Particles Accelerators

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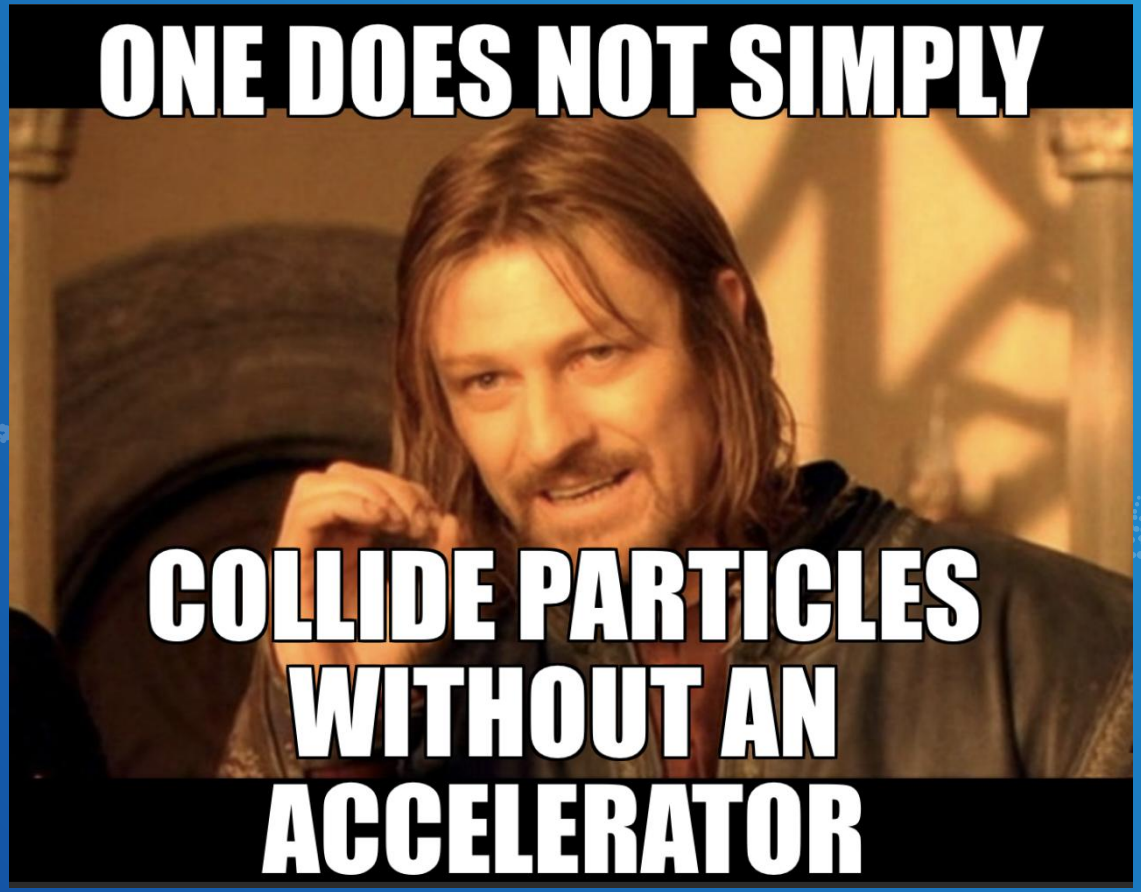
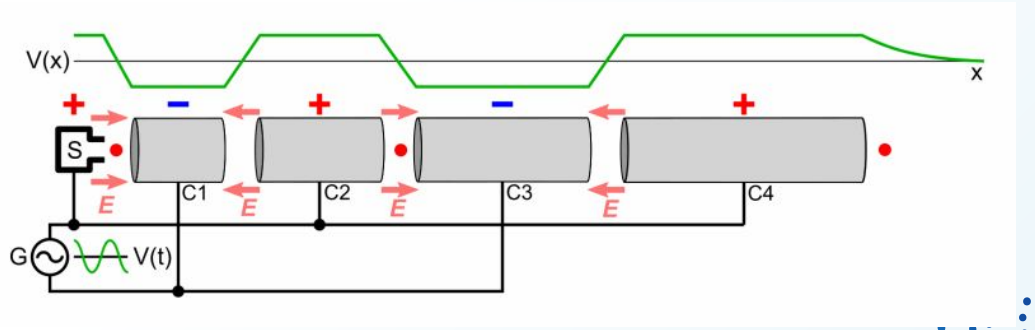

ONE DOES NOT SIMPLY
COLLIDE PARTICLES WITHOUT AN ACCELERATOR

What we want our students to know

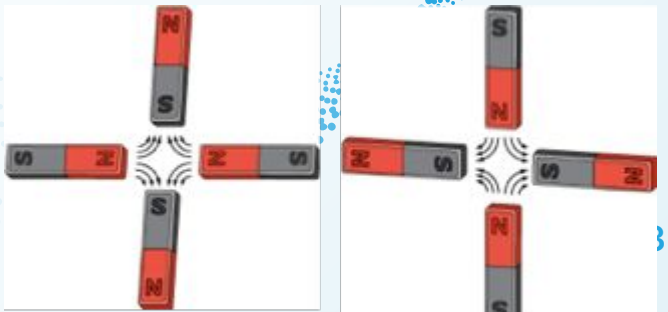
-Accelerators

Generate high speed beams of “particles” using electric fields, bending and focusing them using magnetic fields.



