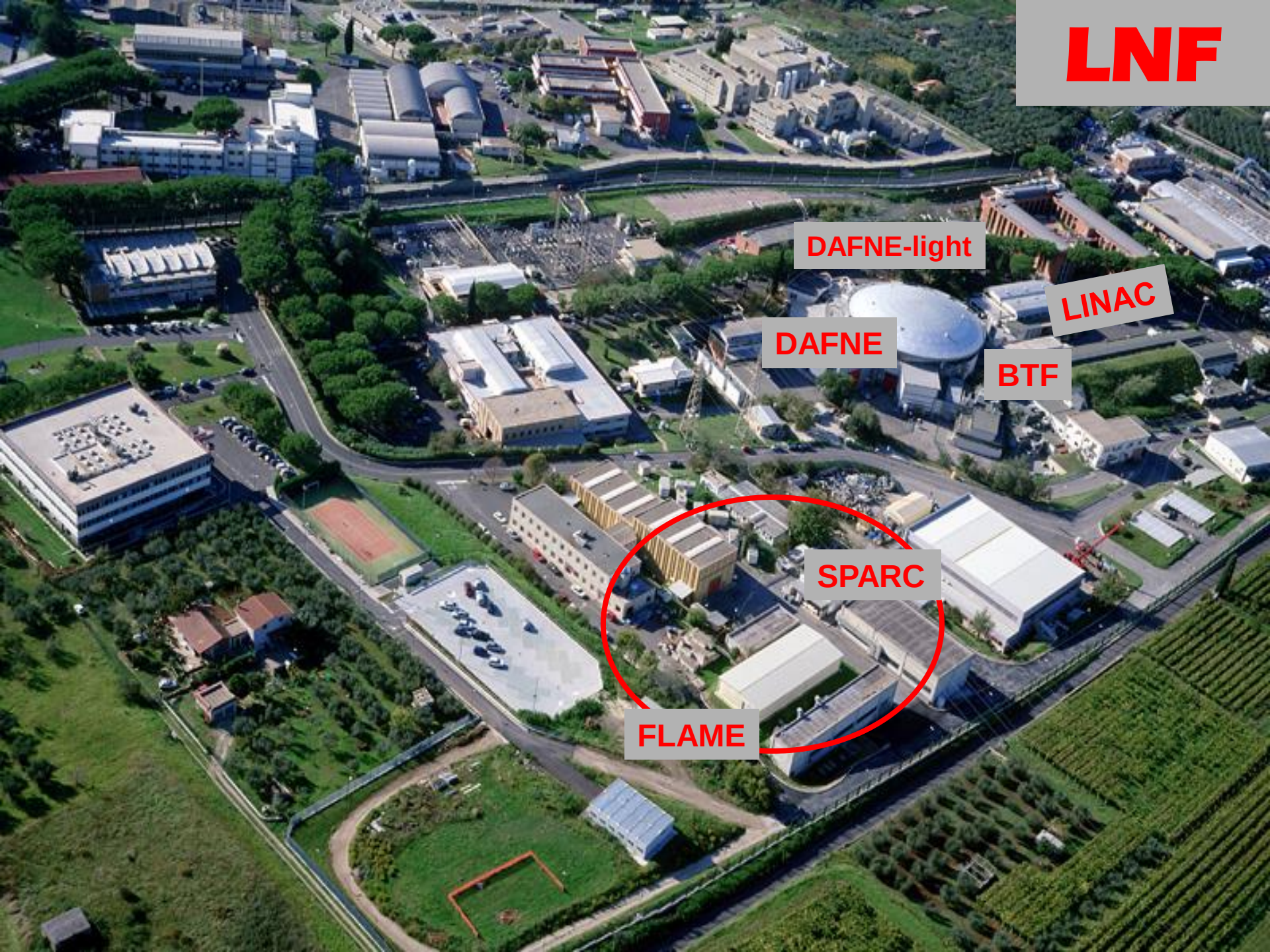
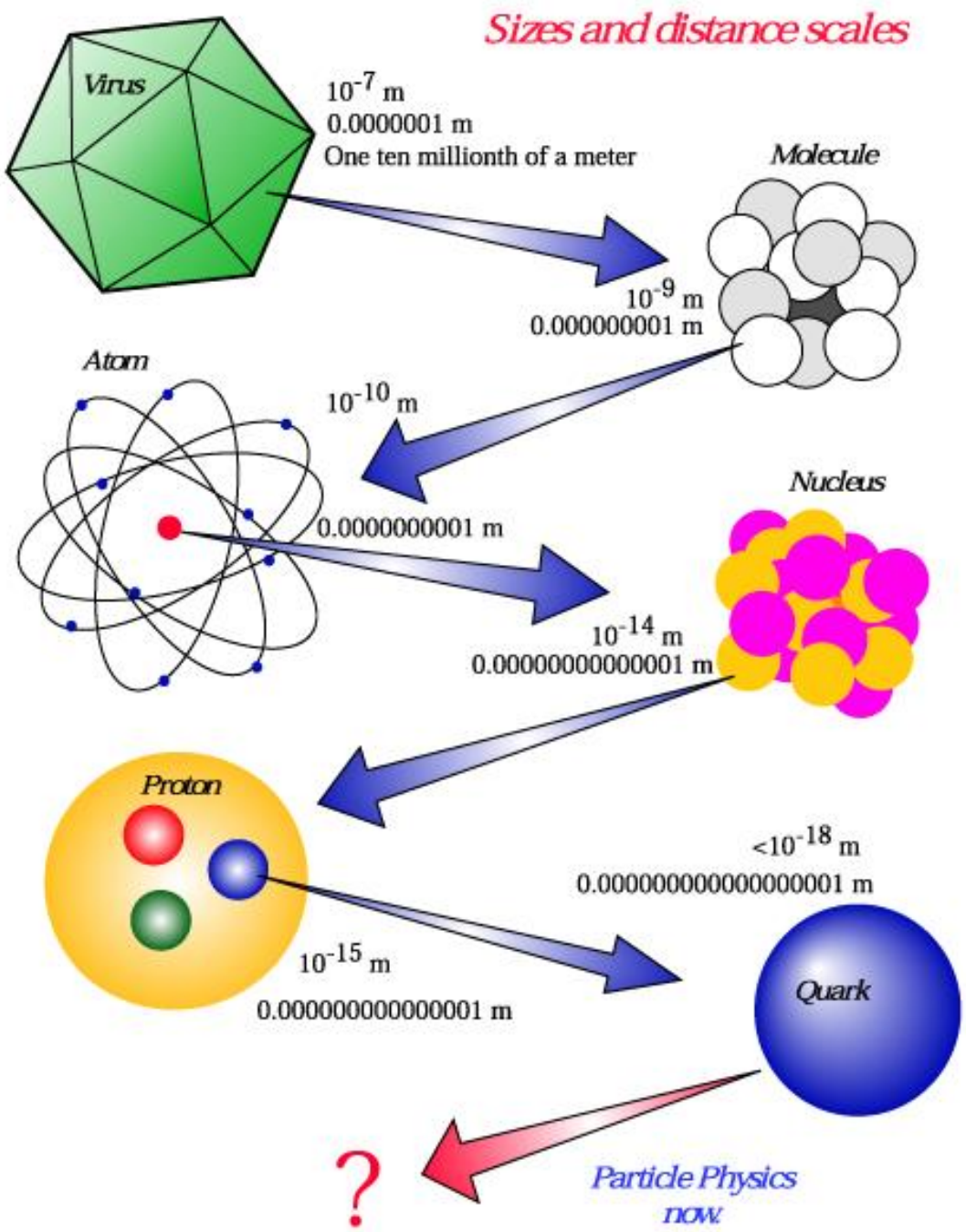
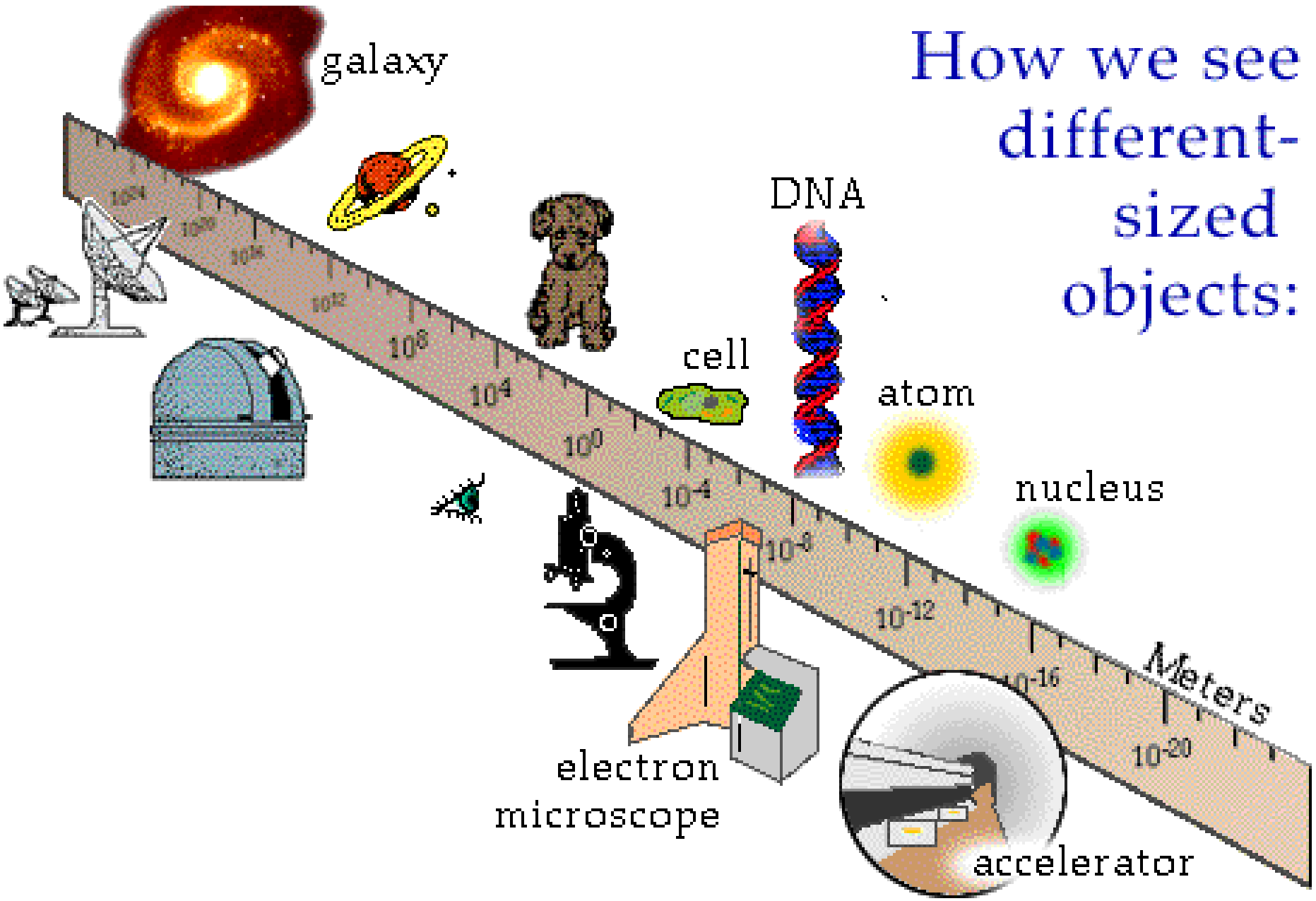

Physics and Society:
from health to art and much more
Catalina Curceanu, LNF-INFN
Mini-stage in MP
4-5 August 2014


