

Particle Accelerators Group 1



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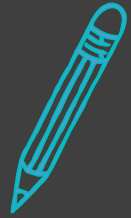


Omid Shamsara



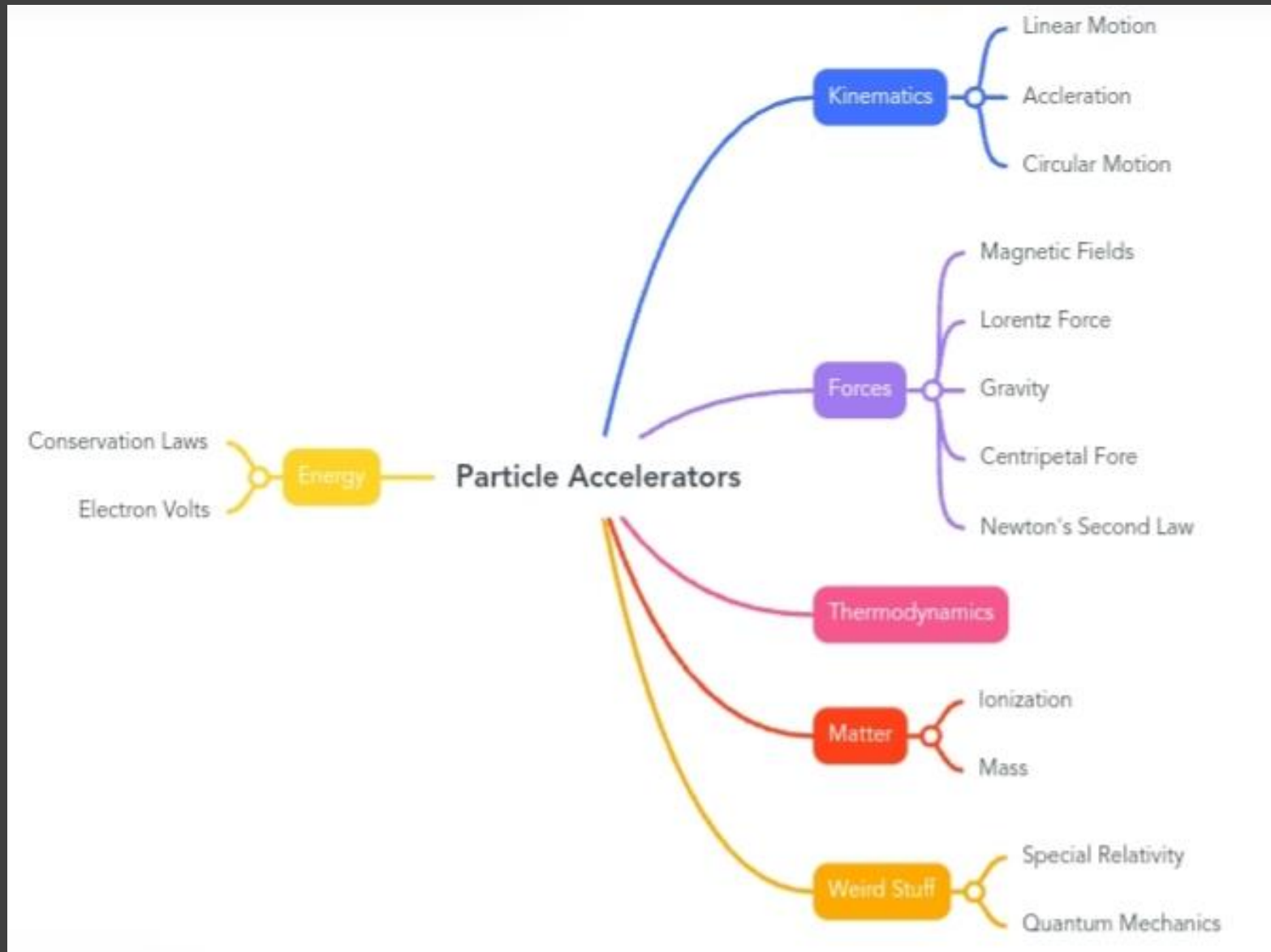
Curriculums

- NGSS
- AP
- IB
- ANAS



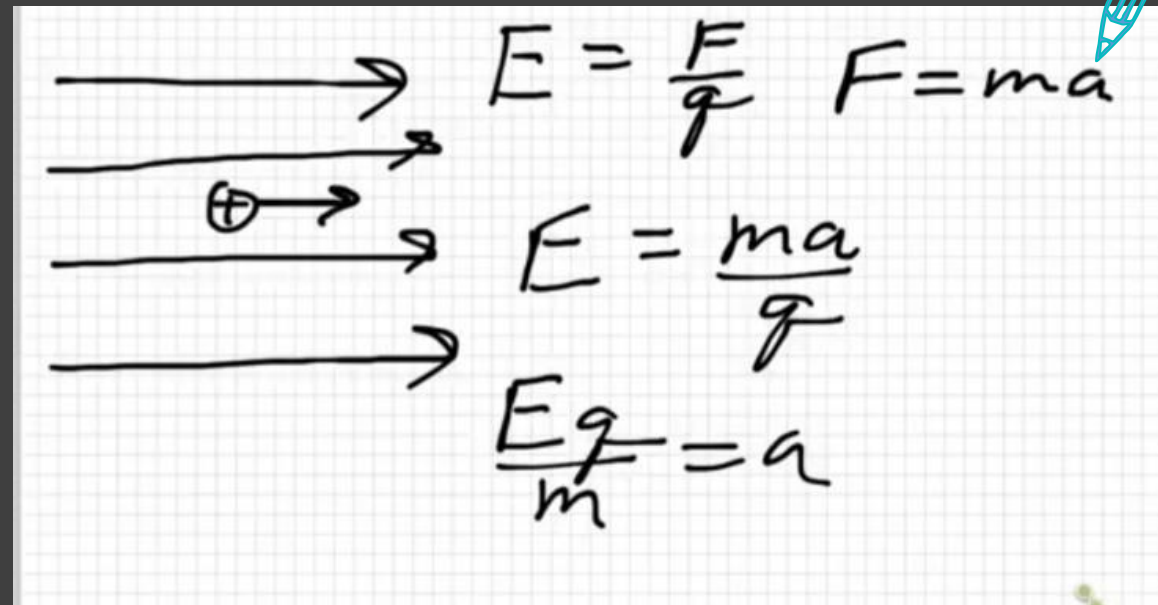
None of these curricula explicitly mention particle physics or particle accelerators

