



Hands-on Experiments for the Classroom and Home



Fabian Bernstein, Oliver Keller
IR-ECO-TSP | S'Cool LAB
fabian.bernstein@cern.ch
oliver.michael.keller@cern.ch





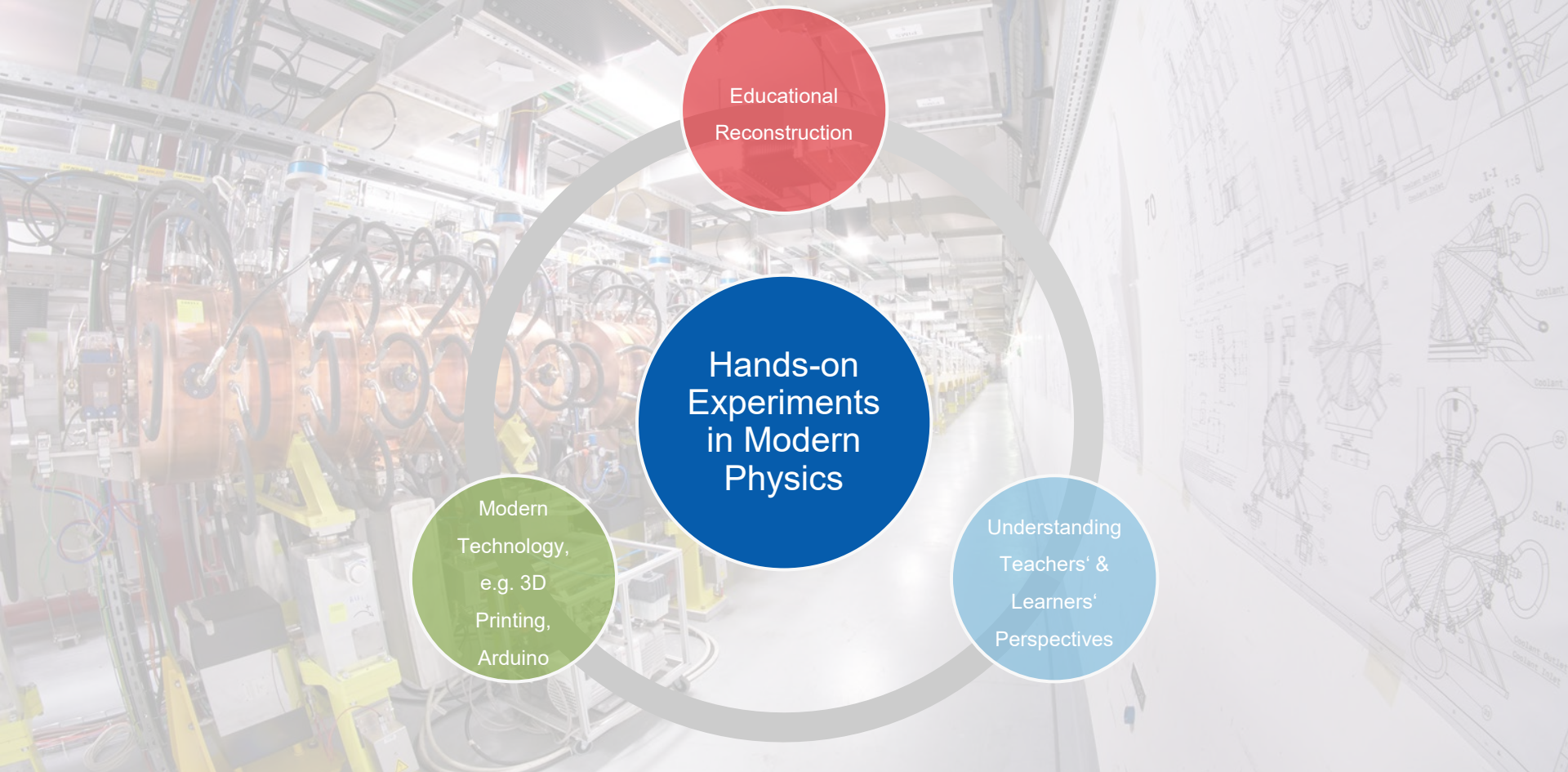
Complexity

Hands-on
Experiments
in Modern
Physics

Limited
Ressources

Diverse
context of use





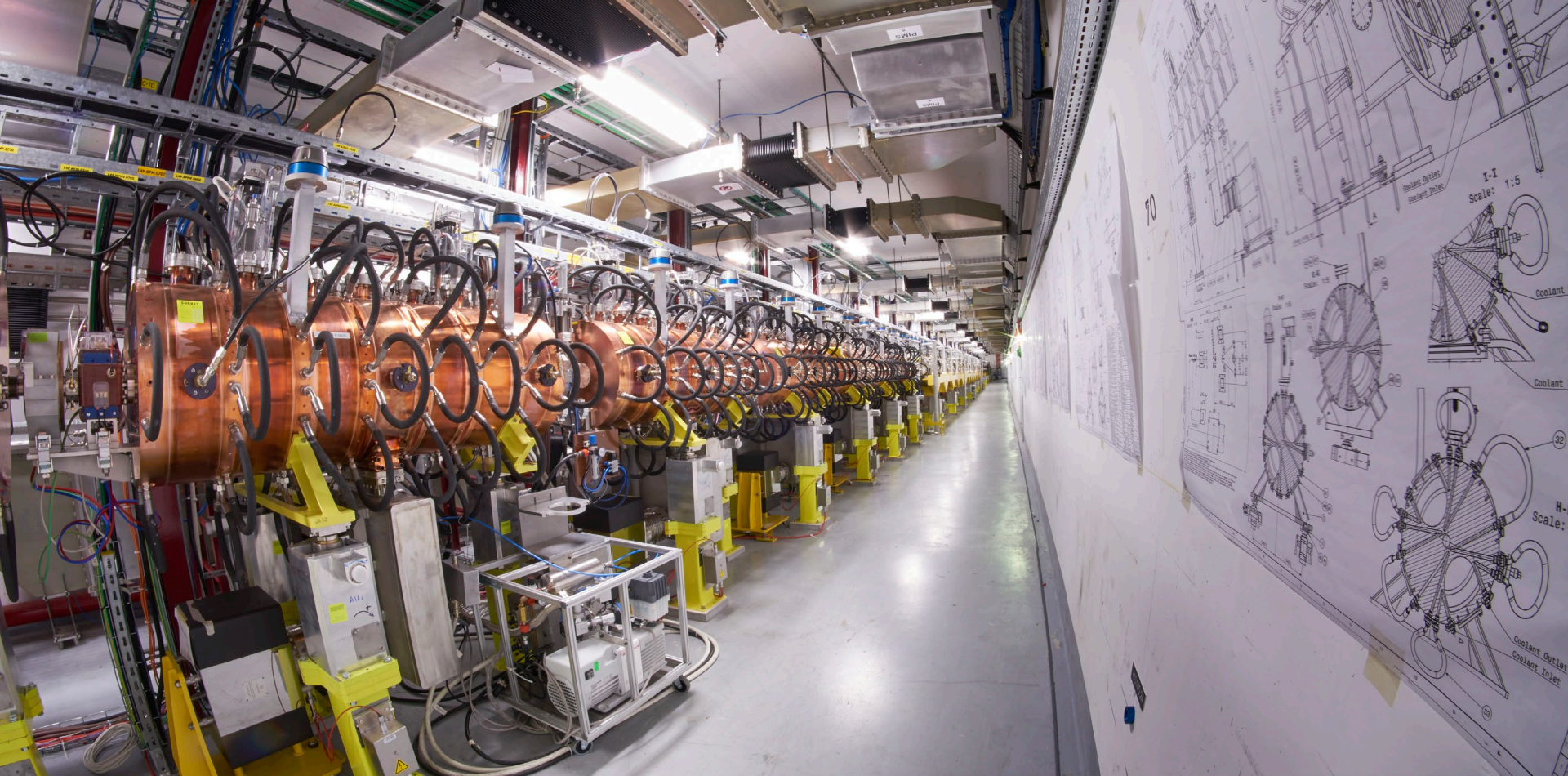
Educational
Reconstruction

Hands-on
Experiments
in Modern
Physics

Modern
Technology,
e.g. 3D
Printing,
Arduino

Understanding
