



#ITW2023

## **GROUP 2** - PARTICLE DETECTORS

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## CURRICULUM & CLASSROOM CONNECTIONS

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*To see a world in a grain of sand  
And a heaven in a wild flower,  
Hold infinity in the palm of your hand  
And eternity in an hour.*

—WILLIAM BLAKE

*“Men are not taught to be honest men, and they are taught everything else”*

- **Blaise Pascal**

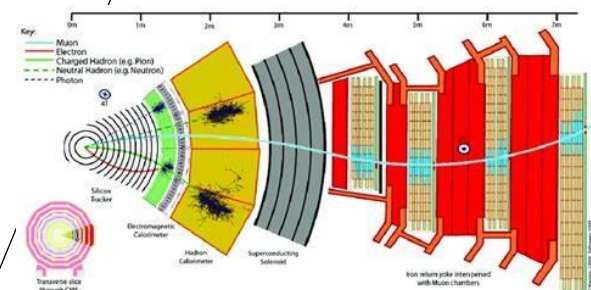
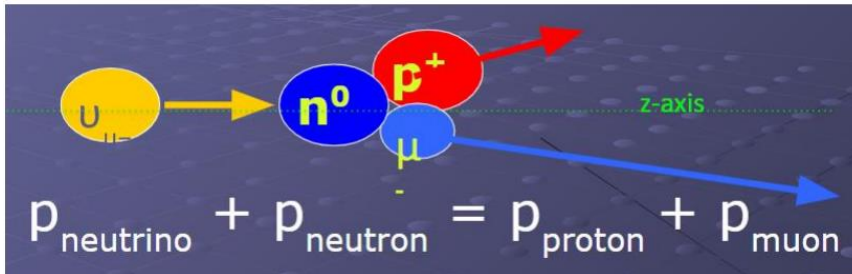
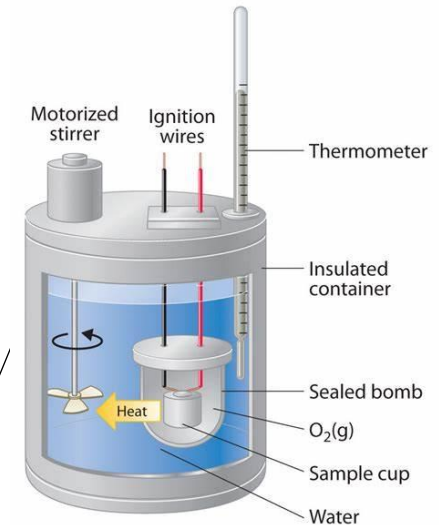
## CURRICULUM & CLASSROOM CONNECTIONS

