

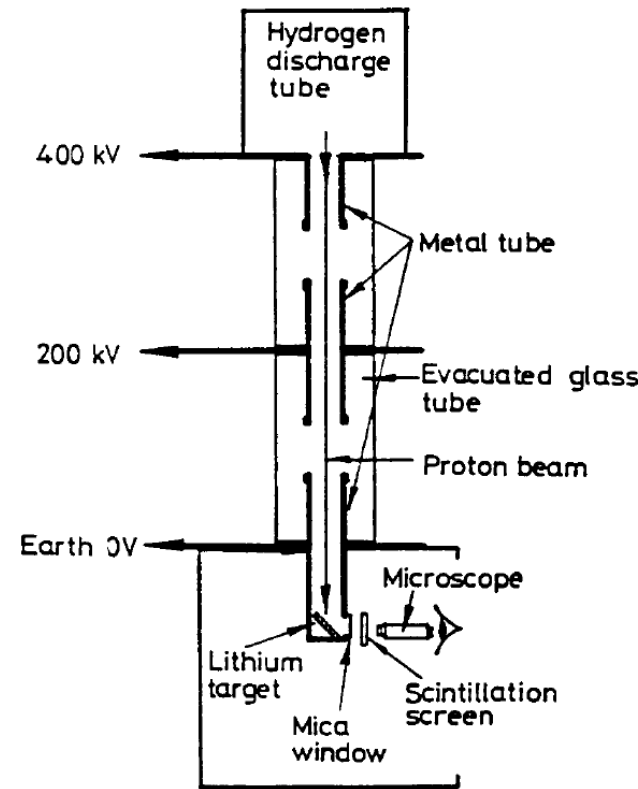
History of accelerators

2018.4.20

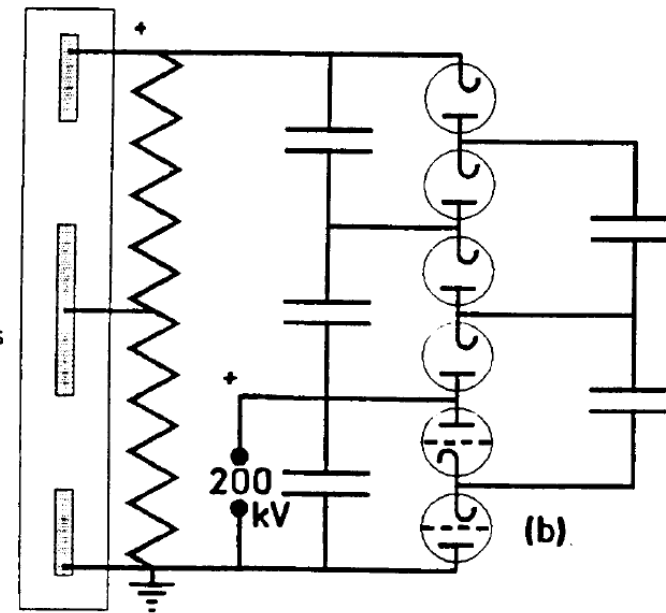
Kong Lingteng

- In 1928, Gurney and Gamov independently predicted tunnelling and it appeared that an energy of 500 keV might just suffice to split the atom, before that time, it is believed that we need a source of many MeV to split the atom.

Cockcroft & Walton created this accelerator based on tunneling theory, it accelerate particles using the electric potential difference.



