

# 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**





**PET is an application of particle detectors in medical diagnostics**  
(e.g., to find a brain tumour)

# SCHEDULE

**14:00-14:20**  
**Introduction**

**14:30-15:20**  
**Virtual PET**  
**Learning Unit**

**15:30-16:15**  
**1) Breakout Rooms**  
**2) Plenary Discussion**

# MOTIVATION



COVID-related challenges for our visitors to come to CERN



Enhancement of our online offers beyond the pandemic times



An Interactive Learning Unit about PET | Sarah Zoechling



Extension of the hands-on PET workshop in our lab

# AIM #1

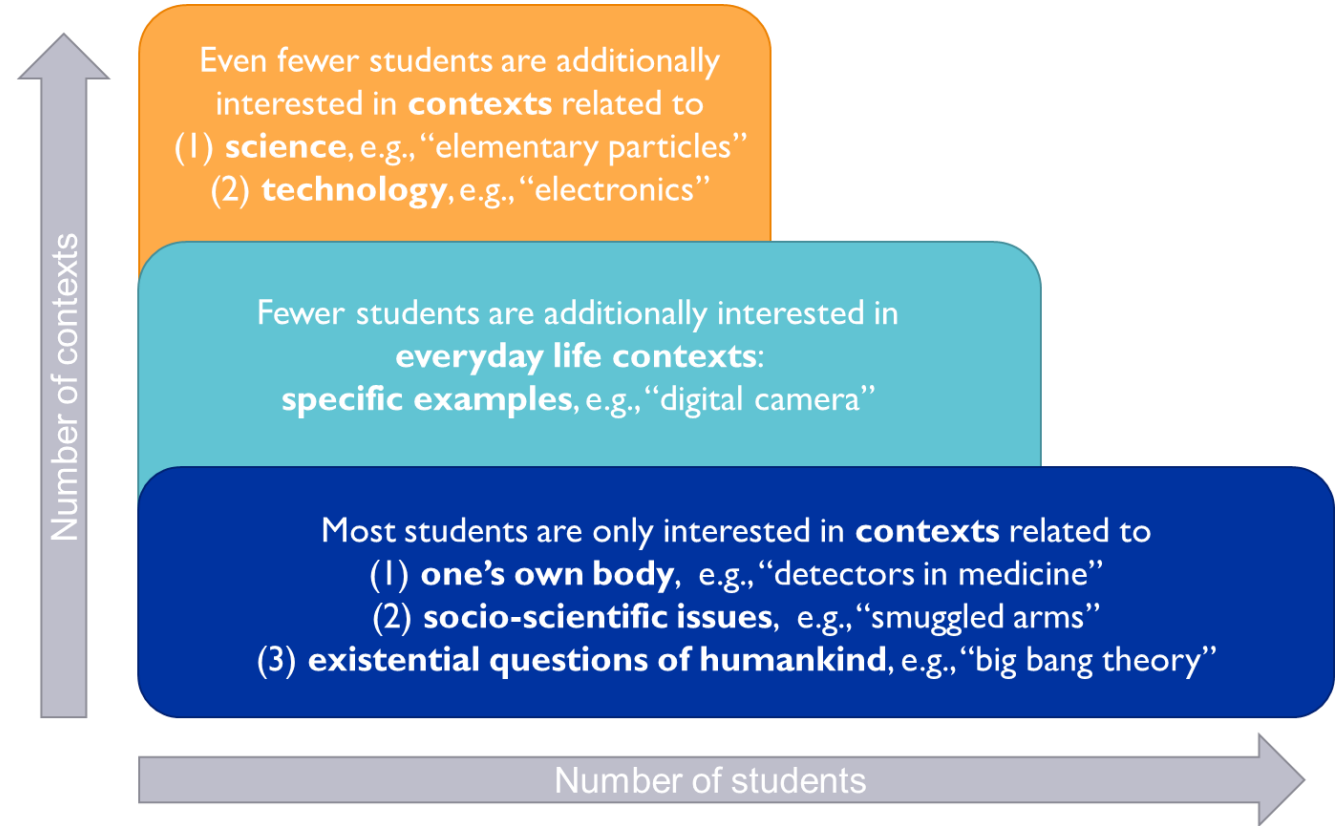
## Foster students' interest in particle physics!