LNF
DAFNE-light
LINAC
DAFNE
BTF
SPARC
FLAME

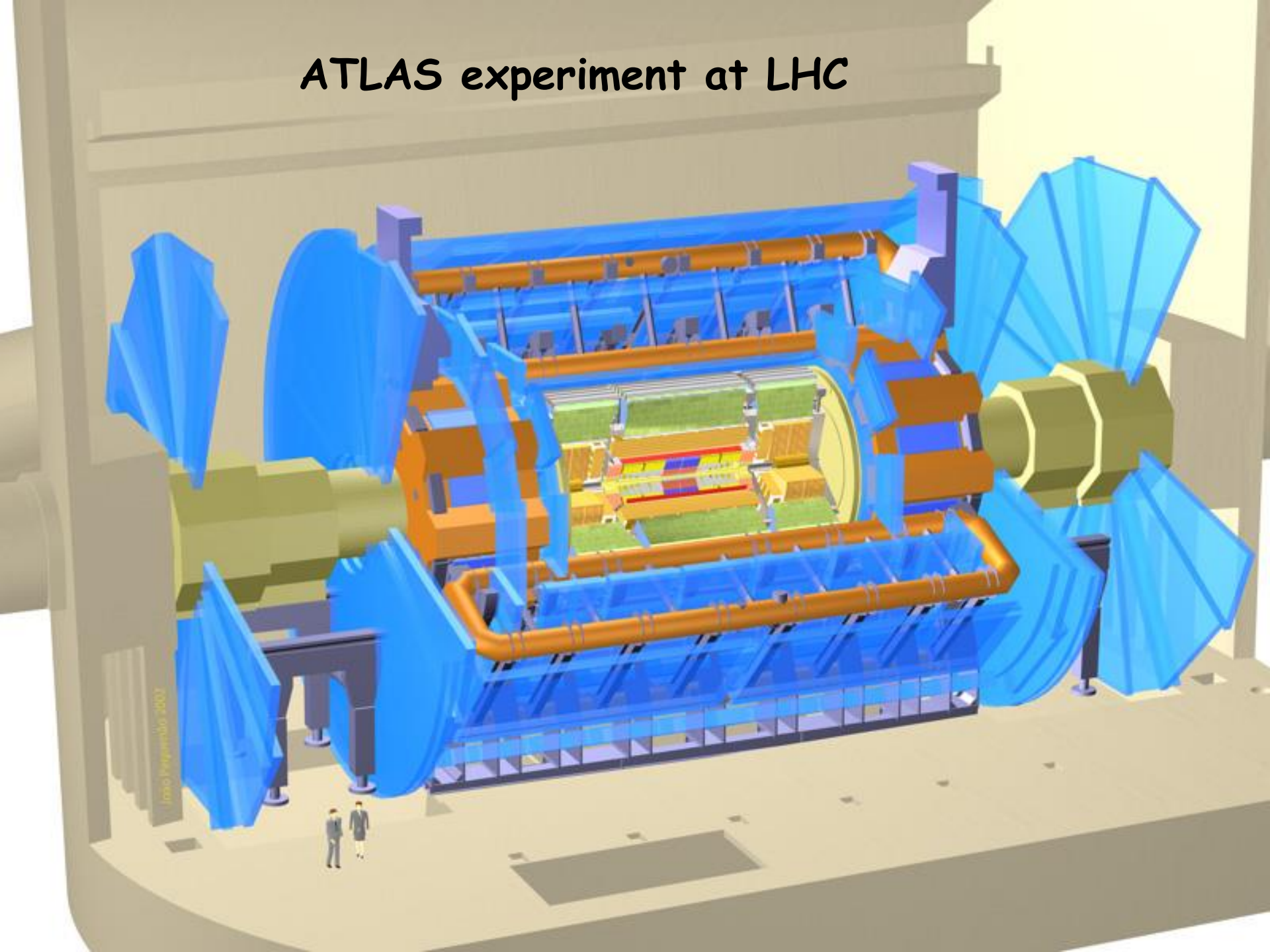
DAΦNE

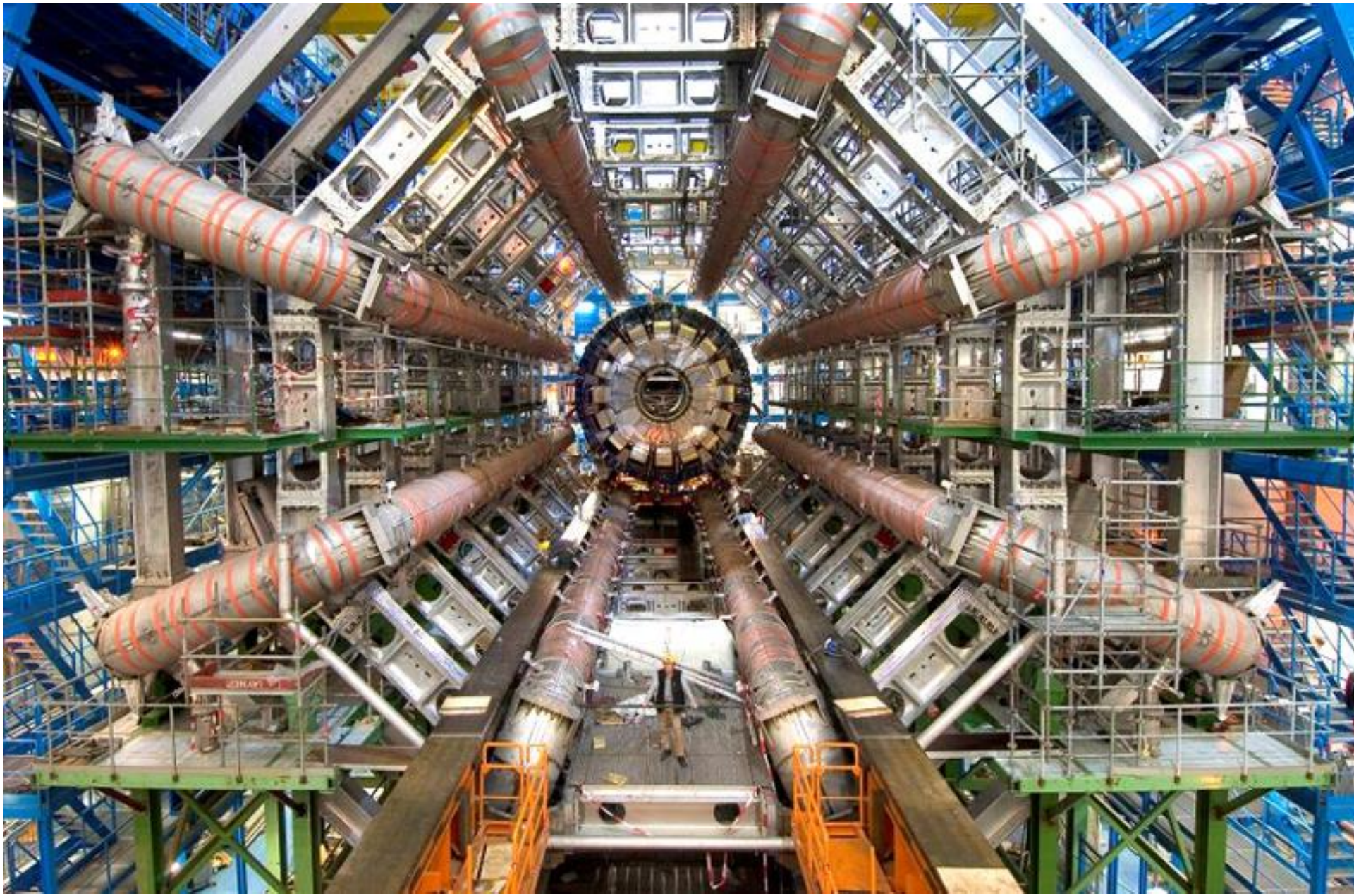

Sizes and distance scales
Virus
10^{-7} m
0.0000001 m
One ten millionth of a meter
Molecule
10^{-9} m
0.000000001 m
Atom
10^{-10} m
0.0000000001 m
Nucleus
10^{-14} m
0.00000000000001 m
Proton
10^{-15} m
0.000000000000001 m
$<10^{-18}$ m
0.0000000000000000001 m
Quark
?
Particle Physics
now

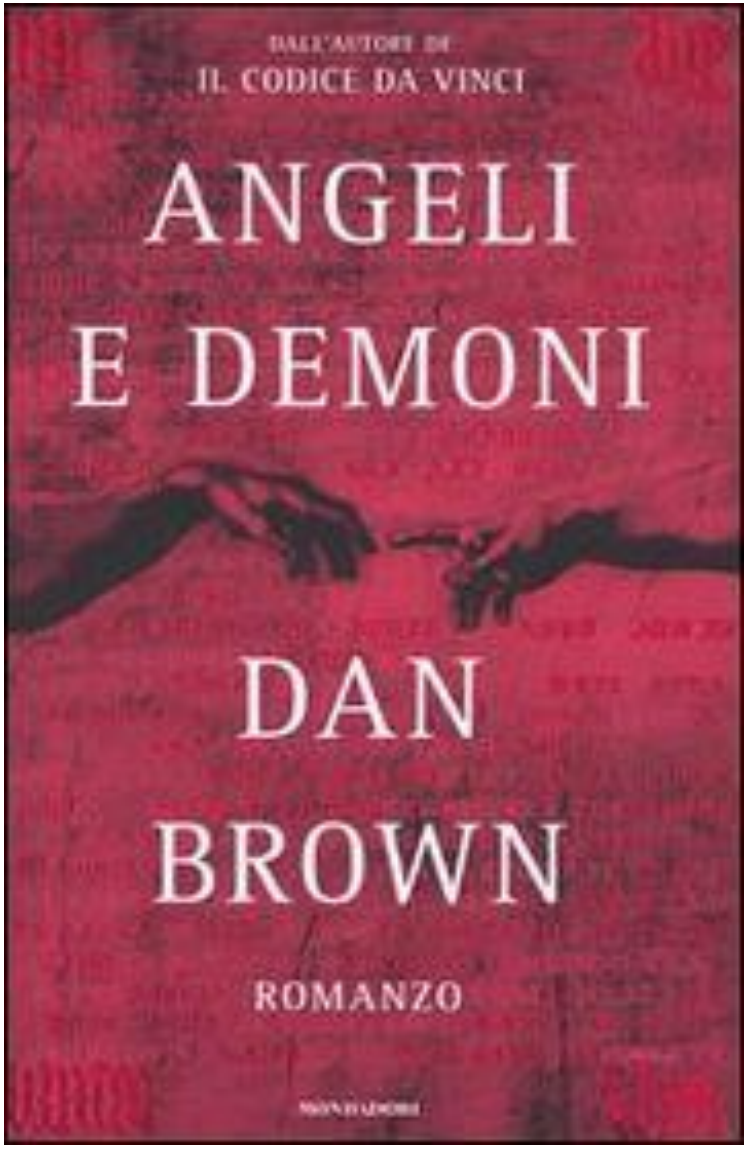
How we see different-sized objects:

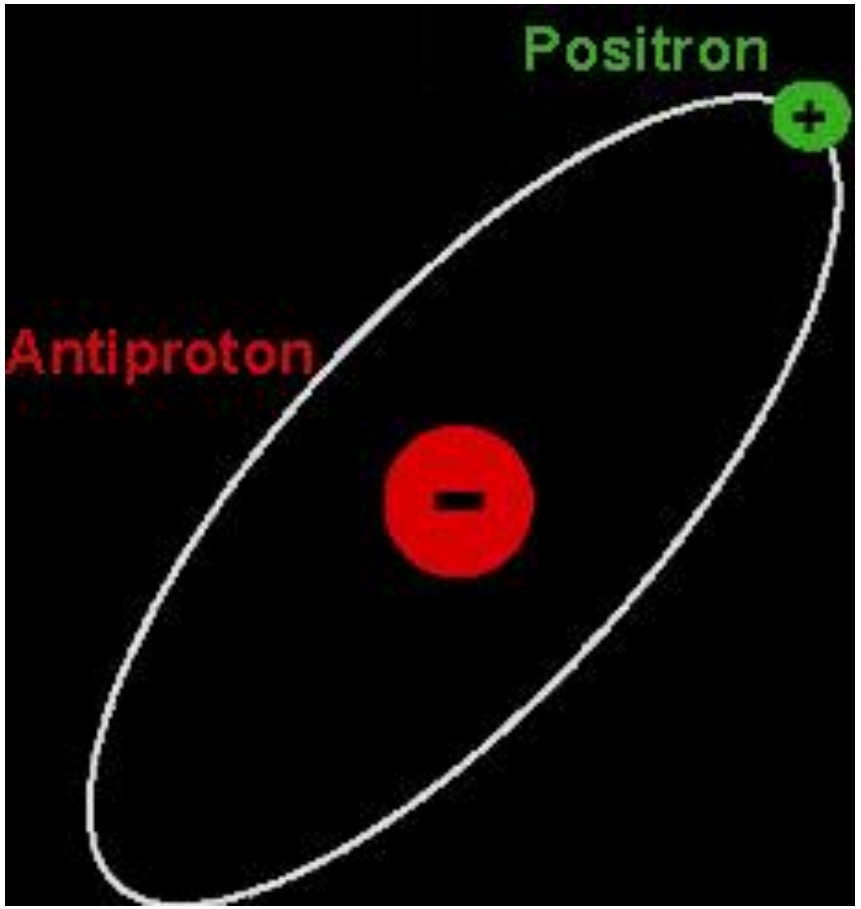


ATLAS experiment at LHC



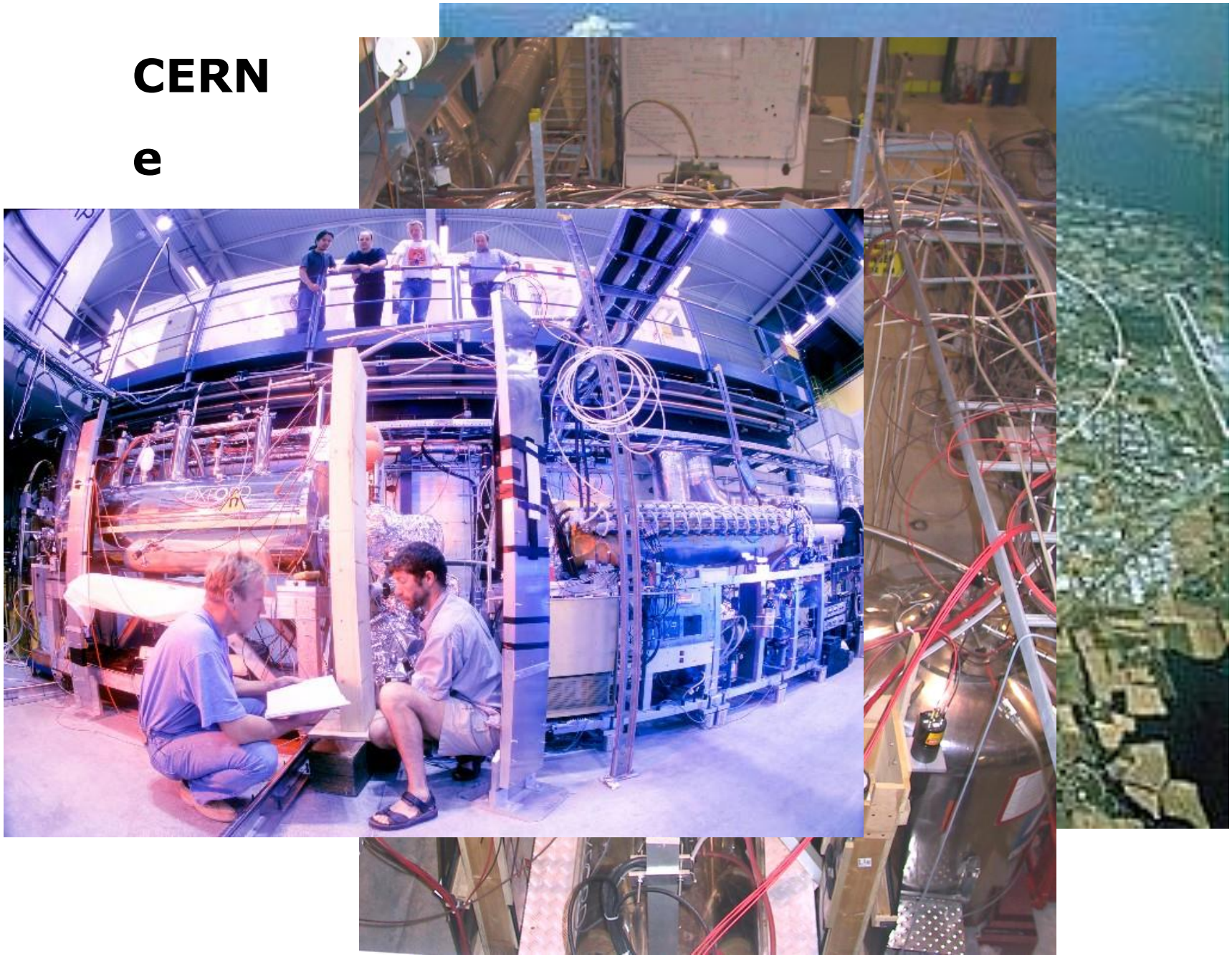



DALL'AUTORE DE
IL CODICE DA VINCI
ANGELI
E DEMONI
DAN
BROWN
ROMANZO


Positron
+
Antiproton
−

CERN

e



0.5 g of matter & 0.5 g of antimatter

-> Hiroshima bomb

$E=mc^2$

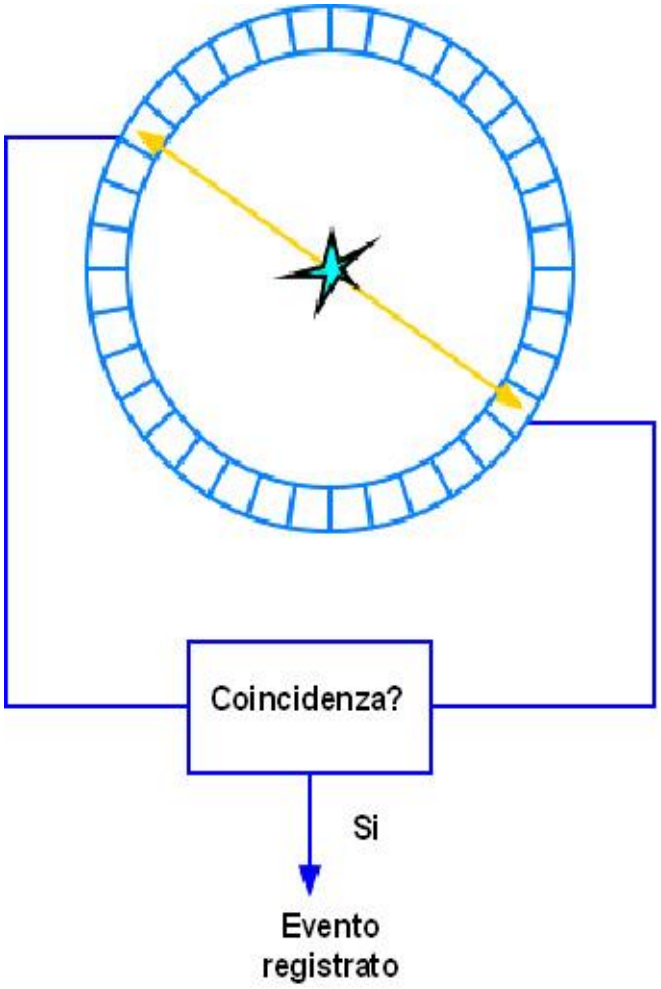
1 g of antimatter at CERN

10^9 years!