(a) Accelerating column

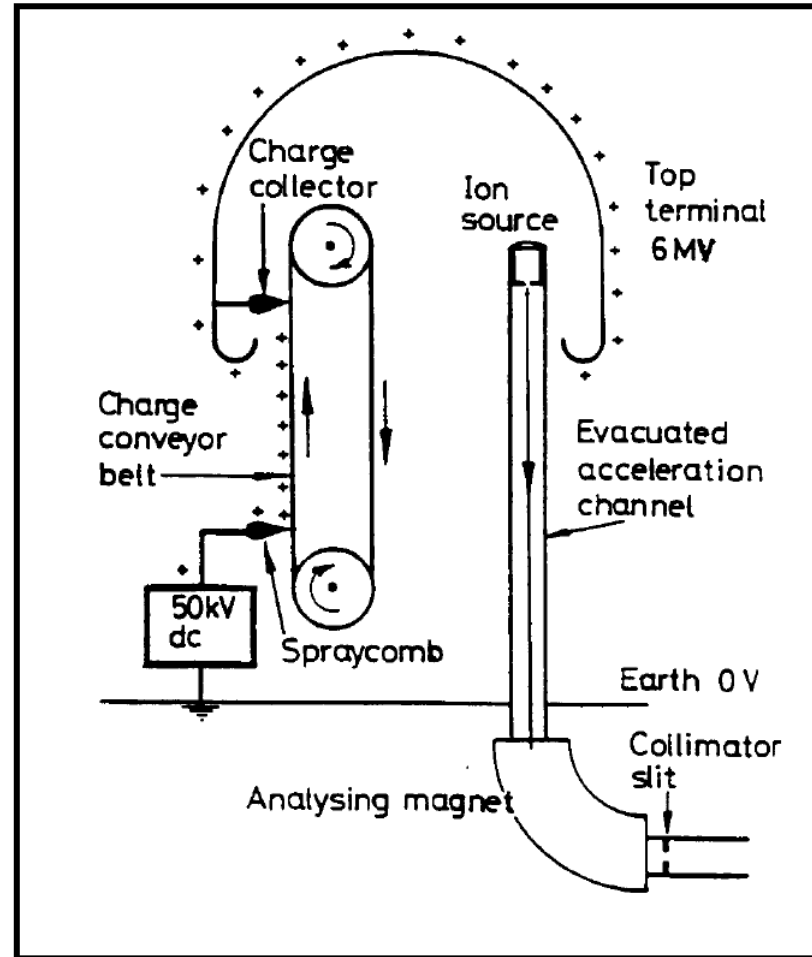


Voltage generator

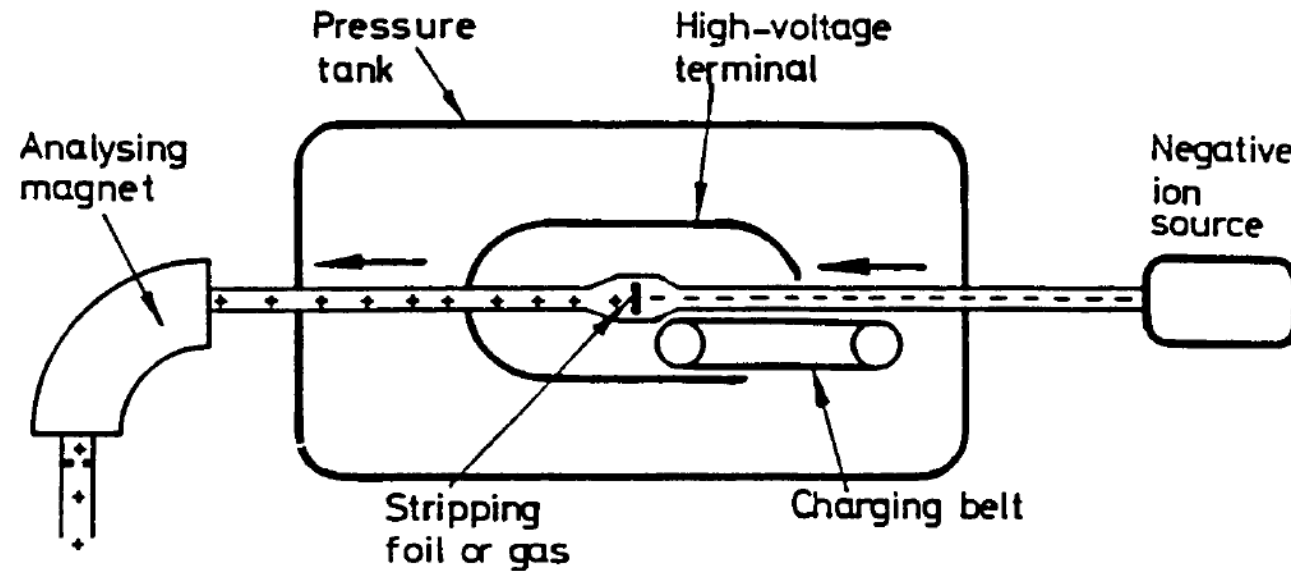
(b) DC generator

- In 1929, Van de Graaff designed a kind of electrostatic generator which reached a potential of 1.5 MV