Used to answer fundamental questions about nature.

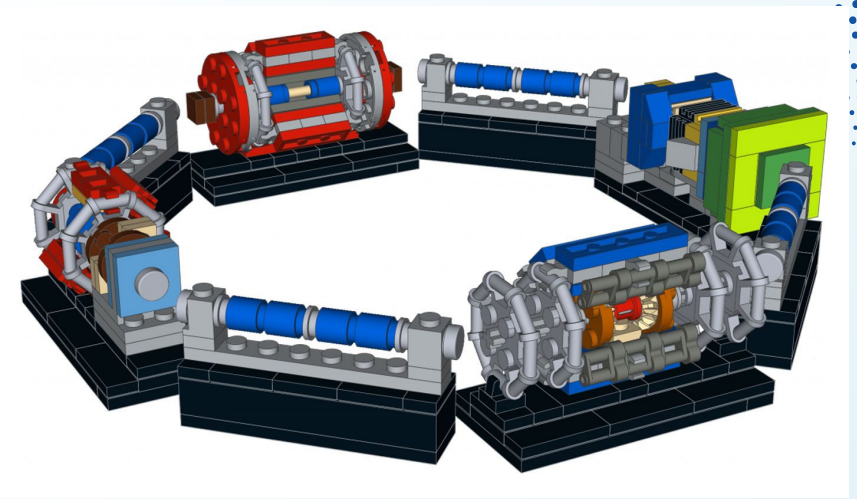
Can be applied to medical applications.



So you want to build a particle accelerator...

Materials

- Particle source (e.g. electron, protons, lead nuclei)
- Vacuum chamber
- Radio Frequency Cavity
- Magnets to bend or focus

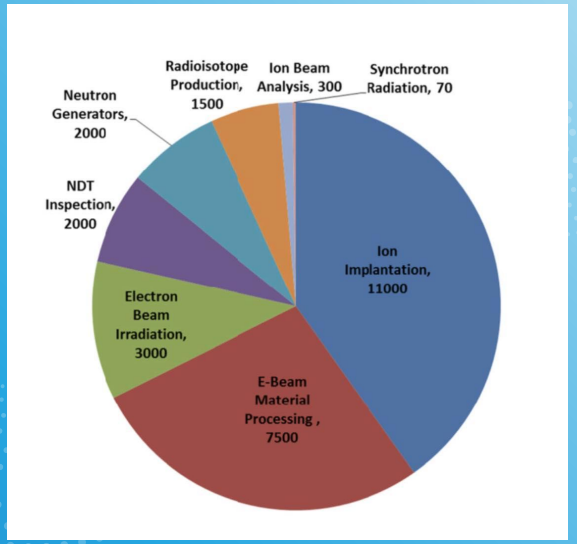


Student misconceptions

- Accelerators only speed up electrons
- Accelerate particles one by one
- Electric field used is static
- You can make a black hole with an accelerator
- This has nothing to do with my life

Your life is full of accelerators

Isabel Alonso



Pedagogical approaches

Adding Context:

Why are they important

Medical Applications - Based

1. RADIOTHERAPY
   a. External Beam radiotherapy

   b. Stereotactic radiosurgery

2. PROTON THERAPY

3. HEAVY ION THERAPY

Heavy-ion Therapy System HyBEAT *2

Based RADIOTHERAPY

A.- EXTERNAL BEAM RADIOTHERAPY

- Utilizes external radiation beams
- Effective for treating various types of cancers
- Precise targeting of tumors while minimizing damage to surrounding tissues