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

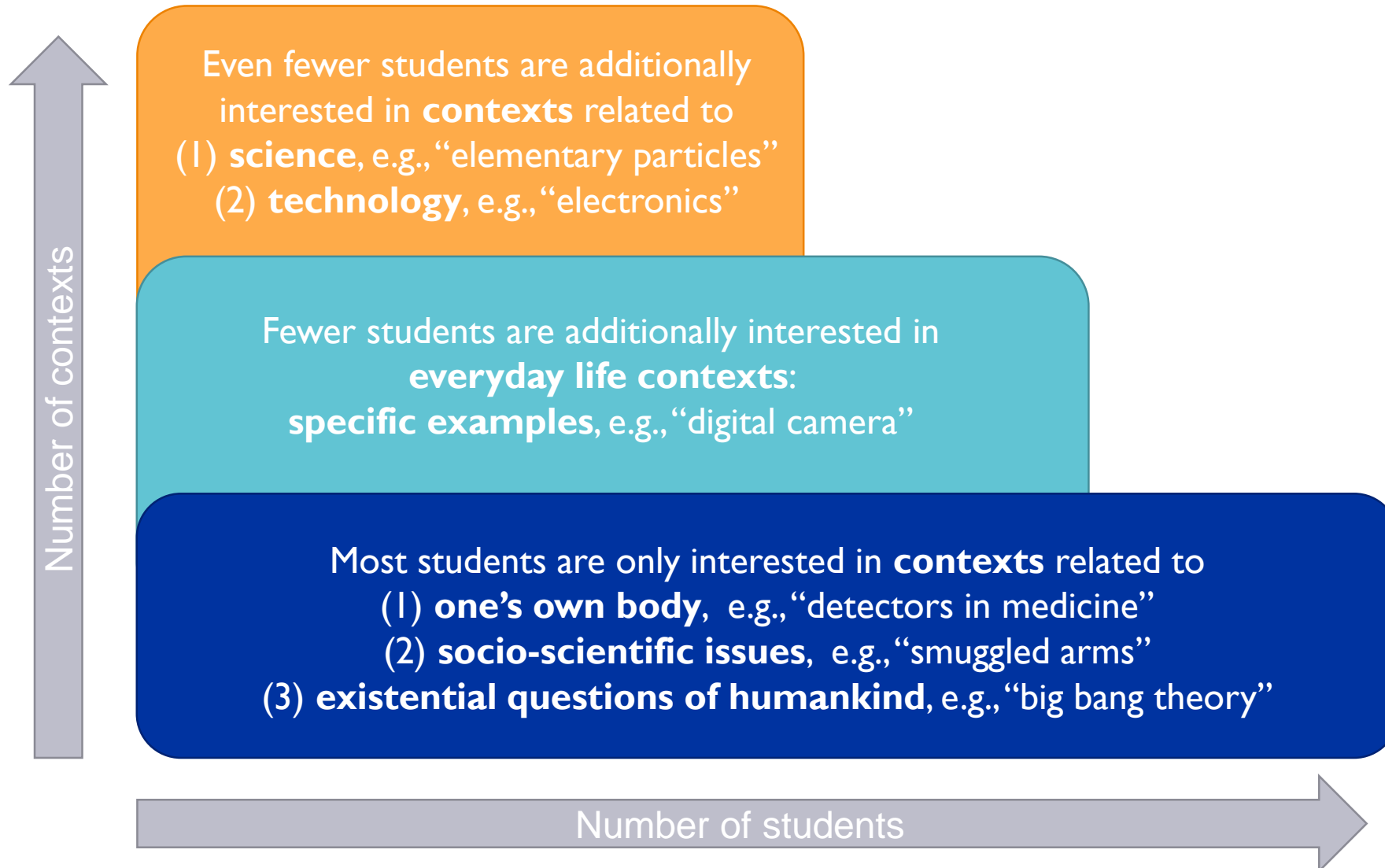
OECD (2016), Levrini et al. (2017)

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

Zöchling et al. (2022)