Classroom Connections

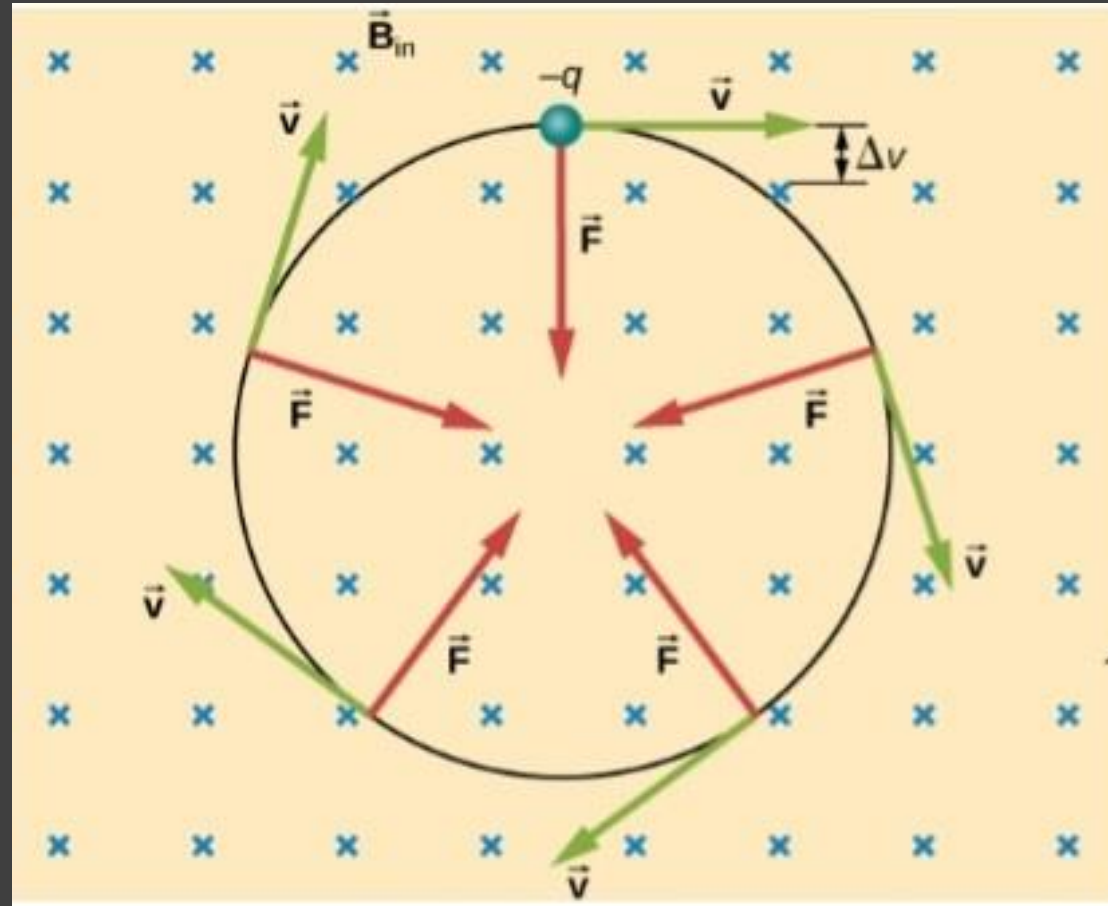


Key Ideas

- Ionization of an atom enables the acceleration of the ion
- Electric fields cause the acceleration of the ion


$$E = \frac{F}{q} \quad F = ma$$
$$E = \frac{ma}{q}$$
$$\frac{Eq}{m} = a$$

- Magnetic fields cause the circular motion of the ion



Pedagogical point of views:

