International High School Teacher Programme 2018

WORK GROUP:7- PARTICLE DETECTORS

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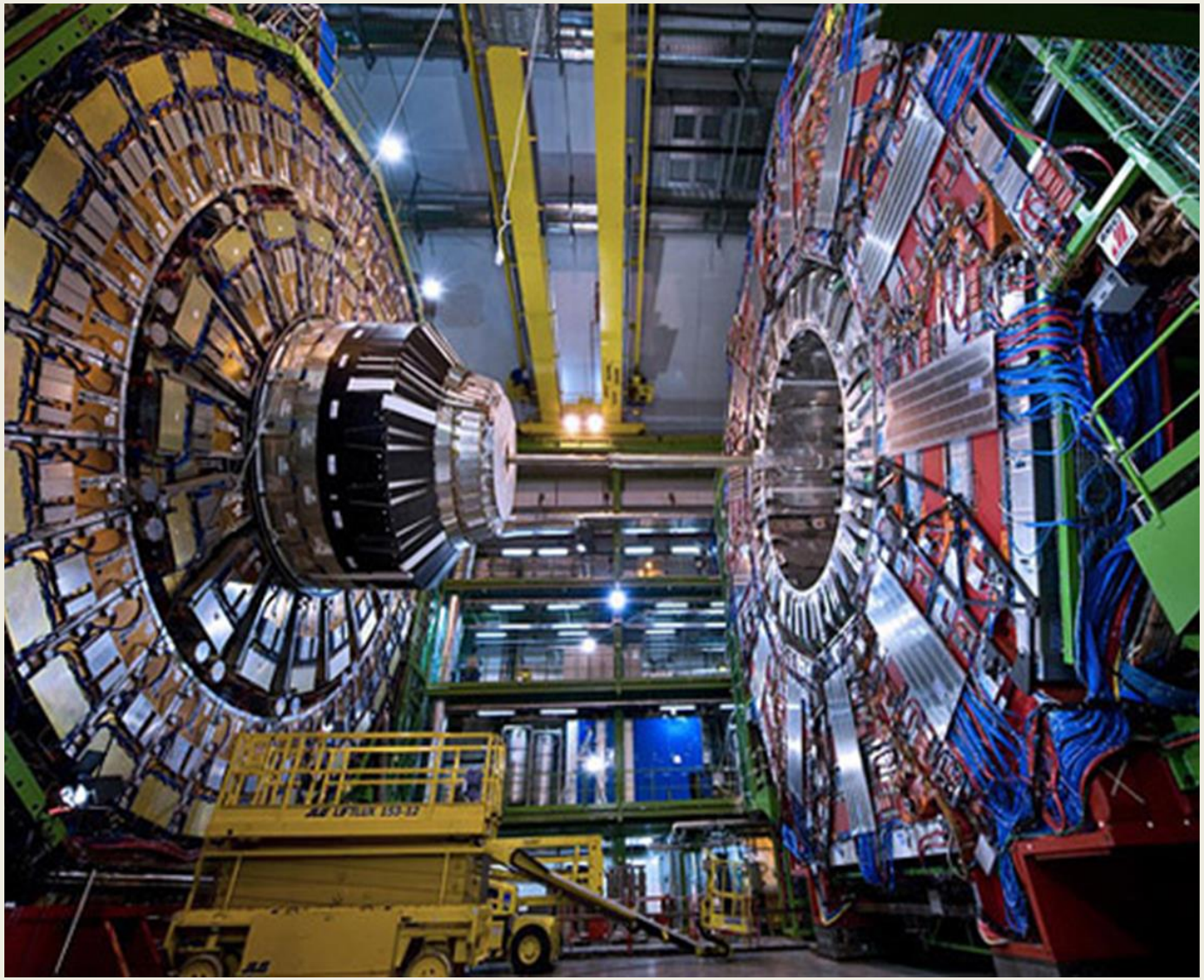


