

Future Particle Accelerators

HST2024 Study Group 4



Future Circular Collider study

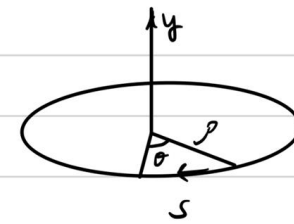
Exploring Concepts and Technologies for The Next Generation of
Powerful Particle Colliders

Curriculum & Classroom Connections

Project-based learning and so-called STEM projects might provide possible connections between various courses. For example, this will aid kids in learning programming and physics.

Students will gain the analytical, logical thinking, and problem-solving abilities necessary for current technology in this way.

Connections of the future particle accelerators is linked to kinematics, magnetic fields, electric fields and waves as referring to the motion of the particles in a magnetic and electric fields.



Lorentz force:
 $F = q v B$

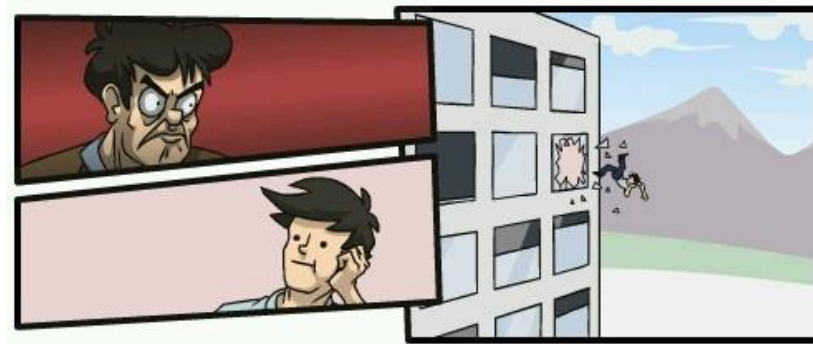
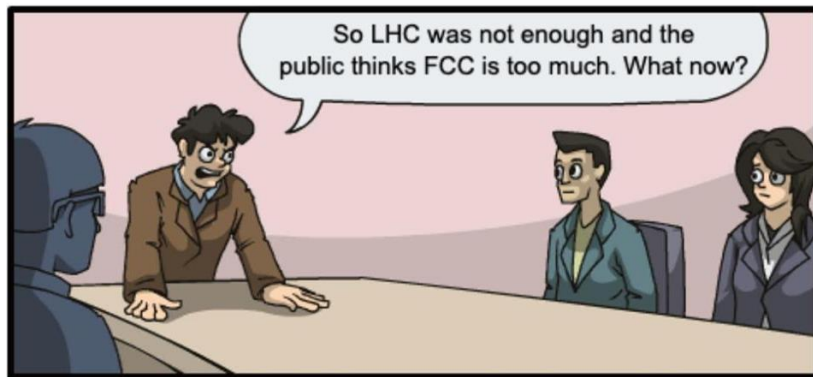
centripetal force: $\frac{m v^2}{r}$

Here: $\delta \frac{m_0 v^2}{p}$ because our particles are really fast!



$$\delta \frac{m_0 v^2}{p} = q \cdot v \cdot B$$

$\frac{p}{q} = B \cdot r$
 momentum $\frac{p}{q}$ = the magnetic field B \cdot radius of bend r