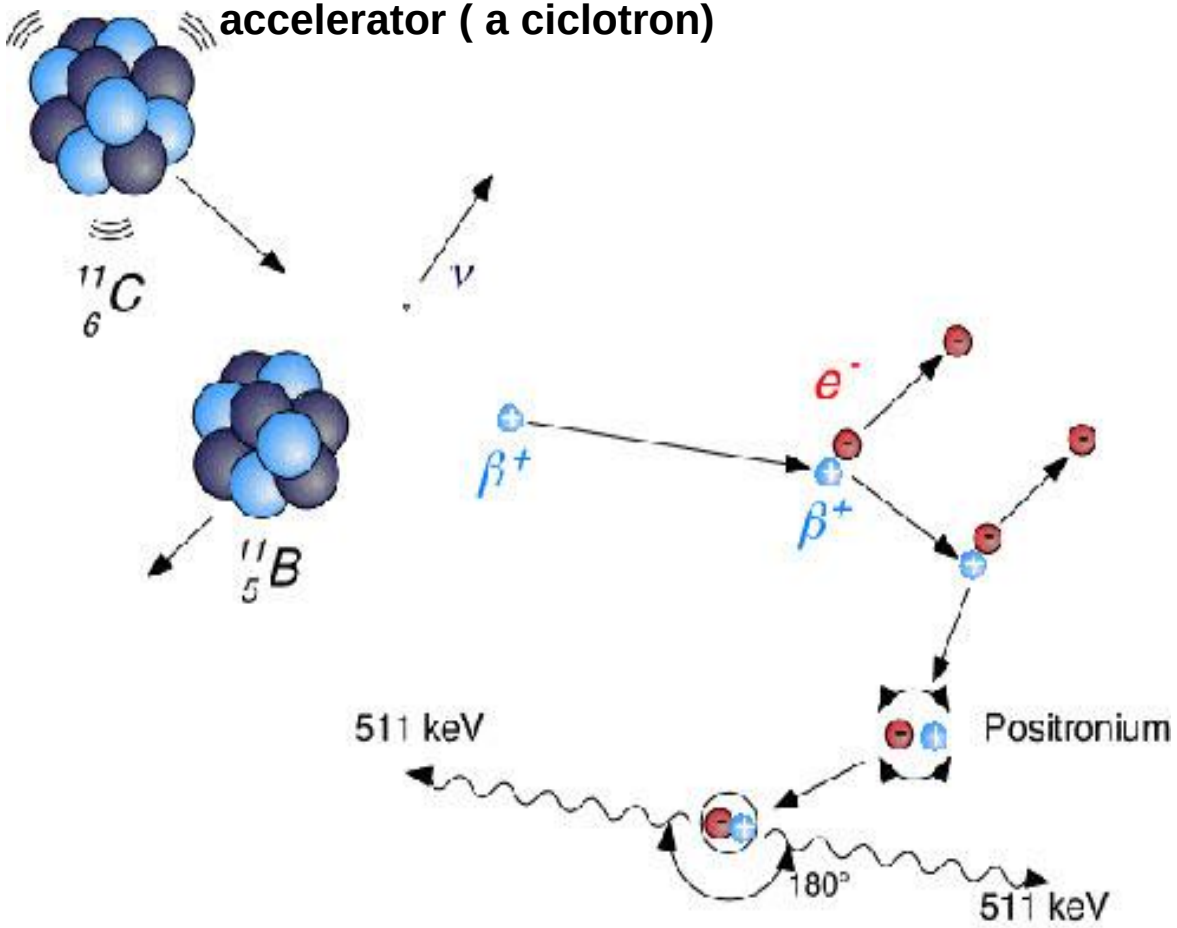
Positron Electron Tomography

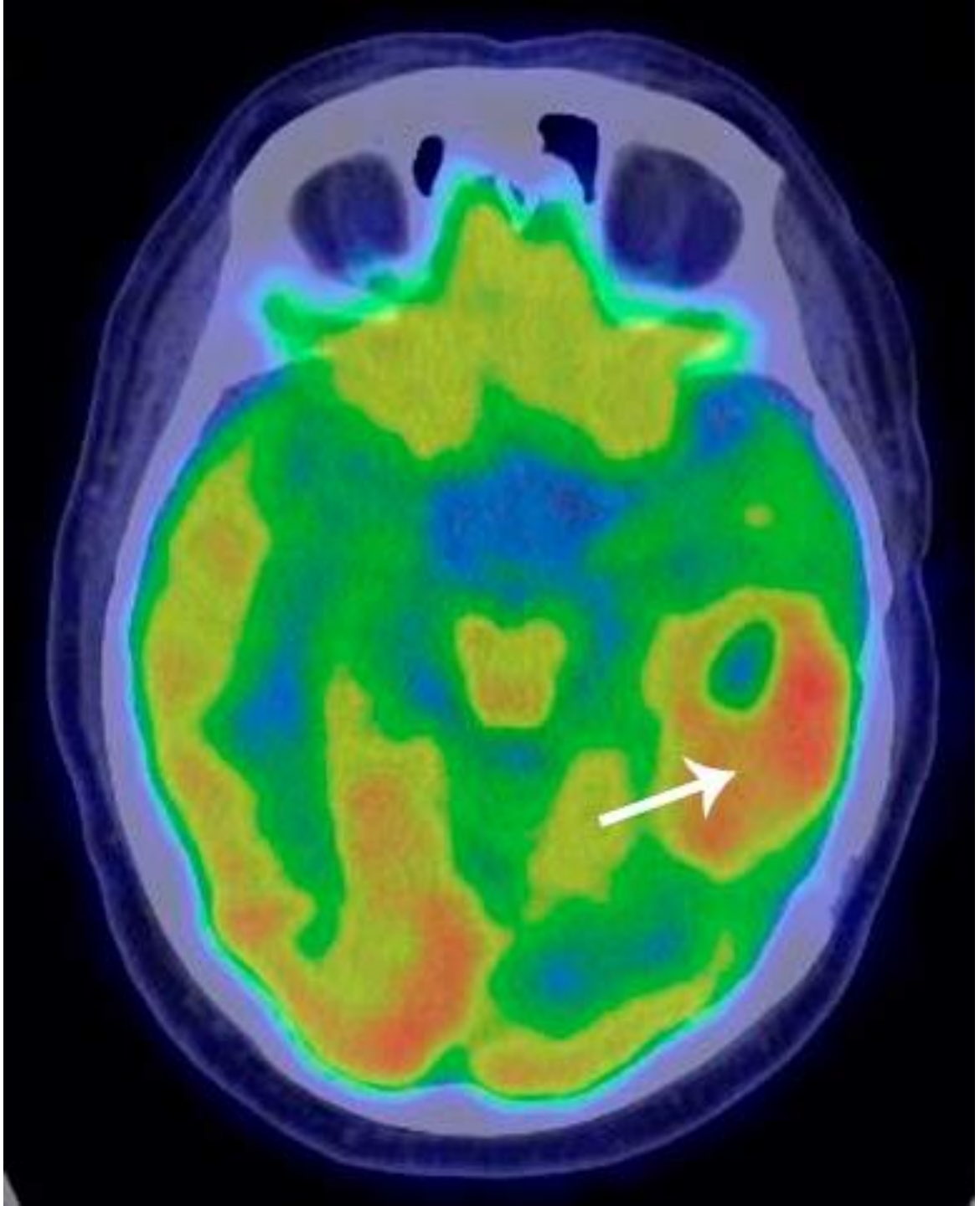
It is a technique used to see inside the body

A PET apparatus has ~ 10.000
Γ Ray detectors

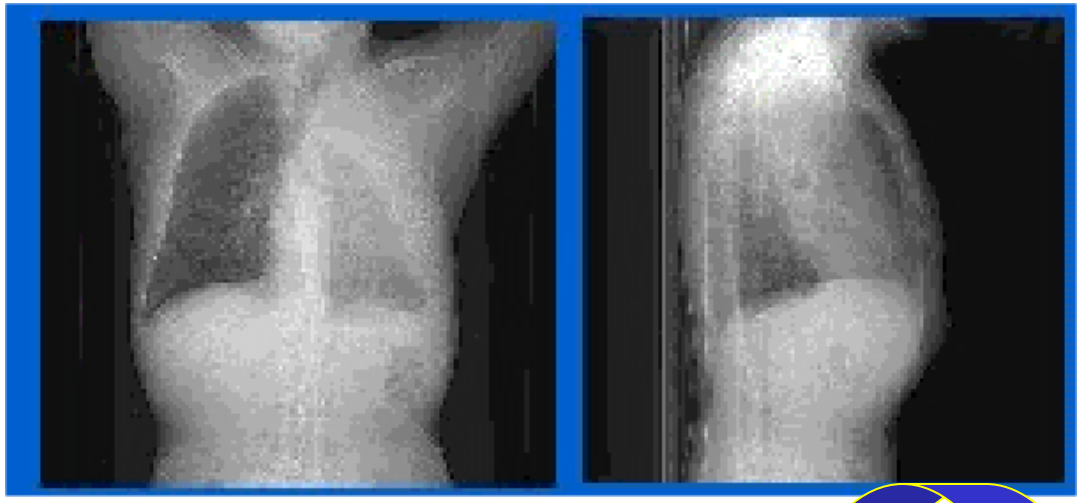


One injects in the patient a substance containing a radioactive isotope (as C11 – glucosium). The radioactive substance is produced in an accelerator (a ciclotron)

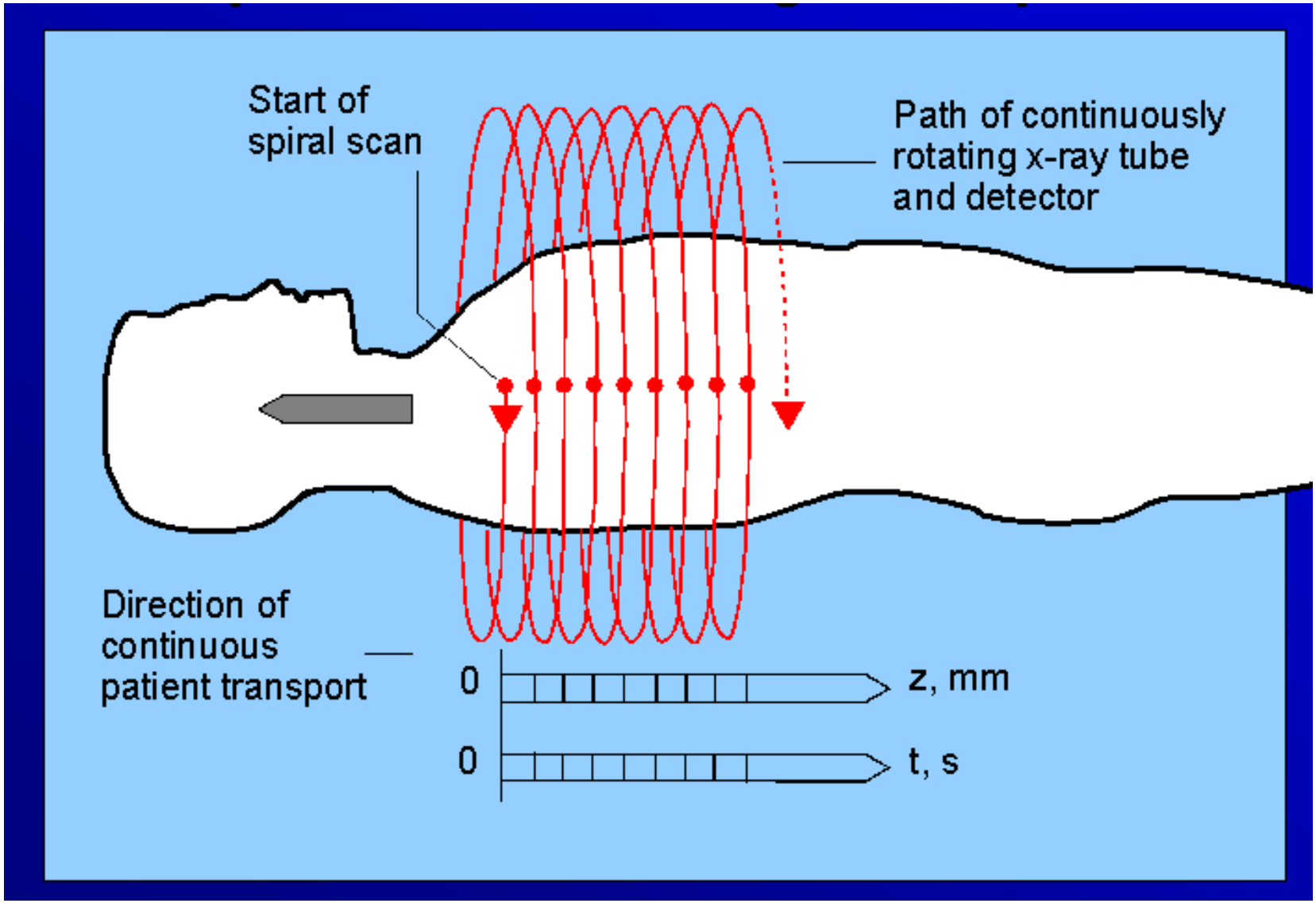


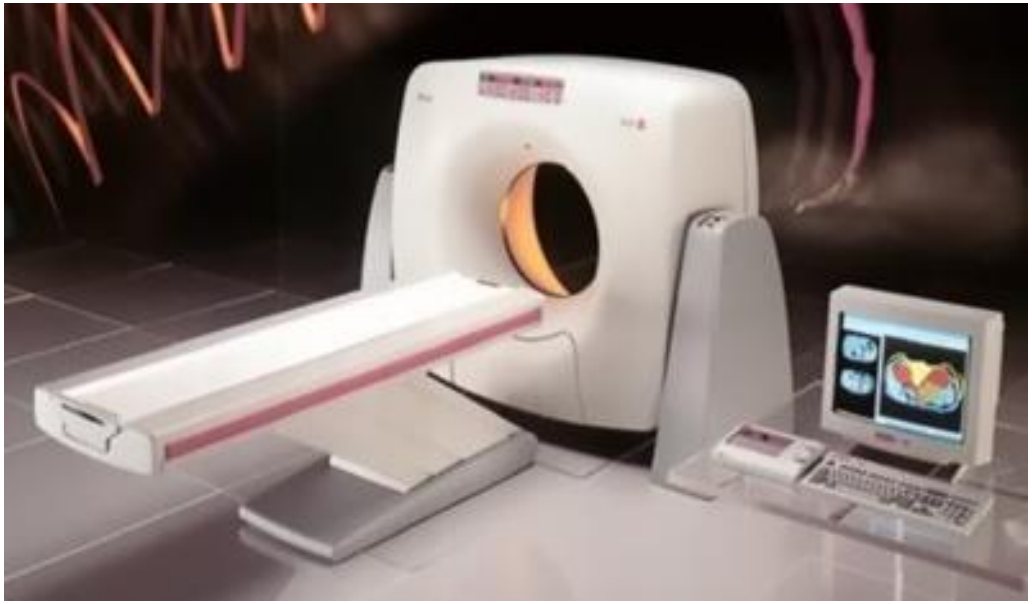


Computerized Tomography



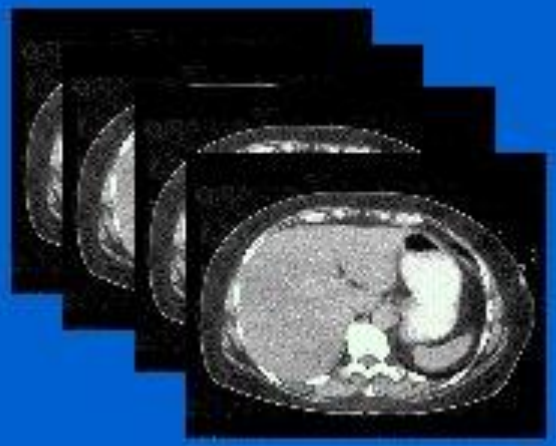
CT allows to have a 3-dmensional map of the body

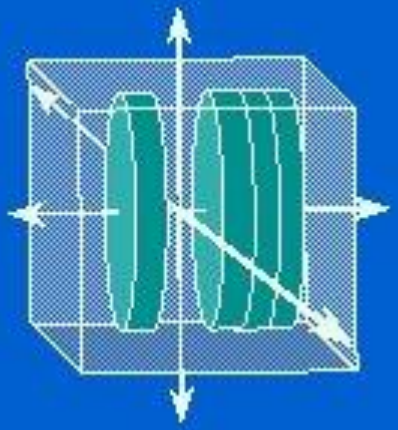

Start of
spiral scan
Path of continuously
rotating x-ray tube
and detector
Direction of
continuous
patient transport
0
z, mm
0
t, s

