

Camera a Nebbia



Alternanza Scuola Lavoro
INFN Sezione di Bologna 2019

La Fisica delle Particelle Elementari

La fisica delle alte energie (HEP) studia le interazioni tra le particelle effettuando degli esperimenti di diffusione tra differenti particelle

Collisioni $\mathbf{P}_{\text{tot}} = 0$ s.c.m.

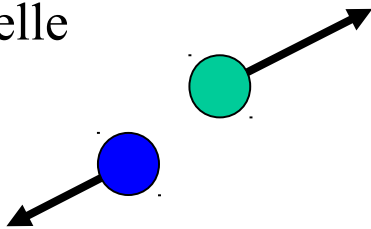


Esperimenti a bersaglio fisso

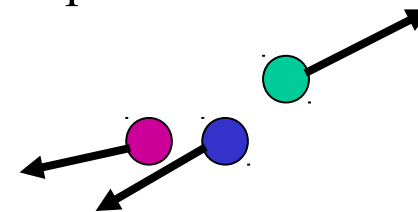


Come risultato si possono:

Modificare direzione, energia, impulso delle particelle



Creare nuove particelle



**ALTE
ENERGIE**

→ lunghezze d'onda piccolissime ($\lambda = h/P$)
studio della struttura interna

→ creazione di nuove particelle $E = mc^2$

$$c=300.000 \text{ km/s} = 3 \cdot 10^8 \text{ ms}^{-1}$$

Quantita` Misurabili

4-impulso (E, P_x, P_y, P_z)

$$E = m_0 c^2 \gamma \quad (\text{energia in eV})$$

$$\mathbf{P} = m_0 \mathbf{v} \gamma \quad (\text{impulso in eV/c})$$

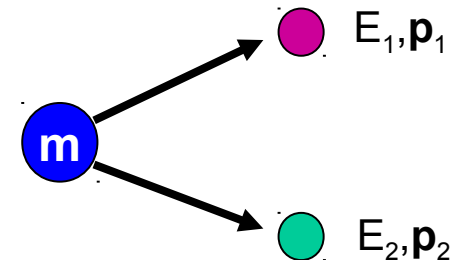
$$E^2 = \mathbf{P}^2 c^2 + m_0^2 c^4$$

$$\beta = v/c \quad \gamma = 1/\sqrt{1 - \beta^2}$$

Massa (in eV/c²)

- quantità derivata da E, \mathbf{P}
- misurata dai prodotti di decadimento

$$m_0 c^4 = (E_1 + E_2)^2 - (c\mathbf{p}_1 + c\mathbf{p}_2)^2$$



Carica

Vita media

$$\tau(\text{Lab}) = \tau(\text{cm}) \gamma$$

- dal percorso prima di decadere



1eV → elettronvolt
→ energia che un
elettrone
acquista da una
tensione di 1 V (1
Volt)

Spin

dalle distribuzioni angolari

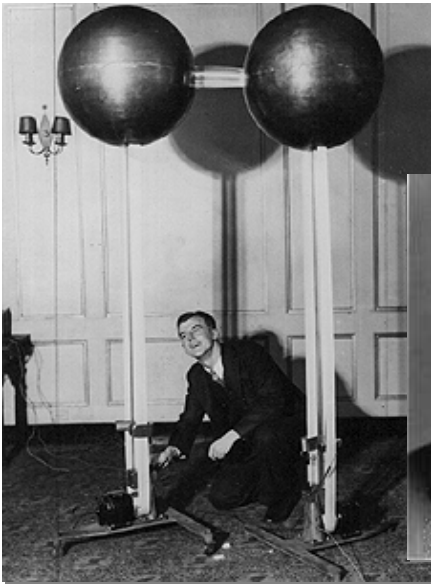


Strumenti di Lavoro

Per investigare la materia a scale di lunghezza sempre più piccole abbiamo bisogno di strumenti:

- **Acceleratori** → “proiettili” per sondare la materia
- **Rivelatori** → per vedere come i “proiettili” interagiscono con la materia