# 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](https://cern.ch/petworkshop)



# 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

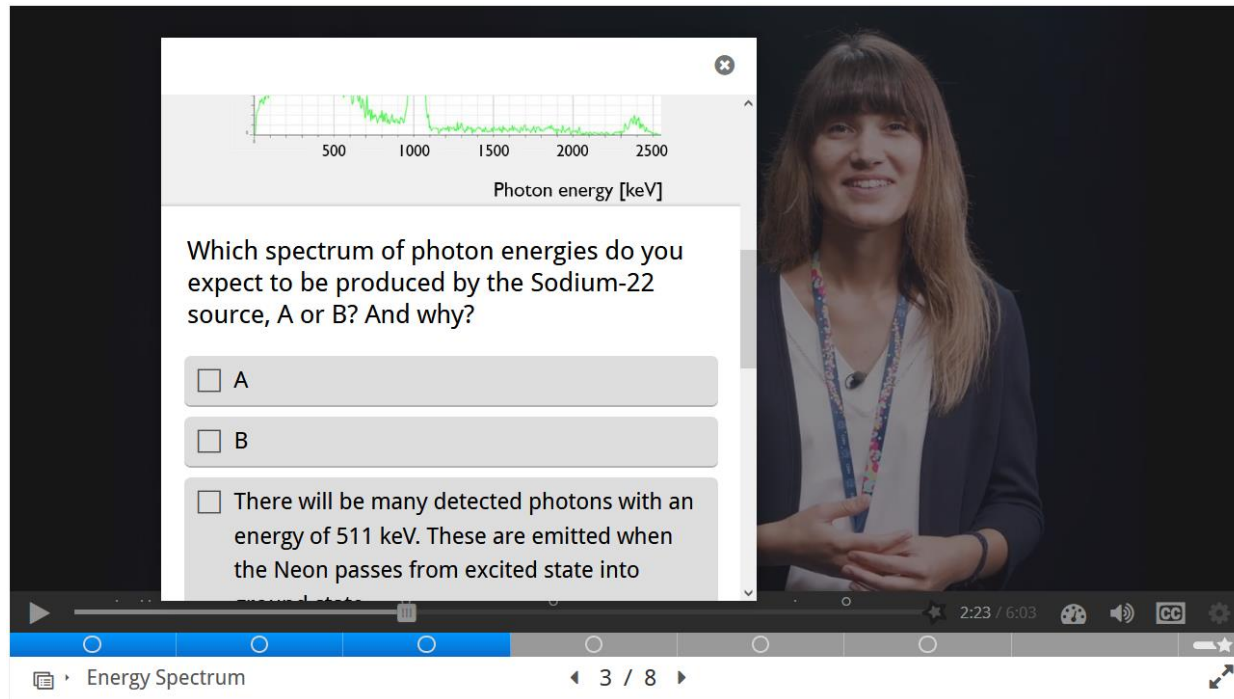
# STRUCTURE

## Experiment Videos

The video shows a woman with long brown hair and a dark blazer 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 corner 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 above the graph says "Note: fast forward". The video player interface at the bottom shows a progress bar at 2:49 / 6:03, a page indicator for 3 / 8, and a title "Energy Spectrum".

# STRUCTURE

## Interactive Elements



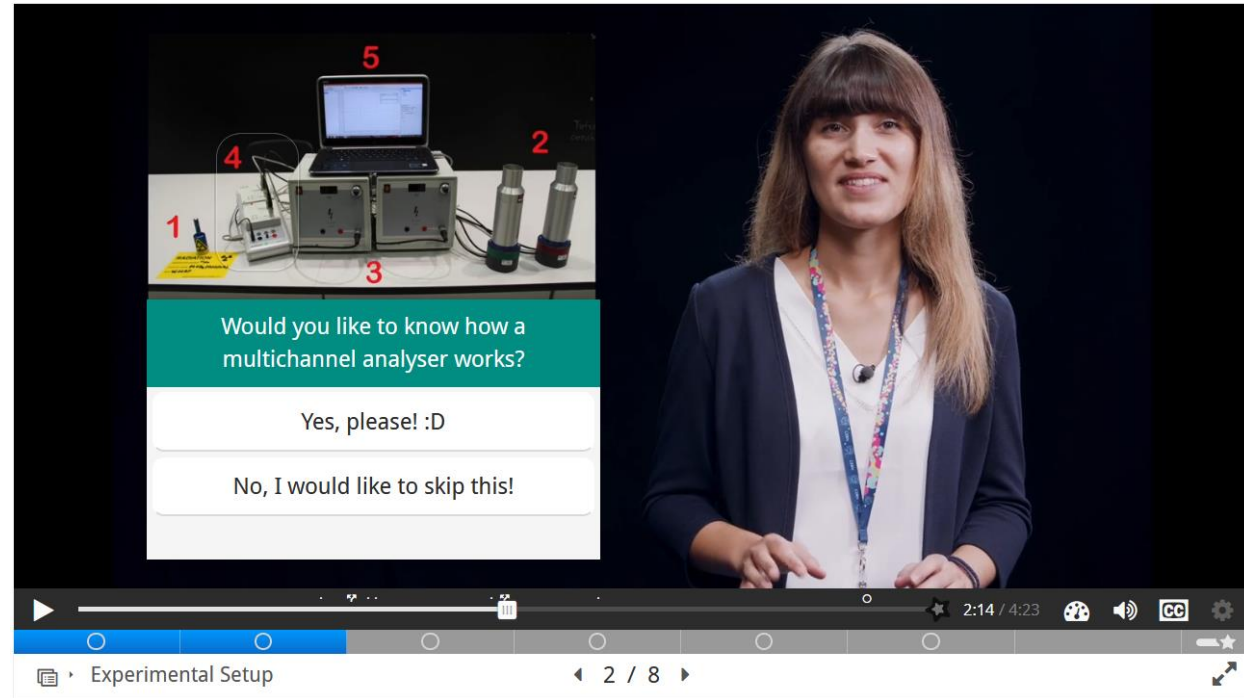
Photon energy [keV]