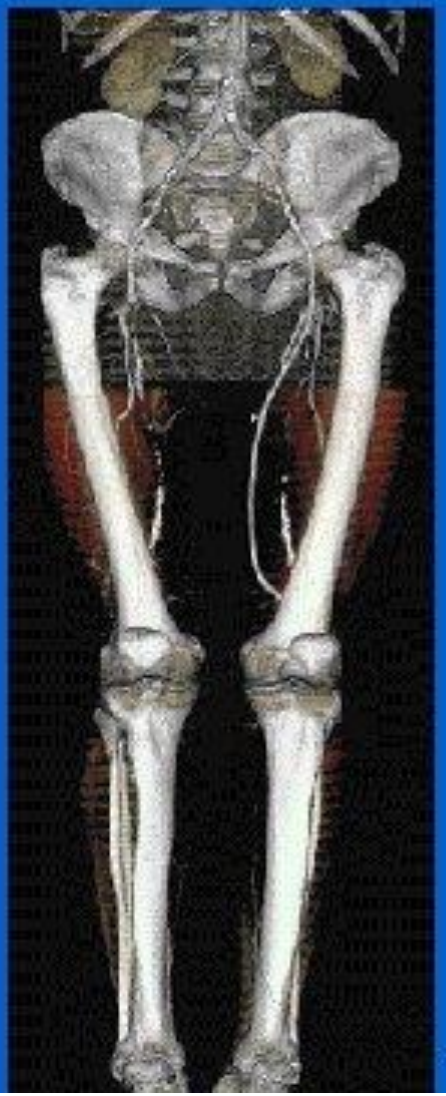


3-D Visualisation

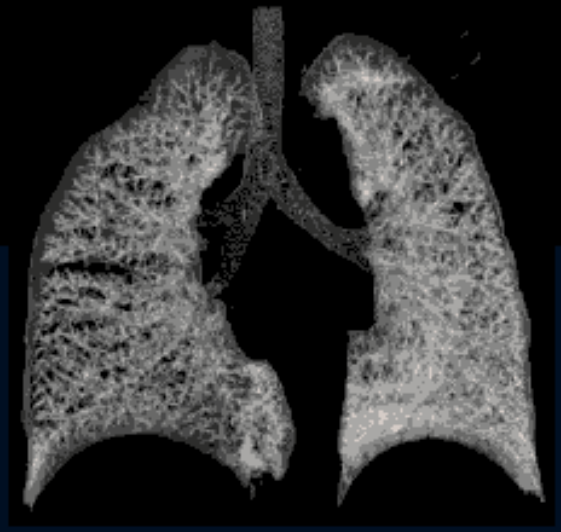
- Greater application with multi-slice

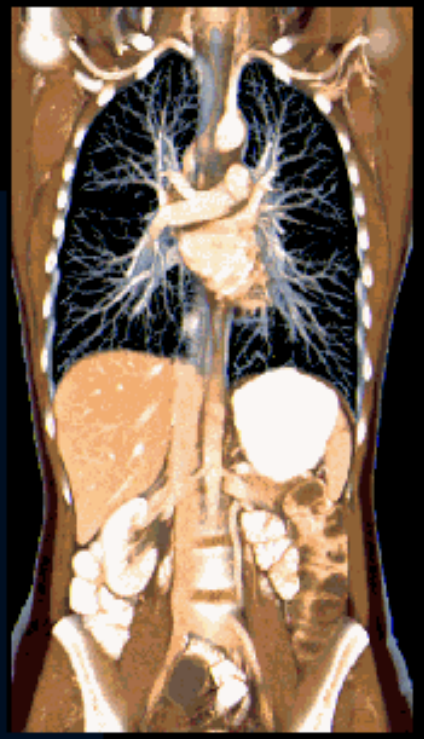
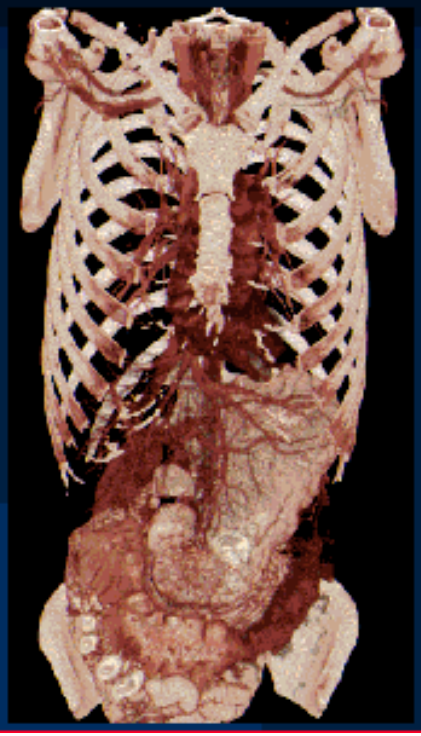


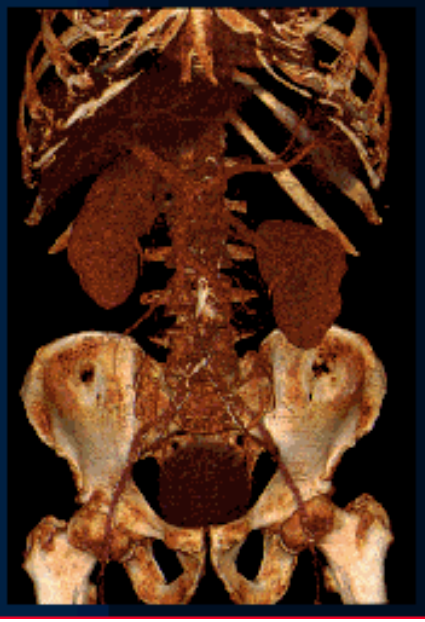




70 sec, 2.5 mm

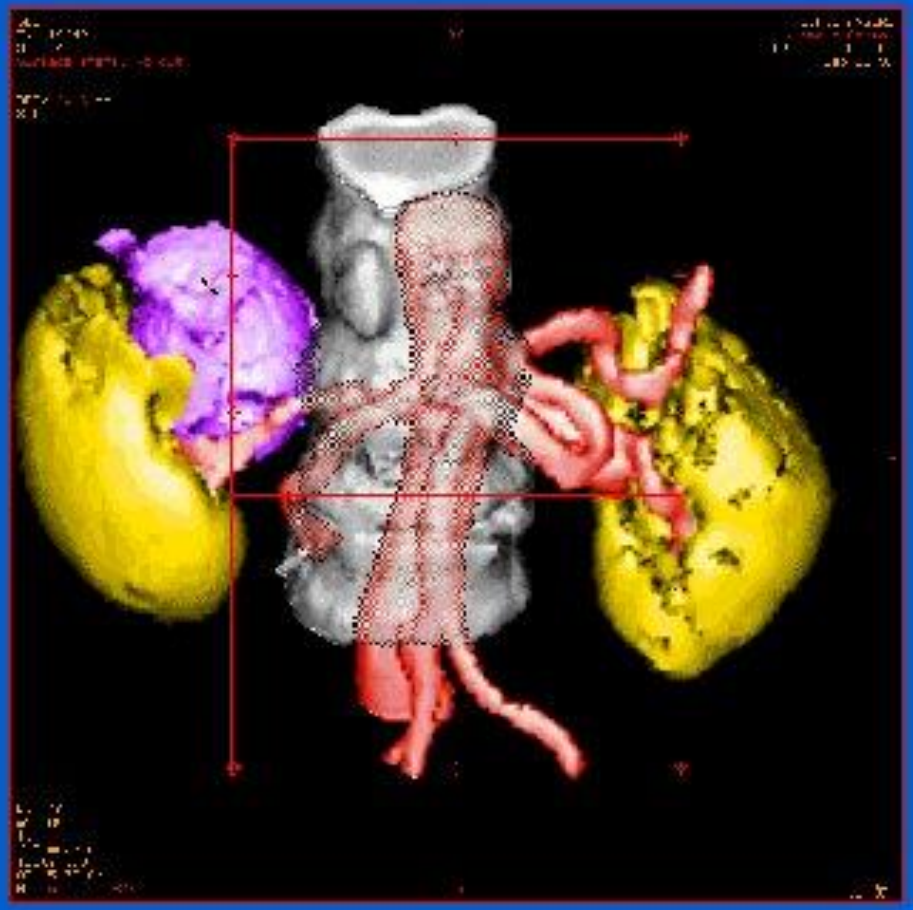





Surface Rendering

- Surfaces are created that connect all pixels with similar attenuation
- Imaginary light is reflected onto surfaces, which are given different colours



The 3,300-year-old mummy of King Tutankhamun is scanned to assess the need for restoration and also to attempt to discover the cause of his early death (January 2005)

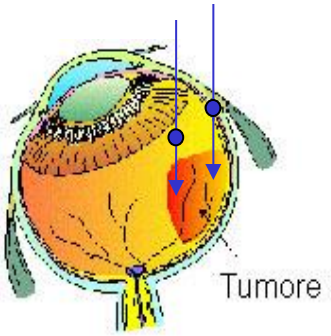
(Computed Tomography Imaging (CT Scan)

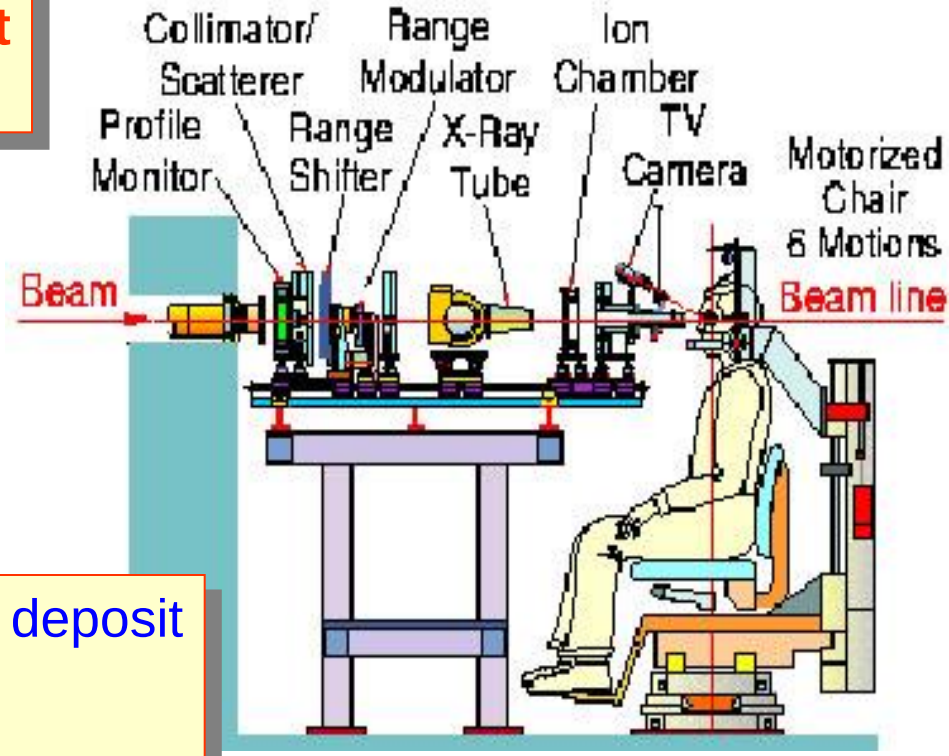
Hadron therapy

Hadrons (as protons or ions. C) can be used to cure tumors.

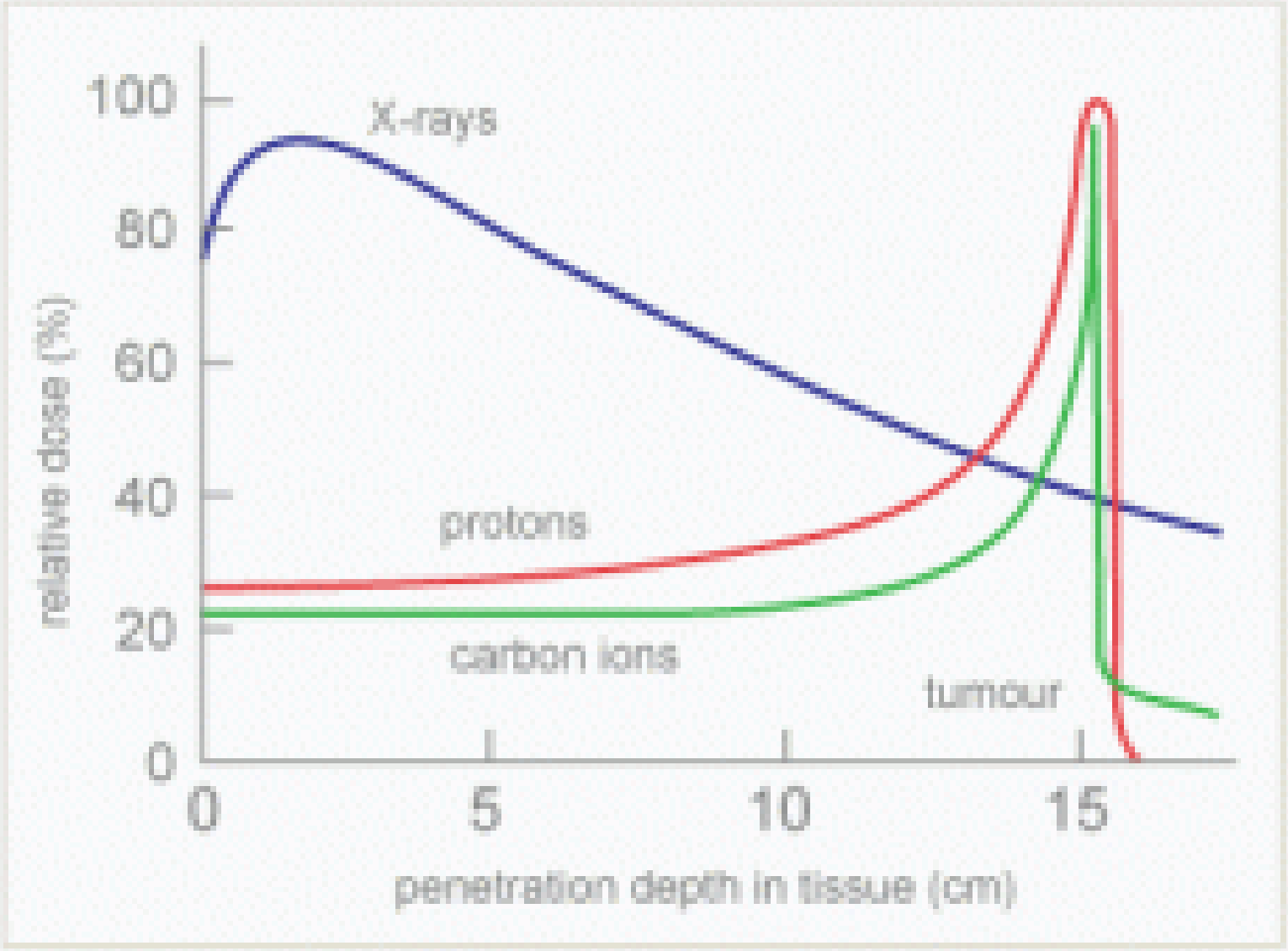
To do this one uses accelerators.

