
BACK
TO THE FUTURE
ACCELERATORS


MONTH
DAY
YEAR
HOUR
MIN
JLY
14
2023
AM
PM
12
15
DESTINATION TIME
MONTH
DAY
YEAR
HOUR
MIN
JLY
14
2070
AM
PM
12
15
PRESENT TIME
MONTH
DAY
YEAR
HOUR
MIN
JLY
04
2012
AM
PM
07
17
LAST TIME DEPARTED
LOADING...

STUDY GROUP 9

WHOA!

NO CURRICULUM CONNECTION

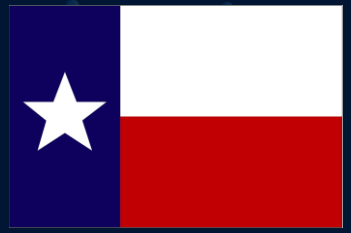
Curricula taught

DP Physics

SL and HL Physics
- Feynman diagrams
- Neutrinos
- Standard Model
- Dark matter (HL Option D)

Catalunya

Particle Physics is a part of the Modern Physics Unit: often skipped



Texas

Particle Physics Objective
- Fundamental forces
- Quarks and leptons
- Unification of forces

Nepal

Part of the Modern Physics Unit
- Standard model (quarks & lepton)
- Brief description of dark matter

Classroom connections

SCIENTIFIC METHOD

For the accelerator / detector design

For ‘discovery’ of new particles

INTERNATIONAL MINDEDNESS

Discussion on why FA require cooperation between different countries.

TEACHING APPROACHES

CONTENT

Knowledge of EM

Basics of the Standard Model

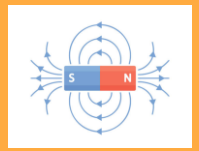
Dark Matter and Cosmology (IB only)

NATURE OF SCIENCE

The relation between the theory, data, and limits of the scientific method

Key Ideas

Most important aspects for meaningful instruction



E&M

Kinematics

Particle Physics

Nature of Science

Key Ideas: Nature of Science (IB)

Most important aspects for meaningful instruction

What is science and scientific endeavour

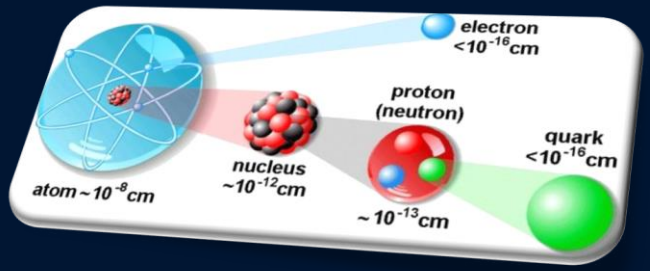
The understanding of science

The objectivity of science

Human face of science

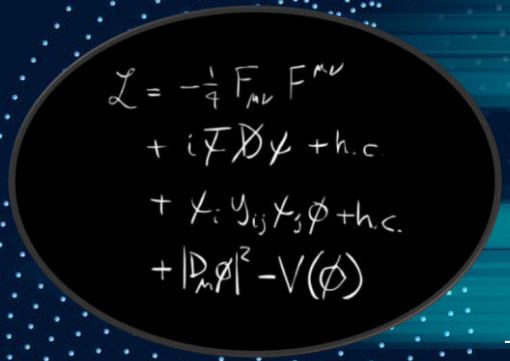
Scientific literacy and public understanding

Potential students' conceptions & challenges



- **Technical Complexity**
  - Size and Scale
  - Technical Terminology
  - Foundational knowledge of Particle Physics

- **High level Mathematics**
  - Challenging mathematical ideas used in accelerator physics
  - Hard to imagine what hasn't been designed or discovered



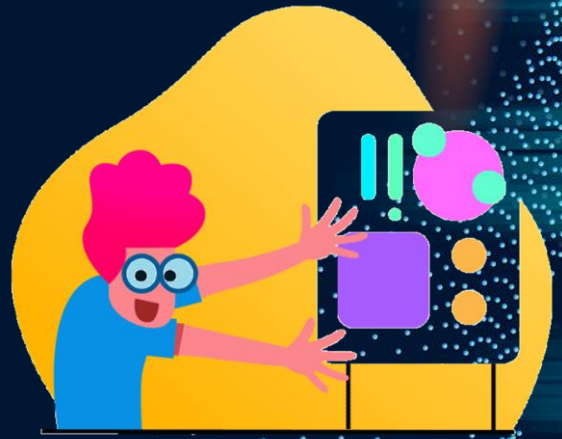
Potential students' conceptions & challenges…