B.- STEREOTACTIC RADIOSURGERY

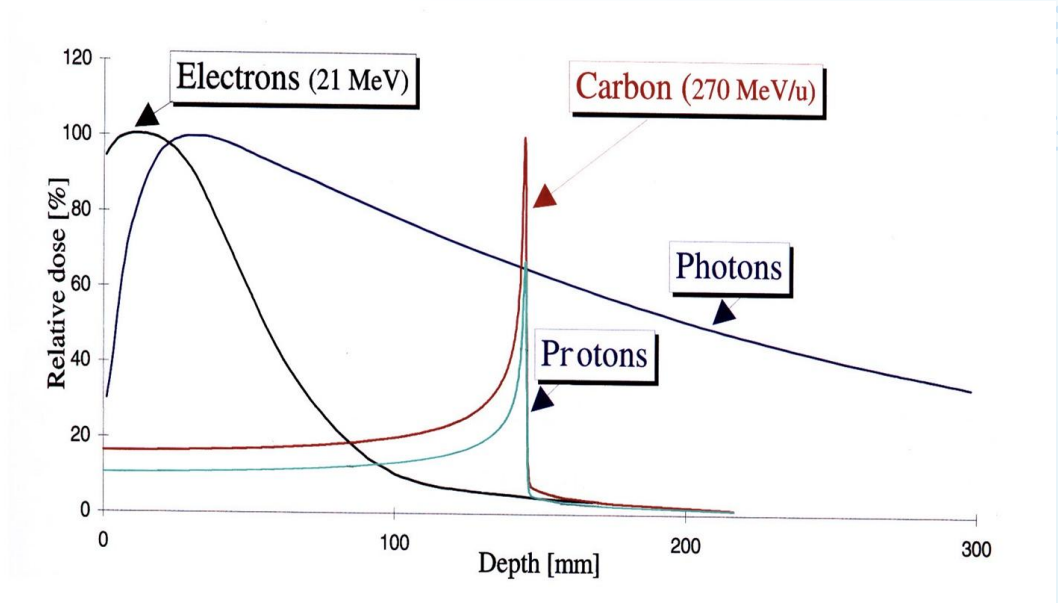
-Non-invasive treatment option

-Delivers high doses of radiation to small, well-defined tumors.

- Commonly used for brain tumors and other localized lesions.

Based Proton Therapy

- Uses protons instead of conventional X-rays
- Precise and targeted treatment with minimal impact on healthy tissues
- Effective for tumors near critical structures and in pediatric cases

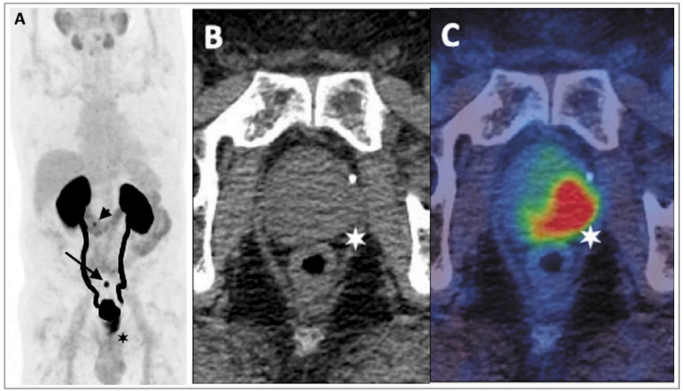


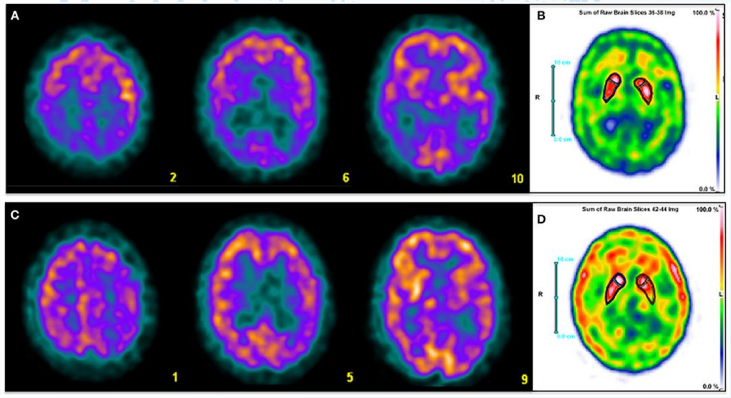
Based Heavy Ion Therapy

- Utilizes heavy Ions like Carbon or Helium
- Enhanced precision and effectiveness in treating resistant tumors
- Particularly beneficial for deep-seated tumors and radioresistant cancers

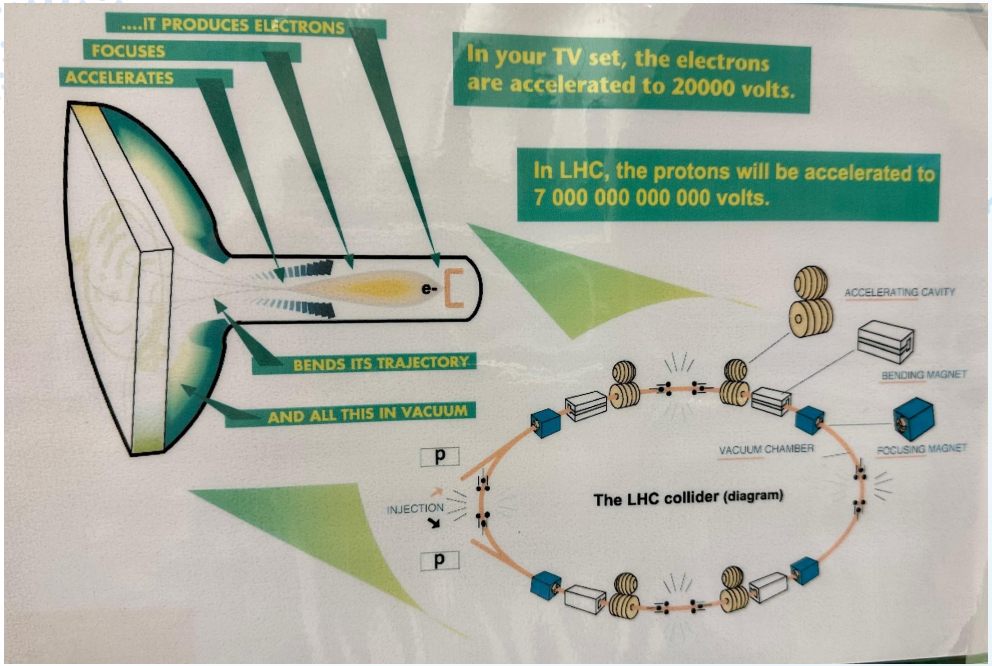
Medical Imaging with Particle Accelerators

