

An Interactive Learning Unit about PET

Positron-Emission-Tomography



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Interactive learning units are a new, virtual, and versatile format for classroom and distance learning

MOTIVATION



COVID-related challenges for our visitors to come to CERN

Enhancement of our online offers beyond the pandemic times



Extension of the hands-on PET workshop in our lab



AIM #1

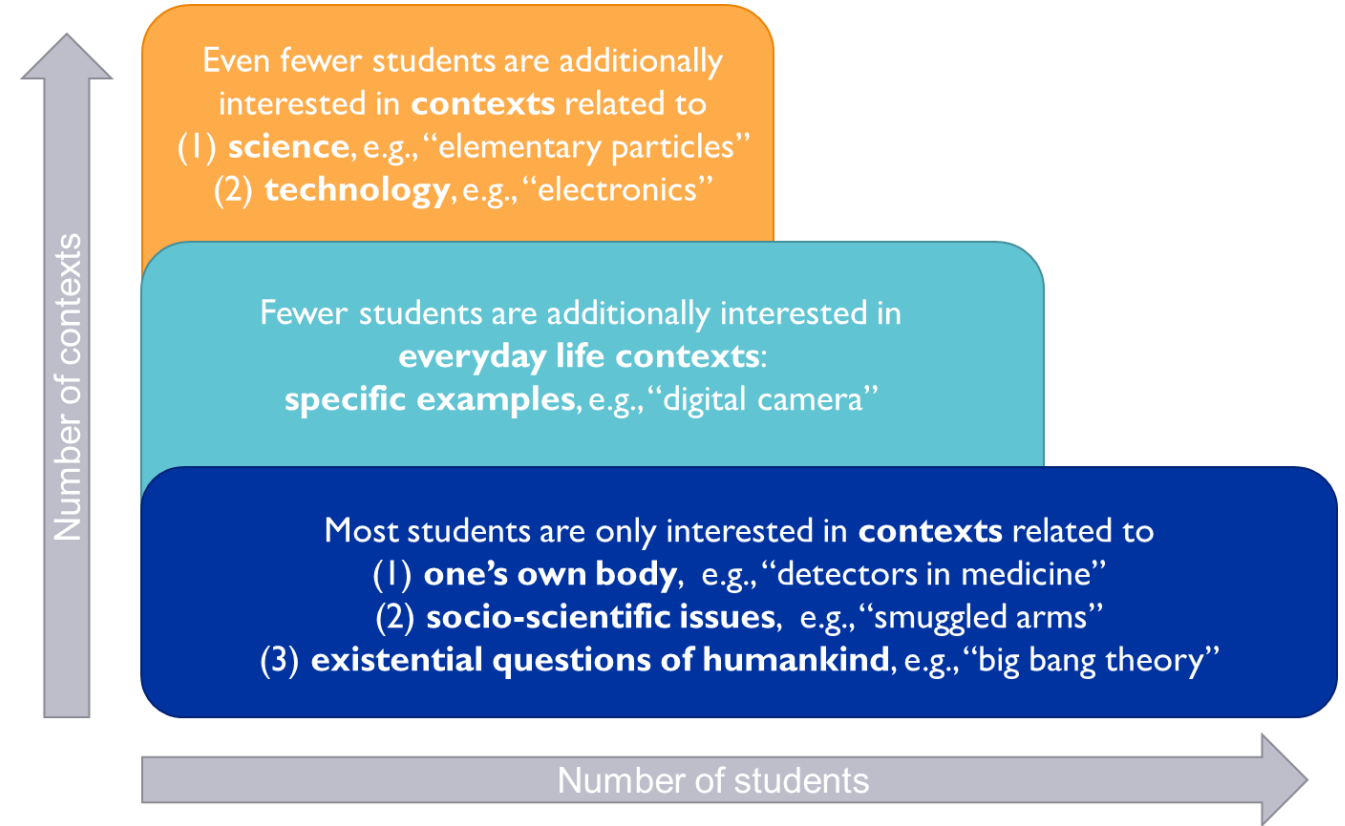
Foster students' interest in particle physics!

