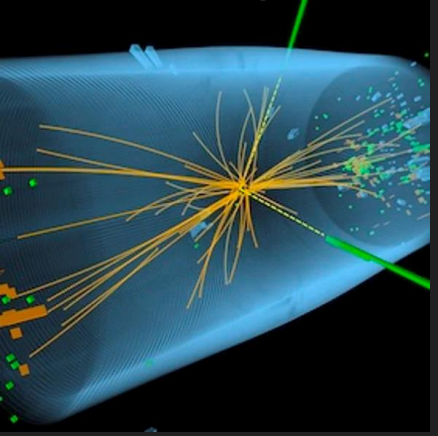
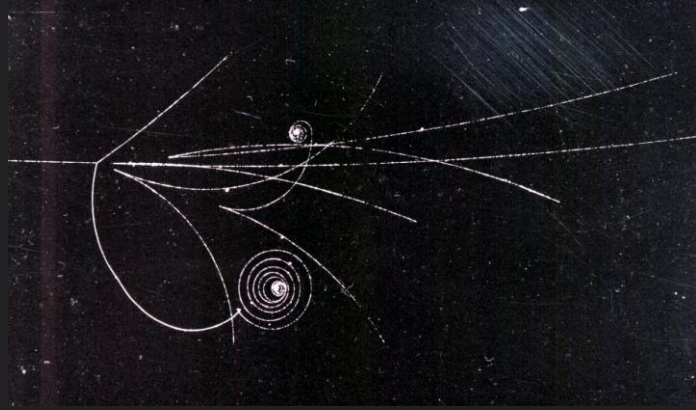
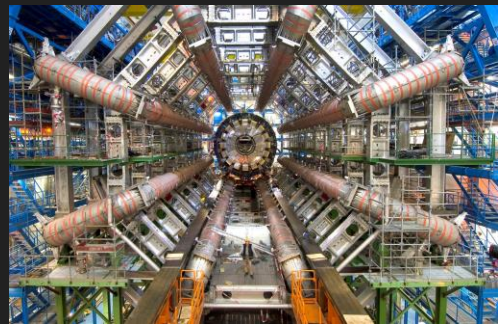




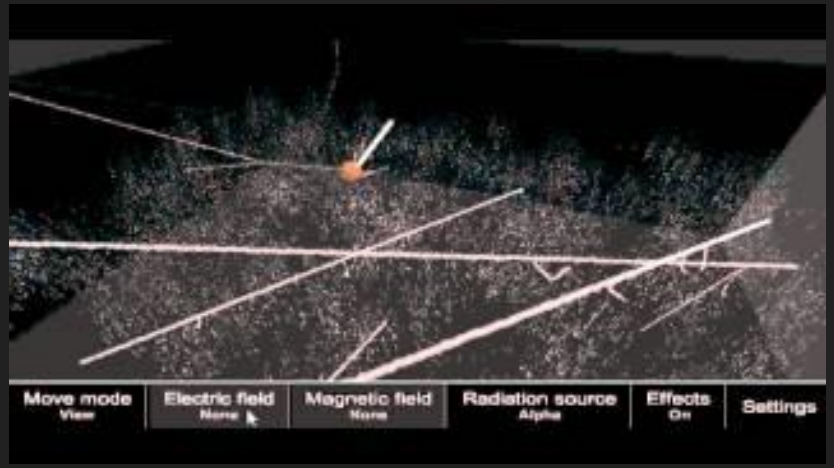
# Particle Detectors

HST 2023



# Engaging Students - Part 1

- Make with students a real cloud chamber or watch Cloud Chamber video
- App available as Android APK (see comments to video)
- Answer question in Mentimeter
  - What phenomena are you seeing? What do you see?




MENTIMETER

# Engaging students - Part 2

- Discuss with the students.
- Work with writing and thinking about language! Talk about the word “Detector” to build his scientific meaning

  Actually we did with the CERN’s Summer Students in the cafeteria, if you want to have a look ….