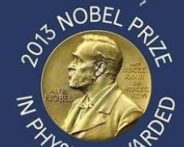
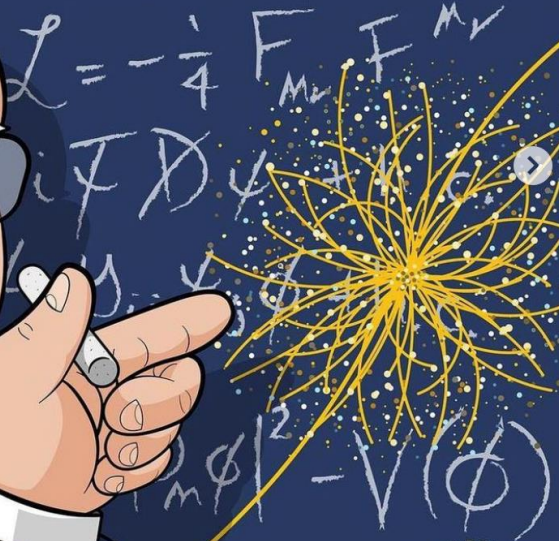
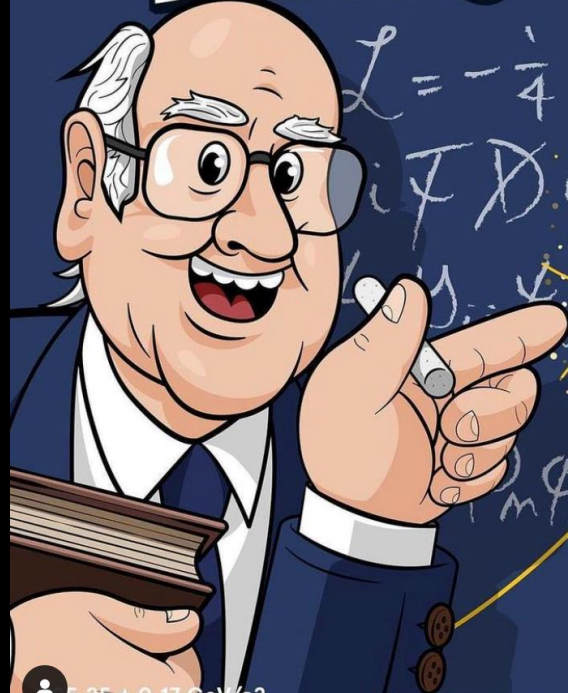




Knowledge's

HIGGS BOSONS

LOW MASS PARTICLES
ZERO ELECTRIC CHARGE
ZERO SPIN



$125.09 \pm 0.24 \text{ GeV}/c^2$

Images for decoration purpose.

Why do neutrinos have mass?

S
S
?

Key Ideas

Most important aspects of the future particle accelerator

- **Cost and Efficiency.**

aimed to make products more affordable.

- **Environmental Impact.**

Development of greener accelerator technologies with reduced energy consumption.

- **Data Analysis and AI Integration.**

- **Innovative Acceleration Techniques.**

Plasma wakefield and laser driver acceleration.

- **Compact and Portable Designs.**



Miniature accelerator, 2 meter long.

- **Global Collaboration.**

International projects like linear collider and funds sharing from many countries.

- **Educational Opportunities.**

Potential Students' Conceptions & Challenges

Synchrotron Radiation

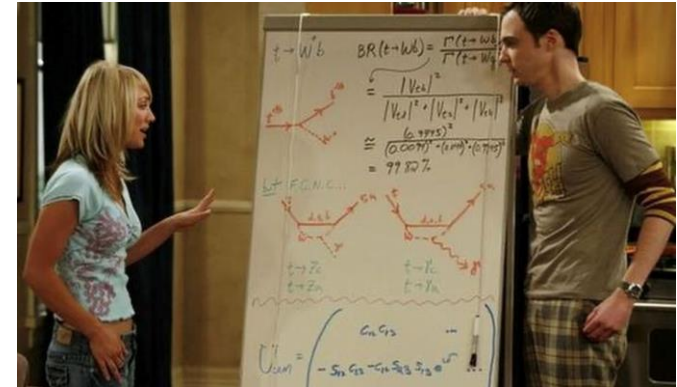
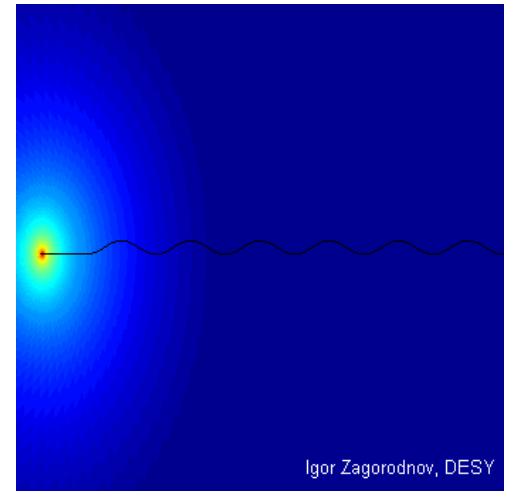
- When charged particles are accelerated in a circular or helical path by magnetic fields, they emit radiation tangentially to their path. This radiation is known as synchrotron radiation.