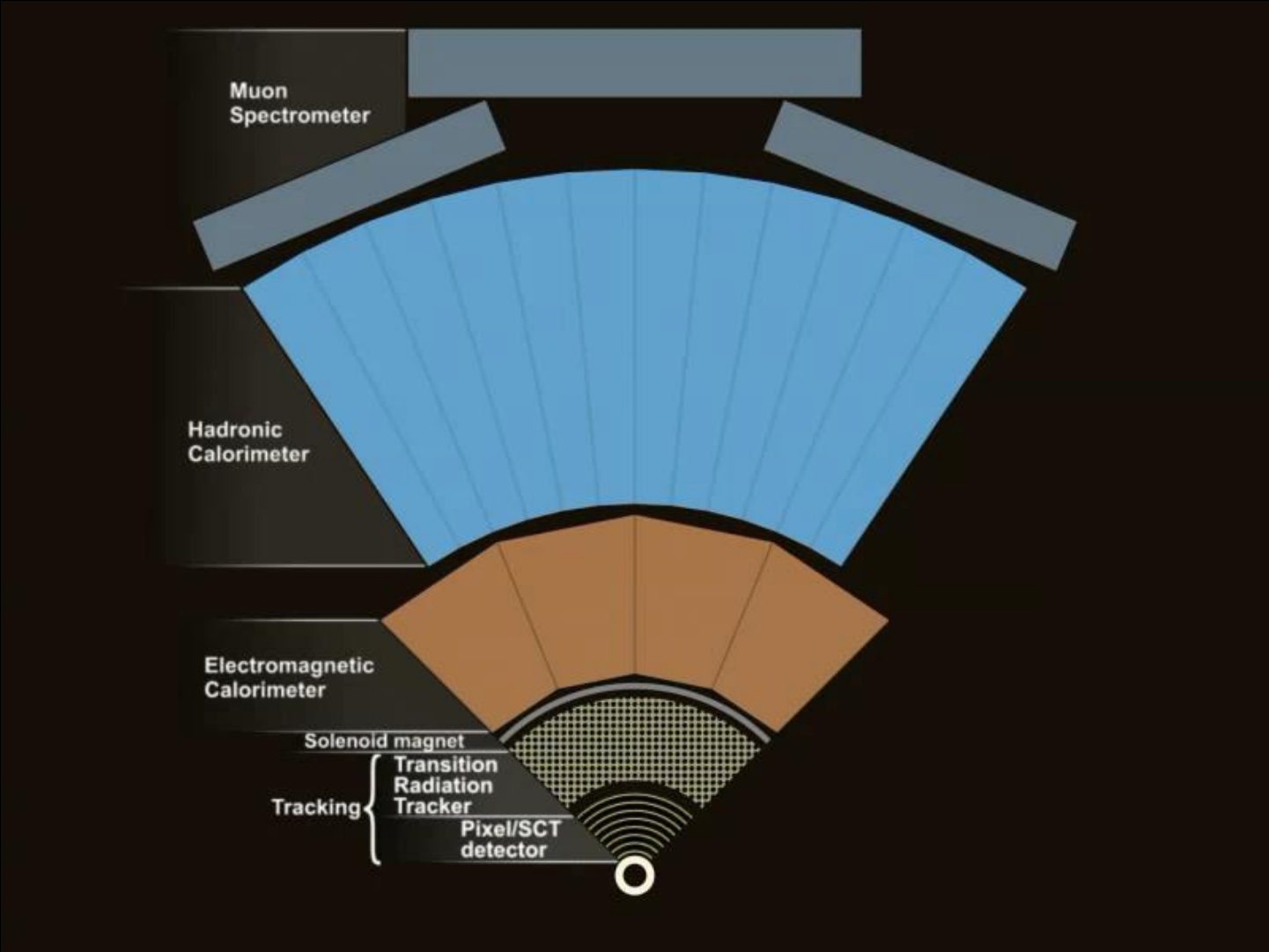
- **Not in any of our curricula:** National curricula have not **yet** incorporated new scientific discoveries.
- **Goal is to increase science literacy for our students**
- **Importance of CERN as an international organization**
- **Everyone, working together, working collaboratively for the good of humanity, is the greatest power of Science and Scientific Research.**



# KEY IDEAS

- Pull from student's prior knowledge on concept of detectors
- 4 various detectors spread out around the LHC
- Conservation laws are utilized daily in the detectors

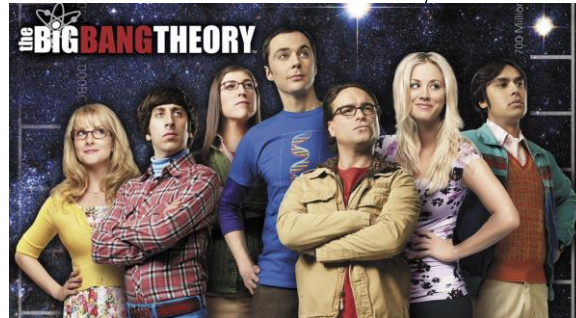




# POTENTIAL STUDENTS' CONCEPTS & CHALLENGES

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- Depend on students' grade, knowledge, experience ... etc.
- Students who have visited some labs may think that some physicists work in cubicles in front of the computers, some physicists and engineers work in a lab.
- Students may think scientists and research look like they saw on TV (e.g. The Big Bang Theory)



# POTENTIAL STUDENTS' CONCEPTS & CHALLENGES

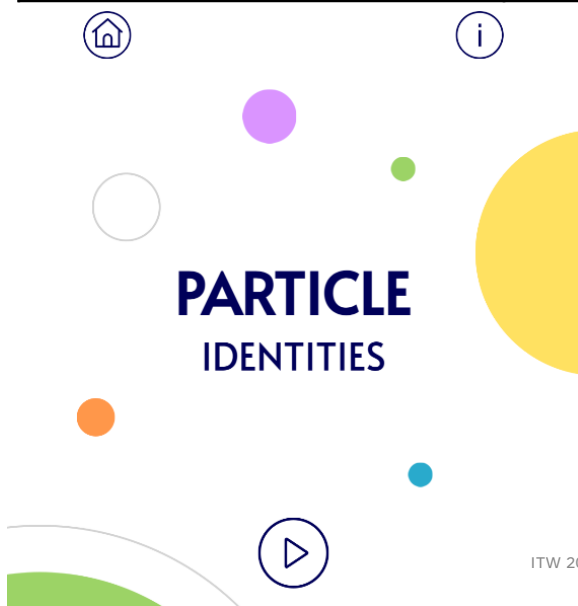
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- Challenges may include:
  - Understanding what does Particle Physics means?
  - What do particle physicists work on?
  - Why do we detect particles?
  - How to detect particles?
  - ...
- Really new field for middle school and high school students! !