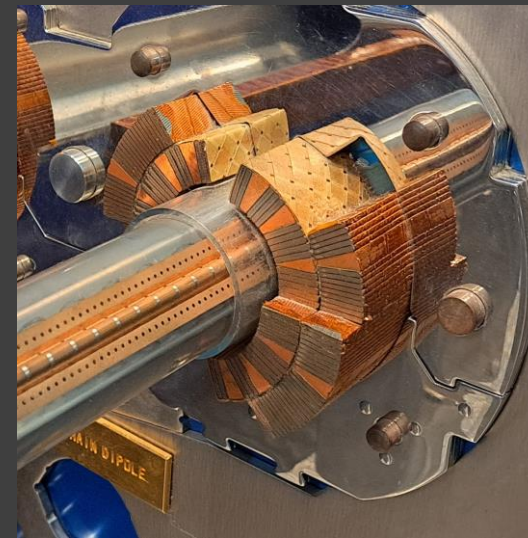
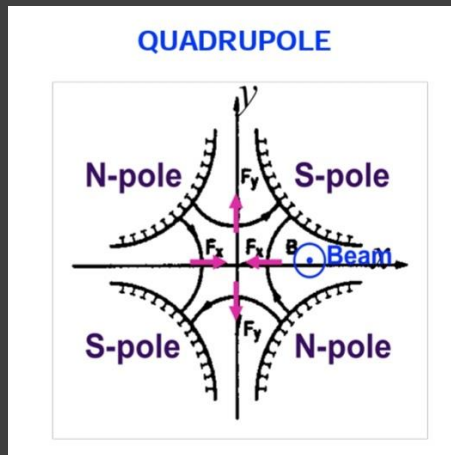
- Scale of mass and energy units
- Introduce particle physics while teaching these topics

Bonus topics for advanced classes



Bonus Topics

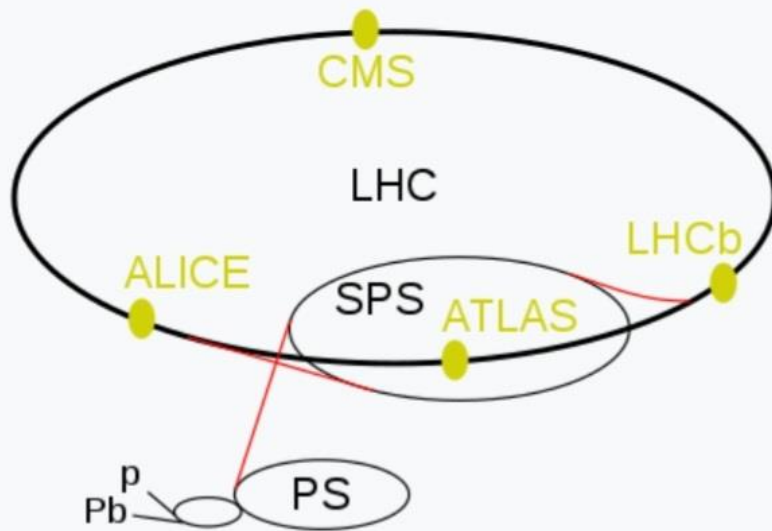
- RF acceleration



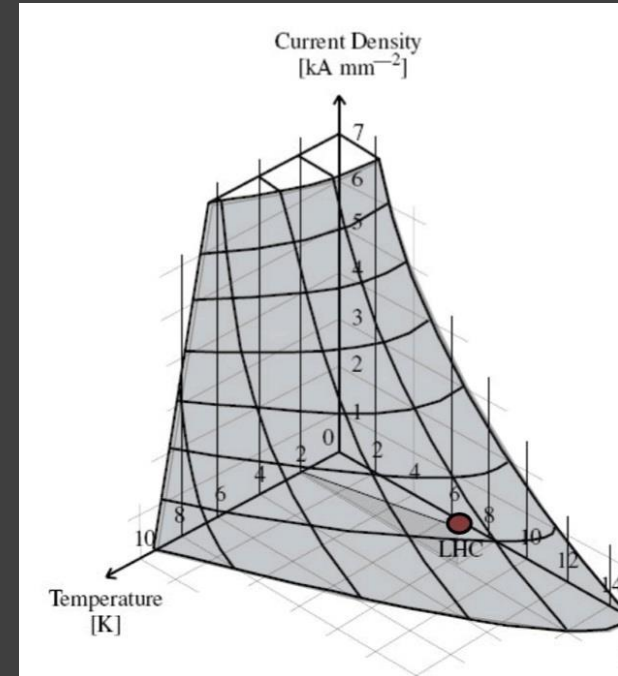
- Quadrupole field
(with optional reference of gravity)

- Superconductivity
- Series of accelerators

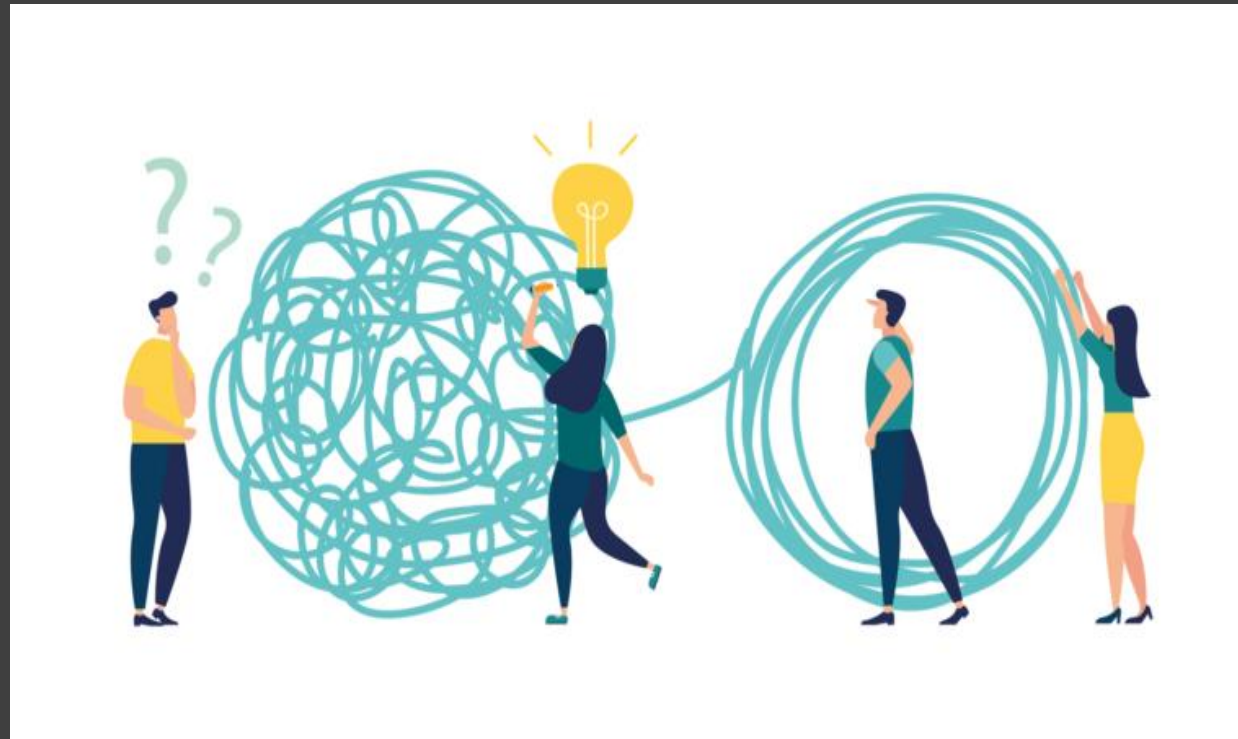
Large Hadron Collider (LHC)