Teachers' &
Learners'
Perspectives





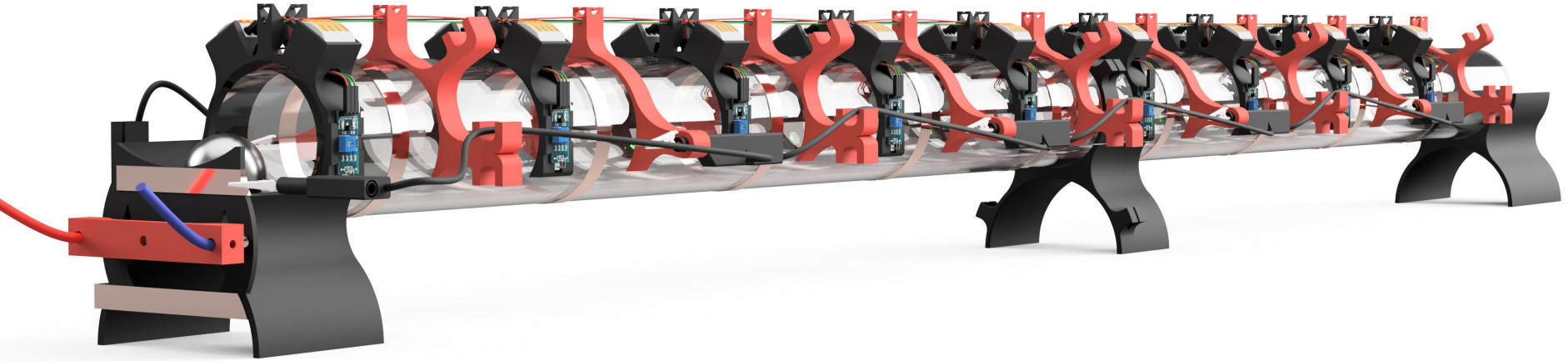


International Relations
Relations internationales

12/8/2020

Fabian Bernstein
Oliver Keller

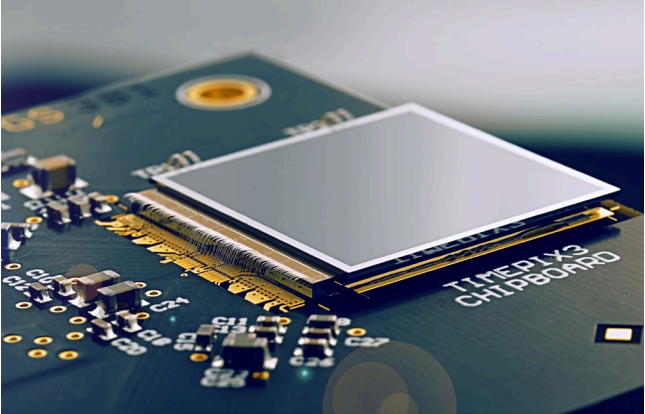




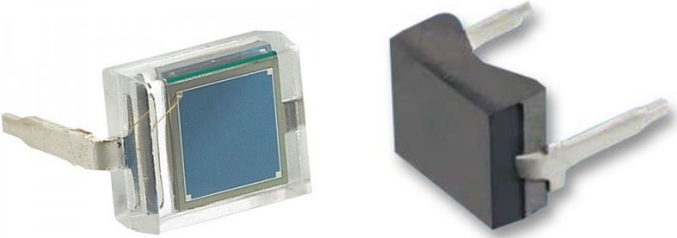
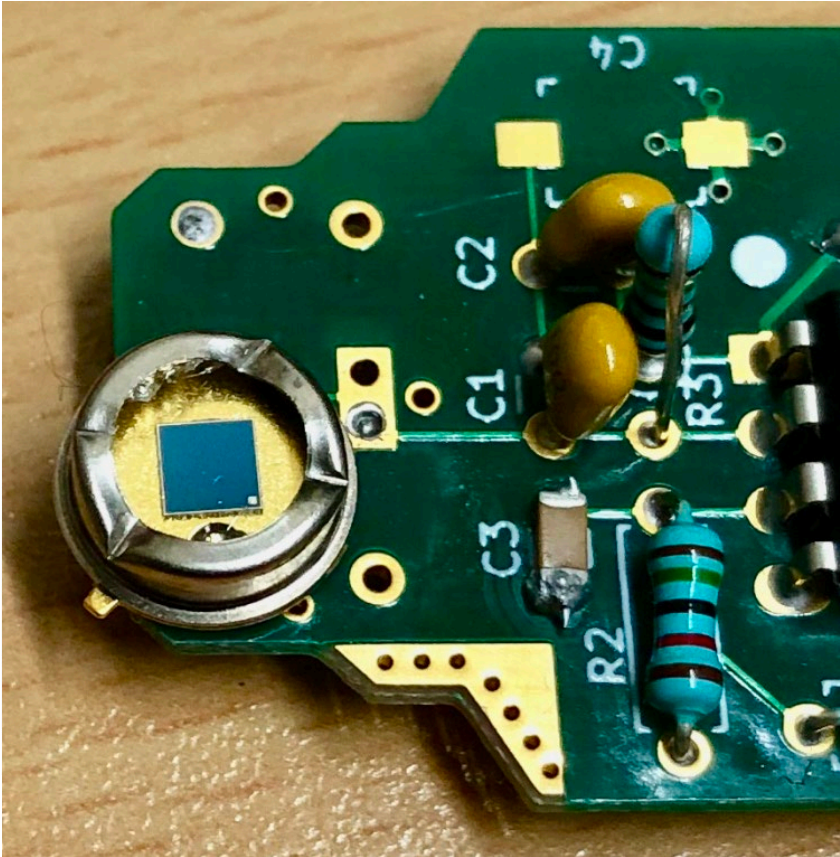
*”Ein LINAC zum Selberbauen –
Funktionales Modell eines elektrostatischen Linearbeschleunigers”
Journal: Unterricht Physik (engl. article in preparation)*



Modern Particle Detectors for Education