- Positron Emission Tomography (PET) *1
- Single Photon Emission Computed Tomography (SPECT) *2
- Advantages of PET, SPECT with particle accelerators: Offers valuable diagnostic tool with improved sensitivity, resolution and qualification capabilities

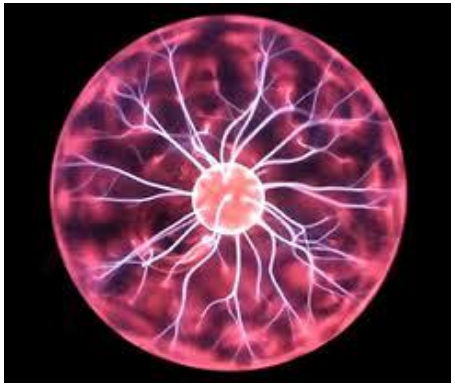


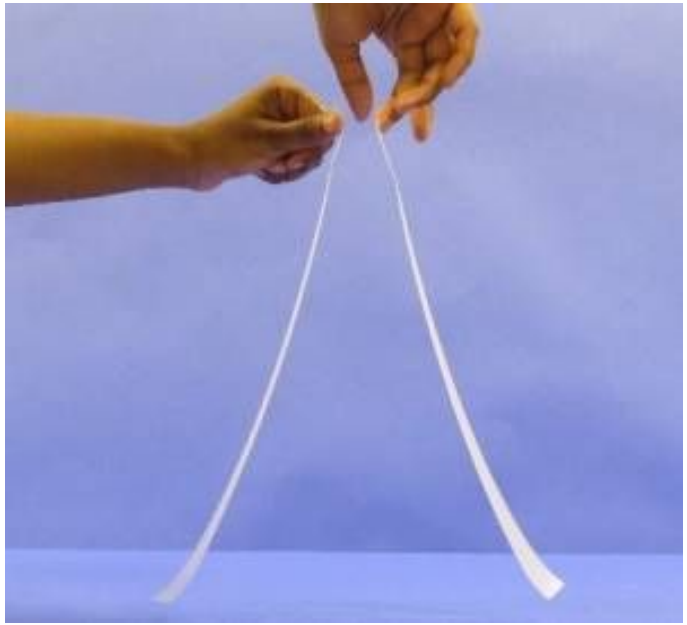


Pedagogical approaches to understanding the steps need to accelerate particles

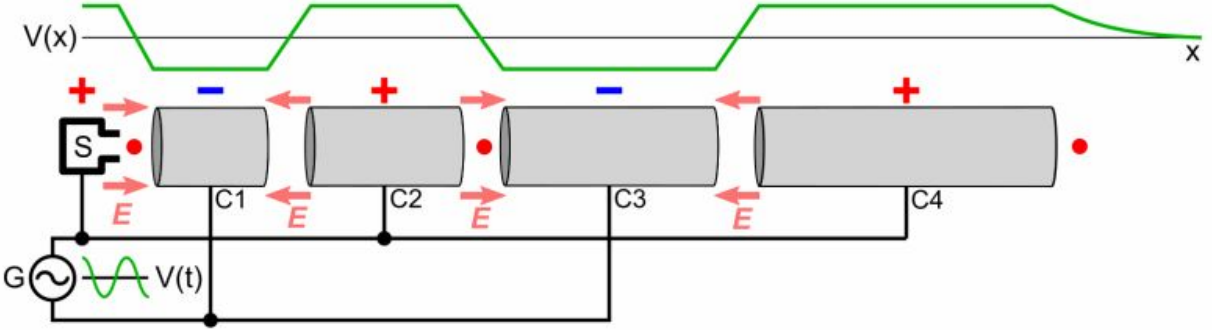


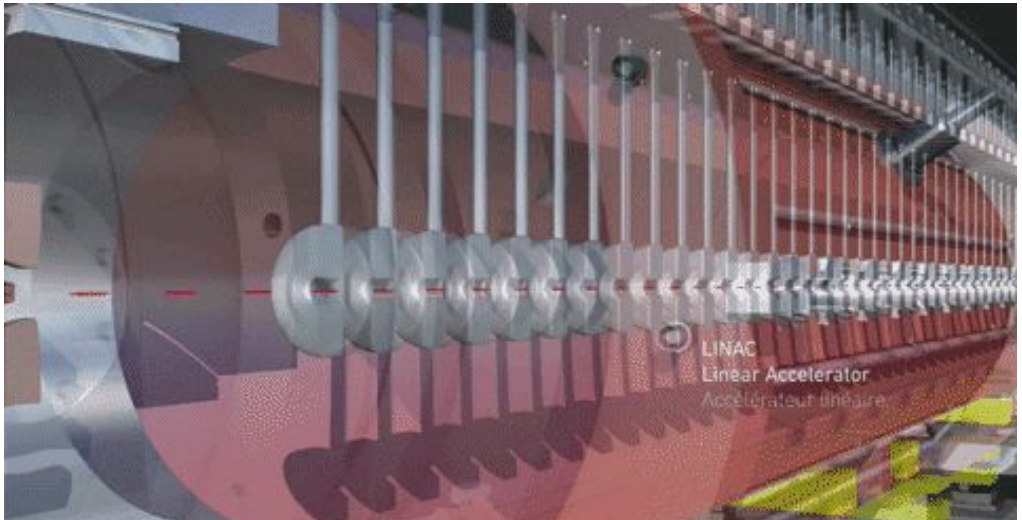