- **Past empirical studies:**
Most students are interested in medical contexts

OECD (2016), Levrini et al. (2017)

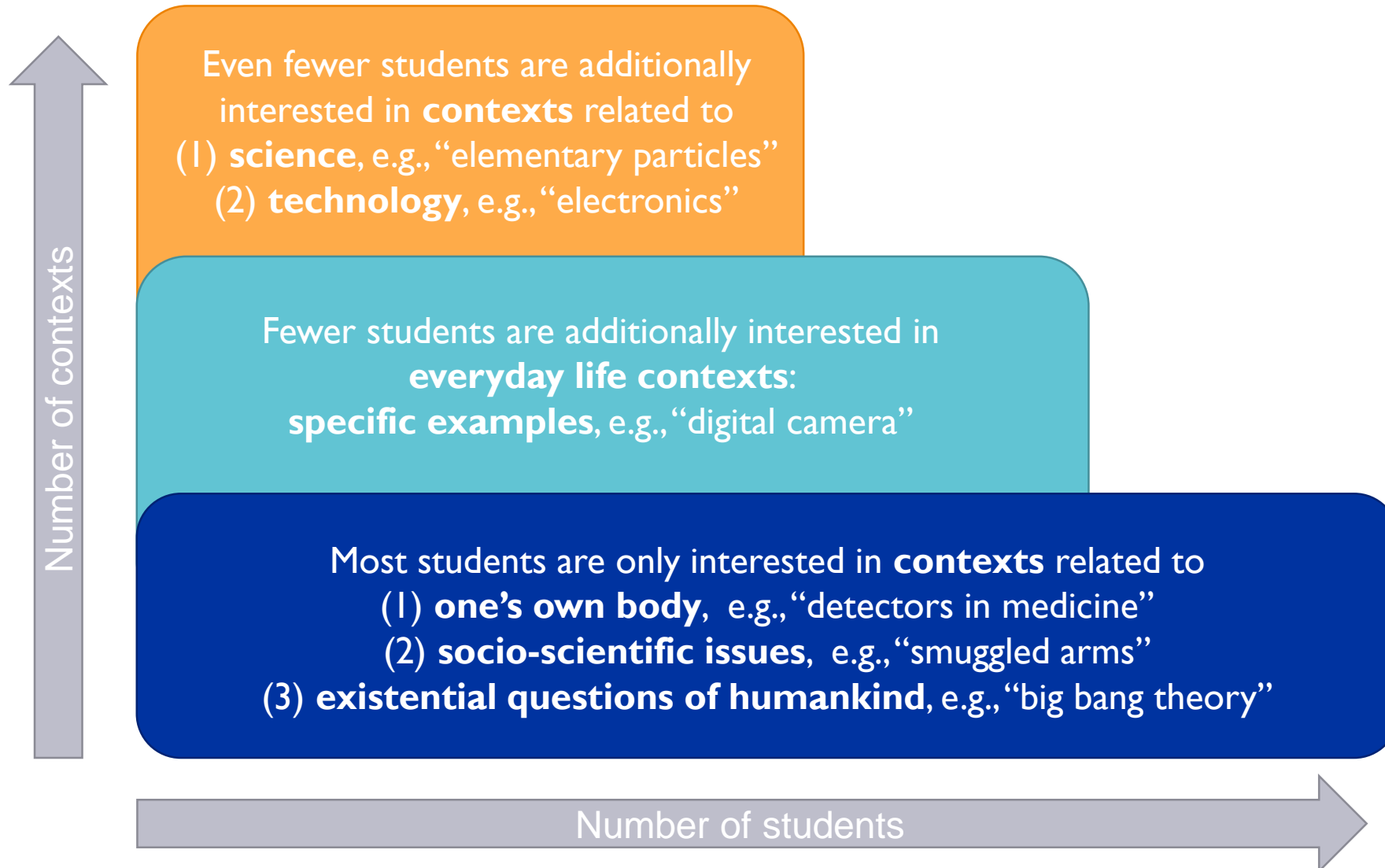
- **My PhD project:**
Conceptualisation of interest in Particle Physics