Understanding Advanced Concepts:

- Grasping the principles of particle physics and accelerator technology, such as the mechanics of plasma wakefield acceleration, can be challenging due to their abstract and complex nature.

Visualizing High Energy Physics:

- Visualizing the processes and effects occurring at subatomic scales, especially when dealing with concepts like electric fields and plasma waves, can be difficult for students without a solid background in physics.



Useful Material & Resources

Future Circular Collider Study

(CERN Web)

CERN Accelerator Complex animation - OVERVIEW · CDS Videos · CERN

<https://home.cern/news/news/knowledge-sharing/miniature-accelerator-treat-cancer>

Lecture slides of future particle accelerator.

https://indico.cern.ch/event/1185606/contributions/5963230/attachments/2893653/5073075/High_School_Teacher_July_2024_p.pdf

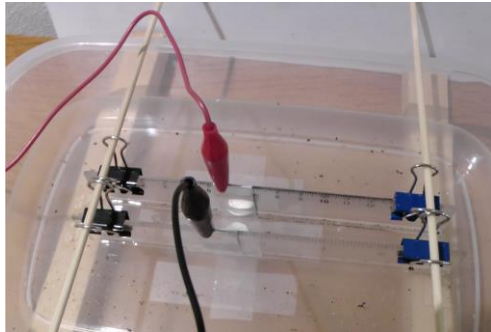
Future particle accelerators

<https://youtu.be/ZxtPGN8lpa0>

https://youtu.be/V_hirIK9eFs

Best Practice Example

The simplest handheld accelerator.

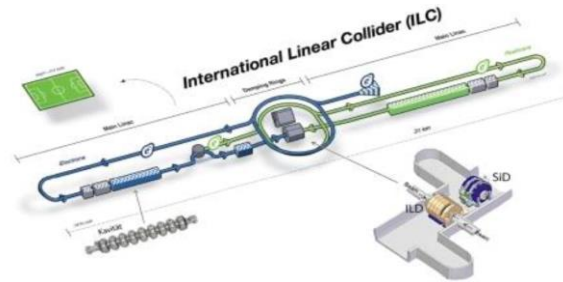


1) How can the velocity of ions be increased?

2) Differences and similarities between the Handheld one and LINAC or CLIC.

3) Maximum voltage allowable.

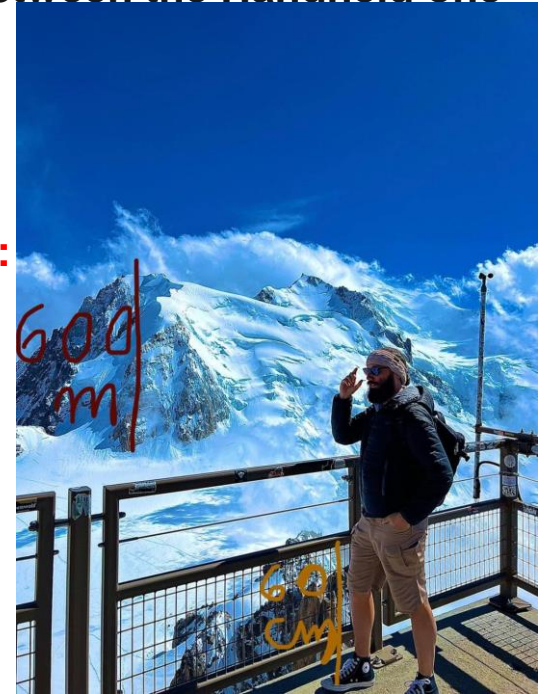
to accelerate electrons to 1 TeV:
100 MeV/m x 10000 m



4) How can I create a professional compact collider?
PLASMA wakefield accelerator.

to accelerate electrons to 1 TeV:
10 m

100 GeV/m x



One way in which things have changed...

- Intense
- To make things more accessible
- We were... other. a fascinating



S...

periments as
of our students

ators. A lot of
important

HEAD, AT THE
OF THE DAY