Layout of the LHC complex

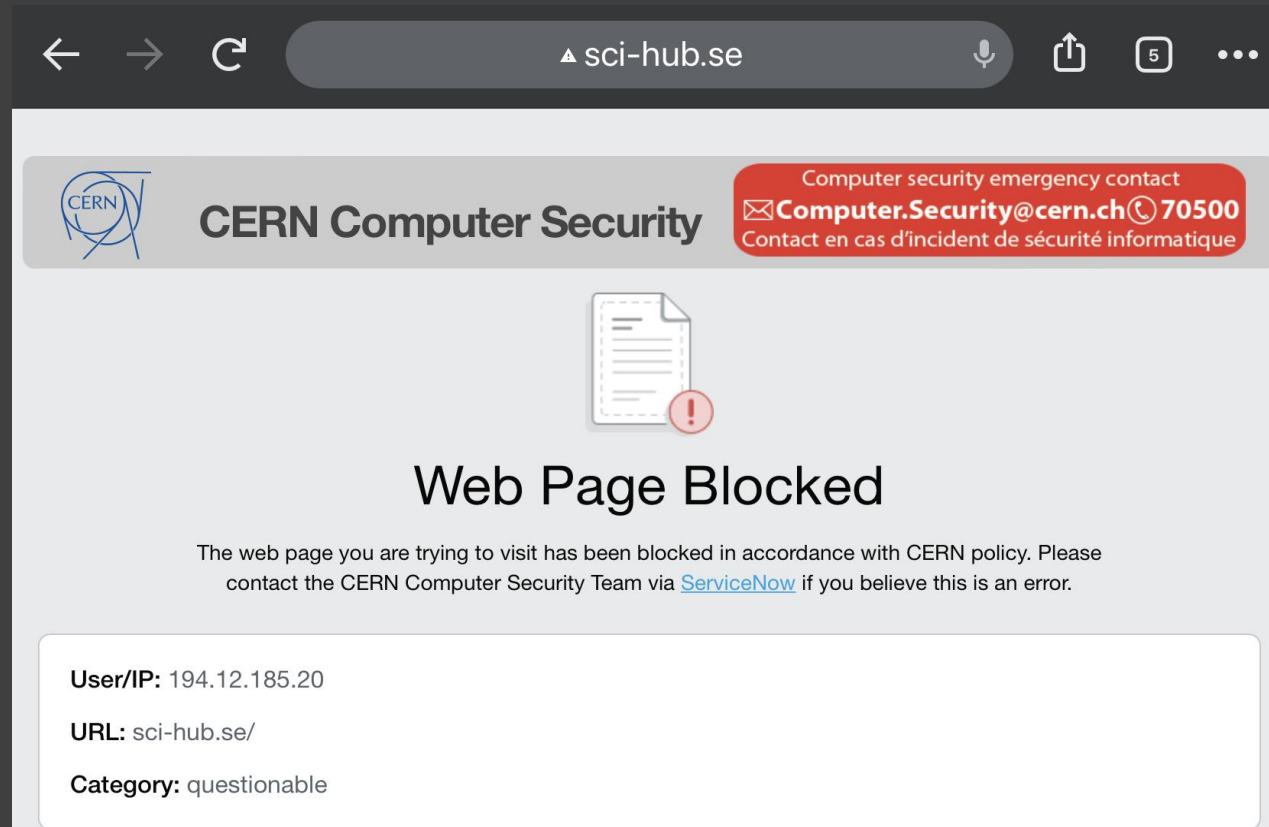


Potential students' misconceptions and challenges when introducing particle accelerators



Picture from <https://www.searchenginejournal.com/blogging-challenges/321109/>

The following misconceptions and challenges are listed based on observations and experience because...