The eye melanoma are curable almost Exclusively by hadron therapy

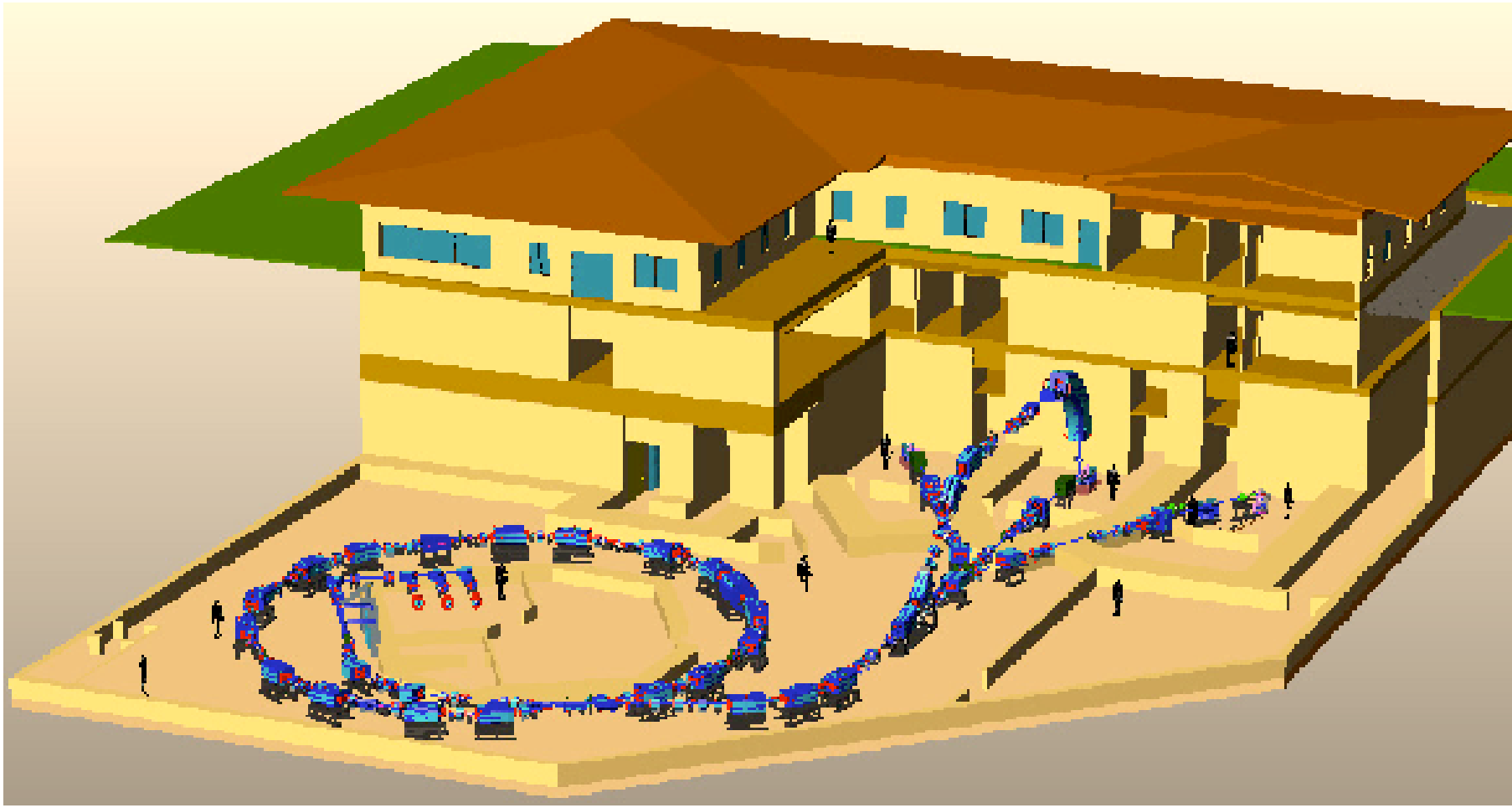




The cure with a proton beam allows to deposit A big quantity of energy only in the tumoral region


100
80
60
40
20
0
relative dose (%)
X-rays
protons
carbon ions
tumour
0
5
10
15
penetration depth in tissue (cm)

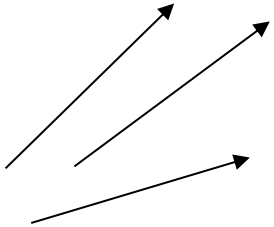
Adroterapia in Italy (CNAO)

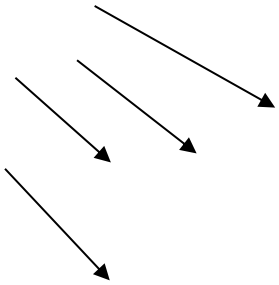


Il bunker sotterraneo del Centro Nazionale copre una superficie di 3500 metri quadrati. Nella figura si ved
tre sorgenti di ioni (protoni, ioni carbonio e ioni berillio oppure litio per sviluppi futuri), il linac iniettor
sincrotrone di 25 metri di diametro e tre sale di trattamento. La sala centrale permette irraggiamenti
orizzontali che verticali

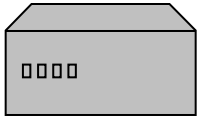
Object to study

X-ray (or particle) source





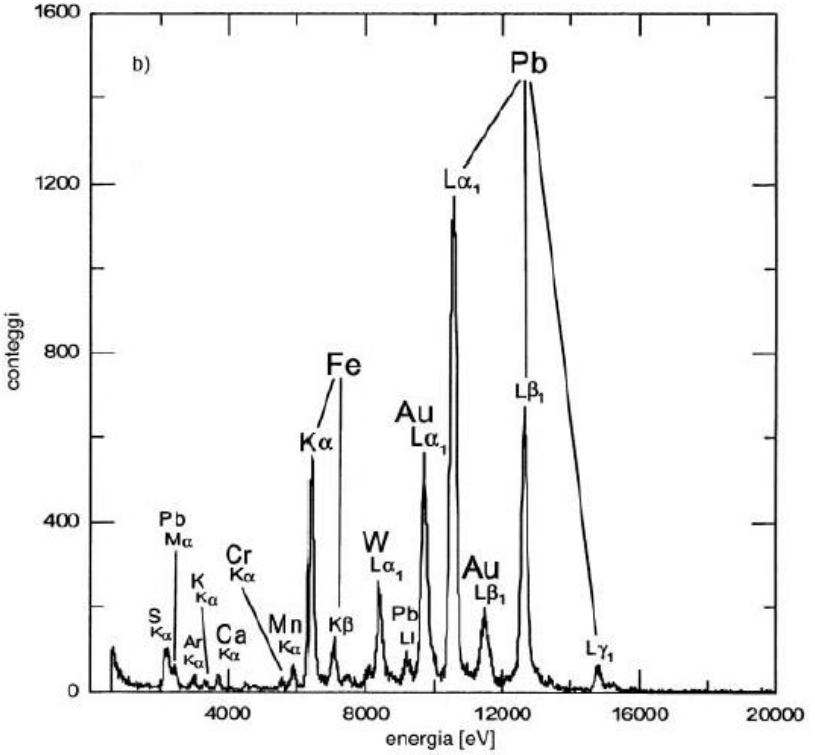
Detector



Physics and art

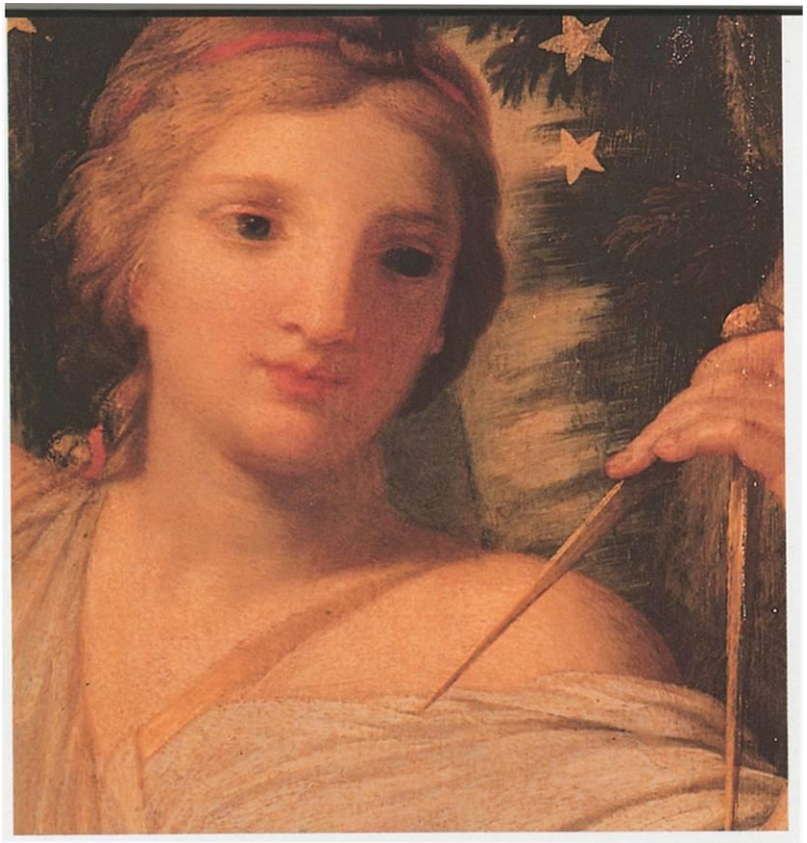
- Each element has a particular (characteristic) energy in the X-ray spectrum

- **Nello <u>spettro di fluorescenza</u> dell'affresco di *Lorenzo Lotto* si nota la presenza di ferro (Fe) e di oro (Au).**



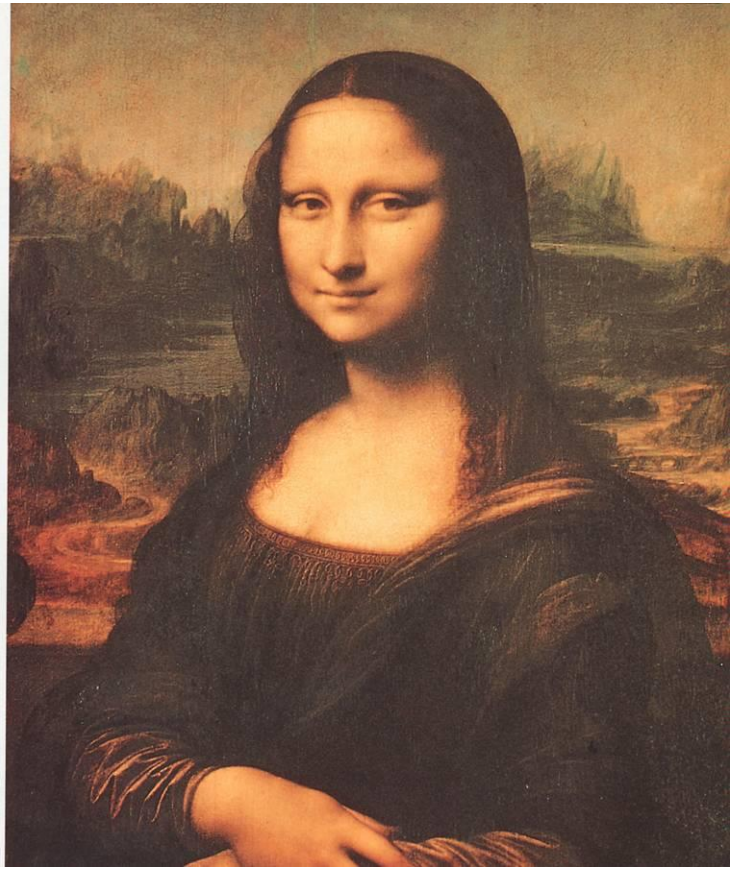
Pentimenti

Le Sueur – musa Urania (particolare)