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

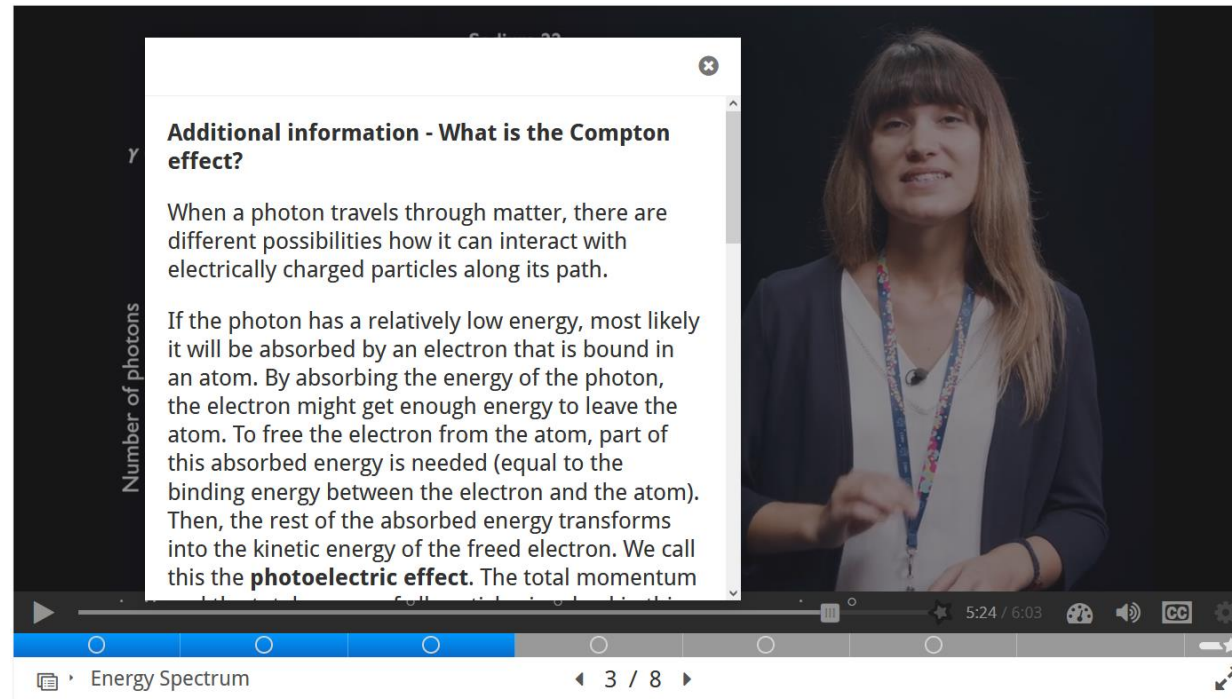
No, I would like to skip this!

Experimental Setup 2 / 8

## Shortcuts

# STRUCTURE

## Interactive Elements



The screenshot shows a video player interface. On the left, a vertical axis is labeled "Number of photons" with a Greek letter gamma ( $\gamma$ ) next to it. A white text box is overlaid on the video, containing the following text:

**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

The video player shows a progress bar at the bottom with a timestamp of 5:24 / 6:03. Below the video player, the text "Energy Spectrum" and "3 / 8" are visible.