It uses a moving belt to accumulate electric charge on a metal globe on the top of an insulated column

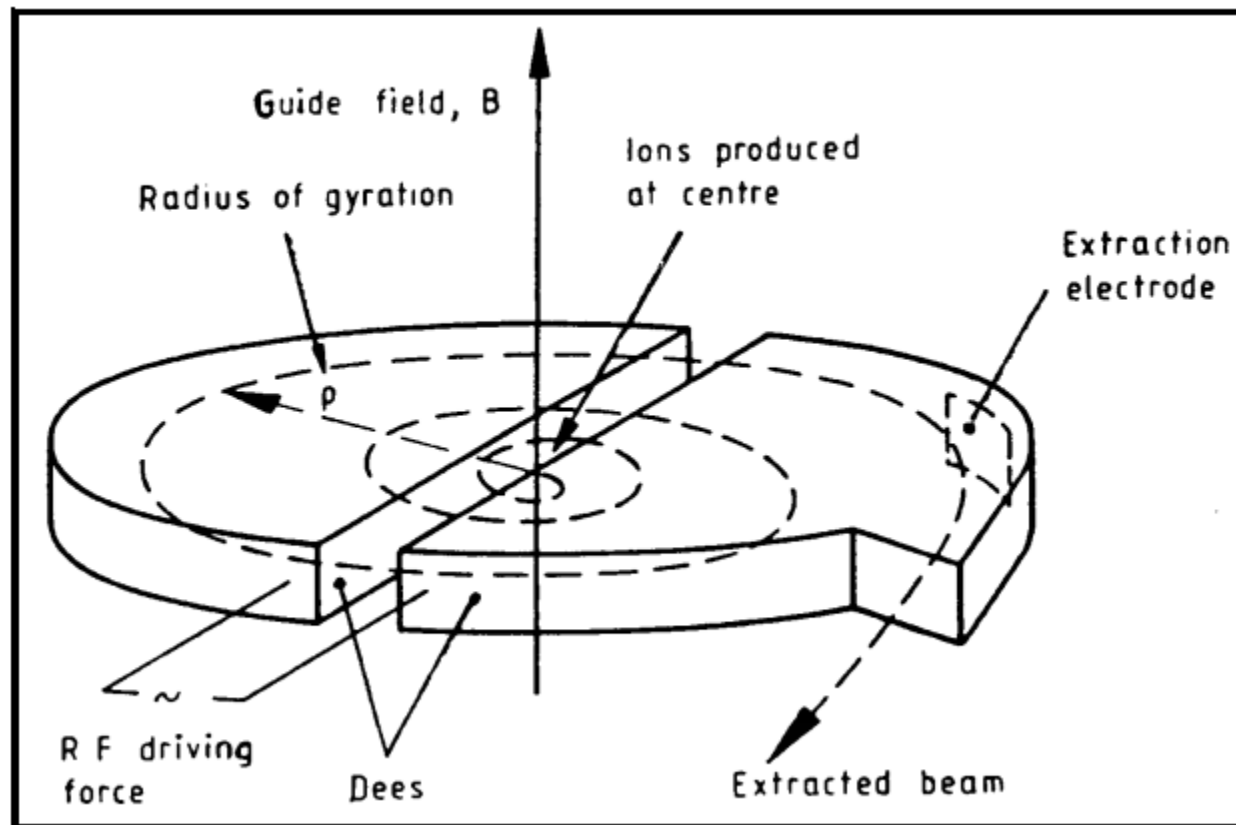


- The improved version of Van de Graaff generator is Tandem accelerator, which can reach 10 MV.

