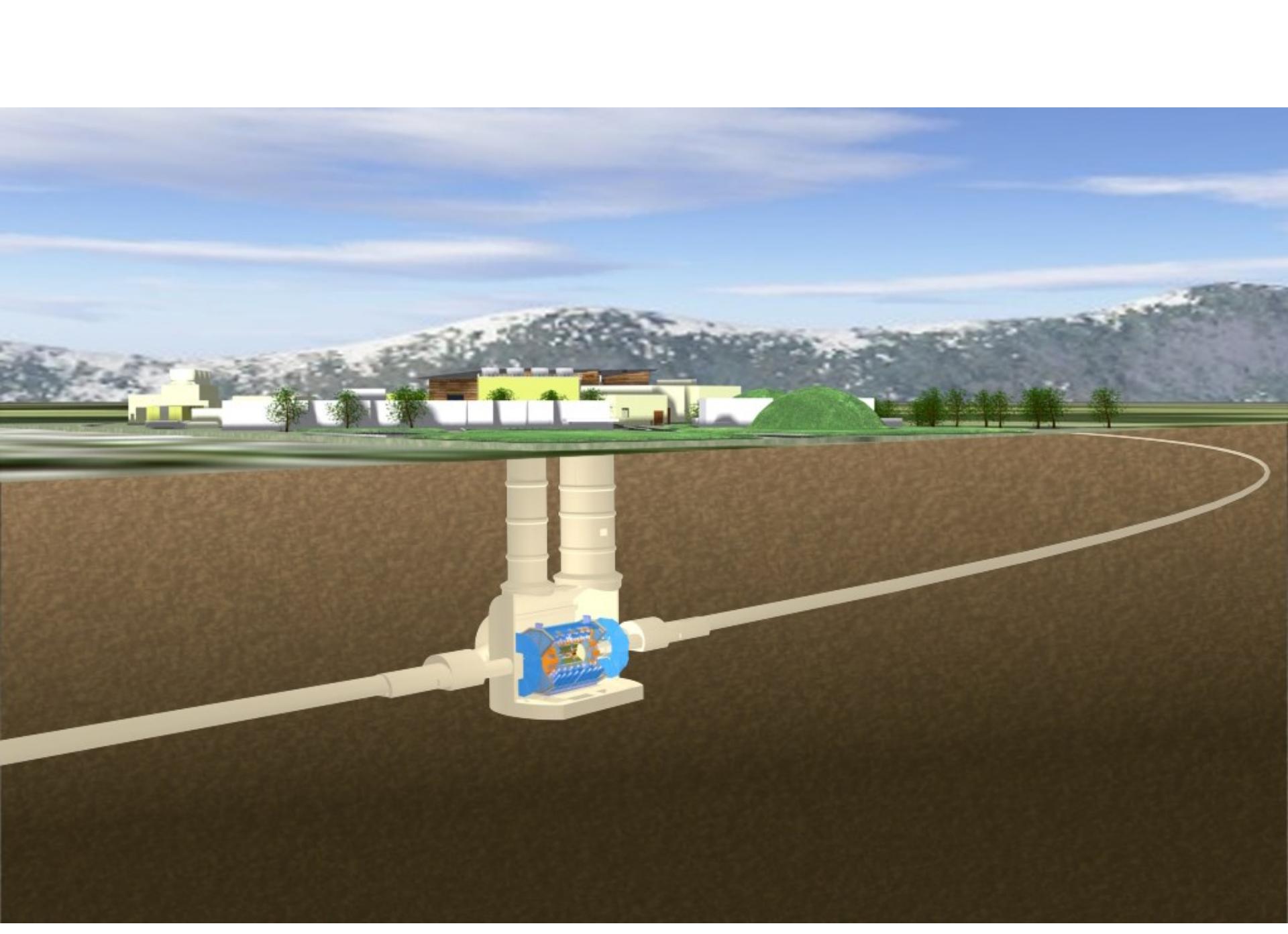
Large Hadron Collider at CERN



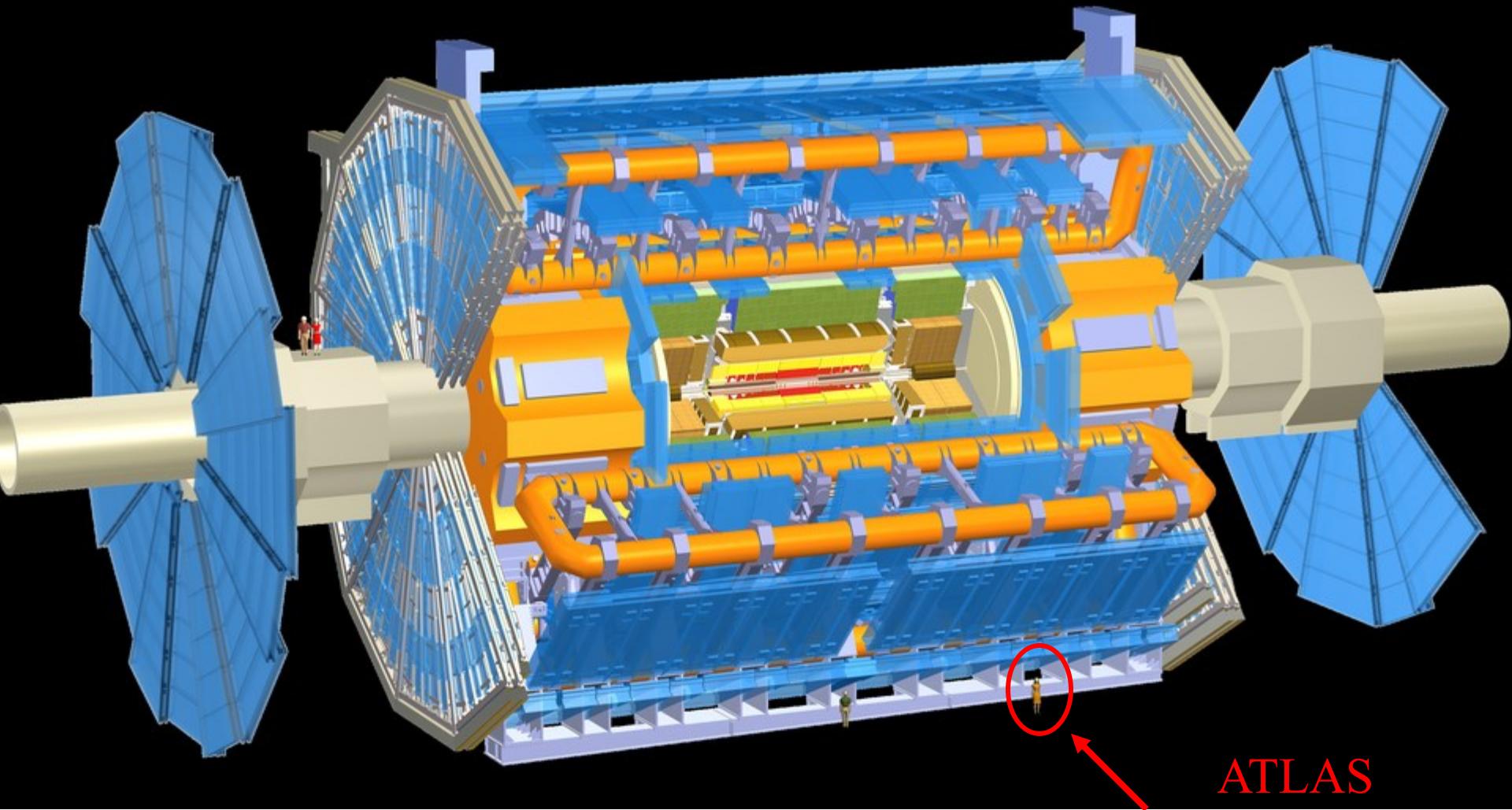
Luminosity target: $10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

Increased production of heavy particles like Higgs, top quark

More particles at **higher** energy requires new detector design and technology

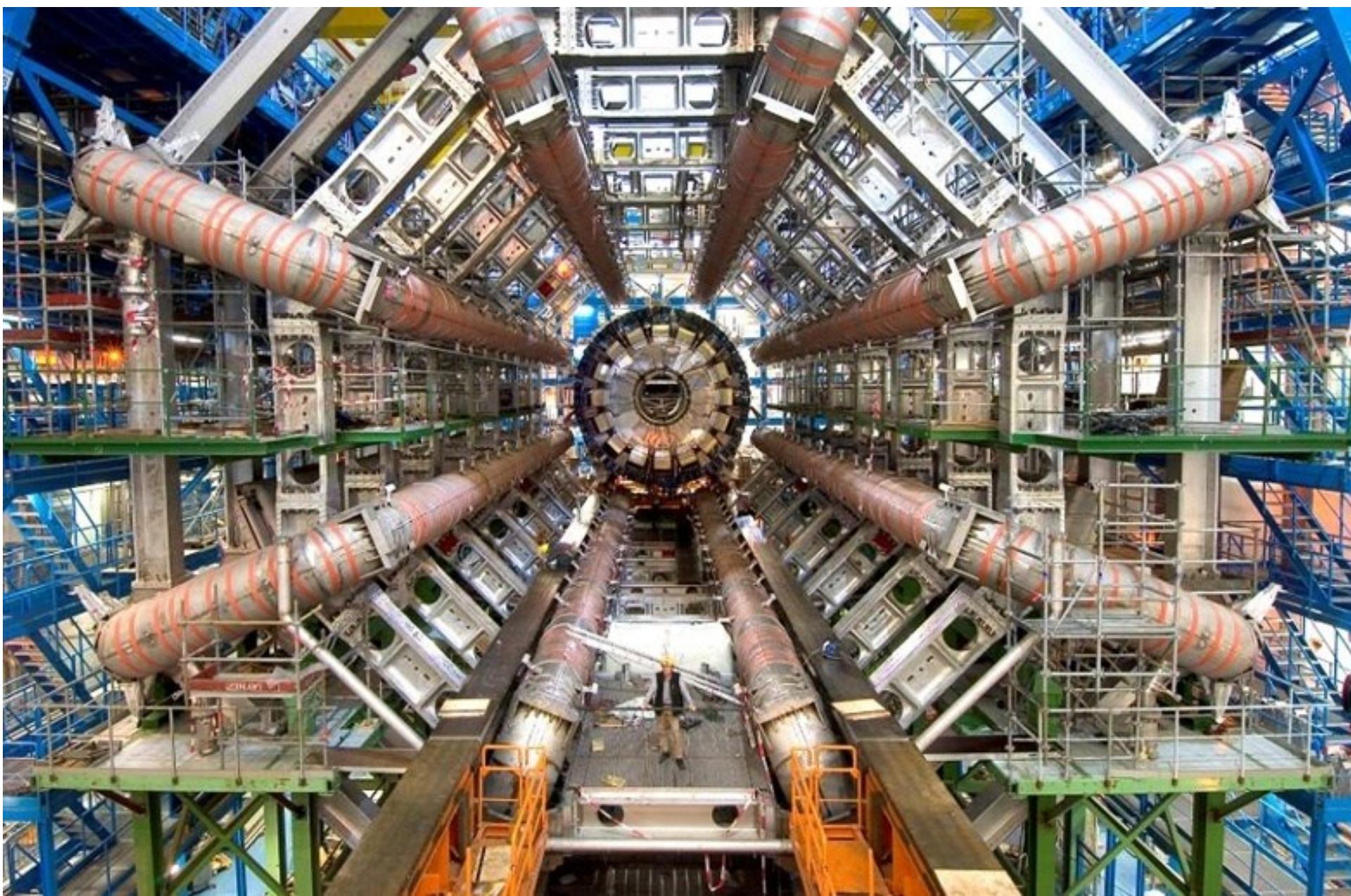


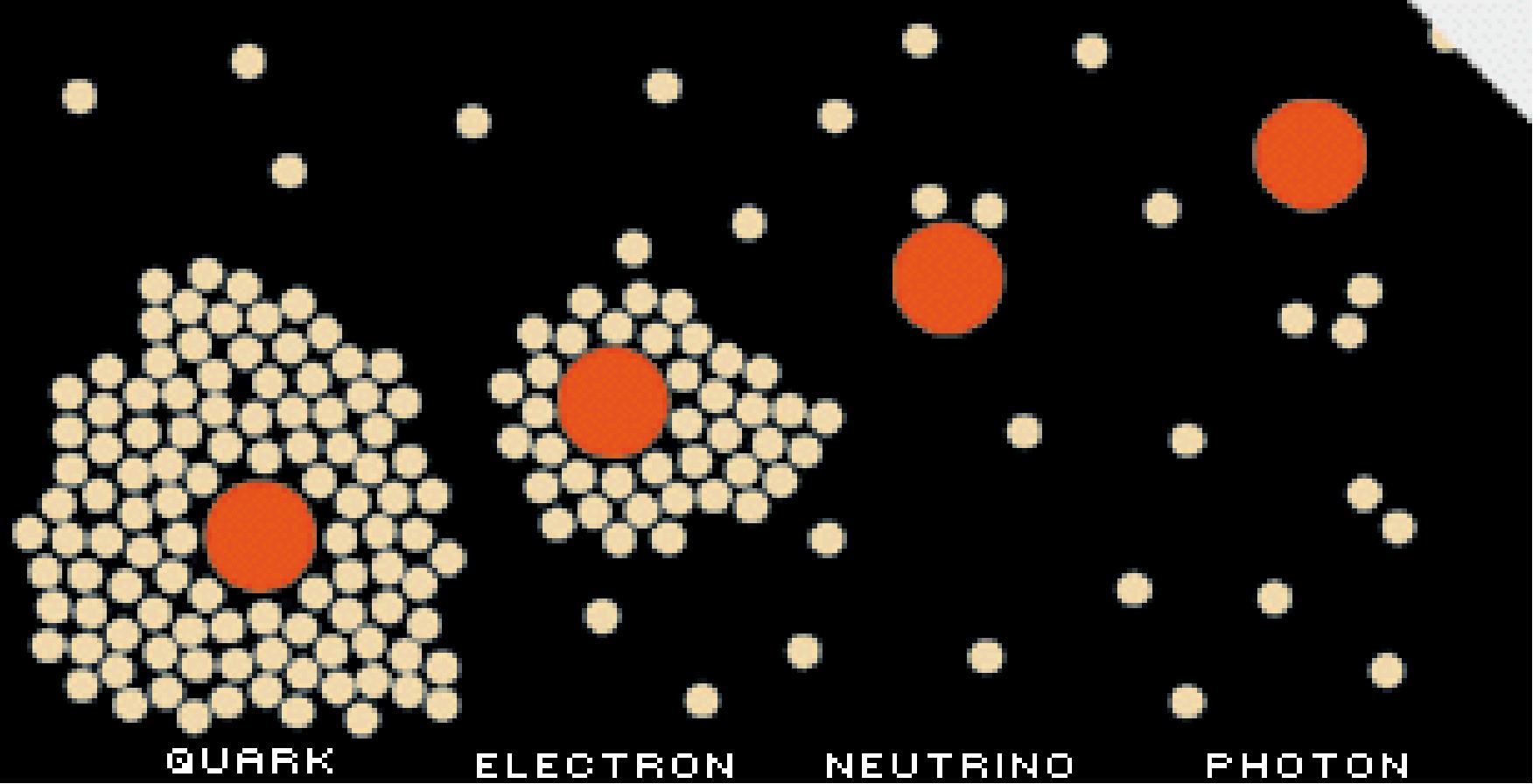
ATLAS Experiment at LHC



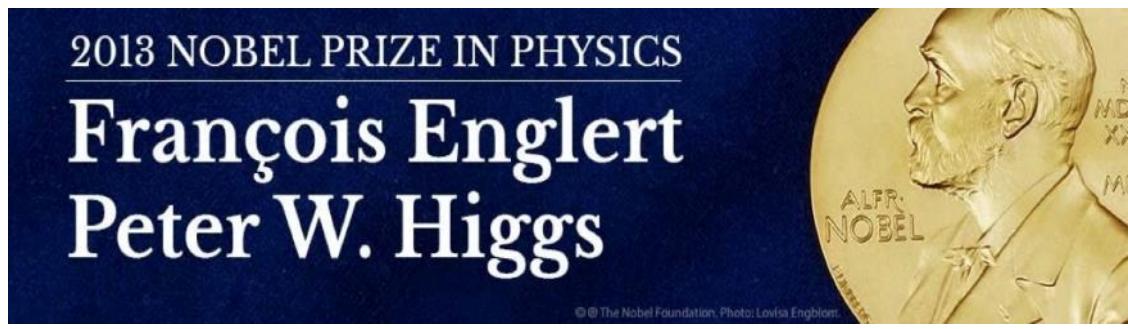
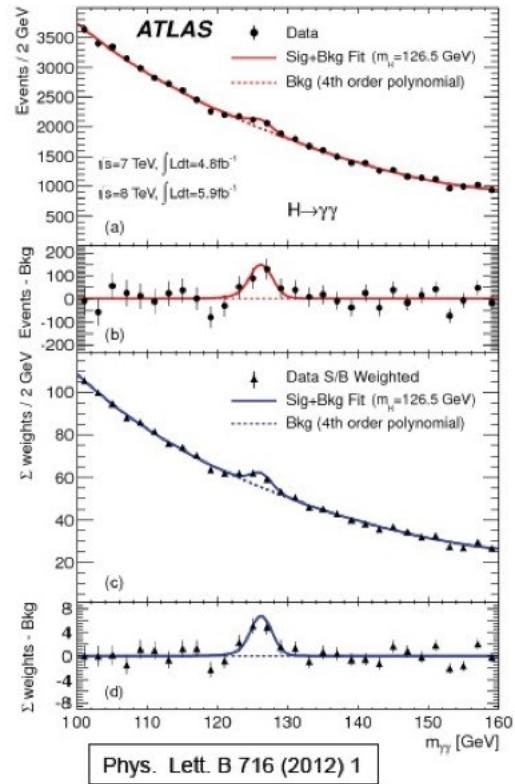
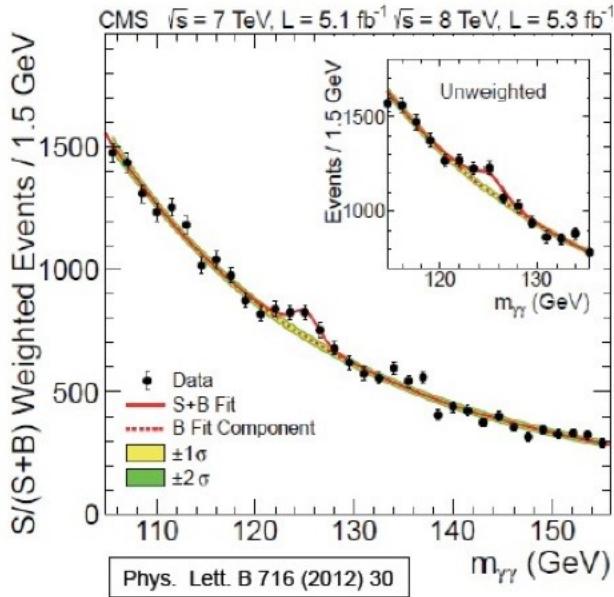
J. Nielsen

