Particle Accelerator

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Definition

"A particle accelerator is a device that uses electromagnetic fields to propel charged particles to high speeds and to contain them in well-defined beams."

- They built for different purpose such as
  - Discovery science,
  - Medicine,
  - Industry and
  - Security

Basic Principle

All accelerators are based on the same principle. A charged particle accelerates between a gap between two electrodes when there is a potential difference between them.

CERN

The name **CERN** is derived from the **acronym** for the French Conseil Européen pour la Recherche Nucléaire,
"European Council for Nuclear Research"
A provisional body founded in 1952 with the mandate of establishing a world-class fundamental physics research organization in Europe.

- It is one of the world's largest and most respected centers for scientific research.
- It is situated just outside of Geneva on the border between Switzerland and France.

Types of accelerators

➢ Particle accelerators can be split into two fundamental types:

I- Electrostatic accelerators

II- Oscillating field accelerators.

I- Electrostatic accelerators use electrostatic fields; simply electric fields that do not change with time.

- The main disadvantage of using electrostatic fields is that very large electric fields need to be generated to accelerate particles to experimentally useful energies.

Examples:

Van de Graaff accelerator

Cockcroft-Walton accelerator

II- The Oscillating Field accelerators require electric fields that periodically change with time.

- It accelerate particles to extremely high energies.

Examples:

- Linear Accelerator (Linac)
- Cyclotron
- Synchrocyclotron
- Betatron

Why we use particle accelerators?

i) They enable similarly charged particles to get close to each other.

e.g. *Rutherford blasted alpha particles at a thin piece of gold foil, in order to get the positively charged alpha particle near to the nucleus of a gold atom, high energies were needed to overcome the electrostatic force of repulsion.*

ii) The more energy given to particles, the shorter their de Broglie wavelength ($E = hc/\lambda$), therefore the greater the detail that can be investigated using them as a probe.

e.g. *at the Stanford Linear Accelerator, electrons were accelerated to high energies and smashed into protons and neutrons revealing charge concentrated at three points – quarks.*

iii) Colliding particles together, the energy is re-distributed producing new particles. The higher the collision energy the larger the mass of the particles that can be produced.

$$E = mc^2$$