Step 1 -Generate particles





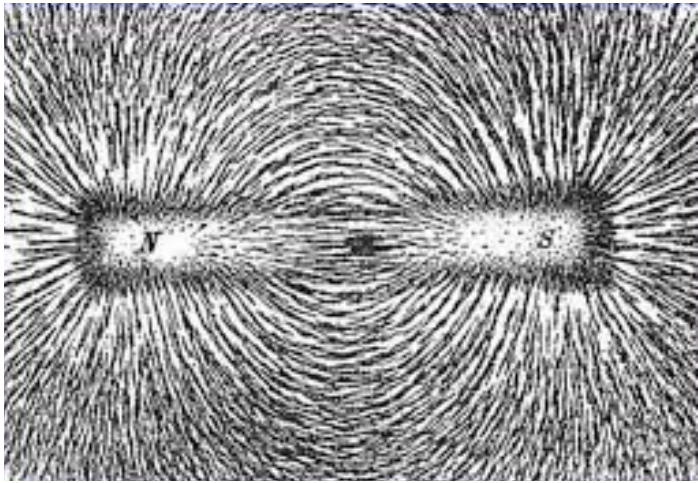
Step 2: Accelerating charged particles in Radio frequency cavities

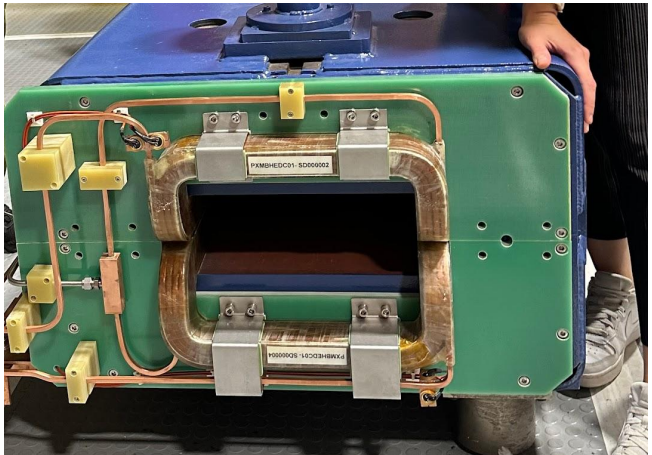




Visualizing Magnetic fields

Most high students are familiar with visualizing magnetic field lines using a bar magnet and iron filings





Step 3: Beams of charged particles bent with magnets

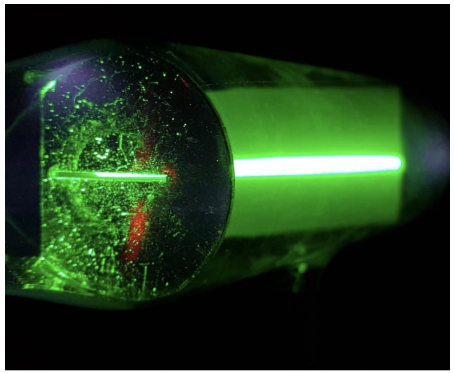
Students can observe that the path of ***charged*** particles can be changed in a magnetic field