ATLAS
collaborator
I2

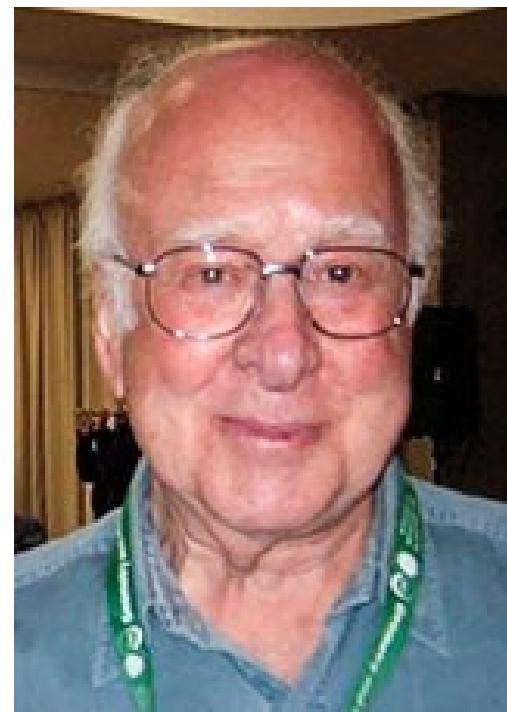
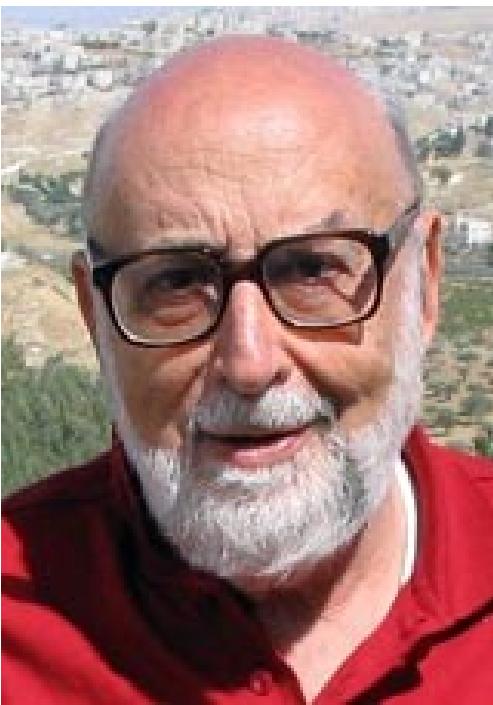




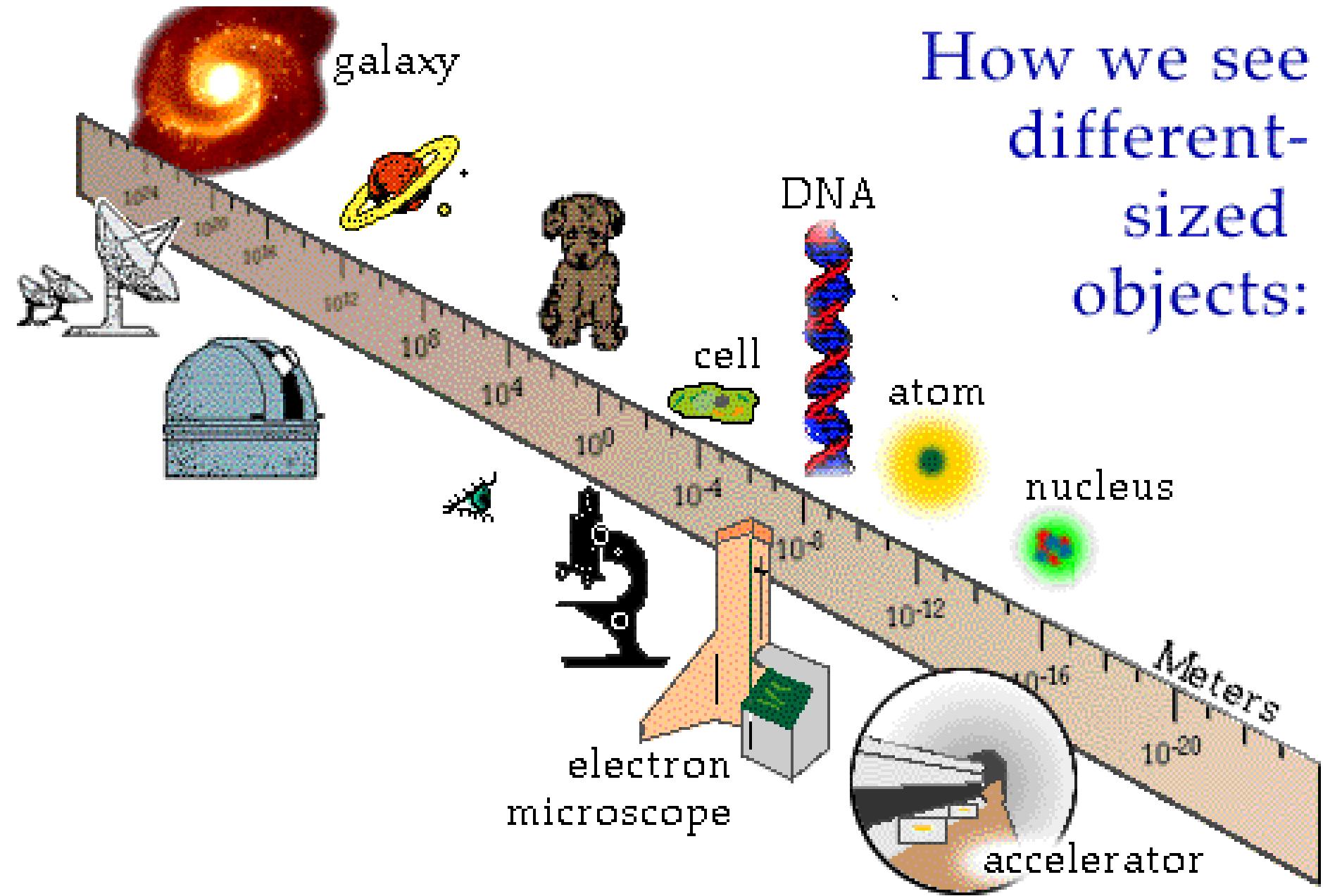
Il campo di Higgs



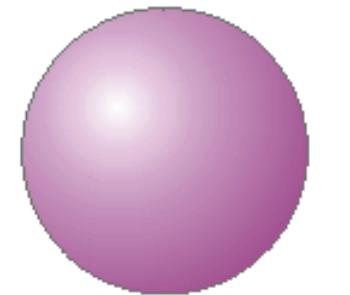
The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs "*for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider*" – *Francois Englert, Peter Higgs*



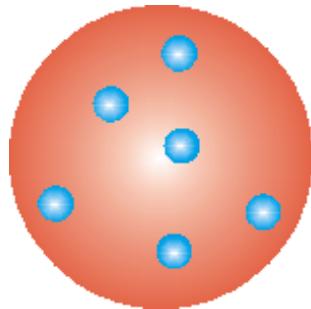
How we see different-sized objects:



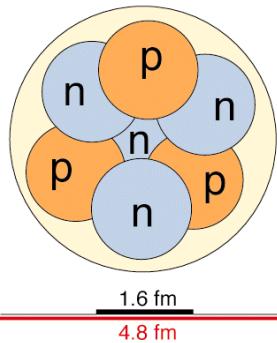
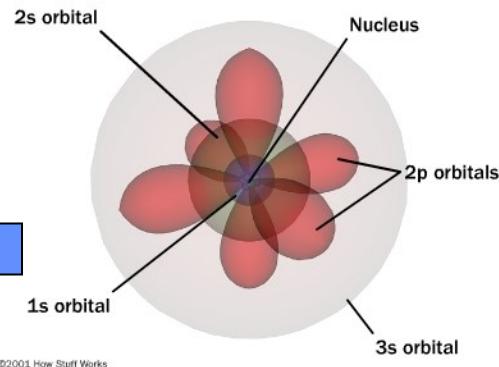
L'atomo all'inizio del '900



L'atomo di Thompson

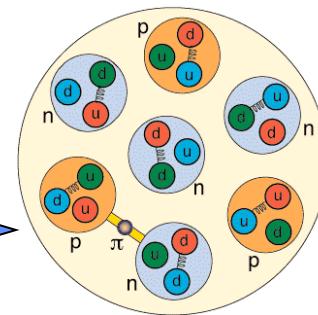


L'atomo quantistico



La struttura del nucleo

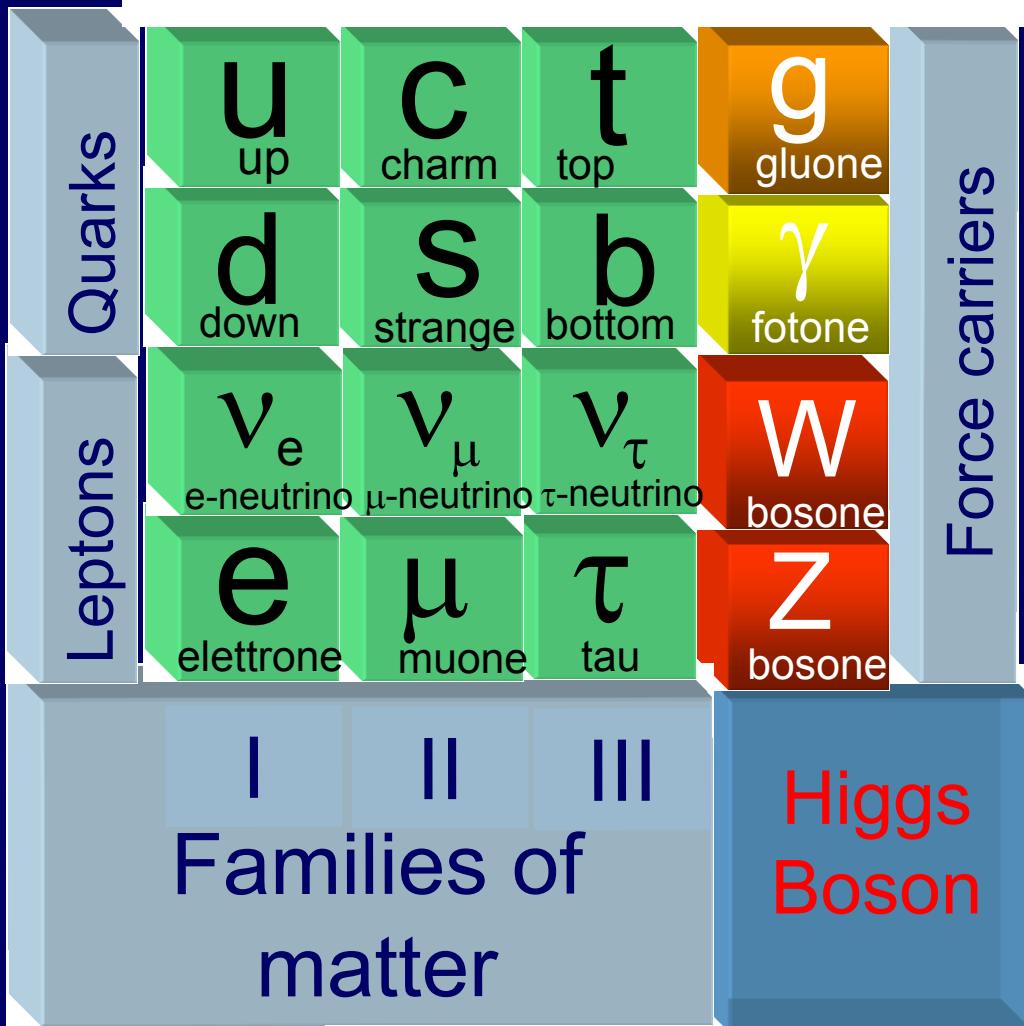
L'atomo di Rutherford e Bohr



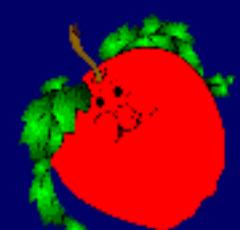
Il nucleo oggi

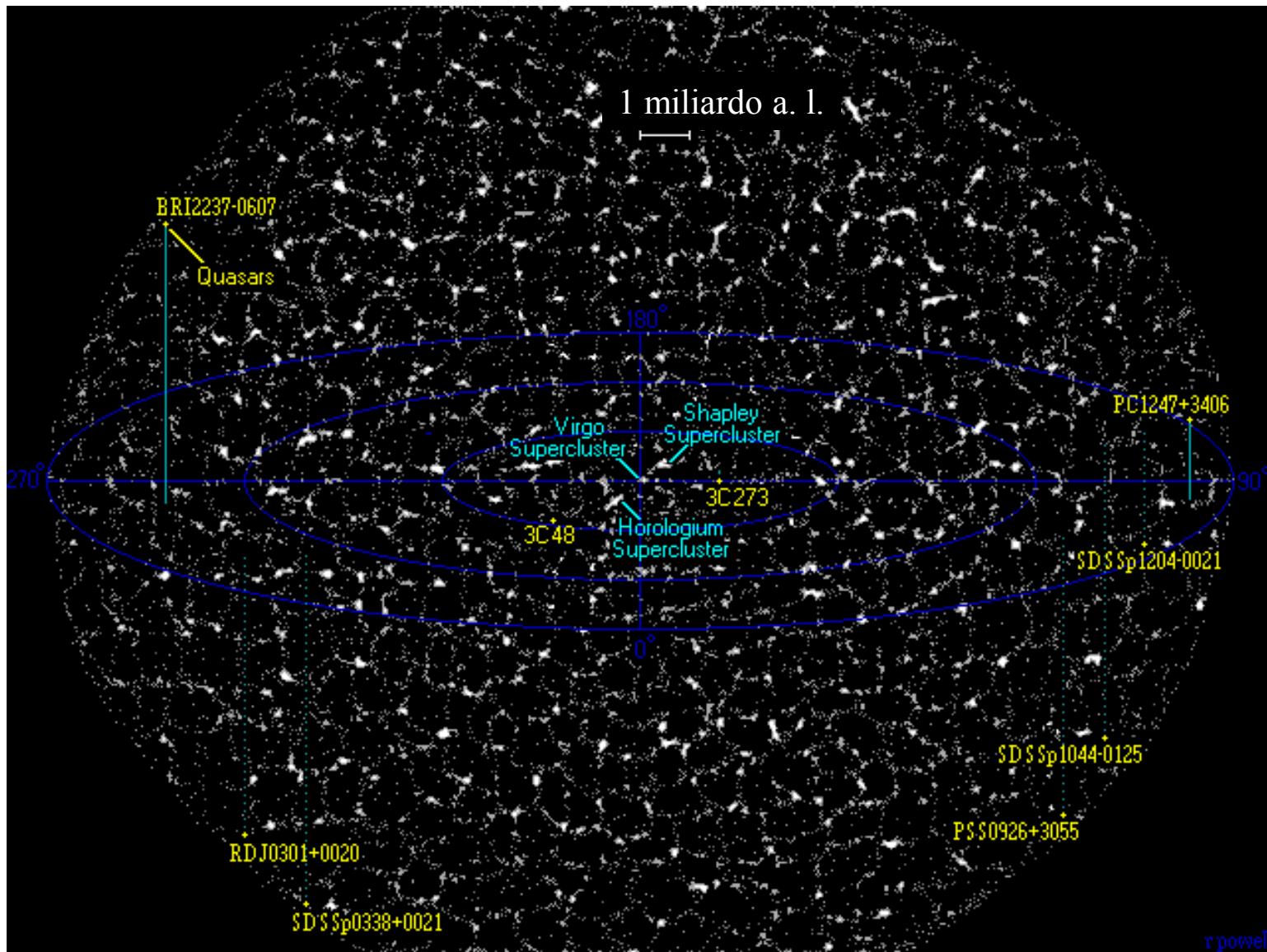


The Standard Model



Gravity
The...
“opera
Ghost”



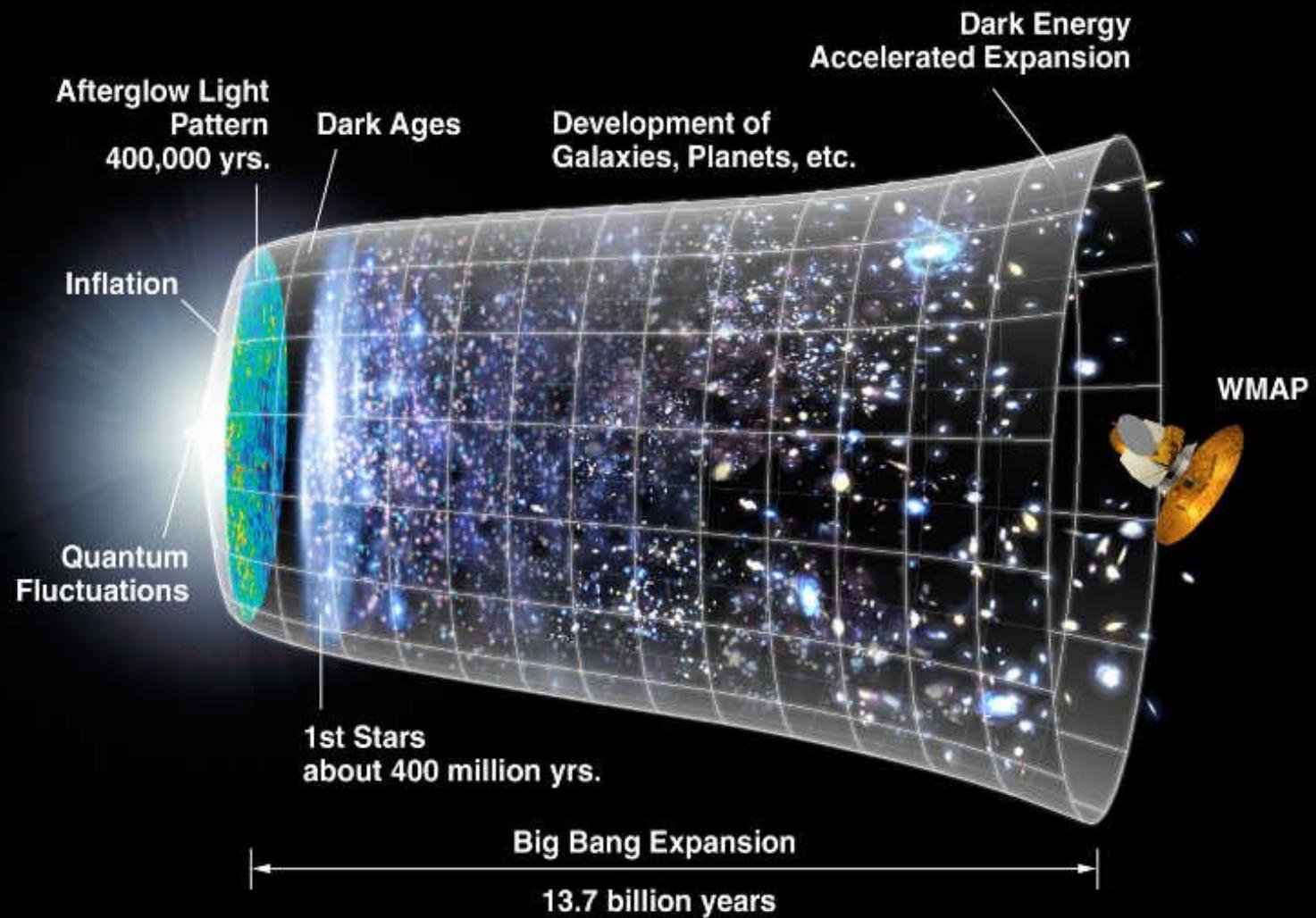


1 miliardo a. l.

r powell

Zoom In x15

The Big Bang Model



Istituto Nazionale di Fisica Nucleare

Ente pubblico di ricerca che promuove, coordina
ed effettua

- la ricerca scientifica nel campo della fisica subnucleare, nucleare ed astroparticellare
- la ricerca e lo sviluppo tecnologico necessari alle attività in tali settori
- in stretta collaborazione con l'Università
- e nel contesto della collaborazione e del confronto internazionale
- Sotto il controllo del Ministero dell'Università e della Ricerca MIUR