Zöchling et al. (2022)



This conceptualisation of interest in particle physics is valid for 79% of students

Conceptualisation of Interest in Particle Physics



AIM #2

Easy to use for teachers in classroom and distance learning

- **Duration:** 2 school lessons
- Can be done on one's **own laptop or tablet**, in the **school IT room** or with **school tablets**
- **Target age:** 16+



AIM #2

Easy to use for teachers in classroom and distance learning

- **Format:** H5P Module
 - ⇒ Can be easily **embedded in learning platforms** (e.g., Moodle, Blackboard, Brightspace, ...)
- **Link:** cern.ch/petworkshop



Examples for Anchoring in Curricula

Austria

Secondary School

Grade 12

medical applications

Germany

Secondary School *in Baden-Württemberg*

Grades 9 and 10

medical applications

USA

Next Generation Science Standards *K-12 in 26 states*

Grades K-12

„The use of various applications of science, such as medicine, [...] would nicely facilitate student interest”

LANGUAGE

- **English**
- **Subtitles in different languages**





STRUCTURE

STRUCTURE

Explanatory Videos

$e^+ + e^- \rightarrow 2\gamma$
Total momentum = 0
Momentum conservation

4:56 / 7:57
Coincidence Measurements 4 / 8

STRUCTURE

Experiment Videos

The video shows a woman with long brown hair and a CERN lanyard sitting at a desk. On the desk is a laptop with the CERN logo, a power supply unit, and a detector. An inset window in the top right of the video displays a graph of the number of photons versus photon energy in keV. The graph shows a series of peaks, with a prominent one at approximately 511 keV. A note in the graph says "Note: fast forward".

Number of photons

Photon energy [keV]

Note: fast forward

2:49 / 6:03

Energy Spectrum

3 / 8

STRUCTURE

Interactive Elements

Photon energy [keV]

Which spectrum of photon energies do you expect to be produced by the Sodium-22 source, A or B? And why?

- A
- B
- There will be many detected photons with an energy of 511 keV. These are emitted when the Neon passes from excited state into

Energy Spectrum 3 / 8

Quizzes

Would you like to know how a multichannel analyser works?

Yes, please! :D

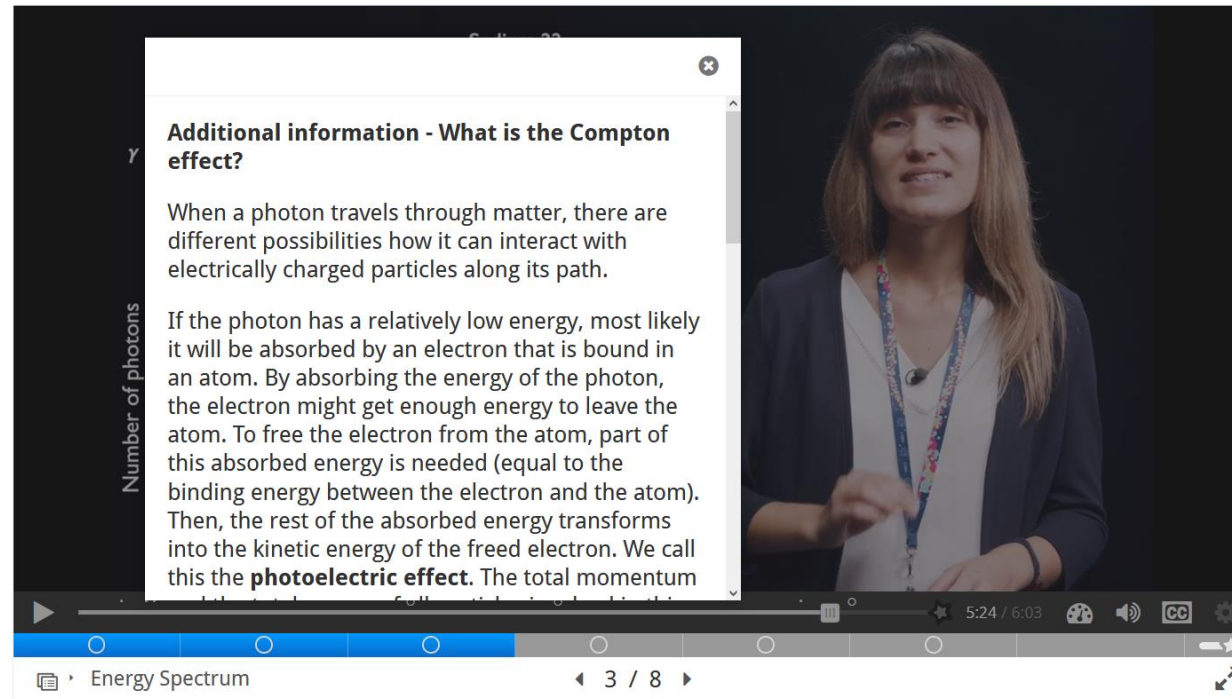
No, I would like to skip this!