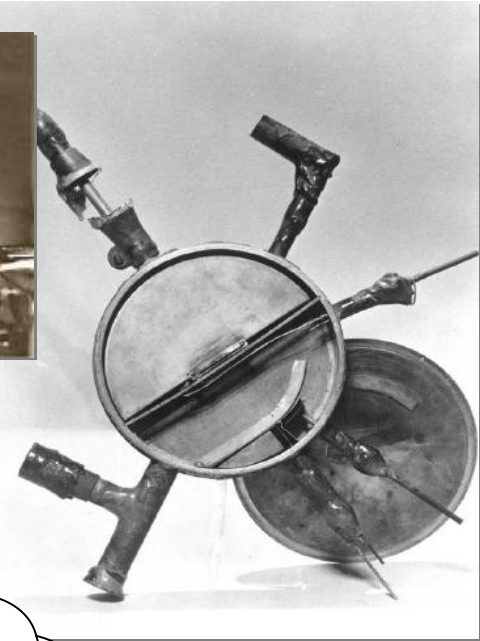
Acceleratori



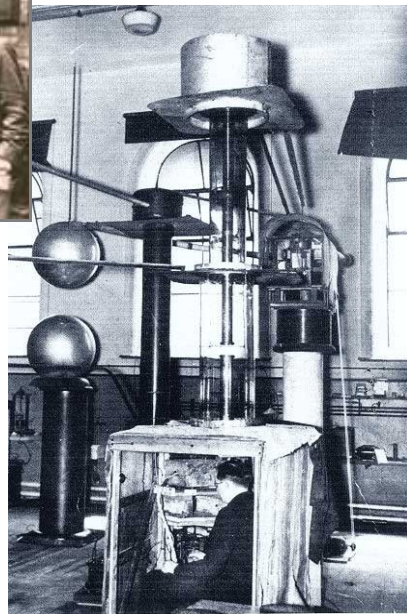
Robert Van de Graaff's 1 MeV generator was demonstrated in 1929.



In 1932 E.O. Lawrence's cyclotron achieved energies of 1.2 MeV and nuclear events similar to Cockroft-Walton.

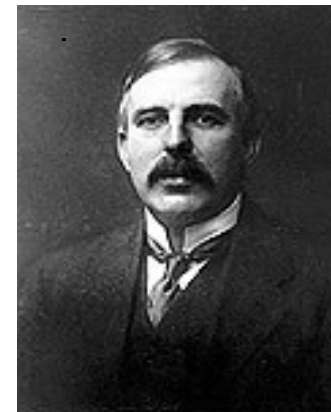


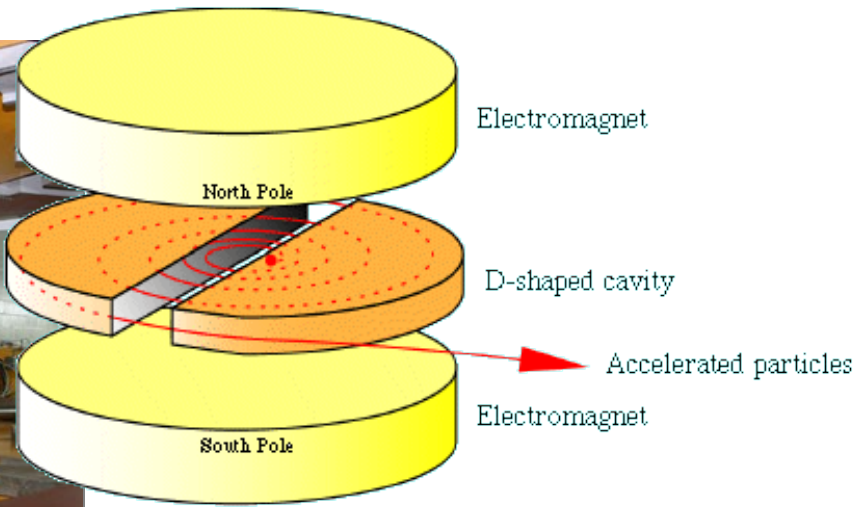
John Cockcroft and Ernest Walton demonstrate the first man-made nuclear reaction in 1930 using their 0.4 MeV accelerator.