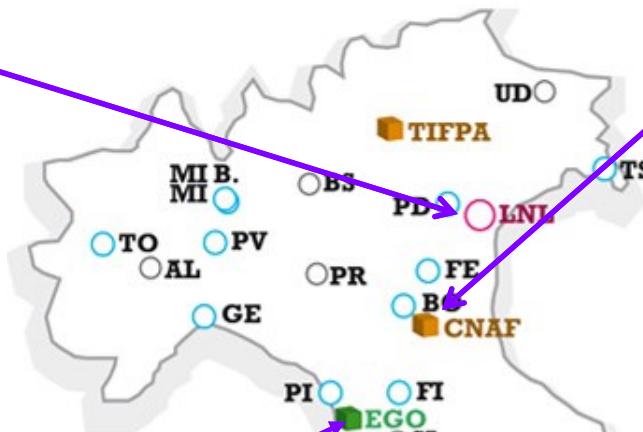
1951
4 Sezioni universitarie
Milano, Torino, Padova, e Roma

1957
Laboratori Nazionali di
Frascati

Legnaro



CNAF



○ Laboratori Nazionali

○ Sezioni

○ Gruppi collegati

■ Centri Nazionali e Scuole

■ Consorzi

Cascina



Gran Sasso



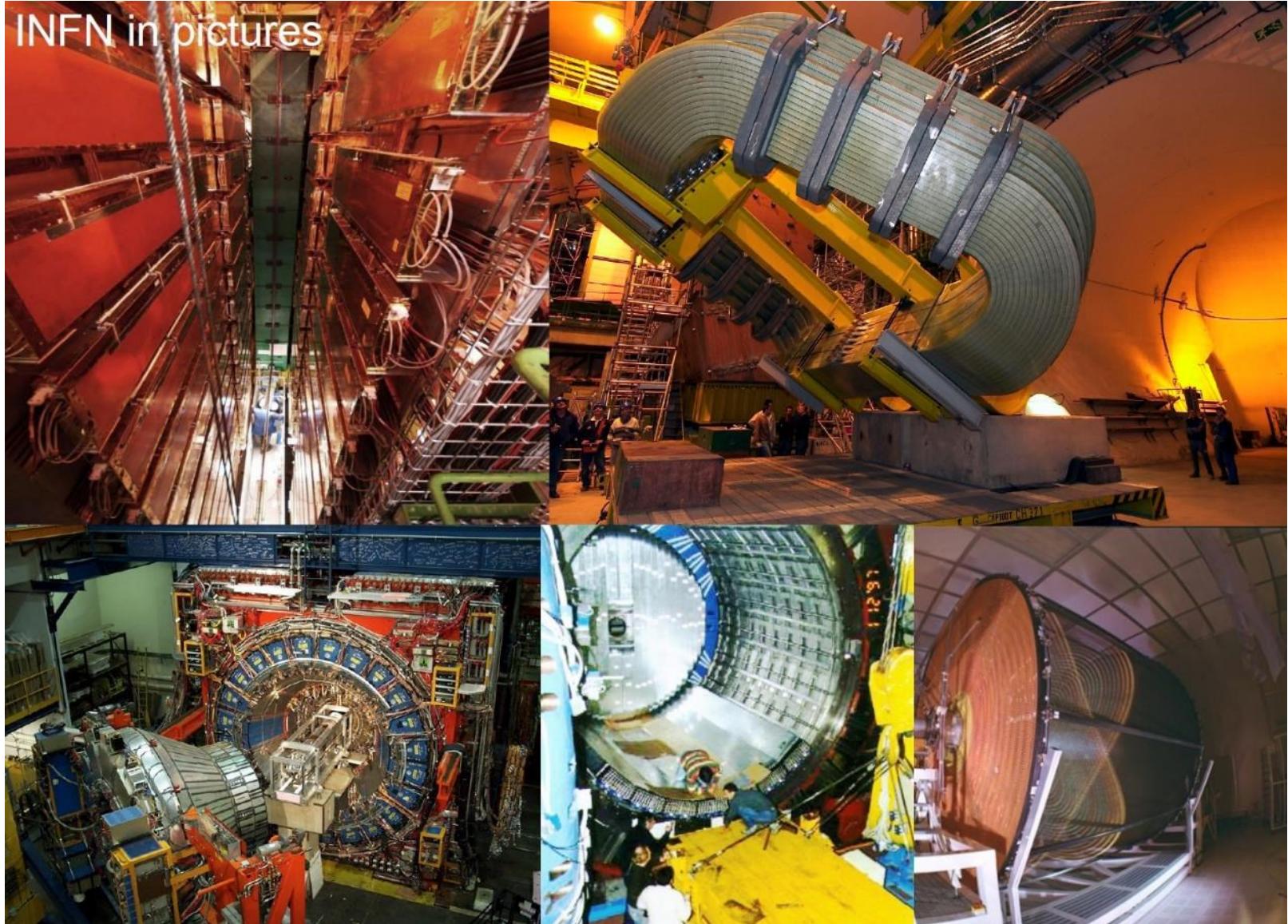
Frascati



Laboratori del Sud



INFN in pictures



La struttura dell'INFN

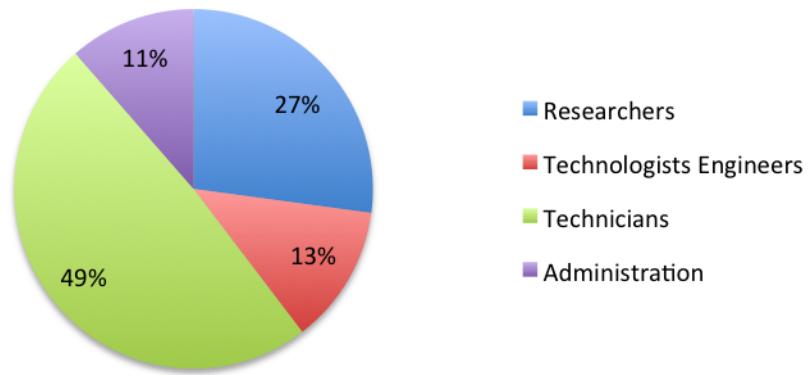
Staff INFN 1864 / 1906	Ricercatori 573 / 610	Tecnologi 230 / 253	Tecnici, CTER 691 / 721	Amministrativi 251 / 254
Tempo determinato 113	42	57	12	2
Associati 3421	1968 + 818	384	251	

5 linee di ricerca

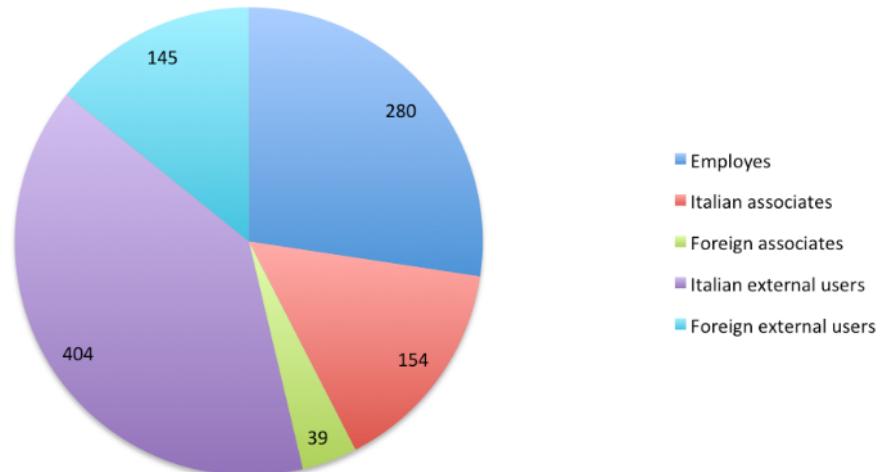
Linea di ricerca	FTE Staff + TD	FTE associati staff	Assegnisti, borsisti, dottorandi	Risorse finanziarie spese 2009-2011 (ME)
Fisica subnucleare	275	321	225	64.3
Fisica astroparticellare	153	260	198	42.12
Fisica nucleare	158	237	146	31.2
Fisica teorica	115	480	450	9.9
Ricerche tecnologiche e interdisciplinari	90	336	192	14.3

Fonte: piano triennale INFN 2012-2014

LNF personnel year 2013

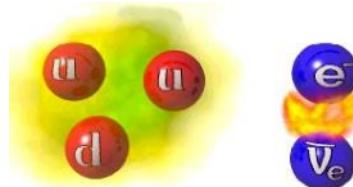


Distribution of LNF collaborators year 2013



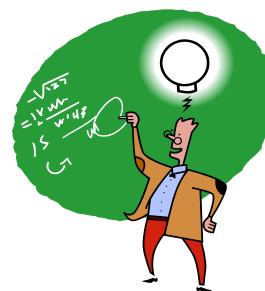
Attività dei LNF

Studi sulla struttura intima
della materia

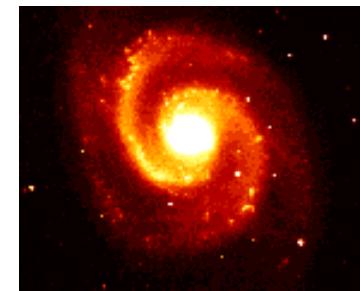


Sviluppo e costruzione di
rivelatori di particelle

Elaborazione di
modelli teorici



Ricerca di onde
gravitazionali



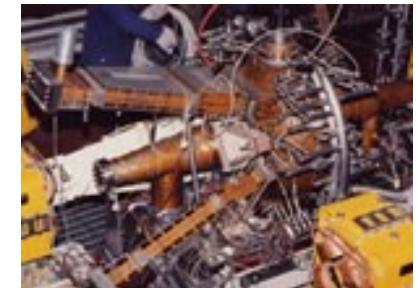
Studi di
materiali e
ricerche
biomediche
con luce di
sincrotrone



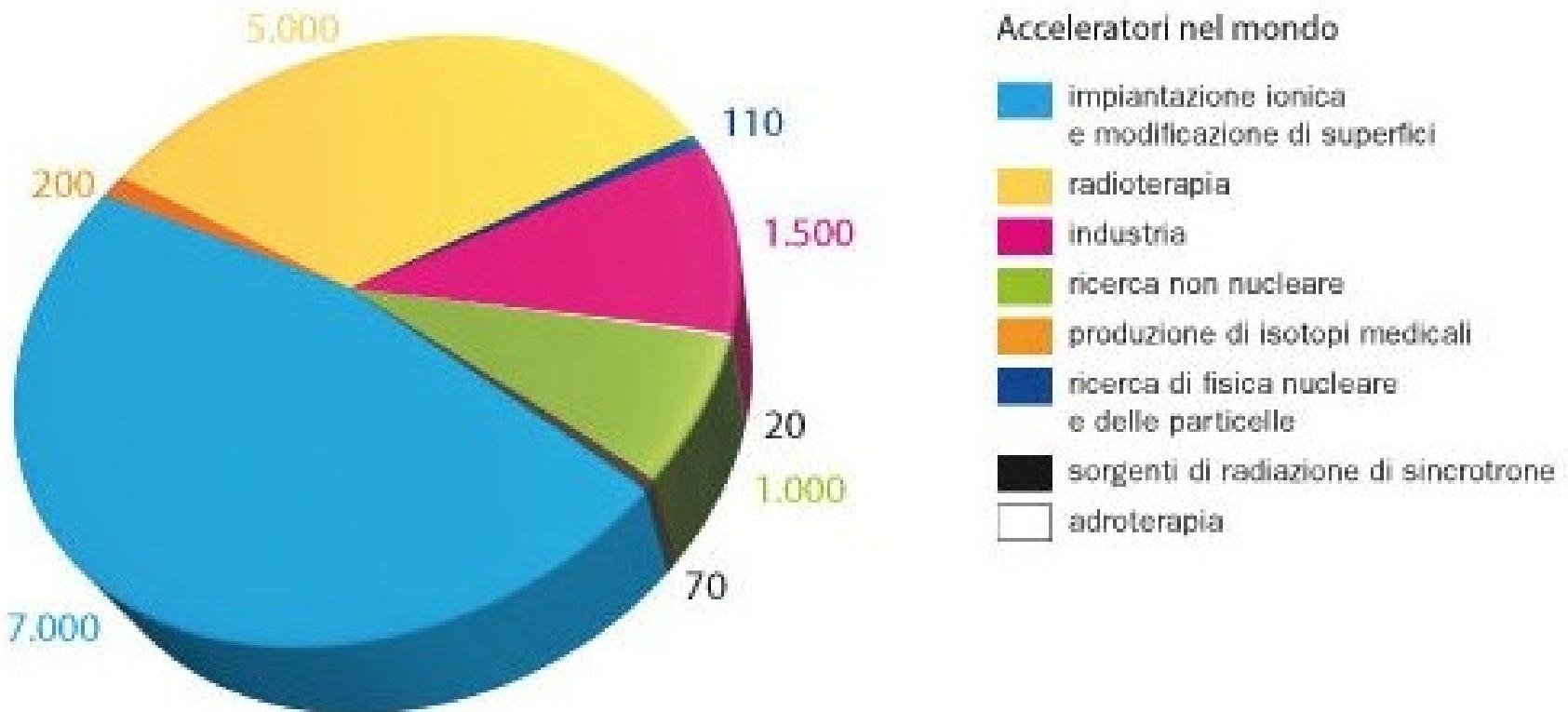
Sviluppo e
supporto di
sistemi d
calcolo
e reti



Studio e sviluppo di
tecniche acceleratrici

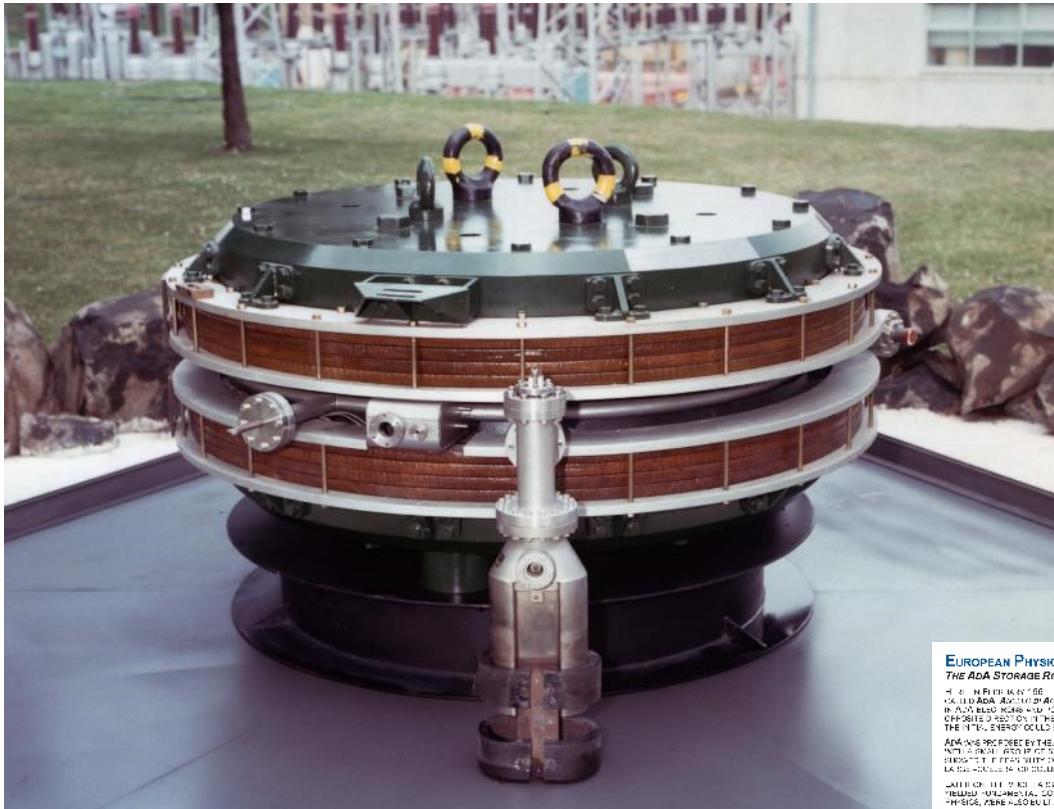


Acceleratori



Collisori Materia-Antimateria

ADA (1961)



EUROPEAN PHYSICAL SOCIETY – EPS HISTORIC SITE
THE ADA STORAGE RING AT THE INFN FRASCATI NATIONAL LABORATORIES

THE INFN FRASCATI NATIONAL LABORATORIES ARE ONE OF THE MOST IMPORTANT INSTITUTIONS FOR PARTICLE PHYSICS RESEARCH IN ITALY. THE INFN WAS FOUNDED IN 1950 AS A COORDINATING BODY FOR SCIENTIFIC ACTIVITIES IN THE FIELD OF HIGH ENERGY PHYSICS. THE INFN HAS BEEN INVOLVED IN THE DEVELOPMENT OF THE WORLD'S FIRST ELECTRON-POSITRON COLLIDER, THE LEP, WHICH WAS OPERATED FROM 1989 TO 2001.

ADA WAS PROPOSED BY THE AUTONOMOUS INSTITUTE OF FRASCATI, THE ENERGIA SULITR, TOGETHER WITH THE UNIVERSITY OF ROMA AND THE UNIVERSITY OF MILAN, IN 1959. IT WAS APPROVED BY THE ANA (THE ITALIAN NATIONAL RESEARCH COUNCIL) IN 1960, AND WORK ON THE PROJECT BEGAN IN 1961.

ADAMO GALLI, AN INFN PHYSICIST, WAS CHIEF DESIGNER OF THE PROJECT, AND DARIO S. TASSANINI, AN INFN PHYSICIST, WAS THE PROJECT MANAGER. THE PROJECT WAS FINANCED BY THE ANA, THE C.R.C., AND THE UNIVERSITY OF ROMA.

SITO STORICO DELLA SOCIETÀ EUROPEA DI FISICA – EPS
L'ANELLO DI ACCUMULAZIONE ADA DEL LABORATORIO NAZIONALE DI FRASCATI
DELL'INFN

Questa pagina è un sito storico della Società Europea di Fisica (EPS), che riporta la storia dell'antiprotoni elettronica (LEP) e del suo predecessore, l'Anello di Accumulazione (ADA). Il progetto ADA fu ideato nel 1959 e realizzato nel 1961. È stato il primo acceleratore di particelle elettron-positrone ad accoppiamento magnetico. È stato utilizzato per esplorare i fenomeni di annichilazione e creazione di particelle elementari.

Il progetto ADA ha avuto un costo totale di circa 10 milioni di lire italiane. La struttura principale era composta da due anelli di accumulazione, uno esterno e uno interno, con un diametro di circa 10 metri ciascuno. I due anelli erano circondati da magneti elettronici che fornivano una forza magnetica di circa 10000 Gauss.

Successivamente, nel 1970, l'Anello di Accumulazione (ADA) fu sostituito dal più avanzato Anello di Accumulazione (LEP), che fu costruito nel 1989. Il progetto ADA è stato un grande successo scientifico, poiché ha consentito di scoprire nuove particelle e leggi della fisica.