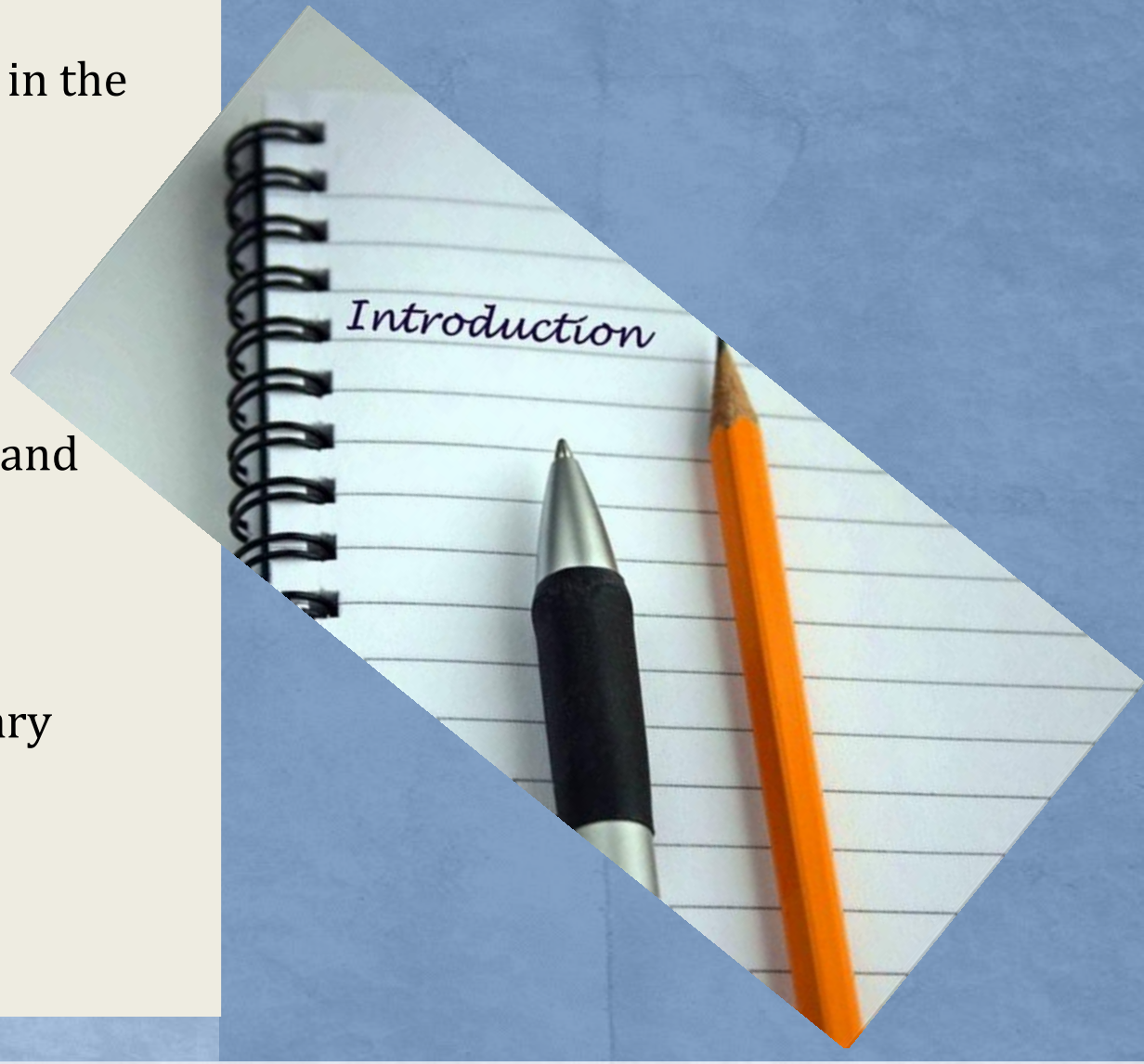
Particle Detectors

in

School Education

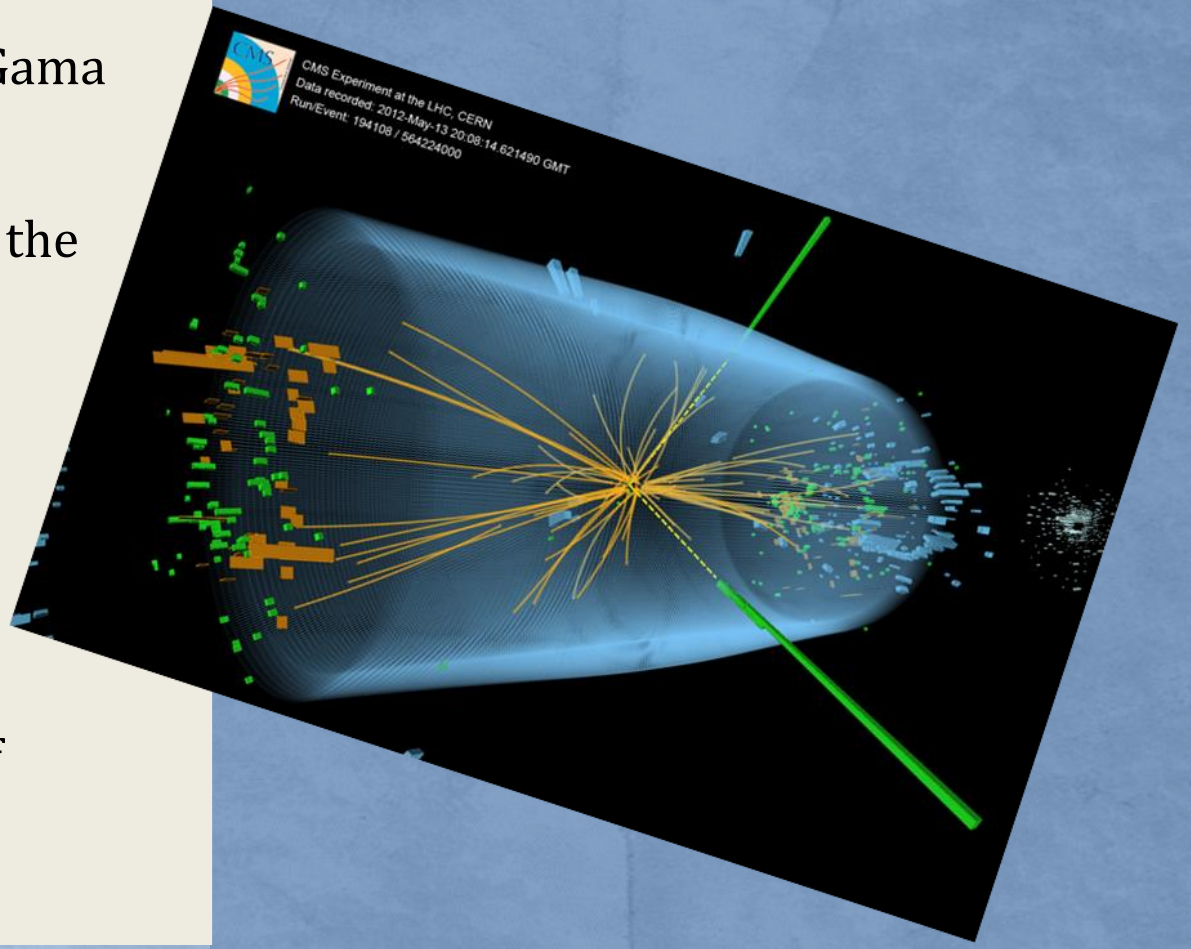
Introduction:

- Basic concepts of particle detectors are introduced in the high school (16 -18 years)
- Particle detectors at the university level.
- Presentation- focus:
  - High school students
  - Fundamental principles of particle detectors and its types.
- Engineering and technical details are not included.
- Particle detectors as stimulus for students in primary school
- Analogy between particle detectors and mystery boxes(primary students)



Introduction:

- Atomic model with an introduction to subatomic particles and properties.
- Nuclear physics, radioactivity with alpha, Beta and Gama decay
- Prior knowledge of these topics is a prerequisite for the students to study particle physics
- Introduction of Lorentz force and its application in determining the trajectories
- Charged particle with mathematical formula and calculations is also introduced
- This information can be used to teach trajectories of charge particles in a particle detector.



Curriculum & classroom connections

- Atomic model (Thompson, Rutherford, Bohr)
- Meaning of elementary particle and identifications
- Describing particles in terms of it's properties(mass, charge, quantum and spin)
- Photoelectric effect (Einstein's equation)
- Radioactivity (He; alpha, beta, gamma) decays
- Provoked Nuclear (Fission, Fusion)

Curriculum & classroom connections

- Standard model
- Fundamental interactions and explanations in terms of exchange particles
- Experimental evidence for the standard model
- Introduction to Antiparticles
- Representation using Feynman Diagrams
- Particle accelerators and detectors
- Counters (Geiger - Miller counter)
- Cloud chambers.

Key ideas

- Identification of observable properties.
- Interaction of particles with materials and fields.
- Data collection and measurement.
- Filtration and Analysis.

Helpful material and resources

Virtual Atom Smasher
An interactive game that lets students become virtual scientists at CERN! Presented with real data and tools that scientists use students are guided step-by-step through the exciting world of particle physics!
http://test4theory.cern.ch/about/

Particle Clicker
A game that teaches players the history of high energy particle physics
https://particle-clicker.web.cern.ch/particle-clicker/

Quark poker
Playing cards to discover the elementary particles and their interactions. Suitable for all audiences.
http://ippog.org/resources/2012/quark-poker

Potential Student (Mis)conceptions and Challenges

- Choosing a relevant model for scientific explanation
- Making connection between conservation laws as applied to particle physics.
- Confusion between mass-energy equivalence.
- Diagrammatic representation of particle interaction(Feynman Diagram)
- Lack of understanding of detection principles (like application of semiconductor physics.)