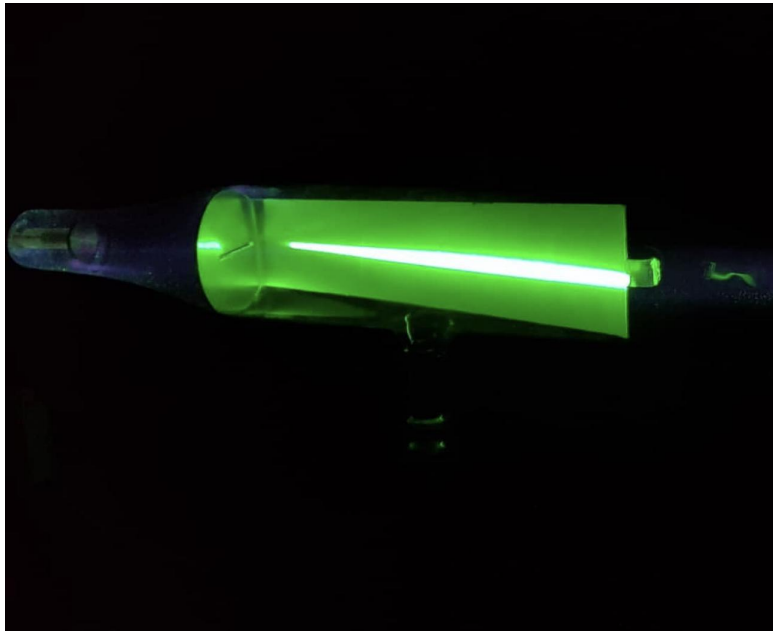
Older CRTs produced images by firing electron guns (red, blue, and green) through the television body onto the back of the screen.

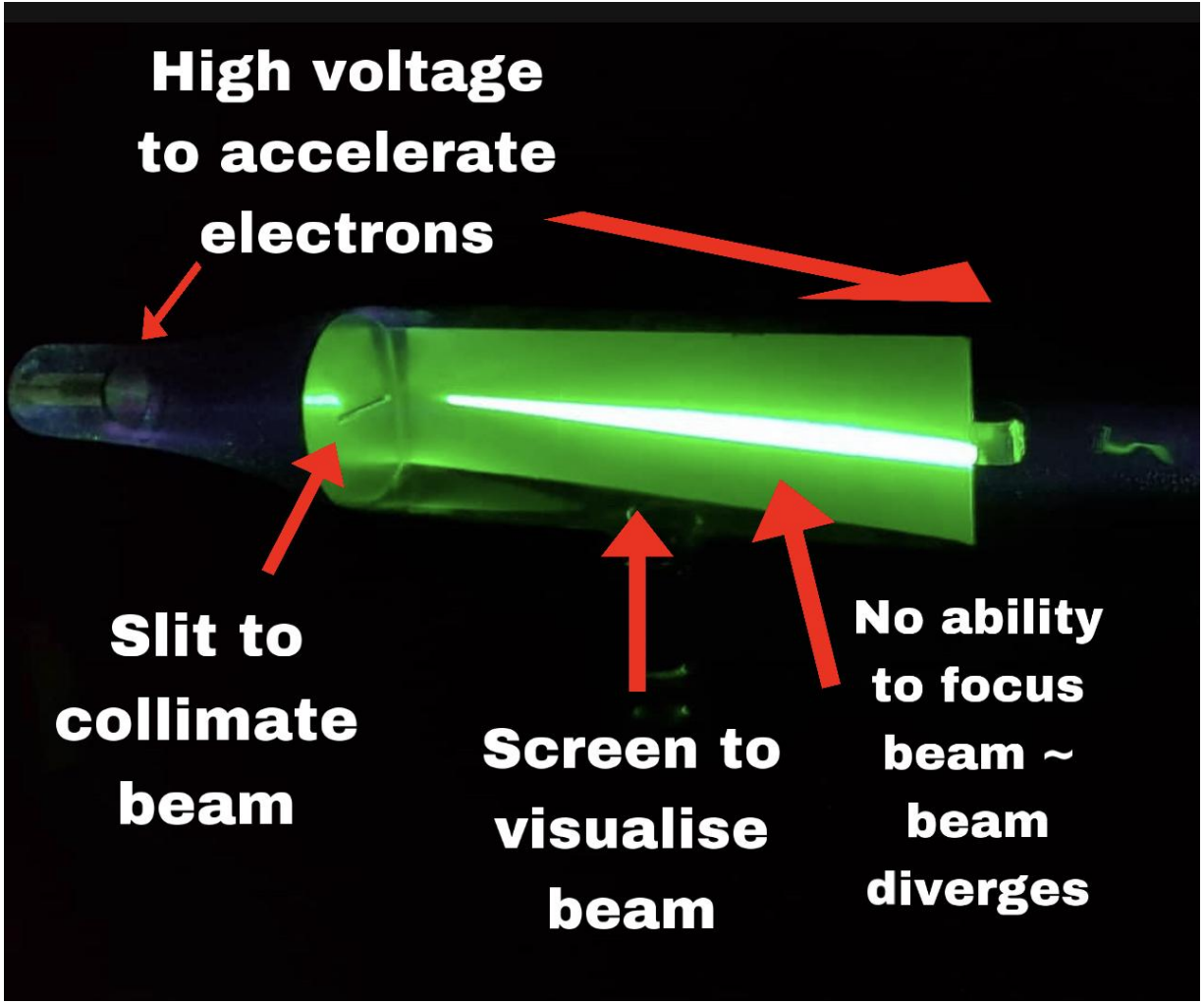
Can use a Cathode Ray Tube as a live demo

A Cathode Ray Tube is a particle accelerator.