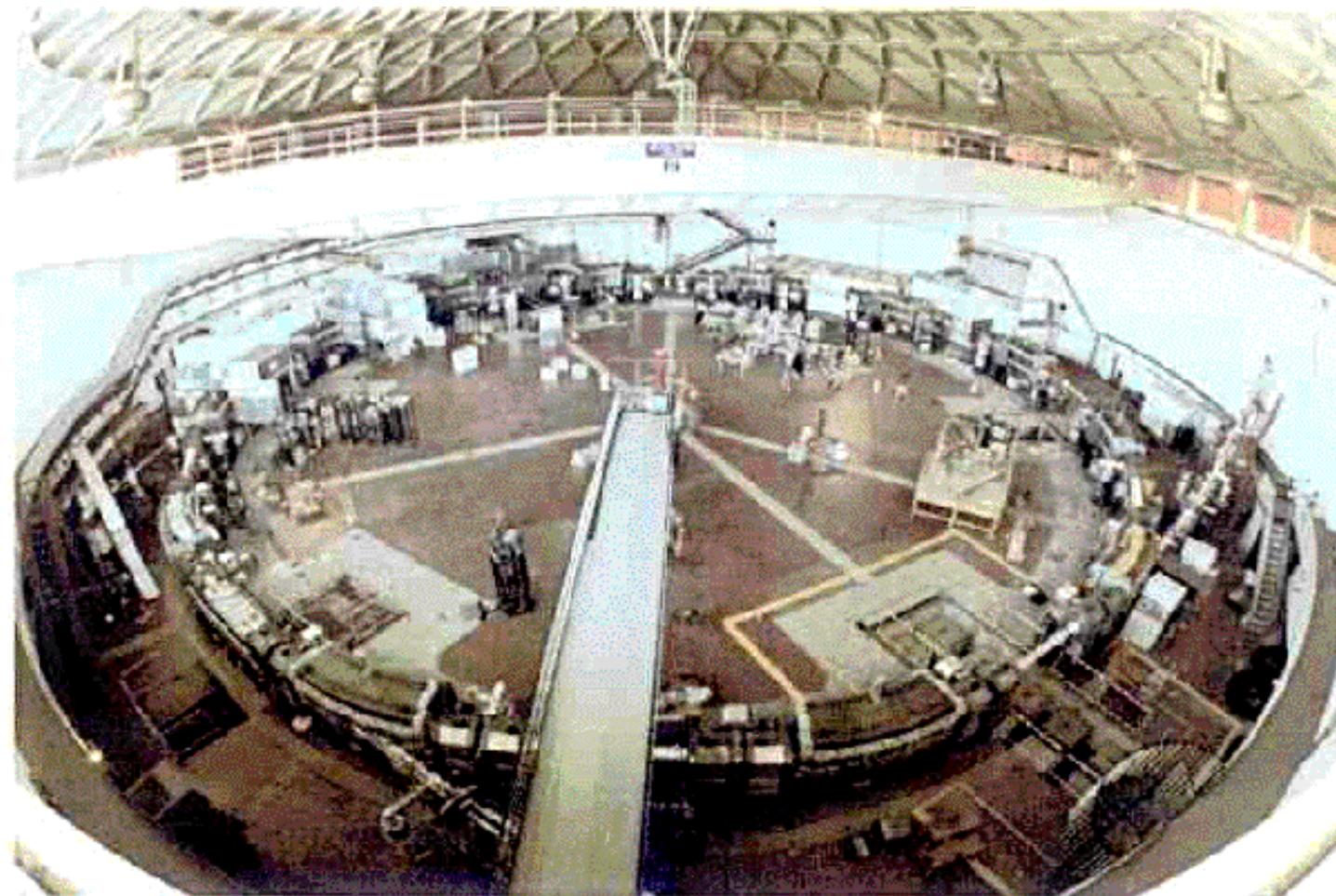
FRASCATI - DICEMBRE 2013

Sito Storico della
Società Europea di
Fisica – EPS



Collisori Materia-Antimateria

ADONE (1969-1993)



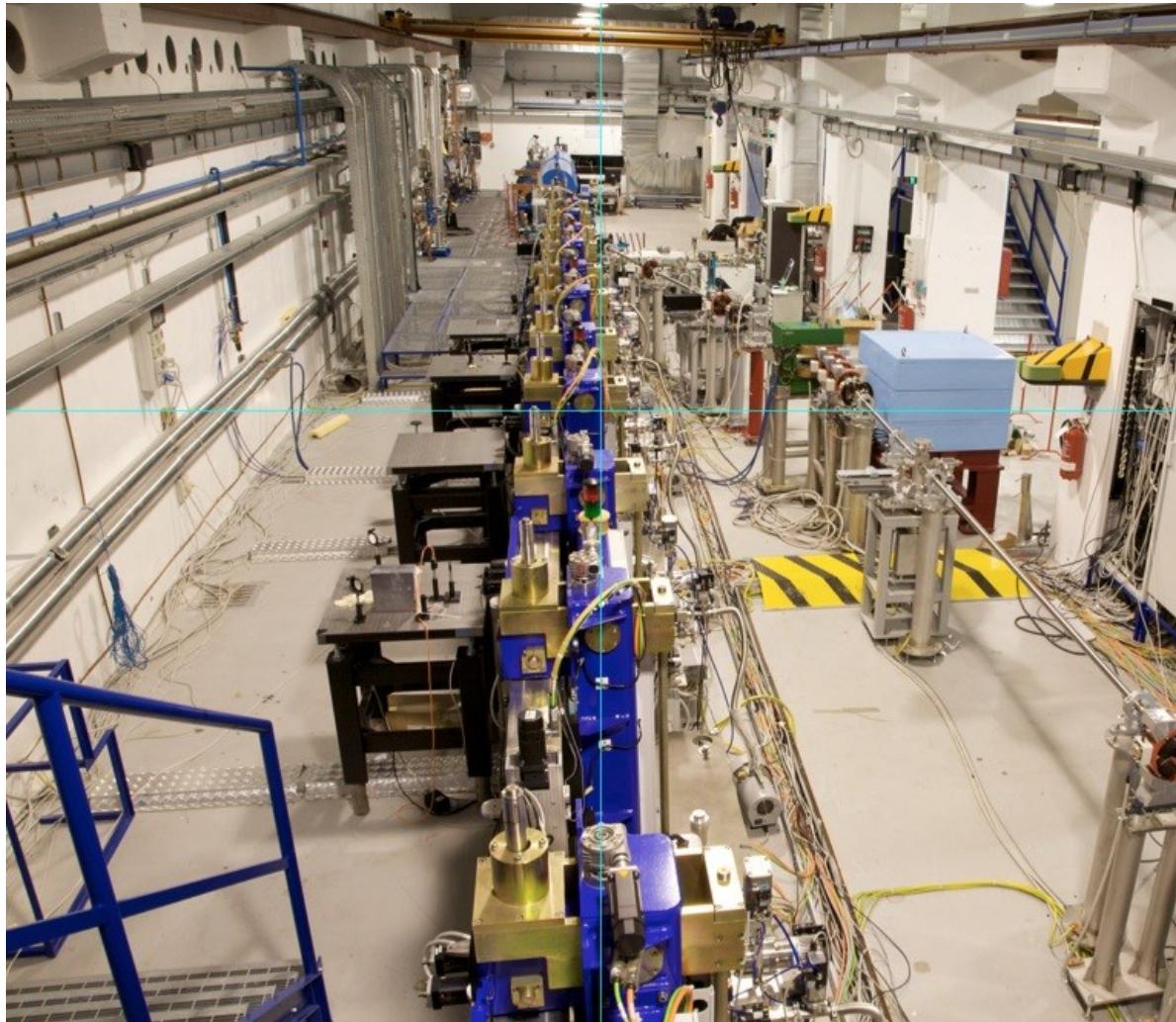
Collisori Materia-Antimateria

DAFNE (1997)



Acceleratori Lineari

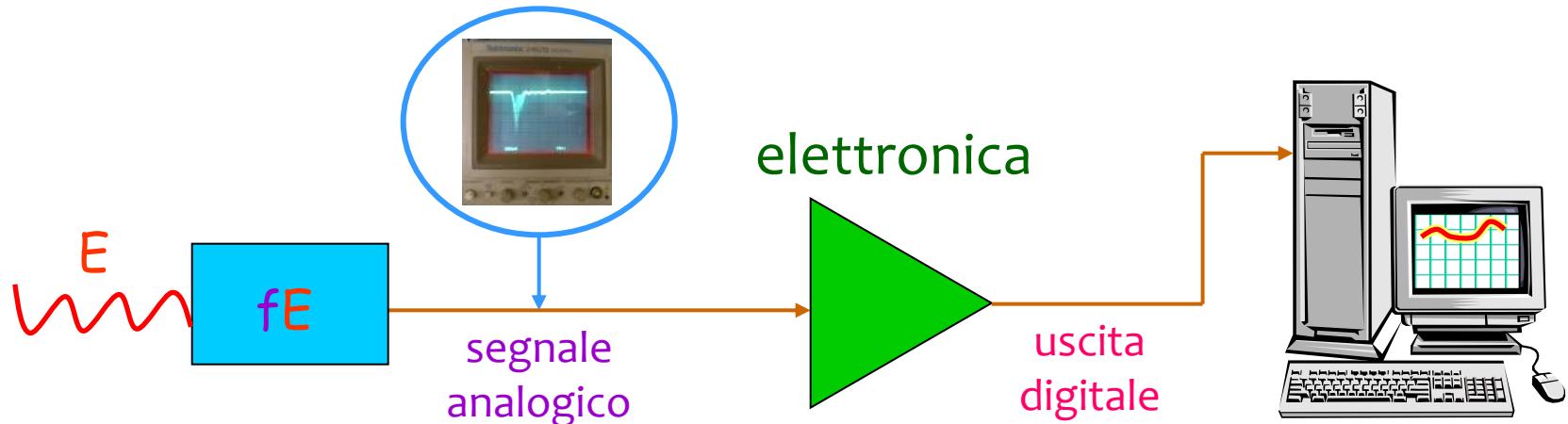
SPARC (2009)



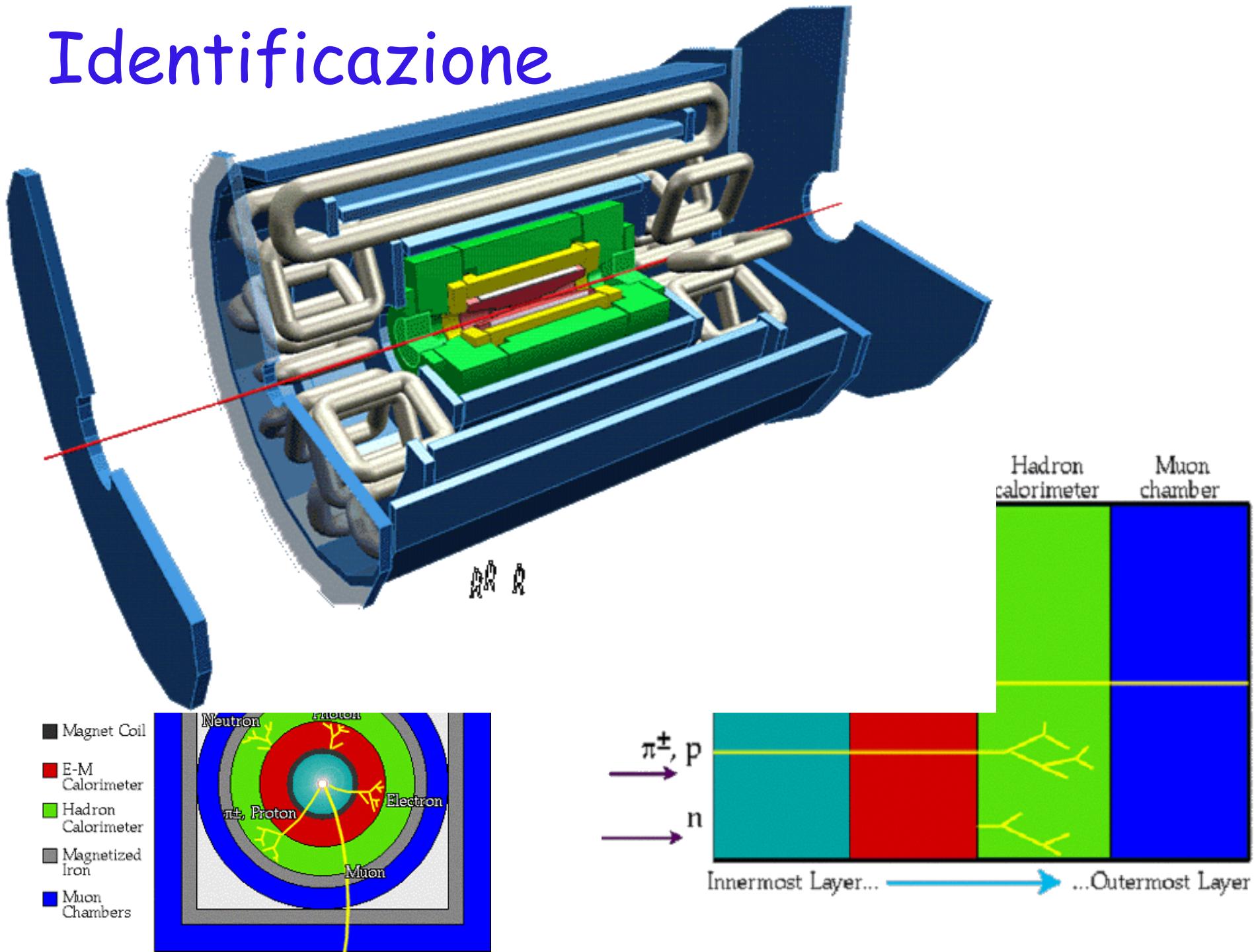
Rivelatori e la loro elettronica

Particella di energia E che attraversa il rivelatore → interazione con gli atomi ($e^- +$ nucleo) del mezzo → trasferimento di energia fE ($f \leq 1$) al rivelatore → conversione in forma di energia accessibile

Rivelatori moderni essenzialmente elettrici: fE è convertita in impulsi elettrici → elettronica (analogica & digitale) per il trattamento dell'informazione



Identificazione

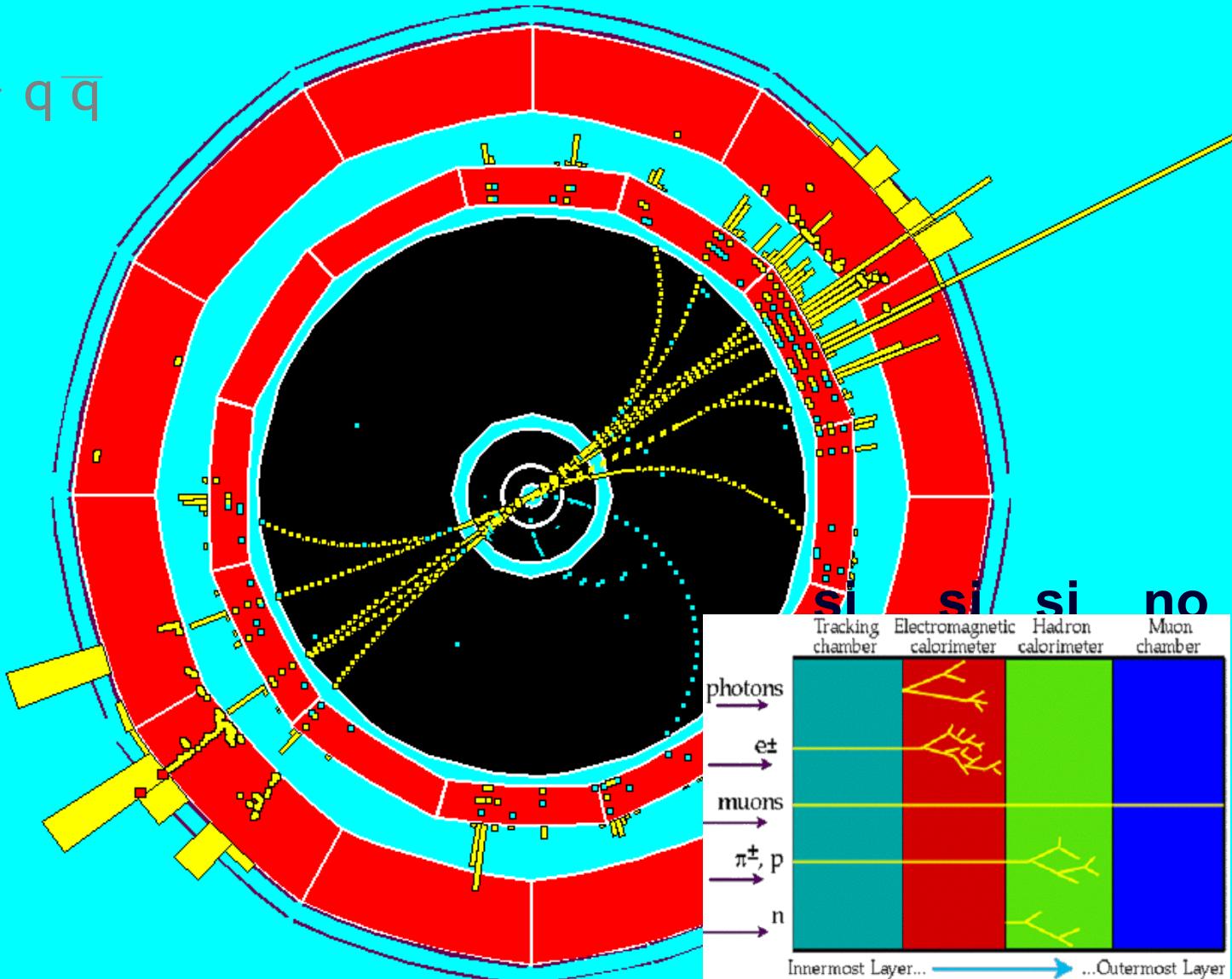


Riconoscere gli eventi

ALEPH DALI

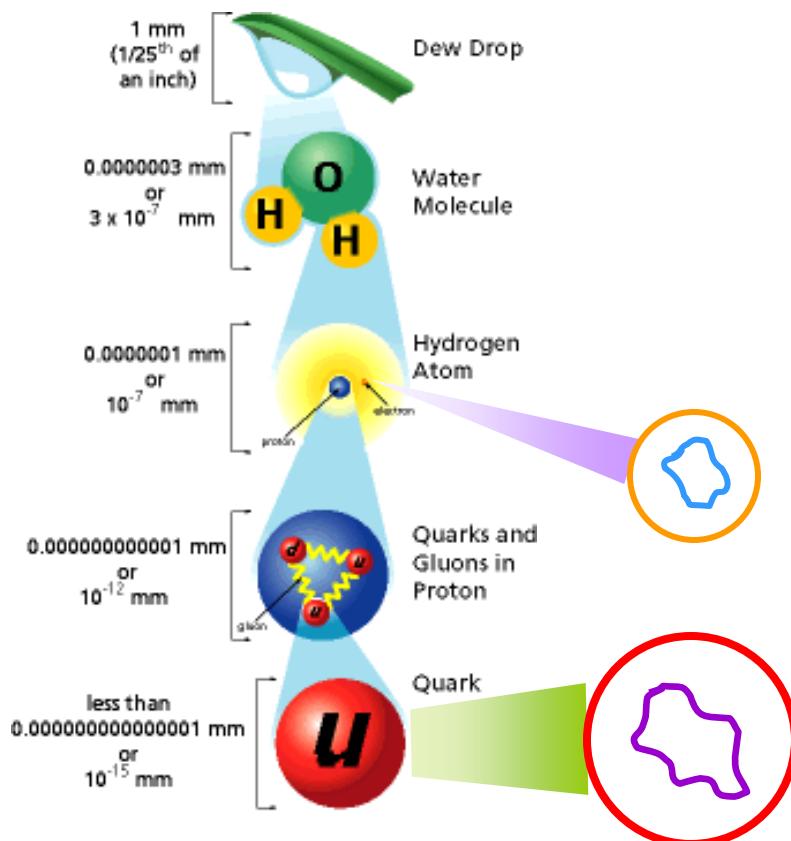
Run=15768 Evt=5906

$e^+ e^- \rightarrow q\bar{q}$



Questioni Aperte

- Le particelle sono veramente puntiformi ?