Experimental Setup 2 / 8

Shortcuts

STRUCTURE

Interactive Elements



The screenshot shows a video player interface. On the right, a woman with long brown hair is speaking. On the left, a white text box is overlaid on the video. The text box has a title 'Additional information - What is the Compton effect?' and two paragraphs of text. The first paragraph explains that photons can interact with charged particles in different ways. The second paragraph describes the photoelectric effect, where a photon's energy is used to free an electron from an atom, and the remaining energy becomes the electron's kinetic energy. The video player controls at the bottom show a progress bar, a play button, and a timestamp of 5:24 / 6:03. Below the video player, the text 'Energy Spectrum' and '3 / 8' are visible.

Additional information - What is the Compton effect?

When a photon travels through matter, there are different possibilities how it can interact with electrically charged particles along its path.

If the photon has a relatively low energy, most likely it will be absorbed by an electron that is bound in an atom. By absorbing the energy of the photon, the electron might get enough energy to leave the atom. To free the electron from the atom, part of this absorbed energy is needed (equal to the binding energy between the electron and the atom). Then, the rest of the absorbed energy transforms into the kinetic energy of the freed electron. We call this the **photoelectric effect**. The total momentum

Additional Information

STRUCTURE

Interactive PET Experiment

The image displays two side-by-side interactive PET experiment panels. Each panel features a top-down view of a human brain within a circular field of view. Below the brain, there is a digital display for 'COINCIDENCE COUNT' and a set of control buttons.