Silicon pixel detectors:
Visualisation & characterisation of particles





CERN
@CERN

...

🔧 Did you ever want to make your own particle detector?

Here is your chance! Build this low-cost open hardware project, investigate natural radioactivity around you and become a true citizen scientist: scoollab.web.cern.ch/diy-particle-d...

🔗 Visit scoollab.web.cern.ch

How to make your own real particle detector!

▶ 64.9K views 0:00 / 0:38 🔊 ↗

Build your own particle detector!

5:58 pm · 13 May 2020 · Twitter Media Studio

709 Retweets 104 Quote Tweets 1.9K Likes



International Relations
Relations internationales

12/8/2020

Fabian Bernstein
Oliver Keller





🔧 Did you ever want to make your own particle detector?

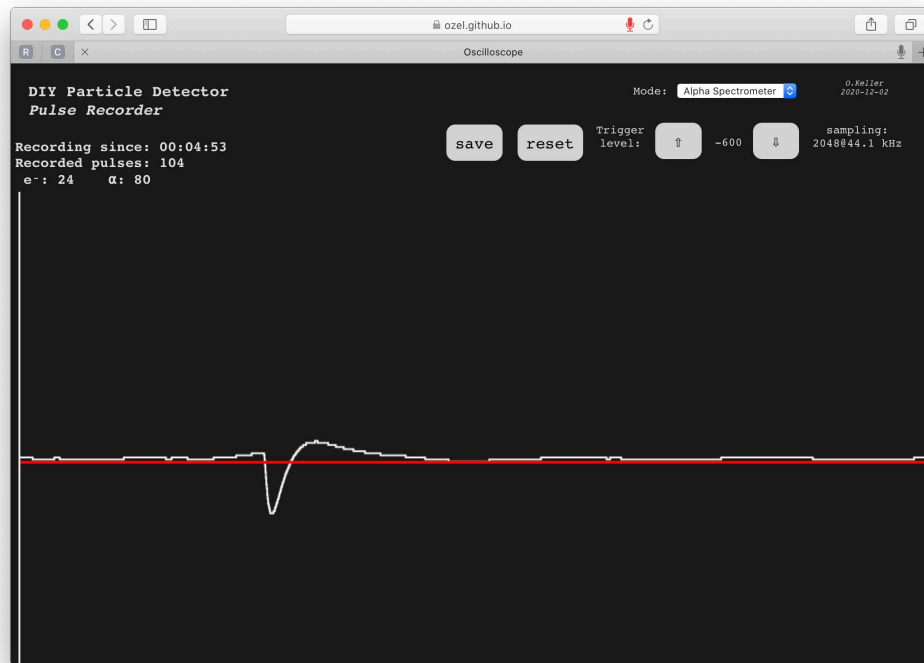
Here is your chance! Build this low-cost open hardware project, investigate natural radioactivity around you and become a true citizen scientist: scoollab.web.cern.ch/diy-particle-d...