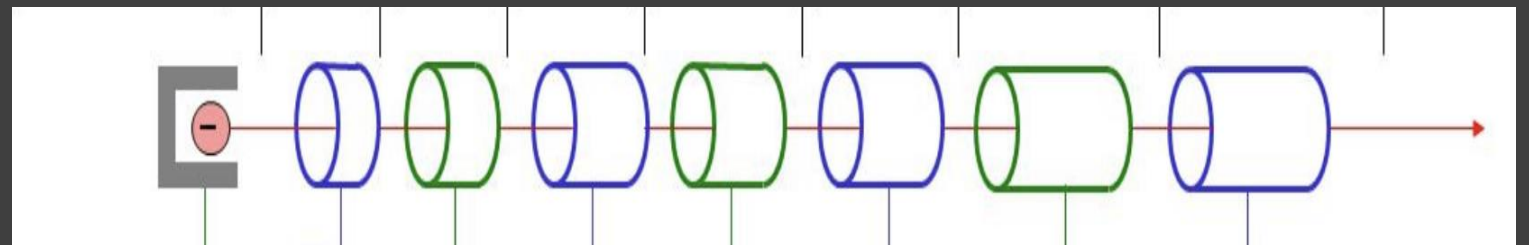
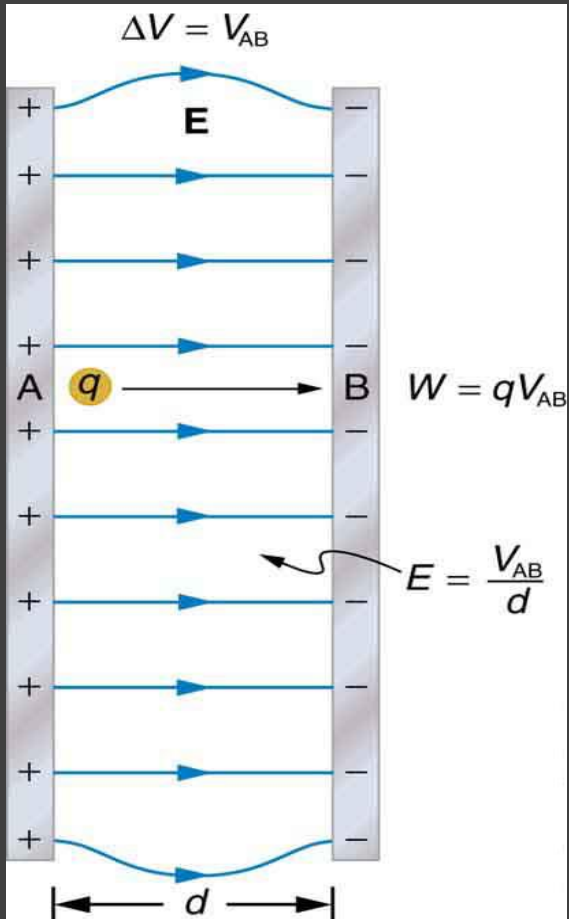


Challenges

1. Students' misconceptions about technical/physical principles of particle accelerators
2. Not knowing the aims from building particle accelerators

1. Misconceptions about technical/physical principles

a. How can you continuously accelerate a particle???



Figures are from

<http://pressbooks-dev.oer.hawaii.edu/collegephysics/chapter/19-2-electric-potential-in-a-uniform-electric-field/>

<https://slideplayer.com/slide/5682354/18/images/7/Linear+accelerator+%28LINAC%29.jpg>

A possible solution

Use visual materials(ex: animation) to demonstrate how it happens.

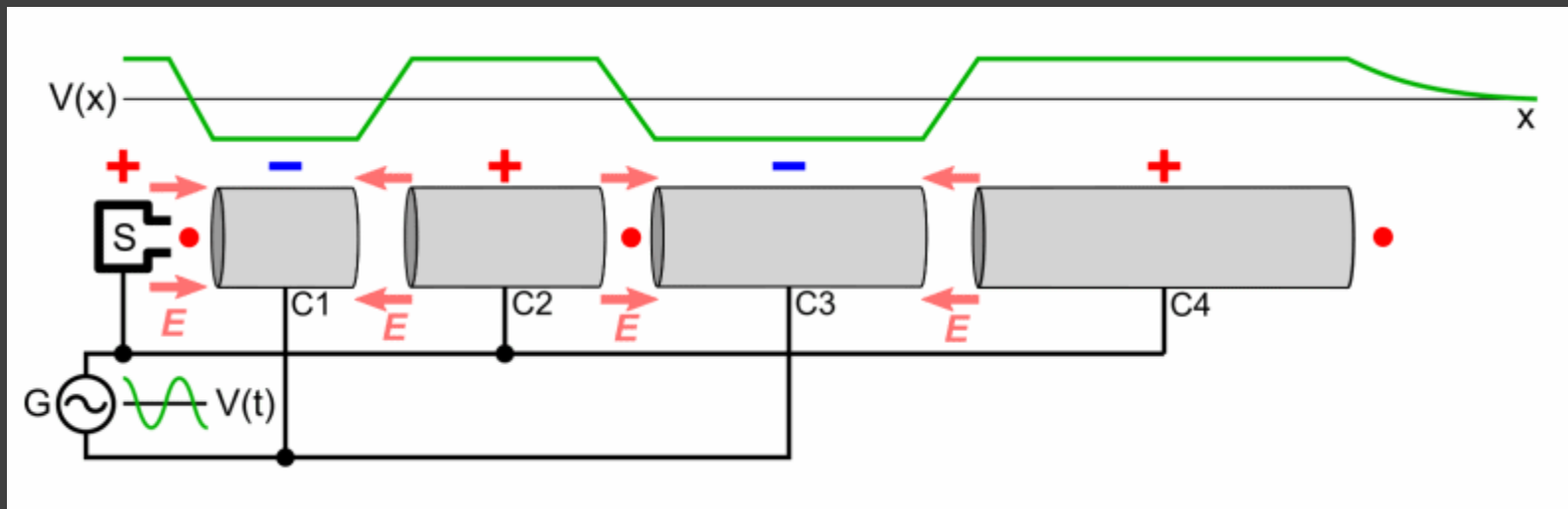


Figure from https://en.m.wikipedia.org/wiki/Particle_accelerator

b. Why are some accelerators circular and how charges move in them?