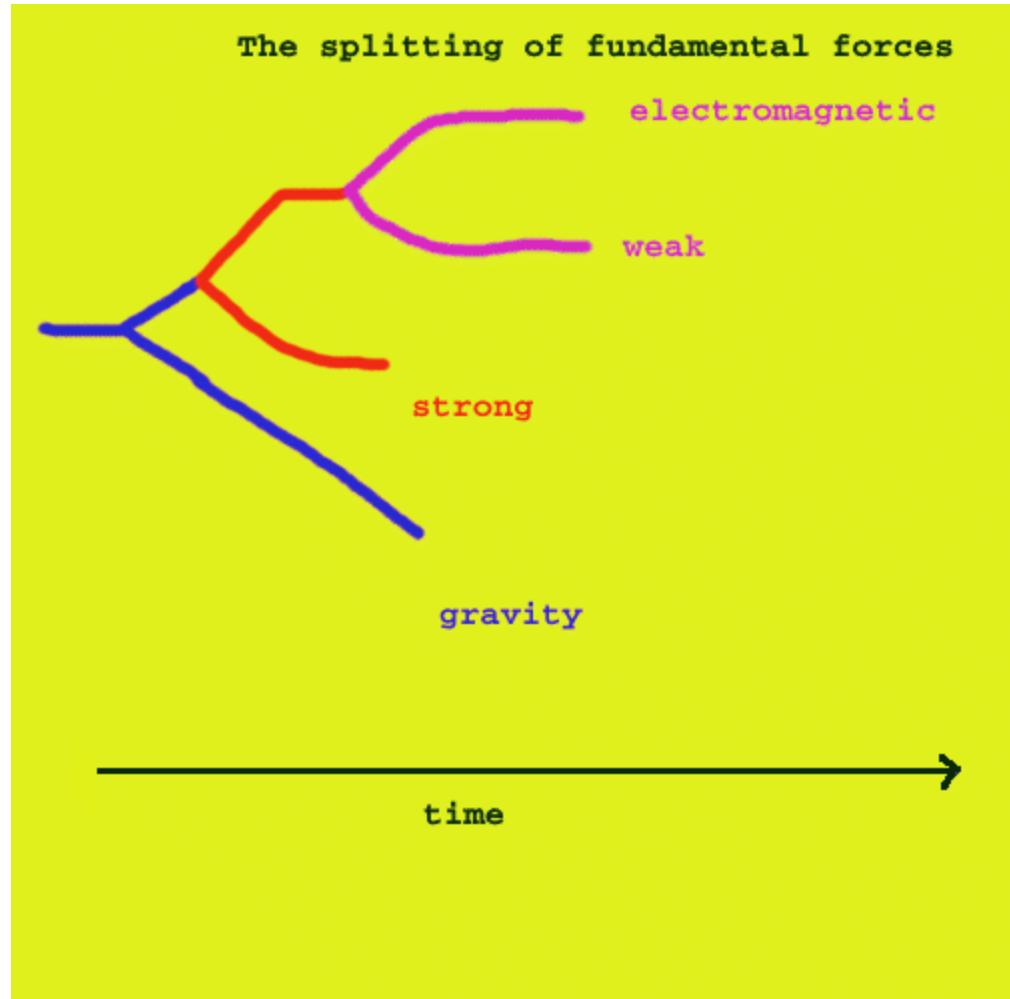


Teoria delle Stringhe

ulteriore livello microscopico: particelle non sono puntiformi, ma piccoli (10^{-33} cm) anelli oscillanti

diversi stati di oscillazione della stringa → particelle diverse

L'unificazione di tutte le forze?



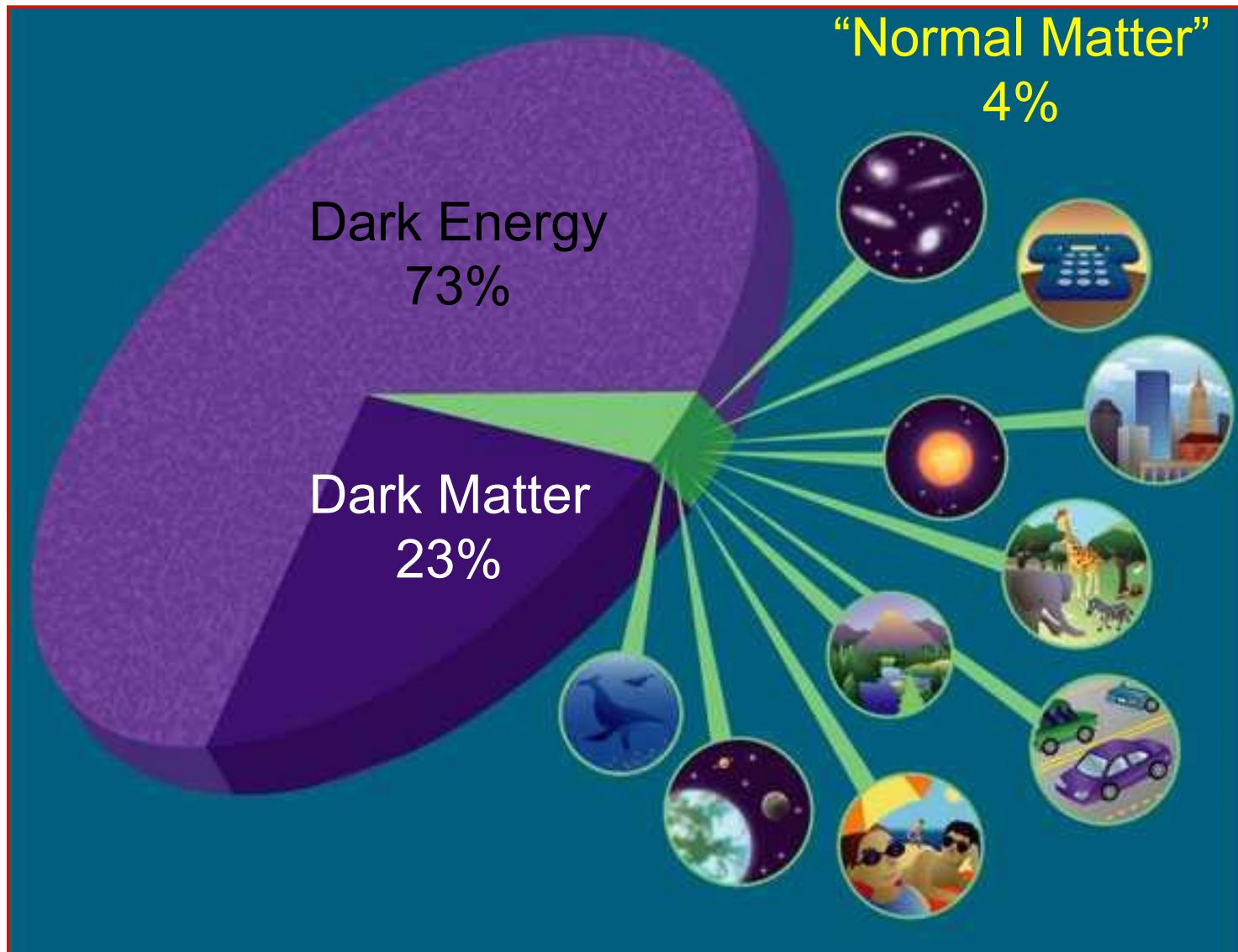
Cosa accade all'interno di un buco nero?