Build your own particle detector!

5:58 pm · 13 May 2020 · Twitter Media Studio

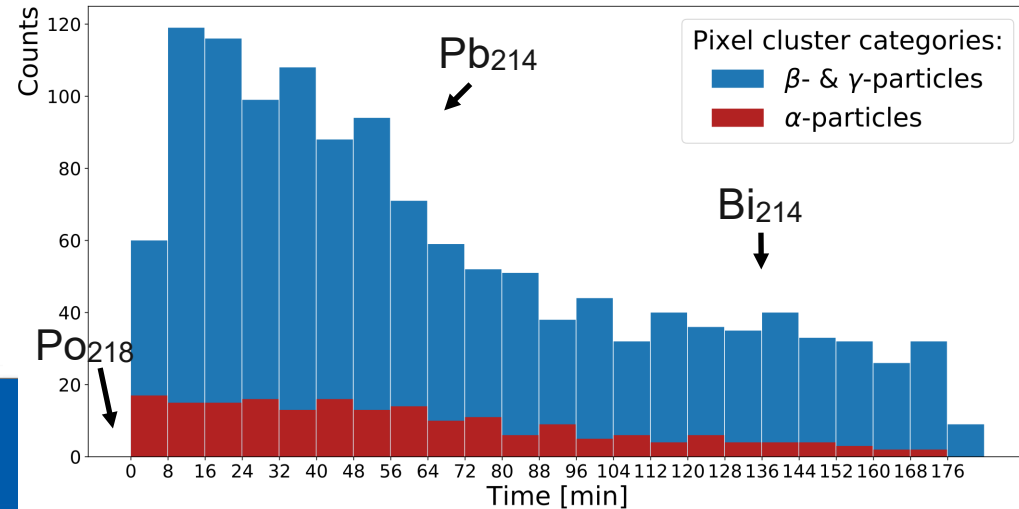
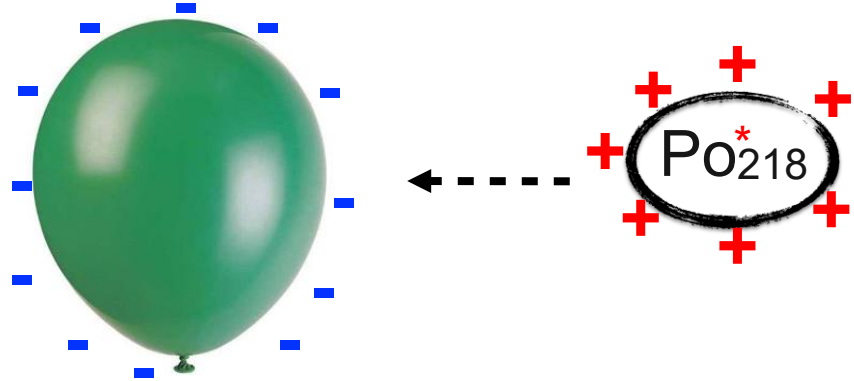
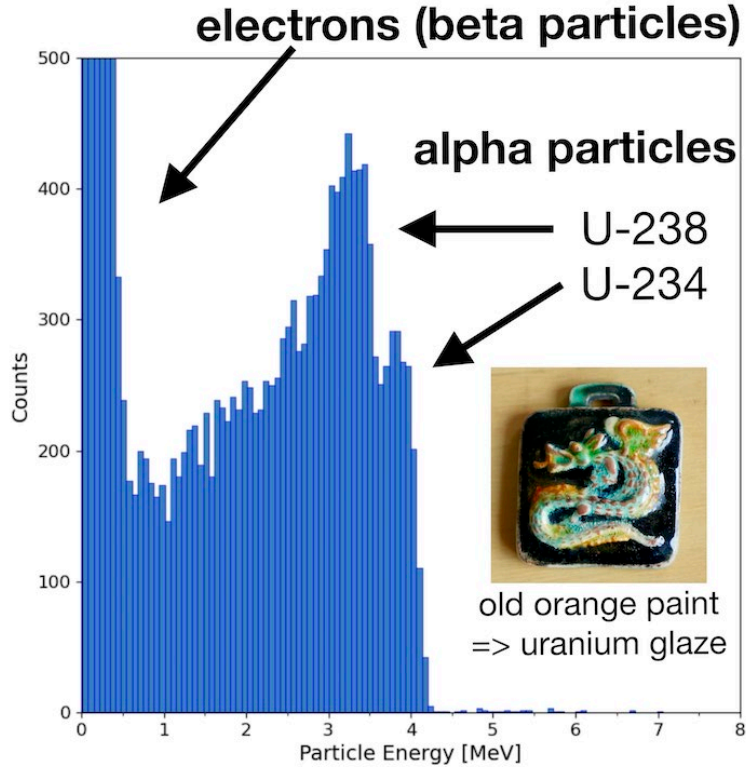
709 Retweets 104 Quote Tweets 1.9K Likes