One day we will be able to accelerate charged particles to energies larger than radioactive decay.... 1927

In 1909 Rutherford's famous experiment used 5 MeV alpha particles to probe the gold atom and reveal the nucleus.

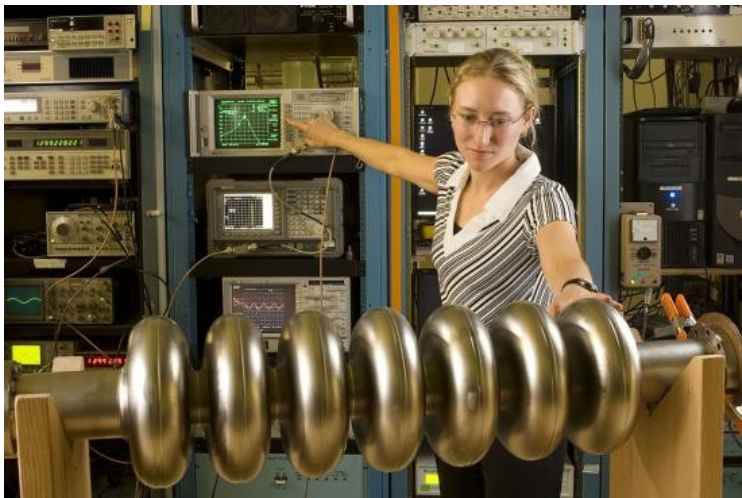
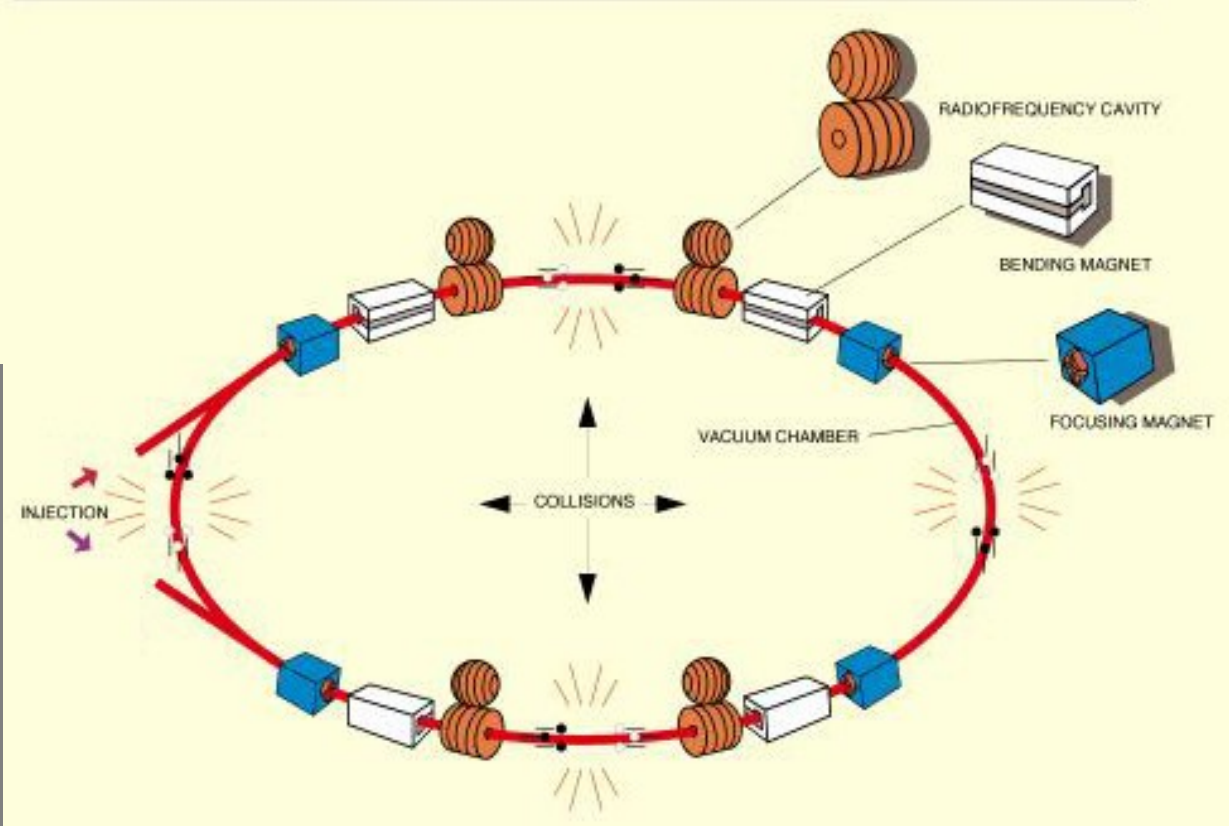