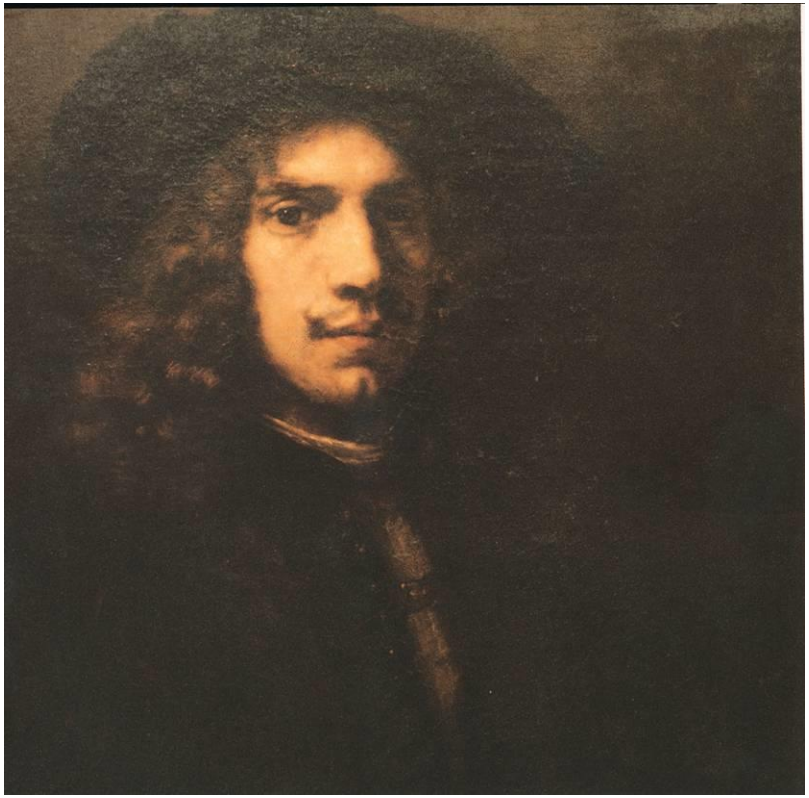
Pigment analyses

Leonardo Da Vinci – La Gioconda

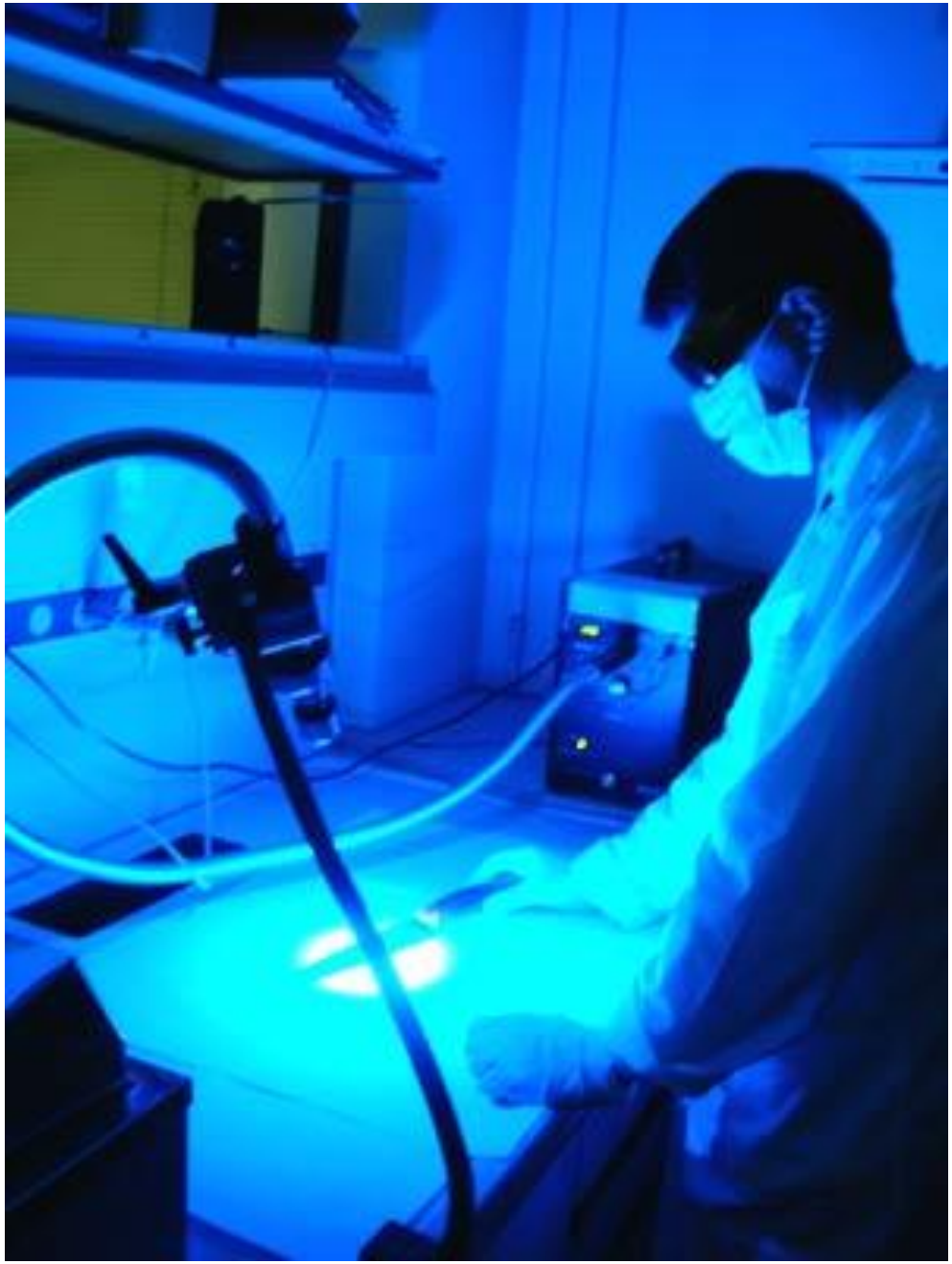


Painting on another painting

Rembrandt – Portrait of young man Titus



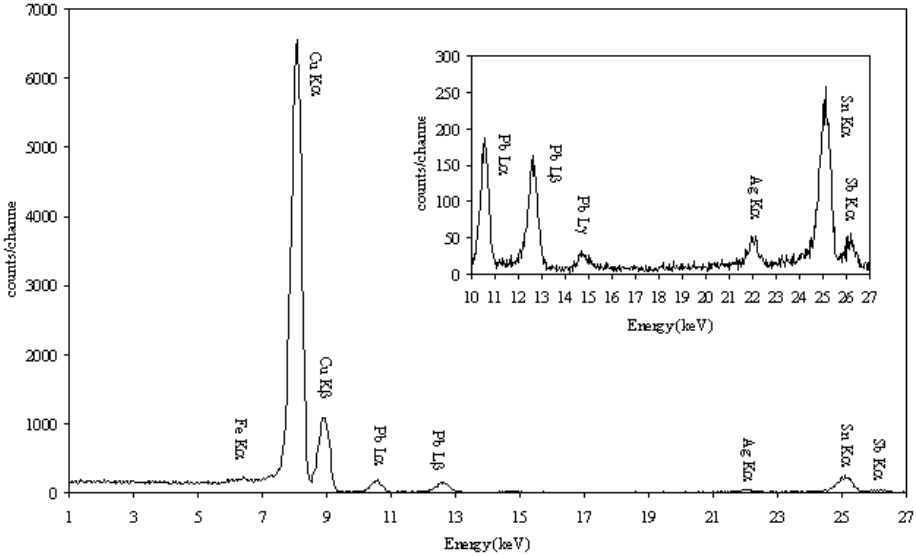
Blood search

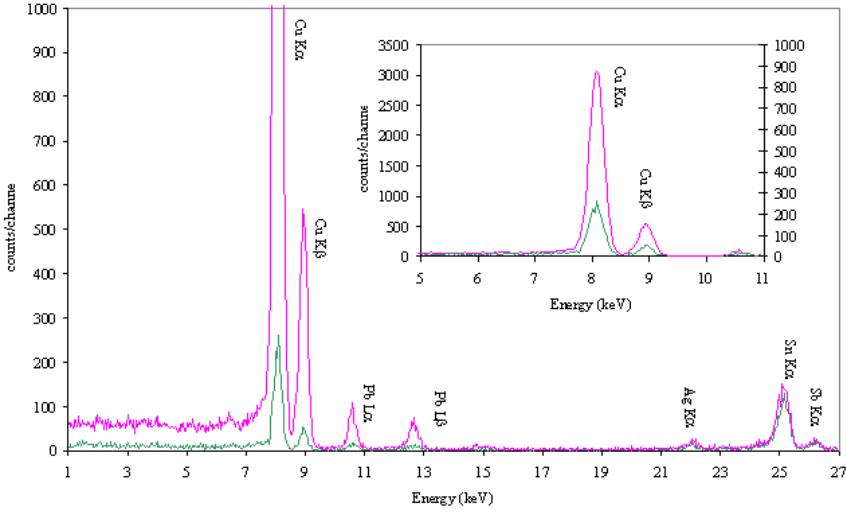


Blood search

Blood search

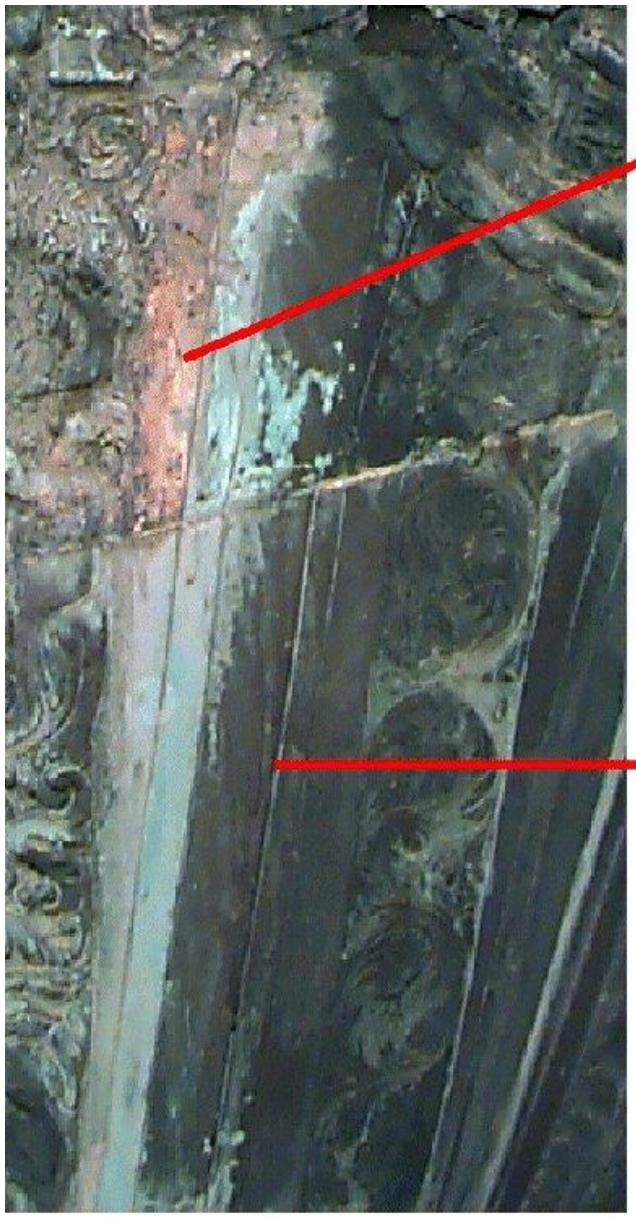
Cellini - Perseo

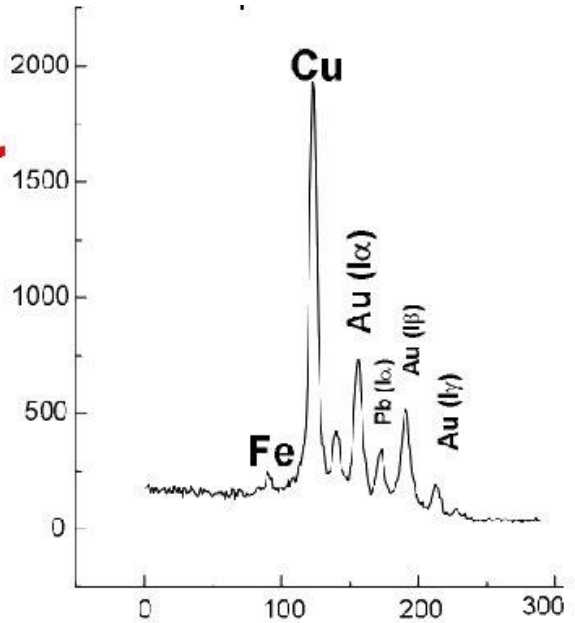


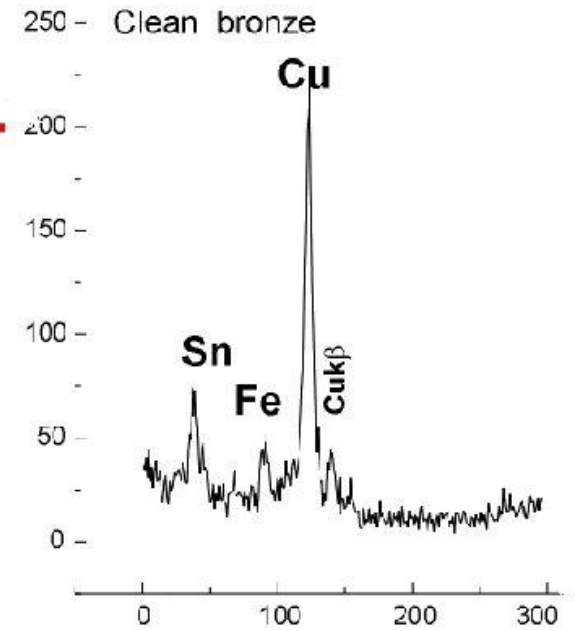


Esempio di influenza della patina sullo spettro.