Measurements via headset/microphone connection and browser “oscilloscope” app on Smartphone/Laptop



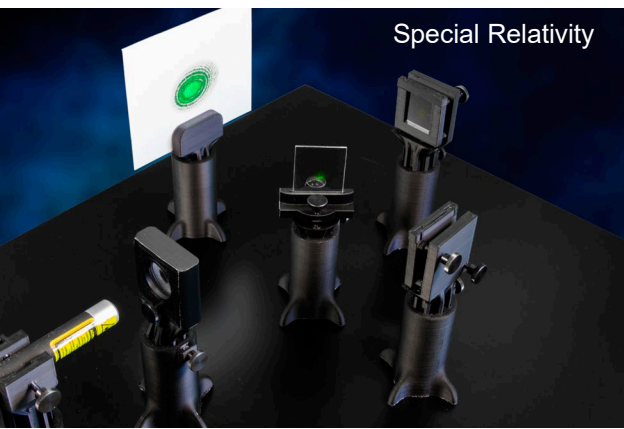
Discerning Particles & Characteristic Energy Spectra



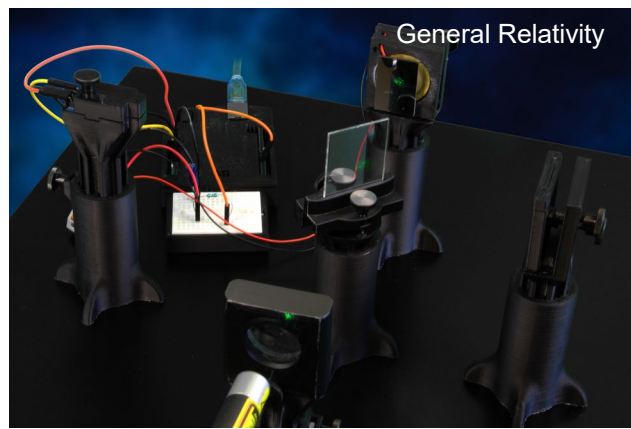
Open Educational Resources:

- DIY Particle Detector: cern.ch/DIY-detector
software, hardware, PDF handouts, wiki, forum on GitHub; parts/kits via Kitspace.org
- **Smartphone and Tablet-Based Sensing of Environmental Radioactivity:**
Mobile Low-Cost Measurements for Monitoring, Citizen Science, and Educational Purposes
Keller, O., Benoit, M., Müller, A., & Schmeling, S. (2019),
Sensors (19) 4264. <https://doi.org/10.3390/s19194264>
- **iPadPix - A novel educational tool to visualise radioactivity measured by a pixel detector**
Keller, O., Schmeling, S., Müller, A., & Benoit, M. (2016), Journal of Instrumentation (11)
C11032. <https://doi.org/10.1088/1748-0221/11/11/C11032>
- 2 articles on **alpha spectra** and **cosmic radiation** in preparation