Cyclotron Simulation

RF Cavity Simulation

THE PRINCIPAL MACHINE COMPONENTS OF AN ACCELERATOR

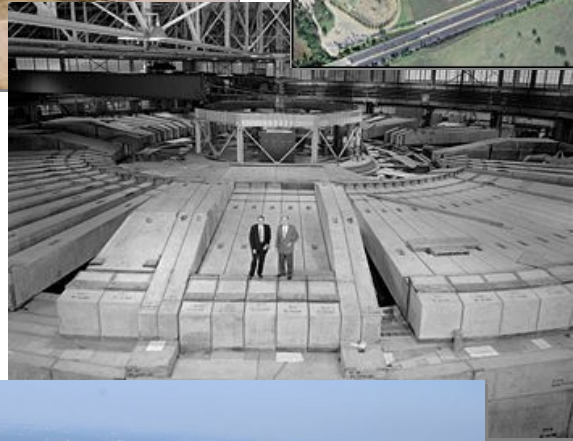




Cosmotron
3.3 GeV protons



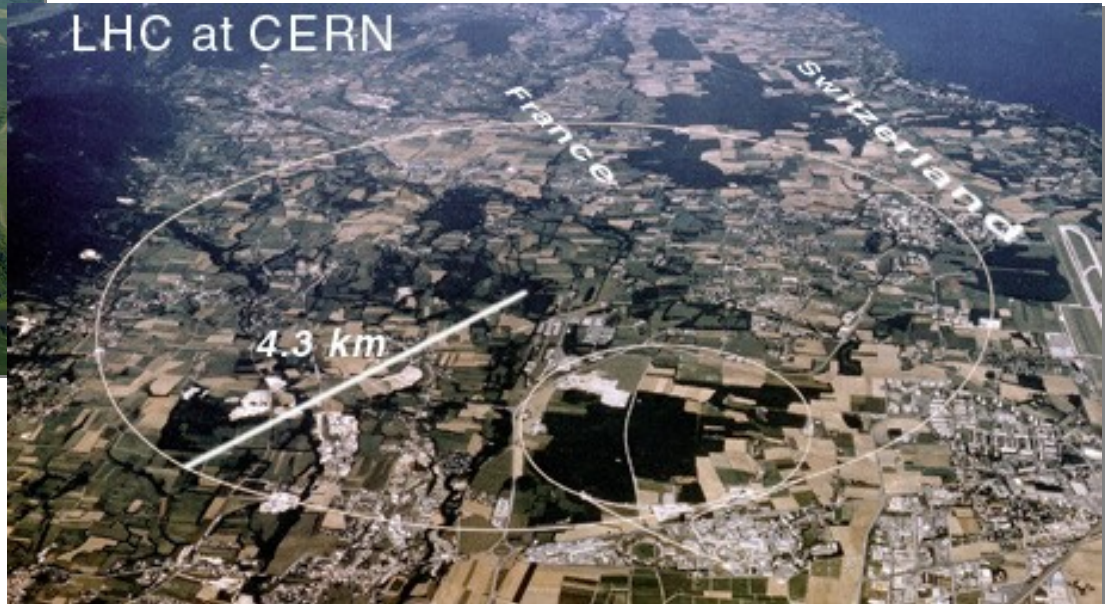
Stanford Linear Accelerator
50 GeV electron-positron