(PLEASE, WRITE JUST 1 SENTENCE)

WHAT IS A DETECTOR?

a machine that ~~see~~ record signals to see stuff

(PLEASE, WRITE JUST 1 SENTENCE)

WHAT IS A DETECTOR?

An instrument that senses the presence of something specific

(PLEASE, WRITE JUST 1 SENTENCE)

WHAT IS A DETECTOR?

Douce to see the traust of a particle.

PLEASE, WRITE JUST ONE SENTENCE

WHAT IS A DETECTOR?

A detector is a device that can measure the existence of a particle by interacting with it via one or more of the four fundamental forces of nature.

# CURRICULUM LINK


Group 2

- South Africa
- Germany
- Italy
- USA
- Thailand

# CURRICULUM LINK

| Country | Atomic model | Electric field | Magnetic field | Radioactivity | Standard model |
|---|---|---|---|---|---|
| South Africa | 8-10 | 10-11 | 10-11 | 10 | — / (opt. 12) |
| Germany | 8-12 | 11 | 11 | 10-12 | — / (opt. 12) |
| Italy | 8-12 | 11 | 11 | 10-12 | opt.12 |
| USA | 8-12 | 11-12 | 11-12 | 10-12 | opt. 12 |
| Thailand | 10 | 11 | 11 | 10 and 12 | 12 |

# CURRICULUM LINK


- Detectors are not explicitly in any of our curricula

# PRE-KNOWLEDGE REQUIRED

- Mass spectrometer
- Atomic models (e.g. in Rutherford experiment) -> scintillation detectors
- **What is particle??**
- Behaviour of charged particles in electric fields & magnetic fields
- Radioactivity:
  - α decay, β decay and γ radiation and how to shield from these
  - Types of particles involved in radioactivity

# LEARNING OUTCOMES

s must be able to:

concept of detection in particle physics.
e the type of a particle and its properties from “raw data”
the following types of particles by their properties:
(beta particles)
rticles (helium nuclei)

basics workings of a cloud chamber.
detectors are important and what are there real-world
.
fly how ATLAS and CMS work.

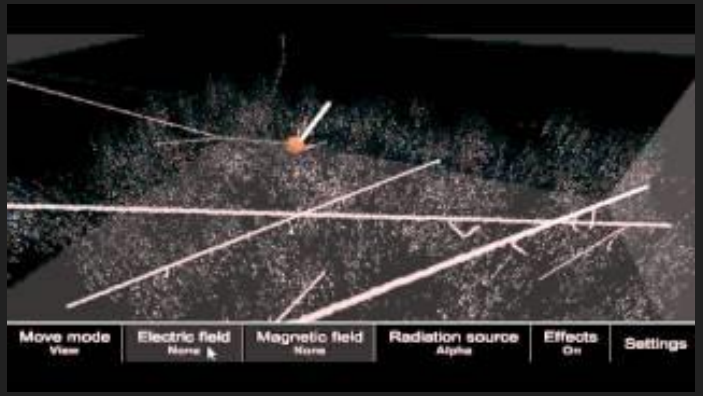
# WHAT MISCONCEPTIONS/CHALLENGES MUST WE ADDRESS?

- Apathy: “Why do we need to learn this?” “When will I ever use this in my life?”
- Difficulty: “This is too difficult?”
- Vocabulary: “What is a detector?” “What is a particle?”
- Varying rules: Which “Right Hand Rule?”
- Attributing human qualities to inanimate objects: “How do detectors “know” what particles are being detected?”