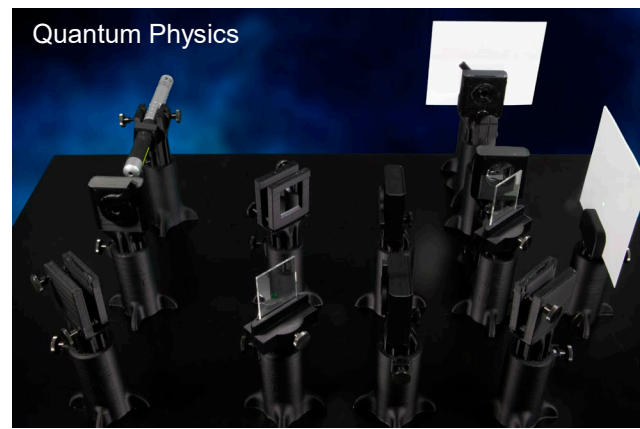




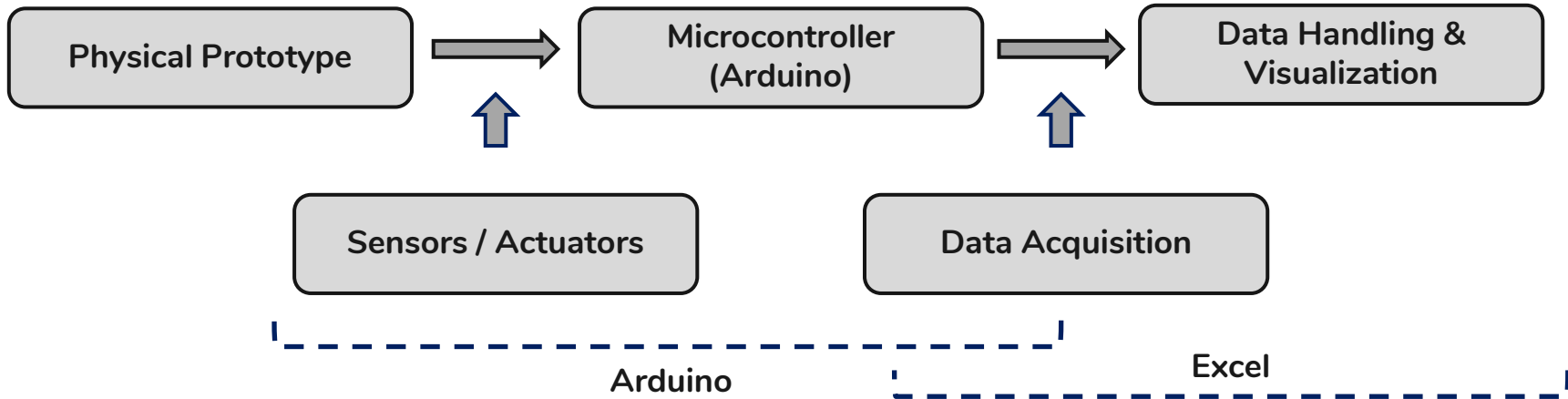
Special Relativity



General Relativity



Quantum Physics





Measuring data with Excel from an Arduino

cern.ch/laserlab3D



International Relations
Relations internationales

12/8/2020

Fabian Bernstein
Oliver Keller



Classroom Activities

Below you will find some ideas how to introduce particle physics in your classroom in a hands-on way. If you visit us in S'Cool LAB, you can have a look at all the listed equipment and take a printed copy of our tour guide "[A hands-on tour through particle physics on a small budget](#)".



Informal Learning



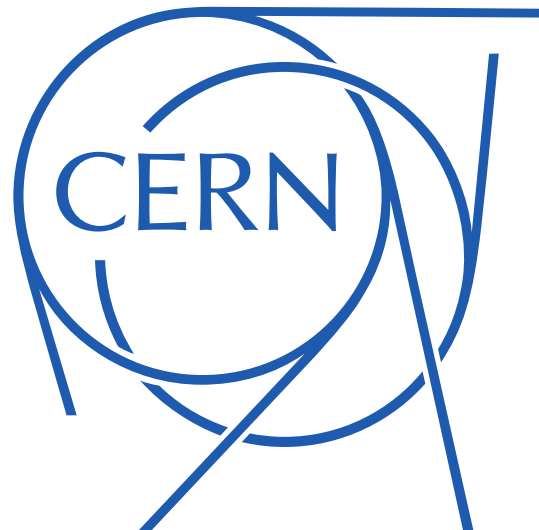
FabLabs & Maker spaces

Out-of-school learning



Formal Learning





fabian.bernstein@cern.ch
o.keller@cern.ch