Bevatron
6.2 GeV protons



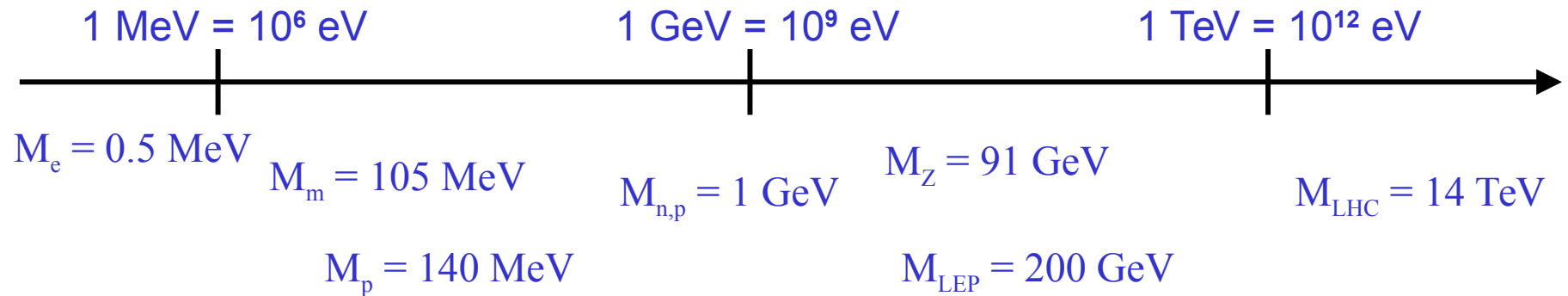
Fermi Lab - 1 TeV protons/antiprotons



Large Hadron Collider
13 TeV protons/protons

Bigger Machines - More Energy

Scale di Masse ed Energie



Paragone energie HEP con energie macroscopiche

$$1\text{eV} = 1.6 \cdot 10^{-19} \text{ J}, \quad c = 300.000 \text{ km/s} \rightarrow 1\text{eV}/c^2 = 1.8 \cdot 10^{-36} \text{ kg}$$



$$m_{\text{ape}} = 1 \text{ g} = 5.8 \cdot 10^{32} \text{ eV}/c^2$$

$$v_{\text{ape}} = 1 \text{ m/s} \rightarrow E_{\text{ape}} = 10^{-3} \text{ J} = 6.25 \cdot 10^{15} \text{ eV}$$

$$E_{LHC} (1 \text{ protone}) = 1.4 \times 10^{13} \text{ eV}$$

Se però si considerano tutte le particelle in un fascio (10^{14})

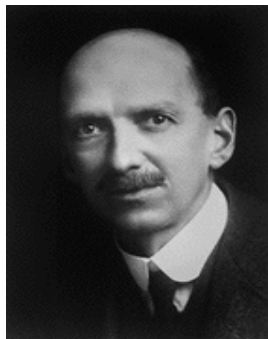
$$E_{\text{tot}} = 10^{14} \times 1.4 \times 10^{13} \text{ eV} \approx 10^8 \text{ J}$$