# Example lesson plan (3+1)

**1 Introduction (+1 for building cloud chamber)**

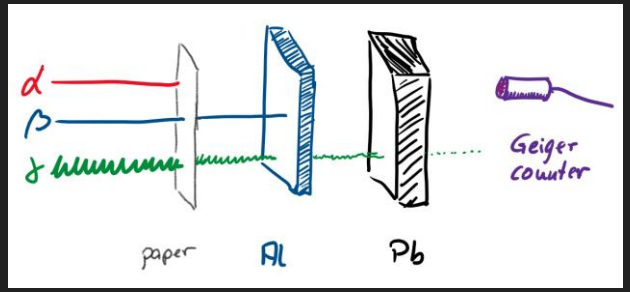
- Engagement with cloud chamber/video/sim



# Example lesson plan (3+1)

**1 Introduction (+1 for building cloud chamber)**

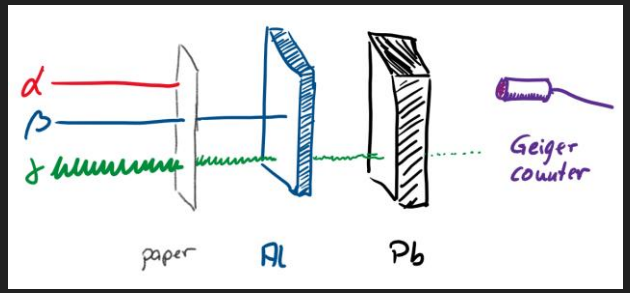
- Engagement with cloud chamber/video/sim
- Show/repeat that in radioactivity, we already did some kind of detection.
- Differentiate particles by penetration behaviour.

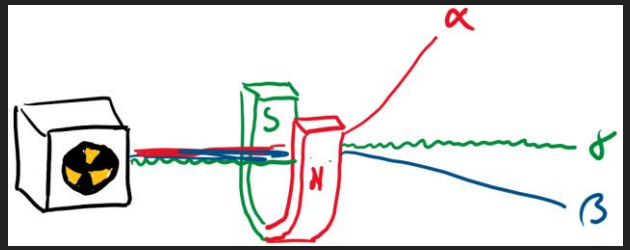


# Example lesson plan (3+1)

**1 Introduction (+1 for building cloud chamber)**

- Engagement with cloud chamber/video/sim
- Show/repeat that in radioactivity, we already did some kind of detection.
- Differentiate particles by penetration behaviour.
- Differentiate particles by their behaviour in a magnetic field.
- Explain the relevant properties of the particles responsible for the behaviour.

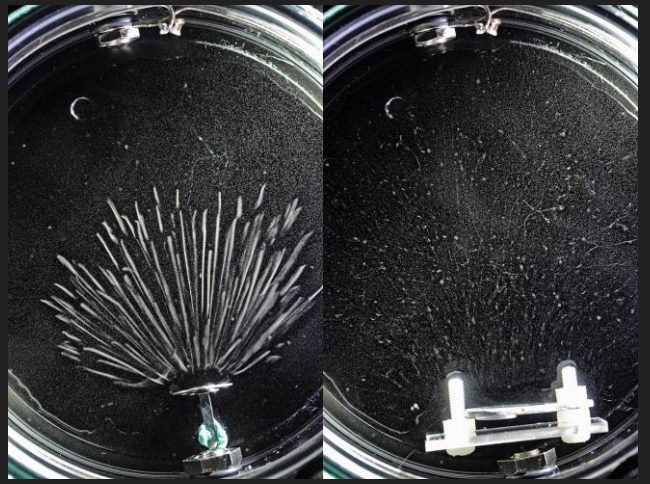


# Example lesson plan (3+1)

## 2 Cloud chamber

- Go back to cloud chamber/video/simulation/…
- Distinguish different types of tracks
  - short & thick (α)
  - thin/jittery (β)
  - (thin/long (μ))



https://en.wikipedia.org/wiki/Cloud_chamber#/media/File:Particle_Tracks_in_AWAN_Expansion_Cloud_Chamber.jpg

# Example lesson plan (3+1)

**2 Cloud chamber**

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- (if possible) add magnetic field, discuss change of tracks)

https://www.leifiphysik.de/kern-teilchenphysik/radioaktivitaet-einfuehrung/ausblick/typische-nebelkammeraufnahmen