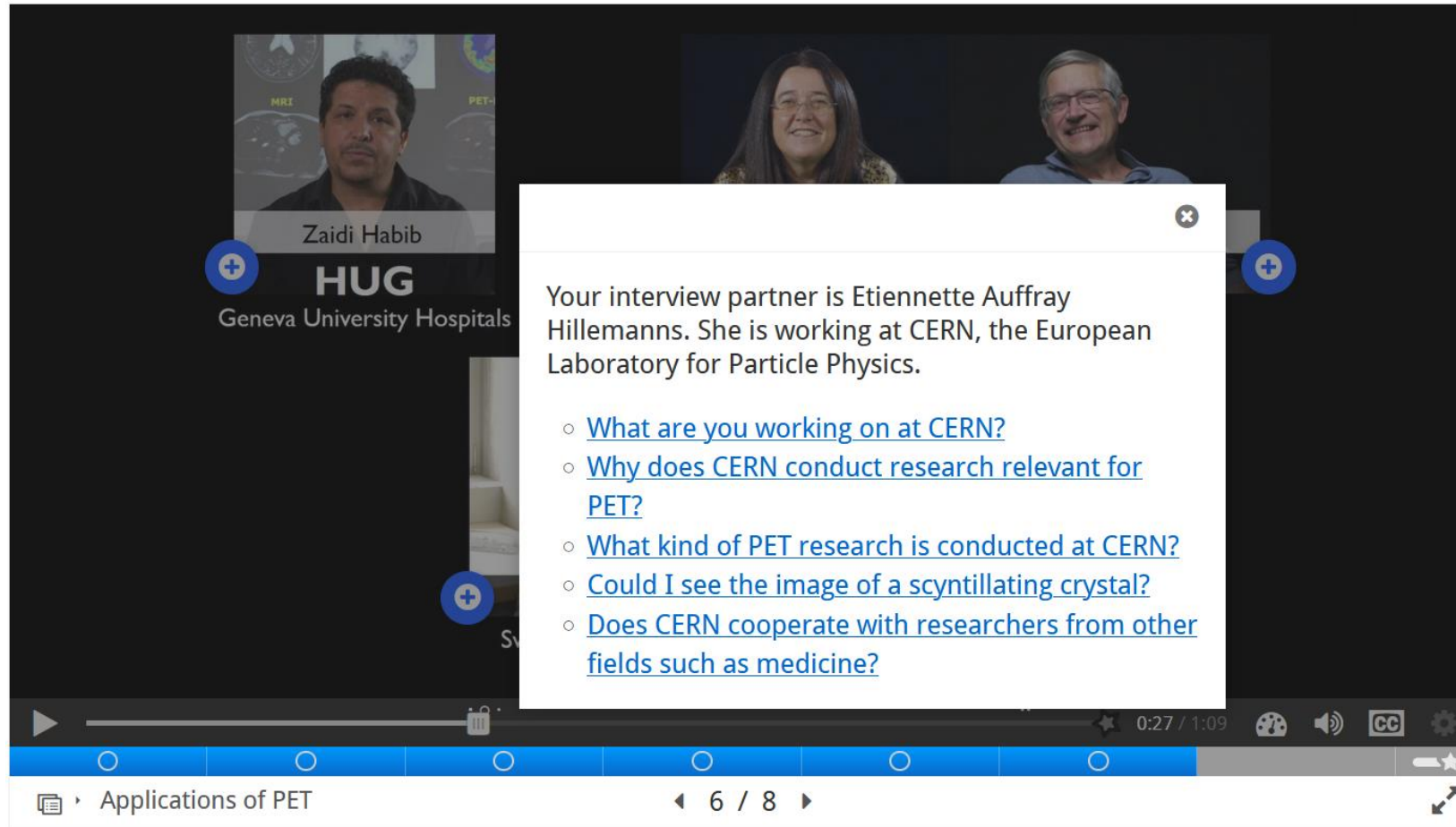
Left Panel: The brain is centered. The coincidence count is 0020. The control buttons are: Draw Line, Delete Last Line, Delete All Lines, Check, Restart.

Right Panel: A yellow line is drawn across the brain, connecting two points on the circular boundary. The coincidence count is 1048. The control buttons are: Draw Line, Delete Last Line, Delete All Lines, Check, Restart.

A large blue arrow labeled "High Coincidence Count" points from the left panel to the right panel, indicating that the coincidence count increases as the line is drawn across the brain.

STRUCTURE

Interviews with Experts



Zaidi Habib
HUG
Geneva University Hospitals

Your interview partner is Etiennette Auffray Hillemanns. She is working at CERN, the European Laboratory for Particle Physics.

- [What are you working on at CERN?](#)
- [Why does CERN conduct research relevant for PET?](#)
- [What kind of PET research is conducted at CERN?](#)
- [Could I see the image of a scyntillating crystal?](#)
- [Does CERN cooperate with researchers from other fields such as medicine?](#)

0:27 / 1:09

Applications of PET 6 / 8

NEXT STEPS



- ❖ **Subtitles:**
Adding further languages

- ❖ **Advertisement:**
Spreading the Interactive Learning Unit about PET among educators worldwide

- ❖ **Physics Education Research:**
Panagiota's PhD project aims
 - to **evaluate** the Interactive Learning Unit about PET and
 - to **develop** further Interactive Learning Units



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Thank you very much for your attention!

Looking forward to your comments and questions!



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Back-up Slides

Examples for Anchoring in Curricula

Austria

Secondary School

Grade 12

Nuclear Physics:

- natural radioactivity,
- ionising radiation,
- medical applications

Particle Physics

Germany

Secondary School *in Baden-Württemberg*

Grades 9 and 10

Structure of matter:

- ionising radiation
- medical applications

USA

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