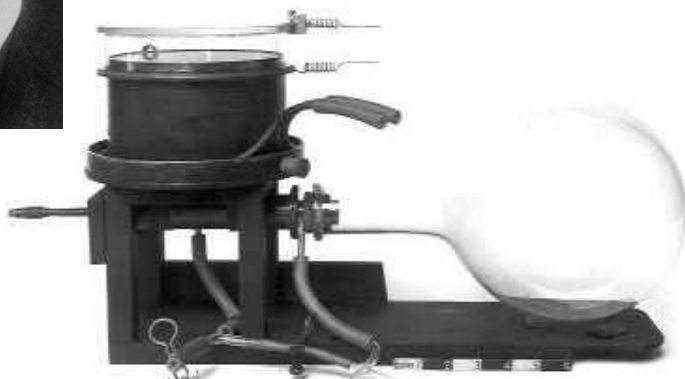
Energia cinetica
di un tir in corsa



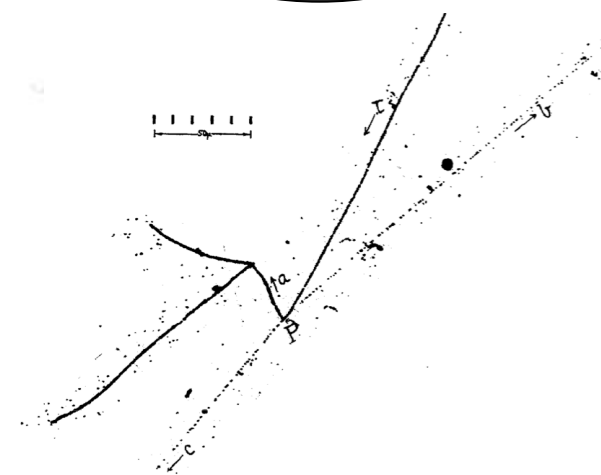
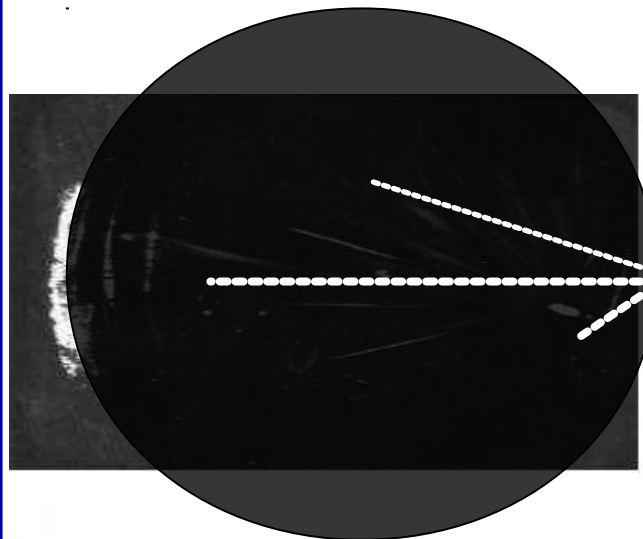
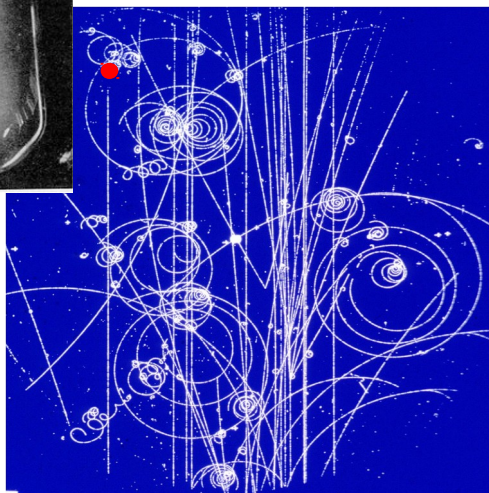
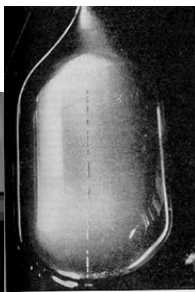
Rivelatori