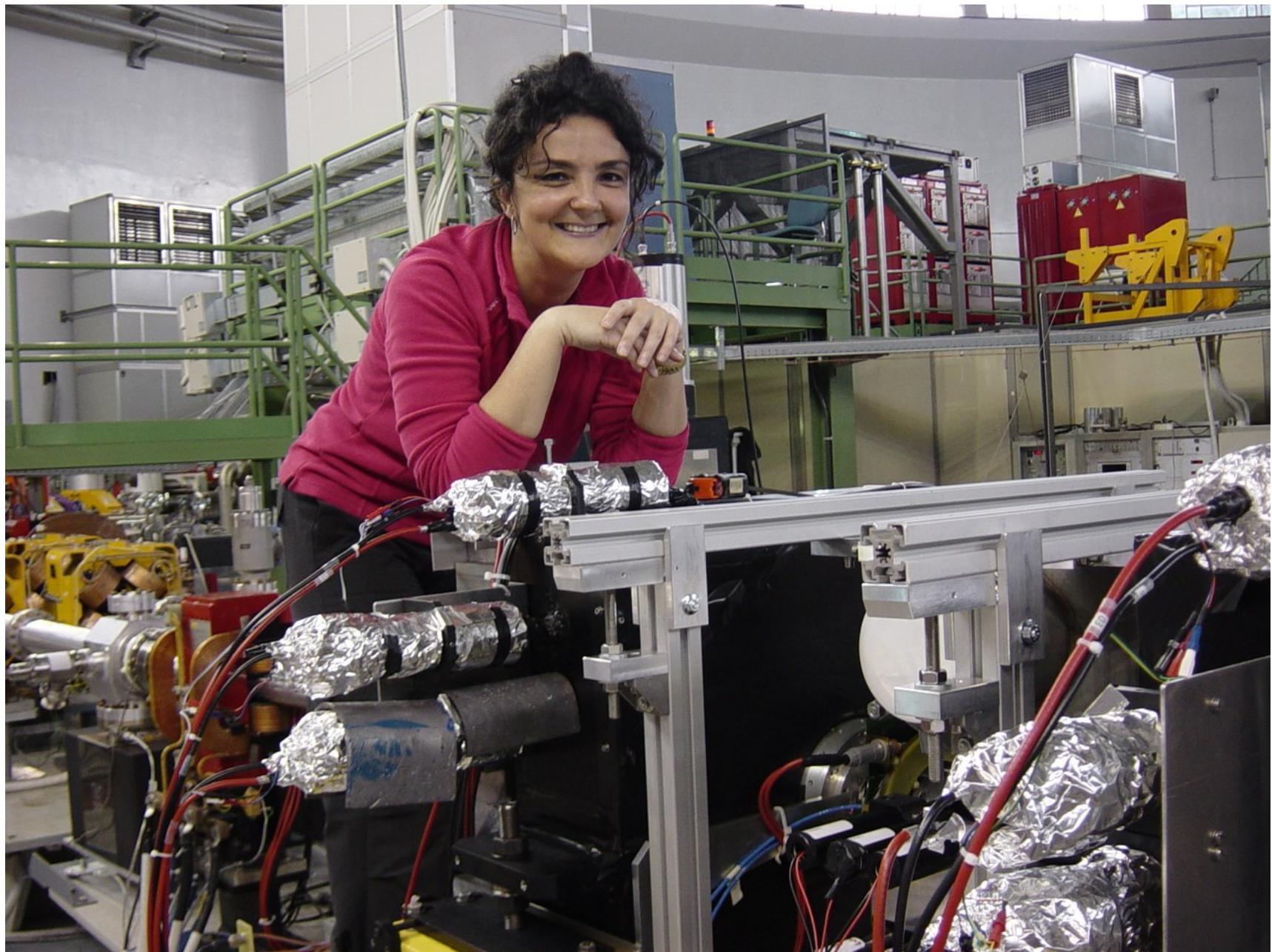


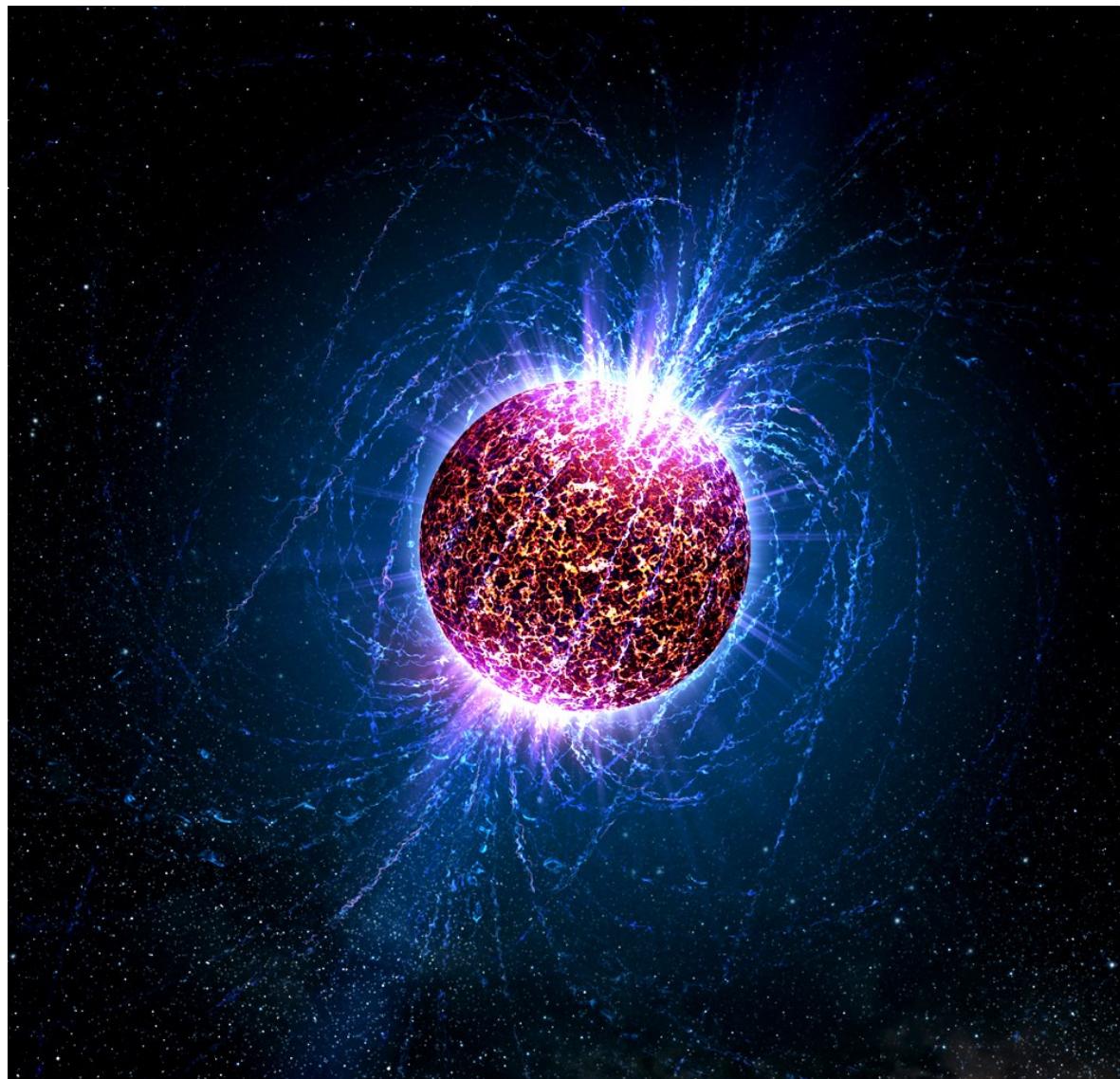
Einstein – l'ultima lavagna



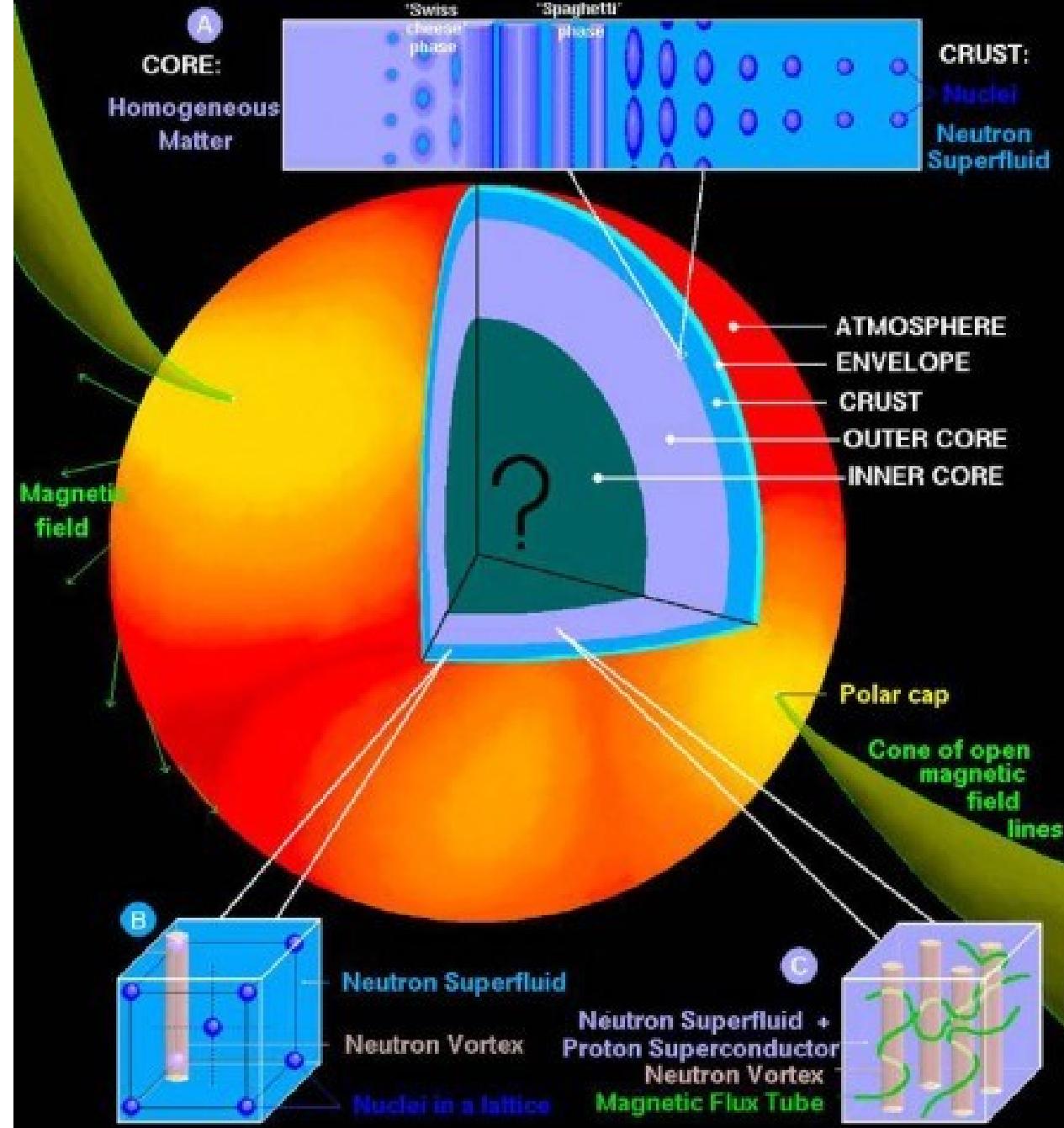
Materia ed energia

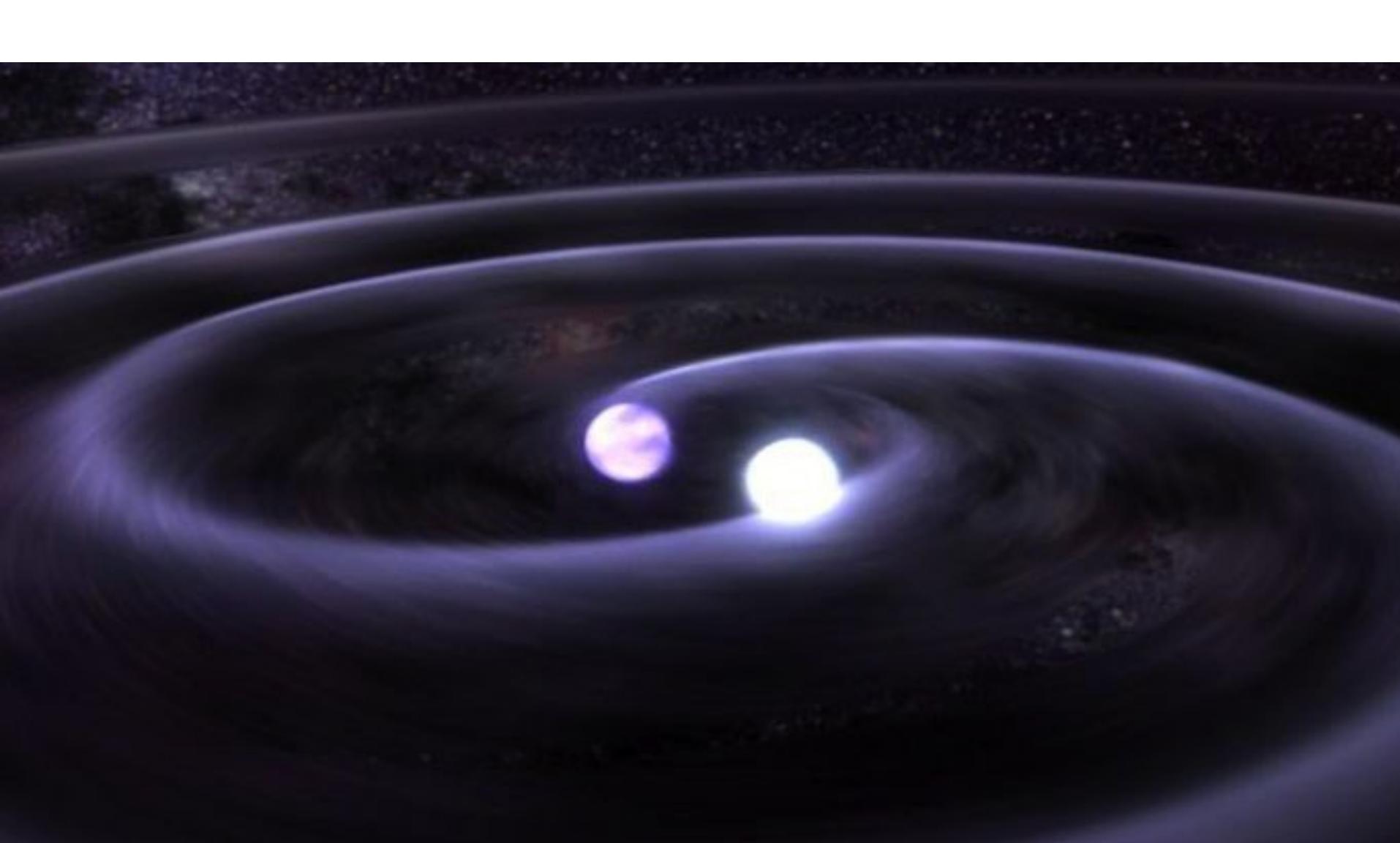






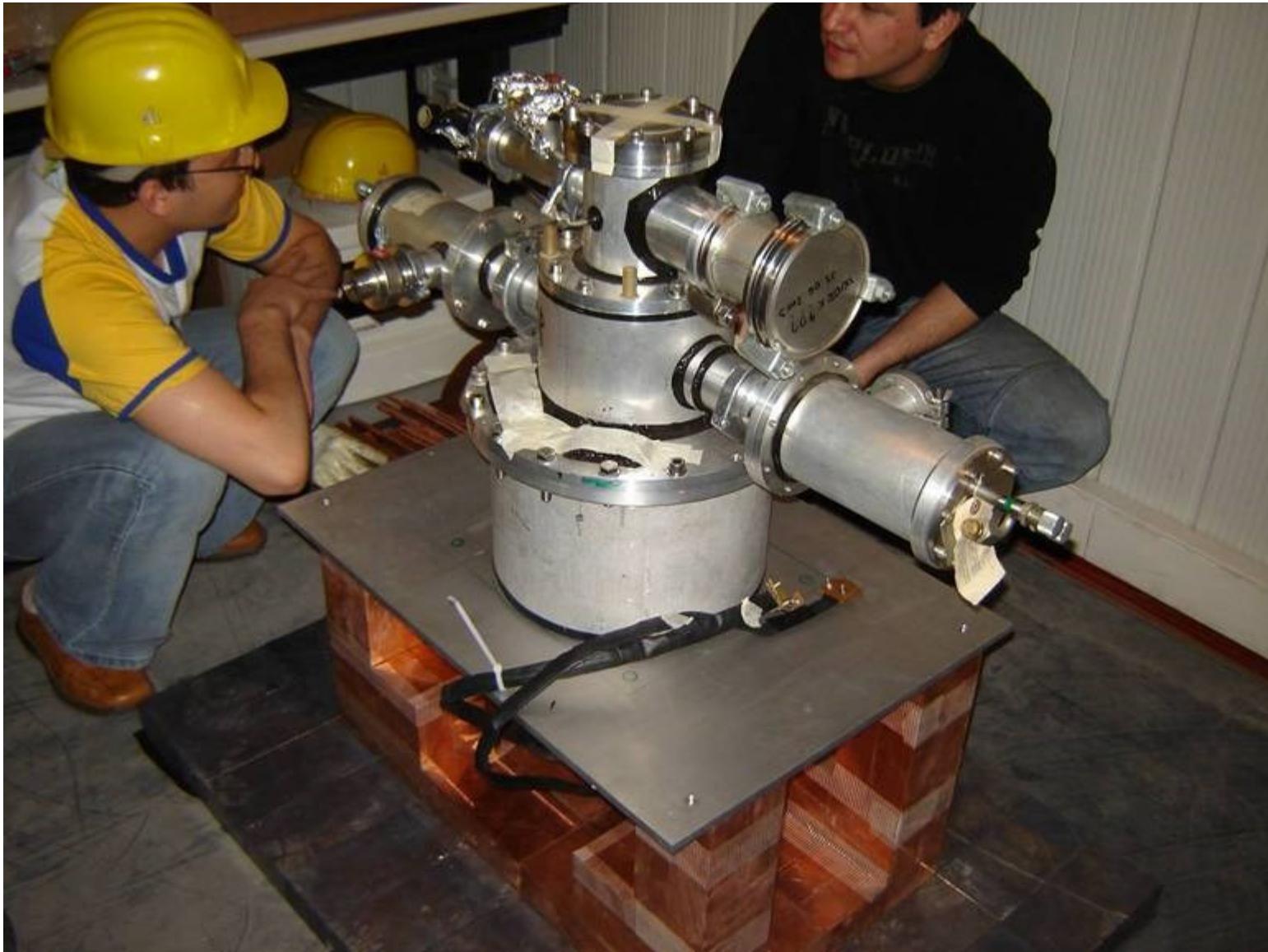
A NEUTRON STAR: SURFACE and INTERIOR







VIP setup at LNGS



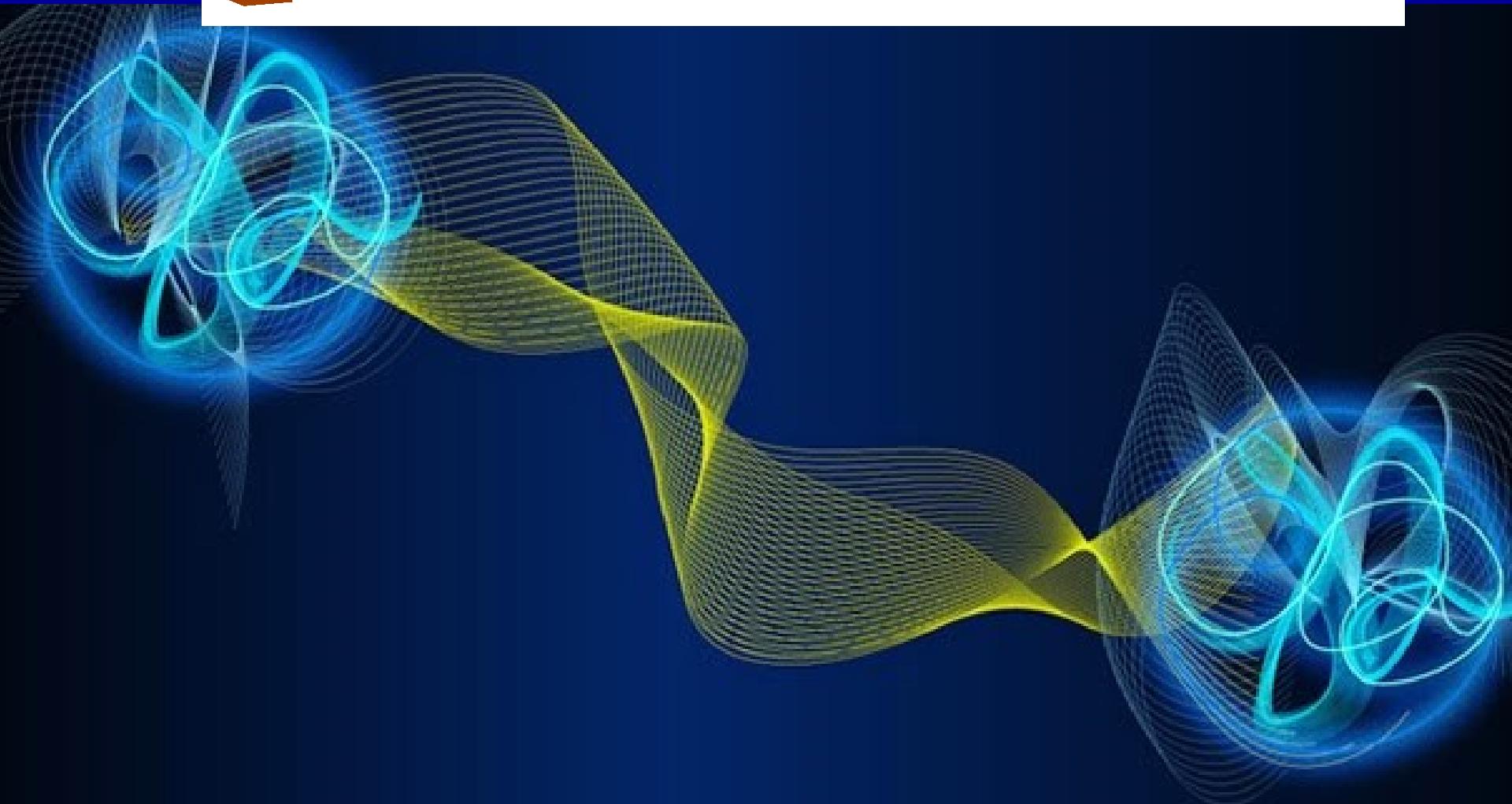
Final setup at LNGS



$$\Psi\rangle = \frac{| \text{alive} \rangle + | \text{dead} \rangle}{\sqrt{2}}$$



L'entanglement



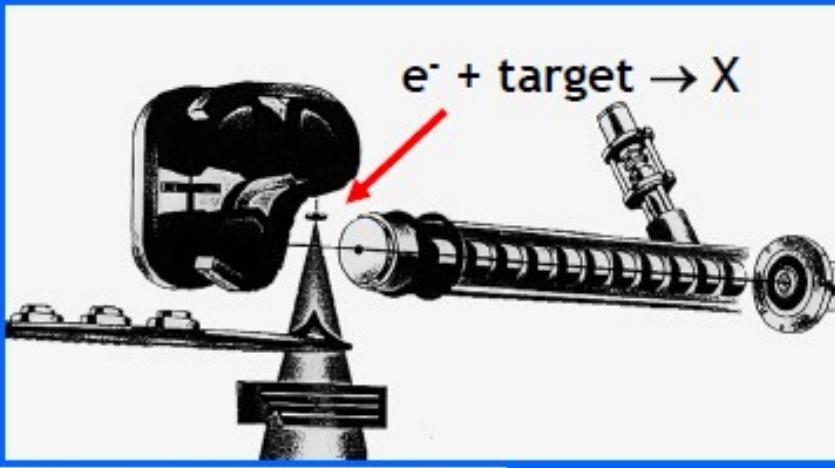
Computer quantistico? CRITTOGRAFIA QUANTISTICA SICUREZZA INFORMATICA!



Fisica Fondamentale
e
Societa'

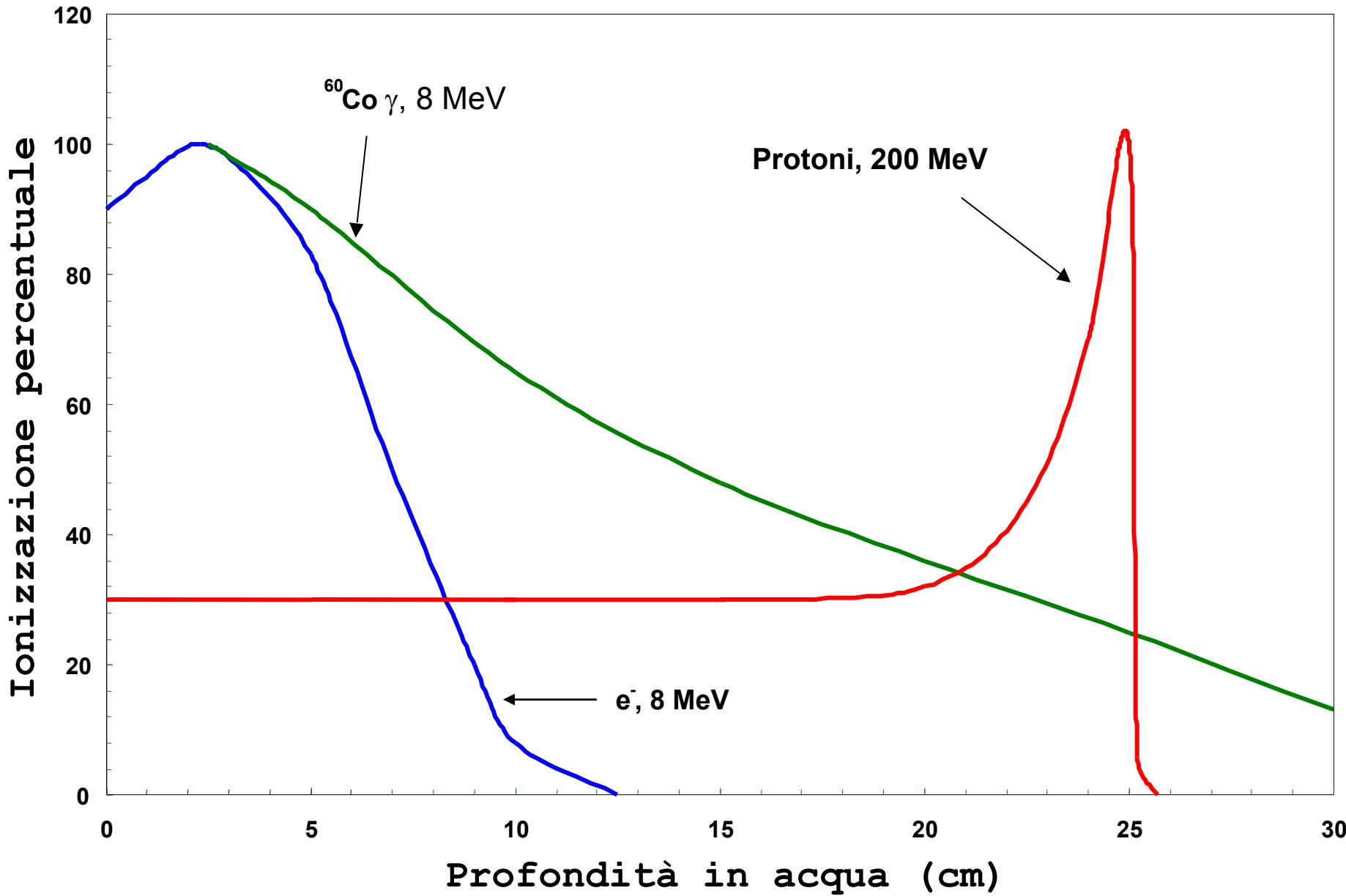


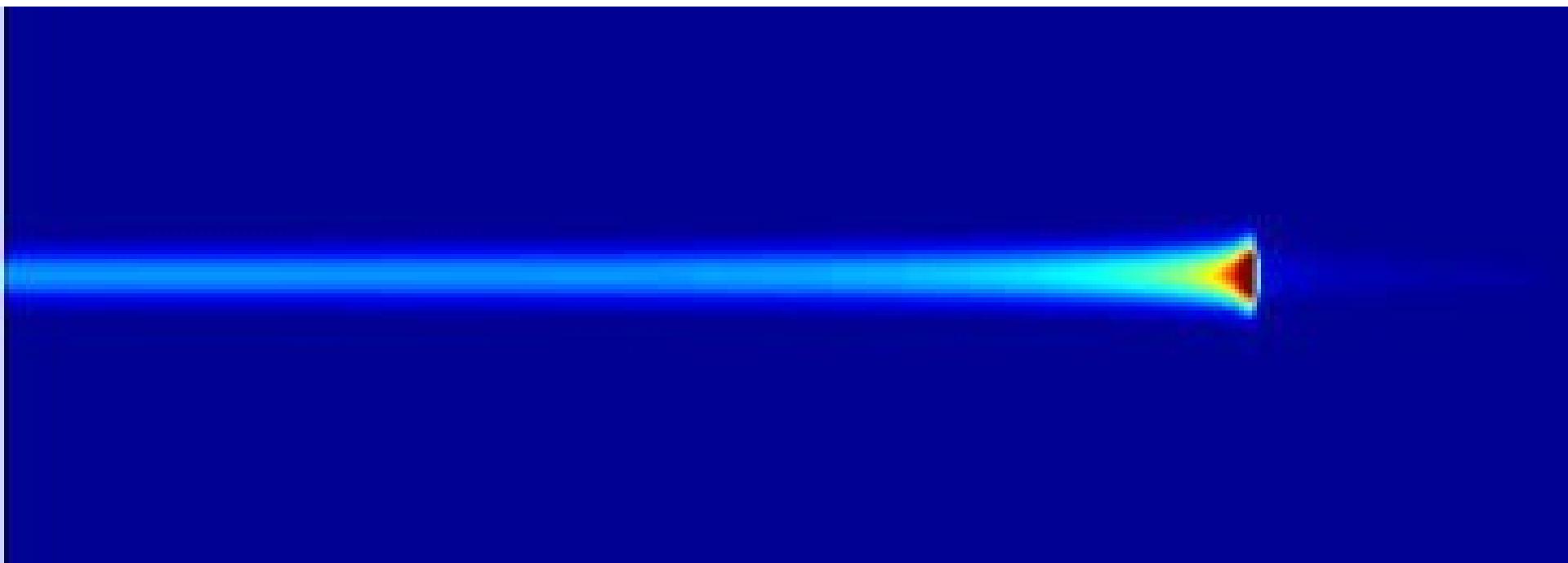
GLI STRUMENTI DELLA RADIOTERAPIA CONVENZIONALE