- Why circle???

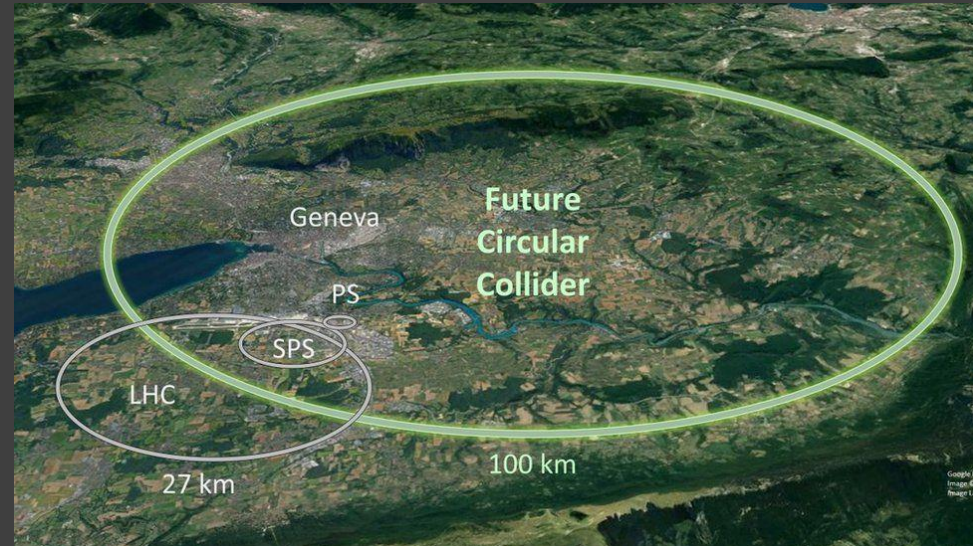
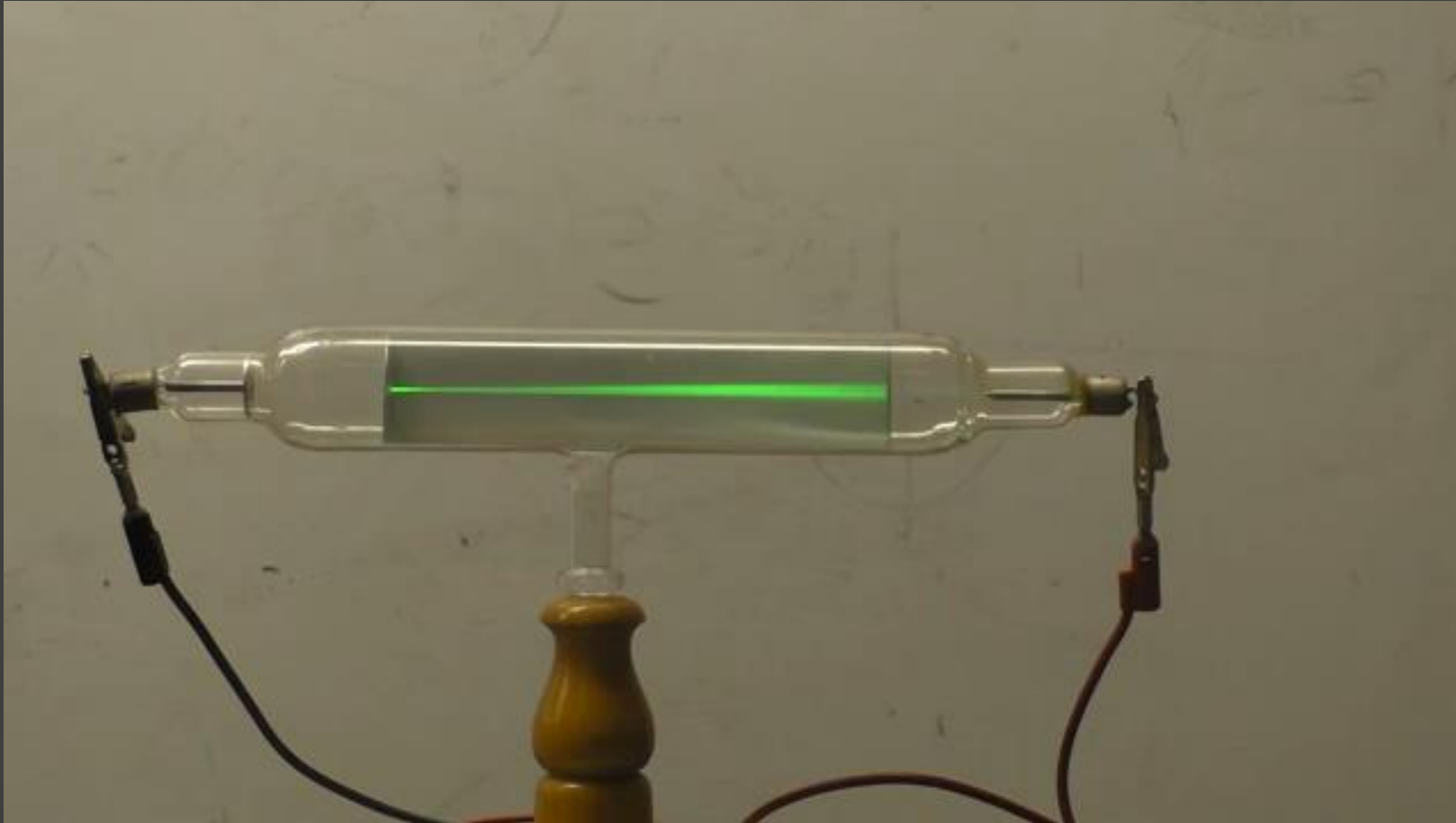


Figure from <https://www.bbc.com/news/science-environment-61149387>

How circle???