# Example lesson plan (3+1)

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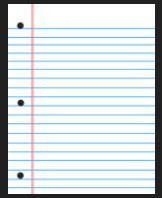
**3 Application/Assessment**

…

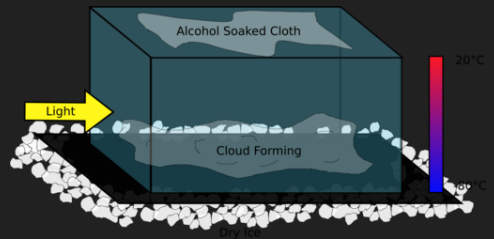
https://www.leifiphysik.de/kern-teilchenphysik/radioaktivitaet-einfuehrung/ausblick/typische-nebelkammeraufnahmen

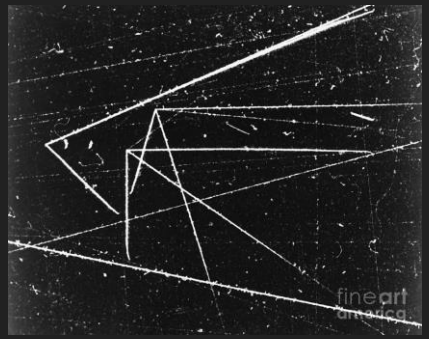
# TEACHING STRATEGIES

- Paper survey.



- Show phenomena (in-person, videos, pictures) and ask questions.



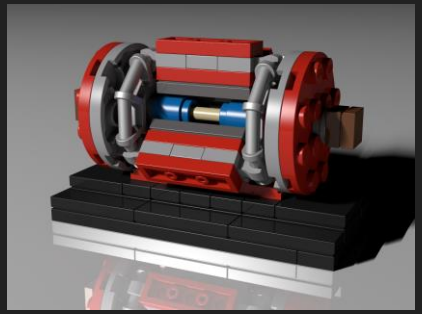
- Use interactive applications to test their knowledge (Kahoot, Mentimeter).

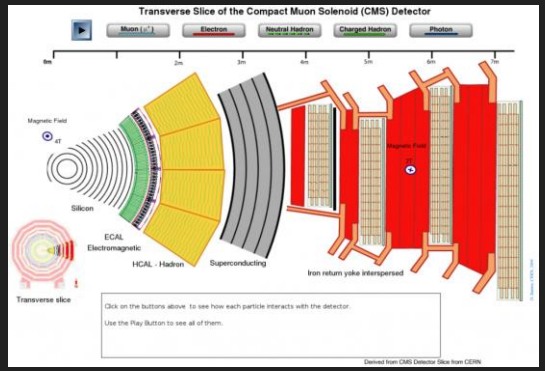
Kahoot!

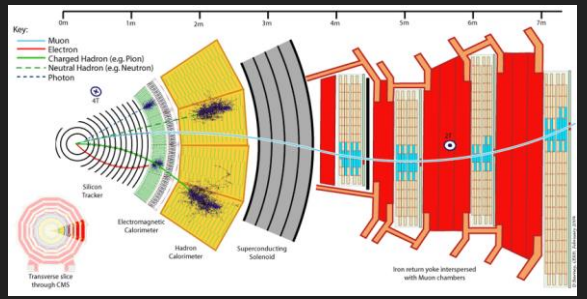
Mentimeter

# LEARNING ASSESSMENTS

- LEGO Detectors
  - Present via video with voiceover, in front of the class with slides, or posters
  - Students would have to explain what each part of the detector is and why it is being used
- Picture of cross sections of CMS/ATLAS without tracks
  - Draw tracks of different particles, explain why the tracks are drawn that way (including characteristics of particles and the characteristics of the different layers of the machines being used).
- Picture of cross sections of CMS/ATLAS with simplified tracks
  - Ask students to explain what they can infer from the tracks (charge, mass, etc.)





Questions?