**circa 200
linac negli
ospedali italiani**

**120'000
pazienti all'anno**

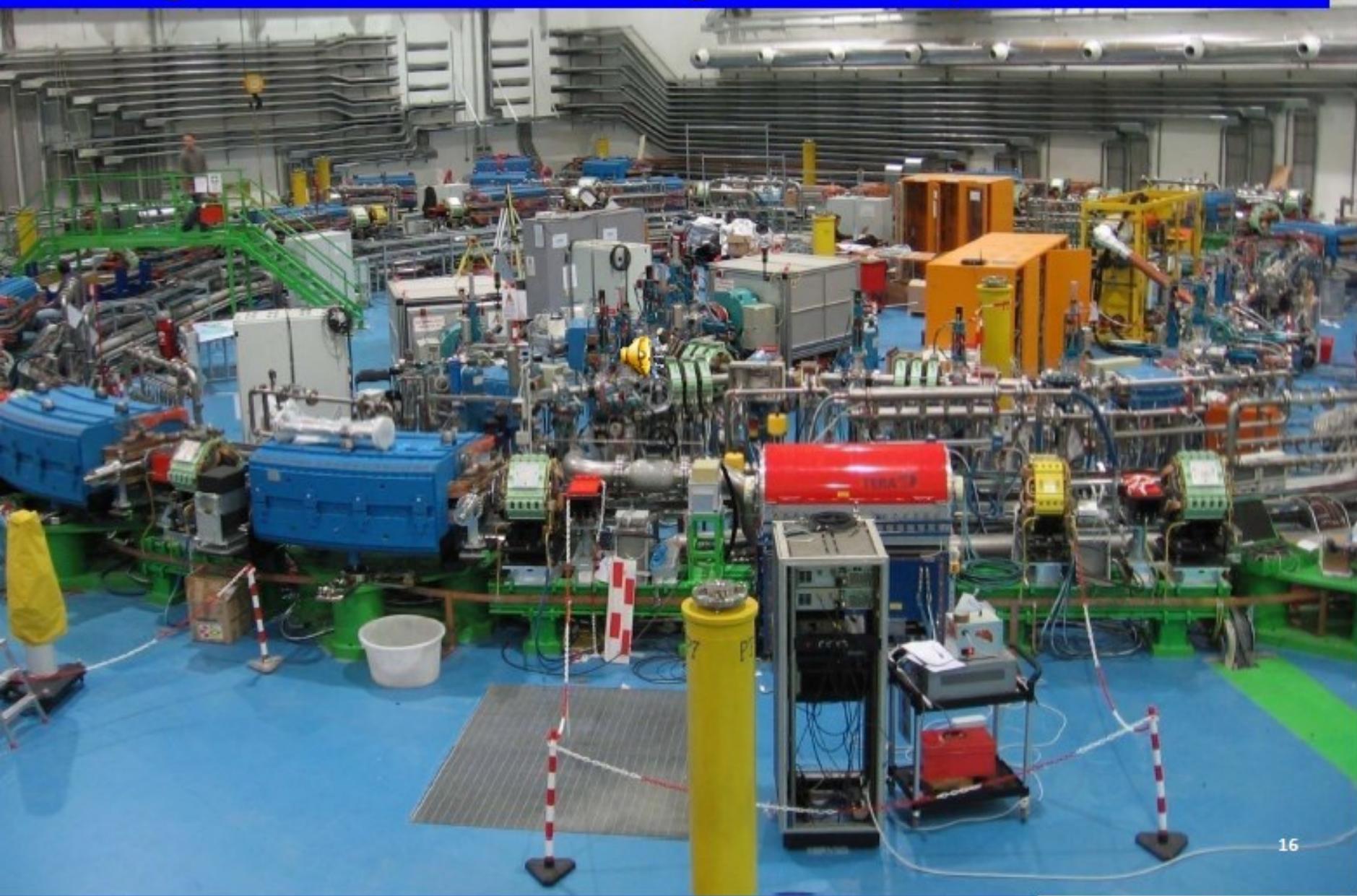




Conosciamo il CNAO



**Scopriamo l'alta tecnologia del CNAO facendo un tour
e seguendo il fascio dall'origine fino al paziente ...**

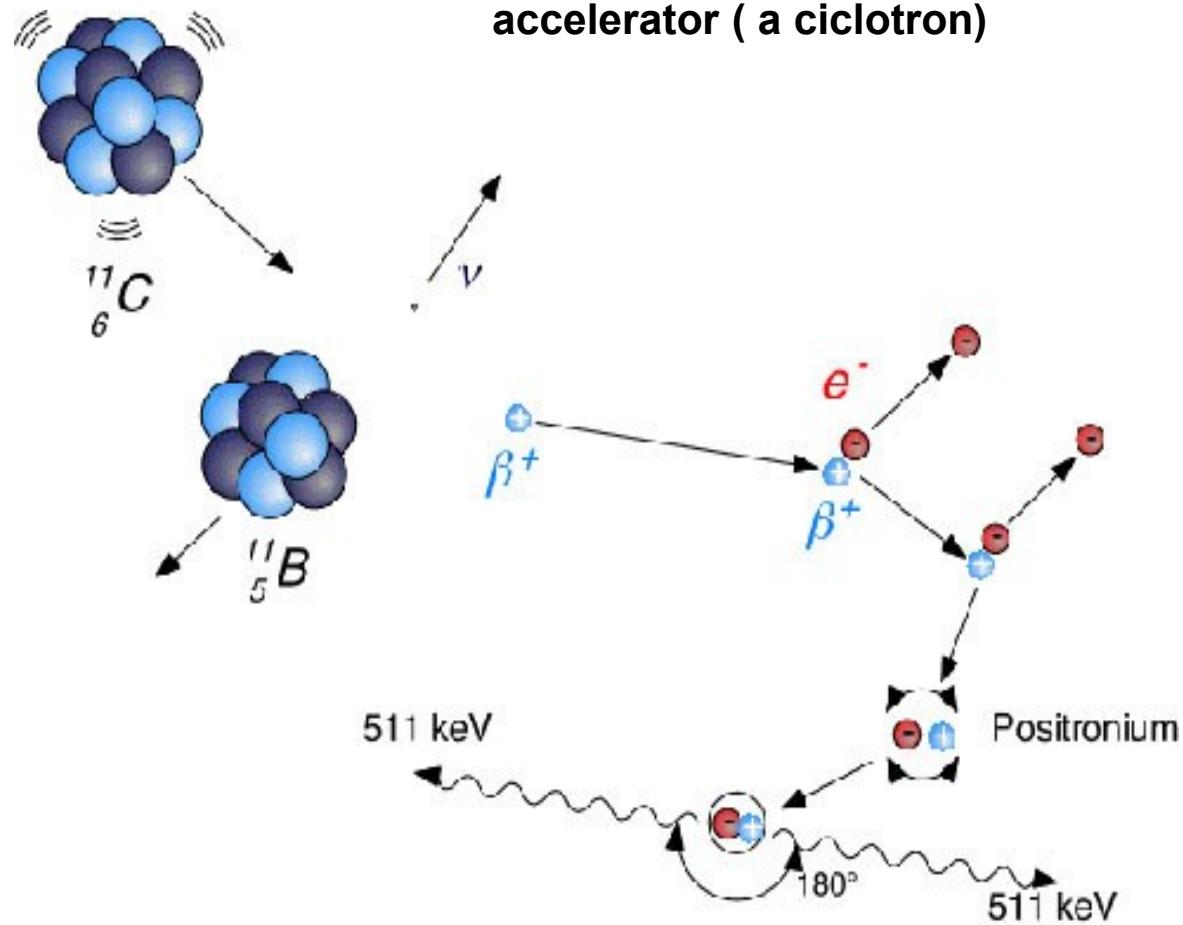
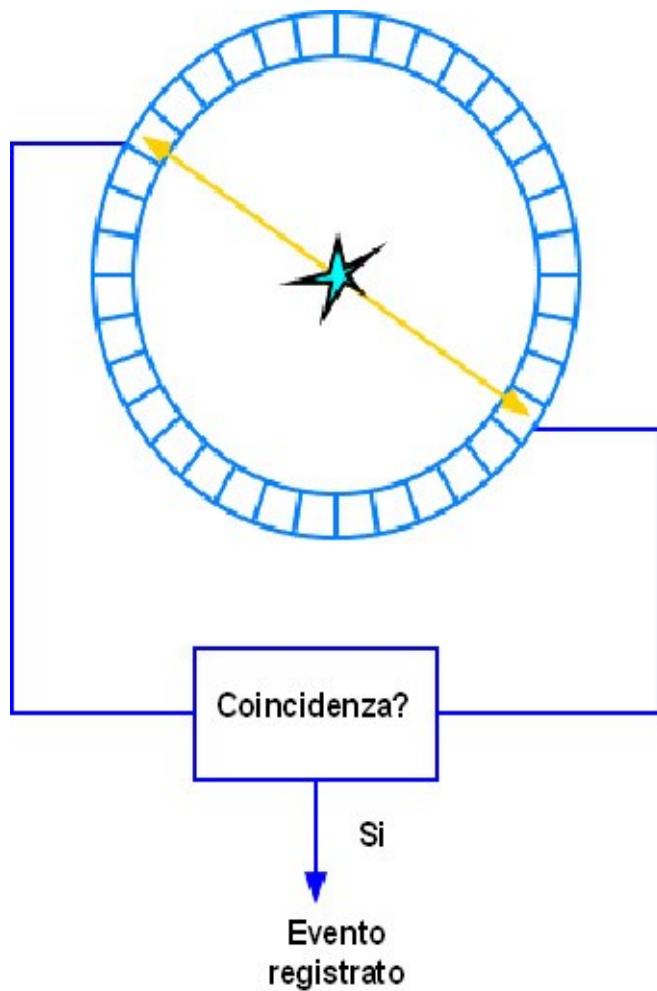


Positron Electron Tomography

It is a technique used to see inside the body

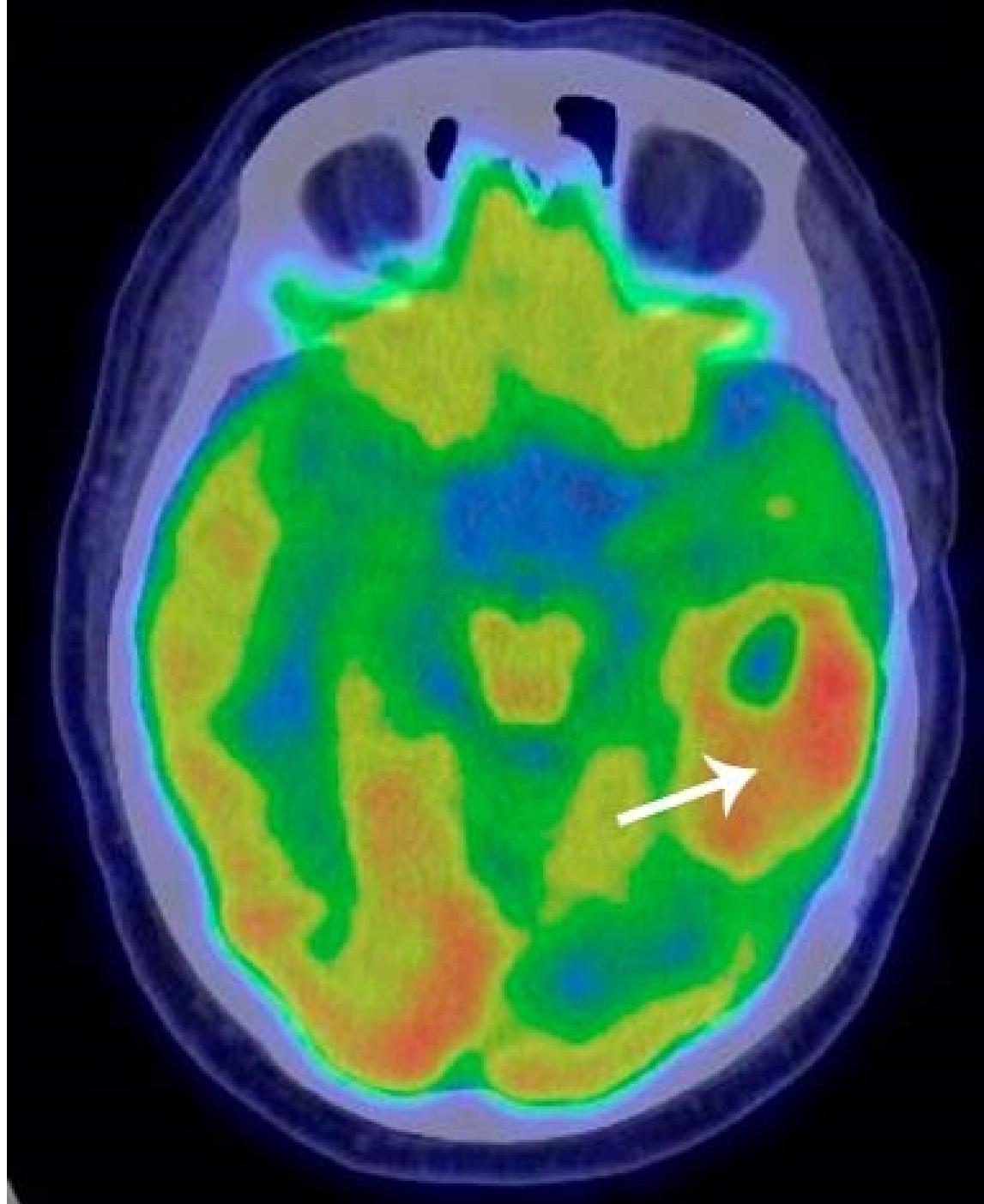
A PET apparatus has ~ 10.000
Γ Ray detectors

One injects in the patient a substance containing a radioactive isotope (as C11 – glucosium). The radioactive substance is produced in an accelerator (a ciclotron)

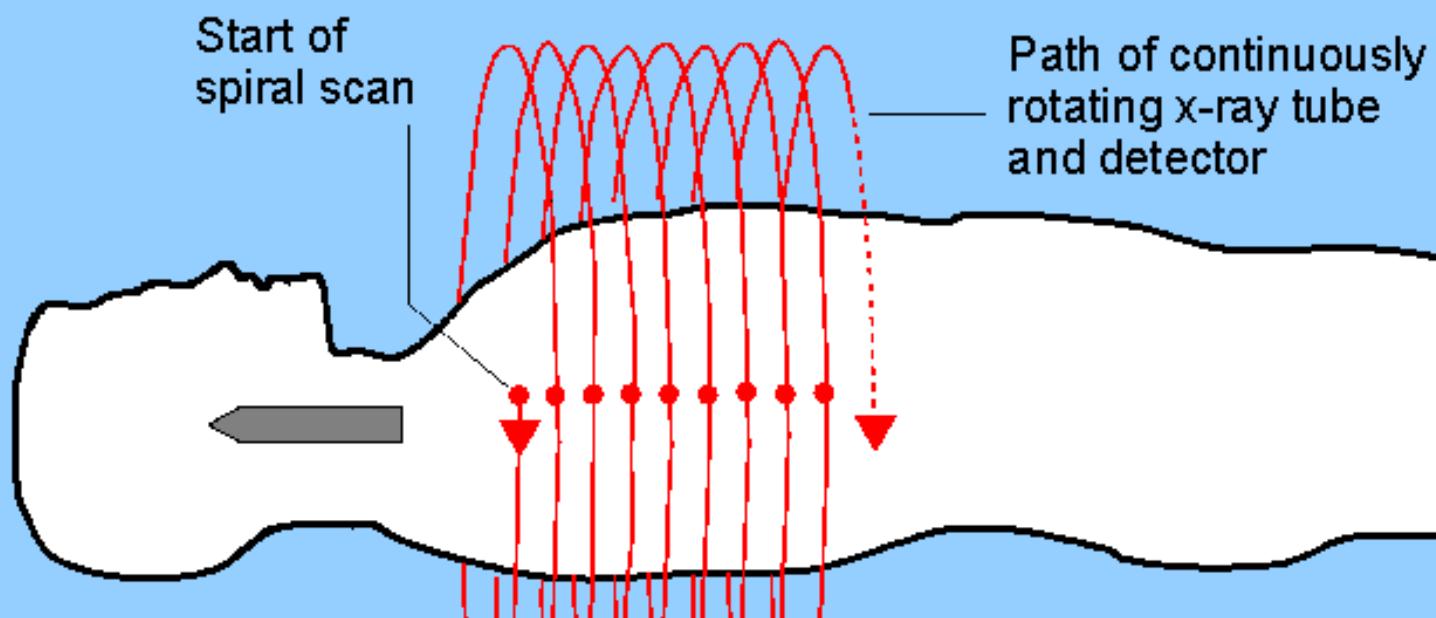




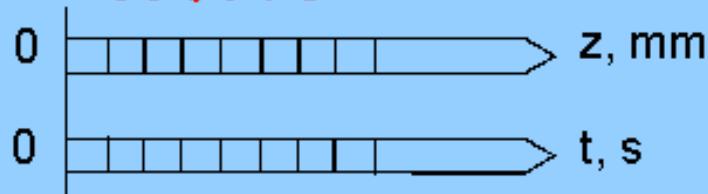


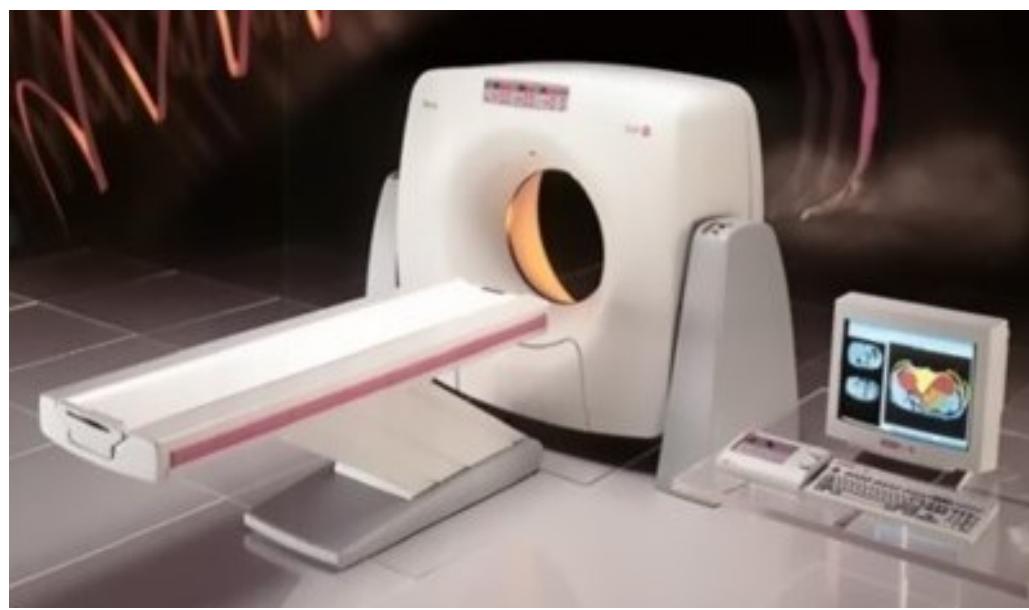


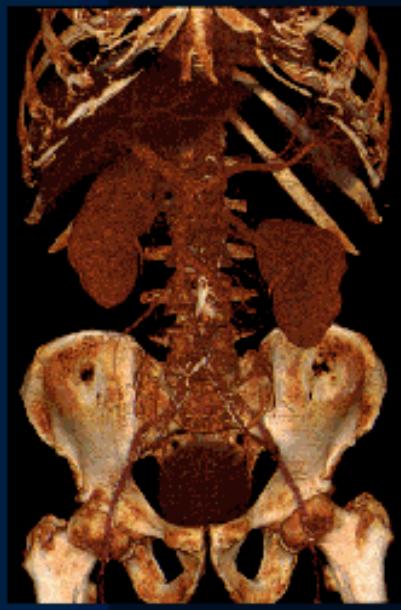
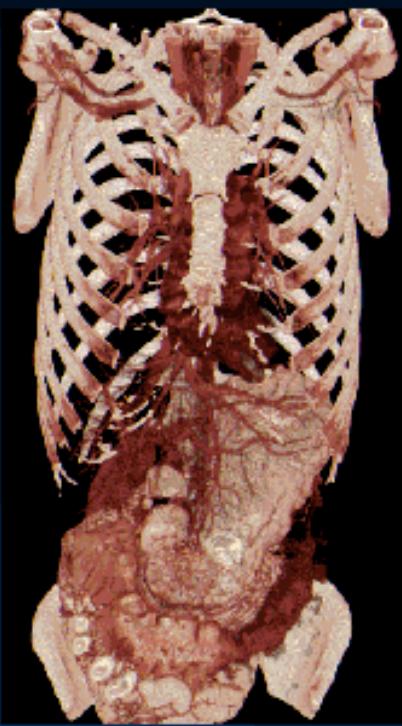
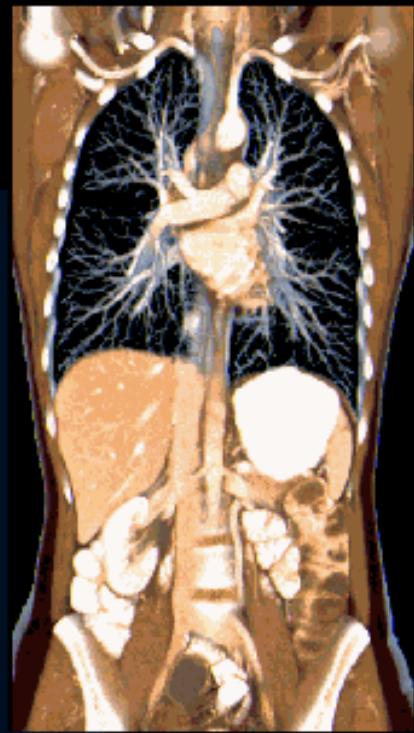
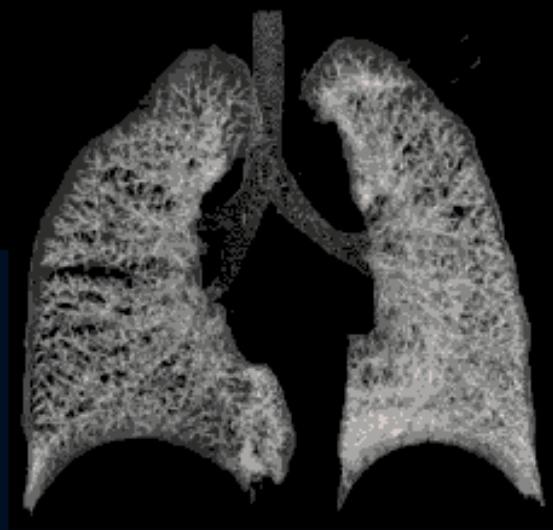
Computerized Tomography