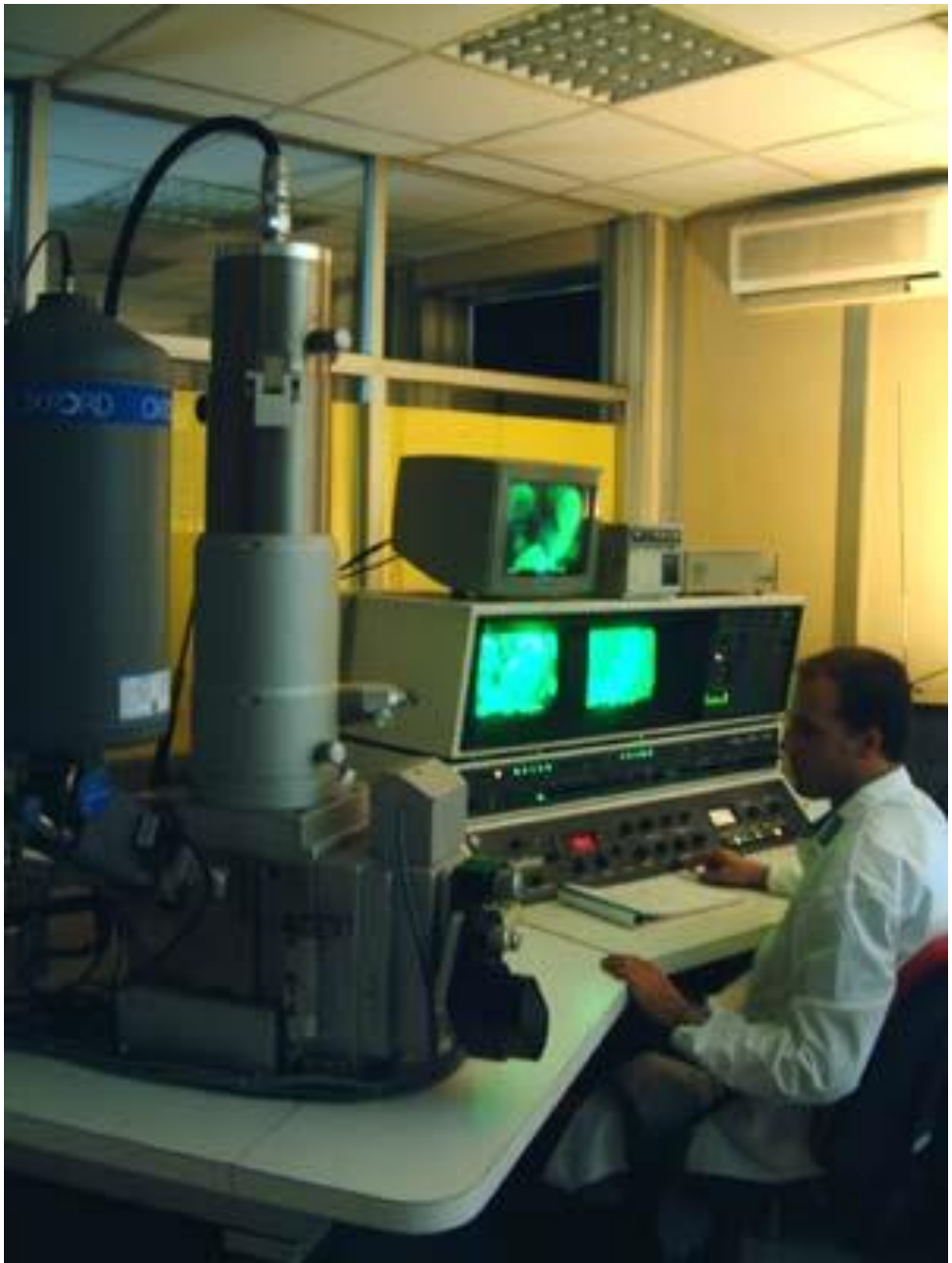
XRF bronze

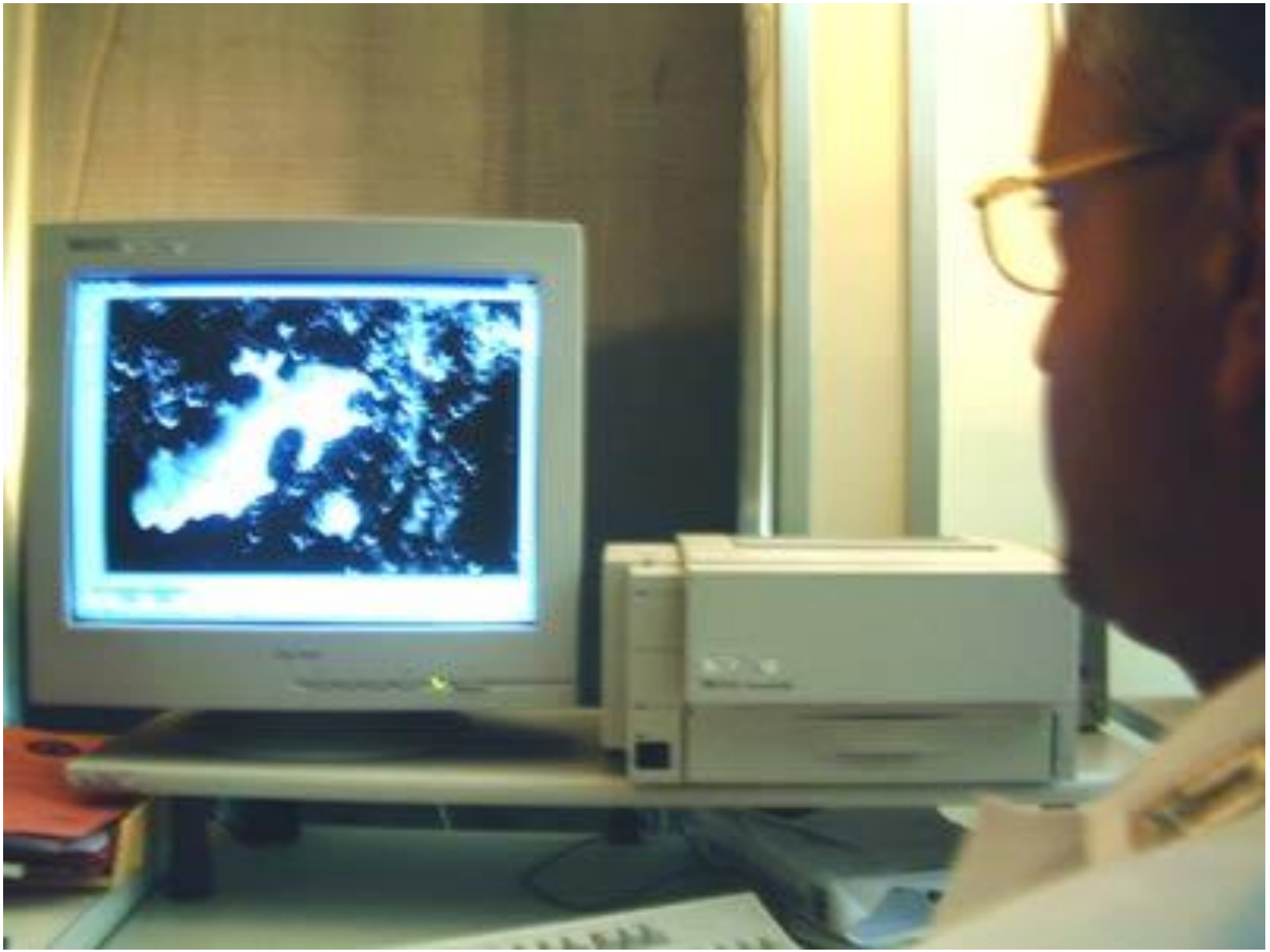



Cu
Au (Iα)
Au (Iβ)
Pb (Iα)
Au (Iγ)
Fe
2000
1500
1000
500
0
0
100
200
300

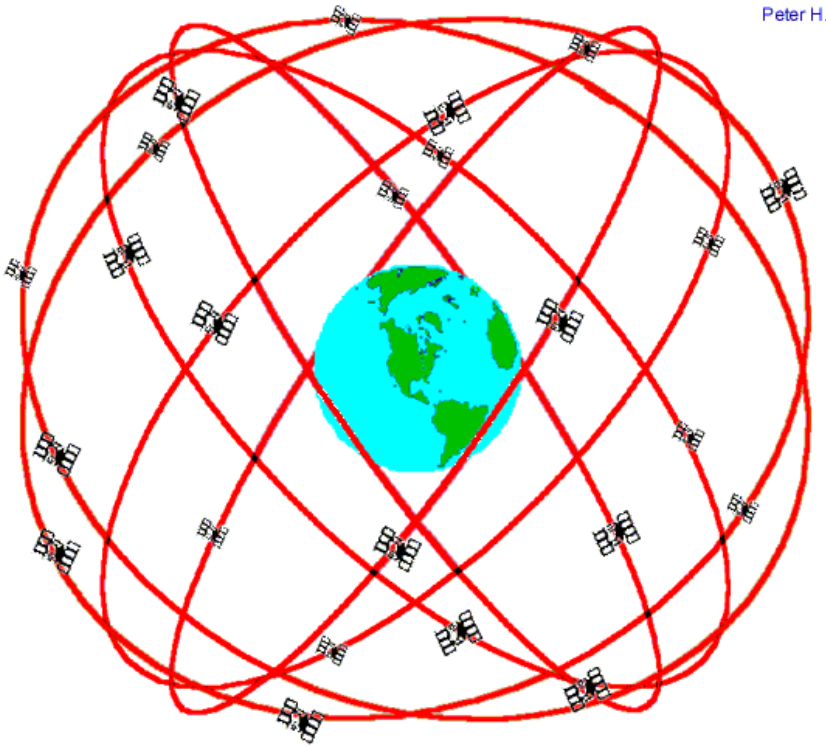

Clean bronze
Cu
Sn
Fe
Cukβ
250
200
150
100
50
0
0
100
200
300

Electron microscope



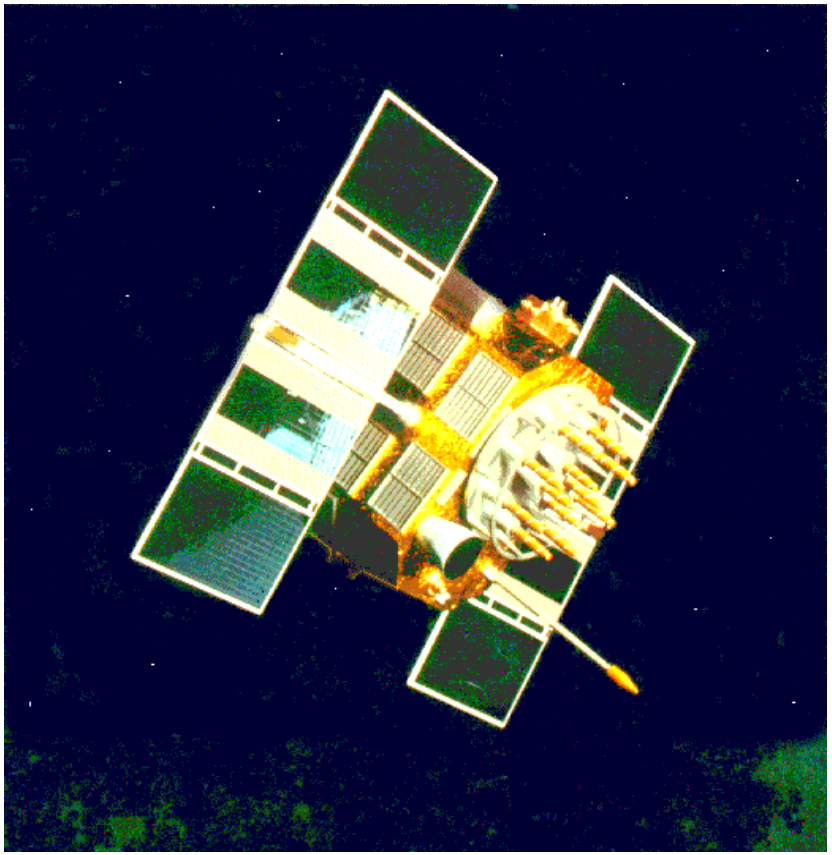


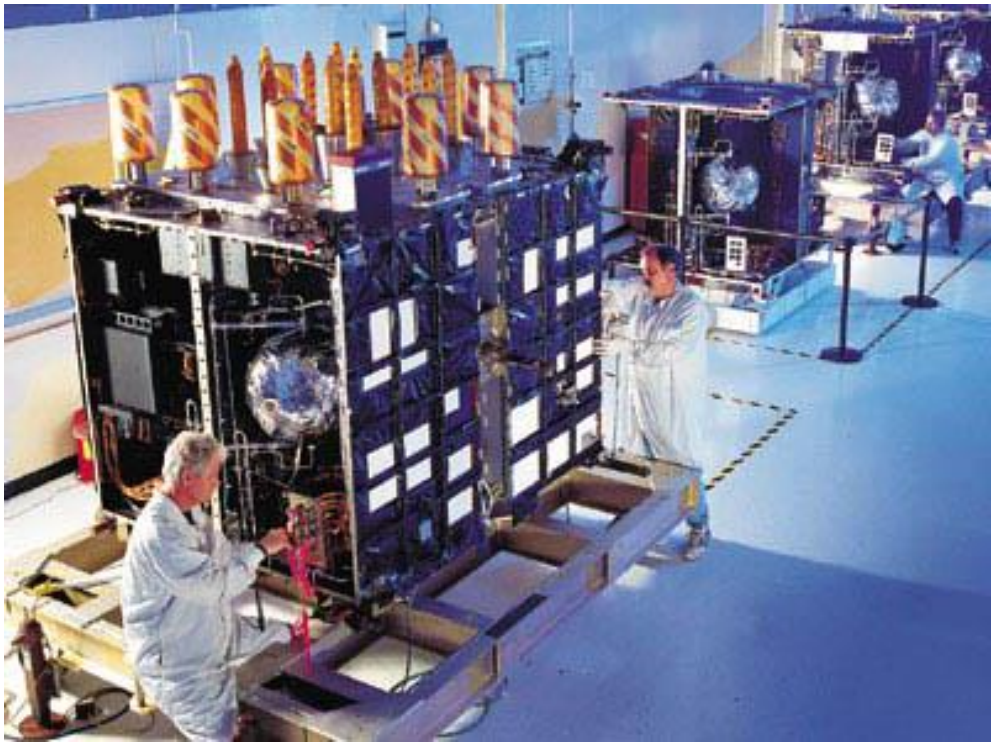
The Global Position System (GPS)



GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination

The Global Position System (GPS)





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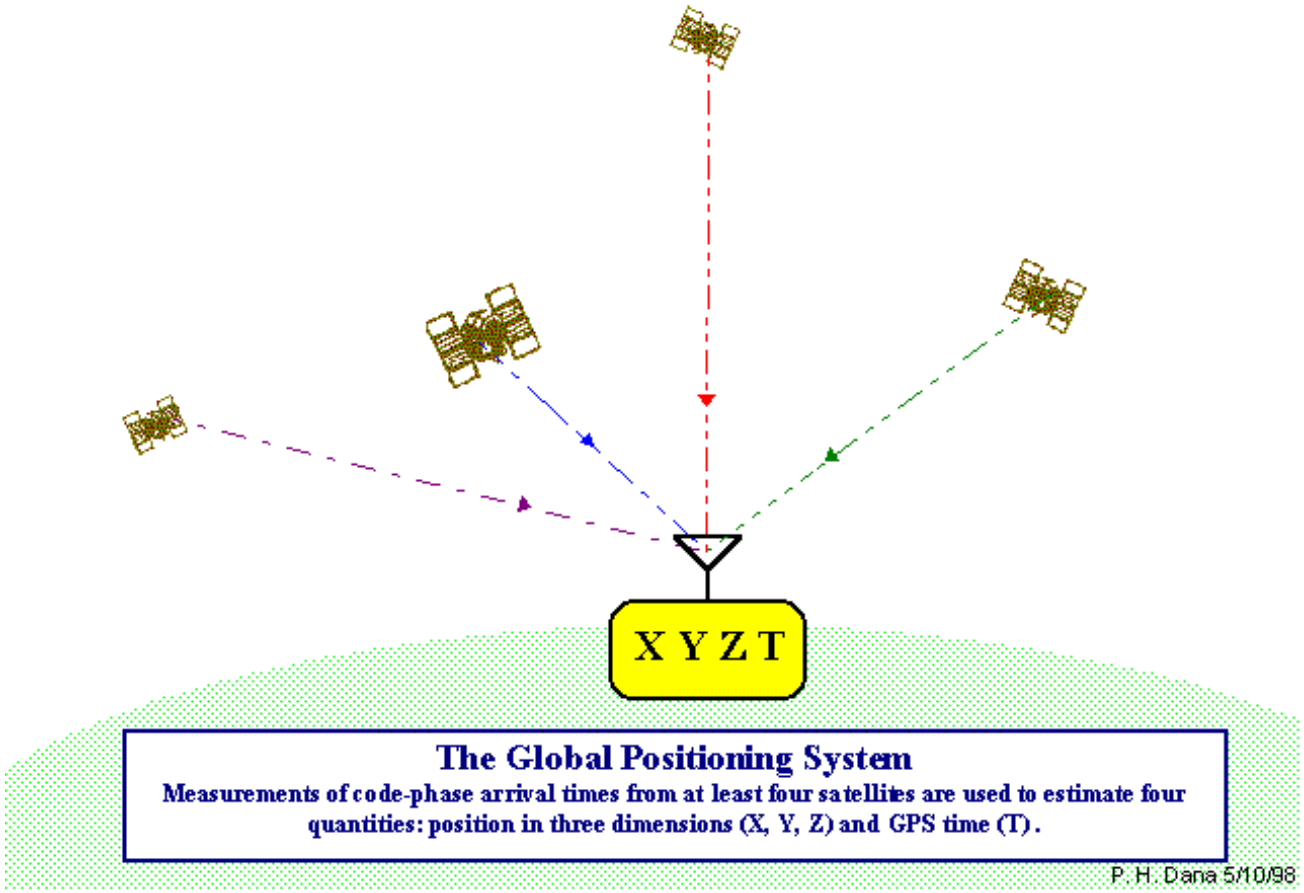
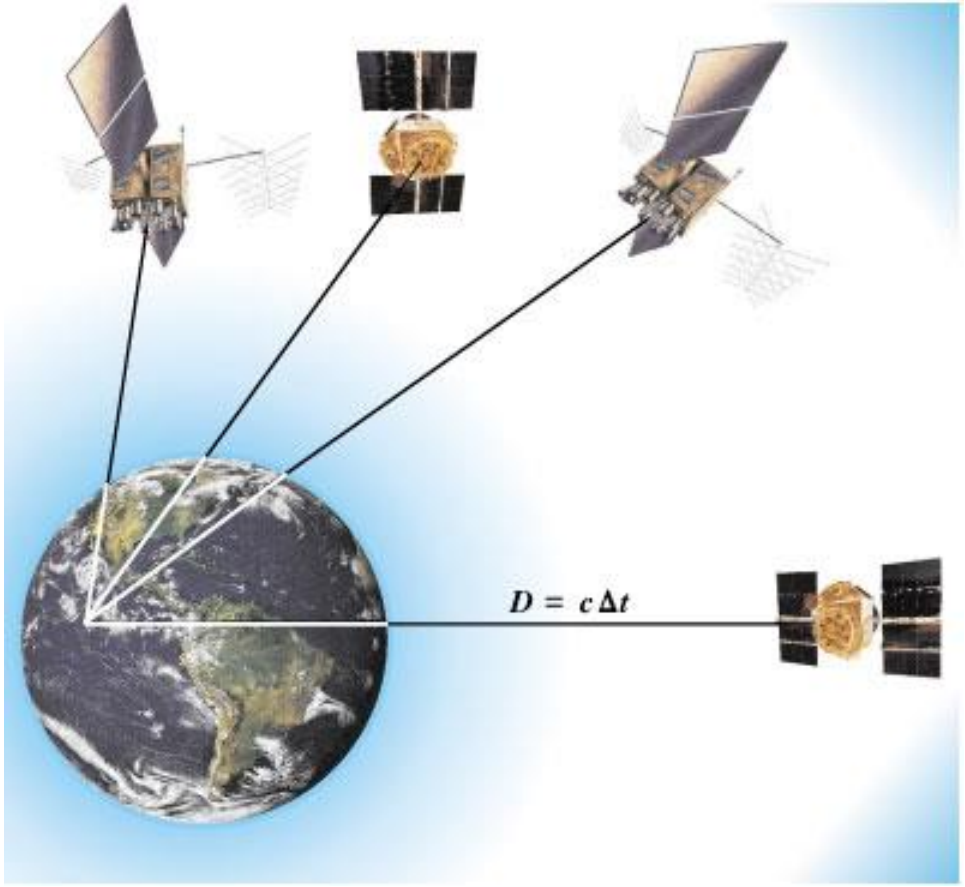
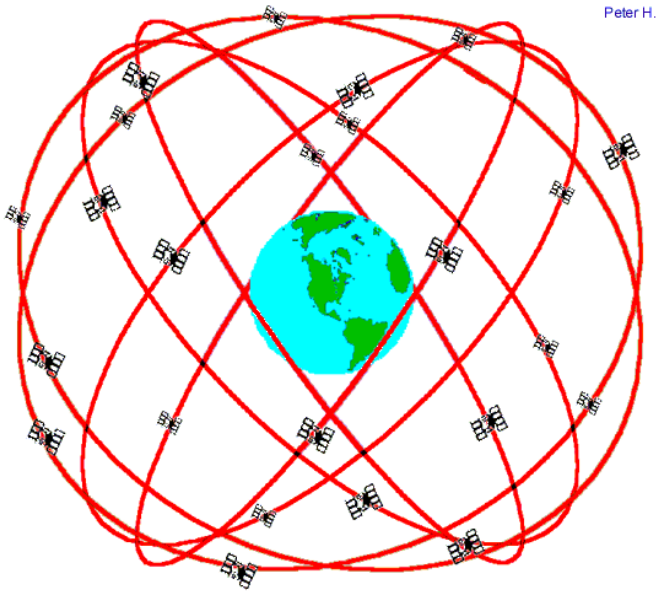


The Global Position System (GPS)



The Global Position System (GPS) e la relativita'!