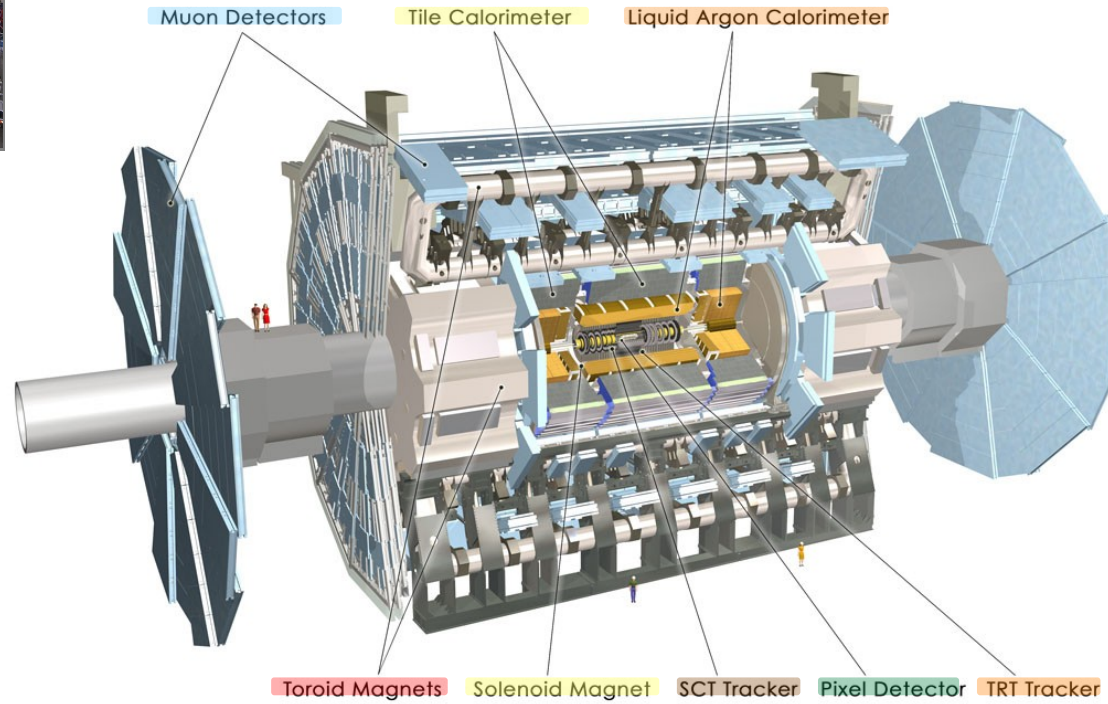
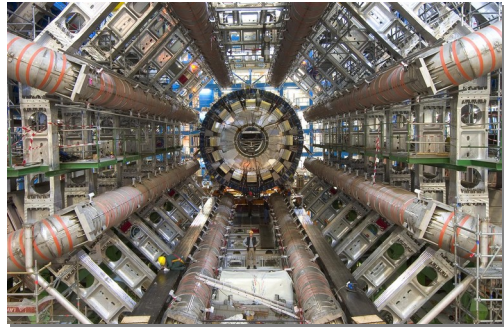
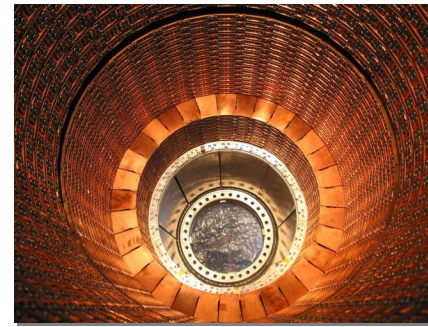
C. R. T. Wilson introduced the cloud chamber in 1912.



Donald Glaser invented the bubble chamber in 1952. His first detector was only a few inches in diameter. The last one used was 15 ft by 10 ft.