Direction of continuous patient transport

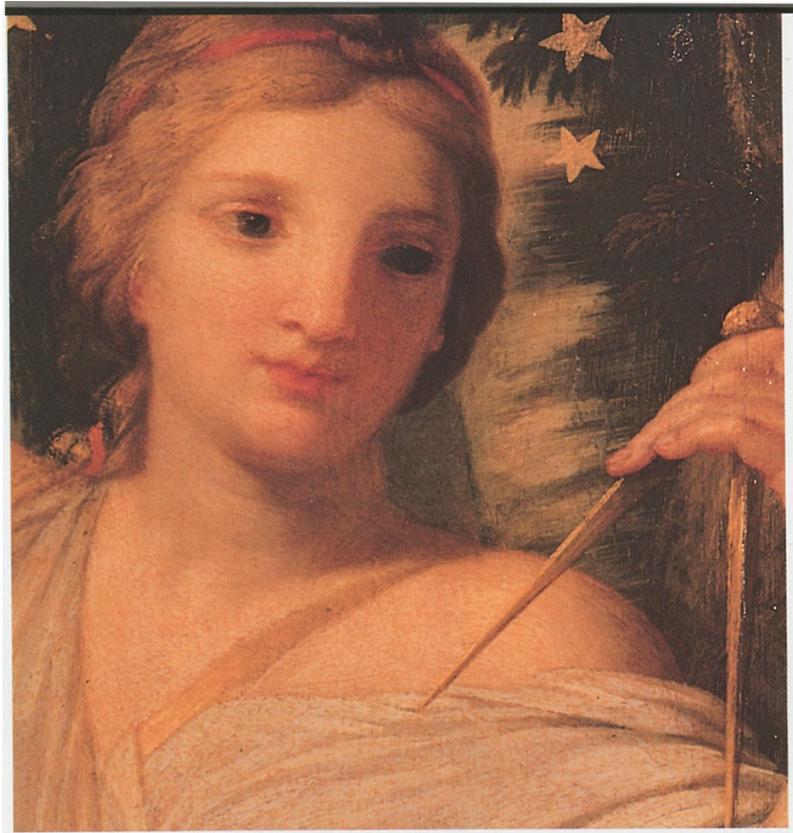






Pentimenti

Le Sueur – musa Urania (particolare)

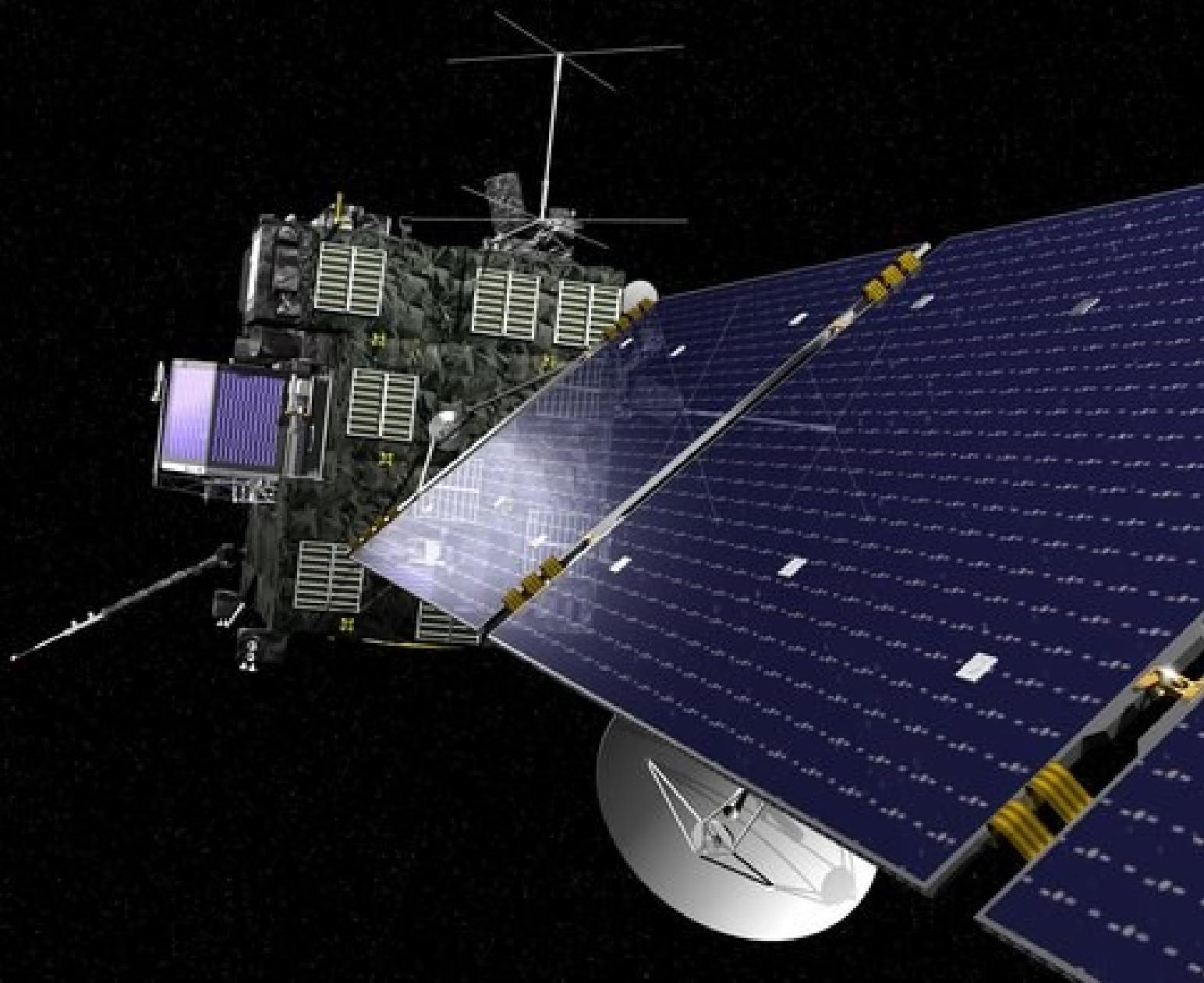


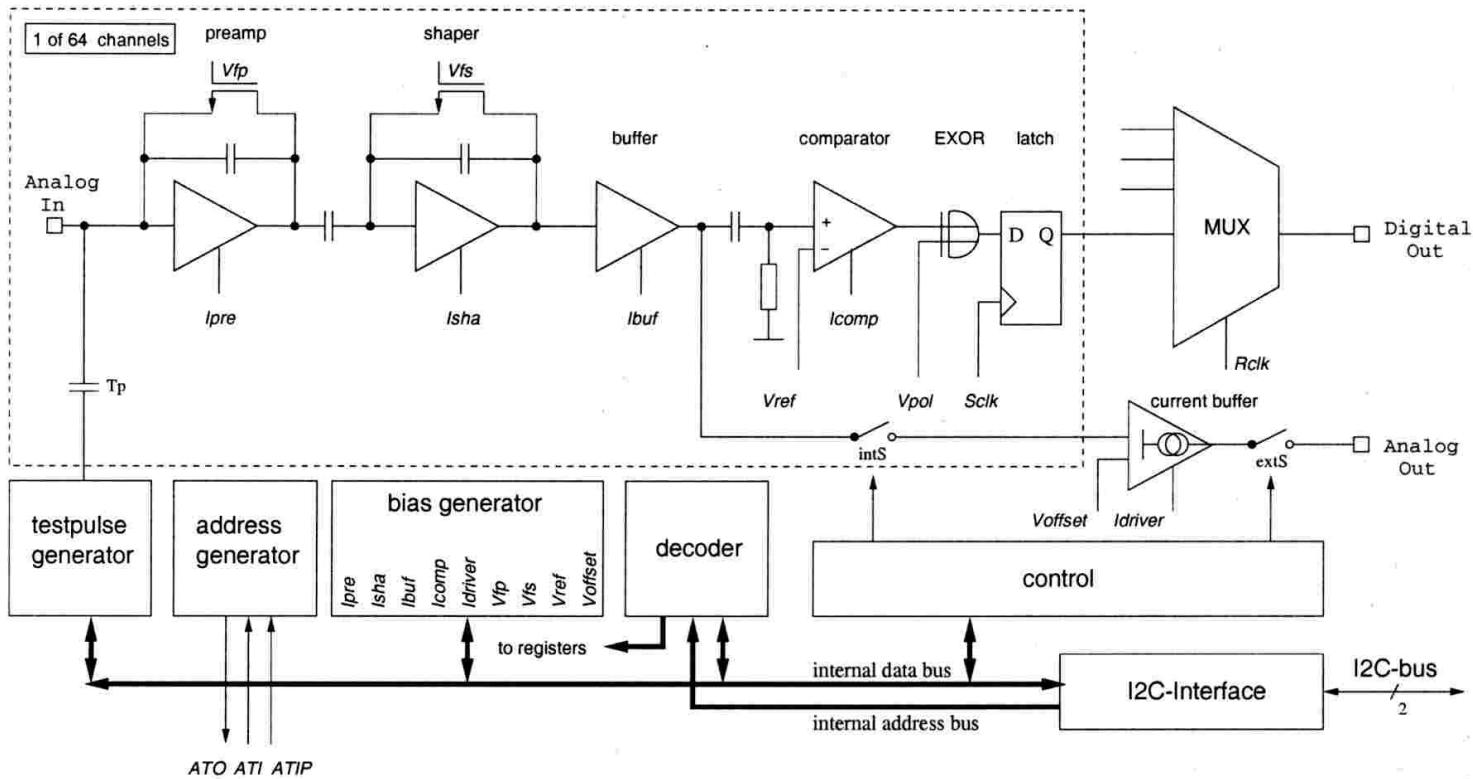
Riutilizzo tela

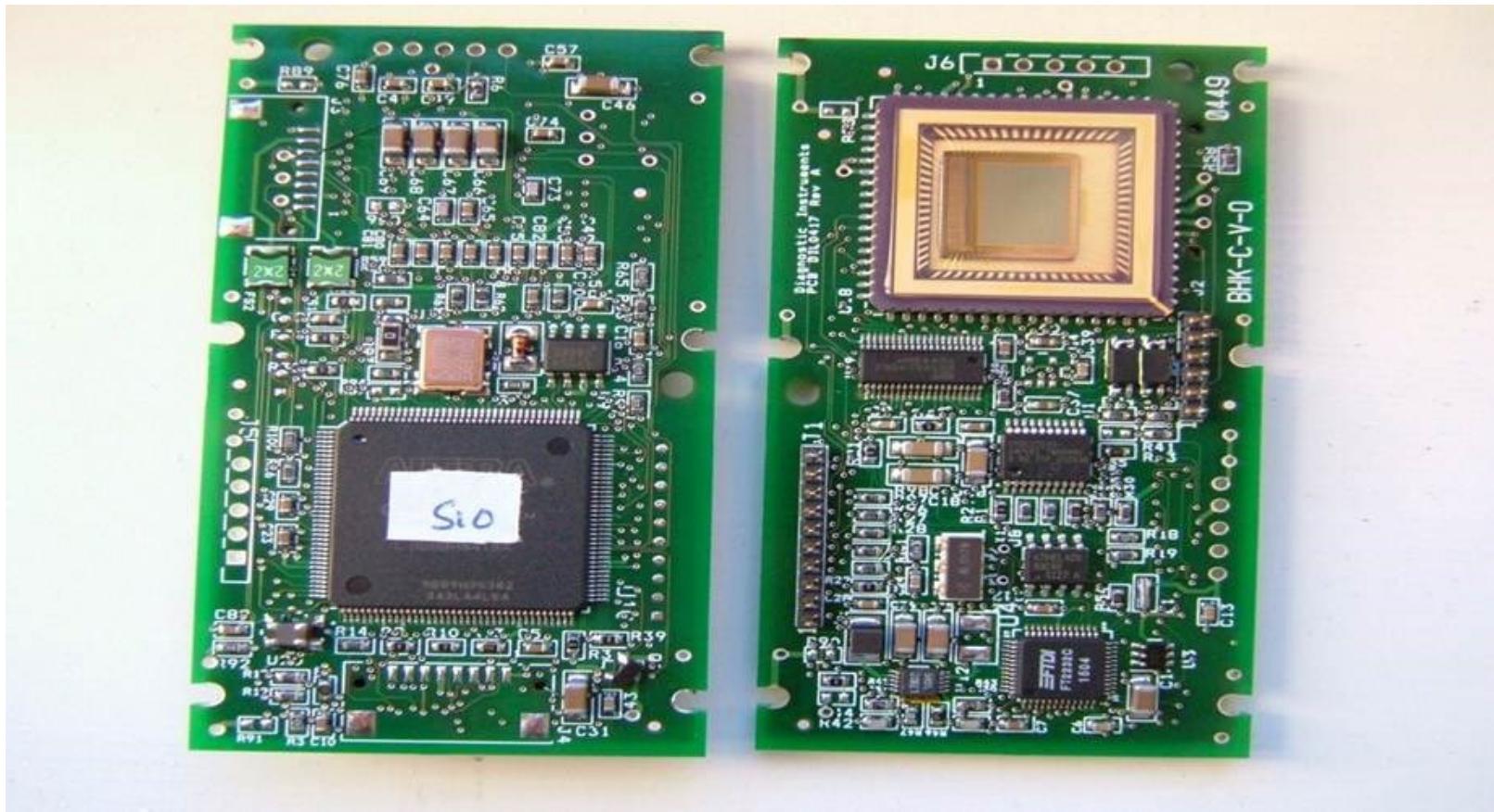
Rembrandt – Ritratto di giovane uomo Titus

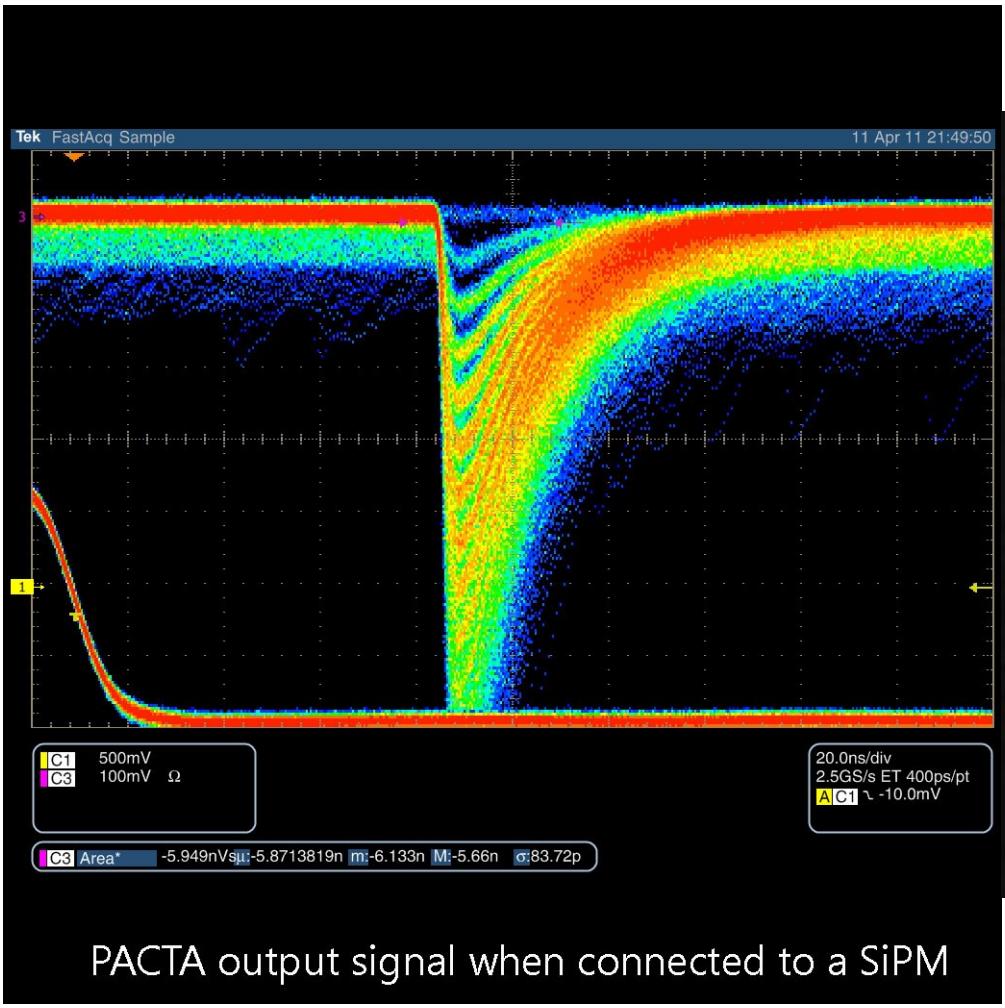












**Ci sono due modi di vivere la vita. Uno è pensare che
niente è un miracolo. L'altro è pensare che ogni cosa è
un miracolo**