# HELPFUL MATERIAL & RESOURCES



Pre-class Activities	<ul style="list-style-type: none"><li>• <a href="#">Interesting Videos or Comics (ALICE TPC Pre-Commissioning Song - YouTube)</a></li><li>• <a href="#">Which particle are you?</a></li></ul>
Lesson Proper	<ul style="list-style-type: none"><li>• <a href="#">International Teachers Week Programme   CERN Teacher Programmes</a></li><li>• <a href="#">Research   CERN Physics Education Research</a></li></ul>



CERN Accelerating science

Sign in Directory

HOME NATIONAL TEACHER PROGRAMMES INTERNATIONAL TEACHER PROGRAMMES FAQ

## International Teacher Weeks Programme

Links to past programmes

https://per.web.cern.ch

RESEARCH TEAM PUBLICATIONS RESOURCES

**Latest Publications**

- Dahlkemper, M. N., Lahme, S. Z. & Klein, P. (2023). How do physics students evaluate artificial intelligence responses on comprehension questions? A study on the perceived scientific accuracy and linguistic quality of ChatGPT. *Physical Review Physics Education Research*, 19(1), 010142, [article](#)
- Woithe, J., Boselli, M., Chatzidaki, P., Dahlkemper, M. N., Duggan, R., Durey, G., Herff, N., Kranjc Horvat, A., Molaro, D., Scheerer, G. W., Schmeling, S., Thill, P. T., Wiener, J. & Zochling, S. (2022). Higgs in a box: investigating the nature of a scientific discovery. *The Physics Educator*, 4(4), 1-15, [article](#)
- Dahlkemper, M.N., Klein, P., Müller, A., Schmeling, S.M. & Wiener, J. (2022). Opportunities and Challenges of Using Feynman Diagrams with Upper Secondary Students. *Physics*, 4(4), 1331-1347, [article](#)
- Kranjc Horvat, A., Wiener, J., Schmeling, S. & Borowski, A. (2022). What Does the Curriculum Say? Review of the Particle Physics Content in 27 High-School Physics Curricula. *Physics*, 4(4), 1278-1298, [article](#)



# HELPFUL MATERIAL & RESOURCES

## Supplementary Activities

- [Quarknet |](#) (e-labs, masterclasses)
- [Classroom Activities | S'Cool LAB \(cern.ch\)](#)
- [Home | CERN Science Gateway](#) (visits)

The screenshot shows the QuarkNet website homepage. At the top, there is a navigation bar with links for 'ABOUT', 'DATA ACTIVITIES', 'MASTERCLASSES', and 'E-LABS'. Below this, there are four main sections: 'For Teachers', 'For Students', 'For Researchers', and 'LHC & Fermilab', each with a representative image. At the bottom, there are four informational boxes: 'Data Activities Portfolio' (supporting curriculum with activities), 'e-Labs' (CERN & Cosmic Ray—addressing ALL practices in Next Generation Science Standards), 'Opportunities for QuarkNet Teachers' (join scientists for research, Data Camp and Coding Camps, and Workshops at CERN), and 'Masterclasses' (students as scientists for a day).

The screenshot shows the S'Cool LAB website. The navigation bar includes 'HOME', 'S'COOL LAB WORKSHOPS', 'CLASSROOM ACTIVITIES', and 'ONLINE ACTIVITIES'. Below the navigation, there are six featured activity cards: 'ATLAS Magnet Model' (showing a particle detector), 'Bubble Chamber Pictures for the Classroom' (showing particle tracks), 'Cloud Chamber' (showing a cloud chamber setup), 'DIY Particle Detector' (showing a custom-built detector), 'Dark Matter Jelly Lenses' (showing hands holding a lens), and 'Particle Identities' (showing a graphic with the text 'PARTICLE IDENTITIES').



The screenshot shows the CERN Science Gateway website. The header includes 'CERN Accelerating science' and 'CERN Science Gateway' with a logo. There are navigation links for 'PROJECT', 'DISCOVER', 'NEWS', and 'PARTNERSHIPS'. The main content area features the headline 'A universe of open exploration' and the sub-headline 'Immersive exhibitions, hands-on learning, events and much more' against a background of a blue sky with clouds.