GPS Nominal Constellation
24 Satellites in 6 Orbital Planes
4 Satellites in each Plane
20,200 km Altitudes, 55 Degree Inclination

$v = 3.87$ Km/s

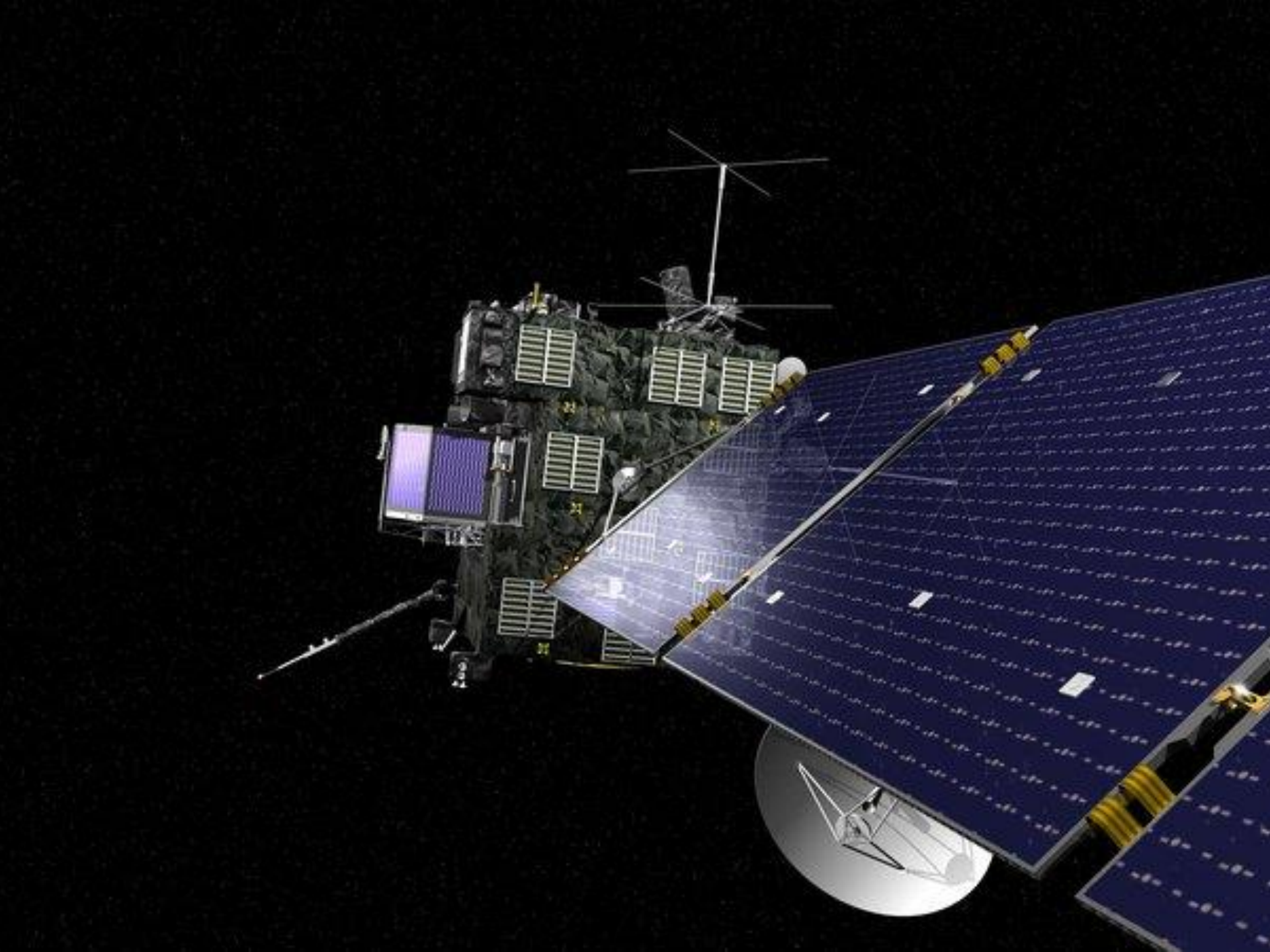
$t_{01} - t_{01}' = (1 - \gamma)\, t_{01}$

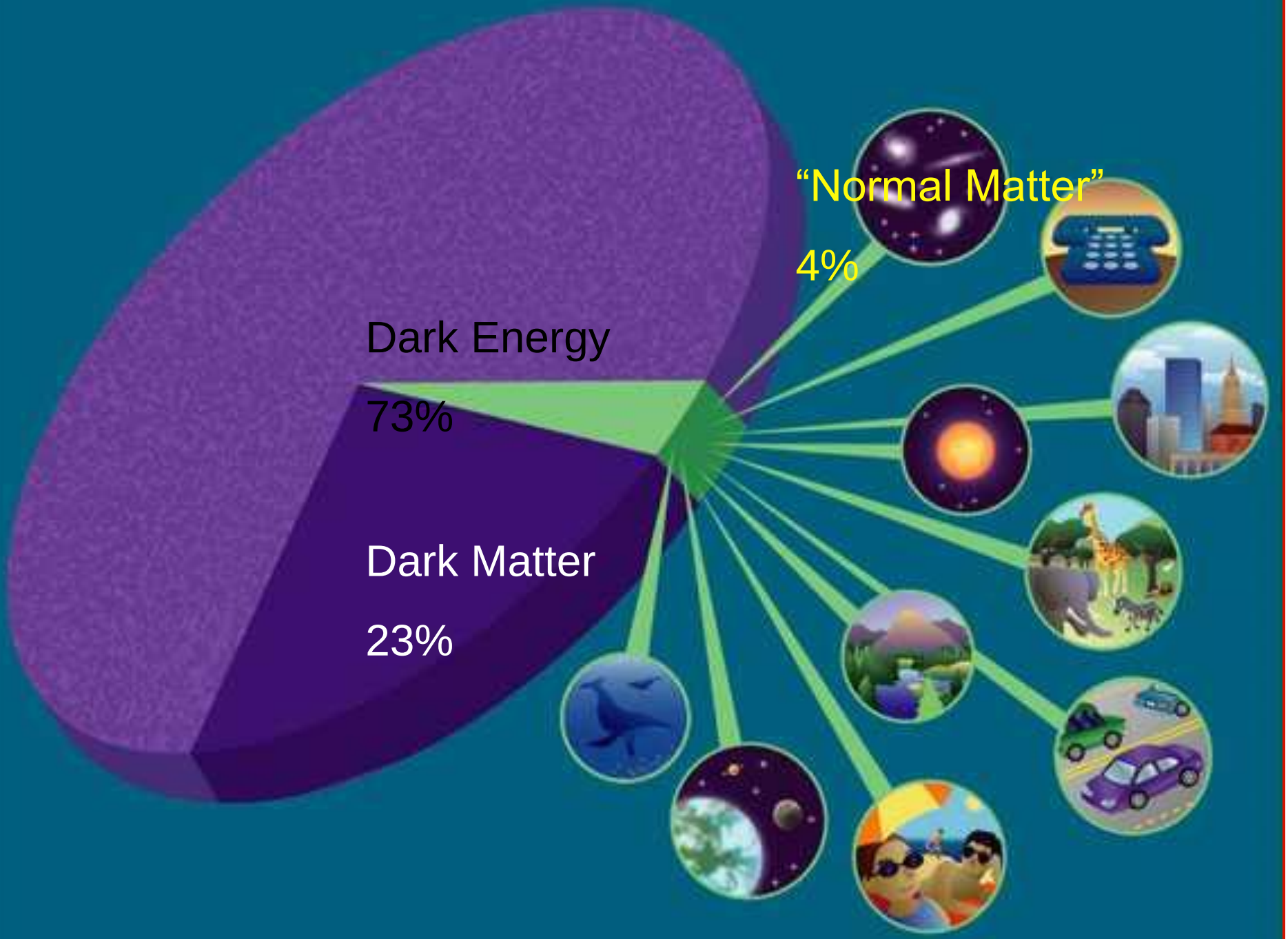
1 orbit ~ 12 hours

➔ $t_{01} - t_{01}' \sim 6\ 10^{-8}$ s

➔ $\Delta D \sim 18$ m

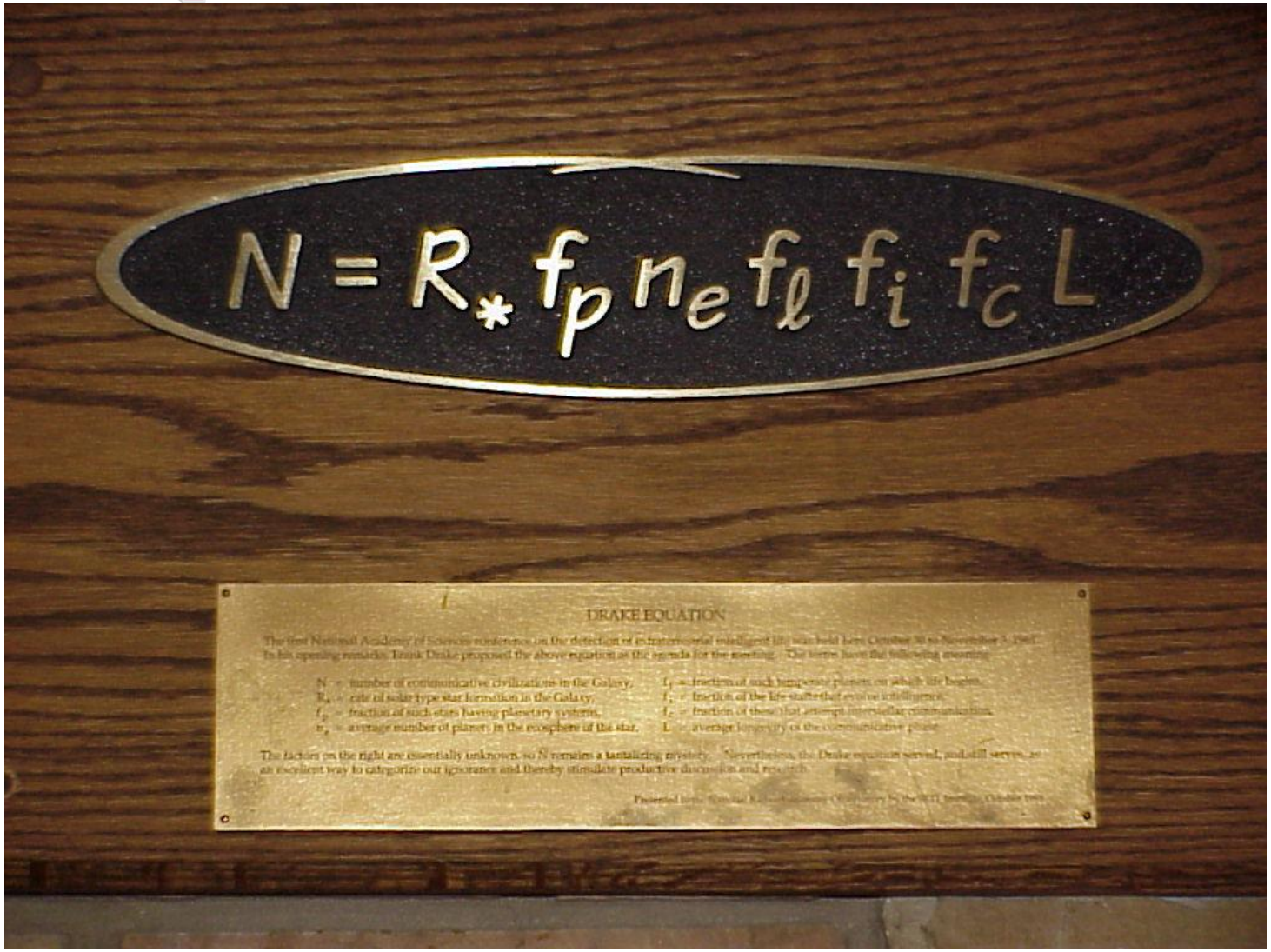
Due to other effects connected to general relativity $\Delta D \sim 100$ m

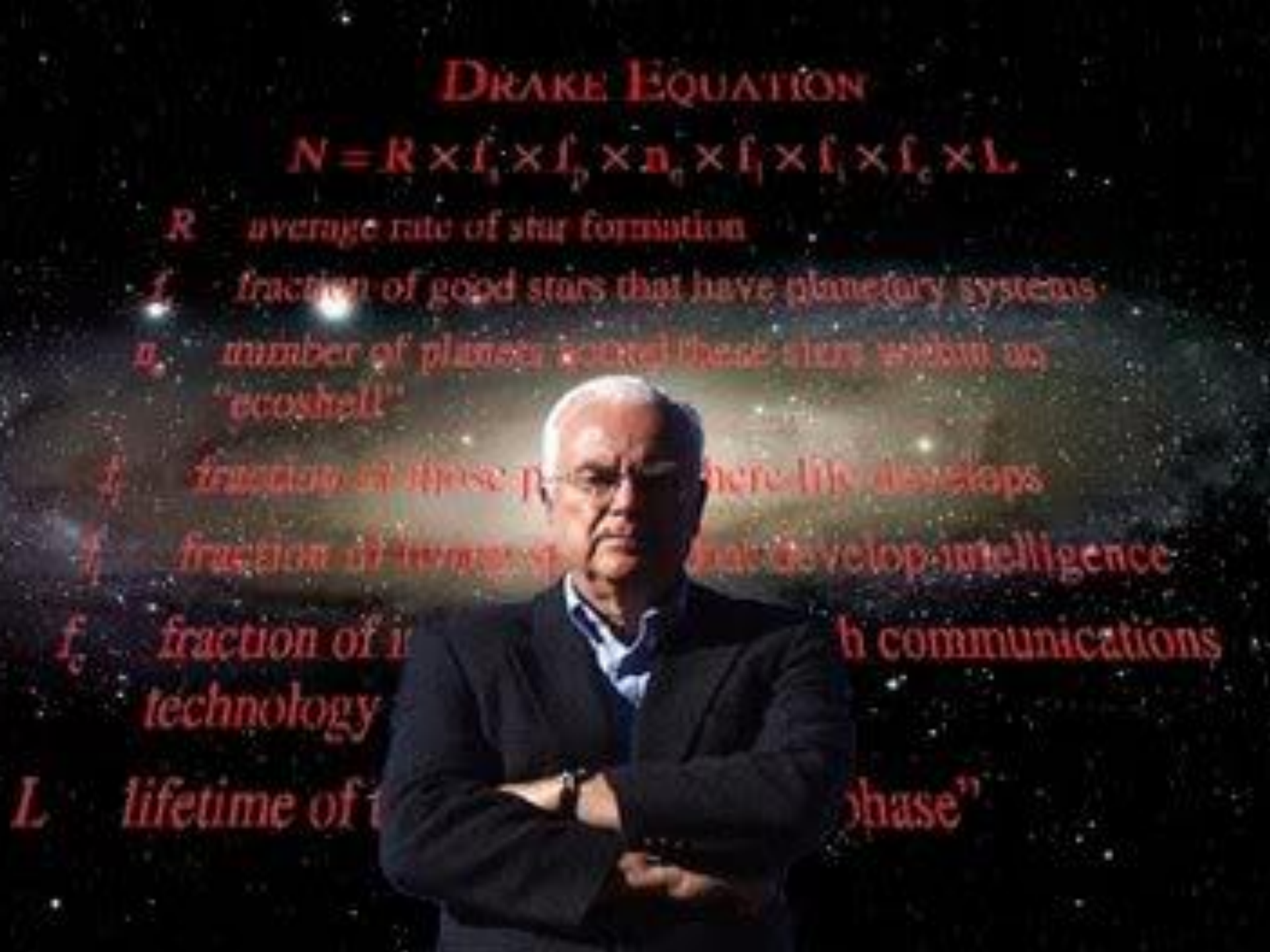



“Normal Matter”
4%
Dark Energy
73%
Dark Matter
23%

Do aliens exist?

Equation of Drake:




DRAKE EQUATION
$N = R \times f_s \times f_p \times n_e \times f_l \times f_i \times f_c \times L$
R average rate of star formation
f_p fraction of good stars that have planetary systems
n_e number of planets around these stars within an "ecoshell"
f_l fraction of these p here life develops
f_i fraction of them t develop intelligence
f_c fraction of i h communications technology
L lifetime of hase"


=
X
X
Intelligent civilizations in galaxy
Star Formation
Planetary System
Suitable Planet
X
X
IQ
X
X
RIP
Life
Intelligence
Technology
Lifetime


STAR TREK

Dai buchi neri all'adroterapia

Un viaggio nella Fisica Moderna

Catalina Oana Curceanu, nata in Transilvania (Brasov, Romania), è Primo Ricercatore dell'Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati. Dirige un gruppo di ricercatori che lavorano nel campo della fisica sperimentale adronica e nucleare, conducendo esperimenti sia in Italia sia all'estero, e coordina vari progetti europei. Ha organizzato varie conferenze internazionali ed è autrice di più di 200 pubblicazioni scientifiche in riviste internazionali. Svolge un'intensa attività di formazione e divulgazione scientifica e scrive per vari giornali e riviste italiane e rumene. Ha la passione di spiegare a tutti quanto sia bello e affascinante il mondo della scienza.