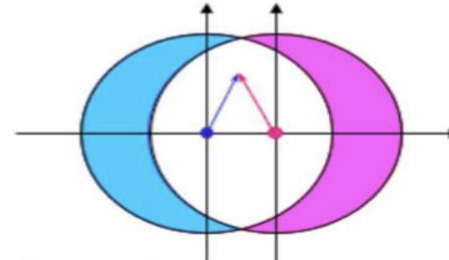
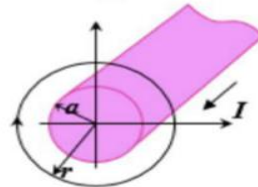
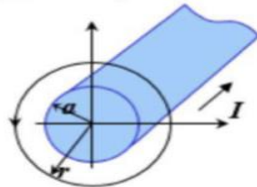


<https://m.youtube.com/watch?v=TVeEJsfD-2k>

c. Math involved

The $\cos \phi$ coil

- Consider now the field generated by two wires
 - They carry equal currents in opposite directions



- Now consider the geometry with the two wire partially overlapping
 - The current in the overlap is zero
 - The magnetic field in the overlap is uniform and directed along y

• $B_x = B_{1x} + B_{2x}$

$$B_{1x} = -\frac{\mu_0}{2} J_1 r_1 \sin f_1$$

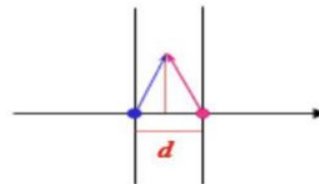
$$B_{2x} = -\frac{\mu_0}{2} J_2 r_2 \sin f_2$$

$$B_x = \mu_0 \frac{|J|}{2} (r_1 \sin f_1 - r_2 \sin f_2)$$

$$r_1 \sin f_1 = r_2 \sin f_2$$

$$B_x = 0$$

$$B_y = \mu_0 \frac{|J| d}{2}$$



$B_y = B_{1y} + B_{2y}$

$$B_{1y} = \frac{\mu_0}{2} J_1 r_1 \cos f_1$$

$$B_{2y} = \frac{\mu_0}{2} J_2 r_2 \cos f_2$$

$$B_y = -\mu_0 \frac{|J|}{2} (r_1 \cos f_1 - r_2 \cos f_2)$$

$$r_1 \cos f_1 - r_2 \cos f_2 = d$$

The best solution:

Ignore math!!!

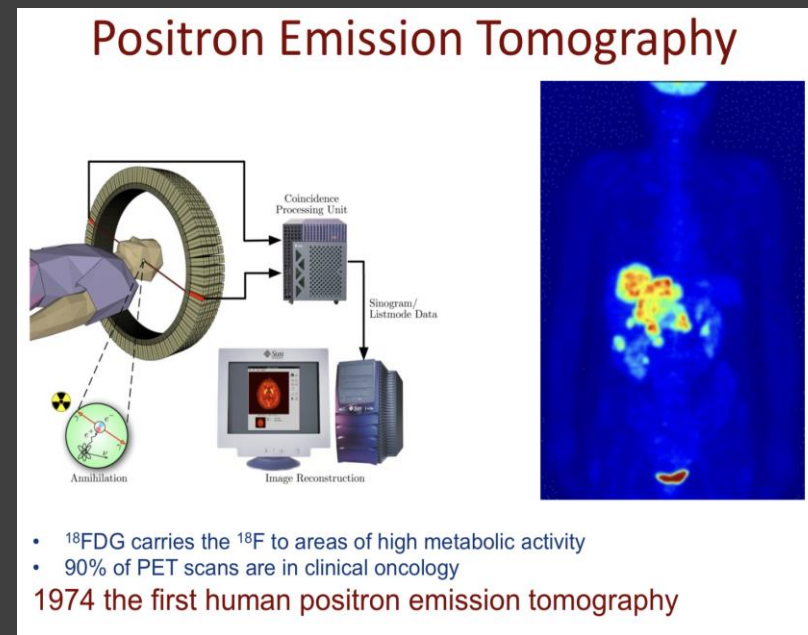
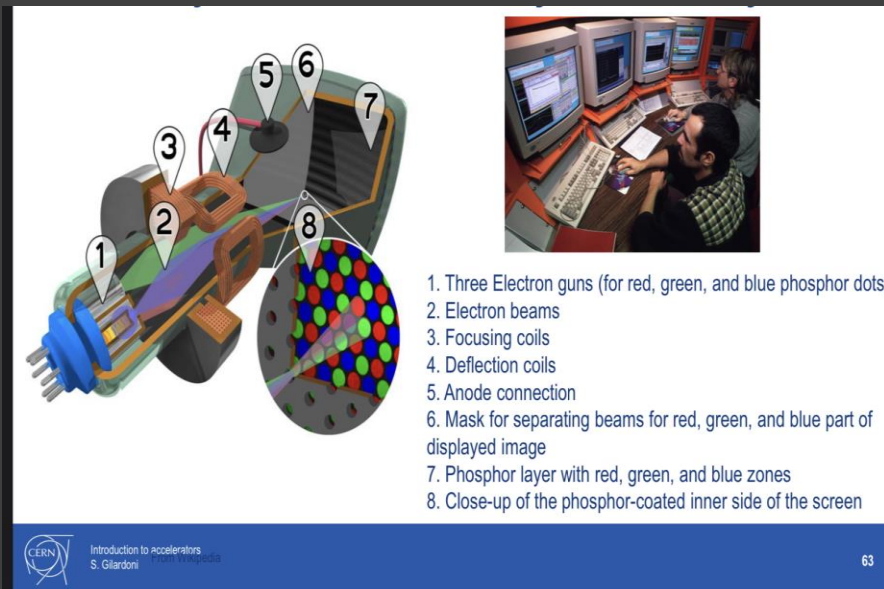