# BEST PRACTICE EXAMPLE

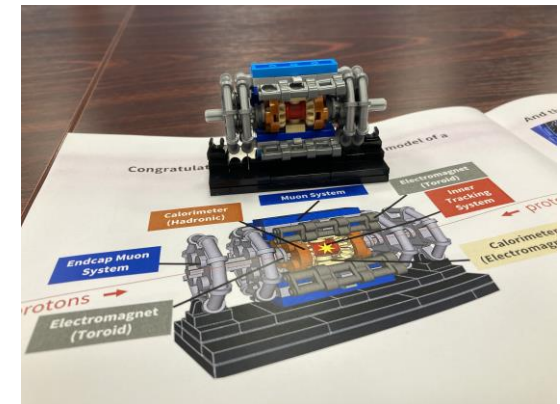
- **WHAT THE DETECTOR IS?**

- activity clarifying the concept of a detector
- what all we can detect – fields, objects
- using tracks to recognize the path of the "offender"

- **BUILD YOUR OWN DETECTOR – LEGO ACTIVITY**

- activity developing not only cognitive but also motor skills
- ATLAS Magnet Model

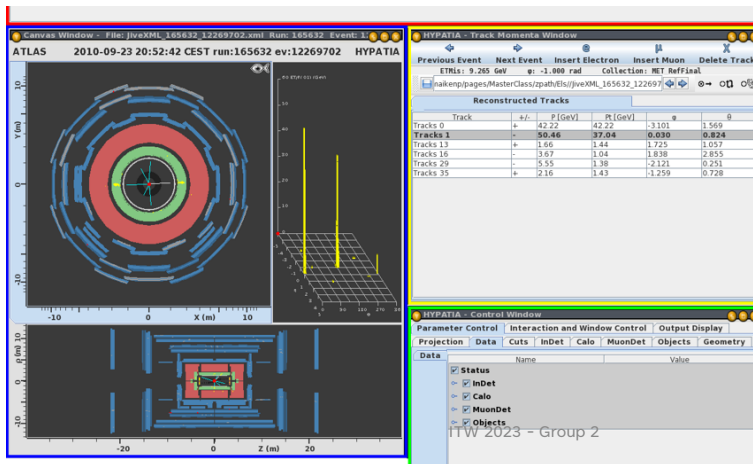
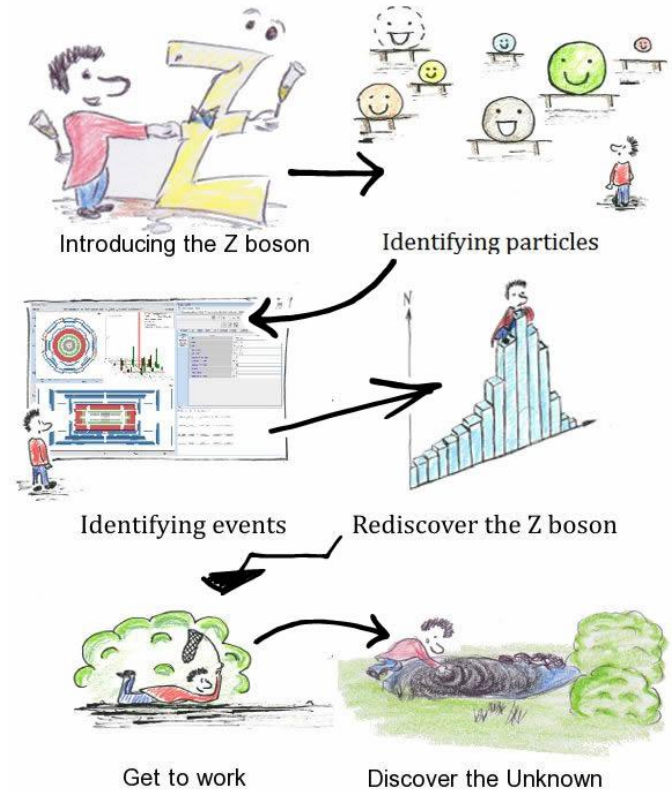
DETECTIVE  
OR



# BEST PRACTICE EXAMPLE

## VIZUALIZATION WITH HYPATHIA

- analysis of data samples that have been recorded with the ATLAS detector
- choice between two different measurements with original data from the ATLAS experiment - W-Path, Z-Path
- 60 – 90 minutes



[https://atlas.physicsmasterclasses.org/en/zpath\\_teilchenid2.htm](https://atlas.physicsmasterclasses.org/en/zpath_teilchenid2.htm)

<https://atlas.physicsmasterclasses.org/sk/downloads.htm>

THANKS/MERCI BEAUCOUP!  
QUESTIONS?