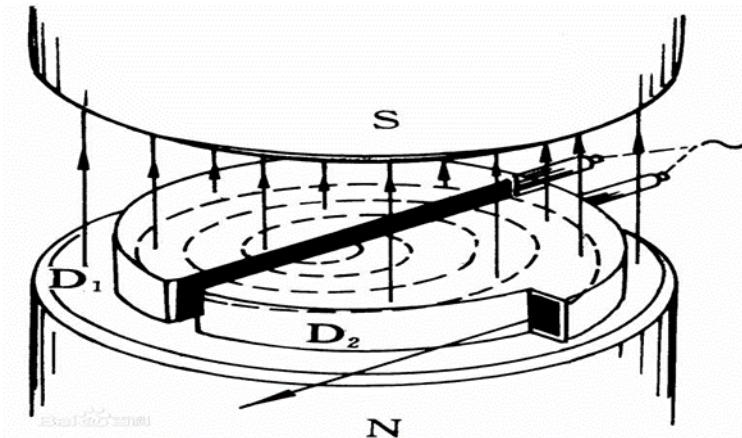
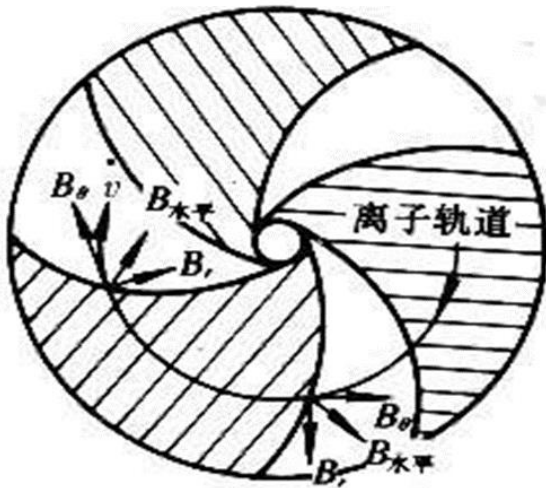


The thin foil strips electrons from negative particles which pass through and turn them into positive particles.

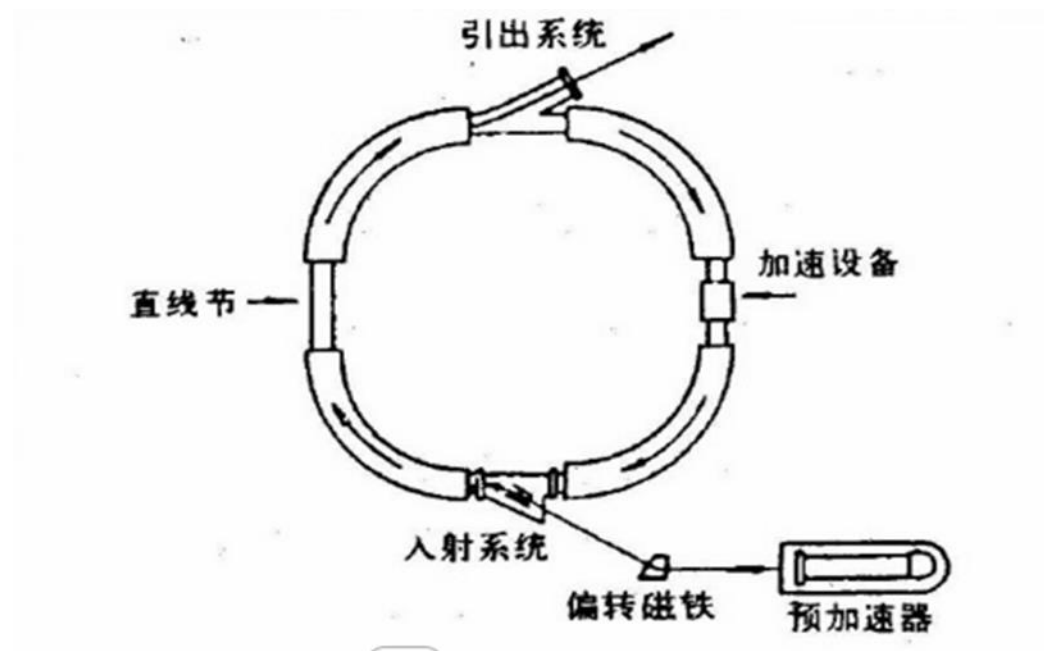
- In 1924, Ising planned to repeatedly apply the same voltage to the particle using alternating fields. Under this principle, we have schematic cyclotron