### Additional Information

# STRUCTURE

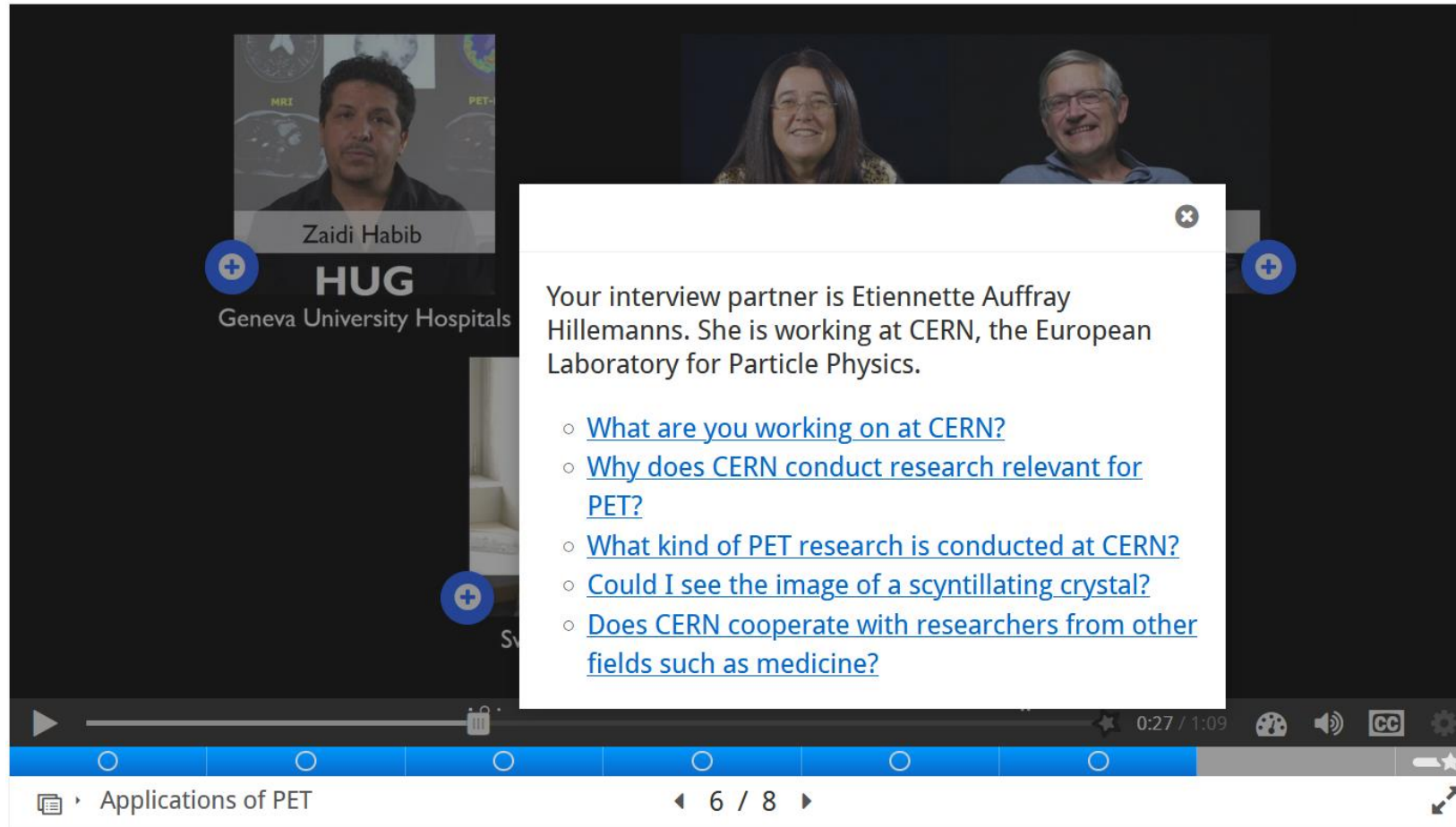
## Interactive PET Experiment

The image displays two side-by-side interactive PET experiment screens. Each screen features a brain scan within a circular field of view. The left screen shows a baseline state with two small grey dots on the circle's perimeter. Below the brain, a digital display shows '0020' under the heading 'COINCIDENCE COUNT' and 'Number of detected photons in coincidence'. The right screen shows a 'High Coincidence Count' state, indicated by a blue arrow pointing from the left. A yellow line connects two grey dots on the circle's perimeter, passing through the brain. Below this brain, the digital display shows '1048' under the same heading. Both screens have a control bar at the bottom with buttons for 'Draw Line', 'Delete Last Line', 'Delete All Lines', 'Check', and 'Restart'.