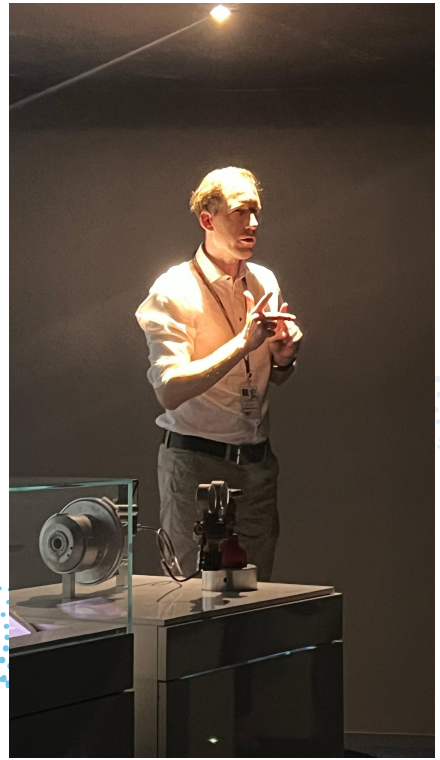
It uses a high voltage power supply to accelerate particles ~ electrons

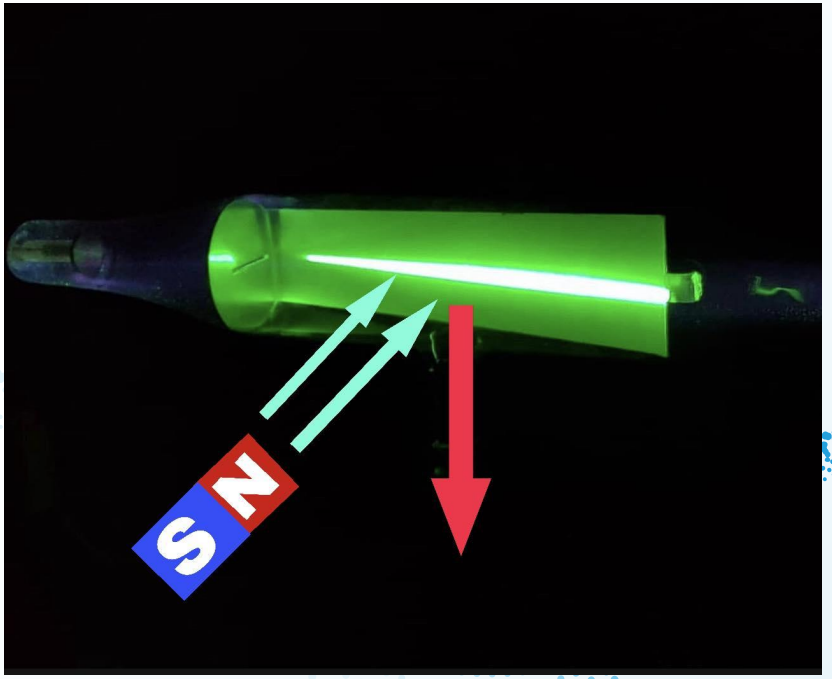




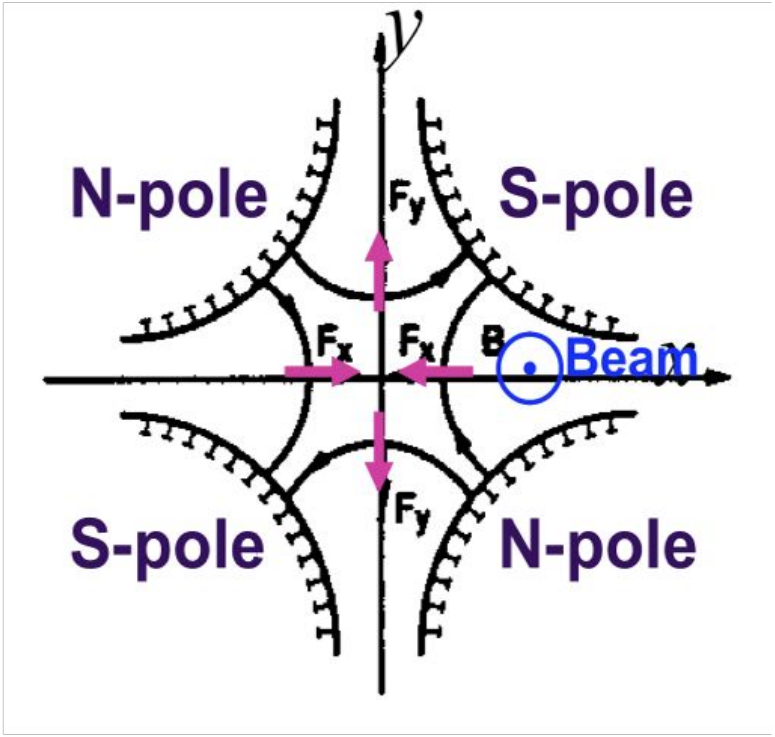

High voltage to accelerate electrons
Slit to collimate beam
Screen to visualise beam
No ability to focus beam ~ beam diverges