- **Curriculum Integration**
  - No textbooks
  - Teacher knowledge
  - Interdisciplinary projects, and flexible teaching approaches
- **Time constraints**
  - May not provide sufficient time to cover the complexities and depth of knowledge associated with a future accelerator
- **Limited prior knowledge & Resources**
  - Engage the students in hypothetical discussions, fostering creative thinking, and investigating the potential effects of future accelerator research

Best practice example

PBL: Feasibility Proposal

Design a feasibility proposal for a future accelerator. Convince your classmates and get the funding!



- Research a real accelerator project
  - Timeline
  - Countries
  - Research goals and relevance
  - Design and technology
  - Extension: Technology transfer
- Present your research in a poster in front of the class
- All students are part of the committee: vote and decide who gets the funding!

Best practice example

PBL: Feasibility Proposal

PRODUCT Poster + oral presentation

GROUPING 3/4 students

SKILLS Science and technology, communication, ability to learn

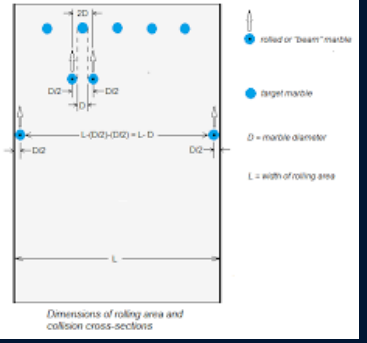
SCAFFOLDING Open activity, draft revision

CONTENT:

- The Scientific Method
- Modern Physics: beyond the Standard Model
- EM & Accelerators
- **Nature of Science**

TIMELINE

1: Introduction	2: Research and design	3: Presentation and votes!
1 HOUR	**3 HOURS**	**2 HOURS**



Dimensions of rolling area and collision cross-sections

Helpful material and resources

Quarknet Data Activities

Rolling With Rutherford

Shuffling the Particle Dec

Making it 'Round the Bend"-Qualitative and Quantitative

The Particle Adventure Interactive Website

CERN

How an Accelerator Works

Higgs in a Box: Investigating the nature of a scientific discovery

Future Circular Colliders Website and video

Youtube

Particle physics made easy - with Pauline Gagnon

Helpful material and resources

Perimeter Institute

Quantum to Cosmos - to help students understand scales of particles

Conversations at the Perimeter- podcasts with some discussing curiosity and discovery

Searching for New Physics at Muon Colliders

The Process of Science- activities to explore the nature of discovery and curiosity

Perimeter Institute for Theoretical Physics - YouTube- a variety of videos that contain teacher and student information about nature of science and discovery

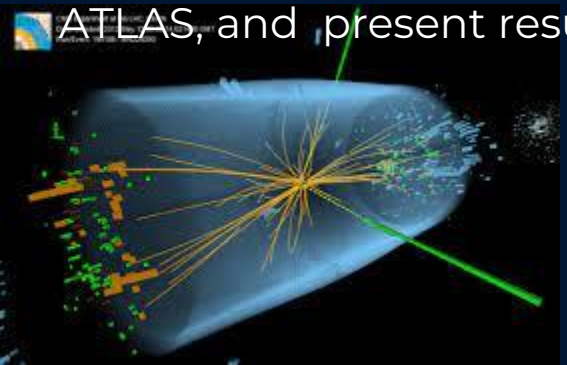
Helpful material and resources

Science Clubs & Extracurricular Activities

Cosmic Ray Studies -student led Cosmic Ray Clubs use high school campus CRD's to complete and collaborate using student collected data and/or Fermilab "blessed" data to complete , present, and publish posters on Quarknet site.

World Wide Data Day-teachers register teams of students to analyze data from CMS and ATLAS to present results on a video conference.

Masterclass- students meet at a Quarknet supported University with a Quarknet Mentor (Professor of Physics) to tour campus facilities, analyze data from CMS and ATLAS, and present results on a video conference.



ANY QUESTIONS?