# 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



**Time for you to try out the Virtual PET Learning Unit!**

# ACTIVE PHASE: Virtual PET Learning Unit

Duration: 1h

## Tasks:

- ❖ Try out the **Virtual PET Learning Unit** ([cern.ch/petworkshop](https://cern.ch/petworkshop))!
- ❖ **Write down your feedback** to the **Virtual PET Learning Unit** in the respective categories on our Padlet (<https://padlet.com/sarahzochling/PETLearningUnit>)!
- ❖ Take a **break!**

⇒ *Afterwards you will have to opportunity to discuss your feedback in breakout rooms and in plenary.*

# DISCUSSION: Virtual PET Learning Unit

## Breakout rooms:

Discuss your comments using your notes from the Padlet in breakout rooms (duration: 10 min)!

## Categories:

- Presentation of physics – appropriate?
- Context – interesting?
- Use in lessons – easy?
- Open questions
- General comments



# DISCUSSION: Virtual PET Learning Unit

## Plenary :

Which discussion points from the breakout rooms would you like to discuss in plenary?

## Categories:

- Presentation of physics – appropriate?
- Context – interesting?
- Use in lessons – easy?
- Open questions
- General comments





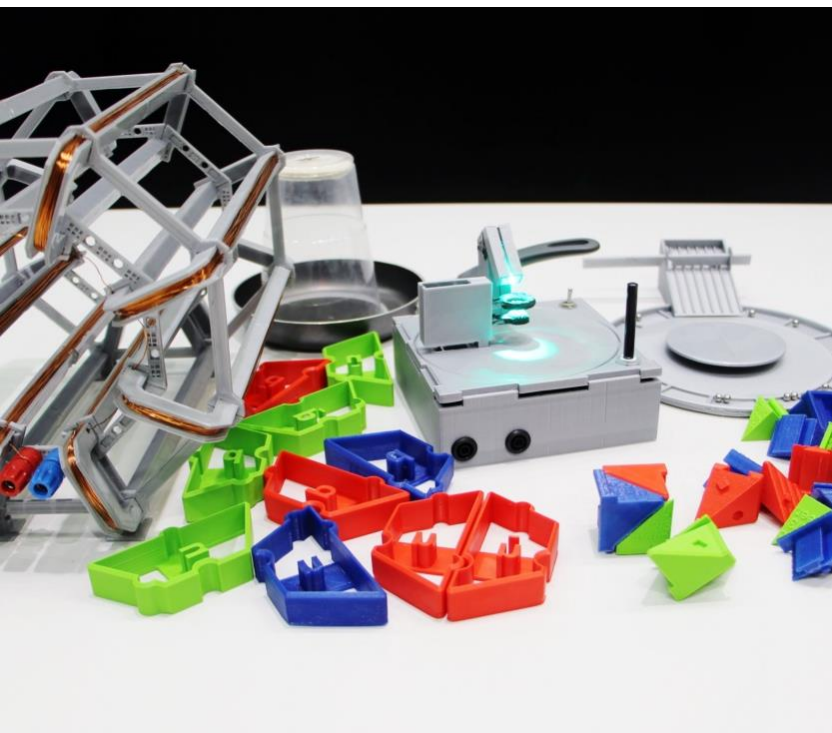
# Thank you for your feedback!

Will you use the Virtual PET Learning Unit in your lessons?



# OTHER ACTIVITIES

[cern.ch/scool](https://cern.ch/scool) [cern.ch/visit](https://cern.ch/visit) [cern.ch/per](https://cern.ch/per)



(3D printable) experiment ideas and videos for your lessons

Virtual CERN visits and introduction talks



Virtual science shows

# Thank you for your attention!

If you have any further comments and questions,  
please contact me via email!



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# References

Levrini, O., De Ambrosis, A., Hemmer, S., Laherto, A., Malgieri, M., Pantano, O., & Tasquier, G. (2017). Understanding first-year students' curiosity and interest about physics—Lessons learned from the HOPE project. *European Journal of Physics*, 38(2), 025701. <https://doi.org/10.1088/1361-6404/38/2/025701>

OECD (2016). *PISA 2015 results (Volume I): Excellence and equity in education*. PISA, OECD Publishing. <https://doi.org/10.1787/9789264266490-en>

Zöchling, S., Hopf, M., Woithe, J. & Schmeling, S. (2022). MAKE IT MATTER: How to foster interest in particle physics by setting it in meaningful contexts. *PoS (EPS-HEP2021)*, 889.