Potential Student (Mis)conceptions and Challenges

- Lack of experimental facilities and equipment(Lot of theoretical information)
- Teacher misconception and lack of experience .

Particle Detectors for primary school students

Curriculum & classroom connections

- Particle detectors extremely specialized for primary education
- Can be featured in the classroom in a broader way

Key idea

- CERN and particle detectors at CMS, ATLAS, ALICE are a stimulus for students and could : Help students understand and follow the scientific method

Potential students' conceptions and challenges

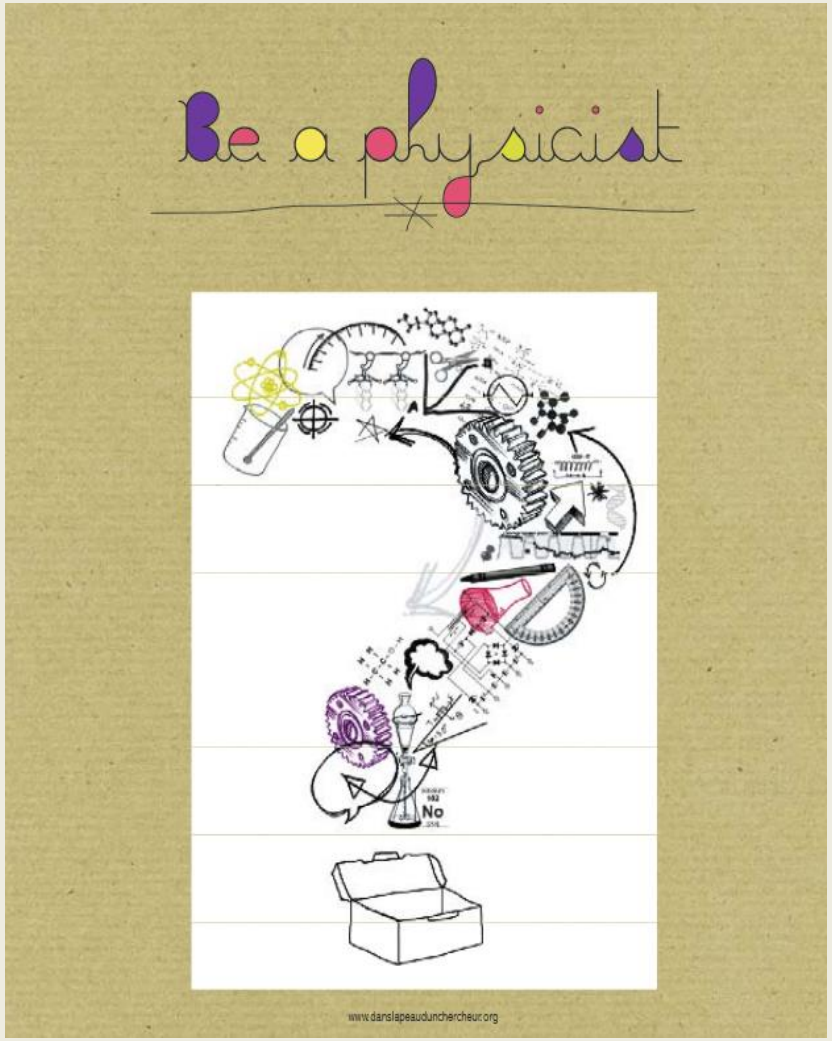
They believe that:
•Science and scientific ideas are absolute.
•Science and its methods can answer all questions.

Practice example

- “Be a Physicist “
- 9-12 year old students
- Offers teachers and their pupils the opportunity to work like real scientists

The kit includes the necessary tools to carry out the project.

- A booklet setting out the theory and containing practical information
- Mystery boxes
- Control boxes



https://voisins.cern/en/offre/be-physicist

Practice example

Particle Detectors

- Physicists at CERN search for invisible elementary particles

Mystery boxes

- Pupils conduct investigations to identity the contents of mystery boxes they cannot open.

Common value : Successive hypotheses and experimentation.

STEPS

Step 1 - Observation

Step 2 - Handling

Step 3 - Equipment

Step 4 - Experiments

Step 5 - Analysis and validation

Step 6 - Communication

Helpful material and recourses

If our students want to learn more about particle detectors

http://www.cernland.net/index.php

https://atlas.cern/colouring-book

http://papadakis.net/books/the-large-hadron-collider-pop-up-book/

Best practice examples

Alpha particle track in magnetic field

Calculation of the radius using Lorentz force using TI-Nspire application.

Bibliography

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http://test4theory.cern.ch/about/

Ευχαριστώ πολύ!

धन्यवाद

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Köszönöm!

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