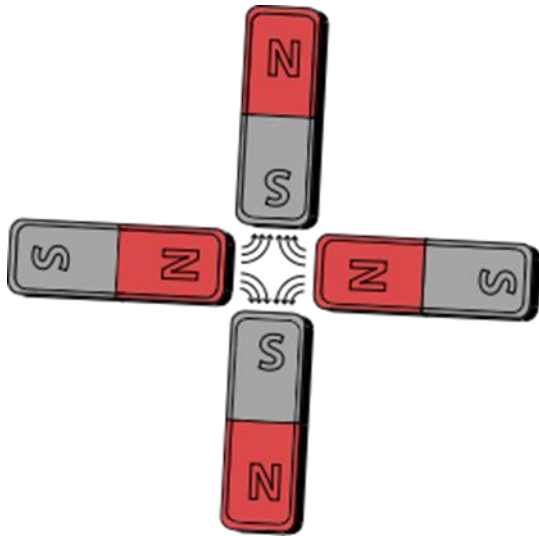
- However, because of the relativistic effect, the particle motion cycle will change with the increase of particle velocity.
- Two ways to solve this problem:
 1. Use changeable magnetic field to offset the relativistic effect.
 2. Use changeable electric field to offset the relativistic effect.



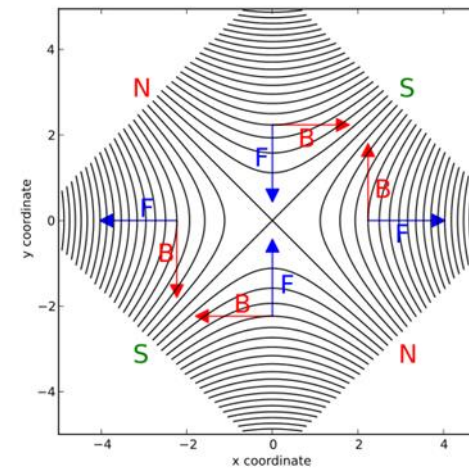
- Theoretically, we can accelerate the particle to infinity, but if we want to get very fast particles, we need very large magnet.
- To solve this problem, synchrotron was created.



- Like electric charges repel, how can we maintain the particle beam?
- Strong focusing principle. We use Quadrupole magnets to maintain the beam.



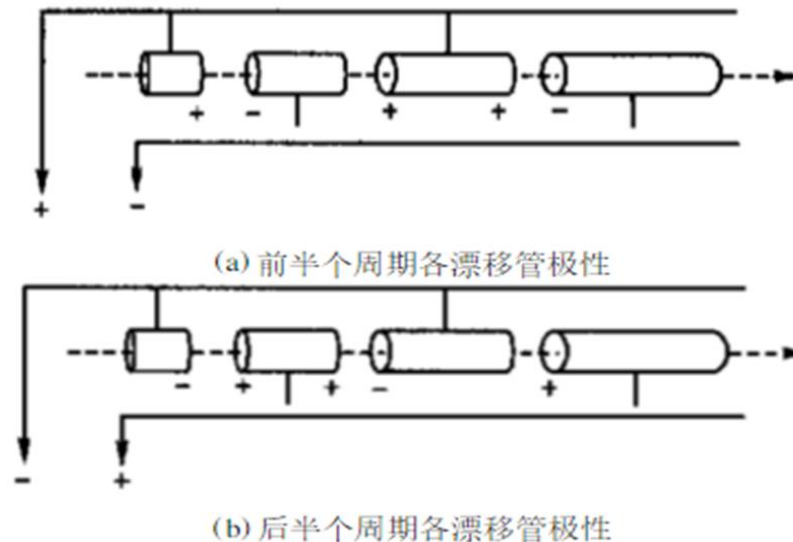
Quadrupole magnets



The forces of particles in the field of Quadrupole magnets

- At present, synchrotron radiation is the main problem of accelerator.
- Future accelerator:
 1. Muon accelerator. Muon is heavier than electron so it has less synchrotron radiation, and it's not as heavy as proton, so we don't need very large acceleration ring. However, its lifetime is too short, but if we can accelerate it to a very high speed, it will exist longer due to the relativistic effect.

2. Linear Collider.



Particles are accelerated between the tubes, the direction of electric field will change after particles pass the tube.

THANKS