

# ACCELERATORS

## Introduction

Particle accelerators are used to study matter and energy. They accelerate charged particles through an electric field in an evacuated tube. The particles collide into a target or another particle. The collision point is in a detector, which records how the particles collide.

All accelerators use a strong magnetic field to move particles. They all have the same three main parts:

- A source of particles or ions
- A tube pumped to a vacuum
- A way of speeding up the particles.

The three main types are:

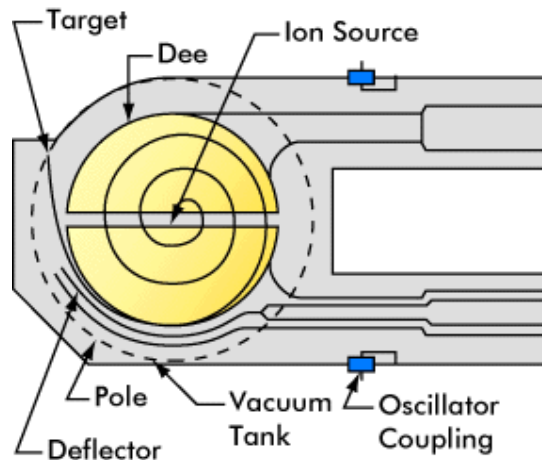
- cyclotron (spiral)
- synchrotron (circular)
- linear (linac)

## Cyclotron

A cyclotron is a resonance accelerator. It has two large dipole magnets which produce a semi-circular region of magnetic field.

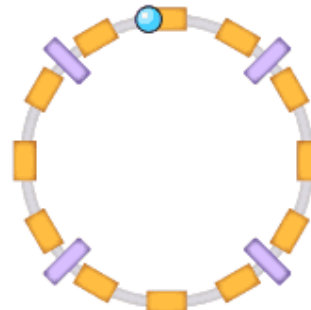
An oscillating voltage is applied to produce an electric field across the gap between the 2 semicircles. Particles are injected into the magnetic field region. They go in a semicircular path until they reach the gap. Then the electric field in the gap accelerates the particles.

The particles have higher energy so follow a semicircular path with larger radius. The electric field frequency must be just right to accelerate the particles.



## Synchrotron

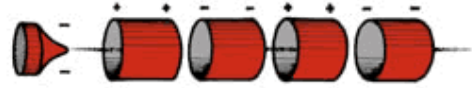
A synchrotron is a circular accelerator which has 'electromagnetic resonant cavities' placed at regular intervals around a ring to accelerate the particles. Particles pass through each cavity many times as they circulate around the ring. Each time they are accelerated a bit. The



radius of the particles gets bigger as the particles get more energy. A magnetic field is used so the particles can stay in the same ring. This is why it is called a synchrotron. Particles are often pre-accelerated before entering the ring using a small linear accelerator.

### **Linac**

A linear accelerator (linac) is a resonance accelerator. It uses alternating voltages to push particles along in a straight line. Particles pass



through a line of metal tubes in a vacuum. The voltage is timed so that a particle is pushed forward each time it goes through a gap between two of the metal tubes.

### **Storage Rings and Colliders**

A storage ring is the same thing as a synchrotron, except that it is designed just to keep the particles circulating at a constant energy for as long as possible, not to increase their energy any further. Colliders are used to collide the particles. They often travel in opposite directions or into a stationary target.