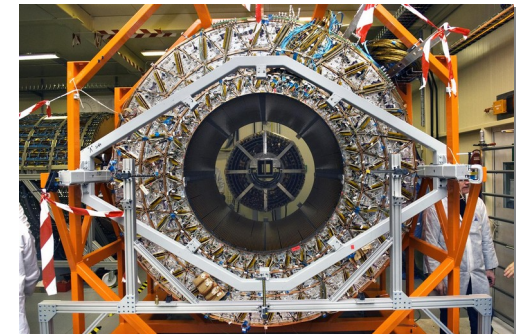
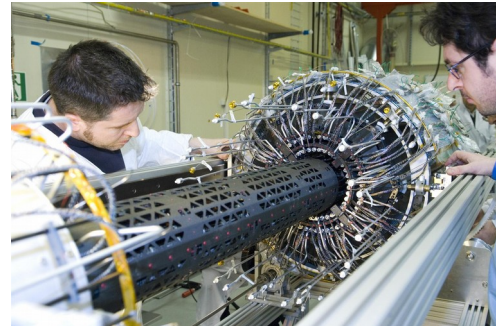


Photographic emulsions have been used since the time of Becquerel in 1896. This is an image of a cosmic ray pion event from 1947.

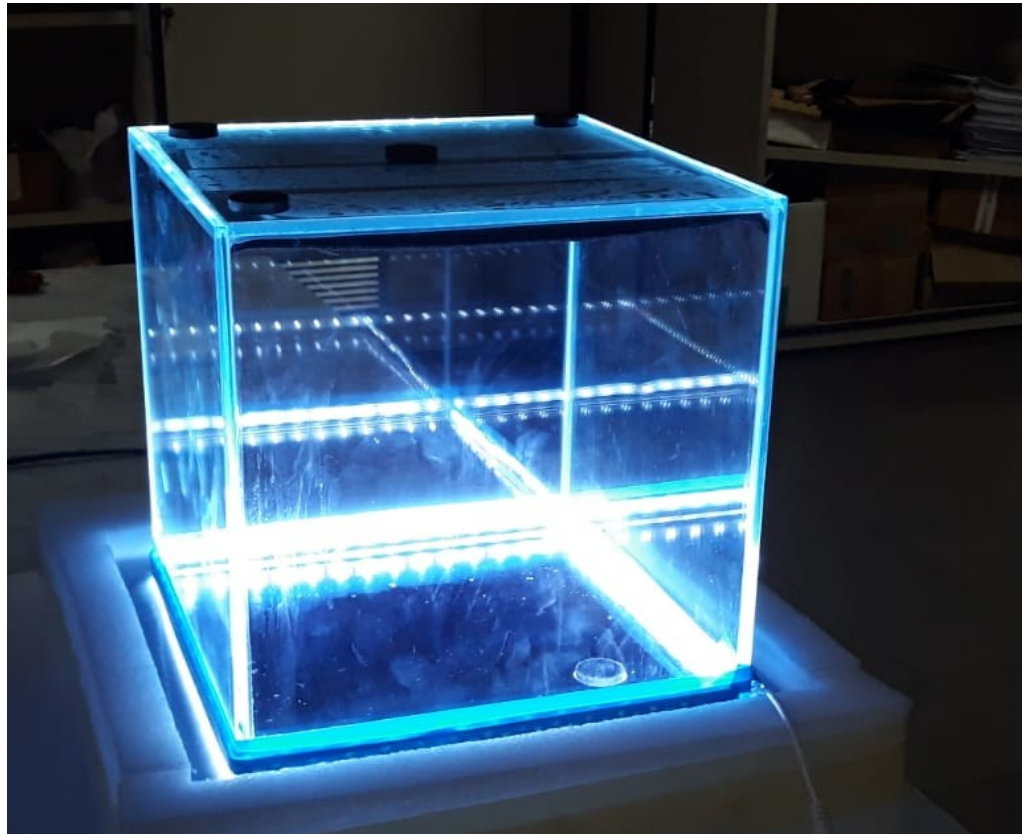


ATLAS

Detailed
Description



Camera a Nebbia



Referenti: Donato Diferdinando, Matteo Franchini, Antonio Sidoti
Luogo: Lab A18 Piano -1 (interrato) – Viale Berti Pichat 6/2
Quando: Mercoledì pomeriggio e tutto Giovedì`