Picture from

<https://gfycat.com/discover/ignore-gifs>

2. Not comprehending the aim from building particle accelerators

- Why do we build accelerators???
- At school do not stress about fundamental research, stress on applications.
- Like, Tube monitors or medical applications



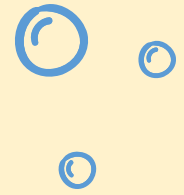
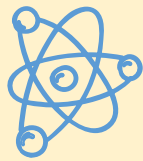
<https://indico.cern.ch/event/932906/contributions/4889583/attachments/2476115/4249589/2022-intro-to-accel-second-general.pdf>

<https://indico.cern.ch/event/932906/contributions/4928501/attachments/2476662/4250567/Teachers%20Programme%20-%20From%20Physics%20to%20Medical%20Applications-6%20July%202022.pdf>

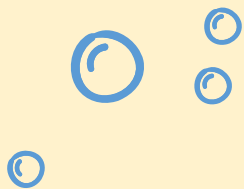
Comic Sans
OFC

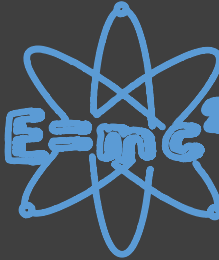
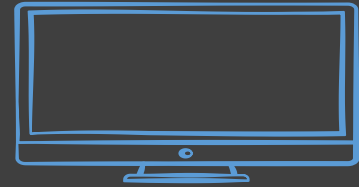
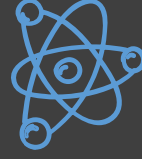
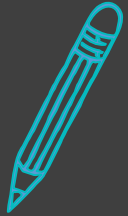
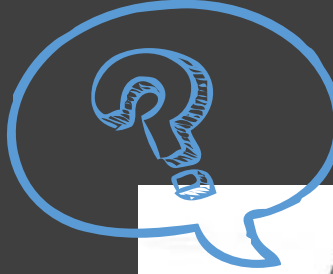
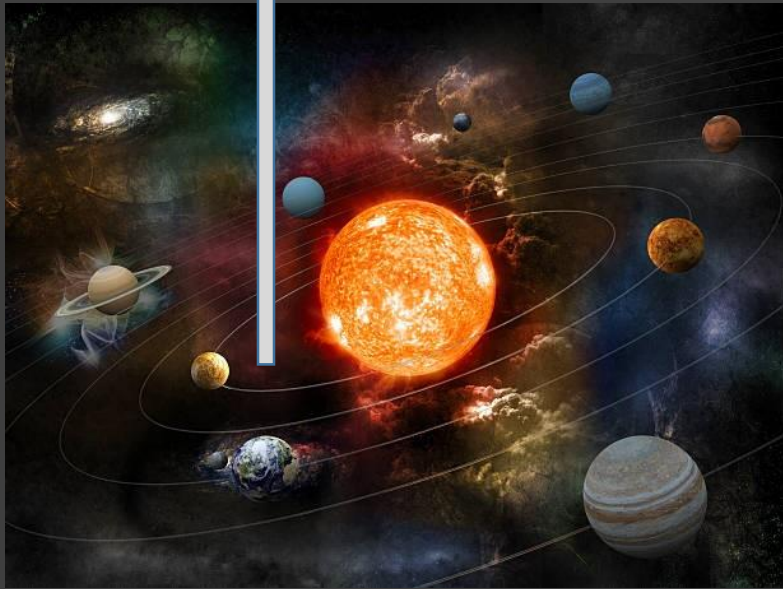
Best practise

Super school



Particle accelerators











THE MIGHTY TEACHERS



Super Tracie



Super Dana



Super Zokir



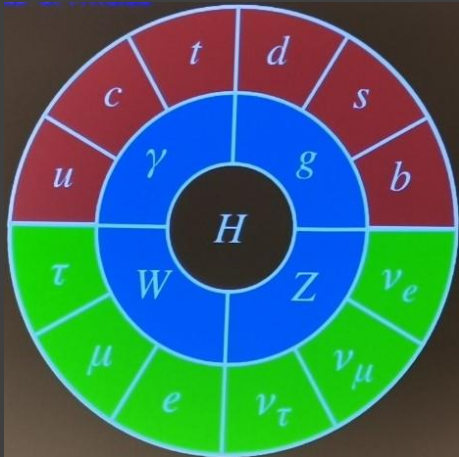
Super Marlana



Super Omid









CERNTINI

Acknowledgement!!!

Our sponsor – Lili Rose Cream...