The Right Hand Rule - Lorentz Force





Step 4: Magnet lattice focuses beam



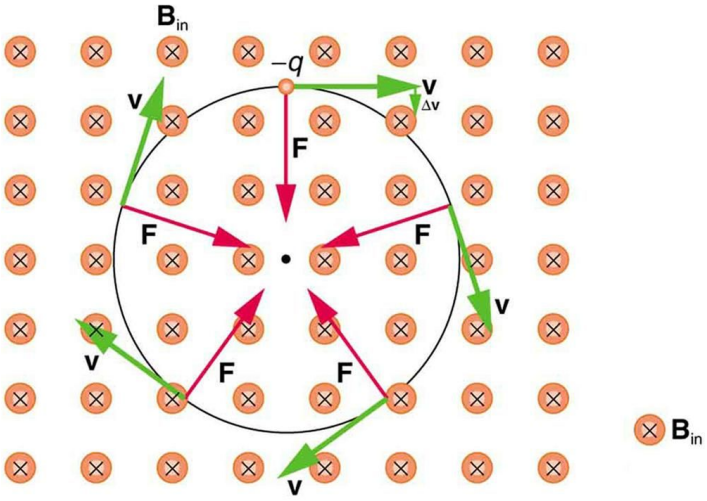
Pedagogical approaches

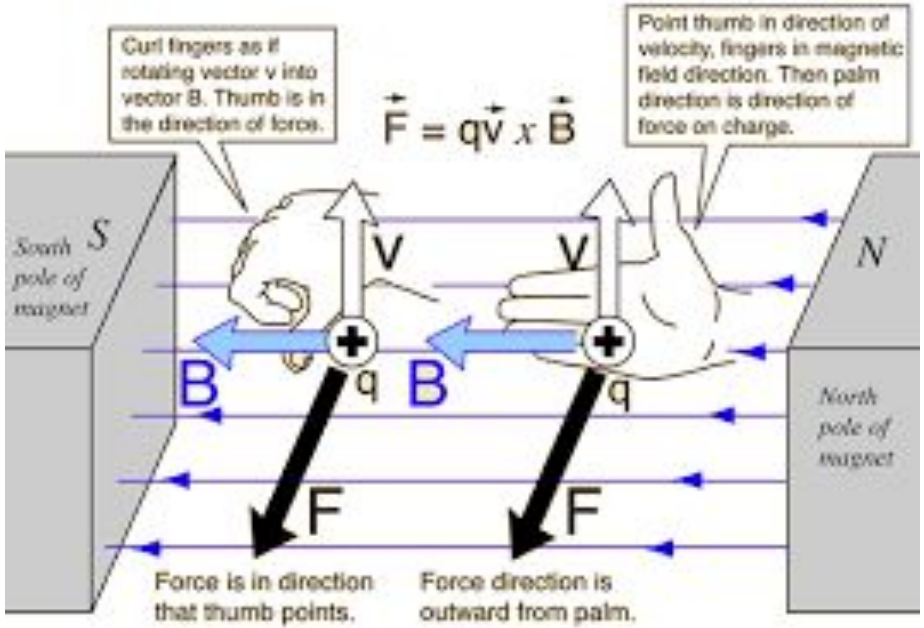
Support their understanding with mathematical representations

Mathematics that would help our students (If we must)

Lorentz force acts as a centripetal force:

$$qvB=\frac{mv^2}{r}$$





Pedagogical approaches

Kinesthetic learning


"O Omnipresent, the embodiment of all virtues, the creator of this cosmic universe,
the king of dancers, who dances the Ananda Tandava in the twilight, I salute thee."
Presented by: The Department of Atomic Energy, Government of India.

Thanks for listening

Resources

https://www.youtube.com/watch?v=pQhbhpU9Wrg

https://onlinestores.factoryoutlets2023.com/category?name=plasma%20ball%20gif

https://www.facebook.com/actitoutlessons/

http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elefie.html

Introduction to particle accelerators S. Gilardoni SY/STI, simone.gilardoni@cern.ch

pictures from physics website. We are so sorry

Pictures (slides from 8 to 12): https://drive.google.com/file/d/1ve1EJ5I5yO-C8ej38EArDR5hduiBoBaW/view?usp=drive_link ;https://drive.google.com/file/d/1vbgiJpOg7Peglp20LcphHGML9g-3xqTQ/view?usp=drive_link; https://drive.google.com/file/d/1vbb_bP25pCp-Ng5qXZqDJtY-Ihlr06tR/view?usp=drive_link; https://drive.google.com/file/d/1vVhJTIohWQMvLJiX3LGOKjR0ZWvdGE8f/view?usp=drive_link; https://drive.google.com/file/d/1vNwrjCcmKSucTRg9mjd0dAOizAbie8c2/view?usp=drive_link

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